HIGHWAY SAFETY, DESIGN AND OPERATIONS

FREEWAY SIGNING AND RELATED GEOMETRICS

(90-39)

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HEARINGS

BEFORE THE

SPECIAL SUBCOMMITTEE ON THE FEDERAL-AID HIGHWAY PROGRAM

OF THE

COMMITTEE ON PUBLIC WORKS HOUSE OF REPRESENTATIVES

NINETIETH CONGRESS

SECOND SESSION

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HIGHWAY SAFETY, DESIGN AND OPERATIONS
Freeway Signing and Related Geometrics

TUESDAY, MAY 7, 1968

HOUSE OF REPRESENTATIVES,
SPECIAL SUBCOMMITTEE ON THE
FEDERAL-AID HIGHWAY PROGRAM OF THE
COMMITTEE ON PUBLIC WORKS,
Washington, D.C.

The subcommittee met, pursuant to notice, at 10:15 a.m., in room 2167, Rayburn Building, Hon. John A. Blatnik (chairman of the subcommittee) presiding.

Present: Messrs. Blatnik (subcommittee chairman), Fallon (committee chairman), Clark, Clausen, Cramer, Duncan, Harsha, Kluczynski, McCarthy, McEwen, Wright, and Zion.

Staff present: Walter R. May, chief counsel; Robert L. May, minority counsel; John P. Constandy, assistant chief counsel; George M. Kopecky, chief investigator; Robert G. Lawrence, associate counsel; John P. O'Hara, associate counsel; Sherman S. Willse, professional staff member; Salvatore J. D'Amico, associate counsel; Mrs. Kathryn Keeney, chief clerk; Mrs. Mildred Rupert, staff assistant; Mrs. Shirley Knighten, staff assistant; Miss Agnes GaNun, staff assistant; and Miss Marti Downey, minority staff assistant.

Also present: Charles M. Harrell, visual information specialist, and Charles W. Prisk, Office of Policy Planning, Federal Highway Administration, Department of Transportation.

Mr. BLATNIK. The Special Subcommittee on the Federal-Aid Highway Program of the House Committee on Public Works will please come to order.

Today we resume public hearings in connection with our continuing broad inquiry into highway safety, design, and operations.

These hearings will constitute the second phase of our study, the emphasis of our earlier hearings having been on fixed objects and other roadside hazards that line the Nation's highways.

Before moving into a new area, I would like to comment briefly on the roadside-hazard phase of our work. The hearings established that in fulfilling the needs of an accelerated multibillion-dollar construction program certain poor design practices of the past were carried over to the design of our new roads. The nature and extent of the deficiencies cited are now well known and are described fully in the printed hearings.

However, the Chair would like to publicly express the pleasure and gratification of members of this subcommittee as the result of action that has been taken by responsible highway people at all levels since

the conclusion of the initial hearings last July. Their cooperation and willingness to act and the corrective measures taken have once again furnished overwhelming evidence of their sincerity of purpose to provide for American motorists the reasonably safe environment to which they are entitled—and for which they pay.

A splendid beginning has been made and the subcommittee expects these efforts to continue despite necessary shifts in the emphasis of these hearings.

Today we begin a review of signing and related matters as they pertain to the convenience and physical safety of the motorists traveling on our highways.

We believe that signing is no less important than roadside hazards. Traffic signs and markings are supposed to regulate, warn, or guide motorists. They are supposed to supply a primary source of information which the driver needs to safely adjust his actions to highway conditions. Hesitation or confusion, particularly on high-speed highways, can create chaos and contribute to traffic accidents. Yet in one recent nationwide survey more than 60 percent of the respondents complained about confusing and inadequate signs. We on the subcommittee contend that the old maxim "everyone loves a surprise" should not hold on the Nation's highways.

We also recognize that the signing and marking of highways bears a direct relationship to other design features and we intend to stress that relationship at these hearings.

It is anticipated that these hearings will demonstrate again there is much that needs correction, and with the cooperation and aid of the responsible people we hope to see the customary fine response that has proved so encouraging on past occasions.

Mr. Cramer, the gentleman from Florida.

Mr. CRAMER. Mr. Chairman, I am glad these hearings are getting underway today. The hearings which we held last summer regarding the hazards of fixed objects close to highways produced invaluable information, and have led to an increased concentration on highway safety by the State highway departments and the Bureau of Public Roads. I believe the information we receive in the next few days of these hearings will prove to be equally valuable.

All of us have had personal experiences, or know of experiences of others, involving confusing, misleading, or inadequate signing. For example, where a guide sign shows both a compass direction and a destination, such as the name of a city or State, the compass direction is generally placed on a line above the destination name.

Thus, a motorist on the Indian Head Highway, approaching I–495, the Capital Beltway, is confronted with a sign showing an I–495 route shield, an arrow pointing to the right, and the word: "West Virginia." He might conclude that he had taken a wrong turn somewhere.

This practice can have more serious results. For example, in Pennsylvania, the separate cities of Chester and West Chester are located several miles apart. Many motorists have complained of getting lost because of confusion over whether a sign saying "West Chester" meant the town of that name or referred to westbound traffic headed for Chester.

According to an article which appeared in the Wall Street Journal on April 20, an out-of-town motorist in Dallas screeched to a halt recently when confronted by the message "Advance Green When Flashing" at a traffic signal. He was too confounded to move. Local highway officials say the sign means a left turn is permissible when the green light is blinking, but they conceded that many residents of Big D cannot decipher the message either. They plan to replace the sign with a lighted green arrow.

Incidents like these can be amusing, particularly when they happen to others. All too often, however, they have tragic results. When a person is driving a 2-ton automobile at 65 miles per hour surrounded by other automobiles moving at a comparable speed, confusing, misleading, and inadequate signs can, and often do, result in death and destruction.

These hearings should shed considerable light on what information a driver needs, what information he does not need, and how information can be communicated to him through better signing practices. The hearings should be of great value to those persons responsible for signing our Nation's highways.

Thank you, Mr. Chairman.

Mr. BLATNIK. Mr. May.

Mr. MAY. Mr. Chairman, for years now, in connection with our efforts, we have received the cooperation and assistance of various agencies and people associated with the highway program. Consistent with such cooperation, last year, during our roadside-hazard inquiry, the Department of Transportation and the Bureau of Public Roads assigned Mr. Charles Prisk to the subcommittee to render us aid and assistance, which he did during the study and the hearings.

Mr. Prisk is with us once again and will be present throughout these hearings to help us with his testimony and advice.

Mr. Chairman, we on the staff will be testifying throughout the hearings, and I would ask at this time that we swear in Mr. Charles Prisk, Mr. John Constandy, Mr. George Kopecky, Mr. John O'Hara, and myself.

Mr. BLATNIK. Do you solemnly swear that the testimony you will give here before the committee will be the truth, the whole truth, and nothing but the truth, so help you God?

(Messrs. W. May, Prisk, Constandy, Kopecky, and O'Hara answered in the affirmative.)

Mr. BLATNIK. Please be seated.

Mr. MAY. Mr. Prisk, will you please state your background and qualifications, for the record?

Mr. PRISK. I serve presently as the highway safety specialist in the Office of Policy Planning of the Federal Highway Administration in the Department of Transportation.

My education was in civil engineering, with graduate training at the Yale Bureau of Highway Traffic in the specialized field of traffic engineering.

My career has largely been in traffic engineering, starting with 4 years of general highway engineering experience in Connecticut.

In 1935 I joined the Bureau of Public Roads working in planning, traffic, highway safety, and research, and in recent years have gradually increased my specialization in safety.

I was made responsible in 1957 for the conduct of the comprehensive highway safety study directed by the Subcommittee on Roads of the House Committee on Public Works and was the principal author of the resulting report by the Secretary of Commerce to the Congress on "The Federal Role in Highway Safety." This document was written after an exhaustive 3-year study directed to highway safety needs as they were seen at that time, at the outset of the Interstate program.

Upon completion of that assignment, I was named as a special assistant to the Director of Research in the Bureau of Public Roads, and later served as Deputy Director first in the Office of Highway Safety, which was organized in 1961 in the Bureau of Public Roads, and then as Deputy Director in the Office of Traffic Operations, also at the Bureau of Public Roads. I moved to the staff of the Federal Highway Administration and to my present position in August 1967, and, of course, continue in responsibilities related to public roads, the new National Highway Safety Bureau, and the Bureau of Motor Carrier Safety.

My affiliations, professionally, have been with a number of national organizations. Perhaps the most important for the record before this committee is the fact I have served since 1944 with the American Association of State Highway Officials Committee in the traffic field, presently as the secretary of its Special Committee on Signing and Marking of the Interstate System. I assisted in the organization and preparation of the Interstate Sign Manual in 1958.

From 1962 to 1967 I was chairman of the Highway Safety Committee of the Highway Research Board. I am a member of the advisory section for their cooperative safety research program.

I did have the honor, about 10 years ago, of serving the Institute of Traffic Engineers as its national president, and have been head of its international relations committee for the last several years.

I have been associated since 1940 with the National Joint Committee on Uniform Traffic Control Devices, first as a staff secretary and later as its vice chairman. I am a member now of the AASHO delegation to this standardization body which is responsible to 5 major national organizations for the development of standards for traffic control devices.

I think maybe this is enough, Mr. Chairman, to give you an idea of the deep interest I have in the subject you will discuss today.

Mr. MAY. Thank you, Mr. Prisk. At this time, Mr. Chairman, we would like to hear from Mr. John de Lorenzi and Mr. Brady.

Mr. de Lorenzi is the managing director of public and governmental relations, and Mr. Charles Brady is director, highway department, both for AAA here in Washington.

Mr. BLATNIK. You are both well known, and I appreciate very much your being here.

Please stand and raise your right hand.

Do you solemnly swear that the testimony you are about to give before this committee will be the truth, the whole truth, and nothing but the truth, so help you, God?

Mr. DE LORENZI. I do.

Mr. BRADY. I do.

Mr. BLATNIK. Mr. de Lorenzi, I see you have a prepared statement. Please proceed with the statement and feel at ease to make any additional comments.

You may yield at any point to your colleague, Mr. Brady.

TESTIMONY OF JOHN de LORENZI, MANAGING DIRECTOR, PUBLIC AND GOVERNMENT RELATIONS, AMERICAN AUTOMOBILE ASSOCIATION; ACCOMPANIED BY CHARLES N. BRADY, DIRECTOR, HIGHWAY DEPARTMENT, AMERICAN AUTOMOBILE ASSOCIATION, WASHINGTON, D.C.

Mr. DE LORENZI. Thank you very much. I may have to take advantage of that.

Gentlemen, I am John de Lorenzi, managing director of public and government relations of the American Automobile Association. Seated with me is Charles N. Brady, director of the highway department of AAA.

I am also accompanied today by Messrs. John W. McDonald, director of engineering and technical services of the Automobile Club of Southern California; Paul H. Fowler, traffic engineer of the Automobile Club of Southern California; and Paul C. Petrillo, assistant director of services, traffic engineering and safety department of the Automobile Club of New York.

I will speak first of the broad problems encountered by our membership and my associates will direct their comments to more specific issues encountered in their respective geographic areas—issues typical of conditions which exist in other areas of the country.

The American Automobile Association is a federation of 239 locally autonomous automobile clubs with 828 offices serving 11 million members in the United States and Canada. Our members take more than 13 million vacation trips per year.

To assist them we produce and distribute annually over 180 million tour books, State, regional, and strip maps. We make our own maps, train our own touring counselors, and carry out an extensive inspection program of approved AAA accommodations. Travel is our business and personalized service is our specialty.

That is why AAA has such a keen interest in the deliberations of the subcommittee on this subject.

Biennially the AAA conducts nationwide membership travel surveys to determine the travel habits and needs of our members. Information gleaned from such surveys aids us in our continuing efforts to upgrade service in accordance with the interests of our members. Pertinent to these hearings is what we learned about membership attitude toward current highway signing practices.

According to our latest survey, which covered travel experiences in 1966, 70 percent of the respondents considered confusing or inadequate directional signs as a major highway annoyance. In 1963 this was also most frequently mentioned, but only 62 percent considered it as their top-ranking complaint. It is evident that the problem is widespread and it apparently is getting worse.

We are happy to have been invited to participate in this constructive effort to bring about improvements and to lead off testimony on the problems of highway signing.

We have been impressed with the work that has gone into the subcommittee's previous hearings on toll road problems and just last year on problems relating to highway safety, design and operations. We are confident that the meticulous work of your very capable staff and the unflagging interest of the subcommittee chairman and its members will bring these issues into proper focus. The average motorist will benefit greatly from your work and we are happy and proud to be a contributor to your efforts.

Indequate, confusing signs on today's high-speed highways can be killers. The driver, hesitant and at a loss as to where he should turn, or suddenly changing traffic lanes or—worst of all—backing up on a freeway when he has missed his turn, creates an invitation to disaster.

When the crash occurs, the accident investigator is likely to write it off as "driver error." It was "driver error" no doubt, but inadequate signing had led the driver into error. In such case the sign, not the driver, is the real culprit.

We believe that a solution to this problem lies in adequate and readily understandable communications—communication at the point and at the time when the driver needs such help.

Requirements for information vary as between drivers and destinations. Such needs are met by maps, official signs, pavement markings, radio traffic reports, and other means.

If the needs were uniform, the communication problem would be relatively simple. Unfortunately, this is not the case and herein lies the problem.

At almost any time of the day or night the roads and streets of this Nation simultaneously serve the needs of drivers who can be classed as "local," "local strangers," or "tourists." Each class of driver has different informational needs. To complicate the matter further, the same driver may qualify for all three categories during the same trip.

The "local" driver is one who is driving in his own neighborhood or his own city. More often than not he has no need for directional signs. Many times he does not even need street names. He moves from landmark to landmark. He knows where he is going and how to get there. If asked to give directions to someone else, he frequently refers to number of blocks, or number of traffic lights, or some easily discernible sign of progress.

The "local" driver usually neither knows nor cares to know the official route number, if indeed the street has such an official designation. His needs are simple and so long as progress does not drastically change his environment too rapidly he can usually find his way from where he is to where he wants to be with little or no difficulty. When construction blocks his familiar paths, a few detour signs, strategically placed to provide guidance along his route, is all he needs.

The "local stranger" is the driver who, although operating in his home metropolitan area, may not be as familiar with street pattern and routes as the "local" driver. He is out of his neighborhood. He finds his way by street and expressway names and may or may not use principal route numbers as supplementary guides. Trailblazer signs to major routes, or major traffic generators such as universities, sports

arenas, or shopping malls, are helpful. Identification of major topographical features such as rivers, or lakes, signs showing remaining mileage to major route intersections also provide helpful and necessary orientation if this driver is to move efficiently in the traffic stream.

The "tourist" is the driver who is operating in completely unfamiliar surroundings. He relies heavily on maps for orientation as well as direction. His signing needs generally require intersecting route numbers, names of major freeways, cardinal directions, some indication of distance and identification of upcoming exits, and route numbers which can be reached by such exits. At the termination of his journey he would also need all the information and signing aids required by the "local stranger."

As might be expected, the varying informational needs of the three typical driver types is only one element of the problem. It is complicated by:

1. Changes in route numbers made at the peak of the travel season. Travel materials must be printed and distributed in the fall and winter so they will be available to fill member or customer requests in the late spring and summer. Highway departments generally make such route number changes in the spring and summer, making even newly printed maps obsolete.

2. Other inconsistencies between signing at the roadside and that shown on the map resulting from the use of outdated maps or establishment of temporary routes.

3. Signs placed too close to the point of decision require abrupt lane changes. Worse yet, no sign at the the point of decision creates uncertainty and doubt resulting in unusual or unpredictable maneuvers.

4. Signs which cause confusion, either by their legend or by their location.

An example here in the Washington area: At the intersection of I–70S and I–270 in nearby Montgomery County, Md., the southbound traveler is first warned that southbound traffic should keep to the right lane. The next sign indicates that eastbound traffic should keep in the left lane. The final sign before reaching the decision point informs the traveler following I–70S south to Washington that he should be in the left lane. This is an extremely dangerous interchange and fatal accidents have occurred there.

5. Signs which are inconsistent in the manner in which the information is presented.

Example: At the intersection of I–495 and I–270, the northbound traveler is advised to keep left to reach Rockville and Frederick. Here the name of the nearest city is mentioned first. On the same overhead sign the traveler is advised to keep to the right to reach Baltimore and Bethesda. In this instance, the farthest city is mentioned first. Such inconsistencies are confusing to the motorist. He could, if presented with a uniform pattern, adapt to it safely and use it efficiently.

Incidentally, the committee staff has some slides which will visualize some of the things I have been talking about, and I believe they are going to show them at the end of this testimony, with some additional comment.

Interchange design. The existence of many different types of interchanges creates additional problems for the average motorist. Probably

the two most frequently used are the cloverleaf and the diamond, with modifications of each. In such situations, the motorist is uncertain as to which exit ramp to use to make a left turn.

If it is a cloverleaf, he must exit beyond the overpass. If a diamond, his exit must be made before reaching the overpass. He is completely reliant on sign messages in advance of the interchange, and at the present time there is no provision for advance pictorial presentation of ramp design.

That was true when this was written, but at the present time on I–95 and I–495 in Virginia there is, I understand, an experimental sign, pictorial sign, of the nature we were referring to here. I have not seen it, myself, yet.

The AAA Cartographic Department has been considering alternate methods of illustrating possible interchange movements. Up to now we have not been able to come up with one that seems entirely adequate. Our small-scale maps currently show the actual geometrics of the interchange ramps. Larger scale maps show interchanges as dots or split dots if only a partial interchange. More study is being given to this problem in an effort to develop a better method of informing the member of the types of turning movements possible at each interchange.

The local street system. While confusion and uncertainty on expressways and freeways is both dangerous and exasperating, it can be just as dangerous and just as frustrating on lower volume roads and city streets. Unfortunately, the present practice seems to result in street identification signs that are too small to read from a moving vehicle in advance of reaching the decision point. They always seem to be placed on the far side of the intersection, often as not tucked behind a traffic signal head or regulatory sign. Few are illuminated, and if reflectorized are often placed above the level at which headlights provide an effective light source.

Happily, California is pioneering in providing at least a partial answer to this problem by installing advance signs giving the name of intersecting streets. Such signs also indicate whether or not the streets are restricted to one-way operations. Mr. McDonald will be providing additional information on this development.

Motorists' services on freeways. Problems encountered by motorists on our new freeways and expressways have created dangerous situations for our members and, indeed, all freeway users. A vehicle stopped on the shoulder while the driver attempts to orient himself by map reference, or waits for emergency road service, is a potential collision hazard to all users.

When the Capital Beltway opened, the District of Columbia Division of the American Automobile Association recognized that the lack of communications and the infrequent police patrols posed substantial problems for the stranded motorist. It, therefore, followed the lead of other AAA clubs in Philadelphia; Los Angeles; Hamilton and Toronto, Ontario; Vancouver, British Columbia; Pittsburgh, and Providence, and initiated its own belt way patrol.

The road patrol initially consisted of two vehicles equipped to handle most service problems with the exception of towing. During the first year the vehicles covered 145,000 miles and provided free service to almost 6,000 persons. "Tire trouble" accounted for 1,006 assists, with

"out of gas" ranking second, with 600 assists. Surprisingly, 1,500 assists were for "information"—people who had stopped to read a map or ask questions. Subsequently, Maryland authorities installed an experimental pushbutton emergency communications network on the Maryland section of the beltway and the AAA patrol was withdrawn.

Experience with the experimental system in Maryland indicates that this has not been an unqualified success. Difficulties with the power sources, interference with transmitter signals, lack of direct voice communication are among the deficiencies discovered. Whether the system can be modified to overcome these deficiences or whether some alternate system should be considered has yet to be decided.

In the meantime, we are still patrolling the Virginia section of the beltway.

As I noted earlier, AAA members take an estimated 13 million vacation trips a year. Many of these trips involve travels in unfamiliar areas. Consequently, AAA clubs provide touring information, routings, maps, triptiks and tour books to millions of people each year.

Despite elaborate preplanning, the most up-to-date maps and latest information on highway conditions, 70 percent of our members report difficulty with finding their way from where they are to where they want to go. One can only imagine the problems of those who do not have such services available.

Recognizing the need for constructive action on a national scale so as to bring about improvement in these conditions, the American Automobile Association and the Institute of Traffic Engineers joined forces in 1967 in cosponsorship of a nationwide series of urban arterial workshops.

The objective of these workshops is to inform traffic engineering, public works, and enforcement officials of new developments in the measurement and analysis of urban arterial traffic problems. The workshops provide for an exchange of information on successful techniques for improving safe and efficient use of our highway systems.

We have indeed been fortunate to secure the cooperation of other national and Federal agencies having direct interest and responsibilities in the improvement of our street networks. Cooperating with the AAA and ITE in this endeavor are:

American Association of State Highway Officials.
American Public Works Association.
American Transit Association.
Highway Research Board.
International Association of Chiefs of Police.
International City Managers Association.
National Association of Counties.
National Highway Safety Bureau.
National League of Cities.
U.S. Bureau of Public Roads.

The first of 13 planned workshops was held November 12–15, 1967, in Hershey, Pa. Workshops have already been held in Houston, San Diego, and Oakland, with additional sessions scheduled in Seattle and Minneapolis later this month. Denver and Charlotte will be the sites of the last two workshops in 1968. Tentative arrangements have been completed for 1969 workshops in Atlanta; Kansas City, Mo.; Fort Wayne; Albany, N.Y., and Ottawa, Canada.

In our view, the workshops held to date have been eminently successful in that they have provided an opportunity to get the story to the grassroots operating personnel as well as the public officials who have responsibility for making decisions relating to street utilization.

As we noted earlier, communication is a major problem and we hope that our efforts and those of the ITE, along with the cooperating organizations and agencies, will bring about a better interchange of ideas between officials, a clearer identification of the problems and resolutions of them, and an expedited program of implementing solutions.

Here to tell you about the experiences of the Automobile Club of New York is Paul C. Petrillo. Thank you very much, Mr. Chairman.

Mr. BLATNIK. Thank you, Mr. de Lorenzi. Can we withhold Mr. Petrillo's testimony for a few minutes? I believe you referred earlier to giving illustrations of problem areas. We have slides to give us a visual sample of the type of problems involved. Mr. May.

Mr. MAY. Mr. Chairman, on page 6 of Mr. de Lorenzi's statement, he mentions two locations. The first one is the intersection of I–70S and I–270. The traveler heading southbound presents a problem. We do have some slides.

Mr. O'HARA. Mr. Chairman, permit me to acquaint the committee with the location we will be talking about. This is the interchange of Interstate 270 and Interstate 70S southbound, as you approach Washington [indicating].

We will be talking about the southbound lanes of I–70S approaching in this direction [indicating]. This is the gore area of 270 and 70S [indicating].



Mr. MAY. Mr. O'Hara, would you continue?

Mr. O'HARA. Yes. After you pass Montrose Road, traveling in the direction of Washington, D.C., this is the first sign advising you that there is a major interchange ahead. This is a shield advising "270, Virginia Jct", which stands for junction, "1 Mile."



On the next sign you see, you notice how they have changed the route from 270 to 495. They now say "495 East Only, Left Lane." The motorist at this point is driving 60 miles an hour. Next slide, please.



Now they have combined both 270 and 495 on the same sign, but have added something new. They have now put "495 South Only." You will recall before they had "East." They also have put back in "Virginia," and added, "Right Lane." We have had three consecutive signs, each with a different message.



Following that, you come up with a new route number. This is the route number you have been on, "70S." And now they have added "70S South, Washington, Left Lane." You will recall on one of the earlier signs it said, "495 East Only, Left Lane." So now we have four signs, none of which are the same.

Mr. BLATNIK. Where does the 70S take you?



Mr. O'HARA. Highway 70S is a connector from Interstate 70, which is a national interstate route that generally runs east and west; "70N" is the destination used for the routing from Frederick, Md., to Baltimore. And for this leg, which comes from Frederick to Washington, D.C., they have designated it as "70S."

Mr. BLATNIK. If I turned left, where would I come out?

Mr. O'HARA. As you come into the gore area, you will note the markings on the road. This is a two-lane facility at this point with about a 10-foot shoulder. If you were to go to the left, that is 70S, and it leads to the intersection of Wisconsin Avenue and Interstate 495, the Capital Beltway, which has received the name "Spaghetti Bowl Interchange" for the reason there are a number of major roads intersecting in that area.

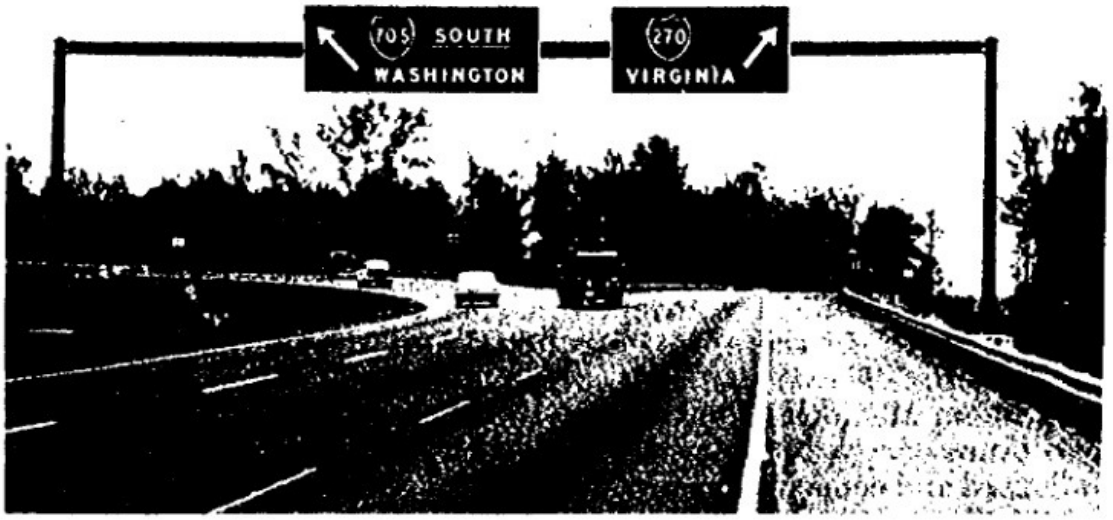
If you were to go straight ahead you would be on a very short connecting spur, approximately a mile and a half in length, known as Interstate 270. It connects I–70S with I–495. This is the road to take if you wish to go in a southerly direction toward Virginia, across the Cabin John Bridge.

We are approaching in here a two-lane facility, linear marking showing the left lane going up in here. You now have two lanes up in this area, as you will see on the next slide.

This is the last sign you will see immediately prior to the gore area, which is behind this truck [indicating]. Here are two lanes heading on 70S in a southerly direction. You can go to Washington this way or this way [indicating]. You can go to Virginia this way on I–270 and you can also go to Virginia this way on I–70S if you want to take the long way around through Prince Georges County and Montgomery County in Maryland.

This sign is the last sign you see, and it reads "70S South, Washington; 270, Virginia."

One thing to note here is the shield. On both of these overhead signs it is in green and white, whereas the Interstate standard is the red, white, and blue, as shown on this particular sign [indicating].



Also, we have changed the messages; we have not mentioned 495 on this last sign at all.

Mr. BLATNIK. Am I correct that if I turn left on 70S, the arrow pointing to the left, I would actually end up in the northern part of Washington, would I not?

Mr. O'HARA. Yes, sir.

Mr. BLATNIK. Extreme northern part of Washington?

Mr. O'HARA. Yes, sir. This would bring you into Wisconsin Avenue.

Mr. BLATNIK. Do I get on the Capital Beltway, too?

Mr. O'HARA. Yes. You get on the Capital Beltway by going this way or by going this way [indicating].

Mr. BLATNIK. If I go to the left, is there some interchange there where you cannot turn left to get off the beltway and you have got to go on beyond?

Mr. O'HARA. That is right.

Mr. BLATNIK. And somehow get around, reversing your direction 180° and coming back?

Mr. O'HARA. That is correct.

Mr. BLATNIK. The only way to get off would be to take you toward Baltimore?

Mr. MAY. It sounds like you were lost.

Mr. BLATNIK. I was lost. The easiest way to get to Washington is not by turning to the left, if I recall—I want to check and have the record corrected if I am wrong—I am just recalling by memory, not having seen a map recently. The easiest way to get into downtown Washington is to go to Virginia, turn to the right——

Mr. O'HARA. Yes, sir.

Mr. BLATNIK. And then you are going south. You are not going south if you turn to the left, you are going to the east?

Mr. O'HARA. Yes.

Mr. BLATNIK. Way up north of Bethesda, as I recall. You have to fight your way down Wisconsin Avenue or Connecticut, through all that traffic, and it takes you about 30 or 40 minutes to get to downtown Washington. You can do that in half the time by following 270 to the right and go down toward Virginia, and there are several interchanges, are there not, such as River Road; am I right?

Mr. O'HARA. Yes, sir.

Mr. BLATNIK. You can take the George Washington Memorial Parkway, as the local commuters who know the area do. You go all the way down to Virginia, across the Potomac River, and turn down the George Washington Memorial Parkway, then come back across either Key Bridge or the 14th Street Bridge, and that will get you downtown a lot faster.

Mr. MAY. Mr. O'Hara, where do you live? How do you come to the office?

Mr. O'HARA. I live in Rockville. Generally, when I come to the office in the morning, I will take this spur on 270. However, there is another way to get there, which is not signed at this time. This is at River Road. There is an exit which takes you down the George Washington Memorial Parkway on the Maryland side, past the Glen Echo Amusement Park, where you then swing up on MacArthur Boulevard and come in that way.

However, yesterday morning I was at this location at approximately 9:15 or 9:30 taking photographs. I was behind a vehicle with two ladies from Florida, who apparently were on vacation. They pulled into the gore, and I started snapping pictures, because I felt it would be interesting to watch them.

They then took 270. They went to River Road, and again the sign says, "Washington"; and again they pulled into the gore area for the collector-distributor road at River Road. They pulled out of the gore area and drove into the next gore area, which is the road leading to the Glen Echo area, known as Cabin John Parkway, but which is not signed.

They then continued south on 495 to the George Washington Memorial Parkway exit on the Virginia side of the Cabin John Bridge, where again for the fourth time they pulled into the gore area and took out a map and started reading it. At that time I left them. This is confusing here [indicating].

Mr. MAY. Mr. Prisk, do you have any reaction to these slides?

Mr. PRISK. Mr. May, it strikes me that some improvement ought to be considered. Certainly there is a failure to follow a very basic principle here, a matter of selecting major destination and maintaining continuity in signing.

Mr. MAY. Is that a misuse, the white-on-green shield, this particular sign 70S and 270?

Mr. PRISK. This particular installation surprises me on this particular detail. I do not know why those shields are green. I would regard that as improper use of the green shield; yes, sir.

Mr. MAY. What is the green shield supposed to mean?

Mr. PRISK. The green shield is used to take motorists through a business area, a business route, which is off the Interstate System. It should not be used on the Interstate System, except for a parallel route off the system.

Mr. MAY. Mr. O'Hara, have you made a study of the accident history of this particular location?

Mr. O'HARA. Yes, Mr. May, I have. At this location my study encompassed the area from just prior to this overhead sign to the gore area, and on 70S to the structure over 270 northbound, which is the spur coming up from I–495, to connect with I–70S northbound.

I want to point out that there is a very steep embankment back in here to the left. There is no guard rail and there is a steep embankment which goes down to the northbound lane of I–270. There is a guard rail around the curve on the right, and then there is an opening in the guard rail from behind this car to behind this truck in here [indicating]. My study will also encompass, just slightly beyond the gore area on I–270, approximately 200 to 250 feet.

Mr. MAY. That is a very small area.

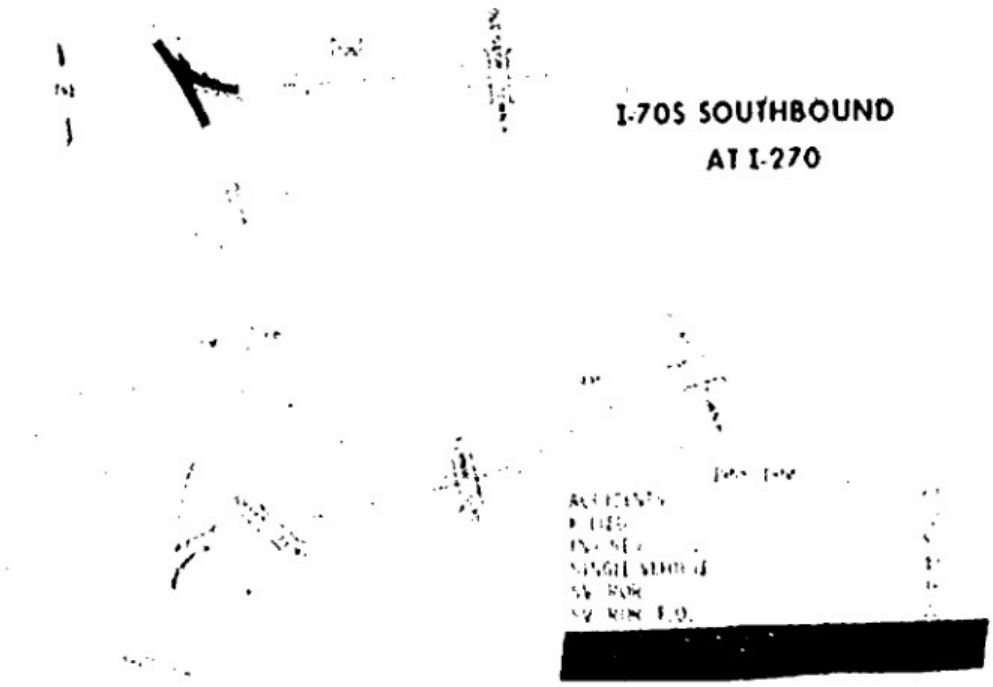
Mr. O'HARA. Yes.

Now, this is the area we are talking about. We have it marked——

Mr. BLATNIK. We are now looking north.

Mr. O'HARA. We are looking north. We are going to talk about the southbound lanes. My study encompassed the years 1965 through the first couple months of 1968. And this covers only the southbound lane.

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In that area which we have discussed, we had 62 accidents in this period. There were two fatalities. Each of those were killed in a separate accident.

In the 62 accidents, 52 people were injured.

Mr. MAY. Excuse me. Mr. Prisk, is that a high ratio of injury to accidents?

Mr. PRISK. Yes. I would say this is quite a high ratio of injuries to accidents. I presume that these are injured people, not injury accidents; is that correct?

Mr. O'HARA. These are injured people.

Mr. MAY. They are?

Mr. O'HARA. Yes, sir. Of the 62 accidents, 42 were single vehicle accidents, where only one vehicle was involved; and of the 42, 38 ran off of the road.

As for the running off of the road accidents, if you will recall the other slide, there is the guard rail, there is the bridge, there is the embankment, and there is the opening between the two guard rails. Of the four single vehicles which did not run off the road, some people have asked me about them. The reason for that is that this is a very tight curve and that gore area is a moment of decision. If you have not made a decision in time, and you have to make it at the last minute, the vehicles will overturn on this curve and they stay on the roadway. We had one vehicle which caught fire and completely burned.

Of the single vehicles which ran off the road, 22 of the 38 which ran off the road subsequently struck one of the fixed objects which we looked at in the last slide.

Mr. MAY. Mr. Chairman, you will recall in the roadside hazard hearing, it was suggested that four times as many people run off the road in the gore area as any place else in the road. Mr. O'Hara, you analyzed the accident reports in these particular accidents, did you not?

Mr. O'HARA. Yes, I did.

Mr. MAY. All 62?

Mr. O'HARA. Yes, sir; all 62 accidents.

Mr. MAY. In the accident reports, was there any indication of admission on the part of some of the people that they were disturbed by the signing?

Mr. O'HARA. Yes. It was quite surprising to me to read some of the statements contained in the description of what happened in the accident. For instance, in one accident that I recall, the driver admitted that she was slowing to read the last sign, because she was not sure which road she wanted to take, and she had slowed to approximately 10 or 15 miles an hour. This is on a 60-mile-an-hour facility.

In another one, the driver was in the extreme left lane, which is the fast lane. He followed the white markings on the road, keeping him in the left lane, when he suddenly realized that he wanted to be on 270 going southbound. And he told the officer he decided he could make it across that area. He did not. This is just an example.

Mr. MAY. How many people admitted that they were confused by the sign?

Mr. O'HARA. Of the 62 accidents which I reviewed, approximately 16 contained comments from the drivers regarding the signing, and also the fact that they had to make the decision when it was too late.

Mr. MAY. You recognize the possibility that others might have been confused by the signing also?

Mr. O'HARA. Yes. From the diagrams and information available, there is an indication it would be much higher.

Mr. MAY. Mr. Chairman, if there is no other question on this location, we will move on to I–495 in connection with I–270.



Mr. O'HARA. This is an aerial view of the interchange of I–270 and I–495. We are now going to be talking about the northbound approach from I–495, and this is 270 going up to connect with 70S. This is 495 going in an easterly direction. This is the eastbound lane, and this the westbound lane [indicating].

Mr. MAY. Mr. O'Hara, let me interrupt just a moment.

Mr. Prisk, going back to the previous location, coming south on 70S, connecting with I–495 going south, we have just about a mile and a half or 2 miles of I–270. Could we not have signed that location as I–495? Why should we mention 270 to the motorist?

Mr. PRISK. This short section of 270, in my judgment, could have been eliminated.

Mr. MAY. In other words, it would have been called 495?

Mr. PRISK. This is an approach to 495 and could have been signed as such at that interchange at the top of the drawing.

Mr. MAY. So it would read, 495 southbound?

Mr. PRISK. Correct.

Mr. MAY. And it could have been signed, 70S northbound?

Mr. PRISK. It could.

Mr. MAY. I recognize that the engineers in their planning, in their work, and in their project papers, can call it I–270; but when we sign for the motorist, we could make it simpler and call it 495 southbound.

Mr. PRISK. Mr. May, I have not thought this all the way through. I am not too sure but what 70S itself could not have been terminated at this northern junction of 70S and 270 and pick up 495 on both routes, as far as the southbound traffic is concerned.

Mr. MAY. Fine. We will move on to this other location, Mr. O'Hara.

Mr. O'HARA. The next slide will be in this interchange leading north. This is a northerly direction this way. This is I–495 swinging over toward Bethesda and Wisconsin Avenue; I–270 swinging north toward Rockville, Frederick, and I–70S. This is the southbound lane, and westbound lane of 495 [indicating]. We will be talking about this area, generally through here [indicating].

Mr. MAY. Well, we have a film, Mr. Chairman, that shows the traffic flowing along 495 headed north toward that gore area of 270. It shows what does happen at that gore area.

[Film shown—no sound.]

Mr. MAY. Mr. Chairman, throughout these hearings we will be showing film and slides, and I want it understood that at no time did we go out to a location and wait for an hour or 2 and simply select the best of what we took. Invariably, going out to that location or any one of these locations, just for a few minutes, we found these are typical maneuvers. Could we have the slide?

[Slide shown.]

Mr. MAY. These are slides of the area and the signs. Would you take over, Mr. O'Hara?



Mr. O'HARA. Again we are northbound on 495. We have just passed River Road, which is exit 16 off the Capital Beltway. This is the first sign advising you that the junction which they are indicating on here is 1 mile ahead. This is a 60-mile-an-hour facility, and we have in this area four traffic lanes.



This sign is the next sign after the one we just looked at, it is approximately 1,700 feet from the gore area. You will notice we have, "Rockville and Frederick, Baltimore and Bethesda," with the designation, "495 and 270 to 70S."

We are approaching Bradley Boulevard, and here you can see

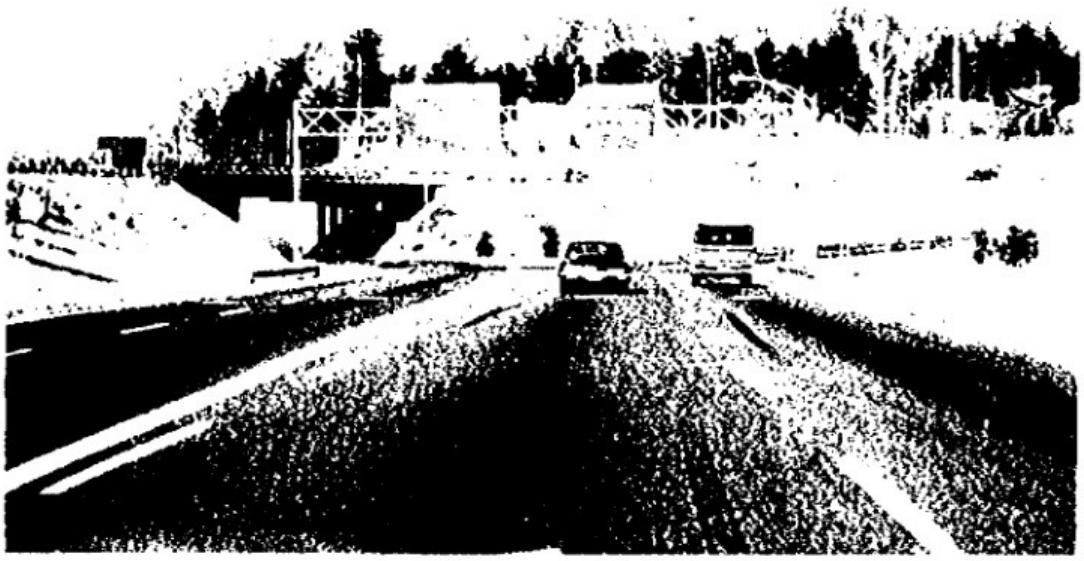
the next bridge sign, which says "Rockville, Frederick, 270 and 70S," and "Baltimore and Bethesda."

We are getting a little closer to the gore area. A little later, when I talk about the accidents in here, we are going to talk generally about the area extending north on I–270 northbound, for approximately 1,000 feet. I will also talk about 495 eastbound for a distance of about 500 feet.

Mr. MAY. Excuse me, Mr. O'Hara. Is that a new sign, a 50-mile-an-hour sign?

Mr. O'HARA. Yes. This was put up since our hearings last June. I do not know the exact date when it went up. There were also some other changes in here, Mr. May, if you want to point them out. At the time last year this solid line was not here. The State of Maryland has now marked this. It is a very wide line, delineating the 270 area from the 495 area. It was a dotted line; so you had your choice of standing here or going this way or going here. They are attempting to channel the traffic in this area to get over into these two lanes to go eastbound on 495. As I say, this sign is a new 50-mile-an-hour sign.

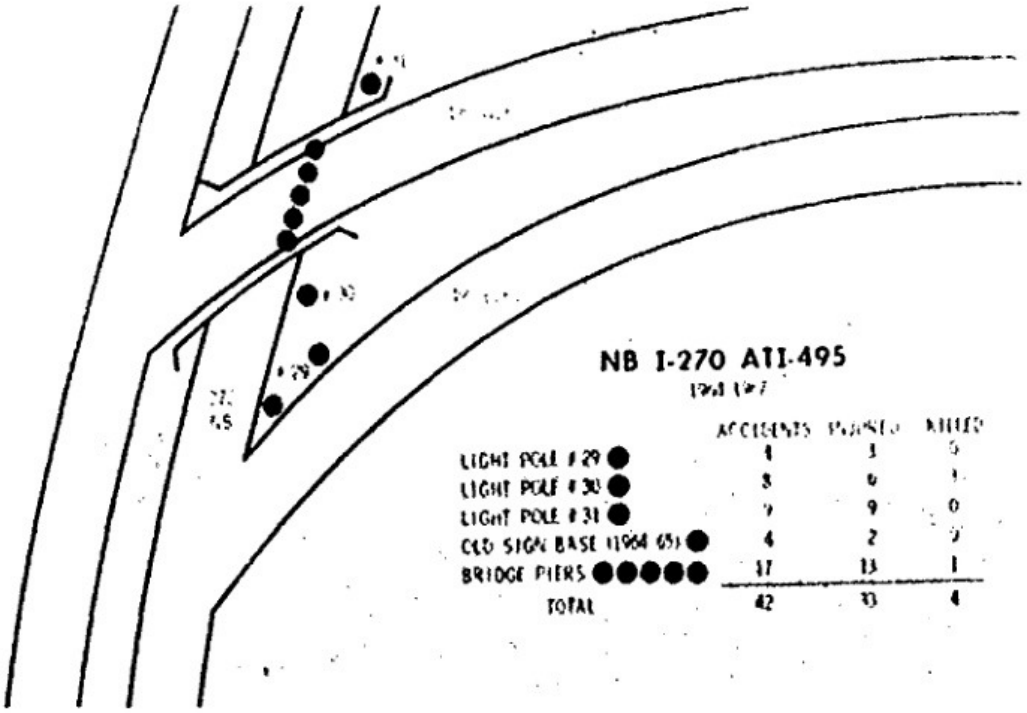




We will talk about this light pole here, No. 29, this light pole here, No. 30, and these bridge piers, and another light pole, No. 31, just beyond the bridge piers.

This is the accident study which was made of this particular area. This study covered 4 years, from 1964 through 1967. Now, this pole No. 29 is just slightly off its proper location. It should be in here [indicating]. This first red dot is the location of the old sign base for the bridge sign, which had been across 495 and 270 in 1964 and 1965. There was a sign here, subsequently taken down and moved forward to its present location. This is light pole No. 30, bridge piers, and another light pole No. 31 beyond the westbound bridge of 495.





Mr. MAY. Does that mean, light pole No. 29, four accidents; and after each accident, a light pole was installed in the same fashion that previously existed?

Mr. O'HARA. That is correct. All of these light poles have been struck the number of times indicated. In a number of accidents the poles were knocked down. In each instance, the light pole was replaced exactly as it was before, that is, imbedded in about three and a half feet of concrete with a steel base.

The light poles were not installed until late 1965, so that when we talk about 1964 through 1967 as regards the light poles, we are really talking about a 2-year-and-a-few-months' period. Light pole 29, which is here, was hit four times, three injuries and nobody killed.

This light pole here, No. 30, and you will recall when we showed the movie, that this road curves slightly.

As you turn (refer to previous picture) this is the light pole we are talking about.

Mr. BLATNIK. Can you identify it by number?

Mr. O'HARA. This is No. 30. No. 29 is here.

Mr. MAY. No. 31 is beyond the structure?

Mr. O'HARA. Yes. And 32 and 33 are beyond that.

Light pole No. 30 has been struck eight times with six injuries and three people killed. With regard to the three people killed at this pole, in one of the accidents there were two fatalities. The vehicle struck the light pole and then struck the bridge piers. We cannot say they were killed as a result of hitting the light pole. But they did hit the light pole first and it caused considerable damage to the vehicle.

Of interest with regard to light pole No. 30 was the fact that from July through October, this same light pole was struck five times. In each instance where the pole was knocked down, and the records show this happened three times, the pole was put up exactly as you saw it in the last slide. Could I have that last slide, please? (Refer to previous picture.)

This slide was taken just a matter of weeks ago. And, as you can

see, the light pole is there, just as it was when we talked about it last year. It is there today. There is no guardrail to shield the motorist who might want to take I–270 and might make the decision too late. You have the bridge piers beyond that.

This light pole was hit five times, from July through October 22; three people were killed. Two of the fatalities occurred when they struck this light pole, and then slammed into the bridge piers. In this last fatal accident, which was October 22, 1967, the driver was a woman. She, according to the police, who made a thorough investigation, had been planning to visit some relatives in a distant State. She knew the area. She had been on this road many times. She had had a good night's sleep. She had gotten up and had breakfast with her husband, and coffee, and left. At approximately 7:20 or 7:15 in the morning she did not make that curve. She hit that light pole. The light pole did not go down, but the car was totally demolished.

Mr. BRADY. May I interrupt? There is another hazard there this morning.

Mr. BLATNIK. Mr. Brady.

Mr. BRADY. They have been repairing the bridge piers that were scarred in a previous accident. This morning there was a compressor and quite a bit of concrete repair material stored in the gore, and that has been there for, I believe, about 2 days now. I would be interested to see if it is there when I go home tonight. This is another hazard that has been placed in that location.

Mr. BLATNIK. I did not hear—what happened this morning?

Mr. BRADY. This morning, as I went by that location on the way to work, this repair material was still stored in the gore, and has been there for about 2 days. There is a huge compressor, and there is some concrete paving equipment sitting there in the gore. So while it is a temporary hazard, it is still a very serious situation that exists as of this moment.

Mr. MAY. This is a coincidence, Mr. Brady, for Mr. O'Hara came in yesterday morning and told us there would possibly be an accident, that they were doing some repair at this location.

Mr. BRADY. I would agree with Mr. O'Hara on that.

Mr. MAY. Mr. Prisk, that is an area of real concern to the Bureau, the parking of equipment alongside the highway, is it not?

Mr. PRISK. Yes.

Mr. MAY. Would you point out light pole 31?

Mr. BLATNIK. Just one question before we get into No. 31. Getting back to No. 30—it is hard to tell the distance to the bridge beyond it—could that light, Mr. Prisk, be mounted off the bridge itself to eliminate the hazard of the pole——

Mr. PRISK. Yes.

Mr. BLATNIK. Mr. O'Hara.

Mr. O'HARA. Mr. Chairman, yes; I believe it can. It is less than 50 feet.

Mr. BLATNIK. That close?

Mr. O'HARA. Less than 50 feet. We do have brackets that are 40 feet long that we can utilize. The light is intended to light this area just before the structure, and I do not think they would lose anything by running it off the structure. They would have to run some cable, but that is no problem. The effect of the light would be the same.

Mr. BLATNIK. Mr. Prisk, do you have any comment on that? Is that correct?

Mr. PRISK. A great deal of work is going forward on improvement of lighting installations, and the solution that you suggest certainly is one that could be considered for this location, possibly mounting on the structure itself, which would put the luminaire almost in the same location, or certainly in a useful location. Another solution that has been experimented with successfully is high mounting of these luminaires, getting the poles much farther away from the edge of the roadside, putting them up high enough, making them brighter, so they floodlight the entire area and eliminate many of the poles that are there in a location of this sort.

Mr. MAY. Also, Mr. Prisk, during the last hearings we came to learn that it is possible to install the frangible base in some steel light poles. Would that be possible with a steel light pole on the beltway?

Mr. PRISK. Oh, yes.

Mr. MAY. Mr. O'Hara, would you point out light pole 31?

[Slide.]

Mr. O'HARA. Light pole No. 31 is the one beyond the bridge piers, and it has been struck nine times, with nine inuries and no fatalities. The old sign, which was here in the gore was hit four times in 2 years with two people injured and nobody killed. As regards these light poles, they represent only the accidents which we located in the files of the police. They have told me that these same light poles have been hit on numerous occasions with the vehicle not having been damaged enough to warrant being towed away. They have found there have been other accidents which have not been reported.

The bridge piers were struck 17 times with 13 injuries and one fatality.

It is approximately 400 feet from the gore to just beyond light pole No. 31; there were 42 accidents with 33 injuries and four people killed, in a 4-year period; remembering the light poles were not there for the full 4 years. And the old sign base was not there for the full 4 years.

Mr. MAY. Those three light poles were hit 21 times and three people have been killed since our last hearing?

Mr. O'HARA. That is correct. Three people have been killed in this location since June 8.

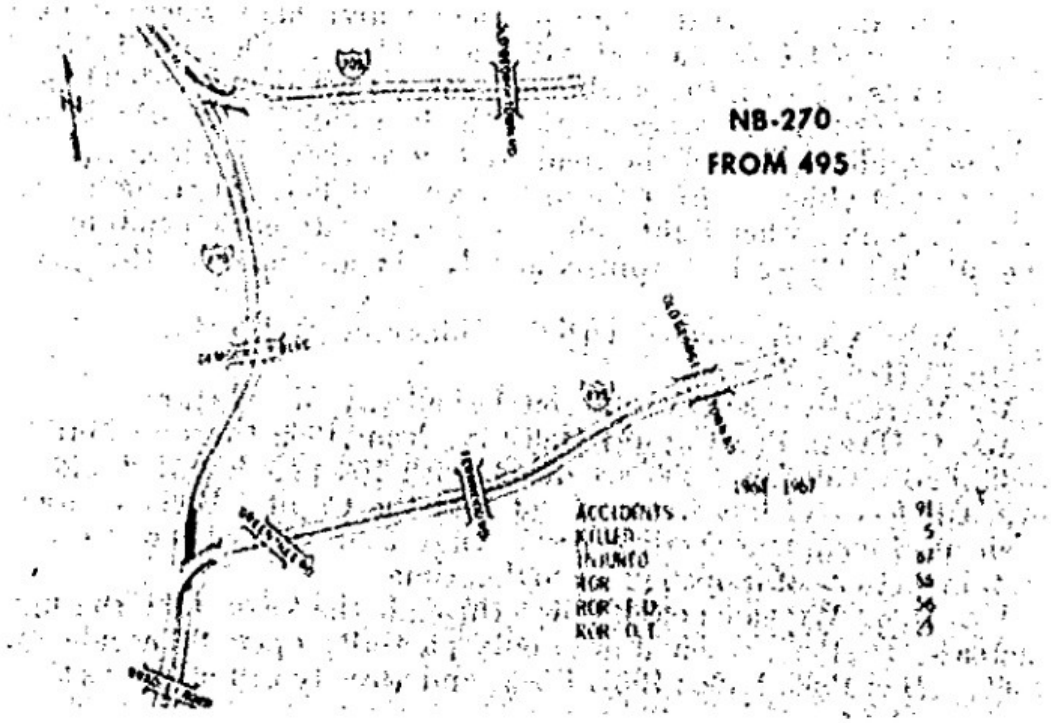
Mr. MCEWEN. I would like to ask Mr. Prisk a question. Mr. Prisk, on this bridge, when we went into the hearings before, has there been anything done in the construction on Interstates to eliminate these piers? I believe there was a committee connected with the steel industry that made a study of this, suggesting that in many cases there could be a longer steel span, eliminating the piers, and in some cases not increasing but maybe lessening the cost of construction. Has anything been done along that line?

Mr. PRISK. Quite a number of the newer undercrossings that are constructed at locations like this have been developed so that the side piers are virtually eliminated, that the span extends all the way through to the abutment wall, which is well up the slope and pretty well out of reach of any vehicle that may be out of control.

Mr. MCEWEN. Thank you.

Mr. BLATNIK. Mr. May.

[Slide.]



Mr. O'HARA. Mr. Chairman, in the accident study of this particular location, we are talking about the northbound lanes of I–270. My accident study used 1,000 feet as the area in which to select the accident reports. However, I would like to point out that only one or two accidents occurred beyond 500 feet; most of them occurred between 200 and 500 feet from that gore area.

In the 4-year period 1964 through 1967 there were 91 accidents with five people killed and 67 people injured. Of the 91 accidents, 86 ran off the road. Of the 86 which ran off the road, 56 subsequently struck a fixed object. And of the remainder, 23 overturned.

There is a median area in here beyond the structure in which some vehicles which happen to go off on this side have overturned.

Mr. MAY. Throughout the hearings we will be analyzing some of the other locations on the beltway. We use the beltway as sort of a laboratory in these hearings. It is a beltway; so it is peculiar in some respects; but most locations are just plain typical locations that you will find on most any interstate road in the country. We will discuss the specific locations as the hearings progress. But, Mr. O'Hara, you made a study of the complete beltway from an accident standpoint. Would you give us the data on that?

Mr. O'HARA. Yes; I will. Before I do that, I notice I left one thing out. Ninety of the 91 accidents referred to on I–270 northbound were single vehicle accidents.

Mr. MCEWEN. How many feet of highway would you say that was, where the 91 accidents occurred?

Mr. O'HARA. It is a thousand feet from the gore area to beyond the light pole No. 33, and 88 or 89 occurred within 500 feet of this gore area.

[Slide.]

Mr. MAY. As I–495 swings to the right here, do you have any accident data on that short stretch of road?

Mr. O'HARA. Yes; I do. This particular area here, where 495 turns to the east is a fairly sharp curve. There were, in 1966 and 1967—this is a 2-year study—in the eastbound lane, 23 accidents with 11 people injured; 20 of the 23 were single vehicle accidents; 20 of the single vehicle accidents ran off the road, and 12 of them slammed into some of the fixed objects which we are looking at here: light pole, guard rail, signs, and other light poles around the curve. So combining the two, 91 and 23, we had approximately 114 accidents in this general area.

Mr. MAY. Are we finished with the slides now, Mr. O'Hara?

Mr. O'HARA. Yes.

Mr. MAY. Give us your totals on the beltway, Mr. O'Hara.

Mr. O'HARA. The Capital Beltway, from 1962 through March 31, 1968, had a total of 5,500 accidents, with 104 people killed and 3,315 injured. I would like to point out that the Capital Beltway was not open as a complete facility until August of 1964. There were only certain sections of it open prior to that time.

Mr. MAY. We can notice down through the years how the figures increase. In 1962, when it was only partially open, 66 accidents; in 1965, 1,214; 1966, 1,462; 1967, 1,665; and already in 1968—was this the first quarter?

Mr. O'HARA. This is for the first quarter of 1968: 359 accidents. There are some accident reports probably not filed at the time records were checked.

Mr. MAY. Unless there are other questions, Mr. Chairman, for the moment we are finished with the beltway.

Mr. BLATNIK. I have no questions, Mr. May.

Mr. MAY. Mr. de Lorenzi, you mentioned in your statement the problem of maps. That has been of concern to us. So often we have gotten a map, from a gas station, for example, and then found the signs did not seem to relate to the map. Once we were looking at the map, and we wanted Route 525, and we did not see a road sign that said 525. Later we found the sign saying Possum Town Road was actually 525. We did not know that; we could not judge it from the map. Is that any severe problem to the motorist?

Mr. DE LORENZI. I–95 disappears, and many motorists think you should follow I–95 all the way down. You get off from Baltimore, off the Baltimore Parkway, and there is no I–95, and this is quite confusing to the average motorist.

Mr. MAY. I personally know people who have come down to the tunnel in Baltimore looking for I–95.

Mr. DE LORENZI. Right.

Mr. MAY. They do not find it. They stop at a few gas stations, and the gas station people do not know where it is because it has not been built yet.

Mr. DE LORENZI. Right. There are other confusions, too, although I understand this has been corrected. If you come off the Dulles access road on 495, if you get there—and if I understand this correctly, I have not seen it; I hope this is true—you used to come to a junction which says 495 south and north; but it would not tell you how to get to Washington. I understand they have finally corrected this.

There is one indication: left for Washington and right for Alexandria. This is another confusing thing for the motorist.

Mr. MAY. Does Triple A each year update its maps?

Mr. DE LORENZI. We update them constantly. And, of course, the more popular maps are put out more than once a year. It is only the very large maps that are put out once a year. The strip maps and others are updated almost every 3 months on most popular routes.

Mr. MAY. The 180 million tour books, State, regional, and strip maps; does that include——

Mr. DE LORENZI. Out of that figure, about 13 million represent tour books, the last represent strip maps, large maps, small maps, regional maps, and so on. And, of course, in addition to that, we get a constant flow of information from the various higway departments on changes, and this is sent out to all the clubs, so that they can update the old maps by pointing out detours and new routings and things of that nature.

Mr. MAY. Mr. Kopecky, do you recall how many maps the oil companies put out?

Mr. KOPECKY. 250 million maps were printed in 1967.

Mr. MAY. Is there coordination among the people who publish maps in this country?

Mr. DE LORENZI. That is a rather difficult question to answer. I cannot speak for the other industries. But some share with certain corporations—one corporation doing a map, and put an imprint of that particular company's emblem on it, and it may be a map shared by another company, too. In our case, of course, ours are ours exclusively.

Mr. MAY. I was thinking along the lines of some uniformity of symbols and scales.

Mr. DE LORENZI. There are attempts at that, yes.

Mr. MAY. We do not find enough of it as we pick up various maps.

Mr. DE LORENZI. I am afraid not.

Mr. BLATNIK. No further questions?

Mr. WRIGHT. Mr. Chairman.

Mr. BLATNIK. Mr. Wright.

Mr. WRIGHT. I would like to ask the gentleman one thing. I am interested in the comment that 70 percent of your members, or those responding to your survey, said that confusing and inadequate signs are a major annoyance, 62 percent say it was a top-ranking complaint. Are you familiar with the plan recently agreed upon in the State of Vermont, which the State plans to undertake, a sort of nationalizing or socializing of the advertising on highways? Do you know about this?

Mr. DE LORENZI. I only know vaguely about this, Mr. Wright. Perhaps Mr. Brady knows more about this than I do.

Mr. BRADY. I have heard that Vermont has outlawed most advertising signs on their Interstate System.

Mr. WRIGHT. I did not hear you.

Mr. BRADY. I understand that Vermont has rather recently outlawed advertising signs, at least on their Interstate. I am not certain whether it applies to their primary system or not.

Mr. WRIGHT. According to my information, Vermont intends to outlaw its being conducted by private enterprise, but to offer advertising to be sold to individual businesses by the State, and to permit each business desiring it to have as many as four signs on the right-of-way,

where the space will be sold by the State and the sign would appear on the right-of-way not off. I was just curious if you had any thoughts or comments as to what this kind of thing might do to the proliferation or confusion of the highway signs.

Mr. BRADY. There have been experimentations with what are called specific information signs. These specific information signs are along the rights-of-way, and for the most part include gas station identification symbols at the next interchange. There is also a type of specific information sign which is installed in rest areas, on which are identified restaurants and accommodations. Now, this is still in the experimentation stage. I do not know if Vermont has proceeded beyond that.

Mr. WRIGHT. I am familiar with what you speak of now. As a matter of fact, south of Washington, on the highway to Richmond, I have observed some of these types of signs identifying the next turnoff where certain types of gasoline, or something of that kind, might be purchased. But the Vermont situation is somewhat different from that.

As I understand it: No. 1, it is not confined to those businesses along the highway nor to directional information concerning those which are approaching necessarily, but to any business that may desire to advertise, not limited solely, if I am correctly informed, to those which provide tourist accommodations, but, rather, it comes as an idea of just more or less taking over that whole outdoor advertising business, operating them by the State. Have you heard anything about that?

Mr. BRADY. No, Mr. Wright. I have not heard any more than I just noted, that I read they were going to outlaw commercial advertising along at least the Interstate.

Mr. WRIGHT. Not outlaw. I do not think it is outlawing. I think it is more of a takeover by the State, to operate it from the standpoint of private industry. What effect do you think it would have, though, if the State were to have the privilege of allowing any business to buy an ad from the State, buying four ads from the State, for example, and these signs were painted on the right-of-way—would that not create a good bit of proliferation and confusion on the rights-of-way?

Mr. BRADY. First of all, I believe the small businessman would suffer under that. It certainly would permit the State highway department to control the outdoor advertising and the proliferation of some of the outdoor advertising along the rights-of-way.

Mr. BLATNIK. We will have to suspend. We are going into executive session on business unrelated to the subject of these hearings.

Mr. MAY. We have a statement, one matter, Mr. Chairman.

We all know how well qualified Mr. Prisk is, but for the future readers of the transcript, I would ask that this qualification be printed in the record at the point that he was introduced.

Mr. BLATNIK. Without objection, so ordered. Thank you, Mr. de Lorenzi and Mr. Brady and Mr. Prisk. The hearings for today will have to be adjourned because of other committee business, unexpected, until 10 o'clock tomorrow morning.

(Whereupon, at 11:34 a.m., the subcommittee was recessed, to reconvene at 10 a.m., Wednesday, May 8, 1968.)

HIGHWAY SAFETY, DESIGN AND OPERATIONS

Freeway Signing and Related Geometrics

WEDNESDAY, MAY 8, 1968

HOUSE OF REPRESENTATIVES,
SPECIAL SUBCOMMITTEE ON THE
FEDERAL-AID HIGHWAY PROGRAM,
OF THE COMMITTEE ON PUBLIC WORKS,
Washington, D.C.

The subcommittee met, pursuant to adjournment, at 10:15 a.m., in room 2167, Rayburn Building, the Honorable John A. Blatnik (chairman of the subcommittee) presiding.

Present: Messrs. Blatnik, Howard, Cleveland, and Zion.

Staff present: Same as previous day; and Clifton W. Enfield, Minority Counsel, Committee on Public Works.

Mr. BLATNIK. The Special Subcommittee on the Federal-Aid Highway Program resumes this morning its hearings on signing and related matters. These hearings move forward our continuing broad inquiry into highway safety, design, and operations. The testimony of yesterday's witnesses suggest that automobile accidents increase dramatically at locations where the signing is poor or inadequate. Crashes dismissed as due to "driver error" are too often due to confusing or inadequate signs that can actually lead the driver into danger. Instead of being helped, such drivers are actually "set up" in an accident-prone situation. As Mr. de Lorenzi pointed out, the confused driver making erratic maneuvers on high-speed highways creates an invitation to disaster.

Surely the state of the art must by now be such that something better may be expected. Commonsense and good judgment dictate that directional signs must be of a nature to help and guide the motorist on his way, without at the same time adding to the perils he already faces on the highways he must travel.

As we resume our hearings our first witness today will be Mr. Paul C. Petrillo, assistant director of services, traffic engineering and safety department of the Automobile Club of New York. Also present is Mr. Charles W. Prisk, of the Federal Highway Administration, who has been so helpful to us throughout these hearings. Would you please stand Mr. Petrillo, and raise your right hand? Do you solemnly swear that the testimony you will give here will be the truth, the whole truth, and nothing but the truth, so help you, God?

Mr. PETRILLO. I do.

Mr. BLATNIK. Mr. Petrillo, just for the record, give your full name again and your title or present position to the reporter.

20-841 O—68——3

TESTIMONY OF PAUL C. PETRILLO, ASSISTANT DIRECTOR OF SERVICES, TRAFFIC ENGINEERING AND SAFETY DEPARTMENT, AUTOMOBILE CLUB OF NEW YORK

Mr. PETRILLO. I am the assistant director of services for the Automobile Club of New York, in charge of the Traffic Engineering and Safety Department.

Mr. BLATNIK. Mr. May.

Mr. MAY. Would you proceed with your prepared text, Mr. Petrillo?

Mr. PETRILLO. Thank you. Two urgencies are apparent to traffic engineers involved with the safe and efficient movement of people and goods over the Nation's developing highway system. The first concerns a needed awareness that a highway is not a static installation to be laid down and forgotten, but must rather be considered in the same light as any productive facility in its requirement for active management. The second relates to the growing recognition that we can no longer speak of a highway or a highway network as if it were operating in a geographical vacuum. Today, all highways are linked together as part of a great complex; they must be administered to and managed as a total entity. In this regard, there are few aspects of highway management which have been as sadly neglected as directional signing; few opportunities for intelligent, aggressive decision offer greater potential for the improved use of the highway plant at minimal expense.

To give a little background: In earlier years, the directional sign problem in the New York metropolitan area was largely one of providing adequate advance warning and developing appropriate letter sizes and contrasting colors to simplify legibility. Fortunately, the Interstate sign standards have been helpful in resolving some of these problems.

However, a new problem has developed: one of providing an understandable, nonconfusing message to effectively and quickly communicate with the motorist while he is traveling at the relatively high speeds that newer highways are designed to accommodate. As things now stand, the motorist relying on many of today's signs could just as well end up in New York's West Side, New Castle, or a Route 95 hospital.

Our problem: As perhaps you know, the arterial highway system in the New York metropolitan area is a network of interconnected parkways, expressways, and limited access highways ringing Manhattan and providing access to Long Island, Westchester, Connecticut, and New Jersey.

Entrances and exits occur frequently, as do connections with other facilities. Thus, motorists often have to change direction and/or route frequently. This condition, together with the high density, high-speed operating characteristics of these multilaned facilities, makes it important that the directional sign system alert the motorist well in advance of an exit or junction point to allow him to change his course of travel safely and conveniently.

Signs which do not meet these requirements cause a motorist to slow, stop, or change lanes precipitously because he is confused or has missed an exit or connection. Obviously, the hesitant, erratic behavior of a motorist who is not sure where he is going, creates a major hazard on these facilities. The directional sign system on any arterial highway is an important safety feature that will, if not properly designed and developed, create many of the operating problems that modern highways were designed to avoid.

In the New York metropolitan area, it has been the practice to designate all controlled access facilities, including those which are interstate highways, by name. This practice was common long before the advent of the Interstate Highway System. It is understandable that from the point of view of the agencies responsible for developing information and publicity on highway construction, there is obviously more glamor and motorist identification attached to such names as the Franklin D. Roosevelt Drive and the Major Deegan Parkway than is attached to the designation of, say, "Route 25–A."

This practice of designating new facilities by name has continued: the Long Island Expressway is seldom called Interstate 495; the Cross Bronx Expressway is not referred to as Interstate 95; nor is the Cross Westchester Expressway known as Interstate 287. Yet, when these facilities, which have been publicized by these names, were opened, motorists found the only identification given to them were signs bearing the Interstate number. Obviously, this resulted in confusion as is evident from the many letters we have received. Shortly, we will show slides of some of the more chronic problem locations.

(Mr. Petrillo stopped reading from his prepared text at this point.)

Mr. PETRILLO. I would like to read a couple of excerpts from some letters we have.

Mr. MAY. Will you, please.

Mr. PETRILLO. These were all received in the last 3 to 6 months. Here is one we received:

On leaving the Manhattan Bridge, a large overhead green and white sign points to an interstate route—I have forgotten its number, which serves to reinforce my point—without any mention of the fact this is the Brooklyn-Queens expressway. This is not a useful sign for local motorists.

Another comment:

It is almost unbelievable that the authorities will not bend to public pressure and identify the highways by the names that people use. It makes no sense for an engineer to decide that people ought not to call it the New York State Thruway, but rather should call it 87 in part then 287; then 87 again, then 90. There may be reasons for changing the route numbers of this highway from time to time, but it is madness to expect the motorist to remember them when he is looking for the thruway.

There is another comment:

How many motorists, like myself, have come over the lower level of the George Washington Bridge from New Jersey aimed for the Major Deegan but found themselves on Bronx streets?

Still another:

I am particularly disturbed by the signs facing motorists as soon as they cross the Throgs Neck Bridge into Queens, the signs give a choice of Long Island Expressway, Grand Central Parkway, or Cross Island Parkway, Jones Beach. Where is the Clearview Expressway?

Another comment:

Coming south on the New England Thruway and looking for the Westchester Expressway going west, you were suddenly confronted with the sign which reads "Gov. Thomas E. Dewey Thruway." This is very confusing, since the ordinary motorist, and that includes myself, always associates the New York State Thruway, now called the Thomas E. Dewey Thruway, with the ending of the Major Deegan Expressway at the city line in Yonkers, N.Y. As it happened, I thought I was on the New York State Thruway going north and I wound up in the Bronx.

Mr. MAY. Mr. Petrillo, how many members are there in the New York Automobile Club?

Mr. PETRILLO. Approximately 405,000.

(At this point Mr. Petrillo continued with his prepared statement:)

Mr. PETRILLO. At the moment, I would like to tell you about a test we made in August 1964. At that time, we asked a number of AAA members visiting our offices to match the commonly accepted names of 12 highways in the metropolitan area with their Interstate route numbers. The results of the study were interesting:

Fifty-four percent of those interviewed were not able to match any highway names with Interstate numbers.

Twenty-five percent could match only one highway and number.

Fifteen percent had up to four correct matchings.

Only one person matched more than five highways and Interstate numbers correctly.

Confirmation of our findings has been furnished by the freeway operations report of the Institute of Traffic Engineers, which states, at page 27, that motorists on metropolitan area trips "do not concern themselves with route numbers and rely primarily on freeway and street names for path and orientation."

Our survey also indicated that motorists generally think in terms of major river crossings and geographical areas for orientation rather than cardinal directions.

Status of the problem: Although there appears to be general agreement by officials, including the commissioner of the New York State Department of Transportation, J. Burch McMorran, and New York City's Traffic Commissioner Henry Barnes, that directional signs should provide the name of the facility, as well as the Interstate shield, little has been done about it.

The matter was bogged down for at least 4 years by a controversy over sign letter sizes. In 1962, New York City's Construction Coordinator's Office asked permission to add the highway name in 12-inch letters alongside the Interstate number to avoid scrapping existing sign panels and sign foundations that would not accommodate a larger size letter.

Permission for using the 12-inch uppercase letters instead of the Interstate standard's, 10-inch uppercase and 12-inch lower case letters, were sought from the AASHO Committee and denied. The matter was pursued with the State, which took a similar position. Following this, the State reported they would only change the sign panels where new footings or sign trusses were not required to carry the larger signs.

After considerable publicity, which included newspaper articles and editorials by all news media about the inadequacy of the existing directional signs, last spring Governor Rockefeller announced he would make $14 million available to improve signing in the New York metropolitan area.

To date, little or nothing has been done.

As a result, the directional-sign system serving most of the Interstate highway network in the New York metropolitan area continues to speak a foreign language—and mathematical, at that—to the vast majority of motorists using the highways.

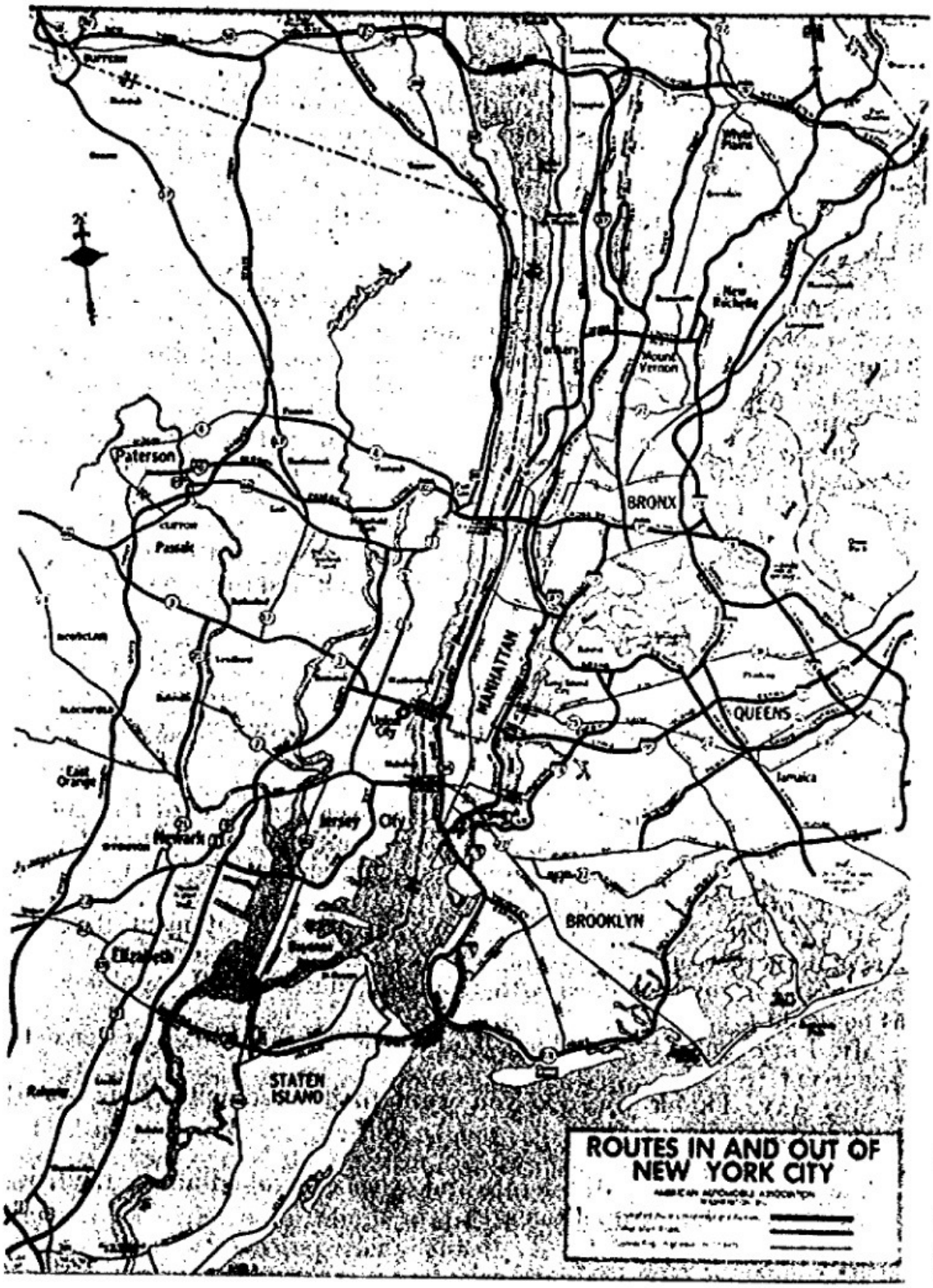
Mr. MAY. Mr. Petrillo, on page 3 of your printed statement, it reads, down at the bottom, "5 percent of those interviewed were not able to match any highway names with Interstate numbers." That should be 54 percent?

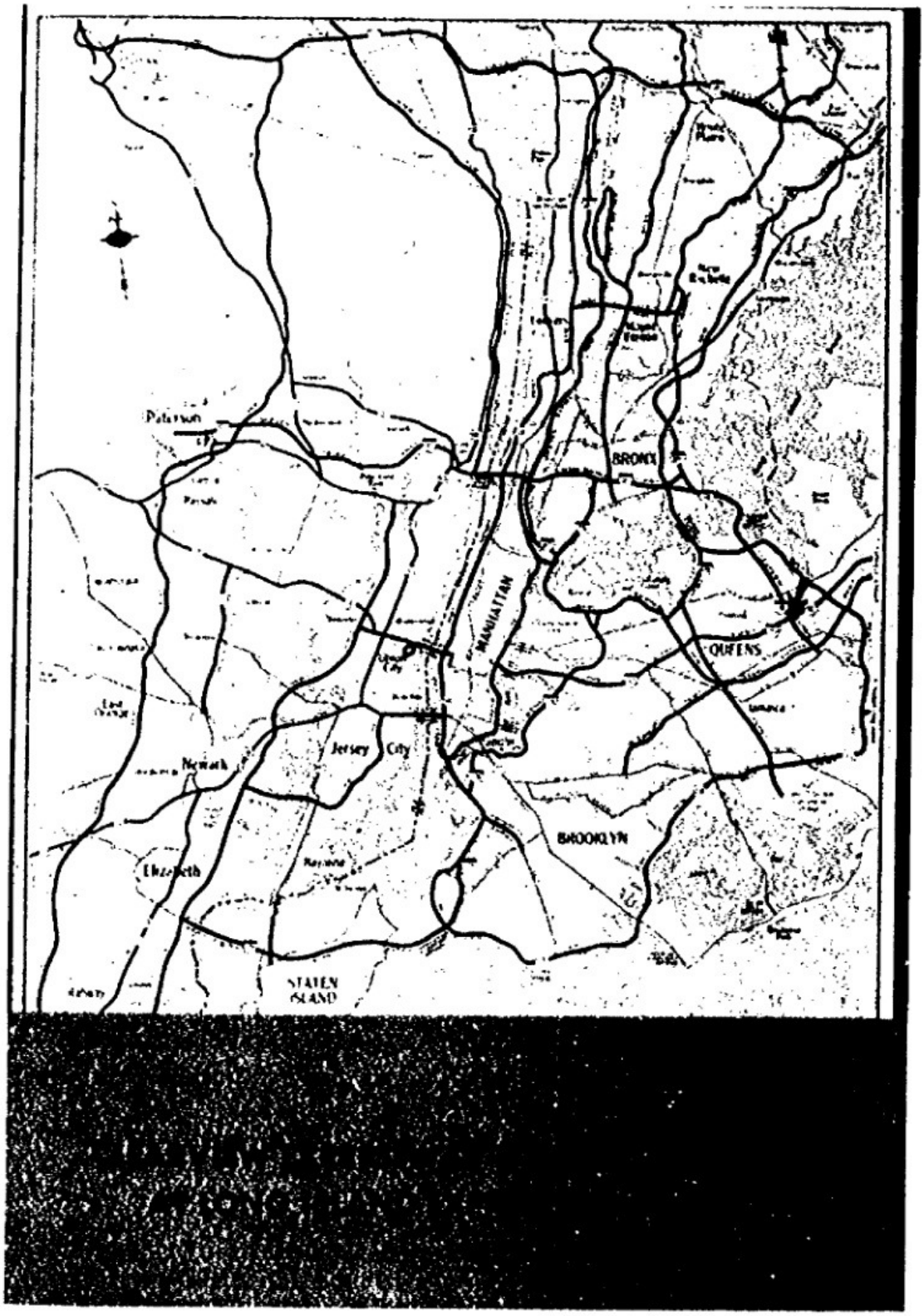
Mr. PETRILLO. Yes, sir. That is an error; it should be corrected to 54 percent.

Mr. MAY. Thank you. Do you want to proceed with your visual presentation?

Mr. PETRILLO. Fine.

This is a map of the Interstate and other controlled-access facilities in the New York metropolitan area.

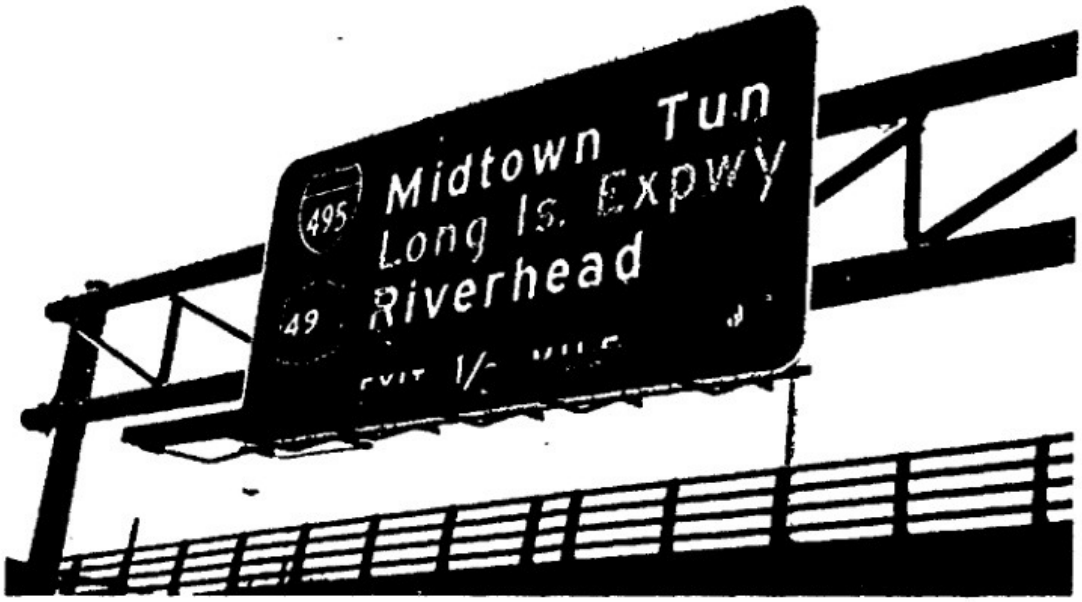

Paterson
Passaic
BRONX
MANHATTAN
QUEENS
Jersey City
Newark
Elizabeth
BROOKLYN
STATEN ISLAND
ROUTES IN AND OUT OF NEW YORK CITY


Paterson
BRONX
MANHATTAN
QUEENS
Jersey City
Newark
BROOKLYN
Elizabeth
STATEN ISLAND

This first location we are going to talk about is shown by the red arrow; it is the Clearview Expressway southbound at the Long Island Expressway. The Clearview Expressway is a facility that runs from the Throgg's Neck Bridge, which connects into the Bronx, south to its present terminus at Hillside Avenue. In that rather short stretch, the Clearview Expressway connects with the Long Island Expressway and this is the intersection that we are going to talk about.

It is an Interstate-to-Interstate facility. The volumes on the Long Island Expressway approach in the neighborhood of 120,000 to 140,000 vehicles on an average daily traffic basis, and operating speeds are in the neighborhood of 50 to 55 miles per hour most of the day.

This is the first sign a motorist sees as he approaches the interchange. Some time ago, about 1962, the department of traffic recognized the need for adding the name of the facility, Long Island Expressway. As the sign was originally installed, it did not contain the name of the facility. It just had: Midtown Tunnel and Riverhead



The department of traffic went out and, in the space available on the sign panel, added the Long Island Expressway. There is some question as to whether or not they have resolved all the problems, because the sign, as it now stands, could be considered confusing from the standpoint of whether both destinations—Midtown Tunnel and Riverhead—can be reached from the Long Island Expressway.

Mr. MAY. Does the Route 49 indicated on that sign go to Riverhead?

Mr. PETRILLO. That should read 495. The "5" fell off that sign panel about a year ago.

Mr. MAY. That is the way it exists today?

Mr. PETRILLO. Yes, that is the way it is out there today. Here is another problem in connection with this interchange and the use of Riverhead as a destination. Riverhead is a relatively small community of 8,000 to 9,000 out on Long Island about 70 miles from this interchange, quite unknown prior to the fact that it received this kind of

publicity, under directional signs, and probably most unfamiliar, or unfamiliar to most motorists who use this location.

As it stands now, the Long Island Expressway does not go to Riverhead. It ends about 25 miles from it; they have not yet constructed the other portion.



This is the second sign, and here again the Department of Traffic, in trying to resolve some of the confusion, added the name of the facility, Long Island Expressway, but this time put it at the bottom. In order to do that, they relocated that arrow that is on the right of Riverhead. And in doing that they may create some confusion as to whether or not this impending exit connects with ramps to both Midtown Tunnel and Riverhead, and whether or not this exit provides access on the expressway to both destinations.

Mr. MAY. Mr. Prisk, does that sign suggest to motorists that the Midtown Tunnel is straight ahead and Riverhead turns to the right?

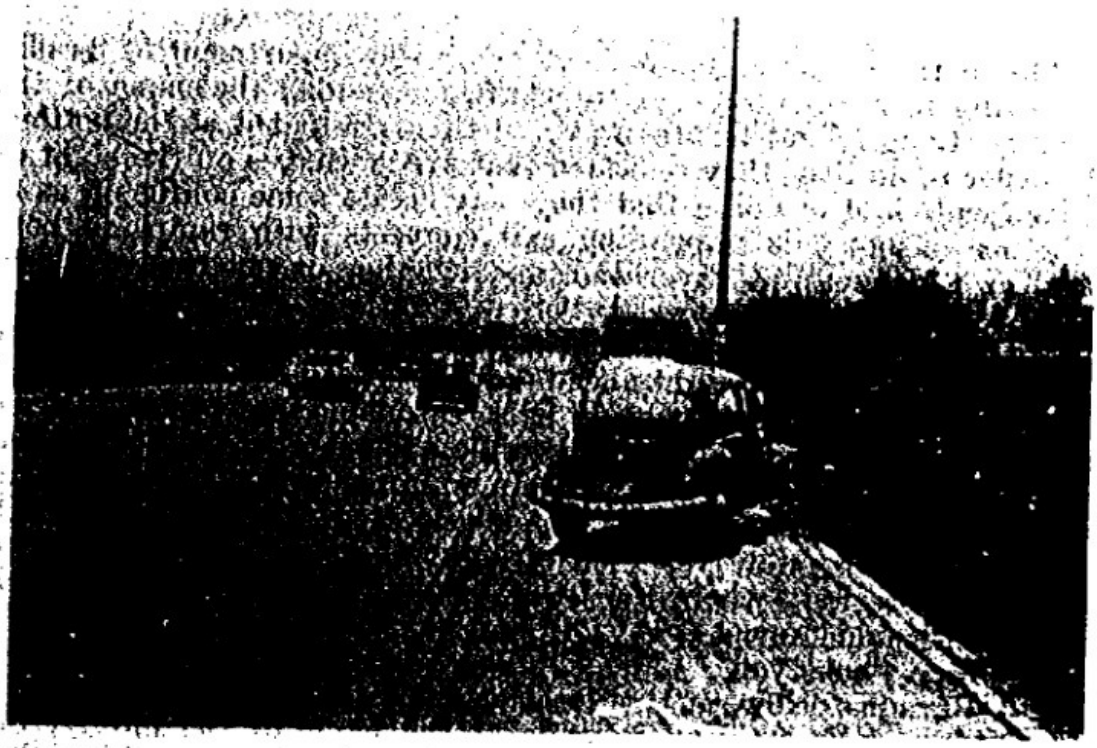
Mr. PRISK. I think that would be a reasonable interpretation from the explanation given by Mr. Petrillo. The arrow originally was underneath both messages, to indicate an impending turn to the right for both destinations. I think, as it is relocated, you might very well assume that Interstate 495 went straight ahead, Riverhead turns to the right, precisely where the Long Island Expressway is. I do not know as I would know.

Mr. MAY. Thank you.

Mr. PETRILLO. Now, at this location, it is the third sign; it is the exit sign and no mention is made of the name of the intersecting facility. This is the primary problem. And I think one thing that may come to mind as you look at this photograph, as was the case in the original one, there is some question as to whether or not a sign truss is needed with overpasses in such close proximity to the first sign and this sign. We have found that this practice of putting signs on trusses in the vicinity of an overpass had led to some cases where

a reading of the sign was actually blocked by the overpass. We will illustrate this point later. And all the value of large letter sizes are lost, obviously.

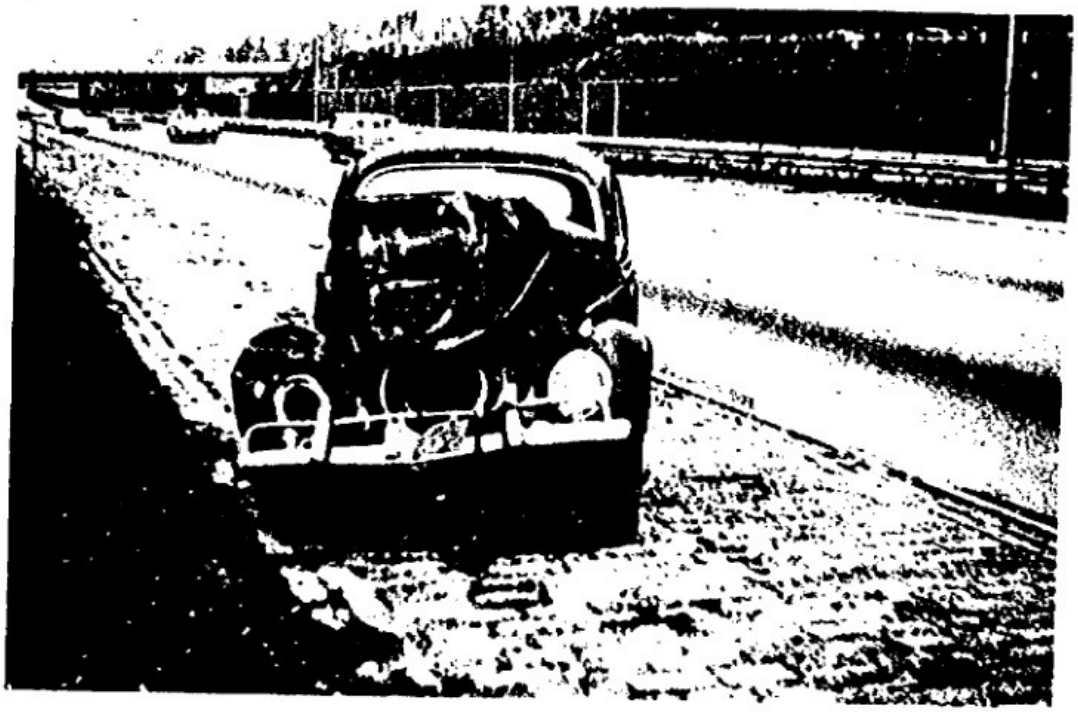




This is a photograph of an accident that occurred out there last week. We do not have the particulars on this accident. We have looked into the accidents that have occurred along southbound Clearview Expressway and the pattern seems to be that a great majority of accidents are rear-end collisions, and they are frequently occurring 75 to 100 feet in advance of the exit. Since this is a tangent, it does not seem any different from that section of the roadway that you might find further away or closer up. It could be an indication that the failure has come as a result of confusion due to the signs.

Mr. MAY. Mr. Petrillo, Mr. Kopecky will comment on this.

Mr. KOPECKY. I was with Mr. Petrillo, and on the first occasion we noticed hazardous movements going from fast lanes up to the ramp. On this occasion, you notice the two cars with their brake lights on, and that car is getting over to the right, and finally, after some maneuvering, is getting over to that ramp.

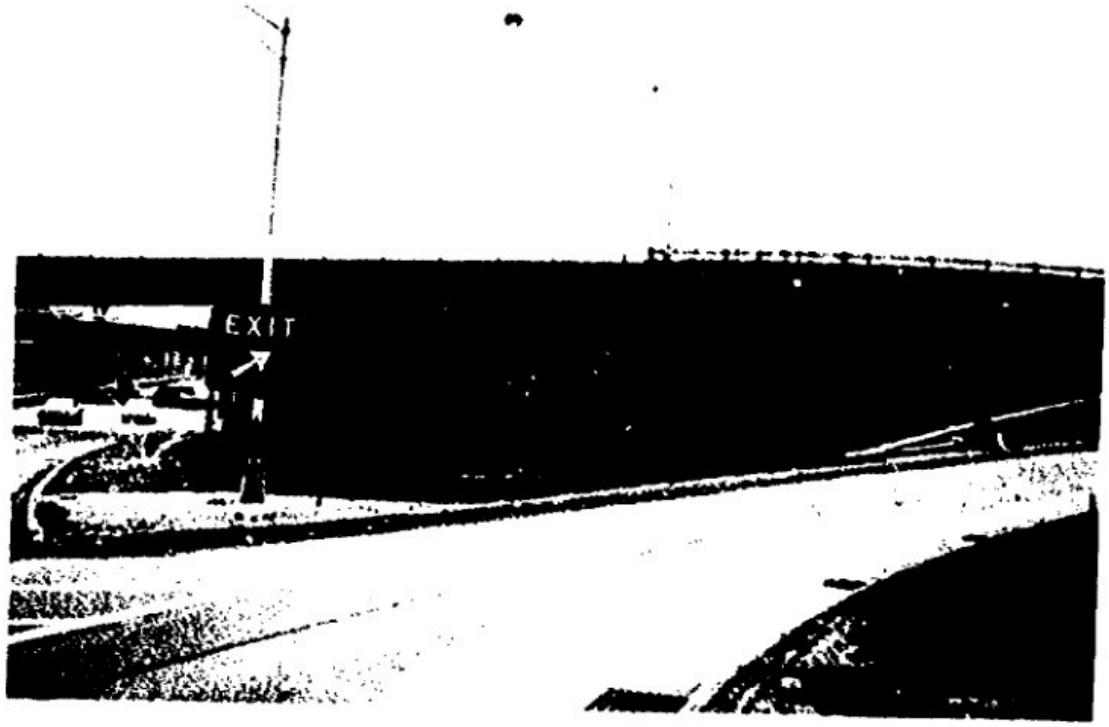


Mr. PETRILLO. This is another picture of the car. It would appear from the damage on the vehicle that it was involved in a rear-end collision.

Somebody apparently went through the windshield.



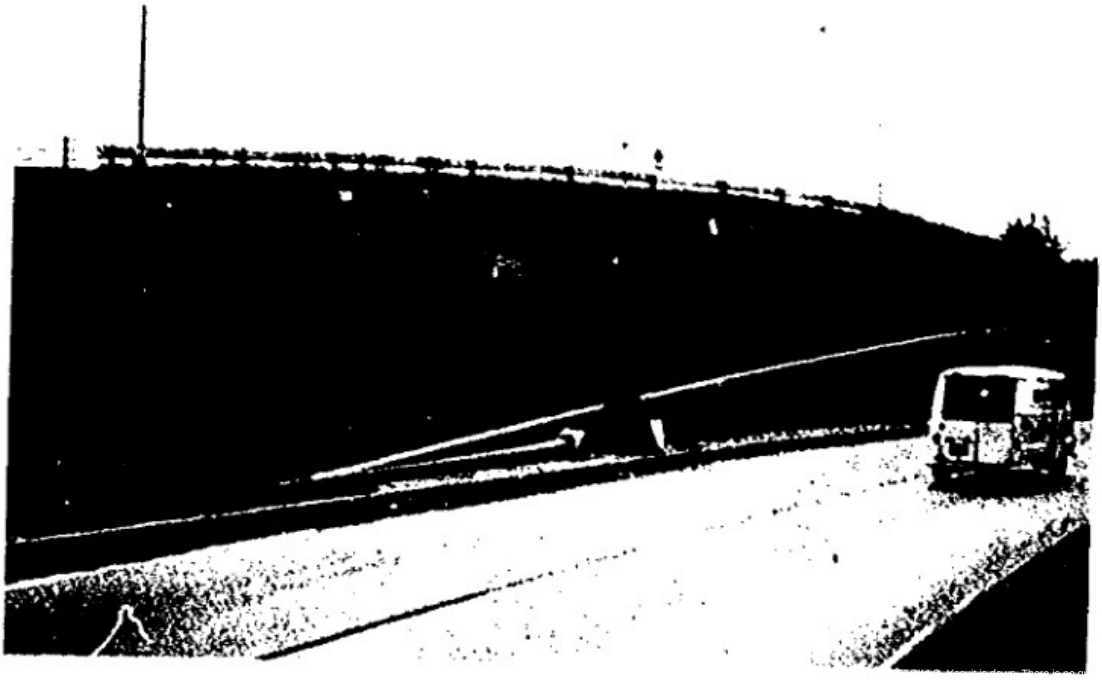
No return to the exit ramp. The sign there is attached to the pole in the gore. And, as you can see, just up to the right we have got a light pole that is down, to be replaced.



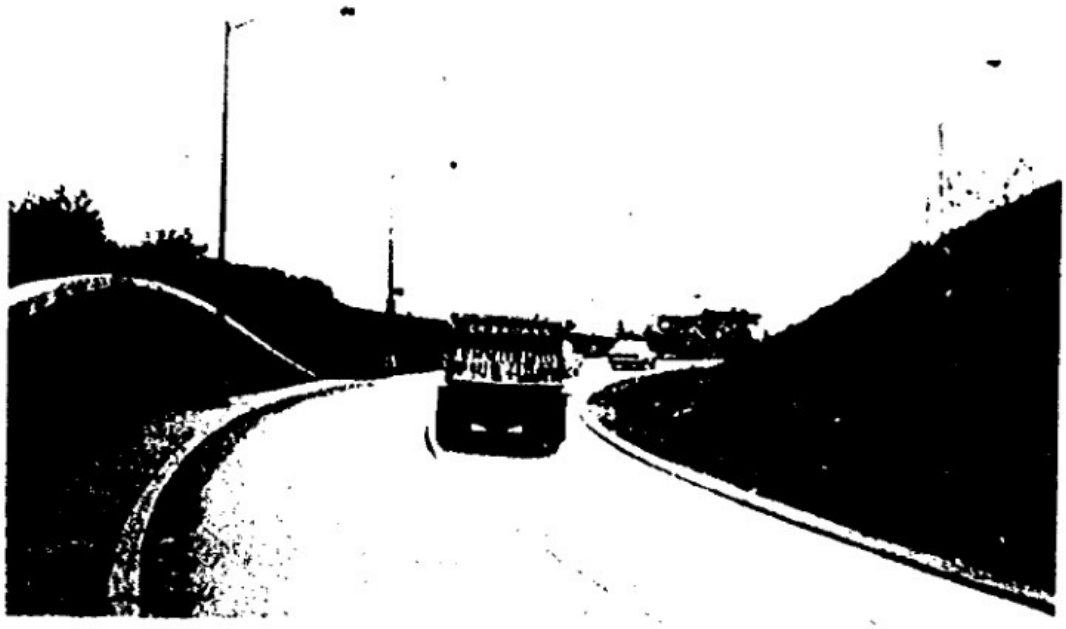
This is what the motorist sees as he goes around this curve. At this point he does not know whether he is going to hit the Long Island Expressway, or where he is going to go; but he is coming into a vertical and horizontal curve which kind of limits his opportunity for evaluating conditions ahead, and perhaps the signs.

Mr. MAY. Is that light pole down?

Mr. PETRILLO. Yes, it is down. There is no question that it is down. They have put the new base in and they have got the new pole to set on top of it there.



This is a vertical and horizontal curve; as he approaches, as he comes off that exit; and keeping in mind again this is Interstate to Interstate connection, supposedly the best design standards that we have, this is what he sees as he comes up at the top of the hill. He begins

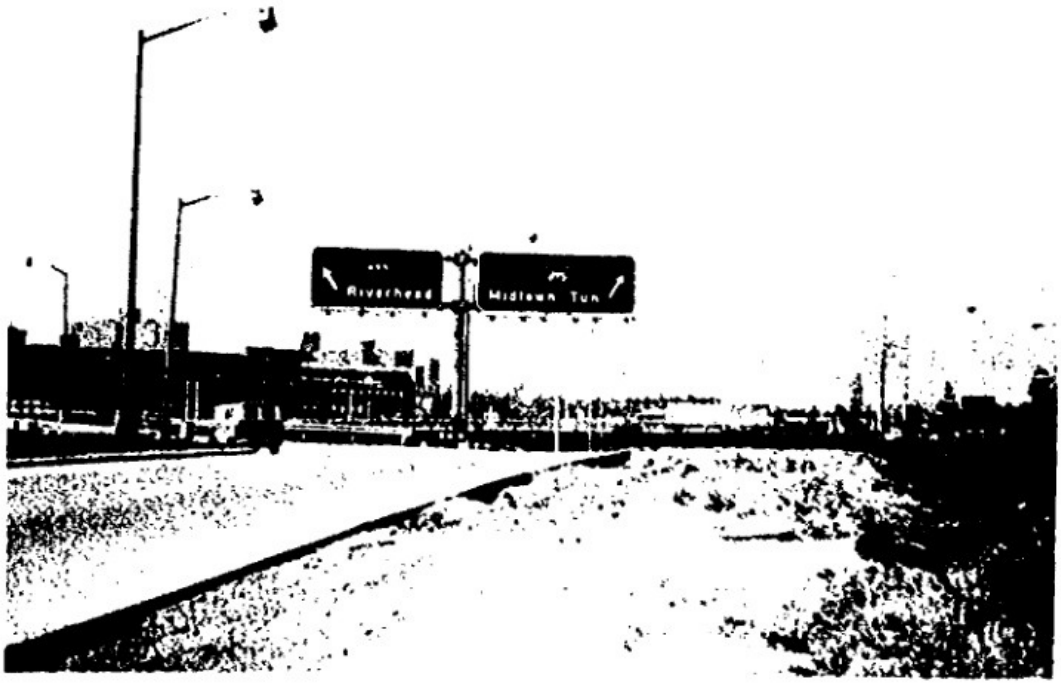


to see signs indicating connection with the ramps. Again he may be looking for Long Island Expressway.

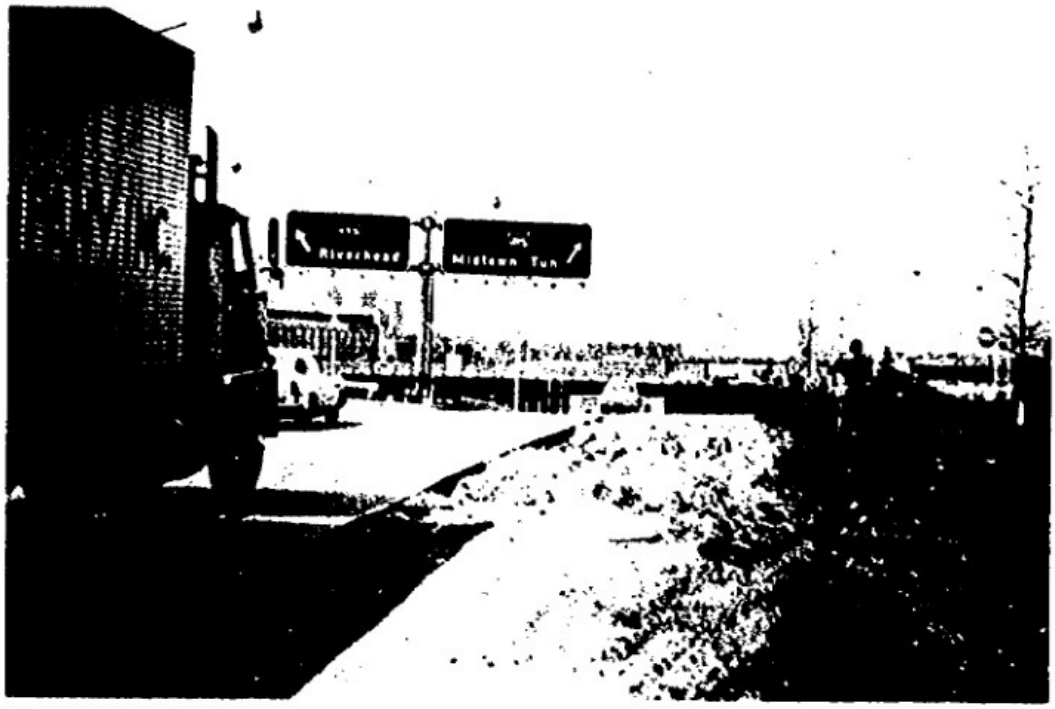
And this is what he sees: Riverhead and Midtown Tunnel. I think the grassed area on the right is evidence to the confusion that develops, where motorists pull to read maps to try to reorient themselves in connection with destinations and where they want to go. Here again the primary problem is: the name of the facility is not mentioned.



We were out at that location for a relatively brief period of time, perhaps 10 or 15 minutes, to get the shots; and this is what we saw develop during our visit.



A car went over the ramp on the right side, and suddenly decided they were on the wrong ramp and they stopped. In the meantime, we have a good-sized rig coming over the ramp.



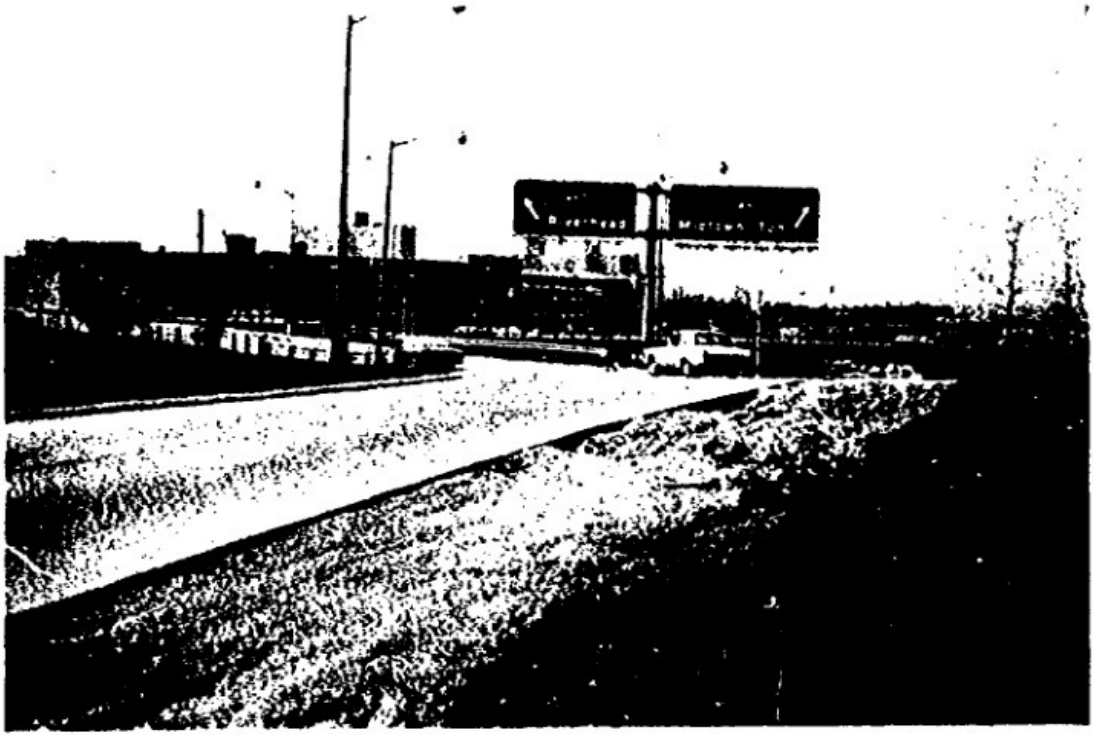


The rig has gotten by. Now they are backing up the ramp to correct their mistake, and then go on the left ramp.





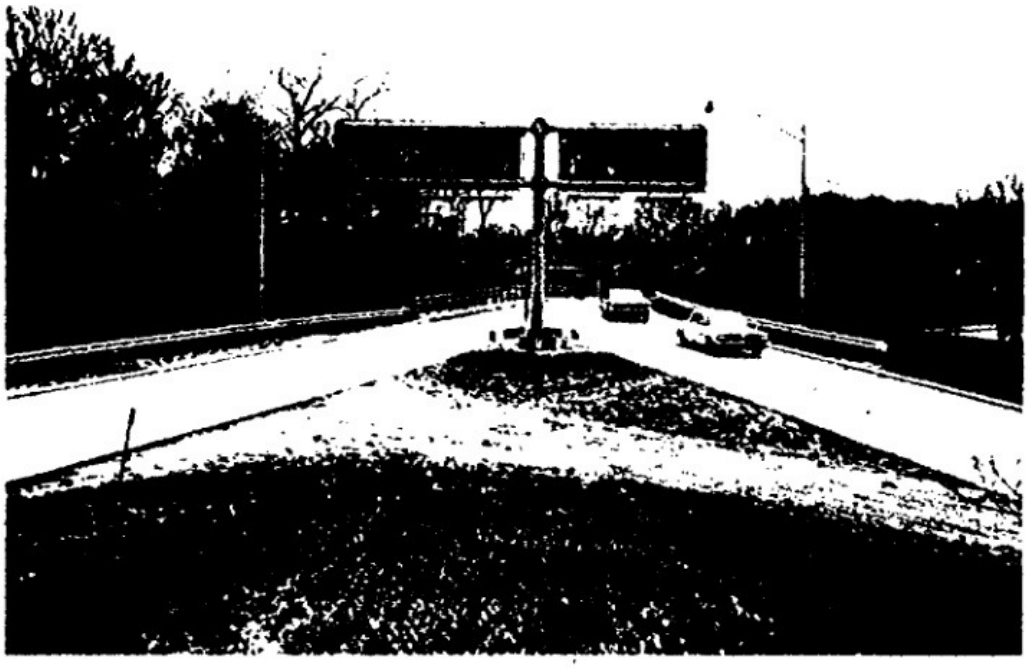
I just want to say, in connection with this location, it was the subject of a CBS-TV editorial by Harry Arough a year ago, in June of last year, which took the form of a letter by Mr. Arough to Mayor Lindsay. The essence of Mr. Arough's letter was: Where is and what became of the Long Island Expressway?





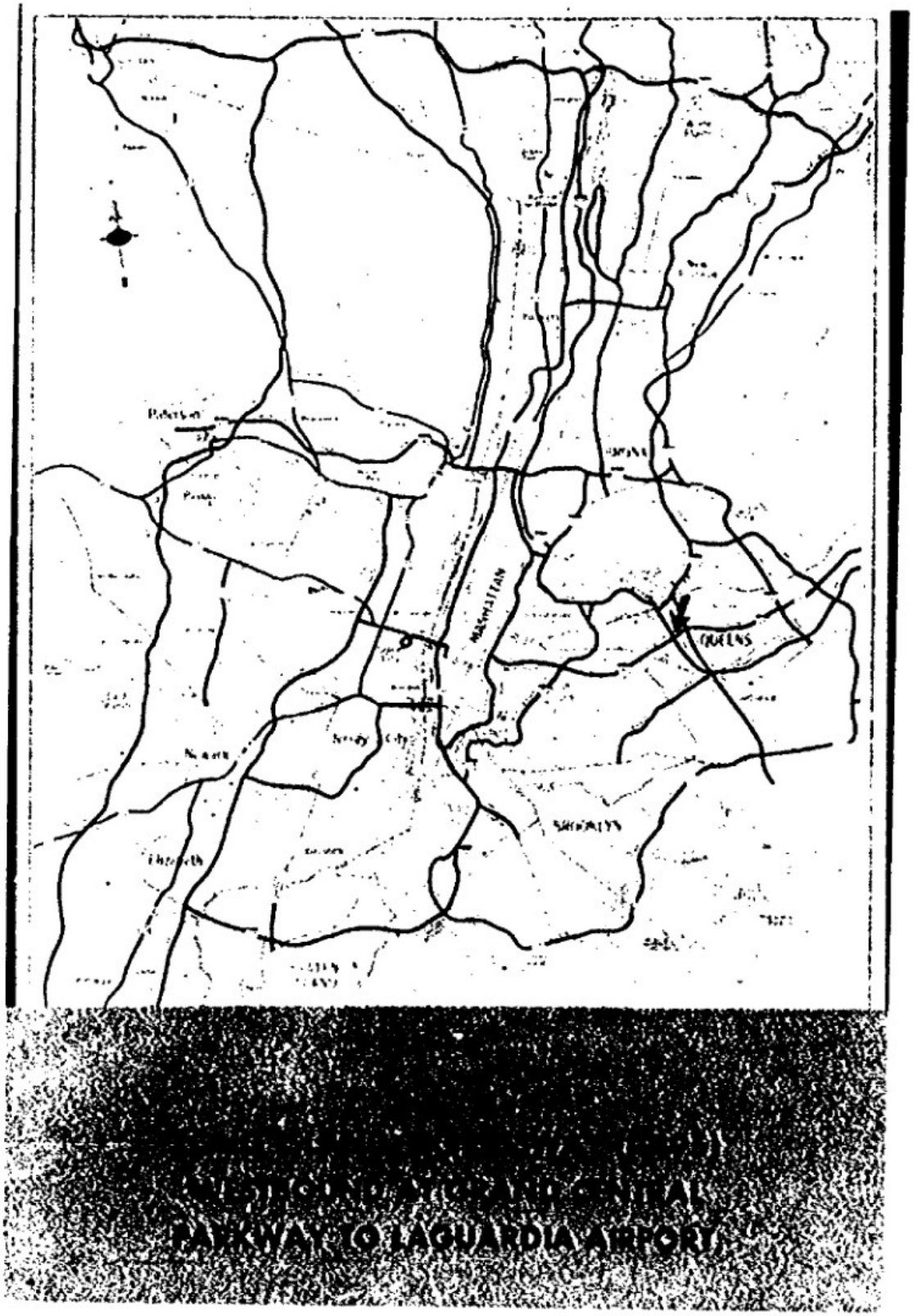


This is the sign coming the other way on Clearview Expressway to the same connection with Long Island Expressway. Now, the signing is very similar at this gore. It mentions again Riverhead and Midtown Tunnel. In no way does it mention the name of the intersecting facility. Testimony to the confusion that exists here I think is shown by the



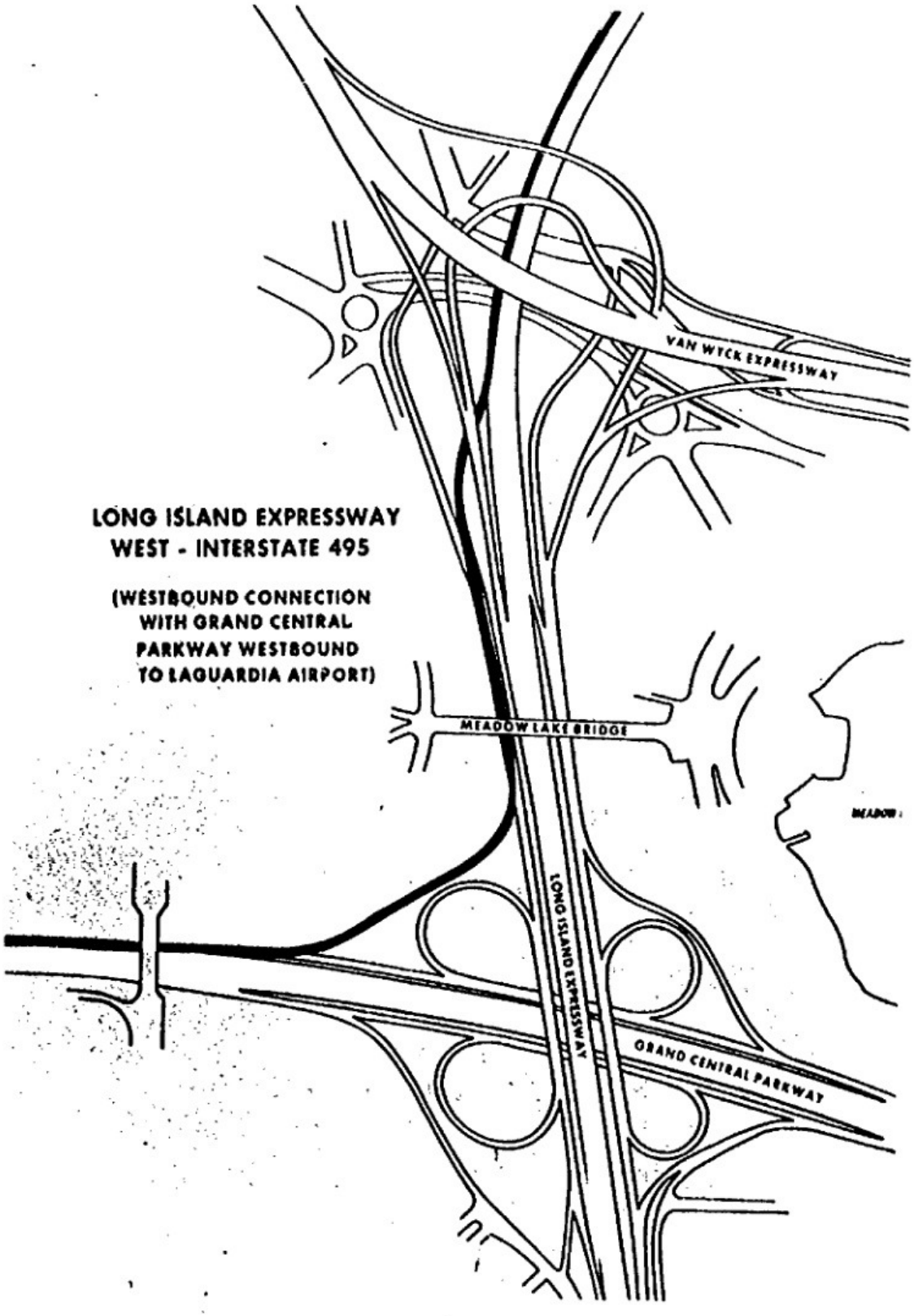
skidmarks on the pavement, and by the wheel tracks in the second slide which is a rear view.

The next location is the Long Island Expressway westbound to Grand Central Parkway. This is the connection to be made if you are destined to LaGuardia Airport. As I mentioned before, Long Island



Expressway is a primary artery coming through Long Island and into Queens, connecting with the Midtown Tunnel into Manhattan. It is an Interstate road.

The Grand Central Parkway roughly parallels the Long Island Expressway except for one point, where it goes north and south, crossing the Long Island Expressway. Both facilities carry relatively high volumes, and again operating speeds are also relatively high.



This is the connection ramp we are going to be talking about, as you come west on the Long Island Expressway, and you reach a point where you feed onto a collector-distributor road that then feeds into both directions of the Grand Central Parkway down at the cloverleaf. But you have got to get on the collector-distributor road from the Long Island Expressway in order to make your connections to the Grand Central Parkway. Now, the connection, shown in red, is coming off the Long Island Expressway on to the collector-distributor road which passes underneath that overpass. And then if you are going to LaGuardia Airport, you would take that right ramp and continue around along that red line.



Now this is the sign, keeping in mind what you want to do, this is the sign you get——

Grand Central Parkway, 108th Street. If you are looking for Grand Central Parkway westbound, or you were looking for Grand Central Parkway eastbound, or looking for Manhattan something else, why, it would be questionable at this point. The confusion, as we see it, is not now the name of the facility, because they have provided that, but the fact that this sign does not seem to be explicit, in that you can make both a connection for eastbound as well as connection westbound.

One thing we found, incidentally, while we were out there is that they apparently have found the need to provide some supplemental information to guide motorists to LaGuardia Airport. They put up some trailblazers here. It is on the gore and upside-down. And the arrow now is erroneously pointing to Long Island Expressway to get to the airport.

As you can see, this gore has been frequently hit. That curb is just about all missing in the front.

[Slides.]



Continuing around, apparently some people misjudge that sign, and as a result of that, do not recognize that this is the way to get off for both connections of the Grand Central Parkway, and they make their own connections: crossing over the shoulders, grassed area, back down to the connector-distributor road. This is the condition all the way down.

Also this slide would tend to illustrate the point we raised before in connection with overpasses blocking signs. As the motorist ap-

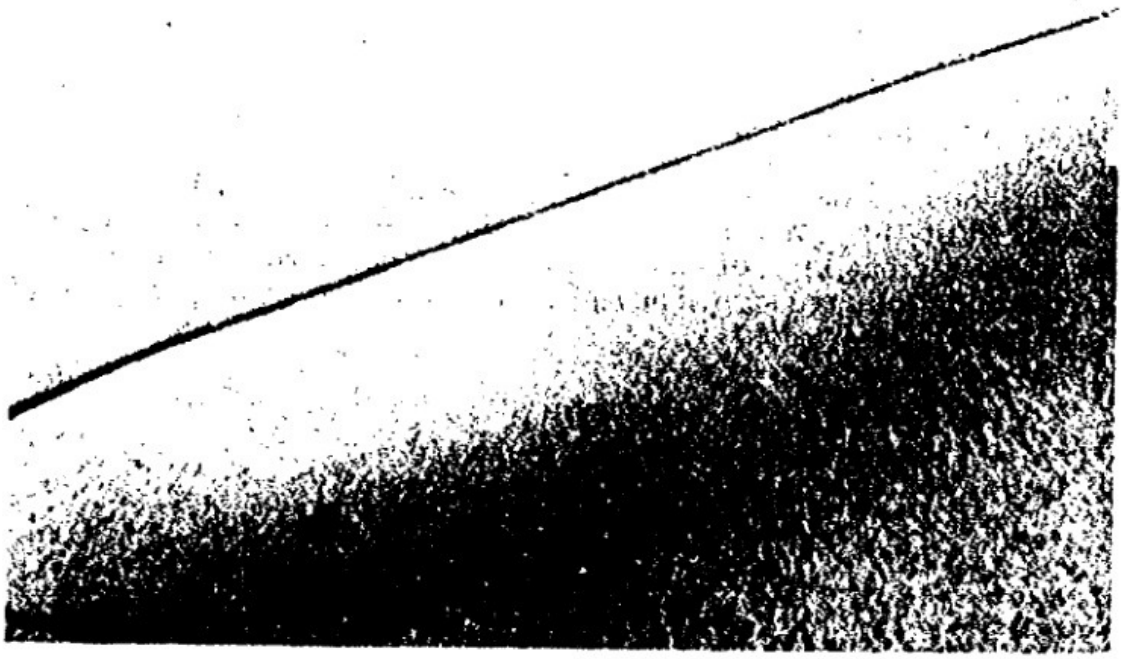
proaches this, the only sign he can see on the right is "No Commercial Traffic." He cannot read the signing at the top.



This is the sign actually at the ramp. Now here we have got another LaGuardia Airport sign up on the right side. We have Grand Central Parkway, Triboro Bridge, which would indicate a westerly direction. On the other side we have Grand Central Parkway, Kennedy Airport. That could be a little confusing, since Kennedy Airport is about 8 miles away and nowhere near the Grand Central Parkway. Yet, LaGuardia Airport is only a mile and a half down the road, and is not mentioned at all, except for the supplemental signs.

That raises the other question as to the supplemental information provided at this gore. There is a lot there for the motorist to read, and that red one kind of catches your eye, since normally you should be stopping for a red sign. The legend on it is: "Snow emergency road" in the event it snows * * *.



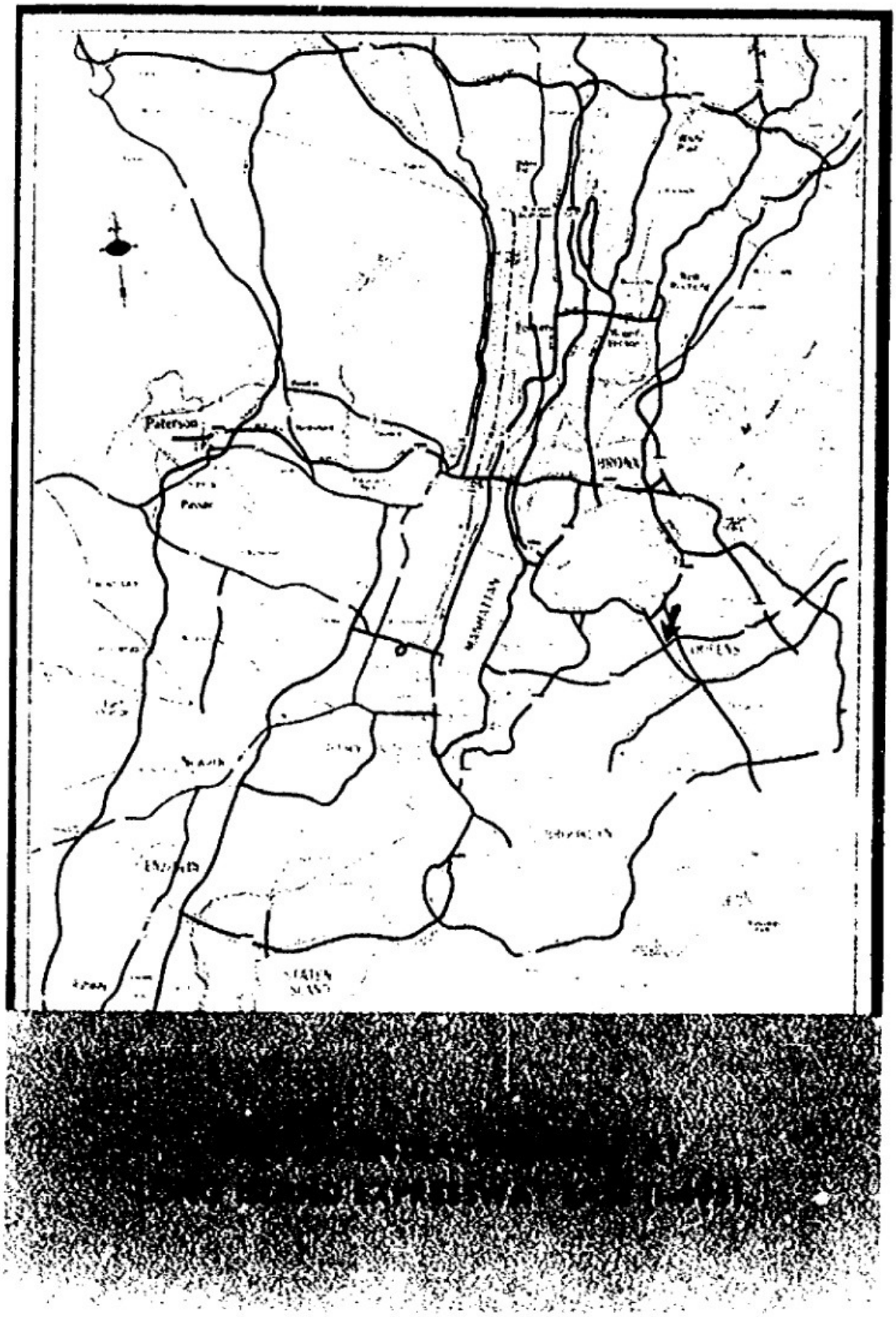


That is a closer shot of the supplemental signs and the gore.
Mr. BLATNIK. The gore is pretty badly chewed up, is it not?
Mr. PETRILLO. Mr. Chairman, in just about all these cases it is.
Mr. MAY. What does that "road service by permit only" mean?

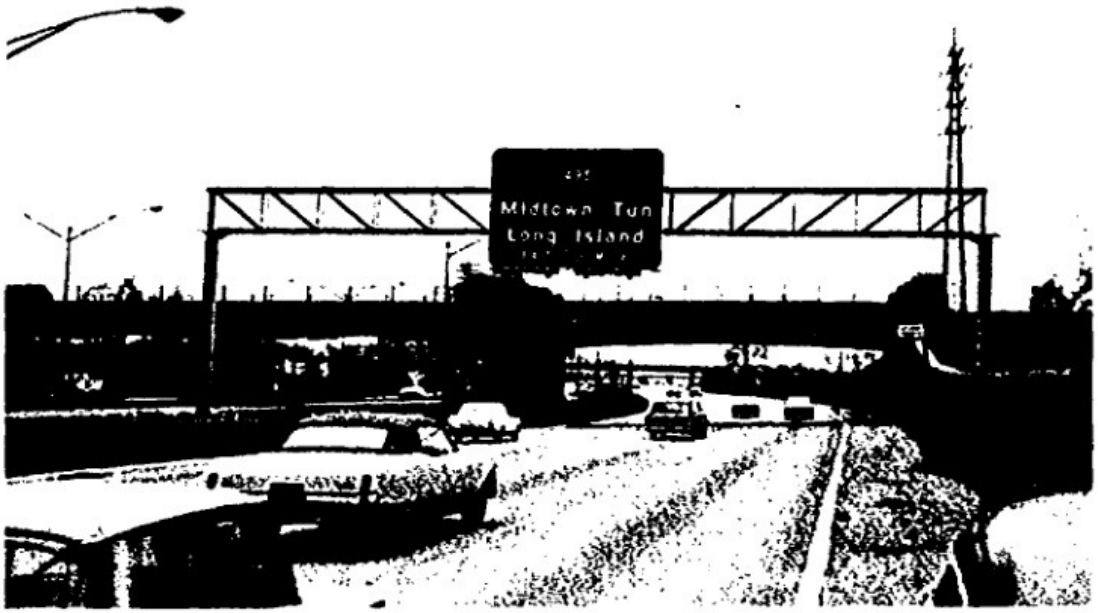
Mr. PETRILLO. That means unless you are a licensed toll operator, you cannot get on that facility.

Mr. MAY. Do you have to put that sign in a gore area?

Mr. PETRILLO. I do not know. I would say not. I do not know that you need the sign. It does not pertain to motorists who will be using that, and that is only a parkway.



This next location is Grand Central Parkway at the Long Island Expressway eastbound. We have talked about the location before. Now we are on the Grand Central Parkway coming toward the Long Island Expressway—I–495—and before we were on the Long Island heading for the parkway. We have changed facilities. This is the same interchange.



This is what you see as you approach I–495: "Midtown Tunnel, Long Island." Now, there are a couple things here. The primary problem again is there is no mention made of the name of the intersector facility, Long Island Expressway. But here we are at the same interchange—or, let us say, the same facility that connects with Riverhead and Clearview Expressway—Long Island Expressway.

Before, when we were on the Clearview Expressway, they thought Riverhead was an important destination, and now they are using Long



Island to indicate an easterly orientation point destination.

Here is the next sign again—no mention of the name of the intersecting facility; 495 is all that is provided.

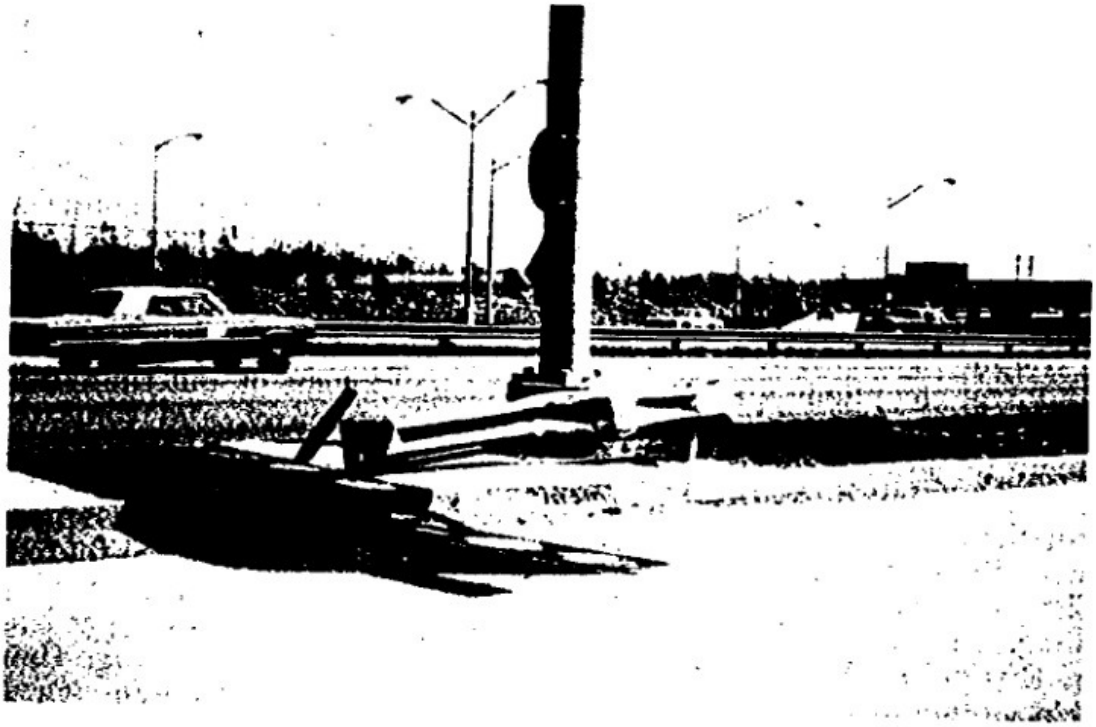
[Slide.]

Again this is the gore area. In order to make your connections you have to use this collector distributor road, and this gore sign would seem to indicate that this is the connection for the Midtown Tunnel in Long Island. Again, no name for the intersecting facility: Long Island Expressway.

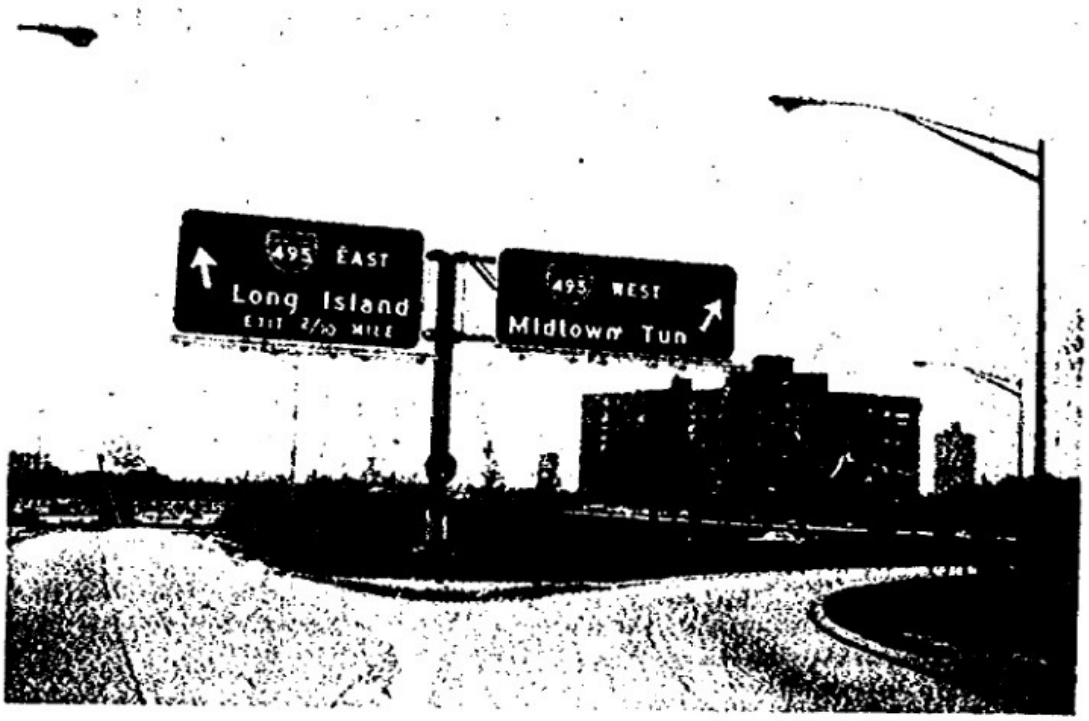
Mr. MAY. Mr. Petrillo—Mr. Chairman, George Kopecky and I, a couple months ago, were going up to Long Island to visit a person, and over the phone the person told George to come on out the Grand Central and pick up the Long Island Expressway, and come out about 20 miles. George and I flew to New York, rented a car, started down the Grand Central Parkway, and about the time I was reaching for the map, it dawned on me that 495 was the Long Island Expressway. We had just passed this gore area. And there was a great temptation to move across the island there and make a right move. But we went straight ahead, and it must have taken us 30 minutes to get back to this point. As we approached interchange after interchange there was no signing to answer our question—is it a full interchange up

ahead? How do you turn around to come back on this freeway? We finally ended up asking instructions and wasting our time.





Mr. PETRILLO. Here are closer shots of the gore area again. It is well beat up.

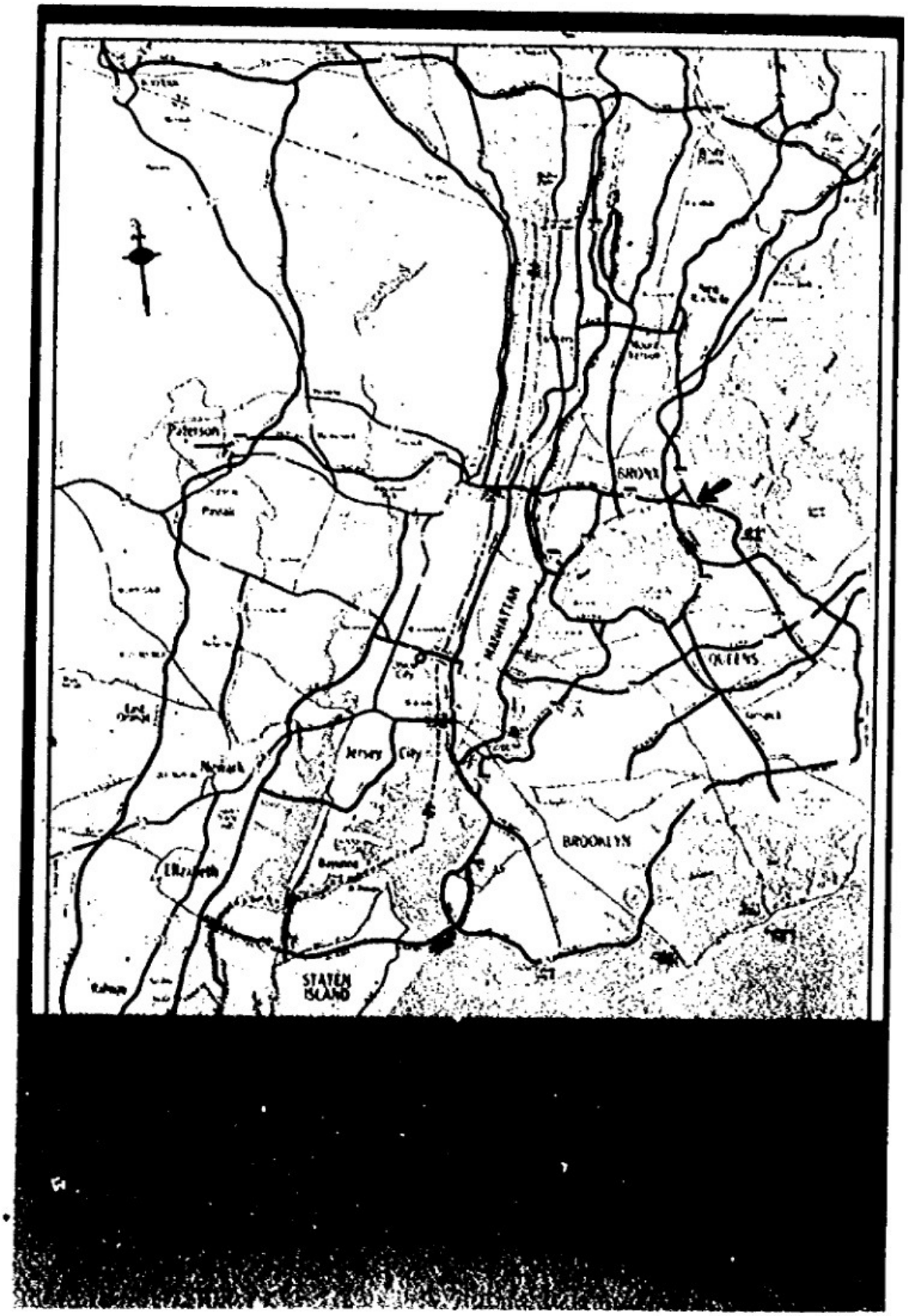


This is the next sign within the collector distributor, and again the facility is not named.



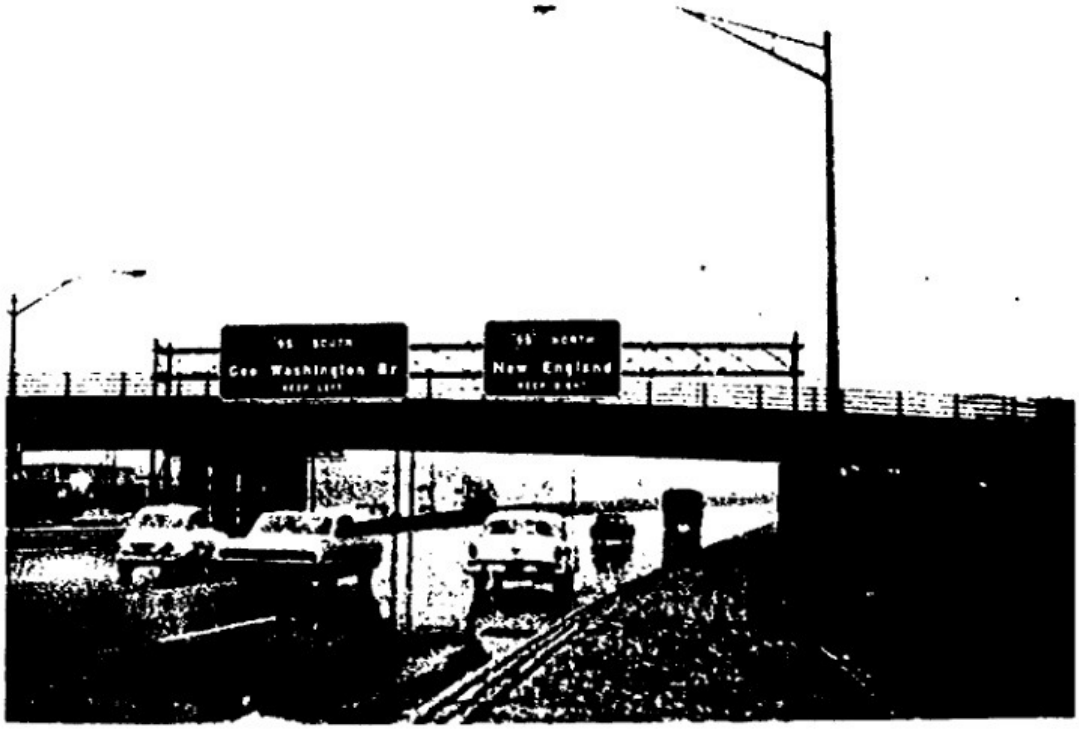
This is an indication that people are, as Mr. May suggested, making their own connections, once they recognize that this is the Long Island Expressway, and this is the exit they would want. As you can see,

crossing from the main line of the Grand Central Parkway, which is on the left, to the collector-distributor roadway.



This next location is the Throgs Neck Expressway westbound at the Cross Bronx Expressway. The Throgs Neck Expressway is a relatively short section; it goes from Throgs Neck Bridge on up to connect with the Bruckner Expressway.

Along the way it also connects with the Cross Bronx Expressway. This is in the Bronx now. We have gone north at this point, crossed over the Throgs Neck Bridge, and we come to a Y in the roadway.



These are the signs that are there. The sign on the left shows the Interstate shield, 95 south. The one on the right is the shield, 95 north. No name of the intersecting facility, which would be on the left.

(Mr. Howard assumed the chair at this time.)



This is the gore. And again the repeat of the Interstate shield. No mention of the names of the intersecting facility. Now, in connection with this, Interstate 95 is the Cross Bronx Expressway in New York, and for the 8 miles that 95 as the Cross Bronx Expressway runs in New York, it is due east and west. The sign would indicate you go south for the George Washington Bridge. This is contrary to the actual direction of the location of the George Washington Bridge from this point.

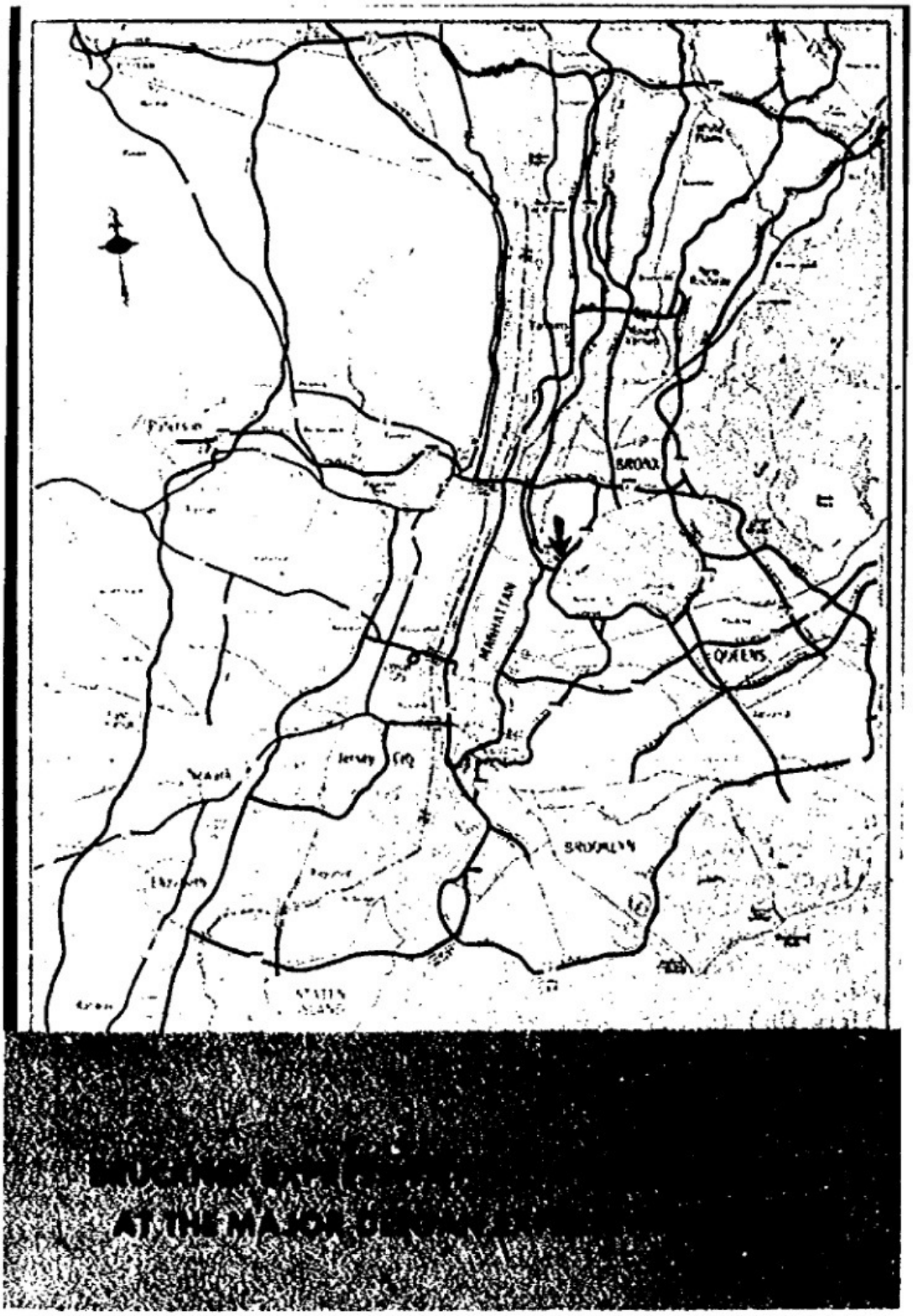
The George Washington Bridge from this point is actually due west. This is confusing to motorists; and while we recognize that the Interstate 95 is a north-south national route, it is confusing to motorists at this point.

On the right, the name of the facility coming up would be the Bruckner Expressway, and again there is no mention made of that. Destination used is "New England." Actually, before you get to New England you have got to go through the Bronx and Westchester.

While we were out on that facility taking some photographs, we had the opportunity to talk with a motorcycle police officer who had been patrolling this location for the last 5 years, and some of the comments he made included the fact that he had seen a number of accidents caused by people who apparently were confused by the signs and lanes too late. He said, also, he continually received inquiries from motorists as to the location of the Cross Bronx Expressway.

In the 10 minutes we talked with him, two motorists approached us and raised the same question, despite the fact that we were parked

on the Cross Bronx Expressway. He also suggested that signs on the Cross Bronx Expressway be washed and that the lighting be improved.



This next facility is the Bruckner Expressway southbound to the Major Deegan Expressway. The Bruckner Expressway runs along the east side of the Bronx, and at the base it connects with the Major Deegan Expressway, which (the Major Deegan) then continues along the bottom of the Bronx and swings on north, on up into Westchester, where it connects with the New York Thruway.



These are the signs you see as you head south. As you head south, you have a connection with the Triborough Bridge, and you have a connection with the Major Deegan Expressway. The sign on the left indicates Triboro Bridge, and the fact that you can reach Manhattan and Long Island from it.

The middle sign indicates Interstate 87 North. This is actually the Major Deegan Expressway. Again they have not named the intersecting facility. The Major Deegan was well known before the Interstate System.

Here they talk in terms of the thruway. The thruway is about 9 miles from this particular point, and therefore would be probably misunderstood or confusing to the local motorists.

"Upstate" is the other legend on this sign, and that would tend to be confusing, since, if you wanted to go upstate, you have already missed your turn about 3 miles before this point. You would be mak-

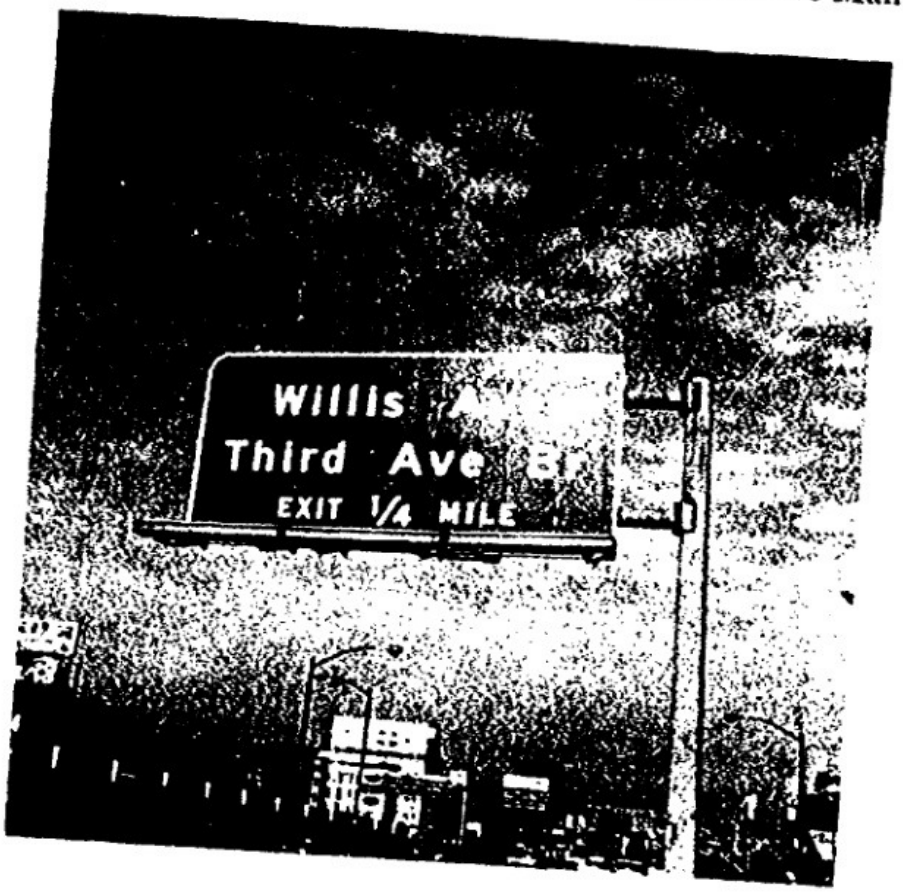
ing a big U at this point, or you would be lost. So the sign at this location would seem to indicate they are signing for lost motorists.

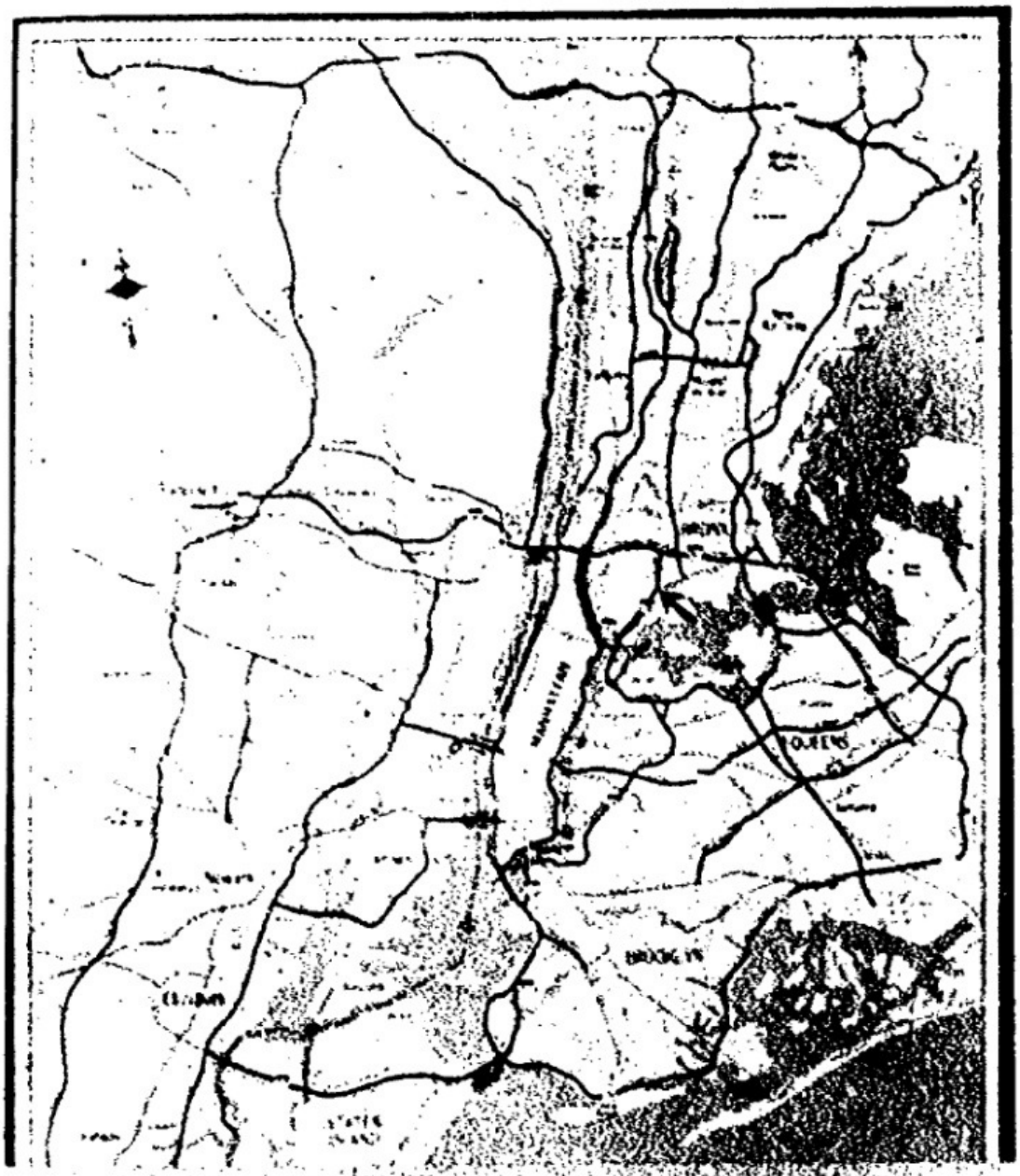


This is the second sign you see as you proceed south. There is no mention made, incidentally, of the fact that there is a free bridge to Manhattan.



Now in this particular sign, if you take this route, which is the Major Deegan, and you continue 1 mile down this ramp and off to the right, you will come to this sign. That is the free route to Manhattan.





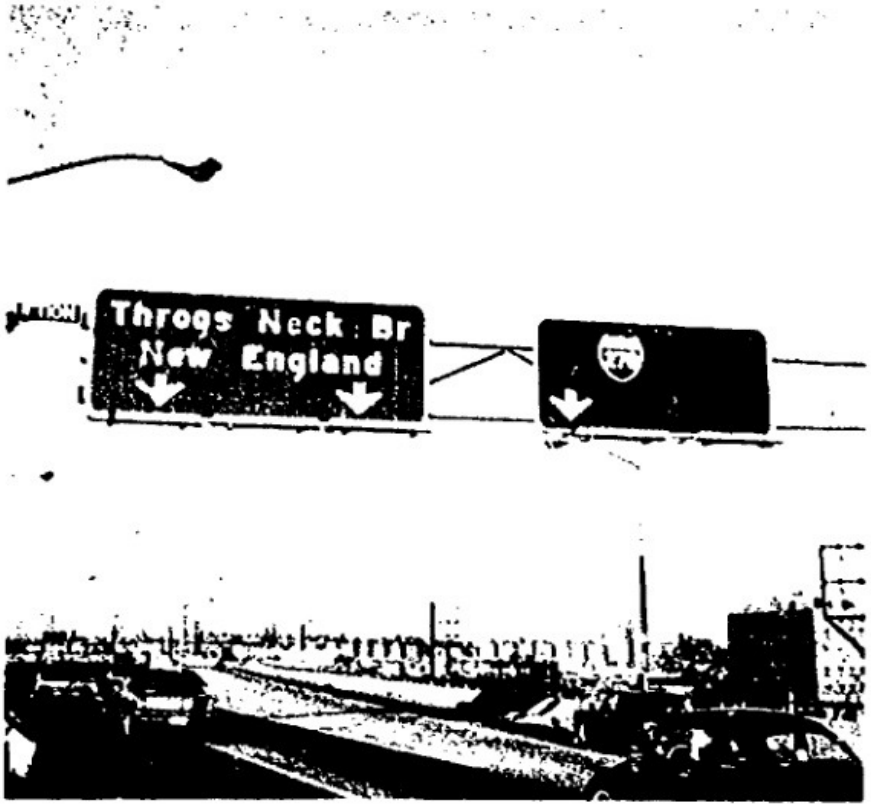
BRUCKNER EXPRESSWAY (I-278) NORTHBOUND AT THE SHERIDAN EXPRESSWAY.

This next location is the Bruckner Expressway, turning around and going north now, at the Sheridan Expressway. The Sheridan Expressway was constructed to connect the Bruckner with the Cross Bronx, and it was intended to come up and connect it with the New England Thruway.

The connection between the Cross Bronx and Sheridan and New England Thruway was to provide an alternate route to Boston Post Road, U.S. Route 1. Unfortunately, there was quite a bit of opposition to the extension of the Sheridan, and it has since been demapped from the State arterial program. So the Sheridan, as exists today, runs from the Bruckner Expressway to the Cross Bronx Expressway.



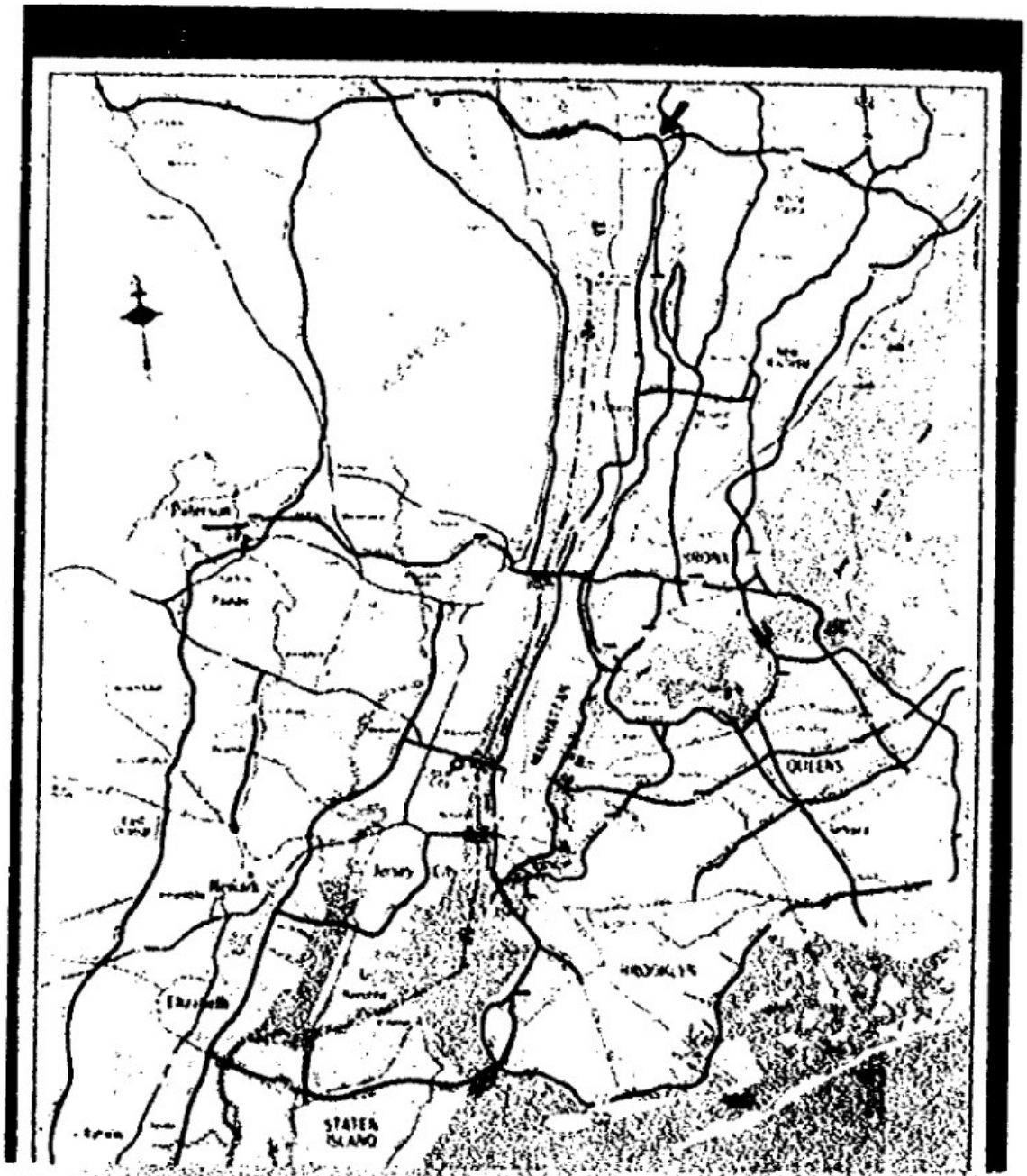
Here again we have the Interstate shield, and no mention made of the intersecting facility. The name on that should have been the Sheridan Expressway.



Here again we have a sign that shows the Interstate shield, number, and no name.



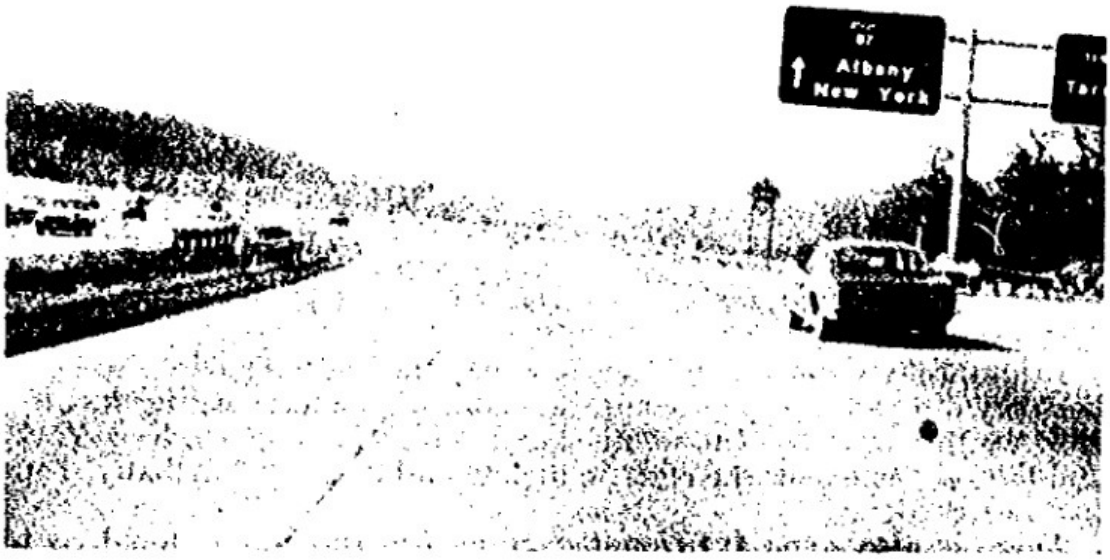
We think the debris and the tire marks in there seem to indicate that somebody has been confused by the sign.



CROSS WESTCHESTER EXPRESSWAY (I-287) WESTBOUND AT THE NEW YORK THRUWAY.

This next location is the Cross Westchester Expressway, westbound at the New York Thruway. The Cross Westchester Expressway spans and cuts across Westchester County up about midway in the county in the vicinity of White Plains, and it connects the New York Thruway, on the west, and the New England Thruway, which runs down the coastline on the east side. The facility carries in the neighborhood of about 70,000 vehicles a day, and the operating speeds are in the neighborhood of 60 to 65 miles per hour.

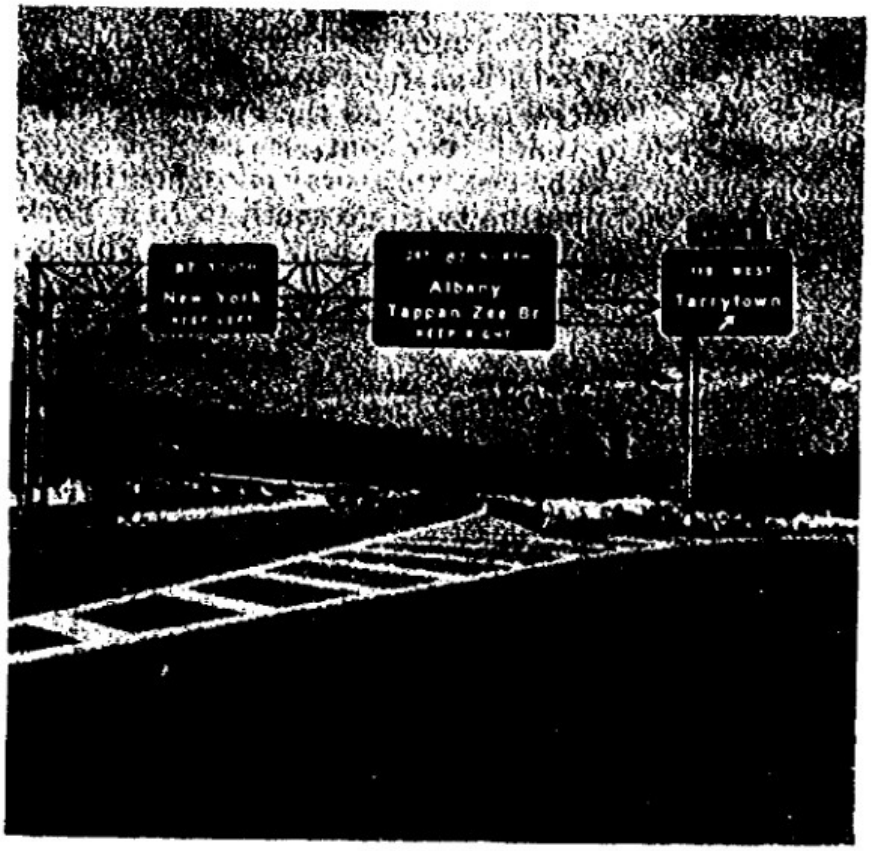
Individuals coming west on the expressway encounter the New York Thruway and have an opportunity to go south to New York or continue west over the Tappan Zee Bridge and upstate. This is the sign they see.



This is the signing that existed prior to about 1966. There was a cantilever out over the right lane, and simply indicated an Interstate shield, Albany and New York. I think there is some confusion there. Maybe it just implied that Albany is in New York.

In any case, we had correspondence with the State regarding this when it existed in this condition, and we pointed out to them the need

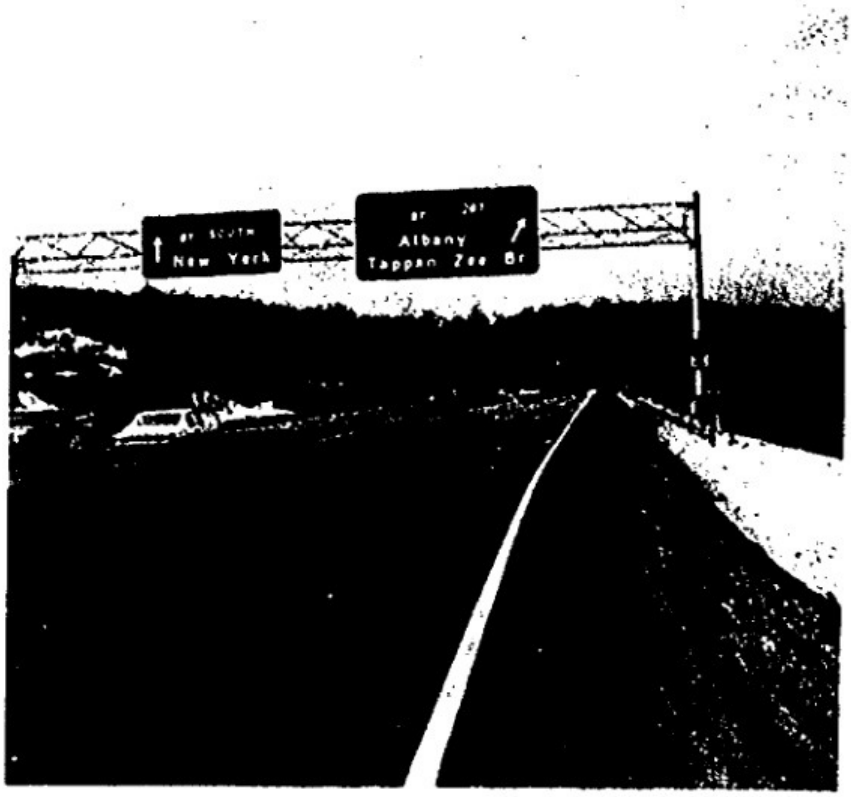
for adding the name "New York Thruway" to it. The State has since improved the signing at the location, and this is what they have done.



I think they went out and they spanned the roadway with the signs, but they did not in any way add the name of the intersecting facility. Now we just have the Interstate shield, which is 87 south, New York, and then the one over the right, which would be 287, 87, Albany, Tappan Zee Bridge.

There is also some question regarding the Interstate shield, as to whether or not 87 is actually in this area here. Now as a supplement for those motorists who might have some confusion at this location,

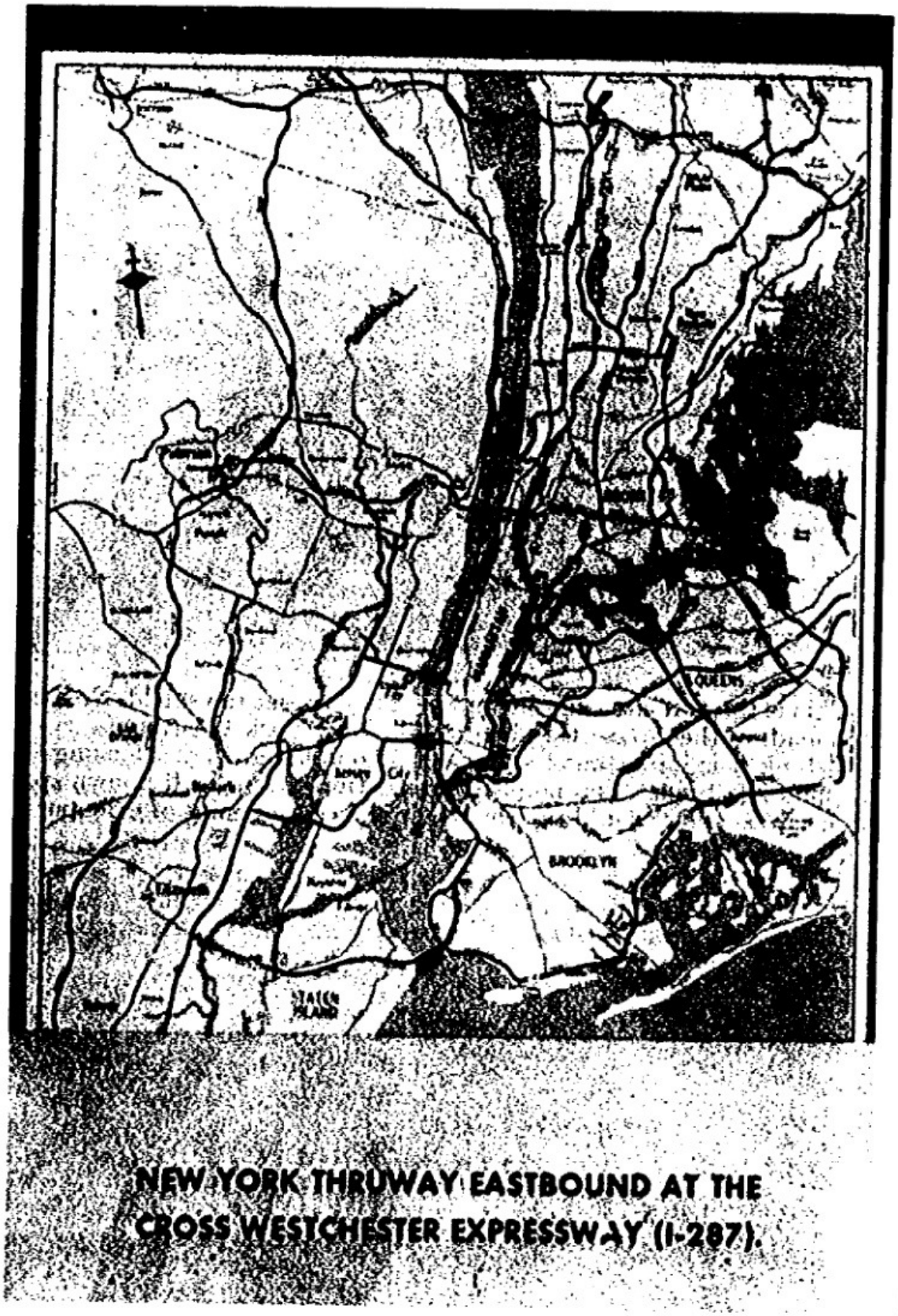
they put a trailblazer out there to indicate the fact that, yes, this is the route to the New York Thruway.



This is the gore area signing again. They repeat the shield. No mention made of the intersecting facility, the New York Thruway.

I think it is important to note at this point that they are using the Tappan Zee Bridge as a point of orientation. It is a well-known span in our area, and I would say that their choice as a point of orientation

was good. Unfortunately, when we get onto the other side of the river. we will see signing that in no way refers to it.



NEW YORK THRUWAY EASTBOUND AT THE CROSS WESTCHESTER EXPRESSWAY (I-287).

This next location is turning around and going eastbound on the thruway at the Cross Westchester Expressway. This would be the

direction you head in if you came off the Tappan Zee Bridge and you approached this interchange from the reverse direction.



The first sign we see mentioning the name, "Westchester Expressway"—actually it is the Cross Westchester Expressway; and while it is on the sign, it does not give emphasis to the name. There are four signs in this sign series, and two of them mention the name of the facility.



This is the second sign, and I think it tends to illustrate the problem you can get into when you start to sign by destinations. Port Chester is a small community off on the east side of Westchester. I do not know how many people at this point would be interested in going to Port Chester. While there may be some headed for Boston, it would seem that it would be a minor destination at this point for all those who use it.



This is a repeat now of the first sign where again they mention the name of the facility, but they don't give it emphasis. They are talking

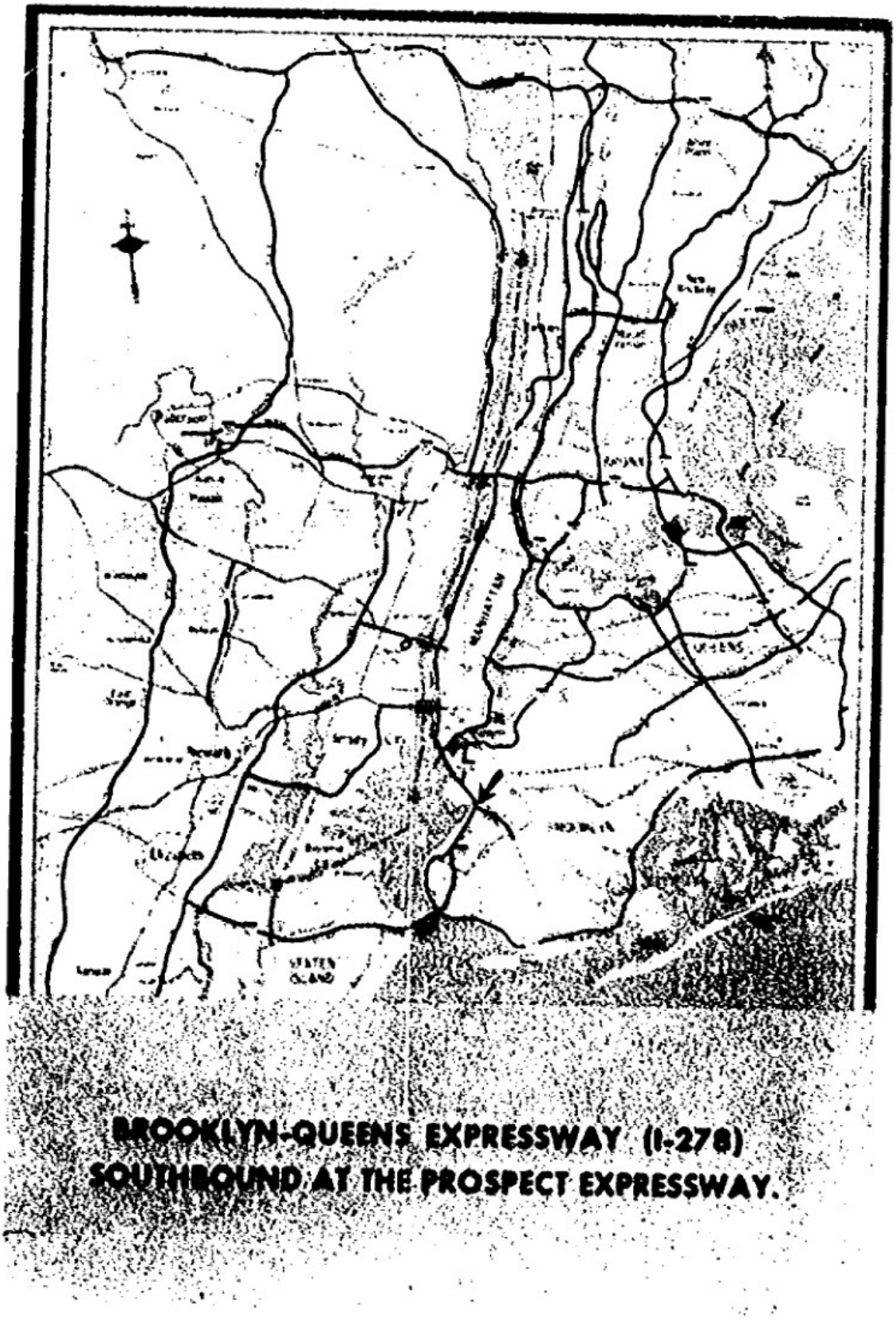
about White Plains, New England. When you reach this point you have digested all that information, and then you get this gore sign.



New York; Now England.

No mention made of the Cross Westchester Expressway.

Mr. MAY. As these hearings progress, we are going to stress some of the problems that come from legibility. In our travels we have noticed that invariably the least legible part of many of the signs is the number within the Interstate route shield. And I think this is an example. You can read everything else on the sign, but invariably have difficulty picking out the route number. Thank you.



BROOKLYN-QUEENS EXPRESSWAY (I-278)
SOUTHBOUND AT THE PROSPECT EXPRESSWAY.

Mr. PETRILLO. This is the Brooklyn-Queens Expressway, southbound, at the Prospect Expressway. As you come out of the Brooklyn Battery Tunnel from Manhattan, you are directly on the Brooklyn-Queens Expressway. And as you continue along the Brooklyn-Queens Expressway, it connects directly into the Belt Parkway.

Now, the Belt Parkway is a very important artery in the New York area, because it serves the south shore of Brooklyn, and is a primary route to Nassau County. Along the Brooklyn-Queens Expressway there are two exits; one is to the Prospect Expressway and the other is to the Verrazano Narrows Bridge, which goes over into Staten Island.



This is the signing at the location, "Prospect Expressway" shown on the left and Interstate shield, "Staten Island" shown on the right. This is probably one of the most chronic problems there is in the New York metropolitan area, this location.

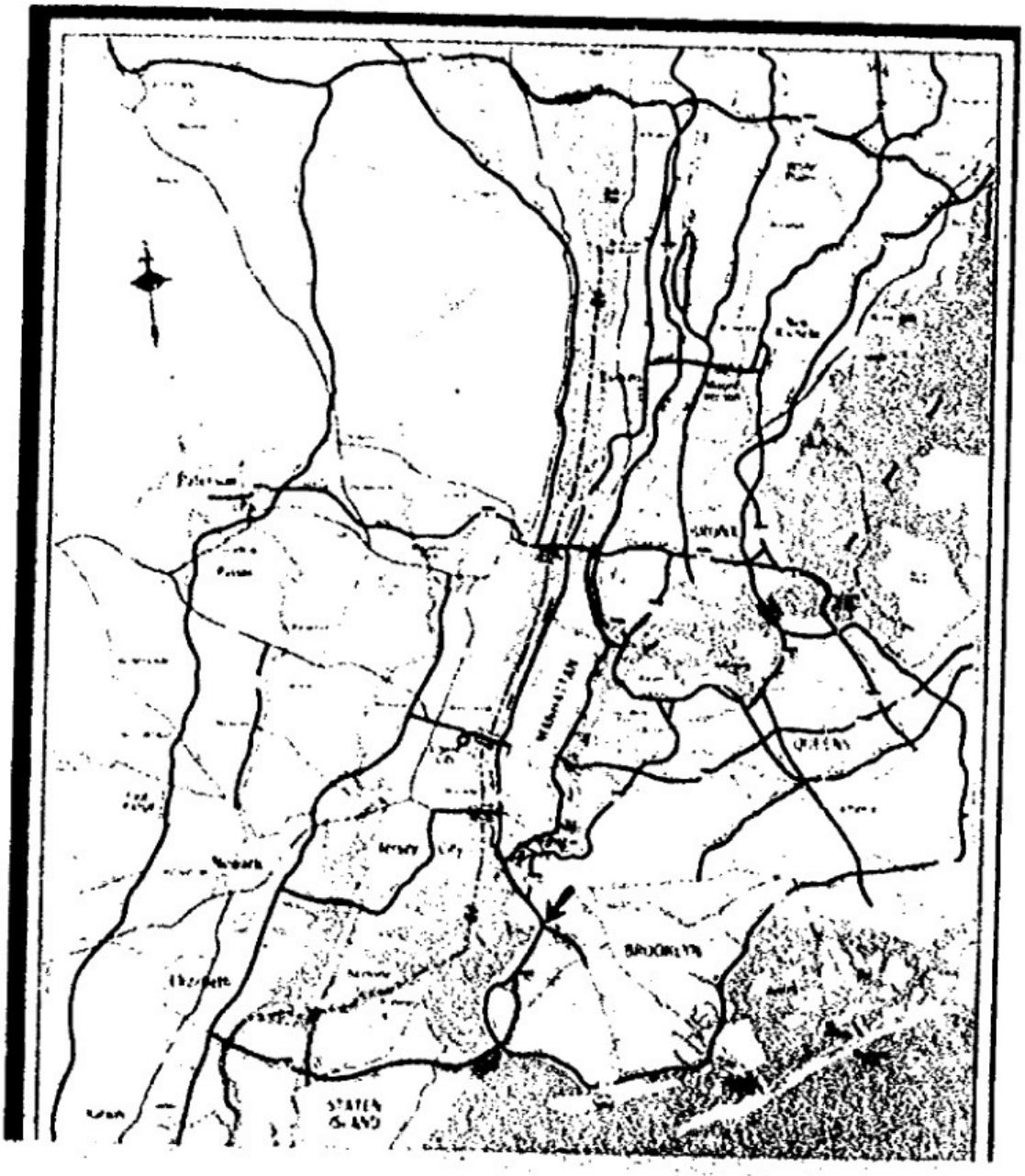
Let me back up for a moment. The fact that they do not mention Belt Parkway is very, very confusing on that right sign because the impression created is, if you keep to the right you are going to Staten Island. Motorists approaching this location are apparently confused by the fact that the sign indicates Staten Island and, as we know, Staten Island is an important destination, but is a minor destination at this point; more people at this point are headed for the Belt Parkway than are for Staten Island.

In any case, apparently through deductive reasoning, the motorist says, "I do not want to go to Staten Island; I want the Belt Parkway; I better get off at Prospect Expressway," and he does this, and ends up in downtown Brooklyn.

I have another shot of this which tends to indicate another problem.



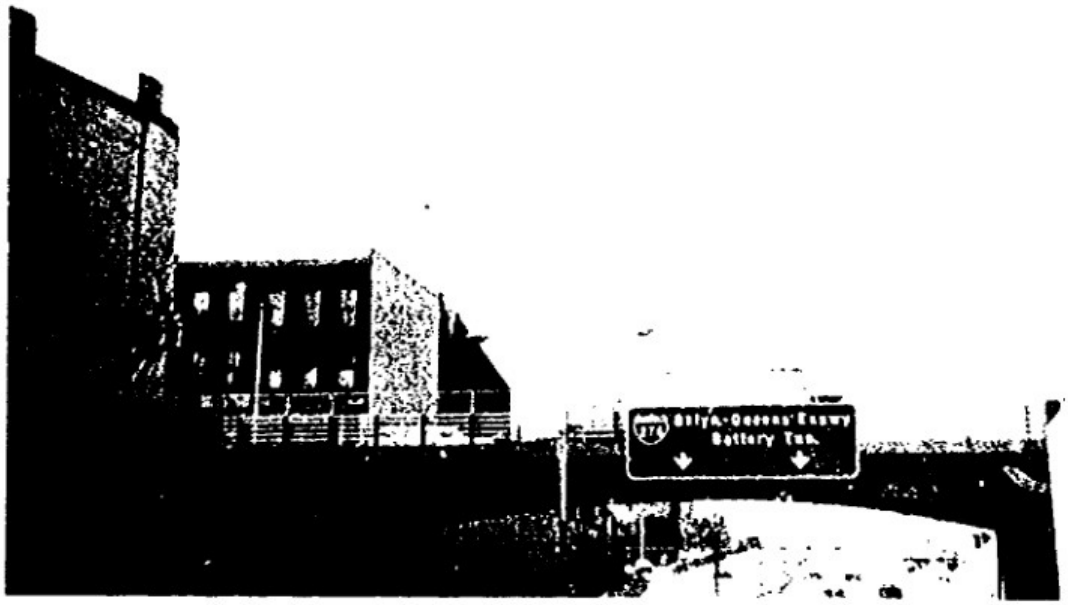
A problem of maintenance. I think there are in this connection somewhere in the neighborhood of 10 fluorescents, and about half of them are out.



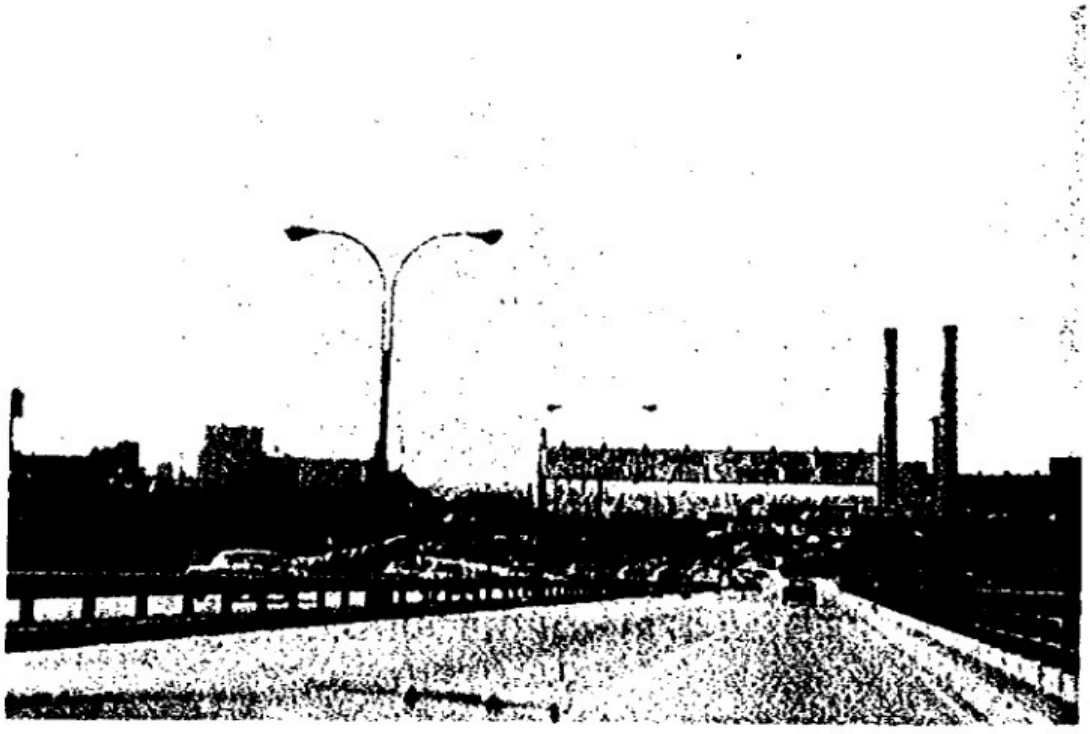
PROSPECT EXPRESSWAY AT THE BROOKLYN-QUEENS EXPRESSWAY (I-278) NORTHBOUND.

Now, this is on the Prospect Expressway coming into the Brooklyn-Queens Expressway. Prospect Expressway is a relatively short section again, connecting downtown Brooklyn with the Brooklyn-Queens

Expressway; and then from there, you go on into the Brooklyn Tunnel from Manhattan.



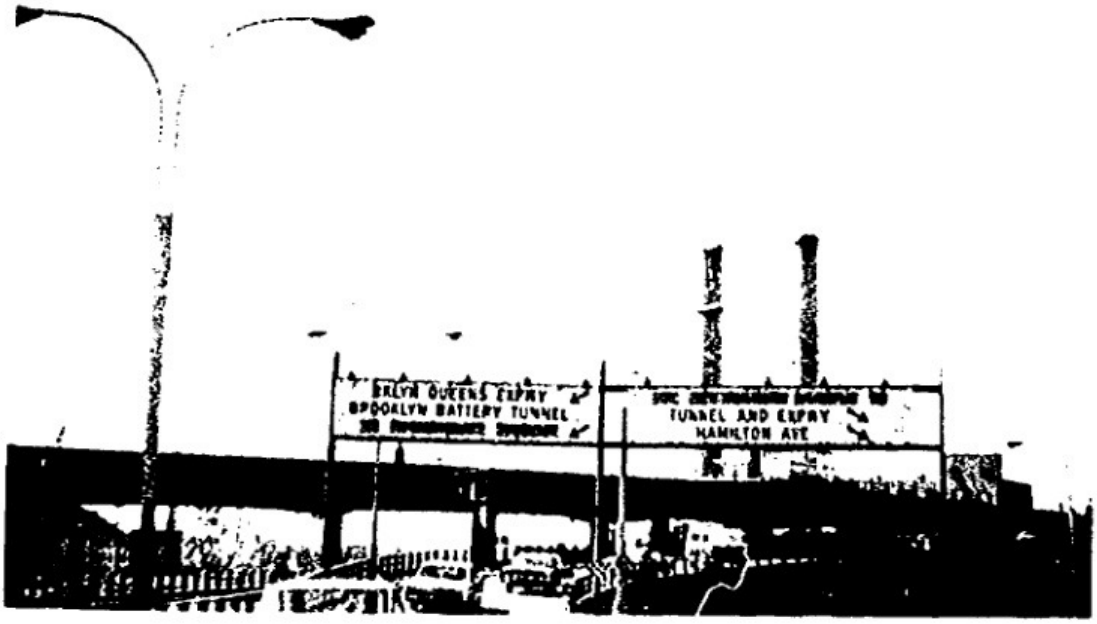
The first sign shows the Interstate shield. It also mentions the facility: the Battery Tunnel. The sign would seem to provide sufficient and adequate information for most motorists.



This is the next sign you see; legend on the left is "Brooklyn-Battery Tunnel, Keep Left." The one on the right says "Hamilton Avenue,"

with arrows pointing horizontally to the right. Nobody is mentioning at this point the Brooklyn-Queens Expressway.

Apparently there were two agencies hanging these signs at this point. This sign is black on white and the other is black on green. In addition to that, you can see a solid white line running down along the inside lane. This might be thought of as a weaving area in order to properly position yourself to make exits, but there are signs posted prohibiting you from crossing the solid white line. If you are in the right lane and you want to keep to the left, you are in trouble.



This is the next sign. This is the sign at the gore. It says "Brooklyn-Queens Expressway, Brooklyn-Battery Tunnel," for the left ramp. It says "Tunnel and Expressway, Hamilton Avenue," for the right ramp. Apparently they were trying to indicate that there is an alternate route by keeping to the right. However, this sign is very confusing as it now stands.

Mr. MAY. Which is the preferred way to go to the tunnel and expressway?

Mr. PETRILLO. The left.

Mr. MAY. Mr. Prisk, what do you think of those signs?

Mr. PRISK. Well, Mr. May, what you see on those signs I think violates one of the cardinal principles of good sign design, in that it shows the same destination on each of the two different signs, and you are confronted with pretty much of a dilemma; you have to read the entire sign message in order to make any decision, really, as to where you want to go.

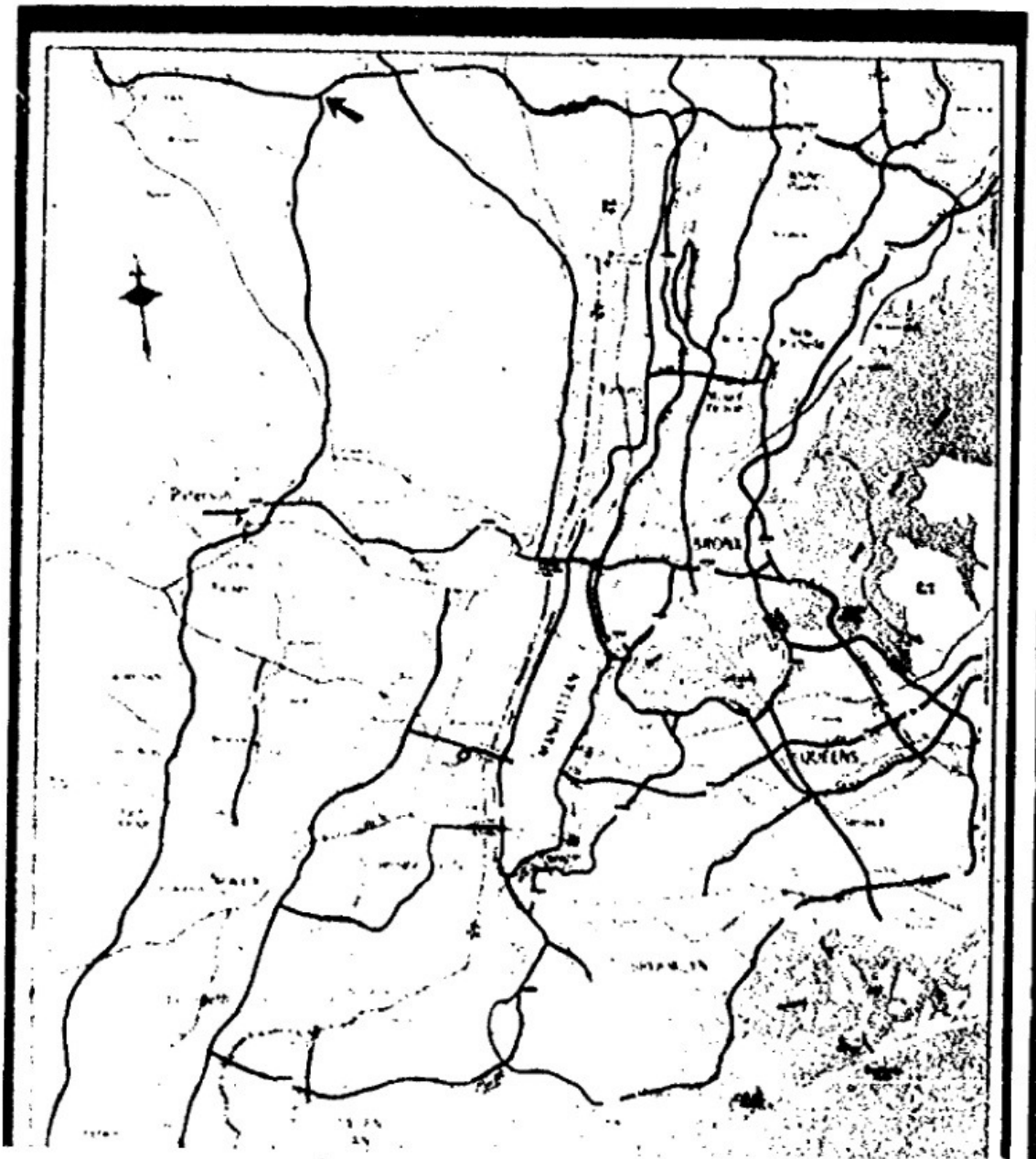
"Tunnel" shows on both signs, "Expressway" appears on both signs, without any identification on the right sign of what expressway you are talking about, as far as I can make out. So it does have complications, to say the least.

Mr. MAY. Mr. Petrillo, if you go right here, you can go to the tunnel, but you have to go through city streets?

Mr. PETRILLO. Yes. It probably is a helpful alternate during peak hours, but most of the day the desirable way to do it would be to go up on the expressway.

Mr. MAY. Local people get to know how to use it, and when to use it.

Mr. PETRILLO. The commuter. People from south Brookyln would be confused by this if they were headed for Manhattan.



GARDEN STATE PARKWAY CONNECTION
NORTHBOUND WITH
THE NEW YORK THRUWAY.

This next location is the Garden State Parkway which connects with the New York Thruway. Over here on the far left, the upper left corner of that map—well, the Garden State Parkway is in New Jersey. It ends at the State line, and this connecion was built by the Thruway Authority to connect the Garden State Parkway to the Thruway. As you can see, across the Hudson River to the right of the arrow is the Tappan Zee Bridge. It is that interchange we talked about before. This is the signing that the motorist sees as he proceeds northbound.



The first sign, Interstate shield, and the name of the intersecting facility, Thruway. There are about seven or eight signs in this sign series, and this is the only one that mentions the Thruway.



Coming back to the primary problem on the other signs, they do not name the intersecting highway. Here we have indication for north and west, with points of orientation being Suffern and Albany.

Mr. MAY. What is Suffern?

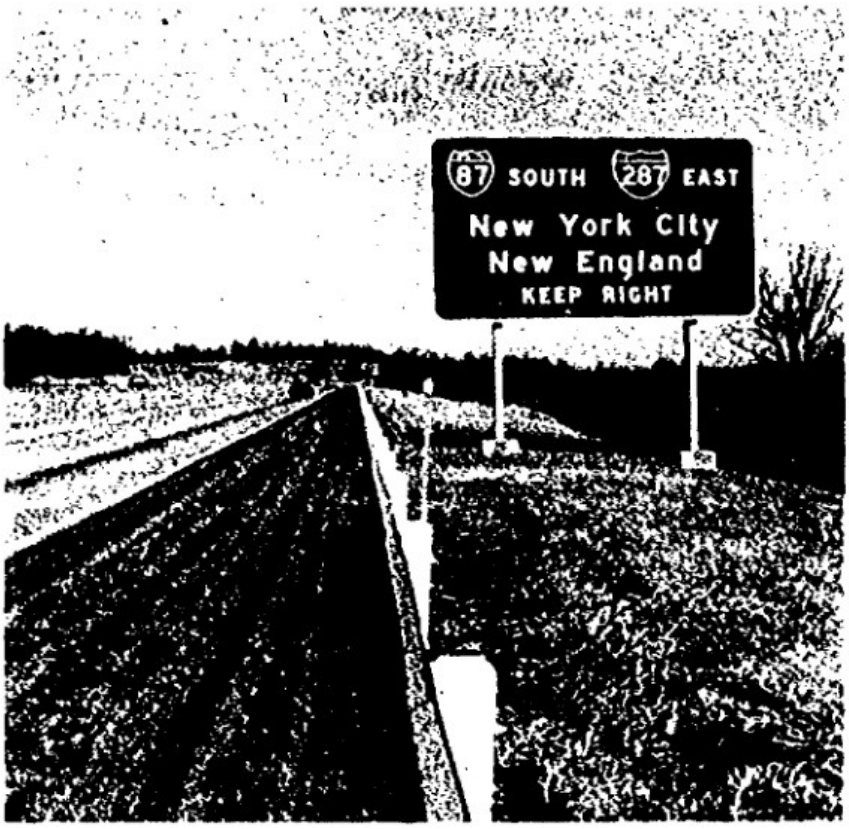
Mr. PETRILLO. That is a little community of about 4,500 people. It is up the road about 4 miles. It is not a major place of destination for people at this pont, nor could it be considered as a major point of orientation.

Mr. MAY. What would you have to do to get to 87 north? Where is that?

Mr. PETRILLO. I don't know. This is confusing. We have got an 87 over in New York. We have got another one running up parallel to Connecticut. I believe this one is on the other side of the river.

Mr. MAY. It is not built yet?

Mr. PETRILLO. It is not built, to my knowledge.
Mr. MAY. That is right.



Mr. PETRILLO. This is the next sign which indicates the point of orientation, if you go to the east. Again no name of the intersecting facility. Now they are using terminology, New York City and New England. If you were at this point and you were headed for New York City, you are in for a ride! You are actually making a big U, because you should be headed in the other direction if your destination is New York City.

As far as New England is concerned, I am certain some people go by this sign destined for New England; but this raises a question that we raised before at the other interchange on the other side of the

river—the Tappan Zee Bridge is an important point of motorist orientation, and they have not mentioned it on this sign, while they gave it dominance on the east side of the river.



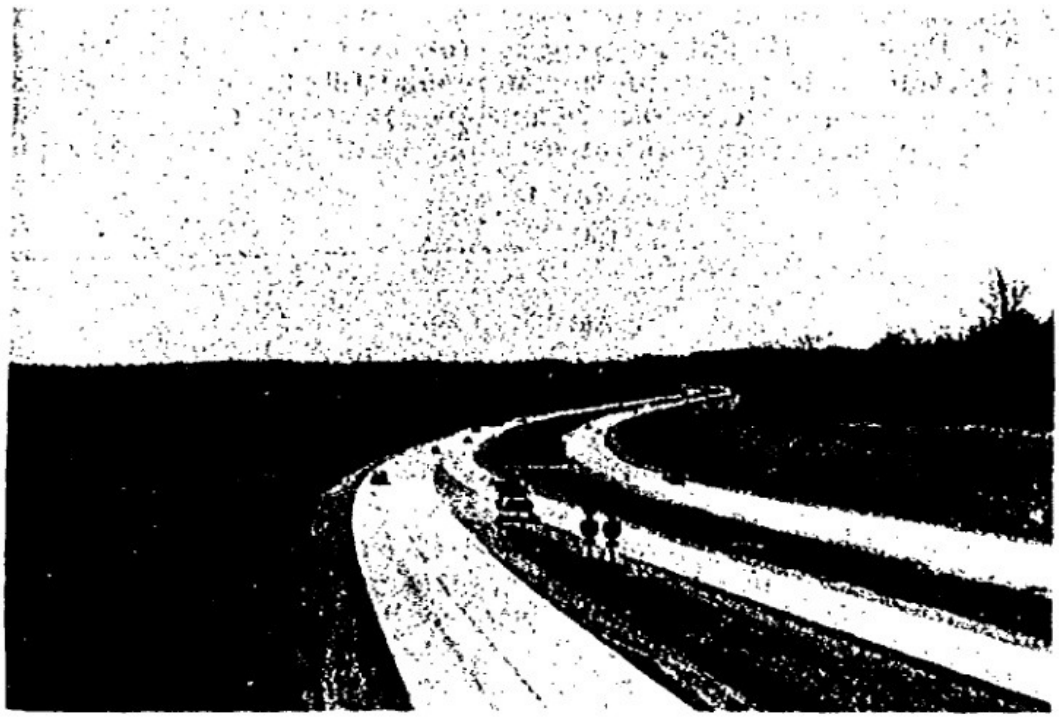
These are the shields that you encounter as you proceed.



This is the first gore sign. Again they are using terminology of Suffern and Albany; no mention made of the intersecting facility.



They reconfirm that with another gore sign. Now, with all of that signing, one would think they would resolve the problem. But we stood on that overpass that you see in the back there and we recorded what actually took place.



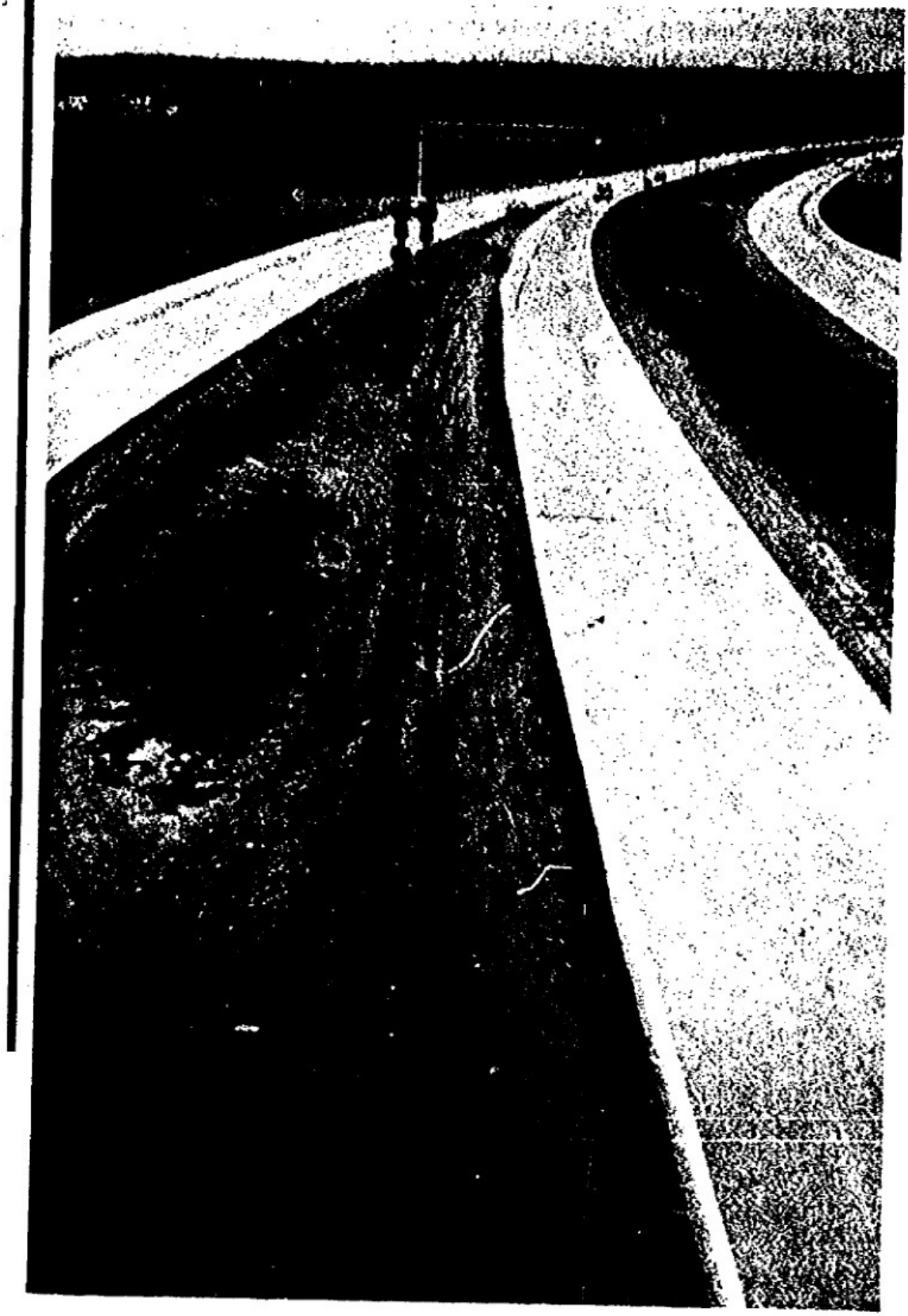
This is the grassed area that has since been well worn out by people who were on the ramp on the left but wanted to be on the ramp on the right. In going up there it does not take but 10 or 15 minutes to record some of these actions. They go on all the time. In this picture note the car at the point of the painted lines. He is stopped under the first of the overhead gore signs.



There is the fellow who stopped; literally backed up, in order to get around the gore point. You can see him crossing sharply. While he was in this confused condition, the surrounding vehicles had to maneuver to avoid him.

Mr. MAY. He did not want to cross over the white line.

Mr. PETRILLO. He did not want to cross over the white line. Fortunately, traffic densities at this time were relatively light. Doing that on Friday evening or weekends, when people are destined to the Catskills or some of these other resort areas, could create considerable hazards.



This is a shot where we see the chap coming across the top. It is a good illustration of the grassed areas being worn out.

Mr. MAY. It appears to me, Mr. Petrillo, lots of people from the Washington area, like myself, travel to New England on occasion, and sometimes we go up the Garden State Parkway in a deliberate effort to miss New York City, particularly when we are approaching rush

hour. If you are riding on this highway heading north and see that sign, "New York City," at this location, and doing it for the first time, it can be a frightening sign for one who intended to head away from New York City.

Mr. PETRILLO. The fact that you went by it and still are coming to it, according to this sign.



There is a chap who crossed the gore area and came out. In order to come out, he kind of squeezed that pickup truck a little bit.

That is the end of our presentation, Mr. Chairman. I think this last location was a good illustration of the hazards that confusing directional signs can create. Thank you.

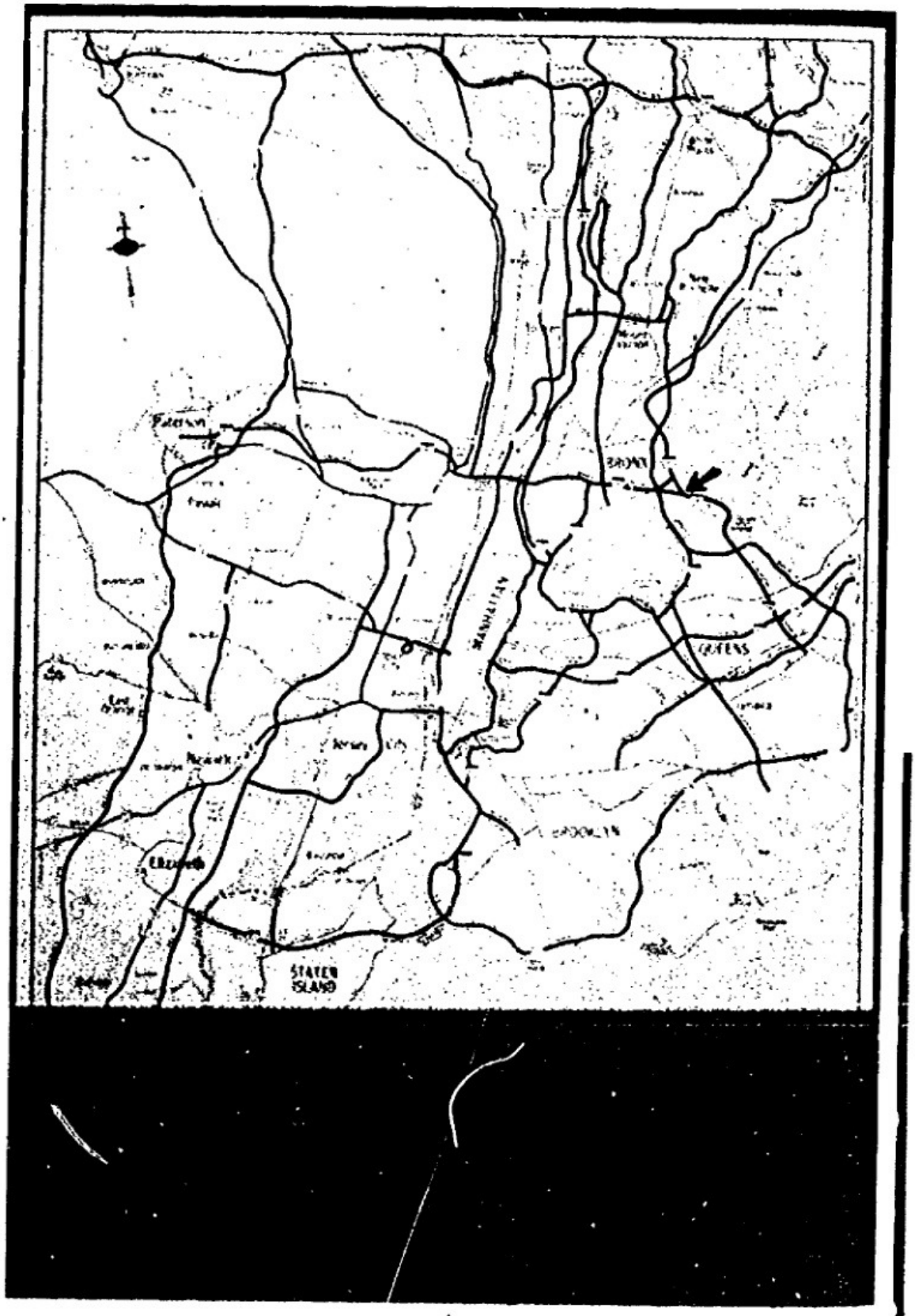
Mr. MAY. Thank you very much, Mr. Petrillo. While Mr. Kopecky was up visiting with you, he rode some of the highways also. He took a few slides that will illustrate a couple of other problems.

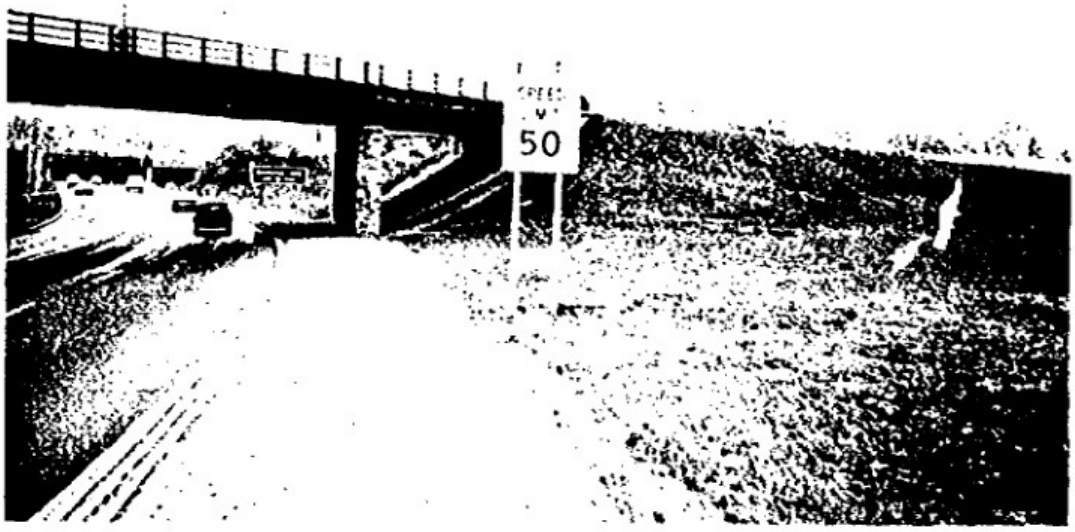
Mr. Kopecky, could you tell us what you saw?

Mr. KOPECKY. Yes. At the Throg's Neck Expressway location where Mr. Petrillo and I talked with the motorcycle officer, and where he related his experience of 5 years, we went back and took pictures of

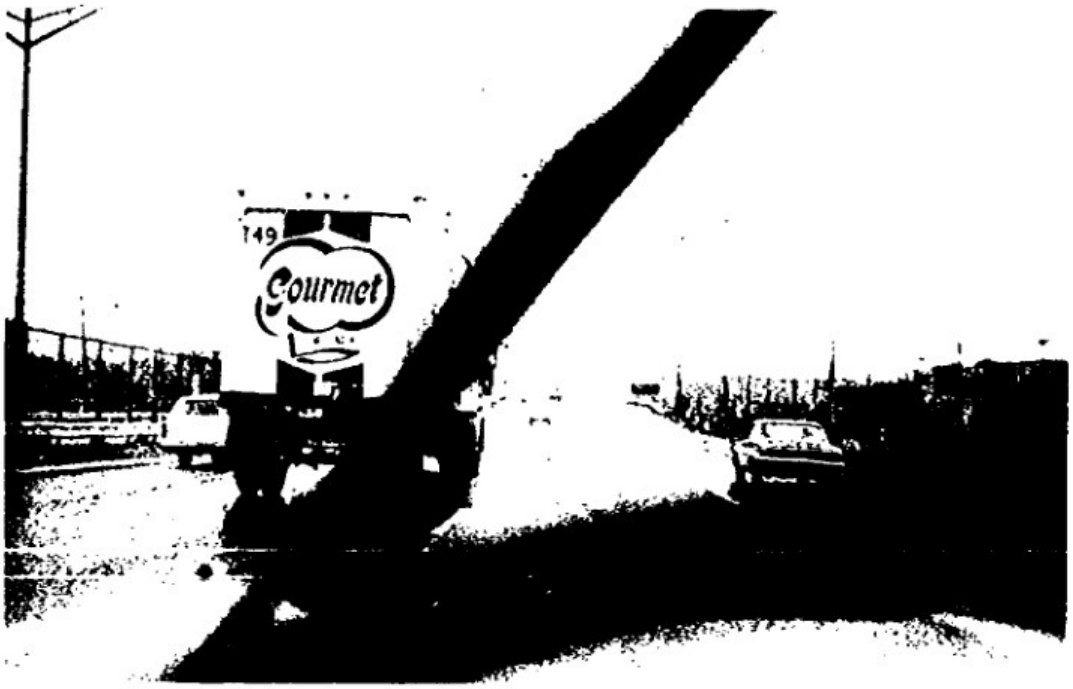
what he described to us. These are representative of the signs and the messages on this section of Interstate 78 and Interstate 95.

This is a map of the location. Note the arrow in the center, on the right side.



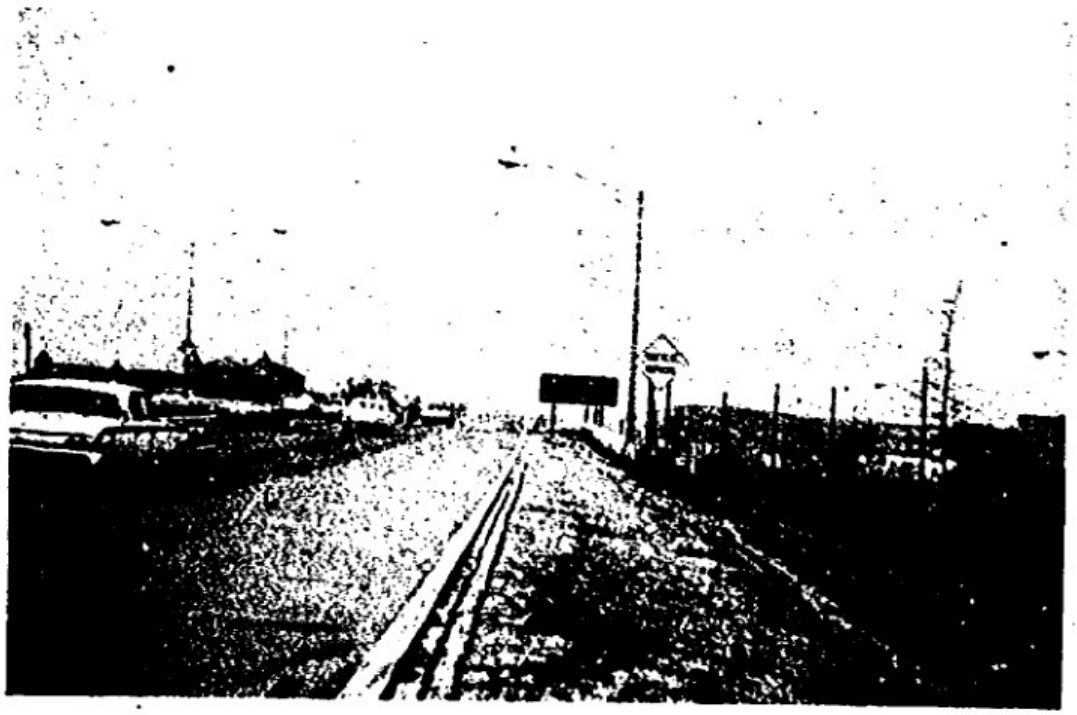


This is a speed-limit sign that the motorist sees after the gore area, and indicates it is a 50-mile-an-hour road. This is a regulatory sign.



He shortly comes upon this segment, and note this vertical curve up ahead. This car on the right is coming in from the entrance ramp, and

he must merge into the through-traffic lanes immediately prior to the vertical curve.



This is at the same, immediate, location and the message here is that a lane on the right side is going to be dropped at the vertical curve. He does not know it, until he gets to the vertical curve here, and the yellow-and-black sign on the right states "pavement narrows."

Beyond that yellow and black sign you will note there is another sign relative to Bruckner Boulevard.



This is a closeup of Bruckner Boulevard sign. The message is "South Keep Left;" "North Right Lane." Just beyond this sign, you can observe that the pavement narrows and the lanes drop by one. It is at this critical point on this 50-mile-an-hour Interstate road, where there is an entrance ramp, where there is a vertical curve, where there is a lane drop, where there are extremely high volumes, that this sign advising of lane assignments is installed.



Beyond this ground, mounted is a small warning sign, yellow and black, indicating a curve to the right and a speed of 20 miles an hour. This is the manner by which you are advised to reduce speed from 50 to 20 and that a lane will be dropped.



This is a view of one of the two yellow and black speed reduction signs which is down, the condition of the shoulder, and the debris on the road.



As you go over the curve you approach and then see this overhead red sign which indicates by an arrow and the word "curve," a sharp turn to the right; again the speed now is 20 miles an hour.

We are still on Interstate 78, and it says ,"To 95," with the arrows straight ahead; but the overhead sign ahead has an arrow pointing right.

This is a closer view of the overhead sign. Observe the guardrail is down right at the center of the curve.



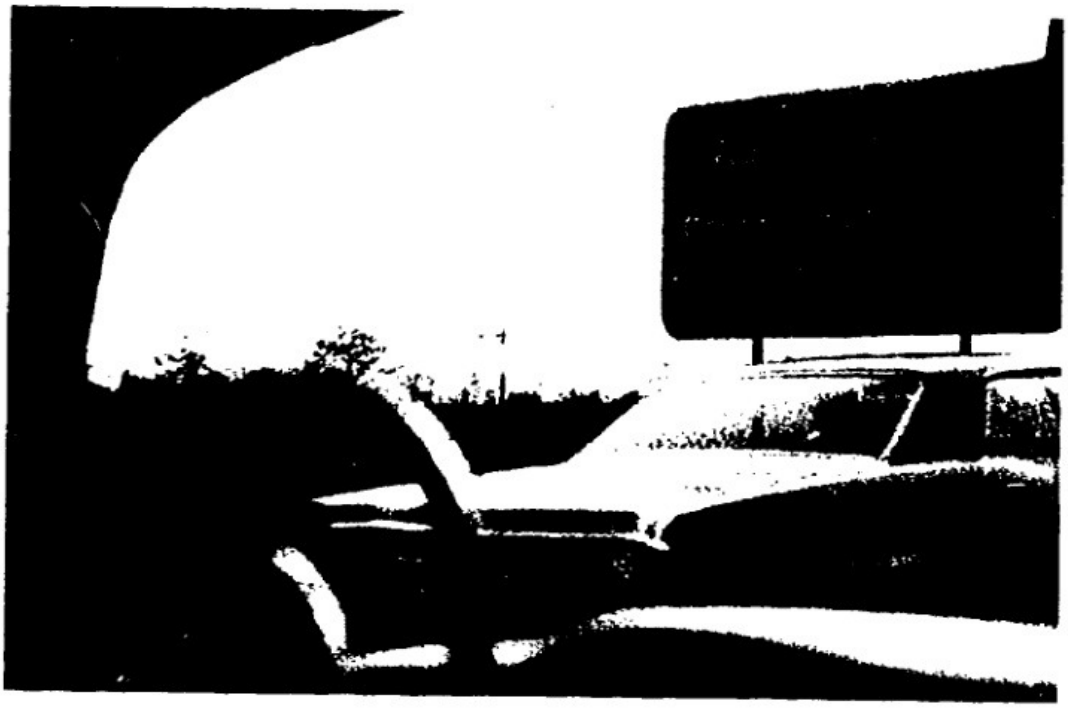
Up to this point, again, the motorist has not been given any message that this is the Cross Bronx Expressway. What he is told is this is the Bruckner Boulevard, south and north, and must make a decision. At this point he still does not know where the Cross Bronx Expressway is.



This is the first message about the Cross Bronx Expressway, and this is after distance and after passing several critical decision points.



This is a closer view of the sign on the left, of the Cross Bronx Expressway.





This begins a series of slides and is representative of the other signs on this Interstate road, their condition, location, and maintenance.

This is one, "Bronx River Parkway, Westchester, Upstate;" there is another sign beneath it which is resting on the ground. That provides information to other vehicles, including trucks and commercial vehicles.

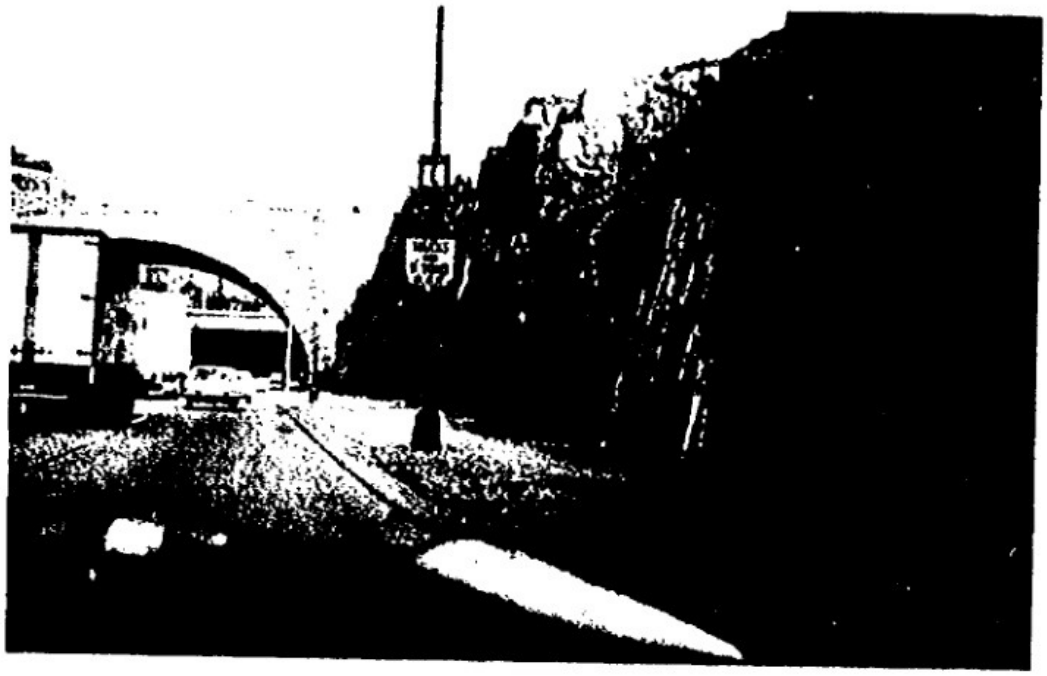
The bottom line is not to be seen; the grass has grown above it. These are older type signs, to be sure, but traffic volumes are 100,000 to 130,000 a day on this Interstate road. Visibility, legibility, and target value are low.



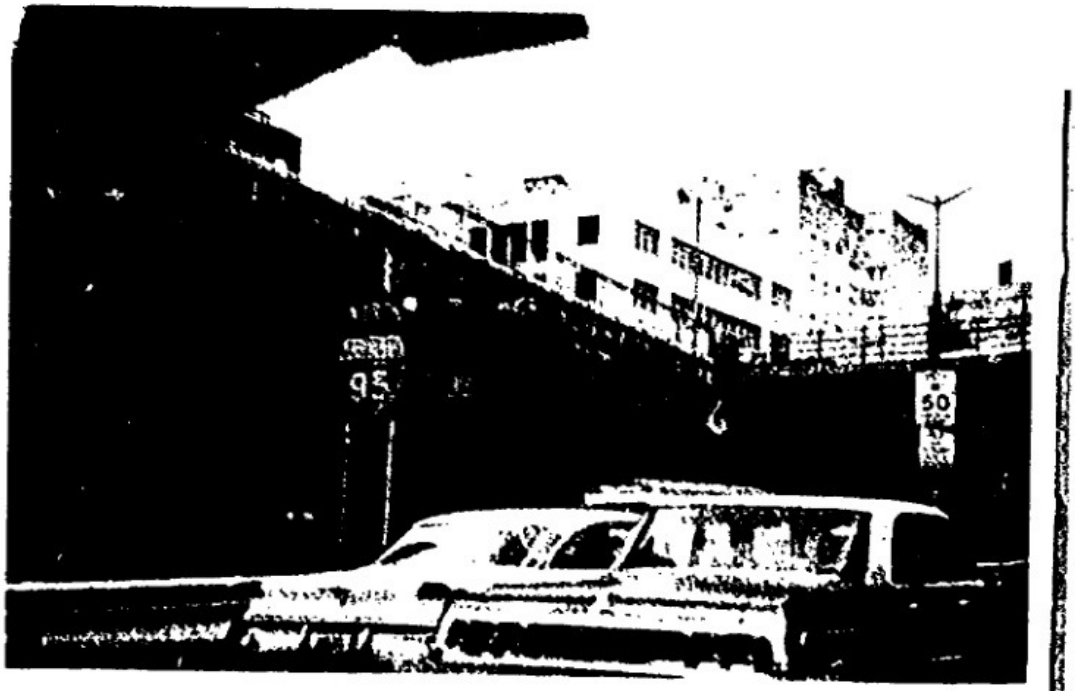
This sign which is on the left in the median of a three-lane road indicates "Westchester, Upstate, Keep Right;" this is the only such sign on the left giving this information. Because of its placement, condition, and dirt it would be easy to miss.



This is the second sign and is on the right side at the exit, the ramp.



This also is representative of the placement and the condition of many of the signs. This sign indicates "Trucks Over Five Tons Keep Right." In some instances on the left side, in most of the cases these are on the right side. This is a three-lane highway, very heavy volumes. Because of the placement on the right side, the three lanes, and the dirt on the sign it could easily be missed.

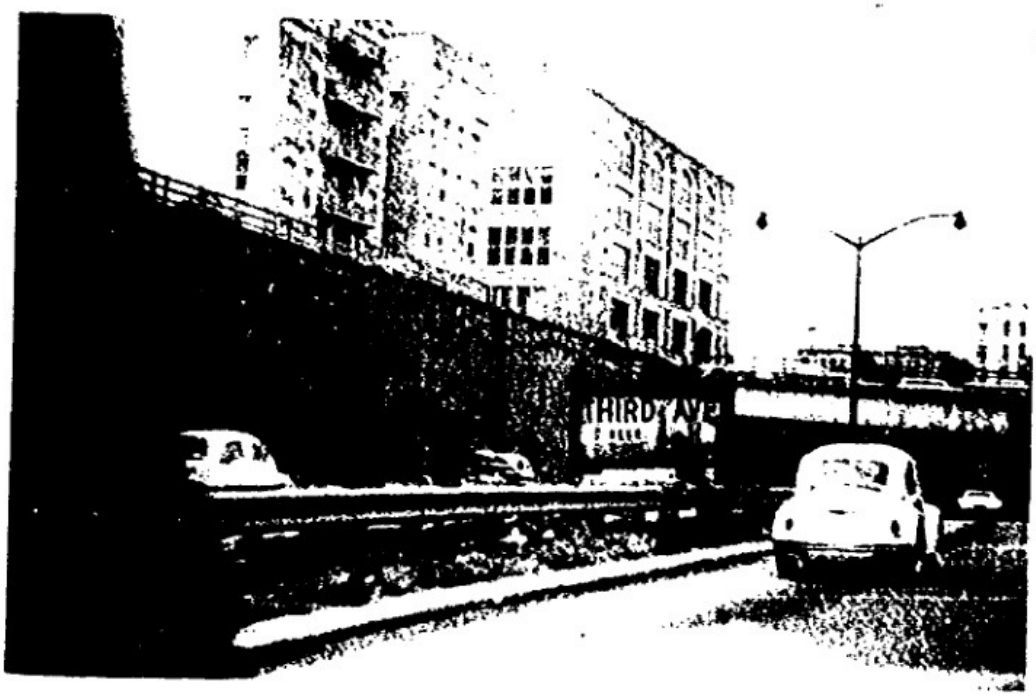


Here is one on the left side. In the event a truck is in a fast lane, where he should not be, he has the information to get over, provided

he can see clearly and easily. The maintenance condition of this sign is such he might not be able to do that.



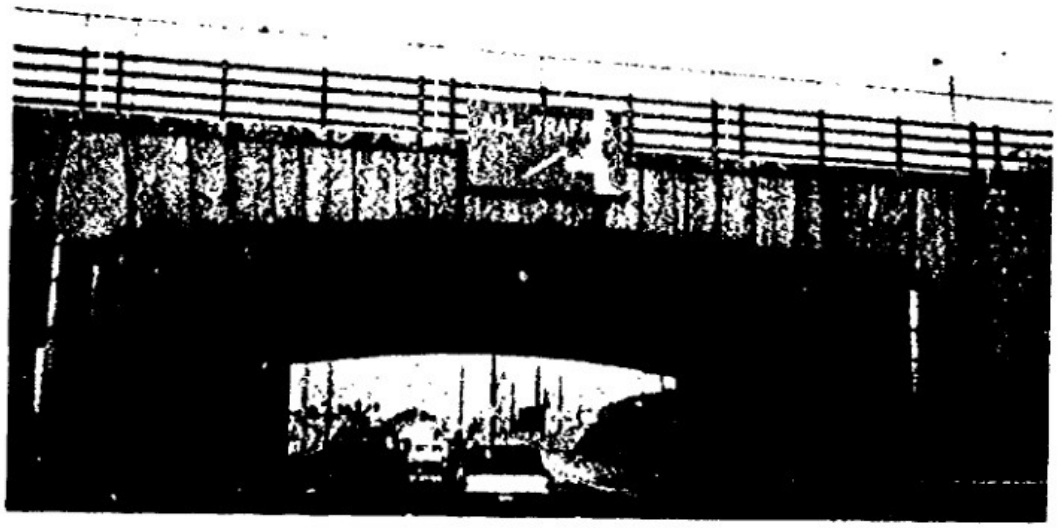
This begins a sequence of three slides. The point of this is through this underpass, through this tunnel if you will, there is an older sign on the left side of this three-lane Interstate to indicate that you must keep right to get to Third Avenue. This is the scene the motorist sees as he comes upon this area. The sign and message are not visible to the motorist at this point.



As you pass through short tunnel, here is the sign, "Third Avenue Keep Right," and the condition of it. You come upon it suddenly on the left, it is low, and the message is almost obscured by the dirt.



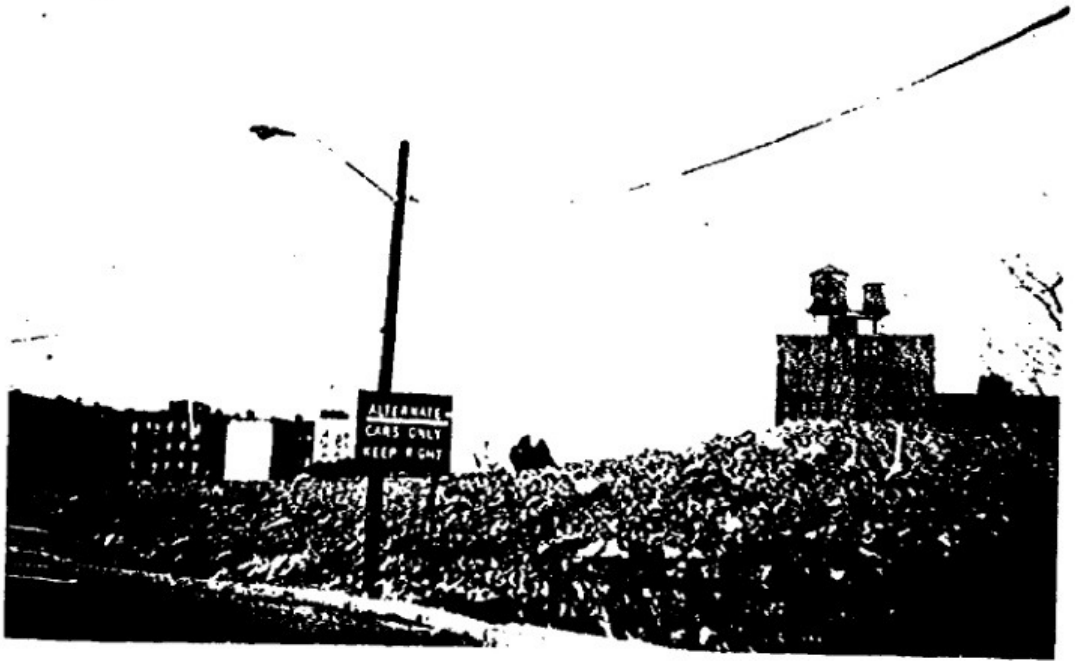
Immediately ahead, by a matter of a few hundred yards, is this second sign, the only other sign, "Third Avenue," off to the right.



This is the approach to a construction area on this interstate segment, and these next few slides indicate some of the signs that have been put up during the construction of this road.



This is a sign which is yellow and black, black border, and it says, "No Shoulders," except you cannot read it. "No Shoulders" is a warning to be extremely careful. There are no shoulders. It is placed a few feet off the traveled way and because of the dirt it cannot be seen.

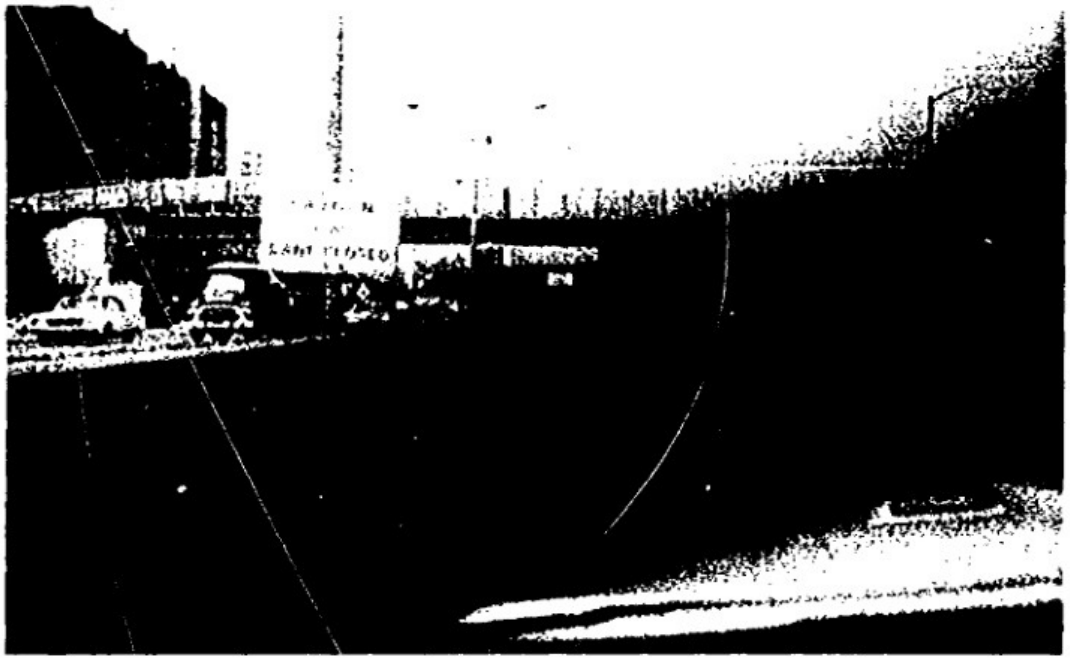


Here is in this area from Interstate 78 to Interstate 95 a temporary sign. It says "Alternate Cars Only Keep Right." I do not know what it means.

Mr. Petrillo, do you know what it means?

Mr. PETRILLO. Every other car keep right? [Laughter.]

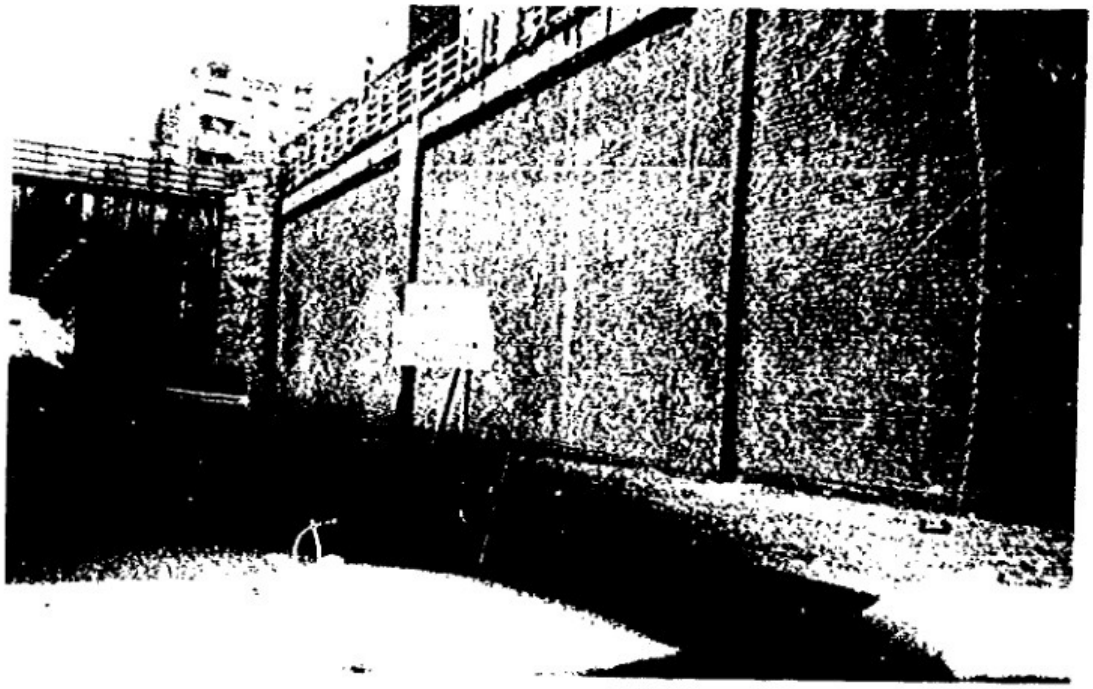
Mr. KOPECKY. We wonder what the trucks might do here, where the sign would indicate keep right, cars only keep right; where do the trucks go?



This was another sign that a motorist would see as he goes through one of the underpasses. This sign is in the median, between the median rail, and, again, it is a three-lane Interstate. You can see, and it says "Caution, Right Lane Closed." There was no other similar sign on the right side at any point. Here is information of significance to the motorist on the right and the message is at the left. We should remember that trucks are obliged to keep to the right here.



This is another one on the same stretch of road. "Dangerous Cargo," and then it says "Trucks over 13 feet 6 inches high" with a small arrow to the right. This is small, not very conspicuous, and there are extremely few such signs. This might also cause one to wonder just what dangerous is and whether it applied to height alone or to something more.



This is to indicate the particular construction area.



This is another location. This and the next picture relate blocking of signs. What you do not see here is the fact that there is a ground-mounted sign with the sign panel blocked by the overpass.



This is the first view the motorist would get of it as he is most of the way through the underpass, with the arrow to the left, telling him he has got to get over and take a left turn to get to the Whitestone Bridge to Interstate 678. He has a very, very short time and distance to see and absorb this message and make decisions.

Thank you.

Mr. MAY. Thank you, Mr. Kopecky. Could we have the lights, please. Mr. Prisk, Mr. Petrillo pointed out that signs in the New York area, particularly the Interstate roads, failed to have the name of the well-known highways. Was there some prohibition in the AASHO Bureau regulations that would prohibit the placement of those named highways on the signs?

Mr. PRISK. I think there was no express requirement that there be names used to identify the intersecting highways. But as these problems developed over the past 10 years there has been a ruling established 3 or 4 years ago now, which is clearly permissive of the use of the names of the highway along with the route number on the Interstate signing.

Mr. MAY. Did that come about in the last couple of years?

Mr. PRISK. About 3 years ago.

Mr. MAY. So at the moment there is no prohibition against putting the names on the signs; somebody just has to get going with the project?

Mr. PRISK. That is right. So long, of course, as the name of the highway is displayed in accordance with the other requirements for Interstate signing—that is, proper internal organization of the sign message, limitation of the sign message to the point where the driver is not overloaded getting too much information, and proper letter size.

Mr. MAY. I want to thank you very much, Mr. Petrillo, for helping to illustrate some of the problems that confront us and the highway people. Thank you very much.

Mr. HOWARD. Our next witnesses will be Mr. John W. McDonald, and Mr. Paul H. Fowler. We wish to thank you gentlemen for appearing before the subcommittee. Will you please stand and raise your right hands.

Do you solemnly swear that the testimony you will give before this subcommittee will be the truth, the whole truth, and nothing but the truth, so help you God?

Mr. MCDONALD. I do.

Mr. FOWLER. I do.

Mr. HOWARD. Mr. Constandy.

Mr. CONSTANDY. Mr. McDonald and Mr. Fowler, will you give your names and your affiliation, please.

TESTIMONY OF JOHN W. McDONALD, DIRECTOR OF ENGINEERING AND TECHNICAL SERVICES; AND PAUL H. FOWLER, TRAFFIC ENGINEER, AUTOMOBILE CLUB OF SOUTHERN CALIFORNIA

Mr. MCDONALD. Mr. Chairman, gentlemen, I am John McDonald, director of engineering and technical services of the Automobile Club of Southern California.

Mr. FOWLER. I am Paul H. Fowler, traffic engineer, Automobile Club of Southern California.

Mr. CONSTANDY. Mr. Chairman, the Automobile Club of Southern California has an illustrious history and has been active in the field of signing for motorists since, I guess, pretty much the beginning of the century; has it not, Mr. McDonald?

Mr. MCDONALD. Yes.

Mr. CONSTANDY. The observations of these gentlemen, based on their own experiences with the club and the experience of many others in the club, can be most helpful to the committee. I think that some of the points they make in their paper will be of considerable interest to the committee as we go through these hearings. If you could begin, Mr. McDonald. From time to time perhaps we can interrupt, if you do not mind. You have a rather lengthy statement, but you go ahead with it.

Mr. MCDONALD. Certainly. I would welcome questions and interruptions. My understanding is that this is to be relatively informal.

Mr. CONSTANDY. Yes.

Mr McDONALD. I do not intend to read the statement verbatim. I had highlighted it, and I will try to run with it, without overlooking it.

Mr. CONSTANDY. Fine. I think the statement has so much value, Mr. Chairman, that I would ask permission that it be printed in the record.

Mr. HOWARD. Without objection, so ordered.

(Prepared statement appears as appendix B.) (See p. 644.)

Mr. MCDONALD. Mr. Constandy mentioned the history, and I would like to mention two or three other historical background items that might be of interest to the committee.

Actually we began highway signing in 1905. And at that time the members themselves, the directors of their club, personally bought and

installed these signs, and they directed motorists from downtown Los Angeles to some of the beach resort cities.

From 1906 until 1956 the automobile club developed and continued a signing program throughout California, a portion of Mexico, and easterly as far as the Missouri River. Signing services were provided at that time on a contract basis to the State division of highways and to 175 cities and counties.

In 1919 the club put together a sign chart, and perhaps that was one of their earliest attempts at uniform signing, to at least give a guide so that you can get a little more similarity in signing in different jurisdictions.

In 1956 the club gave up actively sign posting, the actual installation of signs. Since that time we have provided advisory service in signing to small communities, and we have also served on advisory committees for larger jurisdictions and worked closely with the State division of highways on signing. We are represented on the California Traffic Control Devices Committee and also on the National Joint Committee on Uniform Traffic Control Devices.

As spokesmen of the club, we appreciate and we welcome this opportunity to speak to this committee and particularly since we understand and agree that this is in the interest of improving driving conditions for our members and for the motoring public generally.

I would like to make the position of the Automobile Club of Southern California as clear as possible with respect to this hearing and also with respect to our relationships generally with the responsible public agencies, which I think may be in some respects unique. A fundamental purpose of our organization is to support and strengthen these highway programs and the highway agencies that are carrying out these problems. And so we make every effort to make any criticisms we may have constructive. We feel there is a great deal to be accomplished in the field that you are exploring. However, we also feel that there has been a great deal of positive effort on the part of public agencies and others, and that there is a lot being done, in an effort to meet these problems, particularly perhaps in our own State of California.

To illustrate this point specifically, I would like to read a short letter of transmittal from our report, our 1963 report which was entitled, "Directional Signing on Metropolitan Freeways." I quote:

> This report is intended primarily for those with responsibility for metropolitan freeway signing in California. Hopefully, it may be useful in other areas as well.
>
> Along with Federal, State and local officials, we at the Automobile Club of Southern California also have signing responsibilities. It is our responsibility to support and defend good signing principles and, as illustrated here, to convey to public officials and others our interpretation of motorists' needs in signing. When warranted, it is our responsibility to be constructively critical.
>
> Our hope is to have the report received in the spirit in which it was composed—as an effort toward the evolution of better guidance for motorists—an effort to meet the responsibilities we share.

Later on Paul Fowler will discuss some of the specifics from that report.

In this case, as in most other cases, where we felt it was necessary to be critical on the subject, we took our criticisms and suggestions directly to the people in the agencies responsible. We think this is the most effective method of procedure, and we feel it is essential if we are to perpetuate the mutual trust and the confidence which the automobile

club now enjoys with public agencies such as the State division of highways.

Both Paul Fowler and I know something of signing and highway operational problems from both sides of the fence. We are well acquainted with the public agencies; but in our work with the automobile club we have the additional advantage of being on the outside looking in, sort of in the way that this committee is doing. And we have another considerable advantage which is the availability of a very useful data source, represented by over a million of our motoring members.

California is, and has been since World War II, involved in a very large freeway building program, so that our State perhaps has encountered many of the problems which have only recently been encountered in States where their freeway building program actually got started only as a result of the impetus of the 1956 Interstate Highway Act.

Mr. CONSTANDY. Is it correct that in the Los Angeles area alone the entire freeway system by 1980 will be approximately 800 miles?

Mr. MCDONALD. Yes.

Mr. CONSTANDY. And to date, or at least as of January 1, 1967, there were 444 miles of that 800-mile system already completed and open to traffic?

Mr. MCDONALD. 400; yes.

In 1957, because we were at that time aware of some of the signing problems, we distributed a questionnaire to our members, and we sought their views on freeway signing problems. That was 11 years ago, and we got a response from literally thousands of our members, and it helped us materially in identifying some of the basic problems, some of which, unfortunately, are with us today and we hear about them today.

In 1958 the California Division of Highways obtained the help of the Automotive Safety Foundation in making a study of driver needs in freeway signing, which I think most of you gentlemen are familiar with. There was a report issued by that name. The Institute of Transportation and Traffic Engineering of the University of California also assisted in this report. We believe this was a milestone along the way toward better signing; and although signing practice has changed materially in 10 years, the principles that were identified in that report, we think, are as valid today as they were then. I would like to read the principles.

Mr. CONSTANDY. I wish you would. I think these are most important to these hearings. We will be concerned with these six principles which you identify, and I think at least part of the problem nationally has been the lack of appreciation of these principles; and hopefully, through these hearings, the people concerned with signing nationally will begin to pay more attention to them.

Mr. MCDONALD. As I have them in my statement, these principles are paraphrased and simplified. I will read them this way. Actually, to do full justice, they ought to appear in the record.

Mr. CONSTANDY. I would like to ask, Mr. Chairman, that that report be made part of our record, not necessarily printed in it, but I think it should be part of the body of the testimony here.

Mr. HOWARD. Without objection, so ordered.

(Report was marked exhibit 1 and filed with the committee.)

Mr. McDONALD. I would summarize it this way:

1. The need to carefully phrase signing messages to avoid misinterpretation.

2. The need for continuity with respect to the context of signs read in sequence.

3. The vital need for advance notice and repetition.

4. The importance of relatability as between sign messages and other sources of driver information, such as maps.

(I brought some maps of the Los Angeles freeway system that were produced by our organization, and we might come back, if you want, to discuss that a little.)

5. Need for signs of proper size in relation to traffic volume and speed.

6. Need for special attention in signing where design requires unusual maneuvers—such as left hand off ramp. (Obviously the counterpart of this is extending every effort in the design stage to avoid design which creates an unusual move.)

Mr. CONSTANDY. Those six points seem reasonable. Had attention been paid to the six points in signing the highways we observed in Mr. Petrillo's presentation, much of the problem would have been taken care of.

Mr. McDONALD. I think that is true. I think you can just go down the check sheet and check one or two of these in every instance. That is precisely the way we would summarize the situation. Almost any problem you can see and illustrate today in signing probably violates at least one of those principles, sometimes two or three. Another thing that this Automotive Safety Foundation study identified were the different driver needs among three different types of drivers. Mr. John de Lorenzi mentioned these yesterday, but I will mention them again.

You have the driver on the long trip, the driver on a very short trip in his own neighborhood, and third, you have an intermediate length trip within a large metropolitan area, and that is a category that we give special attention to. It is essential that these three differing needs be recognized in trying to come to solutions to these different signing problems.

Another report that should be mentioned was produced in 1961. It is called, "Freeway Operations—New Information on Emerging Responsibilities." This report stemmed from a series of seminars instituted by the Institute of Traffic Engineers. Among the problems that were identified as urgent in the freeway operations report were these:

Wrong-way movements;

Lack of consideration of signing in the design stage;

Surface street connections within freeway-to-freeway interchanges;

Left hand off ramps;

Too many ramps in a relatively short distance.

Mr. CONSTANDY. Mr. Chairman, I would like to make that publication entitled "Freeway Operations—New Information on Emerging Responsibilities," exhibit No. 2.

Mr. HOWARD. So ordered. (Publication was marked exhibit No. 2 and filed with the committee.)

Mr. CONSTANDY. We discussed that publication last year in connection with roadside hazards. It was very helpful then, as it will be during the course of these hearings.

Mr. McDonald. Now in 1962 we became particularly concerned about this driver making the intermediate length trip in a large metropolitan area, with a fairly well developed freeway system. Obviously, Los Angeles is a prime example of that. We, too, made the use of the phrase "local stranger" to describe this type of driver. The basic need of that driver is identification of freeways by name. It is simply through common usage that people refer to and use freeway names to identify the freeways in a system in the metropolitan areas particularly.

Now, unfortunately, along with the need to show these names on signing, we have the complication that some of these names do not lend themselves very well to use on signing; and a prime example of a poor name and the kind that we unfortunately have several of, is a freeway named for a terminal at one end, so to speak. In other words, the San Diego Freeway: this name obviously becomes a problem when you are trying to sign for traffic that is operating and headed in the opposite direction, away from San Diego.

Mr. Constandy. I had that problem. Is it true that the original freeways led to the center of Los Angeles, and the fact that they did, it then seemed appropriate to give them the name at the other end of the——

Mr. McDonald. Yes. I am sure those who named these freeways in the beginning acted in good faith and thought this was a good way to designate a system of radial freeways. They led to Pasadena, Santa Ana, Long Beach. That is the way many streets are named in cities, and they followed that old pattern.

Mr. Constandy. Once the motorist knows that, it is a big help. It took some time before I realized it. There was one other thing that someone out there mentioned—that frequently, as a new freeway is discussed in the newspaper, the advance publicity for it gives some identificatioin; it may not yet have a route number assigned to it, and people will refer to it as being the freeway named for some prominent landmark along the way, or where one portion of it runs along a river, for example. Then it is difficult to change the name that has been accepted by the public in publicity given to it in advance of its construction.

Mr. McDonald. Yes. This is precisely the problem area that I wanted to go into now, briefly, or in whatever length the committee wants, now or later.

We did get deeply involved in this problem of freeway naming and use of the freeway names on signing. Through the cooperation of the Division of highways and the State chamber of commerce, we were able to get a Senate concurrent resolution in our State legislature calling for a study of names. A report was written which contains guidelines with regard to both parts of this problem: First, providing an orderly procedure for selecting good names and assigning them. (And this I have a copy of, the report, also.)

Secondly, of course, once you have the names established, then you want to get them incorporated properly into the metropolitan freeway signing.

Mr. Constandy. Could you give an example of what a good freeway name would be?

Mr. McDonald. Yes. There are criteria mentioned in here, but a good freeway name, in my judgment, is the Foothill in the Los Angeles area. This gives you some feeling for the general areas served, but there

is nothing directional about it. It is up along the foothills. Also, the Golden State Freeway is not a bad name. It gives you no orientation particularly, but it is neutral, let us say.

Mr. CONSTANDY. That is highly desirable?

Mr. MCDONALD. Certainly neutral is better than some of the ones we have. Really, it is easier to describe a good name by describing what you should not do. And one thing you should not do, obviously, you should not name it for a terminal at one end. You should not name it for a parallel arterial street, which is also an error we have made, which creates problems when people are choosing between operating on the freeway or remaining on the parallel surface street.

You try to choose a name that is short, because this simplifies, obviously, the problem of getting the name on the sign, and this has been a real problem. If you can, it is nice to pick a name that has some helpful orientation, meaning such as Bayshore or Foothill, which I would say were good names.

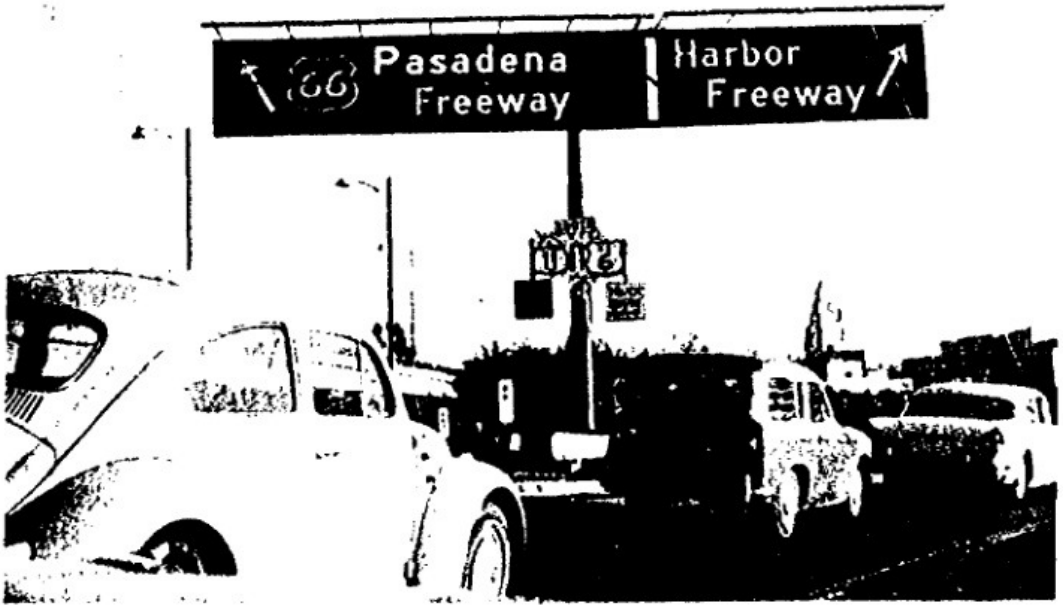
So now Mr. Fowler and I are ready to report on some recent developments in several general areas, and to illustrate these—namely, directional signing on metropolitan freeways, signing to freeways, street name signs, wrongway drivers and delineation of the traveled way. We will be happy to try to answer questions as we go along, or to enlarge on any of these subjects as time permits.

The first subject would be directional signing on metropolitan freeways. Mr. Fowler will take over here.

(Slide.)

Mr. FOWLER. As we have already mentioned, in the early years, right after World War II, and into the early fifties, freeway construction in the Los Angeles metropolitan area was concentrated largely on five radial routes, expanded outward from the central downtown area. Each of these five routes was named individually.

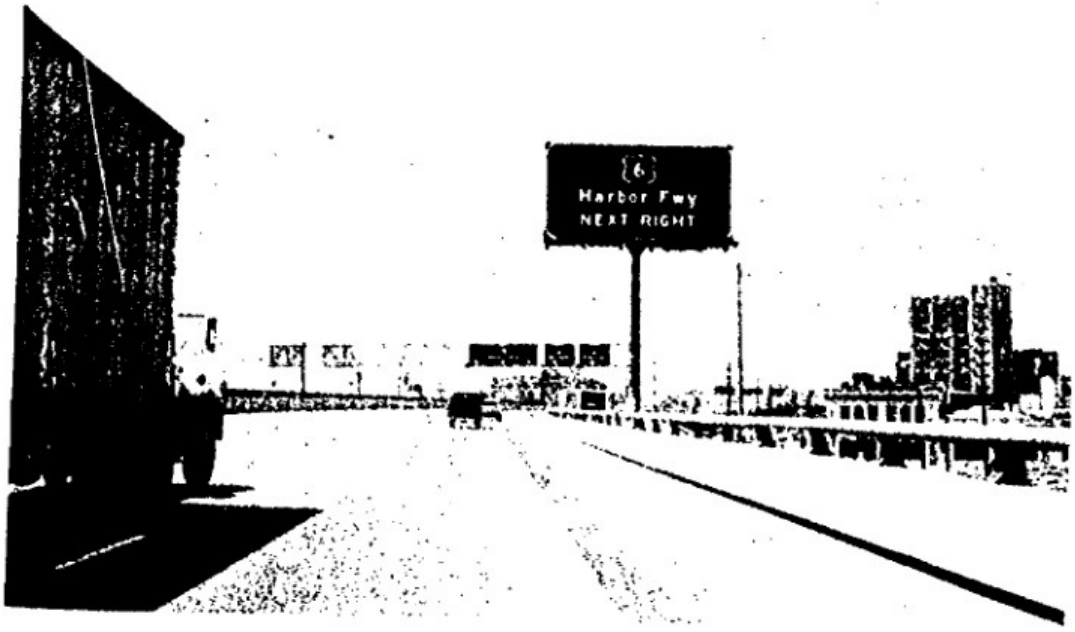
These earlier signs clearly show the original signing to the Pasadena Freeway, the Harbor Freeway.



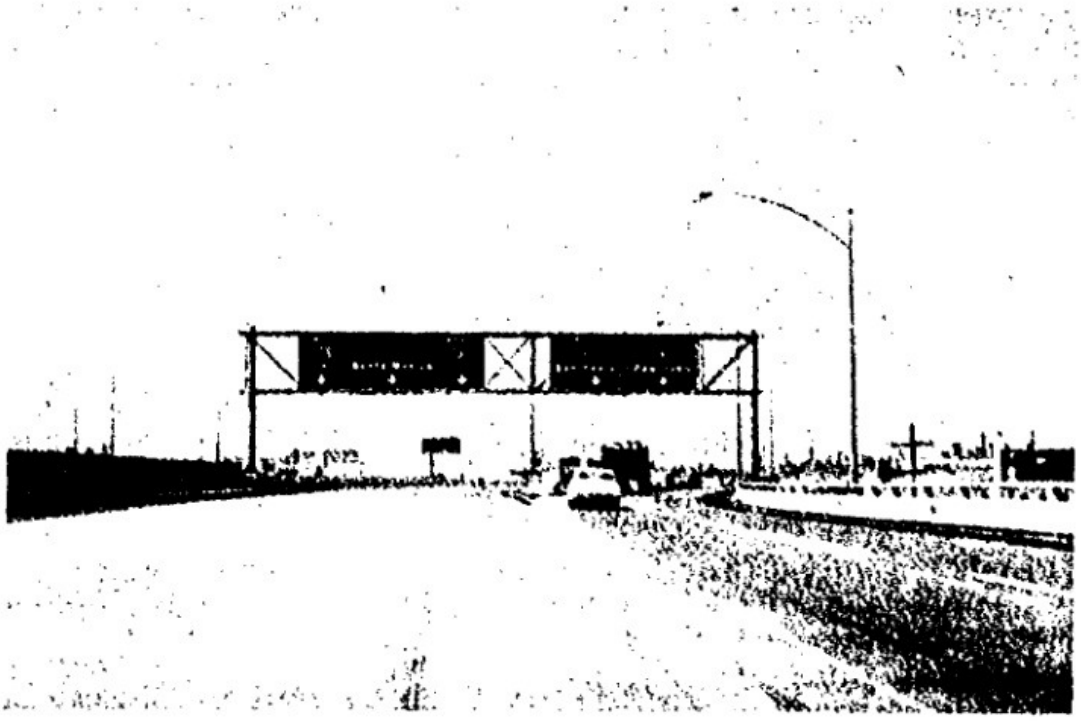
The Hollywood Freeway, San Bernardino, and Santa Ana Freeways.



People recognized these five radial routes by their names, and the minimum amount of confusion resulted. There was very little prominence given to cardinal directions or to route numbers. As the system expanded and alternate routes became available, the problem of adequately identifying directional information to the motorist was compounded.



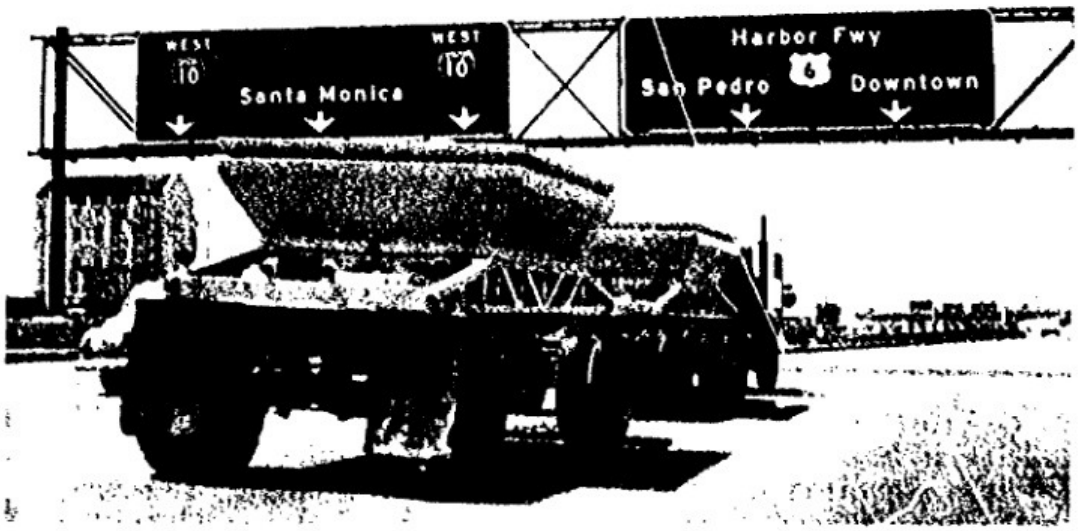
I would like to move, therefore, to a specific location then on the Santa Monica Freeway, which is Interstate Route 10, right on the southerly edge of the downtown area. The original signing that was installed when this Interstate route was constructed contained advance signing to the Harbor Freeway Interchange, and the notation was given on the advance signing: U.S. Highway 6, Harbor Freeway next right.



Unfortunately, at the point of choice, where the motorist either remained to the left on Interstate 10 or took the right-hand connector, which led to the Harbor Freeway, the name of the Harbor Freeway was omitted, and this caused confusion to many motorists because they were tuned for the name.

Instead, the signs merely read: U.S. 6 west to San Pedro and east to the downtown area. And in this case there was an additional point of confusion, simply because while U.S. Highway Route 6 is a major transcontinental east-west highway yet for its entire 300-mile length within the State of California it runs in a north-south direction. This problem was very similar to the one documented by Mr. Petrillo. So the U.S. 6 shield, east and west, was confusing as far as cardinal points of the compass are concerned.

Mr. CONSTANDY. Where is San Pedro in relation to where we are?
Mr. FOWLER. The left-hand sign to San Pedro was directly south.
Mr. CONSTANDY. San Pedro itself is south of where we are?
Mr. FOWLER. Yes.



So, in the second-stage development of the signing then, those last two were removed, and the right hand with these two signs were substituted. The problem was somewhat reduced by noting the Harbor Freeway name and removing the confusing cardinal directions.

So that we have the choice between San Pedro and downtown by the Harbor Freeway, U.S. 6. That was only a partial solution. And it was not really resolved until 3 years ago when, by action of the State legislature, there was a complete and comprehensive renumbering of the entire State highway system in California.

Mr. CONSTANDY. Could we talk about that just briefly? Do you happen to know how many U.S. routes there were in California? There were several?

Mr. FOWLER. Yes. About a dozen, or 15 probably; and that was markedly reduced, by the way, so that, to the best of my knowledge, there were about six that remained in California.

Mr. CONSTANDY. This came about because roads which had run across the United States, in an east-west direction had an even number, but when they got to California, they turned and ran generally north and south; is that correct?



Mr. FOWLER. Most of those routes did terminate either in Los Angeles or San Francisco. In the case of Harbor Freeway, that appeared in our previous slide, the U.S. 6 Route shield disappeared, and the Harbor Freeway became known as State Highway 11. So the advanced signing then was changed, and we simply got the State Route 11 shield, "Harbor Freeway Next Right."

Mr. CONSTANDY. I wonder to what extent the motoring public realizes that roads that are even numbered run east and west, and odd numbered north and south? Has the department done a survey of that, do you know?

Mr. FOWLER. Not to my knowledge, at least not in statistical form. We are aware that in our freeway driving clinics, which we put on monthly for the members, that this question comes up frequently. And it is obvious that the general motoring public is not aware of a system or pattern to the assignment of route numbers.

Mr. CONSTANDY. So the signs which are intended to guide the motoring public have a system of numbering, which is really meaningful only to the engineers; is it not?

Mr. FOWLER. That is a pretty fair description of the present situation, I am sure.

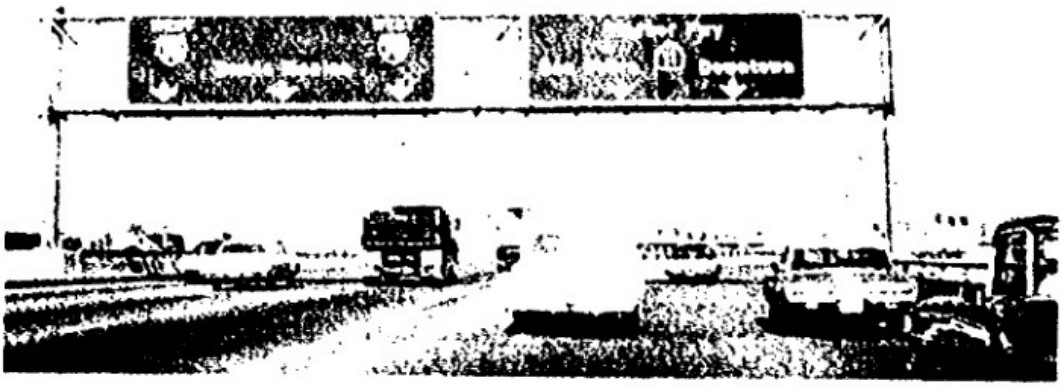
Mr. CONSTANDY. Why I mention that is that you people in California have to some extent, resolved the problem, but it does exist in other places where it has not been resolved. I think it does, as Mr. Petrillo's slides show, create some confusion. I-95 across Connecticut is running almost east and west, close enough so that you can say that, and it is also called the Connecticut Turnpike. On one sign you have a message that reads, "I-95 North and South, Connecticut Turnpike East and West." It is the same road. And I think this kind of thing cannot help but confuse the motorist.

Mr. FOWLER. I would offer the opinion that the significance between an odd or even number is much less important than is the correct assignment of cardinal directions.

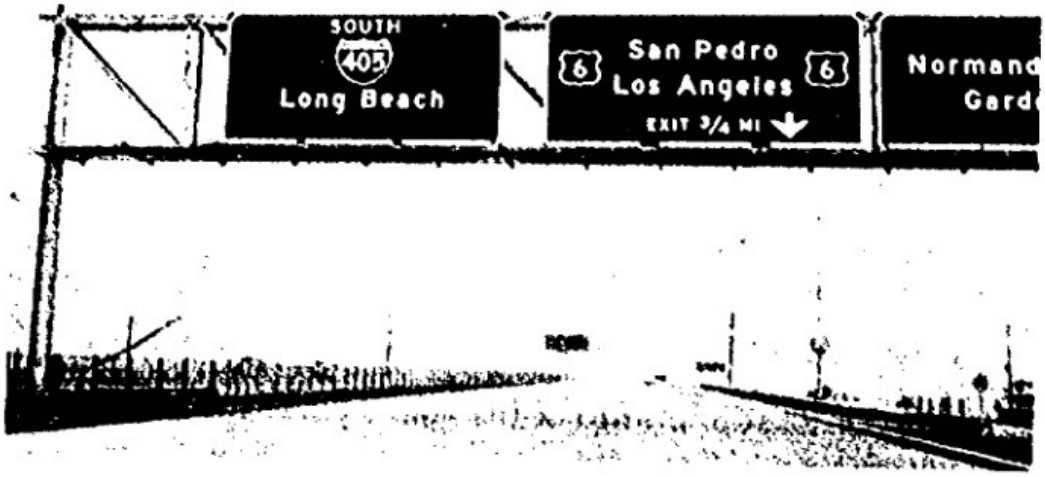
Mr. CONSTANDY. Yes.

Mr. FOWLER. If the route number happens to be out of place, the cardinal direction should remain correct, from our standpoint.

Mr. CONSTANDY. That seems reasonable.



Mr. FOWLER. Then, getting back to the slide series again, at the point of choice the Harbor Freeway name was placed in front position at the top of the sign, with a corrected route shield indicated as State Route 11. And the east-west and north-south designations were omitted, to help clarify this situation.



Turning now to another location along the San Diego Freeway, Interstate Route 405, approaching the Harbor Freeway interchange. This generally is in the southerly portion of the metropolitan area. Once again we have a situation here that actually illustrates three different comprising difficulties. The first confusion is that the advance signing, three-quarters of a mile in advance of the interchange, made no mention of the name, Harbor Freeway.

The second confusion related to the use of the U.S. 6 Route shield, which, at least to the engineers, as we have seen, indicated an east-west route, while freeway was well oriented north and south.

And then the third confusion resulted from inadequate lane designation. You will note there is a down arrow in the right lane, indicating that that serves the connecter to U.S. Route 6.



The next sign, also in advance of a quarter of a mile from the interchange, repeated that message. No mention of the Harbor Freeway. The U.S. Route 6 shield, and the fact that there is a down arrow in the left lane serving the connection to U.S. 6——

Mr. CONSTANDY. May I ask a question? The 405 stands out so much on the Interstate route shield. I wonder, is that the size prescribed in the manual, or is that something larger?

Mr. FOWLER. This is an enlarged size of the Interstate shield, which California adopted for use on all overhead signing.

Mr. CONSTANDY. It is bigger than what is prescribed?

Mr. FOWLER. Yes.

Mr. CONSTANDY. Do you happen to know how many inches the numbers are?

Mr. FOWLER. I believe they are 16-inch height in the numbers.

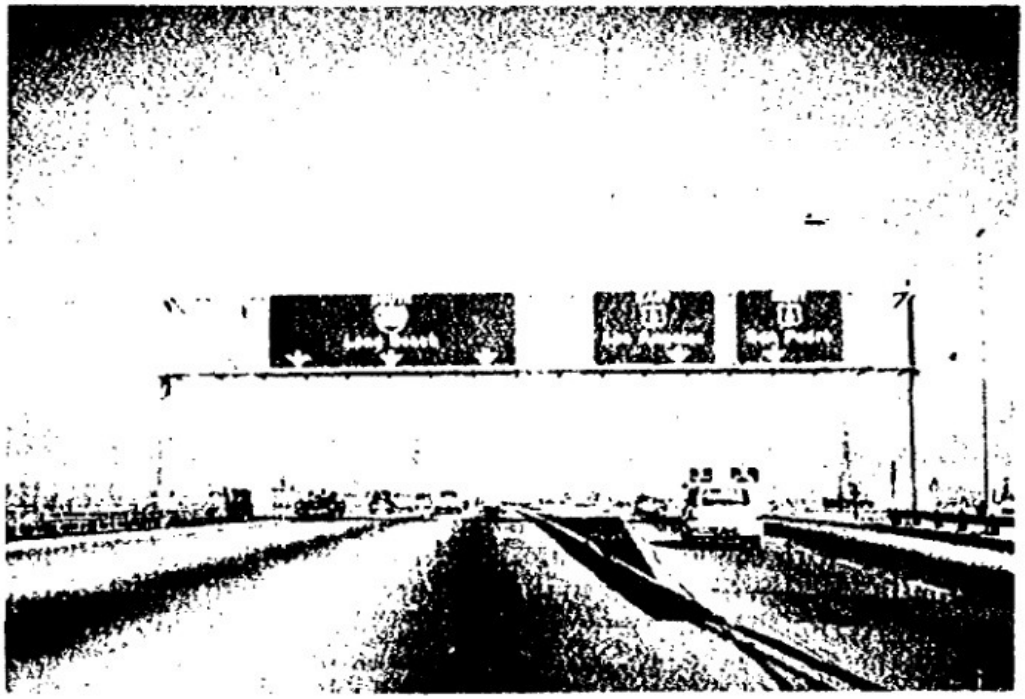
Mr. CONSTANDY. I see.

Mr. FOWLER. They appear to be the same as the caps on the destination.

Mr. MCDONALD. We could get that exactly and supply it to the committee.

Mr. CONSTANDY. We would appreciate that.
(The information follows:)

Herewith is the information requested, having to do with the letter height of the Interstate numerals on our overhead signs here in California. Ordinarily, we use 10-inch upper and 12-inch lowercase letters with 15-inch numerals (for one or two digit numbers). The Interstate shield dimensions are 36 inches by 36 inches for one or two digits and 45 by 38 inches for three digit routes. Occasionally, oversize 20-inch upper and 15-inch lowercase lettering is used for through messages on the overhead signs. When this is done, the numerals are increased to 18-inch size and the interstate shield dimensions become 48 by 48 inches or 58 by 51 inches, depending upon the number of digits.



Mr. FOWLER. At the point of choice now, still no mention of the Harbor Freeway by name. We now have the incorrect cardinal directions for east-west and north-south routes at this location, which is meaningless. You can see some skidmarks.

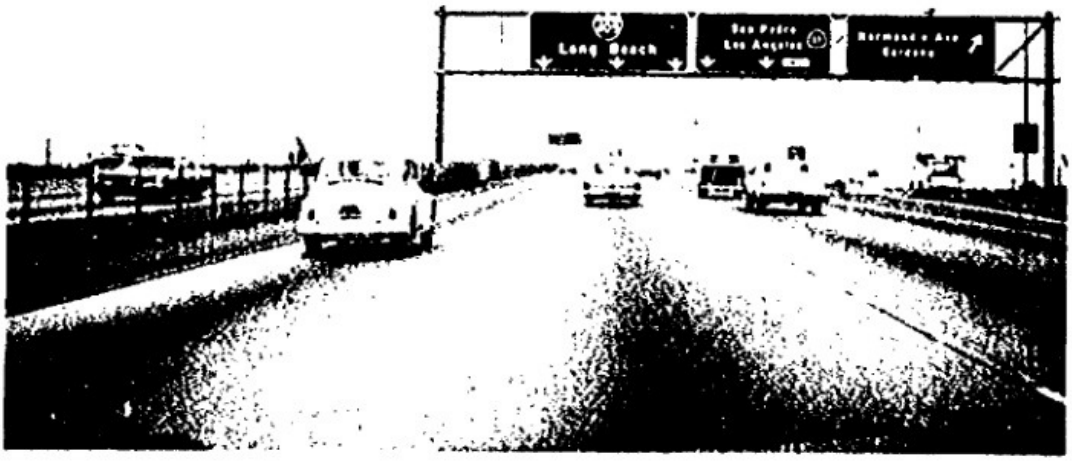
Now I would like to elucidate a little more on the confusion in that No. 3 and No. 4 lane. You will remember we had a down arrow indicating that the right-hand or No. 4 lane directly served the connection to U.S. 6. The problem was twofold.

First of all, there was no indication given to the motorist who was in that No. 4 lane that it was a mandatory connection to U.S. 6, that it was in effect what we call a trap lane. Any person who was in the No. 4 lane or right-hand lane, automatically had to continue into the connection that served U.S. 6.

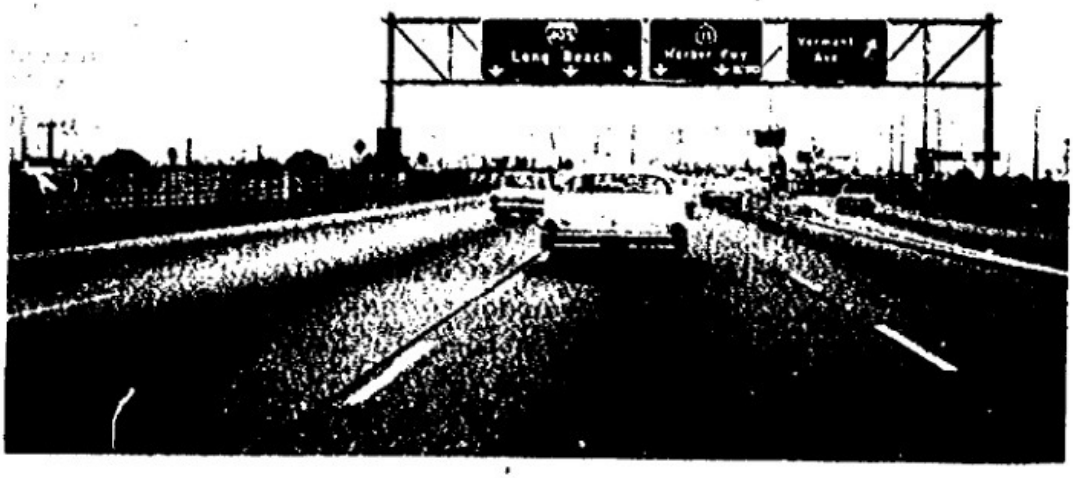
Second, the problem was compounded by the fact there was no indication that the adjacent No. 3 lane turned out in fact to be an optional turn lane. Anyone that was in the No. 3 lane could turn either the connection to 6, or continue straight ahead.

As a result, then, motorists in the No. 3 lane were forcing their way into the right-hand No. 4 lane in order to make a connection, only to find out that it was unnecessary for them to do so. They could have remained in the No. 3 and taken the optional turn; and at the same

time people in the No. 4 lane were forcing their way, at the last minute, into the No. 3 in order to avoid going on to the connector to 6. They had no advance notice.



Those problems were corrected in the re-signing then at this location. This goes back to the advance sign, and there were two changes made principally. You will notice that there are five down arrows on this four-lane section of the freeway, and that two of the down arrows point to the same lane, to No. 3 lane. This is an indication to the motorist then that he may reach either Long Beach on Interstate 405 or Route 11, San Pedro and Los Angeles, from that No. 3 lane. That is an indication that it is an optional turn, serving both destinations.



And then the other includes that which was added, the black-on-yellow plate, reading "Only," and placed over the No. 4 lane with the down arrow. That gave definite indication that No. 4 lane was a mandatory trap lane and was going to go to the connection to Route 11 only.

Mr. CONSTANDY. Is the use of the arrows in that manner and the "only" legend on the yellow shield prescribed within the manual?

Mr. FOWLER. No. The black-on-yellow is unique. Incidentally, there was a testing process that continued for more than 2 years. Originally the message on the overhead sign was white-on-green, just like the rest of the sign, and read "Only," but it did not attract attention sufficiently, and therefore the second stage of the test changed to the black-on-yellow warning designation in order to sufficiently alert the motorist to the fact that it was a trap.

Mr. CONSTANDY. Mr. Prisk, do you care to comment about the use of the arrows over the optional lane in that fashion? When I speak of manual, incidentally, I speak of the uniform manual.

Mr. PRISK. Yes. There was full knowledge in the committee handling the manual that this experimental work was underway, and there has been a continuation fo this type of installation in other States. I believe, if I am not mistaken, that this provision will be, is on the calendar to go into the current revision of the manual that is presently in preparation. So this practice will become a prescribed and specified practice.

Mr. CONSTANDY. If adopted?

Mr. PRISK. If adopted.

Mr. CONSTANDY. Is that true about the use of the arrows on the optional lane?

Mr. PRISK. I think the use of the arrow as portrayed here has not been considered in the same detail as the separate yellow panel.

Mr. CONSTANDY. It would seem to be worthy of consideration, would it not?

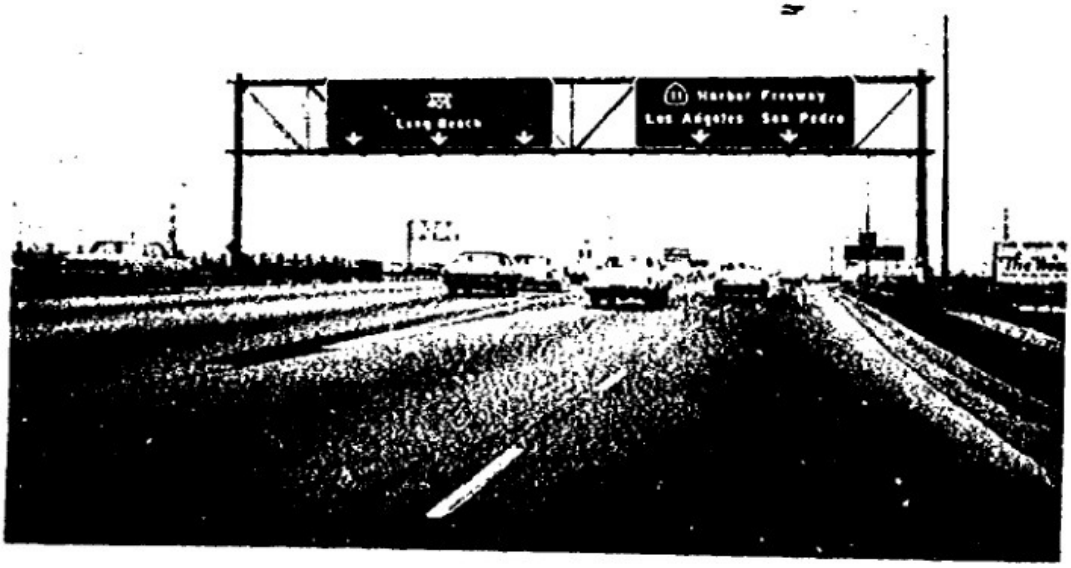
Mr. PRISK. Yes. I have seen this, and I think it would. Whether or not it is appropriate for all situations, I would hesitate to say here.

Mr. CONSTANDY. Maybe that is a good thing to keep in mind, many of the things that should be considered as appropriate may not always be so, and maybe some judgment should be exercised by the signing engineer.

Mr. PRISK. I hope so.

Mr. FOWLER. Getting back to the series, the third change was made at the point of choice, where the right-hand sign did include the name of the Harbor Freeway, with the new Route No. 11, and identified the two alternate destinations by name, either Los Angeles to the left or San Pedro to the right, and there was in this case no north-south or east-west designation made.

Mr. CONSTANDY. In these situations, Mr. Fowler, was the Auto Club able to evaluate the success of the change through the response of its members to questionnaires or perhaps through the lessening of letters to the club about the signs?



Mr. FOWLER. Yes. We are very much interested in maintaining a response directly from the members, and where changes are made and the number of complaints noticeably slackens, we pass the information along to the agency involved and help to evaluate the success of sign changes in that way.

Mr. CONSTANDY. It would seem that the club has the capacity to perform a worthwhile function, and perhaps the State highway department would have difficulty by itself developing this direct contact with motorists.

Mr. FOWLER. We try to fill that order, yes.

Mr. MCDONALD. Could I add a comment?

Mr. CONSTANDY. Yes, please do.

Mr. MCDONALD. I would like to mention that whereas the number of questionnaires in the formal sense that we have done are few, we have directly written articles in our pictorial which is our news publication to the membership, and discussed problems such as signing, to solicit comments informally, not in questionnaire form, but these responses have been helpful, in our judgment, as to how some of these changes have been received by the motorists.

Mr. CONSTANDY. This permits you to evaluate the change?

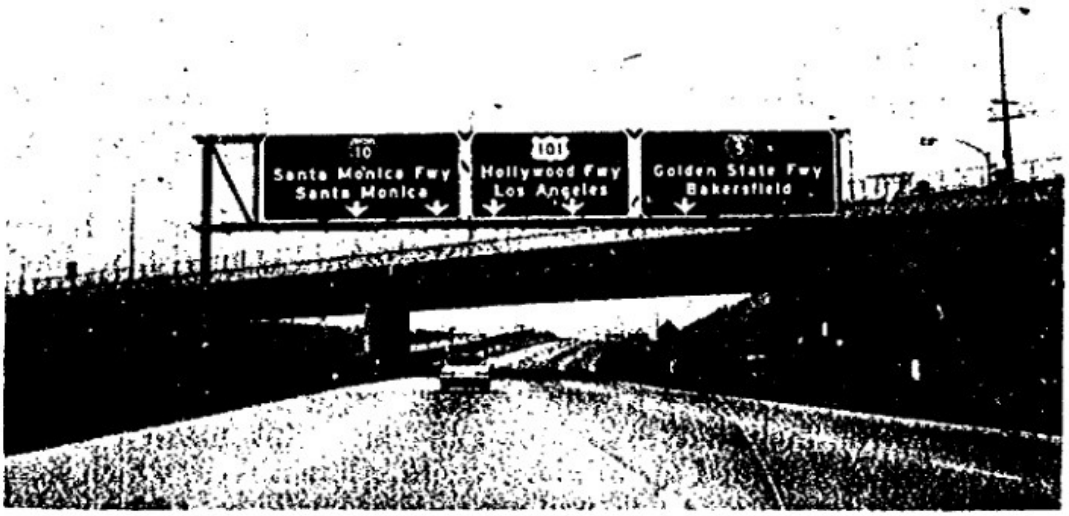
Mr. MCDONALD. Yes, in a general way. Of course there are other activities that I am sure you are aware of, that are attempting to evaluate things like that more precisely.

Mr. CONSTANDY. These series would seem to suggest considerable improvement. I am just wondering how that was reflected——

Mr. MCDONALD. We get letters, good letters.

Mr. FOWLER. This next illustration is of a brandnew section of the Pomona Freeway, just opened last year, where again we have four-lane freeway in one direction, over which there are five down arrows. This is a rather unique situation, because this freeway is leading into a major interchange serving three separate freeways. It is a freeway branch connection, in other words.

Notification here is that the left two lanes may be used to reach the Santa Monica Freeway, Interstate 10; lane 2 and lane 3 serves Hollywood Freeway and the downtown area of Los Angeles; and lane 4 to the right will serve the section to the Golden State Freeway north on Interstate 5.



Mr. CONSTANDY. There is another point in that picture. In many States the outer edge of the sign seems to be always directly over the edge of the pavement, as if there was some rule to that effect. I notice here the sign on the left extends well over into the median, as does the one on the right, extending well over the shoulder, in order to adequately present a space large enough for the sign to be read.

Mr. FOWLER. Yes. Actually we feel there is no direct relation between the edge of the roadway and the edge of the overhead sign. Really, what we are interested in, as far as orientation is concerned, are those five arrows and the placement of those becomes critical.



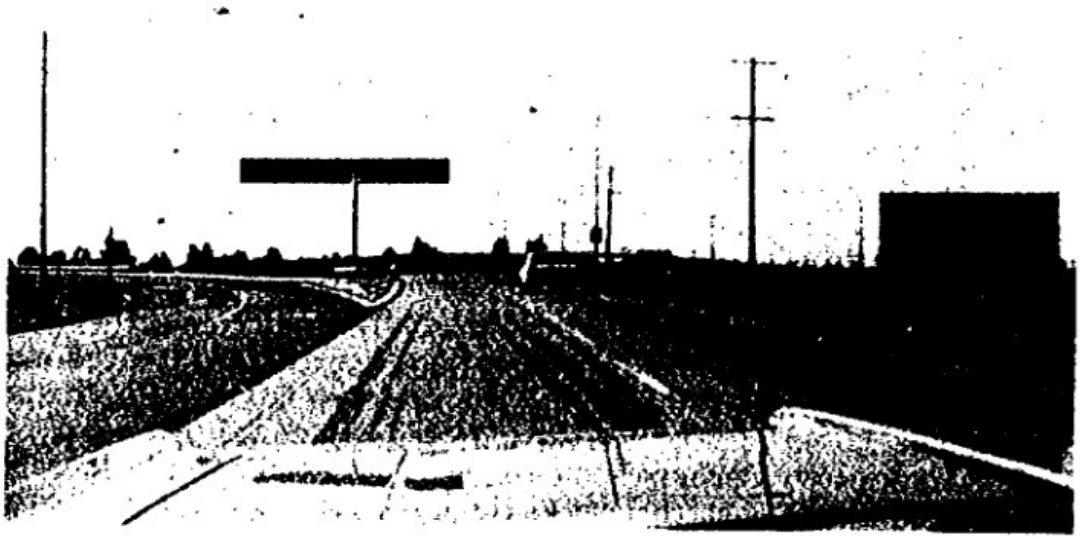
At the point of choice farther ahead, where the freeways diverge, we can see from this picture that lane No. 2, an optional lane, has in fact split and at this point the driver in that No. 2 lane would have to make the decision of whether he was going to the left onto Interstate 10 or continuing to the right on U.S. 101.

I think I should back up briefly to say that I would like to call your attention to the fact that that cable and chain link median fence is equipped with expanded metal glare shield, glare screen, which serves two principal purposes, as we will see tomorrow. This is a typical example of the new cable and chain link type of median fence. There is no possibility of any disruption of traffic from an accident on the other

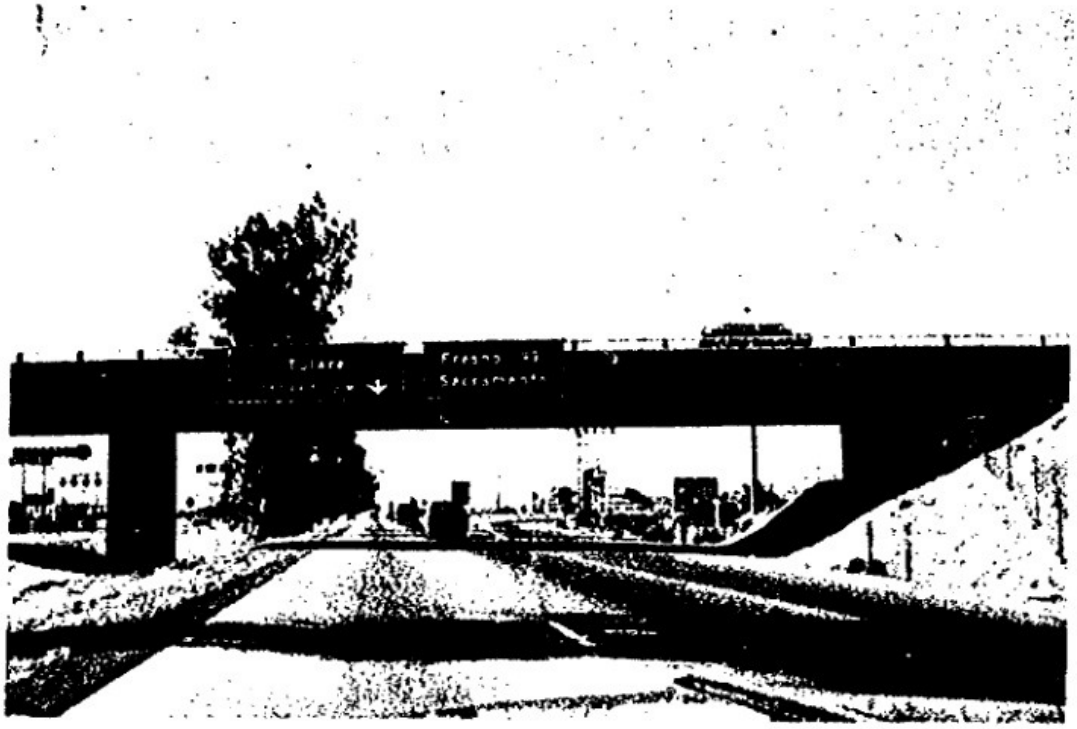
side of the freeway, and it does effectively screen the headlight glare, too.



This location is in a rural area in central California. There is inadequate advance signing of this left lane. As you can see, the sign itself, the message it carries is illegible at this distance, where the driver needs to have the information in order to make a safe turn.



As we approach closer, we get clear evidence of the skidding on the pavement undoubtedly due to last-minute lane changing.



Another similar location, with left-hand exit, also in central California, shows what has been done to partially solve this last-minute changing. Here is an indication of an advance overhead primary directional sign, indicating that the city of Tulare may be reached from the left exit one-half mile ahead from the left lane.

Mr. CONSTANDY. Would there be a sign mounted on the right-hand side, too?

Mr. FOWLER. Yes. A supplementary ground-mounted sign on the right shoulder, reading, "Tulare Left Lane," is standard message and used many times throughout California.

Mr. CONSTANDY. I see.

Mr. FOWLER. That would be standard practice, particularly where the freeway was at least three lanes wide.

Mr. CONSTANDY. I think it is in your paper. I am not sure you made mention of the fact that California has built some left-hand exits and entries on the earlier freeway construction; but they have found that they develop some undesirable results, and they no longer build them, is that correct?

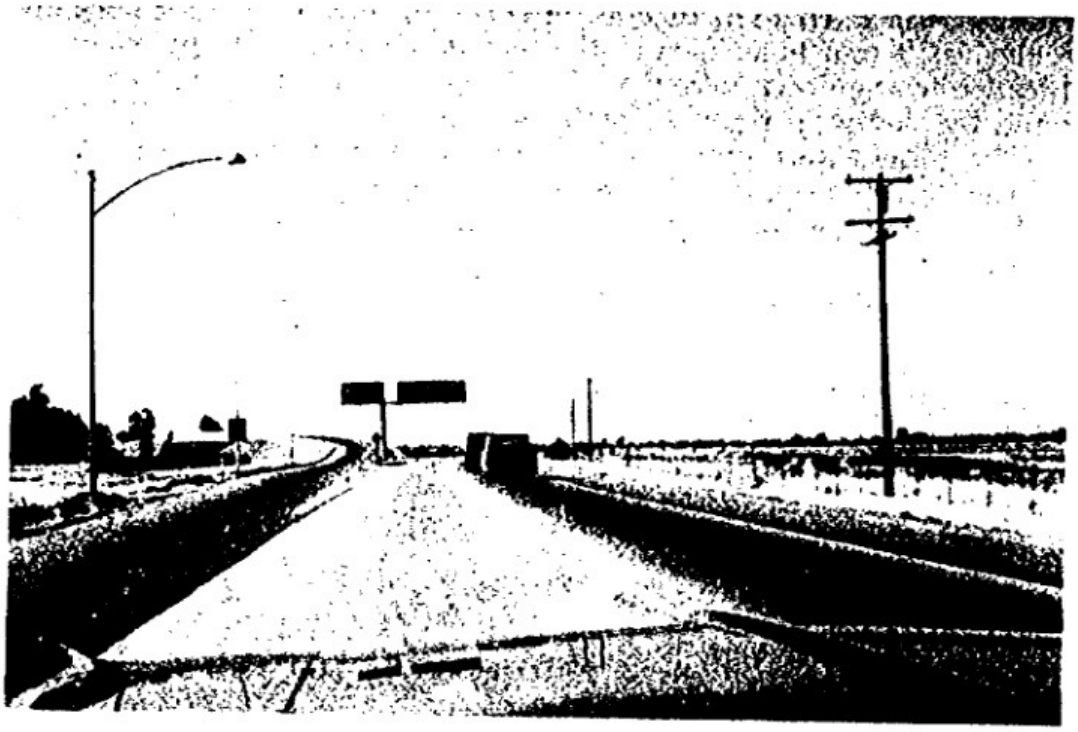
Mr. FOWLER. That is right, yes. The design policies changed about 5 years ago, and we have had no more left-hand connections since that time. The operational problems that showed up involved slow-moving trucks entering or leaving the freeway from the high-speed lanes, and it caused very serious capacity reduction.

Mr. CONSTANDY. Perhaps some of the other States would like to be Forewarned on the construction of the left-lane exits and entries, and profit by the experience California has had.

Mr. FOWLER. This slide also gives an example of the overhead mounting of primary directional signing on the over-crossing structure, rather than on separate massive sign supports.

Mr. CONSTANDY. Yes.

Mr. FOWLER. Trying to make better use of this when we can. And also you will notice the long span bridge with the right-hand abutment located well back from the shoulder——



And as we approach the actual exit itself, you will notice there is a great deal less evidence of skidding in the pavement.

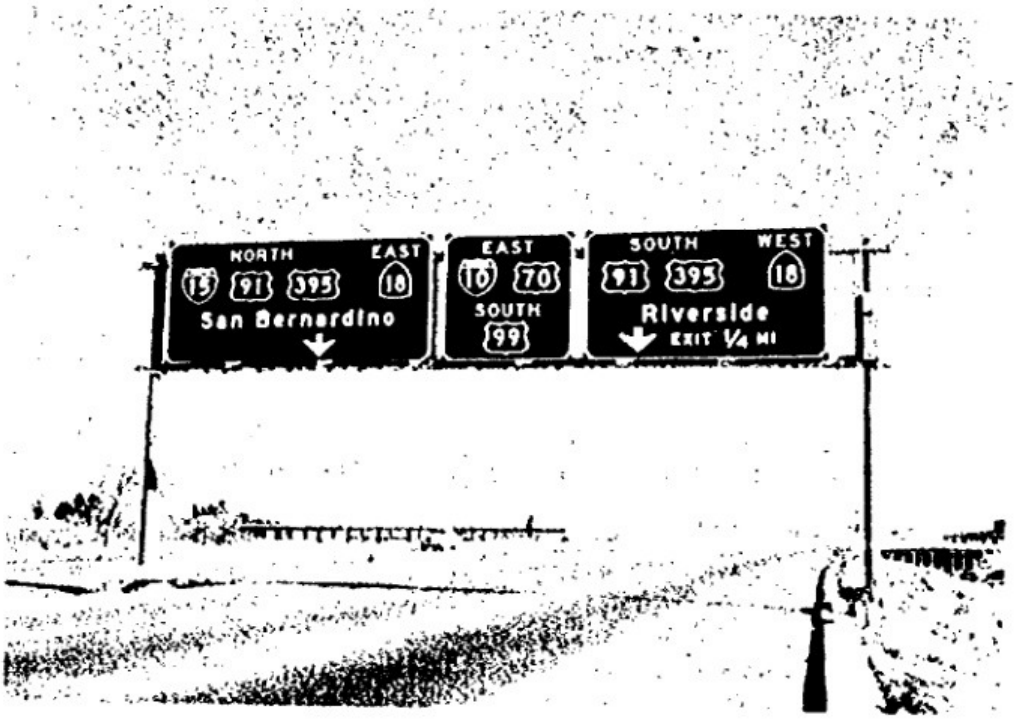


This directional sign calls attention to another of our major points—the confusing format of the sign; it looks like the left-hand lane would serve Interstate 5, and the center would serve San Diego, and the right 101.

Mr. CONSTANDY. If you got past that barrier.

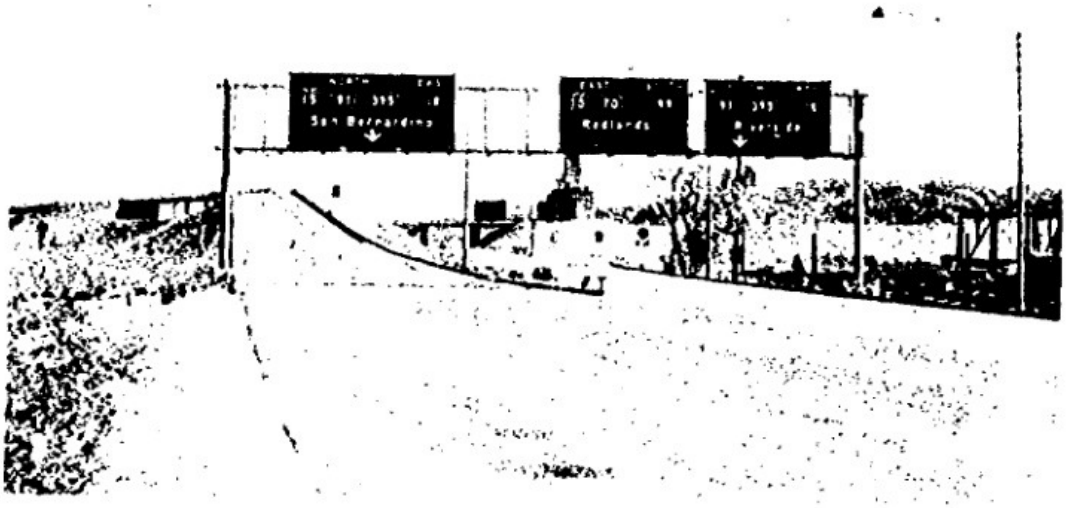
Mr. FOWLER. In fact, of course, the sign is completely misleading because all three lanes serve all three destinations. There is no significance to the down arrow at this location, and the situation is corrected by changing the sign panel so that the Interstate 5 shield and U.S. 101 shield were placed side by side on the upper line of the sign, and the designation, San Diego, was placed directly below the shield on the second line, and all the arrows were omitted. It applies to all three lanes.

Mr. CONSTANDY. All the arrows would be omitted.



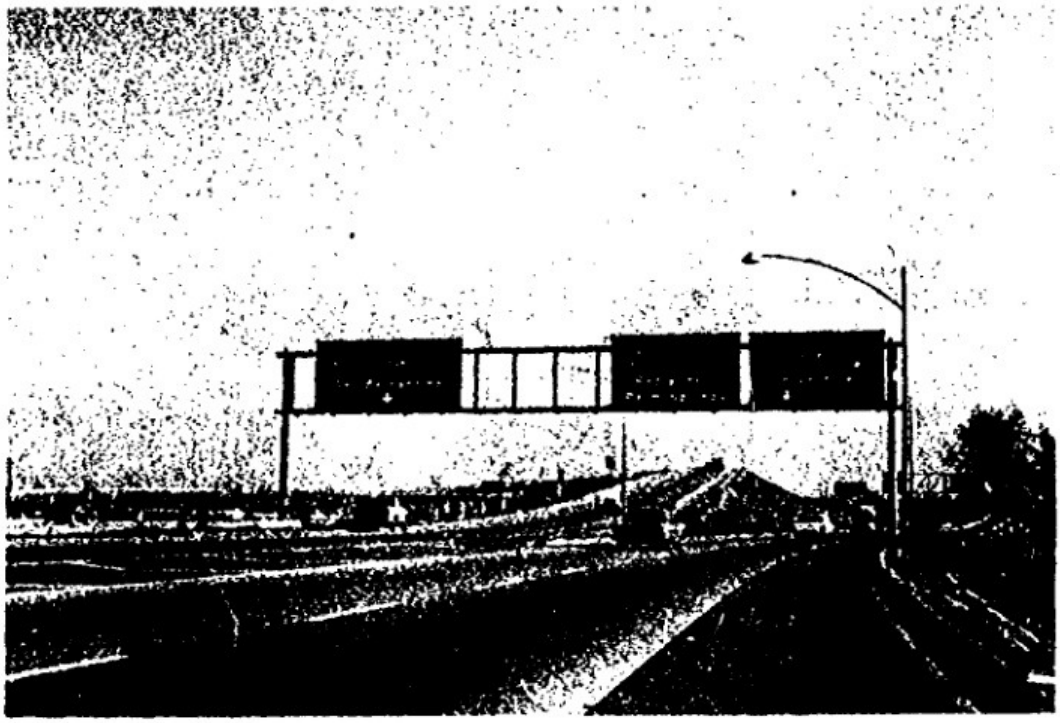
Mr. FOWLER. This brings up the point that we covered very briefly a little earlier about renumbering of the State highway system in California. The confusion here is readily apparent. It goes without saying. Here is a situation with an advance sign on Interstate 10 approaching its interchange with Interstate 15 and several other routes. You will notice that there is a selection of 10 separate route shields.

There are six cardinal directions, and there are two separate destination names.



The following sign, at the point of choice, repeated all of these messages. It was absolutely impossible for many motorists, traveling at a legal 65-mile-an-hour speed to digest this massive information and make a correct decision as to which course to follow. And because of the notoriety that was given to these two signs at this location, the State legislature, in 1965, ordered the renumbering of the highway system and the establishment of a definite priority system as to which shields were to be displayed, and that priority, in its simplest form, merely says the Interstate shield will be shown alone wherever they apply, and that U.S. route shields will be shown as a secondary

priority, and that State highway route shields will only be used where neither of the other two appear.



The sign structure at that location was changed to this, in which you will notice the 10 shields are reduced to a total of four. The six cardinal directions were reduced to only three. And the destination names, which were bound to be more meaningful, were added to the middle sign. Since this change was made, in the ensuing 2½ years, there has not been a single complaint received from the motorists by the automobile club or by the director of highways or by the California Highway Patrol, all of whom maintain a district office immediately adjacent to this in the community.

Mr. CONSTANDY. Do you happen to have any idea of the cost of changing the signs for this renumbering program?

Mr. FOWLER. The total cost of revising State highway signs throughout California, so that by the end of this year they will substantially conform to the national manual, was $7 million.

Mr. CONSTANDY. That included other things, though?

Mr. FOWLER. That included other things, yes.

Mr. CONSTANDY. As a matter of fact, in some cases it goes a little bit better than the manual, does it not?

Mr. FOWLER. Now, the renumbering did not affect all highway routes, of course. The number of routes that were actually changed in designation was more on the order of 25 or 30 routes, about 10 percent of the total.

Mr. MCDONALD. Again, if that is an important piece of information, we could get it and send it to you.

Mr. CONSTANDY. I think we would appreciate it.

Mr. MCDONALD. At least an estimate.

Mr. CONSTANDY. That would relate to the cost of the numbering change.

Mr. MCDONALD. Yes.

[Information follows:]

Herewith is the information requested in connection with the cost of renumbering our state highway system to avoid multiple routes and duplicate numbers. The total estimated cost for this renumbering on a statewide basis was $250 thousand. The U.S. routes which were approved by AASHO for virtual or complete elimination were 6, 40, 60, 66, 91, 99, 299, 399, and 466. Portions of U.S. 50 and U.S. 101 were approved for deletion. The U.S. routes which remain unchanged are 95, 97, 199, and 395. In many cases, the U.S. route was replaced by interstate freeway construction. In the remaining instances, the U.S. route was replaced by a state highway designation using the same digits (that is, U.S. 99 became State Route 99). In contrast to New York and other states, California has never had a state highway route in existence with the same number as an interstate or U.S. highway route number. In this way, the motorist is not confronted with a choice between two different shields, each with the same numerals.

Mr. CONSTANDY. The $7 million reflects other things in addition to that, and in some cases signing practices to a higher standard than what is prescribed in the manual?

Mr. MCDONALD. That is right. Some of the things that might be considered experimental as far as the manual is concerned.

Mr. CONSTANDY. That would not seem to be excessive, when you consider the number of miles of highway that we are talking about and the number of signs we are talking about; it would seem to be a reasonable price for that much improvement.

Mr. MCDONALD. Our feeling at this moment, in this atmosphere, would be to agree, although that is a lot of money and obviously every time you make a choice like that, $7 million for signs, is $7 million you do not build 2 or 3 miles of freeway.

Mr. CONSTANDY. That is always the concern, of course.

Mr. MCDONALD. Certainly we feel that signing is at least that important.

Mr. FOWLER. We would like to turn now to another problem that exists with the signing at a major freeway-to-freeway interchange.

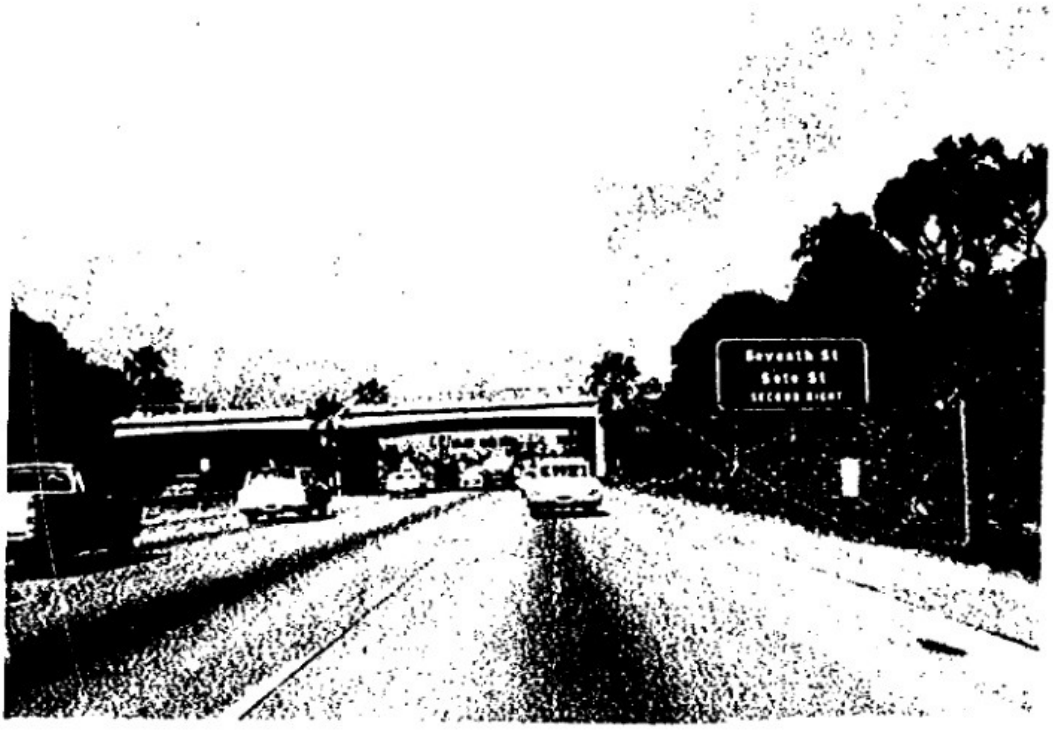


This location is on the Santa Ana Freeway, in the vicinity of the East Los Angeles Interchange. Once again it is a very complex location involving connections to three separate freeway routes. The original signing, as shown in this slide, the complaint arose over the complexity, the confusing message on the left-hand side. You will notice that there is an Interstate 10 route shield, Eastbound. There is a U.S. 99 shield, and a Northbound Interstate 5 shield—all serving the major destination of Bakersfield; and then below that, on the bottom line of the sign, are separate destinations to local service streets, that is Seventh Street and Soto Street.

There was too much information and very little contrast. Wherever possible in designing major freeway-to-freeway interchanges, the effort should be made to eliminate these local street connections in the immediate vicinity. In this particular case, in order to provide adequate traffic service, it was not possible to eliminate these connections to the two local streets; but the situation was considerably improved.



There was an advance cantilever sign installed at the right shoulder, indicating by name the "Golden State Freeway, Interstate 5, and Santa Monica Freeway, Interstate 10, Half Mile Ahead."



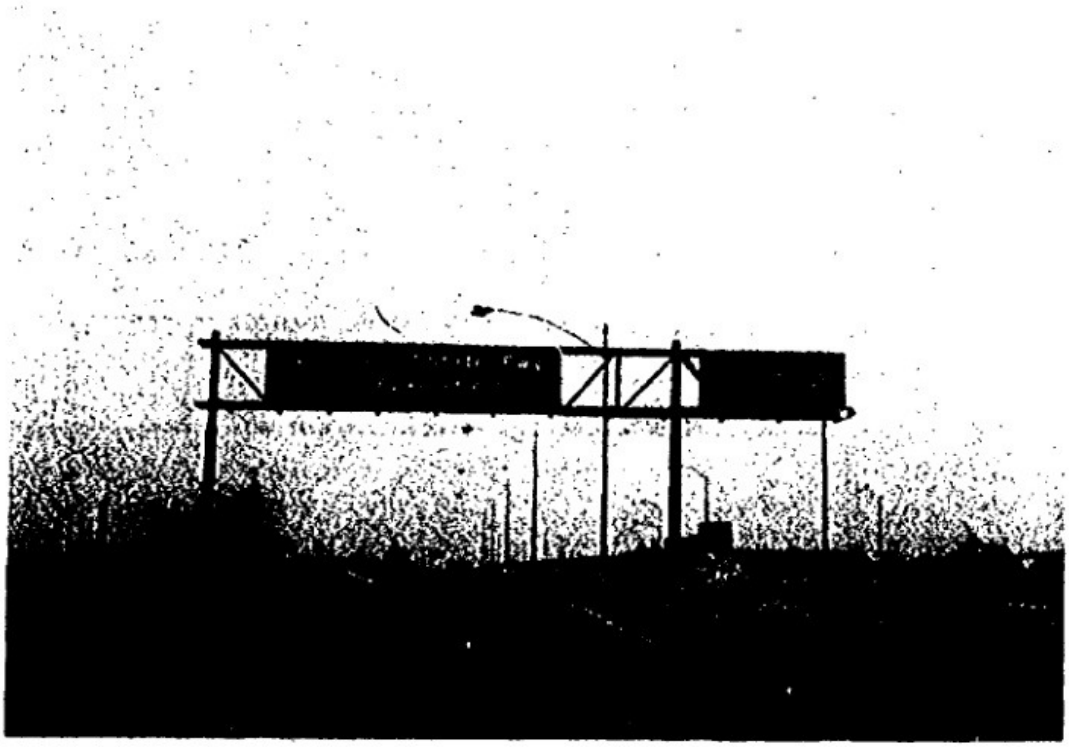
The two local street connections, 7th Street and Soto Street, were separated into a secondary sign which was groundmounted on the right shoulder, indicating 7th Street and Soto Street, second right.



That was followed by the primary overhead signing at the point of choice, the Golden State Freeway and Bakersfield to the left by Interstate 5. The Santa Monica Freeway, Santa Monica, Interstate 10, was served by the two lanes to the right.



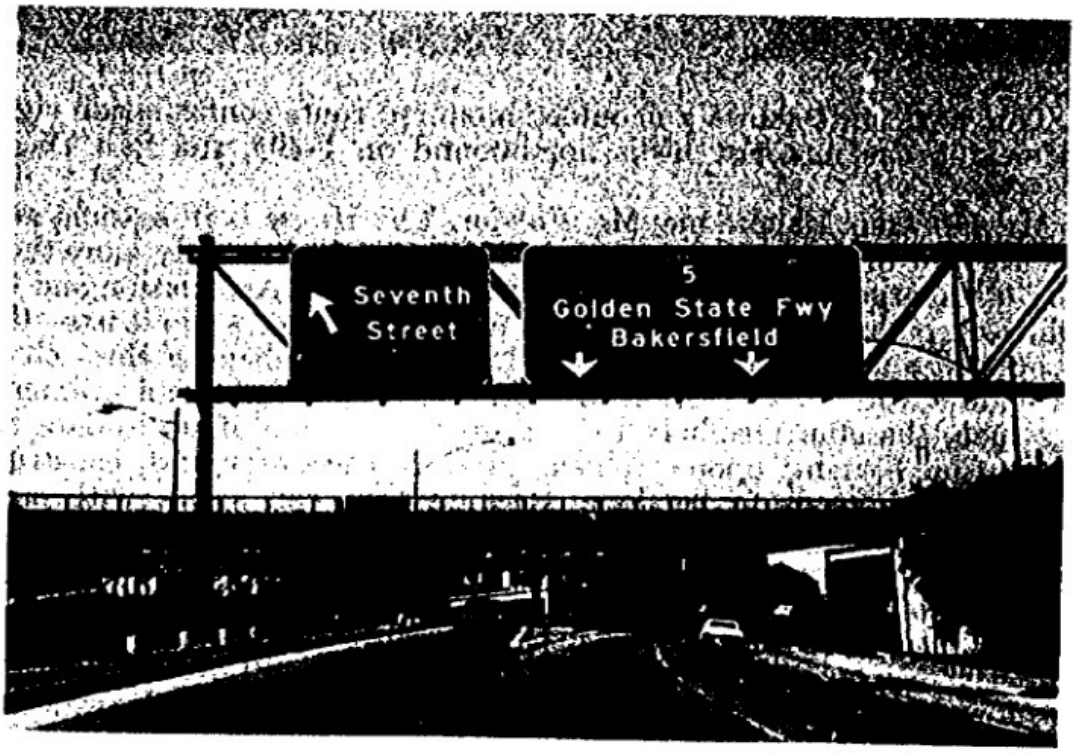
Beyond this sign, then, another ground-mounted secondary unit reading, "Soto Street right lane."



And beyond that, at the point of choice, the Golden State Freeway, Interstate 5, Bakersfield, is the lefthand major roadway, and the connection to Soto Street went off the right.



Immediately beyond this, 7th Street on a cantilever sign from the median area reading, "Exit One-Quarter Mile," and a down arrow indicating it was left exit.



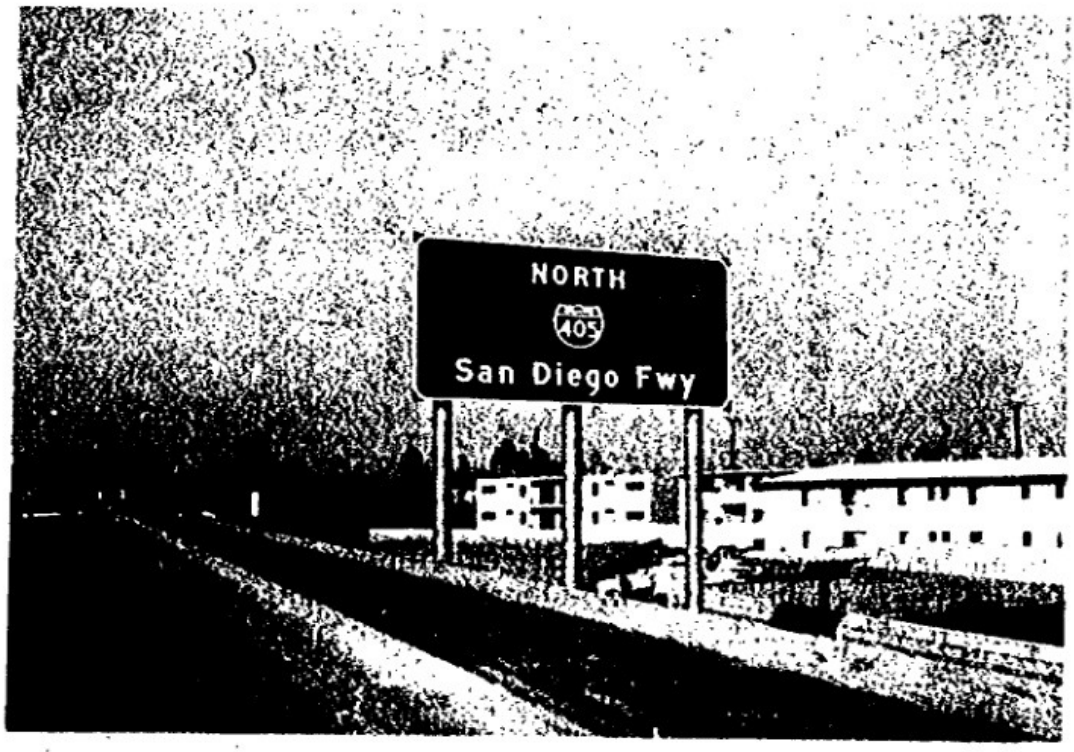
And at the point of choice, the Golden State Freeway, Interstate 5, to the right, and 7th Street and local connections off to the left.

Mr. CONSTANDY. Could this sign and the one preceding it have had the yellow plate with the word "Only" in addition?

Mr. FOWLER. This one more specificially would carry the message, "Left Exit" instead of using "Only." And the present thinking would be, in the case of a left lane off, would be to use the sign "Left Exit."

Mr. MCDONALD. In this case you would not put "Only."

Mr. FOWLER. The situation applies to a trap lane, and this is not a trap situation. This is the deceleration lane here.



This next slide shows a shoulder mounted route confirmation sign, informing the motorist he is northbound on I–405, the San Diego Freeway.

Mr. HOWARD. Excuse me, Mr. Fowler. The House is in session, and we are now in the second round of a quorum call. Probably more than any other organization, the American Automobile Association and its affiliated clubs are in close contact with the Nation's motorists—the people who use the highways. The 11 million members of these clubs provide a wide cross section of motorists' experiences and opinions. As such, the club members form a great reservoir of up-to-date information bearing upon problems drivers encounter and, constructively, what needs to be done. Because they can speak with such authority, the testimony of these gentlemen has been doubly impressive. The problems they have identified for us in the area of signing and related geometrics are common to motorists all over the Nation, not just in the localities shown in the slides thus far. As was the case in our hearings on roadside hazards, further study will disclose that the weaknesses disclosed in the metropolitan areas discussed yesterday and today exist on a coast-to-coast scale.

On the plus side, it has been gratifying to note that some improvements have been made, and that thought is being given to further upgrading. It is an important element of highway safety, and vitally important to the motoring public.

The Chair wishes to thank you gentlemen for your valuable testimony and assistance in these sessions. The subcommittee will now recess until tomorrow morning at 10 o'clock.

(Whereupon, at 12:21 p.m., the subcommittee recessed, to reconvene at 10 a.m., Thursday, May 9, 1968.)

HIGHWAY SAFETY, DESIGN AND OPERATIONS
Freeway Signing and Related Geometrics

THURSDAY, MAY 9, 1968

HOUSE OF REPRESENTATIVES,
SPECIAL SUBCOMMITTEE ON THE
FEDERAL-AID HIGHWAY PROGRAM
OF THE COMMITTEE ON PUBLIC WORKS,
Washington, D.C.

The subcommittee met, pursuant to adjournment, at 10:10 a.m., in room 2167, Rayburn Building.

Present: Messrs. Blatnik (subcommittee chairman), Clausen, Johnson, McCarthy, McDonald, and Zion.

Staff present: Same as previous day.

Mr. JOHNSON (presiding). The Special Subcommittee on the Federal-Aid Highway Program will come to order. We resume this morning with the third day of public hearings before the subcommittee on the subject of signing and traffic messages for motorists on our Nation's highways.

When we recessed yesterday we were hearing from Messrs. McDonald and Fowler of the Automobile Club of Southern California, who are well qualified to speak for the millions of motorists who belong to the American Automobile Clubs in general, and those of southern California in particular.

Mr. Paul H. Fowler is with us again this morning, and will continue his testimony.

We will also hear today from representatives of other highway-user groups who, like the automobile clubs, have a firsthand working knowledge of conditions on our roads. I refer to the trucking associations and their drivers who daily ply the highways and byways of the Nation's 3,750,000 miles of Federal, State, county, and local roads.

It is obvious how important good signing must be, how vital a factor to efficient and successful operation, to the entire trucking industry. And once again, the factor of safety becomes a key consideration.

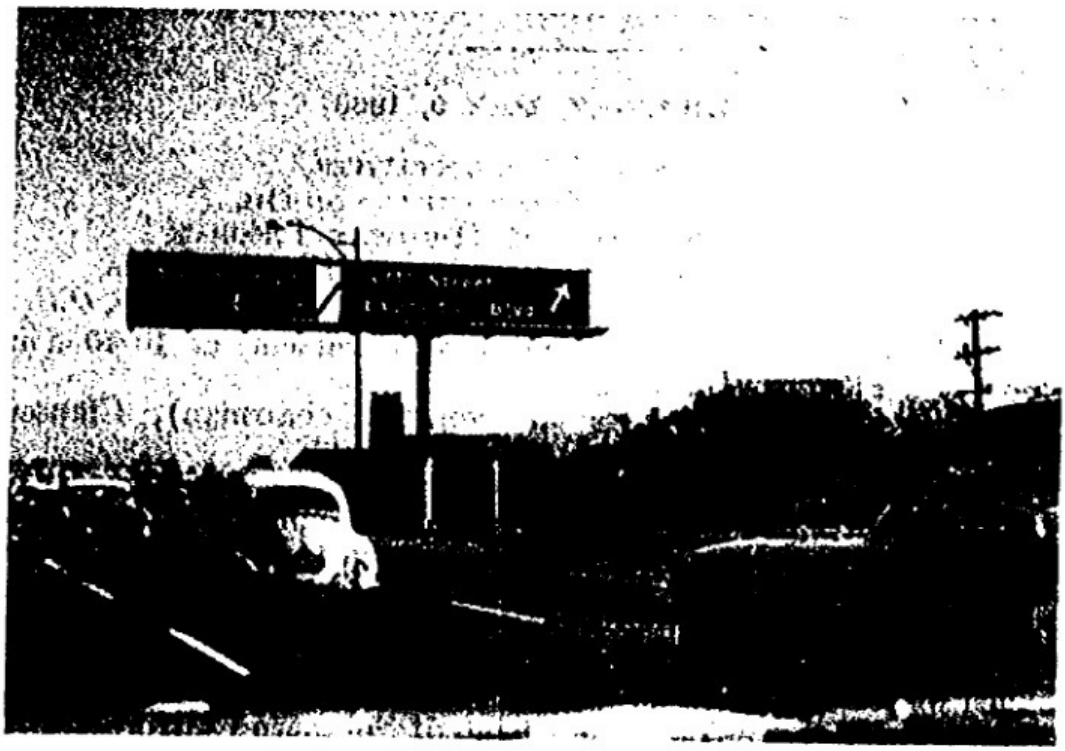
We again welcome you, Mr. Paul H. Fowler, traffic engineer of the Automobile Club of Southern California. We are very happy to have you here again this morning, to continue your testimony.

We have with us also this morning another distinguished group. We have with us, as observers today, a group of right-of-way appraisers from the Bureau of Public Roads, under the guidance of Mrs. Minnie Lee Harkins. These men have been with the Bureau of Public Roads for about a year, and are now in Washington for a 3-week right-of-way training program. Part of the training program includes visits to observe a congressional committee in action, and

we welcome them to the hearings today. We now have Mr. Constandy here, who will continue the questioning at this time.

Mr. CONSTANDY. Mr. Fowler, when we left off yesterday, we were discussing freeway interchanges. I think if you could continue that, we might move along and complete your testimony this morning.

TESTIMONY OF PAUL H. FOWLER—Resumed



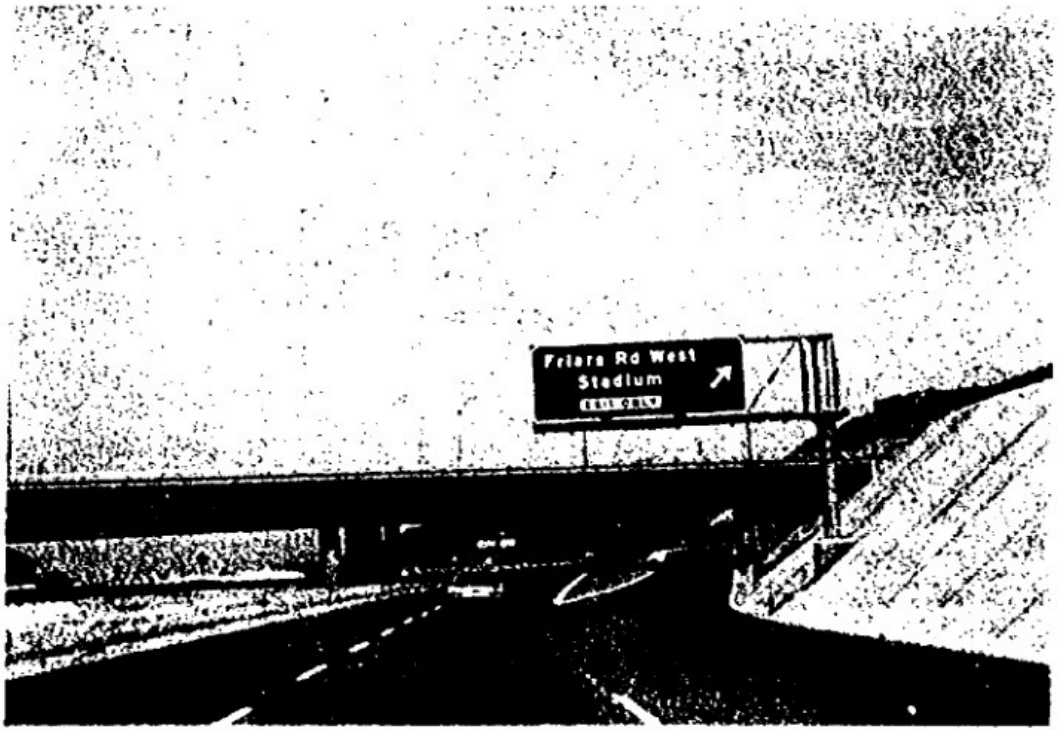
Mr. FOWLER. Yes.

This next series of slides shows connections from the freeway to local surface streets. As we mentioned yesterday, the early development of the metropolitan freeway system in Los Angeles did not include large oversized directional signs as you would see in this picture. This shows the second stage of development of the signing to local street connections.

There was an advance sign included on the Harbor Freeway when it was constructed in the early fifties, but the little sign shown in the gore there, the ground-mounted reflective sign, reading 37th Street, constituted the sole notice for the destination at this ramp.

Mr. CONSTANDY. So, actually, we are looking at the first and second generation of signing from freeway-to-surface——

Mr. FOWLER. That is right. This was taken during construction, in which the large butterfly-type sign was being installed.



This is used at this time to illustrate two things: first of all, it is no longer standard practice to install massive sign structures in the gore area at off ramps. And this brandnew job in the San Diego area shows the new cantilever-type mounting from the right-hand shoulder, without any massive structure in the gore area.

The second point to this illustration also is the fact that this constitutes another one of those trap lanes, where the right-hand lane of the freeway is exiting, and therefore advance notice is given of the fact that it is an "exit only."

Mr. CONSTANDY. Mr. Fowler, the sign which we see in the gore would be mounted on some breakaway, frangible support?

Mr. FOWLER. Yes. Actually they are on wood posts.



One of the greatest sources of complaint from the motorist, we find, has been generally the difficulty in obtaining enough advance notice as they approach an interchange. As a result, California for a number of years has followed a practice of installing what they call an orientation sign located on an overhead structure in the median. This is a typical example, and we are particularly directing your attention to Vermont Avenue.

Mr. CONSTANDY. This type of sign for orientation is pretty much a keystone of your signing system in California?

Mr. FOWLER. Yes, that is right. This is the first notification that the motorist gets in advance of the interchange that he may be looking for. It is located in the median, because on eight-lane facilities we are particularly interested in giving maximum notice to the drivers that are in the left-hand lanes, so that they will have time to move to their right safely in order to take the exit ramp. So this first notice, then, of Vermont Avenue, indicates that Vermont is the third interchange ahead, at a distance of a mile and three-quarters.



The next notification shows that Vermont is now the second interchange ahead, at a distance of three-quarters of a mile.



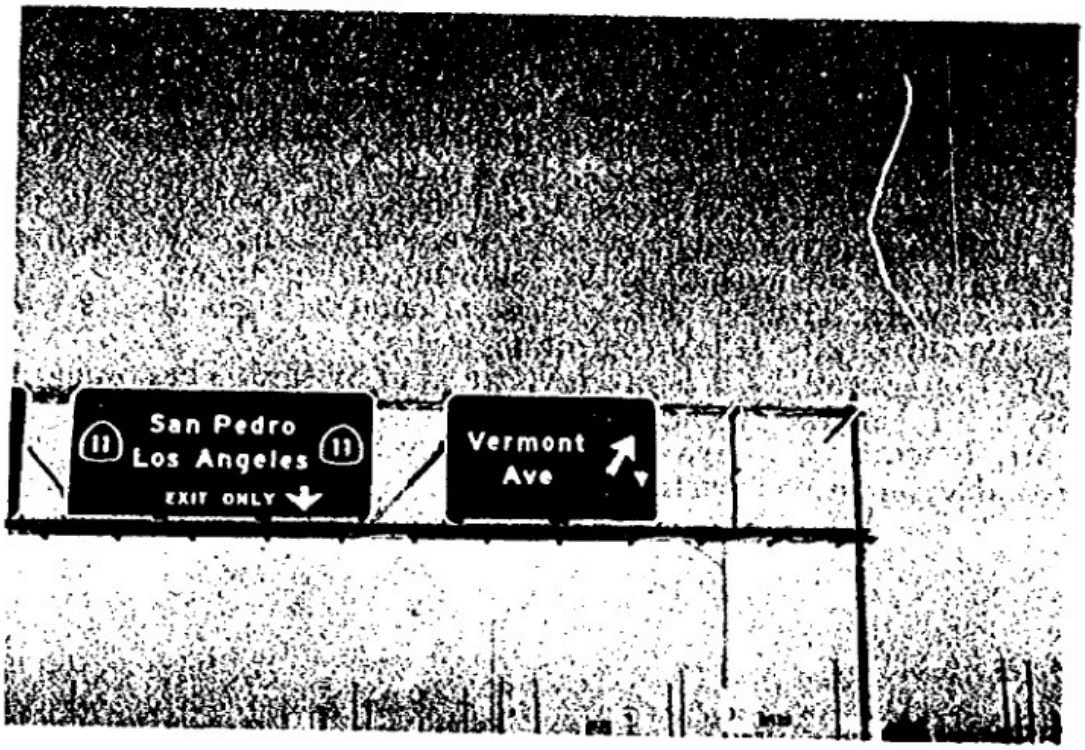
The third one shows Vermont Avenue at the top of the sign, indicating the next interchange, a distance of a half a mile.



Then on the right-hand shoulder there is a ground-mounted secondary sign reading, Vermont Avenue right lane.



This is followed by an overhead cantilever sign, Vermont Avenue exist one-quarter mile, and with a down arrow indicating that the exit may be reached from the right lane.



And then at the point of choice, Vermont Avenue is noted on a separate panel with an up arrow indicating a destination off the freeway.



And since, in this case, Vermont Avenue does not connect directly to, that is the ramp does not connect directly to Vermont Avenue, but instead intersects a parallel frontage road, down at the foot of the ramp there is an additional ground-mounted sign indicating you must make a left turn in order to reach Vermont Avenue.

That is the standard series of advance directional signs that are installed on all the metropolitan area freeways, wherever there is sufficient distance between the interchange connections to put in this full service.

Mr. CONSTANDY. As Vermont Avenue moves up from third to second to first, it is replacing the next interchange, and below it, then, appears in the same sequence the following interchange?

Mr. FOWLER. That is correct. These orientation signs always show the next three exits. It is a continuing series.

Mr. CONSTANDY. That is my favorite kind of sign. They would be very helpful to have in other places.

Mr. FOWLER. We have certainly had very good acceptance and favorable comments from the motorists.



I would like now to turn to another slightly different subject, the matter of signing to the freeways. These are the surface-street signs directing to the freeways. And, as we mentioned yesterday, in the early days of freeway development in the Los Angeles area, there were relatively few freeway routes being constructed, notably just five of them radiating out from the downtown area.

Under conditions such as that, the earliest signing was quite small, reasonably difficult to find. On the other hand, it was quite easy in the public mind to direct to a single freeway by name. As the freeway system grew, of course the number of freeways in the metropolitan

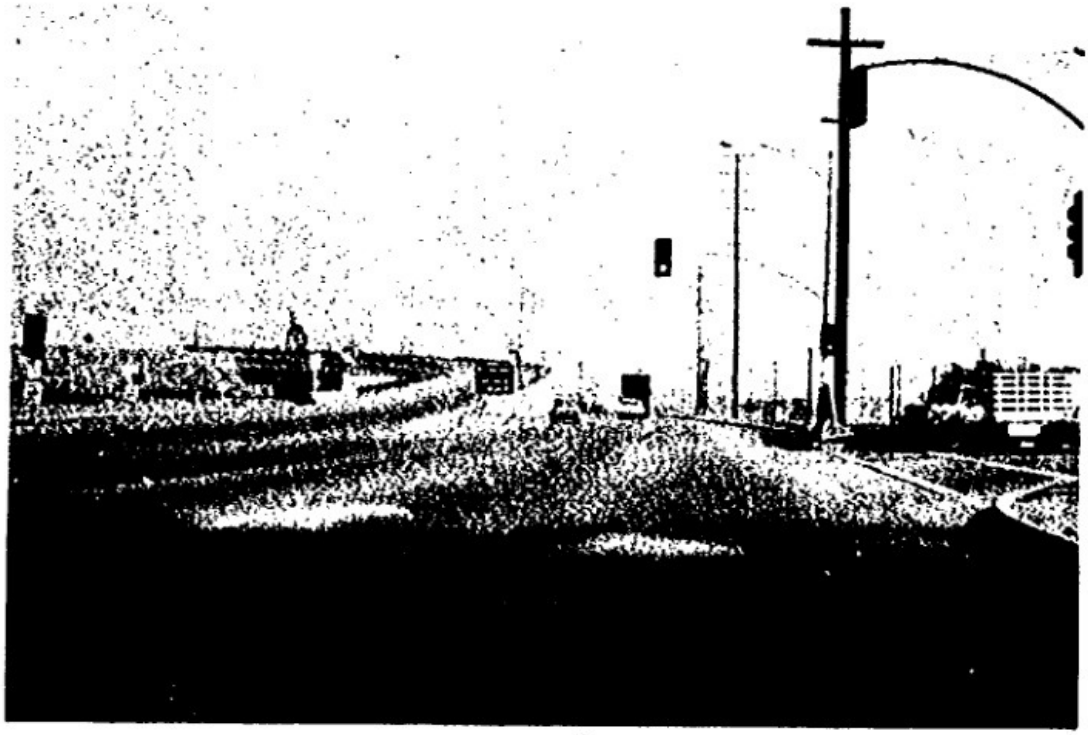
area increased, and it was not sufficient just to install a sign reading, "To the Freeway," or "To the Harbor Freeway," as this one reads.



As time went on, the signs grew a little larger and a little more prominent. This is one of the earlier ones, back in the 1940's, indicating, to reach Los Angeles you could turn left to Pasadena Freeway.



In one of the outlying communities in the central part of the State, there was only one freeway route in town, and the early signs then simply read, freeway north. There was no point of confusion, as far as the public was concerned, except that it was difficult to find the sign itself in the midst of a rather distracting background.



This was sort of a second-stage or intermediate development in the signing to the freeway. The sign was certainly a little larger and a little easier to read, but it was placed poorly, and actually the legibility of it was insufficient for the distance that was involved at this intersection.



Shortly after the beginning of the Interstate program in 1956, the city of Los Angeles recognized the need for installing larger, more easily recognizable directional signs to the freeways in Los Angeles.

This is one of the earliest attempts by the city, using white-on-green directional background, simply reading Harbor Freeway. It was placed, as you will note, at least 100 feet in advance of this signalized intersection and located directly in the sidewalk area.



But that type of signing also had its disadvantage and was not adequate. So it was not long before the city then undertook the installation of overhead illuminated signs for greater legibility and attention.

Mr. CONSTANDY. I would like to call attention for a moment to the straight line under Ventura Freeway, and the box that is formed perpendicularly, the right-hand box, reading east, right lane. We will hear more about that later on in the hearing, as this subject of separating line message was developed largely in California; is that true?

Mr. FOWLER. There were many examples of it in the earlier years. We do not see this as much any more as we used to, however. I would not call this exactly a current standard.

Mr. CONSTANDY. We will have testimony later from Dr. Hulbert of UCLA, who did some research on the underlining subject, and it is perhaps something that signing engineers will want to give more consideration to.



Mr. FOWLER. This is another example of the ground-mounted sign, and in the sidewalk area again, and also with the separated message.



About 3 years ago the State legislature recognized that since there were so many locations on major arterial streets that required signing to the freeway interchanges, and because the expense involved was mounting all the time, the legislature made it possible for the expenditure of State highway funds to install major directional signs to the freeway interchanges outside the limits of the State freeway right-of-way. In this case the sign was installed by the State highway department at a distance of some thousand feet perhaps from the interchange,

which you can see in the background. And this represents the current type of signing that is in use on the arterial.

Mr. CONSTANDY. I think this represents a critical problem nationally on the placement of signs leading to freeways. State highway departments are frequently prohibited from the spending of State highway funds on signing off their own road network right-of-way. Very frequently a community in which the need exists for a sign to the freeway either does not recognize the necessity for it, or does not have the funds to provide that type of sign. I think more and more of the State highway departments will be giving their attention to the same type of legislation, giving them permission to leave their own State system to expend funds to make their own State system more functional.



Mr. FOWLER. This is another example of a recent installation in a divided arterial road, and again the divided message on this sign. Incidentally, we were talking yesterday a little bit about the Interstate shields in use in California. And I wanted to call attention to this particular sign, which I overlooked in some of the signs yesterday. You will notice that on the interstate shield the State designation is omitted. Interstate appears, but the name California, which would normally be on the blue background just below the divider, at the top of the Interstate shield, is omitted. And it is done for the particular reason that by omitting it, it is possible to use larger route numbers in the shield. This is particularly true in the case of three-digit numbers.

Mr. CONSTANDY. Mr. Prisk, is that in conformity with the manual?

Mr. PRISK. Mr. Constandy, yes, it is. The requirement set forth in the Interstate Sign Manual is that the State name is to be omitted when the shield is displayed as a part of the guide sign message, which this would be. When the shield is displayed separately, in isolation from other guidance information, then the State name must be shown.

Mr. CONSTANDY. What would be an example of the type of sign where it must be shown? Is that the confirming sign after an interchange, where just a shield appears on a support?

Mr. PRISK. Yes.

Mr. CONSTANDY. That is a trail blazer?

Mr. PRISK. If, beyond the interchange, you want to confirm to the driver that he was still on Interstate Route 405——

Mr. CONSTANDY. In the State of California?

Mr. PRISK. In California, and you are erecting a sign simply for that purpose; and the requirements of the Interstate Sign Manual are that the word, "California," must be on that particular shield. There are two signs, therefore, for the Interstate shield. One of this type, and one with the word "California" in it.

Mr. CONSTANDY. Any sign of this type, then, that carries the State designation would not be in conformance with the manual; it that correct?

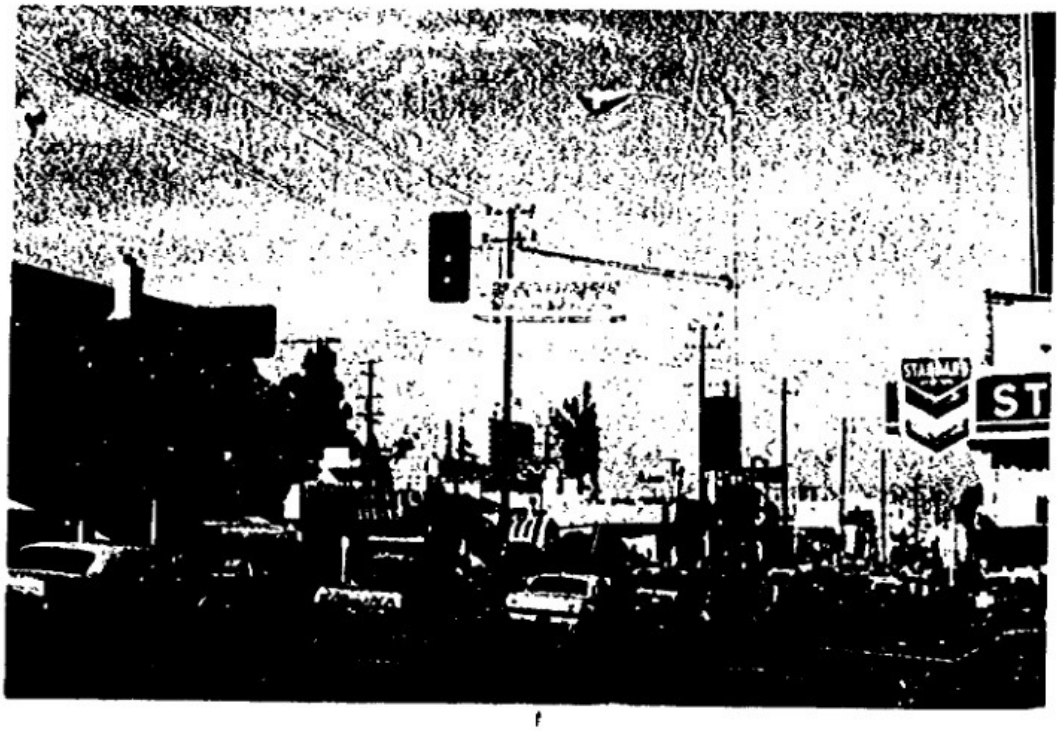
Mr. PRISK. If the State designation were on this sign, it would not conform to the manual; that is correct.

Mr. CONSTANDY. I think we have seen situations where the State does—it does make the letters smaller, does it not, when the name appears?

Mr. PRISK. Definitely so. These are Interstate routes, and much of the other information in the context of the display would tend to tell you that you are in California, and it is difficult to make a case actually for California being a part of the shield message.

Mr. CONSTANDY. Most motorists would know they are in California. Some large percentage of the motoring public knows what State they are in.

Mr. FOWLER. We have another advantage, that the State is relatively large, and we have no neighbors on the west and south; so we are at the end of the line, you might say. But those represent modern examples of the most recent signing to freeways in California.



We will skip along now to another subject, a very important one, and that is the subject of street name signs.

Mr. CONSTANDY. Is this a subject about which you find the general public is very sensitive?

Mr. FOWLER. Yes. Mr. McDonald mentioned that a number of years ago the Automobile Club circulated a questionnaire on the subject of highway signing to all of the members. And although the subject of street name signs was not mentioned on that questionnaire, we were surprised to find that, by write-in under "Comments," the subject of street name signing and their inadequacies actually was the No. 1 response on the part of the members. So it attracted a greater response, a greater complaint than any of the other items that were included.

Mr. CONSTANDY. Without even being asked?

Mr. FOWLER. That is right. Now, the National Manual for Uniform Traffic Control Devices specifies a 3-inch minimum capital letter for street name signs. And under many circumstances that probably is adequate and satisfactory on narrow, local streets, and at low operating speeds. But in our area, in 1956 there was a general conclusion that 3-inch letters were not adequately visible under our conditions, and therefore, at that time, the State of California adopted a 4-inch minimum, which is now being considered as a possible new standard in the manual.

Mr. CONSTANDY. Do you know what the AASHO standard is for that, either you or Mr. Prisk?

Mr. PRISK. The American Association of State Highway Officials has accepted the standard Mr. Fowler mentions, minimum of 3 inches for street name signs.

Mr. CONSTANDY. In California it is four, when it is considered that is a major street; it that it?

Mr. FOWLER. All street signs in California, since 1956, have had at least a 4-inch legend.

Mr. CONSTANDY. In the Western States the streets are generally wider.

Mr. FOWLER. That is right.

Mr. CONSTANDY. And there are more traffic lanes; is that correct?

Mr. FOWLER. Yes.

Mr. CONSTANDY. So that the problem becomes more acute for a motorist to know in advance of the turning movement which street it is he wants. In other words, he has to stay in the right-hand lane to be able to read the sign, and it is too late then to be able to turn across the other lanes of traffic to make a left turn, and the converse, of course, is also true.

Mr. FOWLER. Yes. That certainly is a critical problem.

Mr. CONSTANDY. The thing may be true even in other States, not in the Far West, where streets either are of comparable width—or with high traffic volumes, competing sign messages where commercial establishments exist—the need exists there, too, perhaps, for larger than 3- or 4-inch letters on street signs. Has there been any objection to the placement of oversized street signs, that you are aware of? It would seem to be the type of thing that everybody would be in favor of, like motherhood.

Mr. FOWLER. Without exception, the motorist has been in favor of it. The only objections that I know of have been in well-developed residential neighborhoods where there is frequently an objection to street signs, particularly in front of somebody's picture window, you see. But those are the only objections that I know of, and they do not really object to the sign, they merely say it should be located in front of my neighbor's house instead of mine.

The example I am using here shows the familiar street name sign just above the pedestrian signal indication, reading, Doheny Drive; and that is a 4-inch legend there. And the city has installed on the signal mast arm a very much enlarged oversized street sign, and in this case has even illuminated that overhead indication. This is becoming more and more common practice on the major boulevards.

Mr. CONSTANDY. One other point on street name signing I just cannot pass without mentioning: Frequently you find yourself in a strange city and while the intersecting streets are named, the one you are on has no name posted. And you can go block after block after block not knowing what street you are on. Apparently they assume, since that is a main street, that you know what that street is.

Mr. FOWLER. At the intersection of two major boulevards, if the cross street were a major boulevard, there would be overhead signing on the cross street mast arms, too.

Mr. CONSTANDY. Could that be read from both streets?

Mr. FOWLER. Yes, as you went by.



This is a much less desirable type. Another city installed this. And it is at a particularly complicated channelized intersection. It is better than the countermounted signs, but not as easily visible as the other samples that I have shown. Washington Boulevard being a long name, and with a somewhat distorted letter size, is particularly difficult to read.



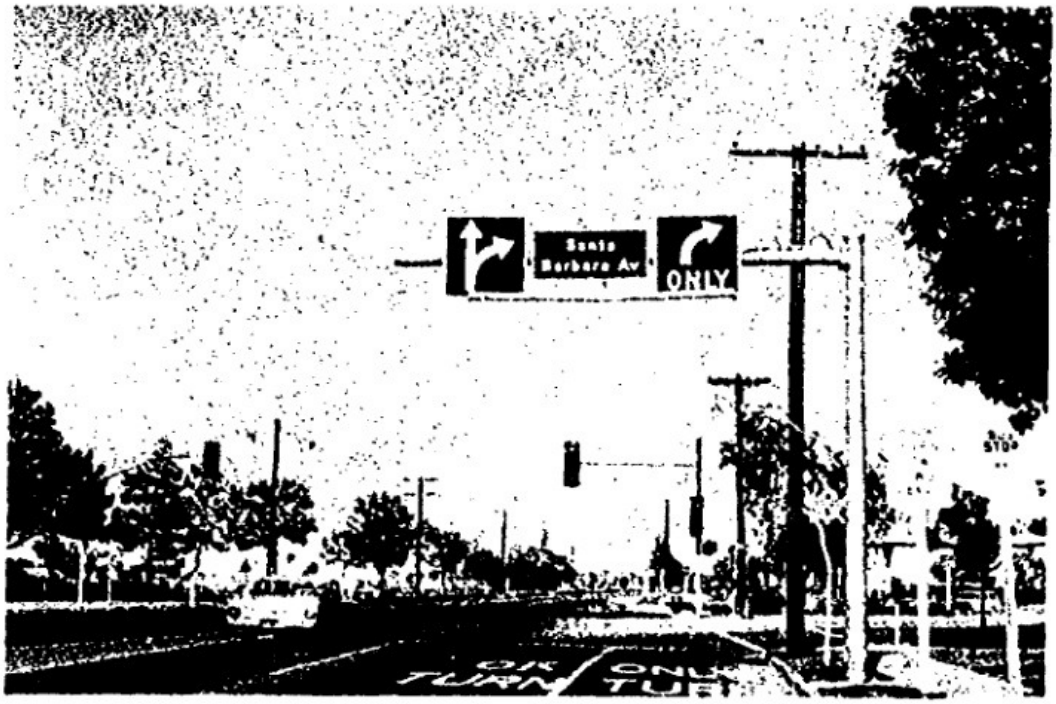
This one is a little better. It is a reflective sign, located again on the traffic signal mast iron at the far side of the cross intersection.



This explains the situation in which we find ourselves, and I merely put it in for humor. Highway signing can be a problem wherever you find it.



Back to street name signs again. Another example, with a 6-inch and 8-inch upper and lower case combination here. You can clearly see the difference from the contrast of the overhead installation and the corner sign on the far corner.

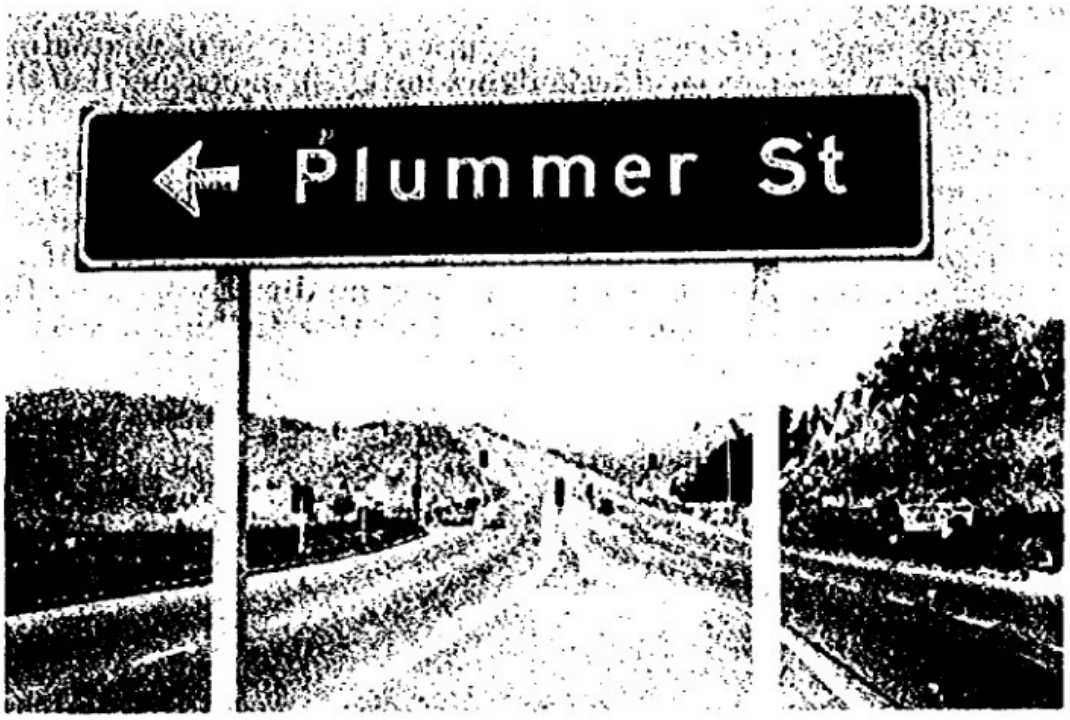


There are special circumstances that arise as traffic volumes increase and particularly where arterial boulevards serve a major freeway interchange; it is necessary oftentimes to install mandatory turn lanes and optional turn lanes in order to increase the traffic capacity of the intersection.

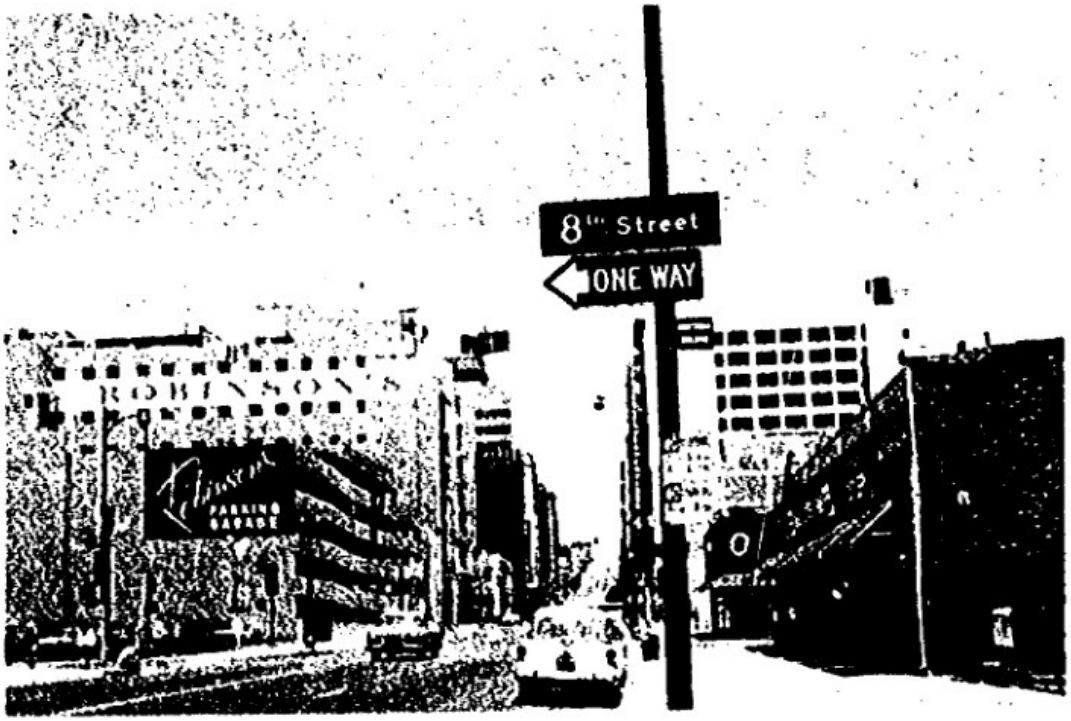
This represents a rather typical picture of that type of a situation in California where pavement legends are installed, indicating that the right lane must turn right and the No. 2 lane, middle lane in this case, may turn to the right or go straight ahead. The message is repeated, and two regulatory signs on the overhead structure, and it is illuminated. This is a full-time regulation, not a part-time regulation. And it offered an excellent opportunity for the installation of an oversized street sign on the mast iron structure directly between the two regulatory signs, giving the indication that the cross street is Santa Barbara Avenue.



A more modern version of that treatment is shown in this sign, where the street name has been incorporated in the same sign panel with the mandatory and the optional turn signal.



The installation of oversized street name indications on divided rural arterials is quite well established, and I am sure is familiar to us all throughout the country.

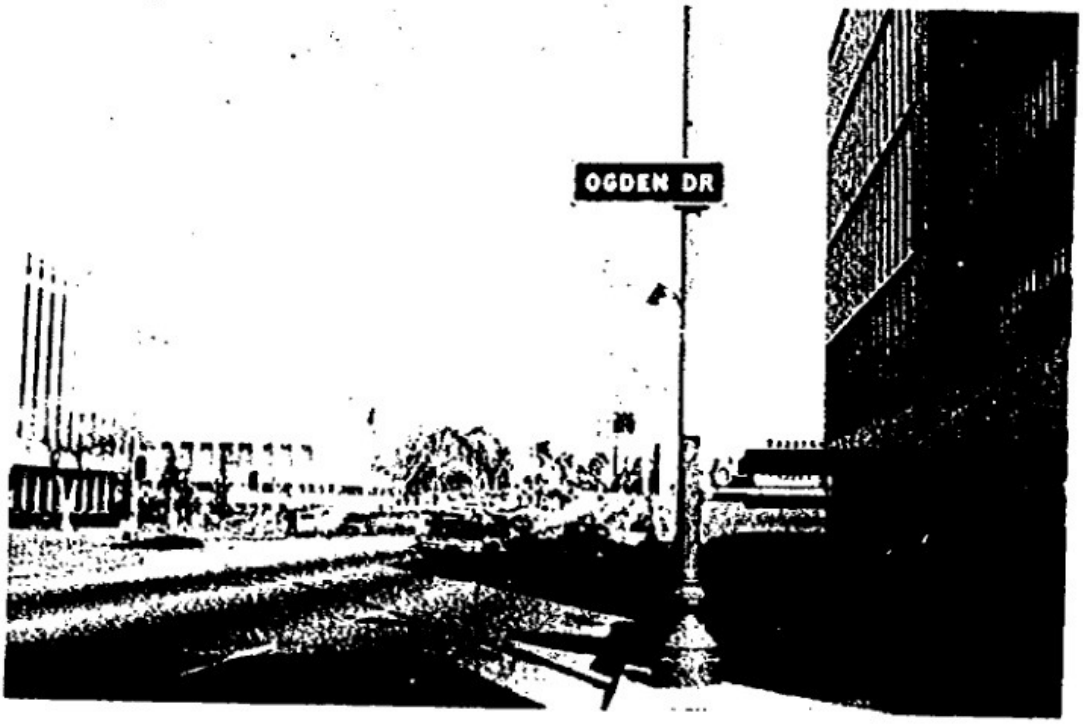


But it is unusual to find an advance street-name sign in a downtown urban area, as in this case right in the center of Los Angeles. But there is a one-way street, one-way bridge pattern of streets in the downtown area, and this location is noted in advance. Eighth Street is the next intersection. And it also has a one-way arrow, indicating in advance which direction the traffic moves on the cross street.

Mr. CONSTANDY. This sign is located roughly mid-block before Eighth Street?

Mr. FOWLER. That is right, yes. And it was also mounted sufficiently high so that it is not obstructed by any parked vehicles or trucks. We have had very favorable comment over this method of signing in the downtown area.

Mr. CONSTANDY. As a stranger to Los Angeles, these things have been extremely helpful to me, when driving through the city.



Mr. FOWLER. This is another example of a reflective advance street name sign on a street light pole in the Beverly Hills district.



This probably is not a good example, nor is it a typical example, but it has been successful in many instances. This is a painted channelization island, and there is no other physical protection for this post. It is actually mounted in the middle of the street; but the sign has been in for a number of years successfully, merely indicating that the next intersection has both Brockton Avenue and Mary Street.

Mr. CONSTANDY. It is odd to see this. If there was a curb there making that a raised median, it would not disturb anybody, but since the median is flush, it does look unusual, does it not?

Mr. FOWLER. We would certainly prefer to have more reflectives on this installation, too, with a black background and silver legend, and the nighttime illumination really is not outstanding——

Mr. CONSTANDY. Mr. Prisk, do you have something you want to say?

Mr. PRISK. I was interested in Mr. Fowler's comment and wondered if it might be a slip, in saying there is no protection for the sign?

Mr. FOWLER. No physical protection.

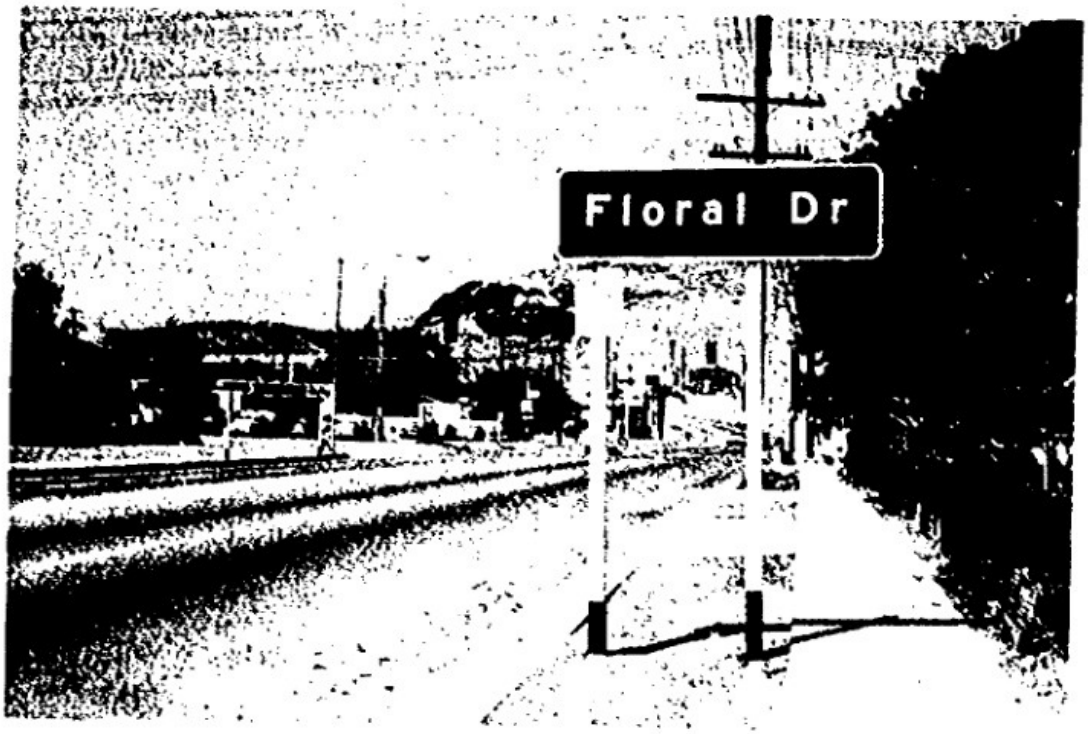
Mr. PRISK. Even no physical protection for the sign. We often talk about protection for signs—and instead of protection for the motorist. I think perhaps the superior concern is the protection for the motorist. If this sign were knocked down, it probably would accomplish less damage to the motorist than if a curb were there or if some physical protection were provided, do you not think so?

Mr. FOWLER. Yes, I do.

Mr. CONSTANDY. This may not be as bad as it first appears, then.
Mr. FOWLER. That point is well taken.



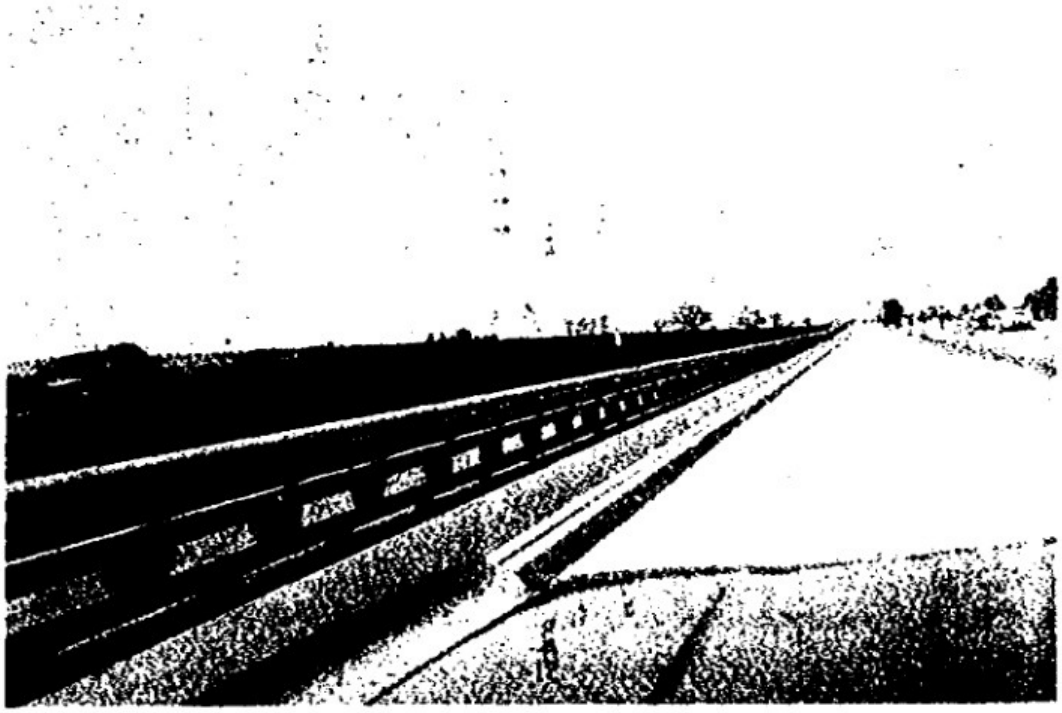
This is another example of what we would call a partially landscaped center median island in the Disneyland area.



And a side-mount offset over the sidewalk in an outlying residential area.



This one is a particularly complicated location, because there actually is a six-legged intersection here, and that accounts for the two separate side street indications on each side of the boulevard. That completes the section showing original examples of street name signing and the more modern ones.



I would like to move along now to another subject, a very serious one, and that is the problem with the wrong-way movements on the freeway. I think maybe we could get a little better dimension on the problem if I could tell you that in a period of 18 months the California Highway Patrol in California documented 1,200 cases of motorists being apprehended while they were driving the wrong way on freeways throughout the State.

Mr. CONSTANDY. Just to make sure we understand, in 18 months they apprehended 1,200 people driving the wrong way on a freeway?

Mr. FOWLER. That is right; yes. And that did not include a number that were involved in accidents. These were people who were apprehended by the police in the normal course of their patrol duties.

Mr. CONSTANDY. Before they had an accident?

Mr. FOWLER. Yes.

Mr. CONSTANDY. There are some hair-raising stories that you hear in California about people driving the wrong way on the freeways, for some distance, frequently ending up the same way, with a fatal accident.

Mr. FOWLER. Well, we have recorded distances as great as 31 miles on the wrong side of the freeway. They did not usually involve accidents, however. The number of accidents involving wrong-way movements is a very small percentage of the total wrong-way movements. Or, to put it another way, we have had an average of about 35 fatalities per year, statewide, in wrong-way accidents, although over a period of a little under 4 years there have been about 90 accidents involving more than 150 fatalities, including the sensational one that I am sure you have heard about, within the last 2 months, in which a bus burned and only about 12 survivors escaped from the vehicle.

But, oddly enough, and this might be worth noting, and perhaps Dr. Hulbert will comment on it later, in a smaller sample the highway patrol indicated that over a 3-month period, where they had apprehended 80 drivers on the wrong side of the freeway, 20 percent of them, or 16, admitted to the officer that he knew he was going the wrong way at the time he entered.

Mr. CONSTANDY. Twenty percent was deliberate?

Mr. FOWLER. Sixteen people out of 80, in a 3-month period, admitted to the officers that they knew they were going the wrong way when they entered.

Mr. CONSTANDY. Is there some further statement about why? Does anyone know?

Mr. FOWLER. There were varying excuses given, of course. Some said: "I always used to go this way, and so I still do, as I am just going down to the next interchange."

Mr. CONSTANDY. It seems fair enough. [Laughter.]

Mr. FOWLER. Then there were others that just did not think there was anything wrong with a little bit of a trip, you see. "I have done it before, and I can make it again" or "This is the easiest way to get where I am going." These were the general type of comments that they offered.

Mr. CONSTANDY. Mr. Fowler, are they out on the pavement or are they running along the shoulder?

Mr. FOWLER. This was out on the main pavement, out on the traveled way.

Mr. CONSTANDY. If they caught 1,200 of them in 18 months, you can imagine how many of them did it without getting caught.

Mr. FOWLER. That is right. Now, the problem has been attacked in at least two ways, and in other more indirect ways, too. First of all, there was a long series of full-scale dynamic tests of median barriers. This was for the purpose of trying to eliminate a vehicle going across the median and ending up on the wrong side of the freeway, because of a cross-median situation.

Mr. CONSTANDY. Inadvertently in those cases, largely, I guess. The car going out of control and crossing the median, entering the opposing traffic stream.

Mr. FOWLER. That is part of it. But in the border areas, and under other certain circumstances, we have found people going through the median—that is, an unfenced median, and then continuing in the same direction rather than making the U-turn. It is an illegal maneuver in California, and it is one reason why the double solid yellow line appears along the left-hand edge of our pavement—to prevent driving to the left thereof; but, at any rate, this situation also did prevail, particularly in the areas near the border with high incidence of alcohol and so forth.

Mr. CONSTANDY. That double yellow line on the left-hand shoulder, is that in conformity with the manual, Mr. Prisk?

Mr. PRISK. No; this is not in conformity with the present manual.

Mr. CONSTANDY. It seems to be effective in California, is it not, Mr. Fowler?

Mr. FOWLER. In urban areas, on six- and eight-lane freeways, our design includes a full-paved median for an emergency shoulder or breakdown area. So that the shoulder is paved as a refuge for a disabled vehicle. And, as a result, the double solid yellow barrier line has been installed, partly for delineation purposes and partly for legally prohibiting claim jumpers, as we call them, from moving into the median in order to pass a string of stopped cars ahead of them.

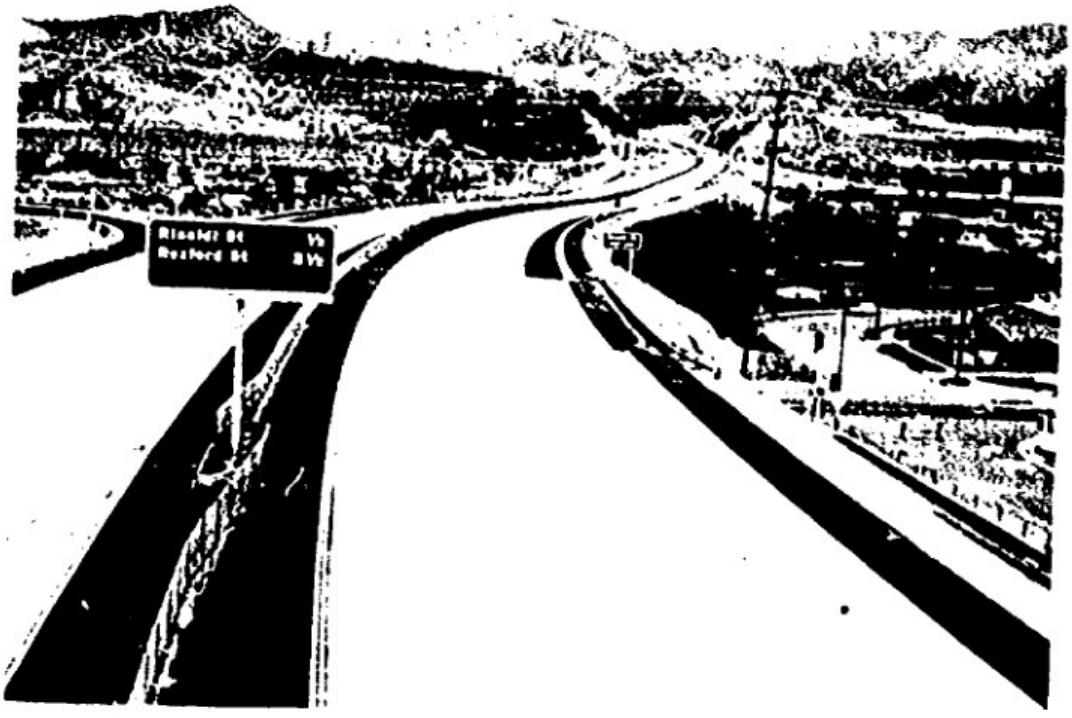
Mr. CONSTANDY. I see.

Mr. FOWLER. And so it is a dual purpose. And then, of course, where median barriers are installed in an urban area, the importance of some left-edge delineation becomes especially important in order to prevent cars from inadvertently straying into this flush paved median and colliding with the barrier.

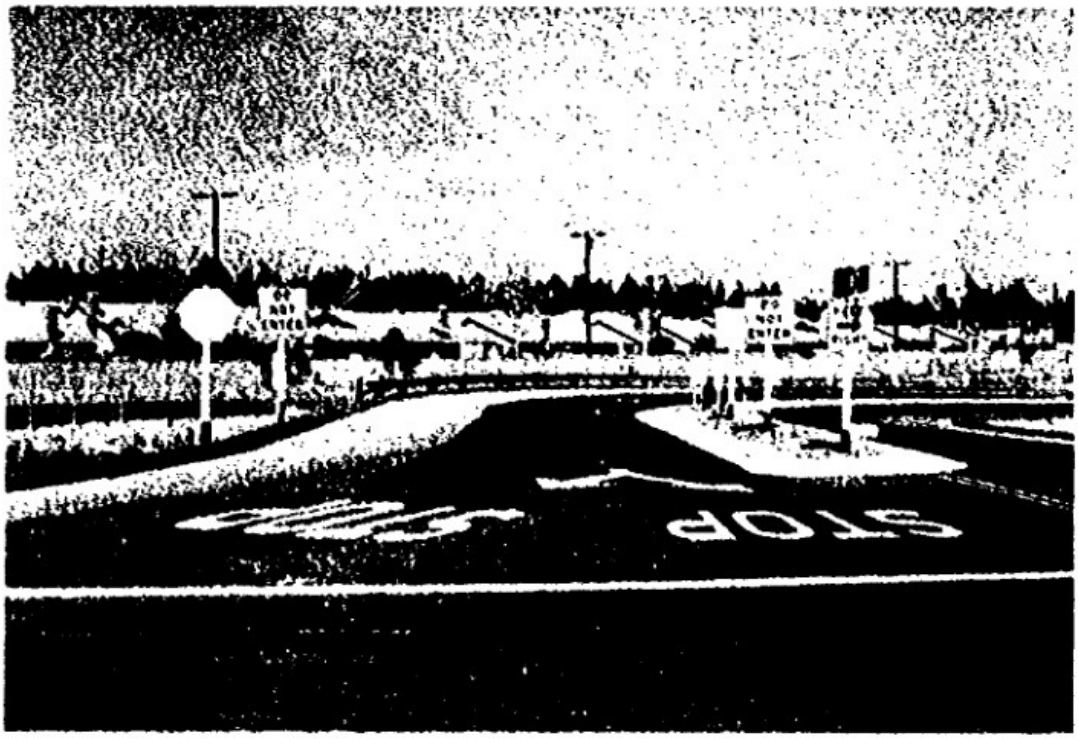
This is one of the two main types of median barriers in use in our State. I am sure you have seen it before. It is a double blocked out steel barrier beam, and I wanted to call attention to the fact that above the barrier beam is an expanded metal glare screen and curiosity shield. You will notice that is serves a dual purpose. Oncoming headlight glares are effectively blocked and, at the same time, when traffic is passing the scene of an accident on the other side of the freeway, it cuts down on the distraction to the motorist. It helps to remove the principal cause of secondary collisions and slowdowns, then, on a freeway, to pass an accident scene.



The other type of median barrier in use, I guess is unique to California. It is a more flexible type and generally used on urban medians that are greater than 22 feet in width. It consists of a double cable mounted very carefully 27 inches above the pavement, and then also includes a cyclone fence, a chain-link-type of fence. It does a little bit better job of decelerating a vehicle more slowly than does the barrier beam. It is quite an expensive installation, runs about $35,000 a mile.

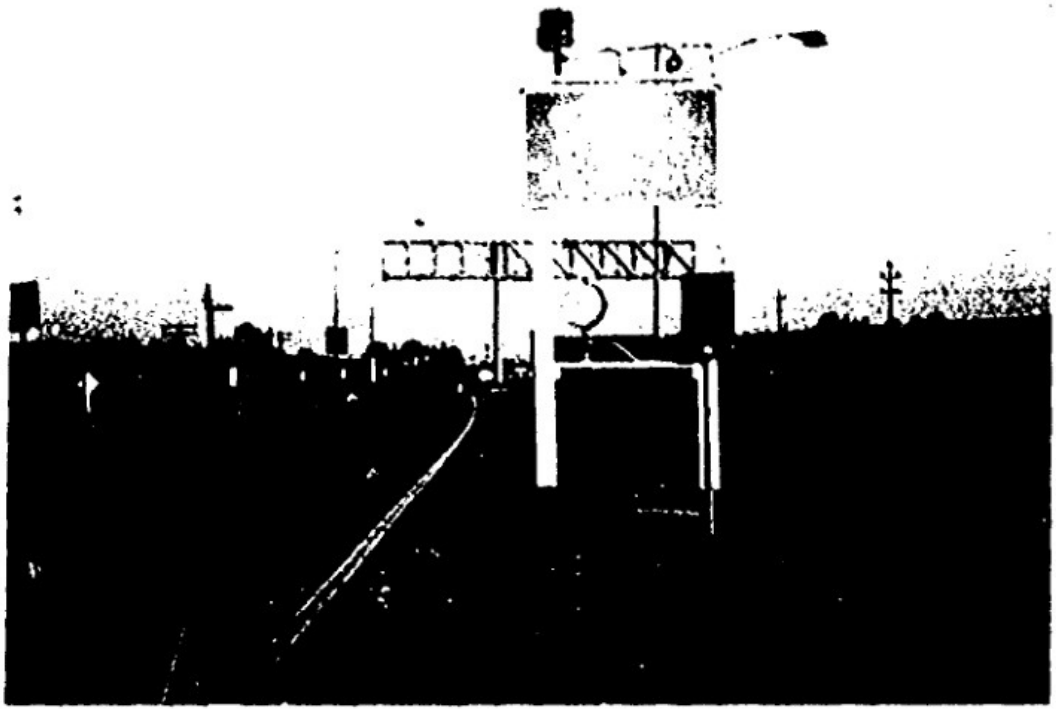


This is a photograph of a newly completed, but unopened, portion of the San Diego Freeway in the San Fernando Valley, and I use it to show the left-edge barrier striping and the two different types of median barrier fences. The blocked out guard rail there is installed in order to prevent injury and damage to vehicles if they inadvertently stray into the area where that signpost is located. This is another one of those orientation signs and at the bottom, the third line on it, the bottom message is missing because that will be assigned to an interchange yet to be built.



Now the other problem with wrong-way drivers is how to prevent wrong-way entry, and in many cases our exit ramps and our entrance ramps were located in very close proximity, one to another. This represents the standard sign that formerly was used. You will notice that there are very large pavement arrows, both here at the intersection and back at the curb, indicating that traffic in that lane would be coming to you. There are a pair of "Do Not Enter" signs; there are a pair of one-way arrows, and there is a "Keep Right" sign with an arrow on it. In spite of that, there is still a high incidence of wrong-way entry.

Some of the wrong-way entries result from the fact that the design of the ramp exit invites a motorist to do the wrong thing. This is a case of that type in the Sacramento area, where a long, straight off-ramp comes toward us, emptied into a two-way frontage road, so that drivers had a compulsion to continue ahead. And in that case, would go onto the freeway via this off-ramp.



So there was a rather elaborate testing process that was undertaken here at this location. It involves the installation of a directional detector in the pavement to the left of this sign, and then any vehicle crossing that detector in the wrong direction, headed toward the freeway, turned on the flashing red signal lense, turned on the illumination on the white-on-red reading, "GO BACK, YOU ARE GOING THE WRONG WAY"; turned on the siren directly above that, and turned on the floodlight that you see in the background and actuated a movie camera at that location.

And it aroused the neighborhood very soon. They found there were 11 wrong-way entries here in the first 10 days that the equipment was installed. The camera recorded the action of the wrong-way motorist and found that 10 of the 11 either stopped and backed up to get off of the ramp, or made a U-turn, which is physically possible in this particular location. The other one continued blithely on past the camera and was seen no more. And since he did not show up on accident reports, we assumed he got where he was going.

Now, the camera did pick up and identify the license plates on the front of three of these 11 automobiles. The registration was checked through the Department of Motor Vehicles, and an effort was made to contact the registered owners, all three of whom denied ever being in Sacramento.



As a result of the testing, the standard sign that was adopted in California then was this white-on-red sign, reading "WRONG WAY." And it is located directly below the "DO NOT ENTER" sign on both sides at the end of each off-ramp in the State. The sign in the background was one of those special test signs, and those are not in use.

And then, as a reassurance to the motorist, every on-ramp in the State of California received a pair of these white-on-green freeway entrance signs.

Mr. CONSTANDY. Is that signing package in compliance with the Interstate Manual, Mr. Prisk?

Mr. PRISK. This particular effort on the part of California Division of Highways was approved as a statewide experiment and will be included as a part of the Interstate Manual now under revision. It was not in the 1961 edition.

Mr. CONSTANDY. That would not be in the Uniform Manual——

Mr. PRISK. That is true, the Uniform Manual also did not include it in the 1961 edition of that manual.

Mr. CONSTANDY. Is there consideration being given to the inclusion of it in the Uniform Manual, too?

Mr. PRISK. In both manuals; yes, sir.

Mr. CONSTANDY. That includes the freeway entrance sign, does it?

Mr. PRISK. The wrong way sign is the one that has caught the principal attention of the committee, and this is still under deliberation, and a little bit fluid; but I think you can say with some confidence that the wrong way sign will be recommended by the National Joint Committee to its parent organizations. Freeway entrance sign, I would not be as sure.

Mr. FOWLER. I might mention there were some 5,000 of these signs involved, and they were installed on a crash program statewide on all existing freeway entrances and exits, and actually a statistical sampling in the year following the installations indicated a 41-percent reduction in the incidence of wrong-way entries.



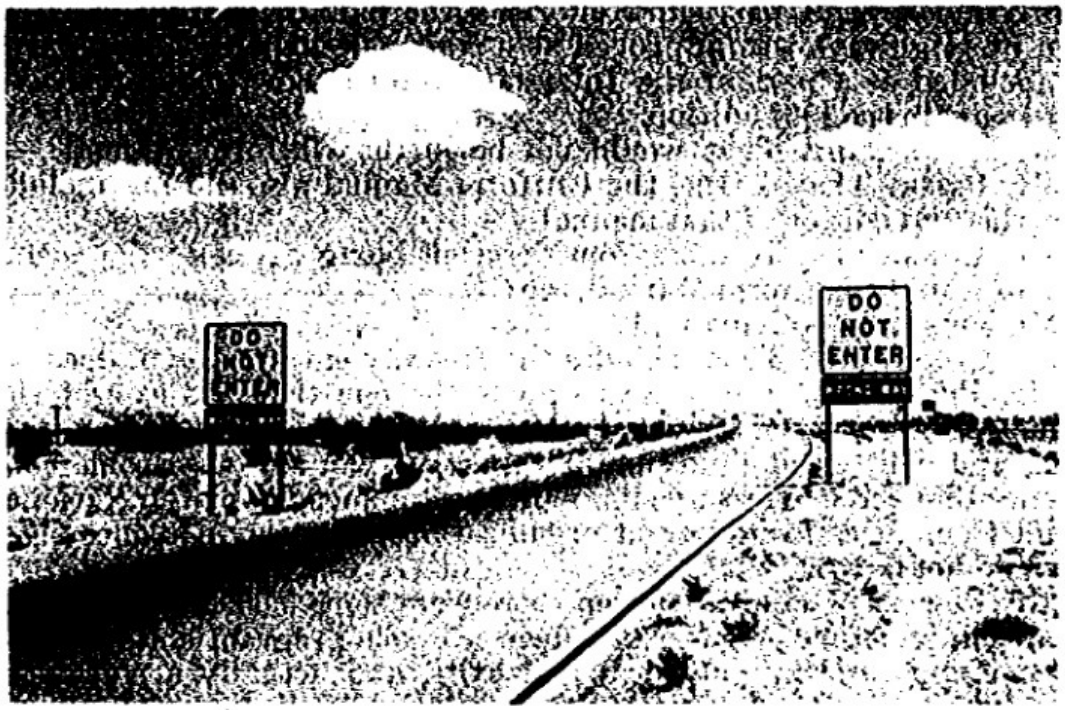
Mr. CONSTANDY. That seemed to be a worthwhile effort. Do you happen to know the cost of that, Mr. Fowler?

Mr. FOWLER. I do not have that offhand; no. About $500,000, as I recall, for the reflective signs, a double installation at each off-ramp, and in many cases including the post, labor, and equipment.

Mr. CONSTANDY. Are you able to approximate the number of ramps?

Mr. FOWLER. There were 5,000 signs, and I would assume that means about 2,500 ramps.

Mr. CONSTANDY. I see. And a 41-percent reduction in accidents?



Mr. FOWLER. Yes.

Mr. FOWLER. Yes.

In the desert areas, where higher speeds prevail and where there are some expressway-type developments, that is a freeway with limited access but with occasional grade intersections, we are using special oversized "DO NOT ENTER" signs, and the double "WRONG WAY" plates beneath it. You might be interested in knowing that in this desert area there was an unusually high incidence of wrong-way movements. And in the space of less than 18 months there were three separate wrong-way accidents, fatal accidents, in this stretch of Interstate 10 in the desert area near Palm Springs.

Mr. CONSTANDY. Was that before the placement or subsequent to it?

Mr. FOWLER. Most recent was after—all three of them involving alcohol, and one of them with 31 miles of wrong-way movement prior to the accident.



In addition, out in the desert areas, where freeway construction is proceeding more or less on a piecemeal basis, that is, a stretch of 10 or 20 miles at a time, and then a gap of the old highway, we find it necessary to give the motorist an extra indication as to whether he is on half of a complete freeway or whether he is still on the old two-lane highway. This, then, would give him the clue. You will notice that the median is over 100 feet wide in the desert area. There is a double yellow line down the left-hand edge of the pavement, which would give him the clue as to which direction the traffic travels, and there are occasional pavement arrows indicating the direction of movement; and that is further amplified by this special symbol-type sign with two up arrows, indicating the two lanes of travel, both going in the same direction, and the plate under it explaining, "One Way."



The opposite situation then would apply on a piece of the old highway, where two-way traffic is still operating. The arrows are reversed, so that one is up and one is down, and the plate reads, "Two Way Traffic."

Mr. CONSTANDY. Is that type of signing in compliance with the manual, Mr. Prisk?

Mr. PRISK. This particular type sign, and the one shown before it for one-way traffic, is not specifically prohibited, because there is an open end to the types of information that you can put on the yellow diamond. There has been no specific provision in the manual, up to the last publication in 1961, of this type of—specific type of sign.

Mr. CONSTANDY. So it would be permitted, but it is up to the ingenuity of the individual signing engineers, State highway departments, to conceive a type of sign to accomplish a given purpose?

Mr. PRISK. Precisely.

Mr. CONSTANDY. If it were included, examples were included, might it not encourage some of the others who perhaps did not have that idea, that perhaps this is a solution for them?

Mr. PRISK. Exactly. And that is in the process.

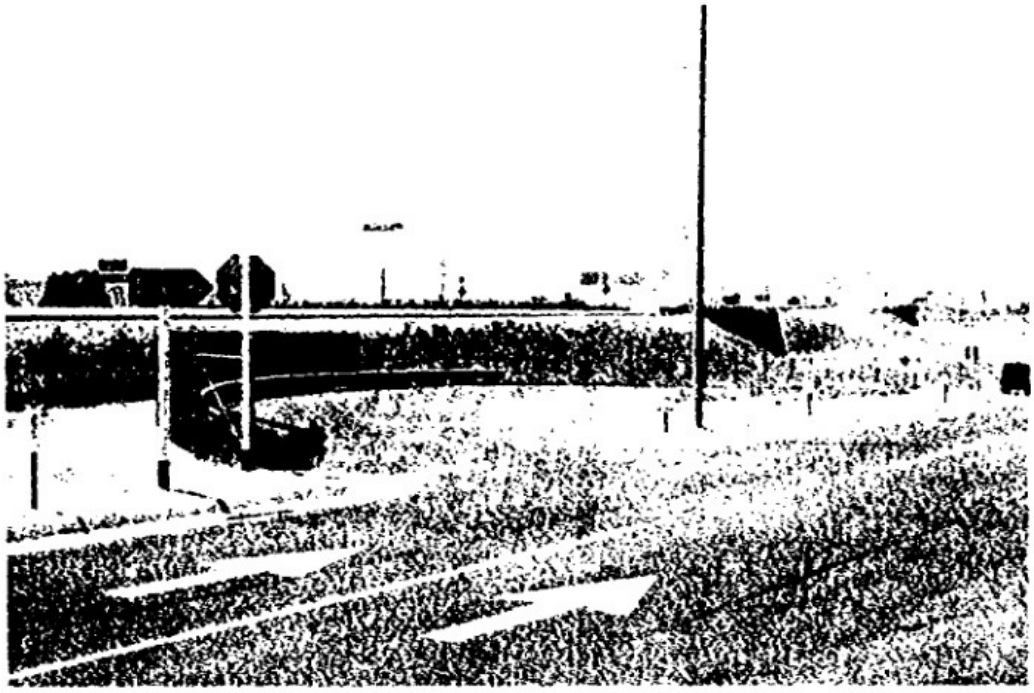
Mr. CONSTANDY. Thank you.

Mr. FOWLER. I might add one other statement, and that is that part of this problem results from the fact that our pavement markings policy is really inadequate. There is not an adequate basic, philosophical background.

Mr. CONSTANDY. When you say "our" you are not talking about California, you are talking about nationally?

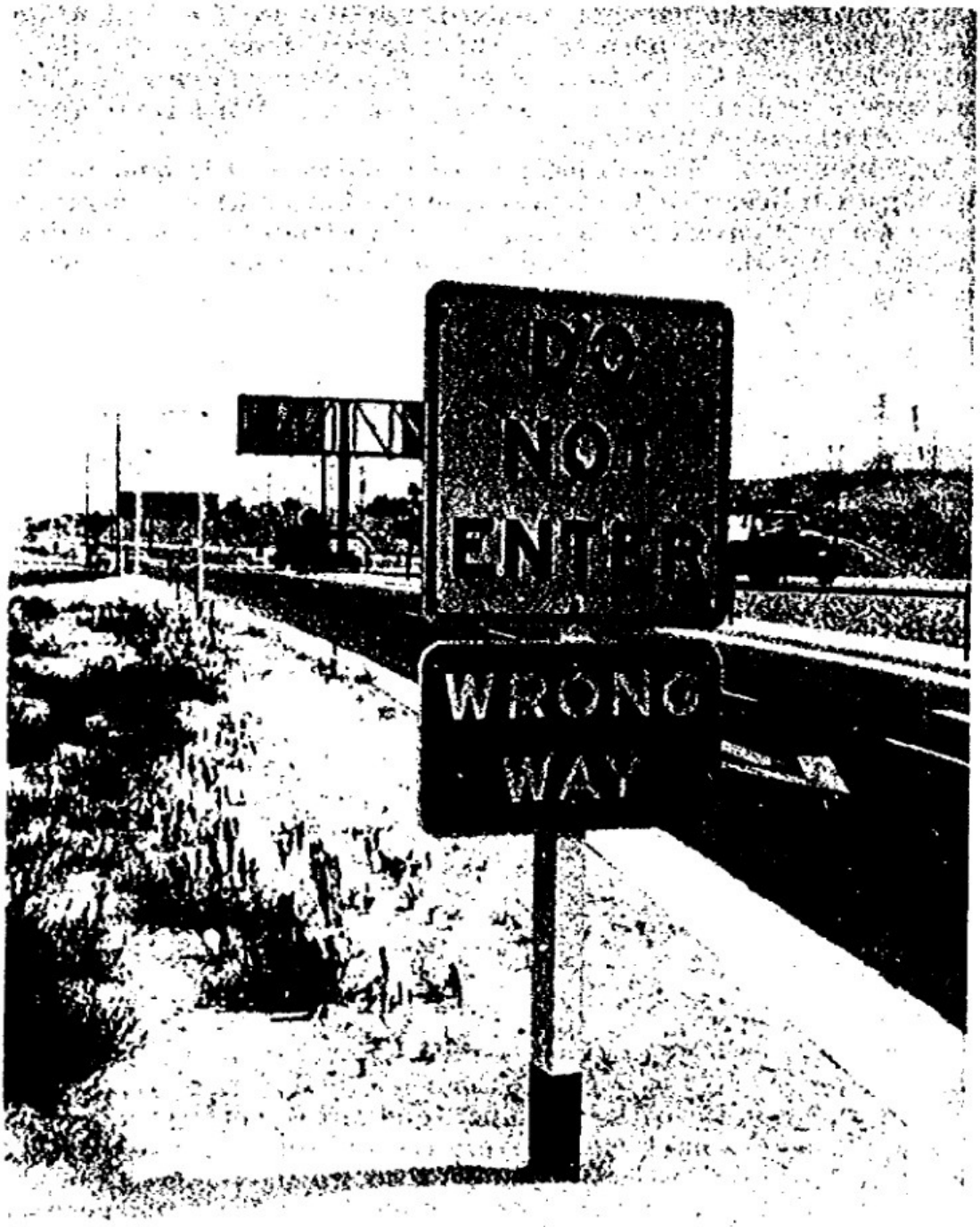
Mr. FOWLER. The national standard, yes. We use a dashed white line for more than one purpose. In this case you cannot tell the difference by looking at the roadway, whether this is a lane line separating two lanes of traffic in the same direction or whether it is a rural center line separating opposing traffic.

Mr. CONSTANDY. We will get into this subject a little later in the hearings. I believe that the joint committee has under consideration a new system of pavement marking that will attempt to overcome that problem and perhaps others, and give some uniformity to pavement markings.



Mr. FOWLER. Yes.

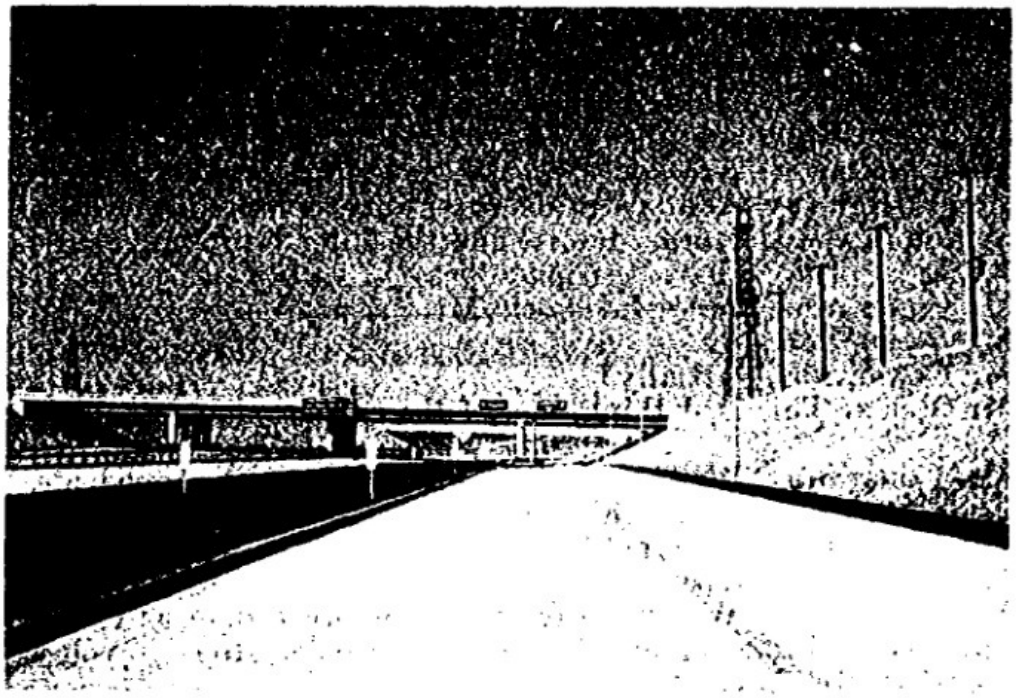
This merely indicates a recent installation that represents improved design in order to try to minimize the possibility of wrong-way entry. The freeway is in the background here and directly in the foreground is a two-lane off-ramp from the freeway. And this two-lane off-ramp goes directly into a two-way frontage road. So the center island has been installed separating the two pavements on the frontage road and then on-coming traffic on the frontage road is bent around a 90-degree angle into a normal cross intersection, and in that way any on-coming traffic from the frontage road would have to deliberately make a right turn in order to inadvertently enter the off-ramp.


DO
NOT
ENTER
WRONG
WAY

And if he did that, of course, he would be looking directly into the end of pavement.

Mr. CONSTANDY. I think we can recognize that signing can only do so much.

Mr. FOWLER. I am safe in saying that there is a great deal more care being recognized in the design of ramp connections than there ever was before, because of the awareness of this one-way entry problem.



My last section relates to the matter of pavement delineation, and this first slide represents a view of an unopened section of new freeway. This particular section of freeway involves a collector-distributor road. We are on the collector road. The main freeway is to the left. I use this slide to indicate the roadside reflectors that are placed along both roadways, and the point that I am going to make here is that although these are installed at prescribed regular intervals, there are enough random reflectors installed on many freeways so that you lose the effect of the pattern.

Mr. CONSTANDY. On the question of those delineators, I was surprised to find out that the installation of them, at least in the past, has not been mandatory. Mr. Prisk, you and I, in the course of our tour last year, visited one State where they just did not subscribe to the use of delineators at all. And on their Interstate System they have none, except, I believe, at the exit ramp. Is that not right?

Mr. PRISK. Yes.

Mr. CONSTANDY. Do you know whether the present standards, as promulgated by the Federal Highway Administrator, now require the installation of these reflectors?

Mr. PRISK. The Interstate Sign Manual, as far as the Interstate System is concerned, does require the installation of the delineators.

Mr. CONSTANDY. Did it at the time we visited that——

Mr. PRISK. It did 1 year ago. Also, there was no general observance of this particular provision.

Mr. CONSTANDY. There was no observance of it?

Mr. PRISK. No general observance. Many States have resisted the application of delineation, particularly on lighted sections, such as this one that you see here, from the standpoint that there was adequate delineations used through color and texture of the structure or pavement, or through lighting and other purposes, other than the erection of these delineated panels at the roadside.

Mr. CONSTANDY. Of course, then, there are others where that is not true. The one we visited was not a lighted highway.

Mr. PRISK. Many are not lighted, that is true.

Mr. CONSTANDY. And not reflectorized, either, by delineators.

Mr. PRISK. Right.

Mr. CONSTANDY. Are you aware of any effort on the part of the Federal Highway Administrator to enforce compliance with that provision of the Uniform Manual and the Interstate Manual?

Mr. PRISK. Efforts have been made, yes.

Mr. CONSTANDY. Successful efforts, Mr. Prisk?

Mr. PRISK. Partially.

Mr. CONSTANDY. Partially?

Mr. PRISK. This is, I think, one of the educational problems that we have.

Mr. CONSTANDY. Well, if it is required, well, it is a good idea to educate people as to why they are required to do something. It can be enforced though, can it not?

Mr. PRISK. It could be, yes.

Mr. CONSTANDY. We will leave to some future date as to how. I think it is good to recognize that this is a problem, too. Do you want to continue, Mr. Fowler?

Mr. FOWLER. You will note, then, that there is a regular pattern of reflectors along the right shoulder, but reflectivity from the left-hand side here would appear to be a little bit scattered at night, because we are not talking about one continuous row of reflectors, we are talking about two. And the pattern would appear to be scrambled to the motorist, as he saw these in the headlights at night.

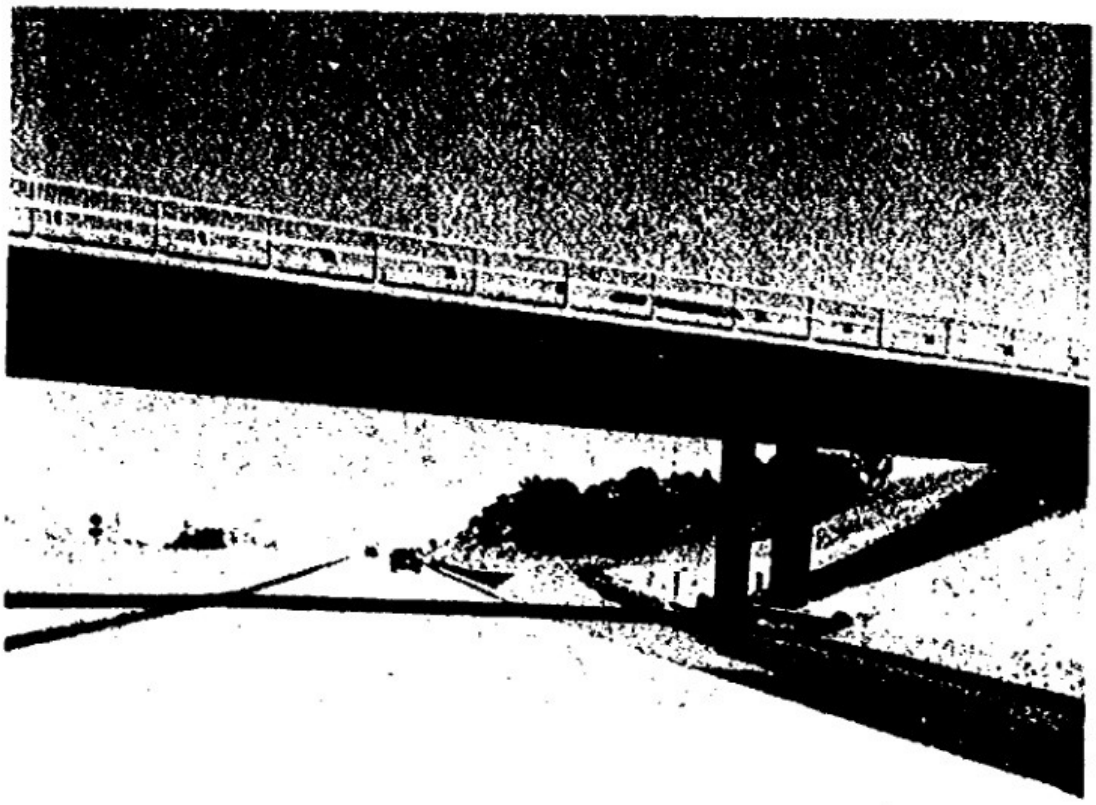
Mr. CONSTANDY. He would see all of them from both roadways?

Mr. FOWLER. That is right.



This is not an exaggeration. This is a photograph taken through the windshield of a car, and you will have to discount the reflections at the lower portion of the slide, because that represents reflection off the hood of the car.

But looking at the roadway in the upper half of the photograph, you can recognize four sets of taillights, and you can probably see about four sets of oncoming headlights, or a little more. The fact that there is an overhead illuminated sign, and the fact that there are yellow reflectors in the center top of the photograph, shows that there is an off ramp to the right. That also means that there undoubtedly is an overhead structure in the background. And because of that, there are various guardrails and other lighting poles and culverts, perhaps, and other highway hardware that have had reflectors installed. And the reflectors themselves, then, at night give a rather confused pattern.



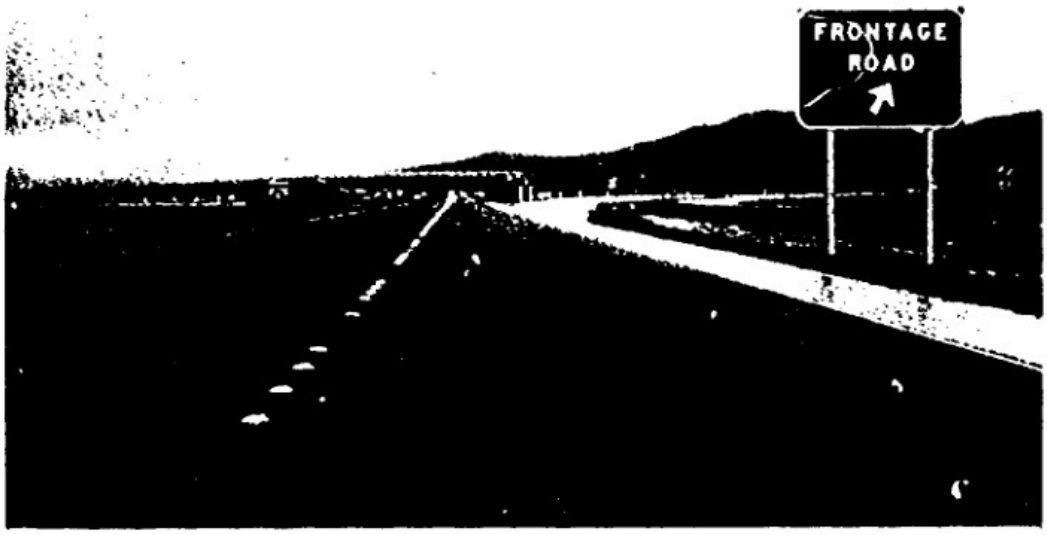
The point we are making then is that by going to raised pavement markers, California is attempting to put the delineation down on the roadway and clearly identify the traveled path to the motorist, thinking that this is of more benefit to him than is random reflectorization of various roadside objects.

So that there would be an attempt under this system to concentrate, or to eliminate roadside reflectors and instead reflectorize the roadway itself. The particular markers that are shown here have been adopted in California to replace standard painted lane lines. Now, the painting had already been done on this piece of rural freeway, and the ceramic buttons have been put in after the striping was done. The striping is not to be repeated. The buttons themselves are roughly 4 inches in diameter and about five-eighths of an inch high. Some of them, in the testing program, have been down and in use on California freeways for more than 11 years. They are quite durable.

Well, they are put down in a pattern, spaced 3 feet apart, four dots to simulate one dashed stripe. And then, in every other gap, at a distance of 48 feet, is a brilliant silver reflector.

Mr. CONSTANDY. That is what appears in the photograph as the black mark between the stripe?

Mr. FOWLER. Yes. I have a pair of them here on the table with me. This is the silver reflector that you see in the first gap [indicating].



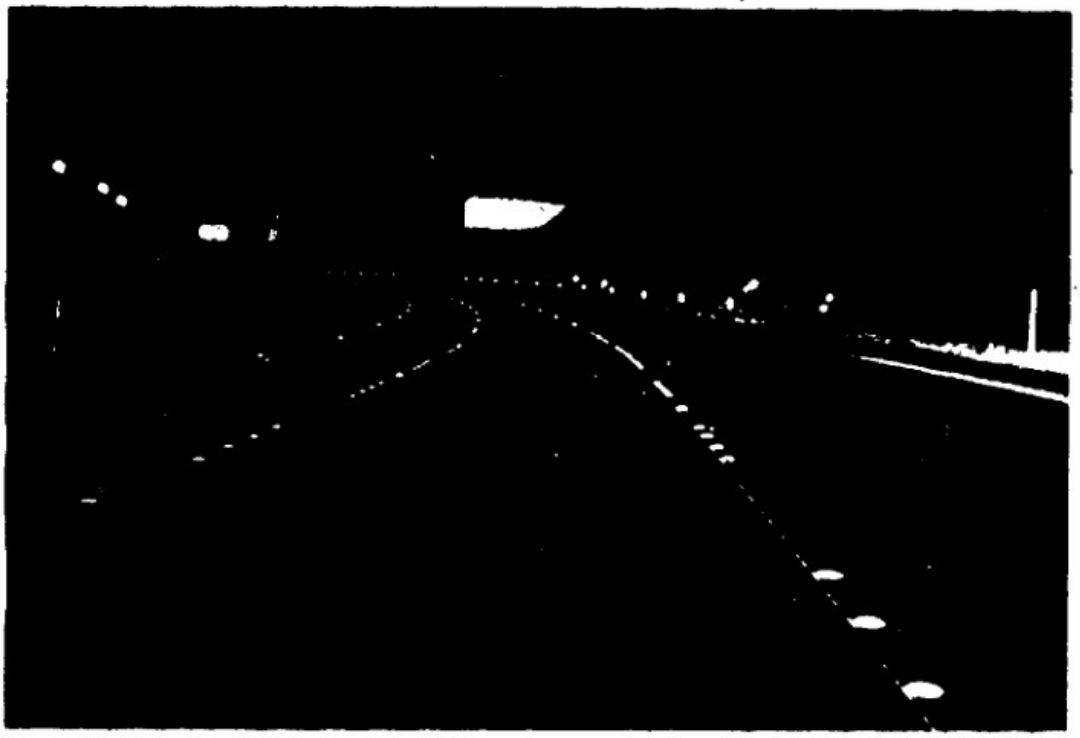
This is illustrating some of the advantages of raised pavement markers. This particular shot was taken in the north coastal area of California, which experiences a great deal of wet weather and fog. And some of the principal advantages of the ceramic markers is that on a gray, overcast day, the white ceramic markers show up considerably better than the reflective ones which would show at night.

Mr. CONSTANDY. What happens to paint striping in the rain?

Mr. FOWLER. Well, as we have already experienced, of course, on a wet roadway surface, particularly when there is oncoming headlight glare, the painted stripe completely disappears. It is a phenomenon known as specular reflection, a glare surface. As a result, in wet weather, the motorist frequently complains about loss of orientation, they cannot tell which lane they are in nor whether they are straddling one; and this could lead to serious trouble.

With the raised marker, then, not only is there a continuous indication of where the lane line is, but at the same time any motorist that does stray across the line, he receives both an audible and a contactable sensation; that is he can feel the bumping over these as the car crosses the lane line. And a sleepy driver, therefore, would be expected to be benefited particularly by these, because as the car drifted a little bit and crossed it, it would awaken a less-than-alert driver.

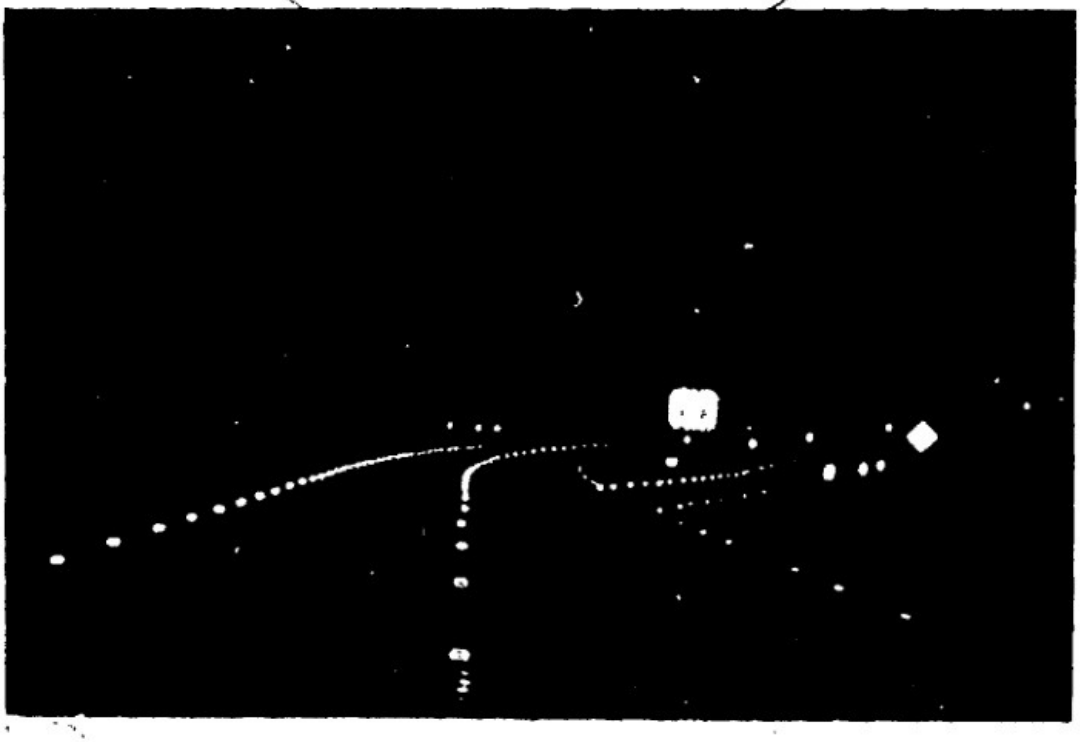
There are other advantages, too, of course: The fact that the markers offer the prospect of long life, means that we are reducing the hazards from slow-moving paint-striping vehicles straddling the line, as they do in California. The problem with the striping operation is that it has become so great in the metropolitan area, where the freeways are busy, that the painting can only be done on Sunday mornings, between 4 in the morning and 10 or 11, and that was not only a very expensive process, but a source of hazard too.



Now at night this is what the delineated roadway would look like, in the high beam of the headlights for the first hundred feet or so, and you can see the ceramic dots because they reflect from the headlights. Beyond the first hundred feet you do not see the dots, all you see are the reflectorized markers that are 48 feet apart. In the background, on the right-hand side, there is a guard rail, and that right-hand row of reflectors are units that are mounted on the guard rail itself.



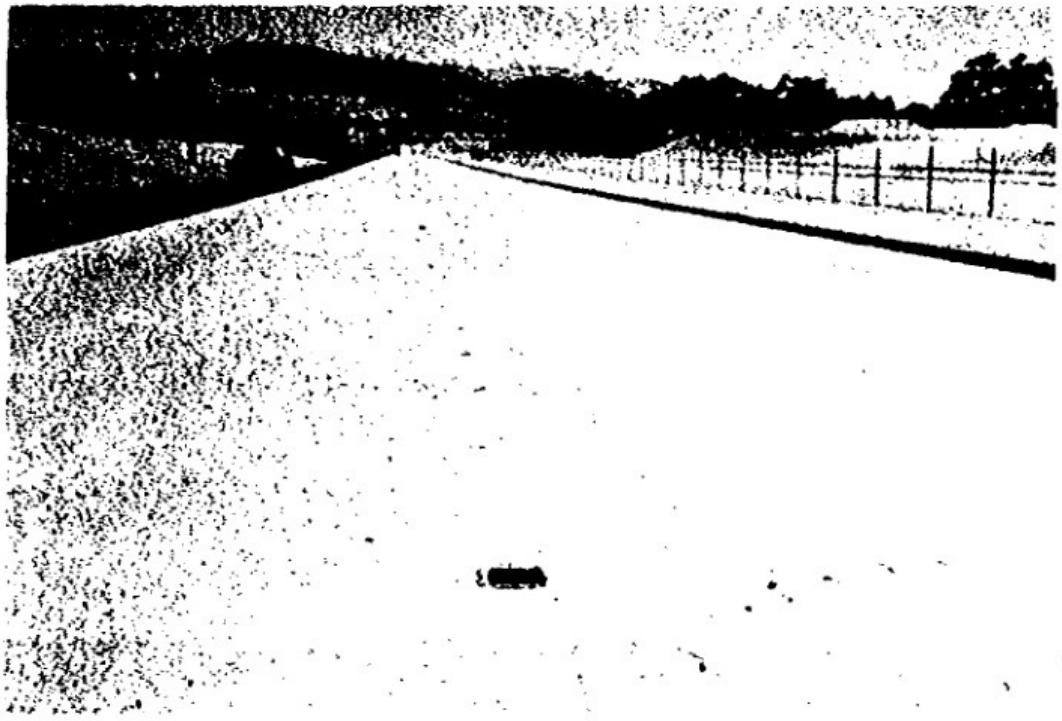
There has been some more experimenting done. This was on an unopened piece of Interstate 5 in the Sacramento area, showing the silver reflectors down the lane line in the center, and delineation of an off-ramp to the right, using some blue markers for indicating the edges of the roadway. The yellow reflectors in the background are on some of these objects that are along the edge of the road, that I mentioned before, the random markers.



This is another example, clearly marking once again the off-ramp by using yellow markers, as we have adopted for the left-hand edge of the one-way road.

Mr. CONSTANDY. Is that in lieu of the double yellow line?

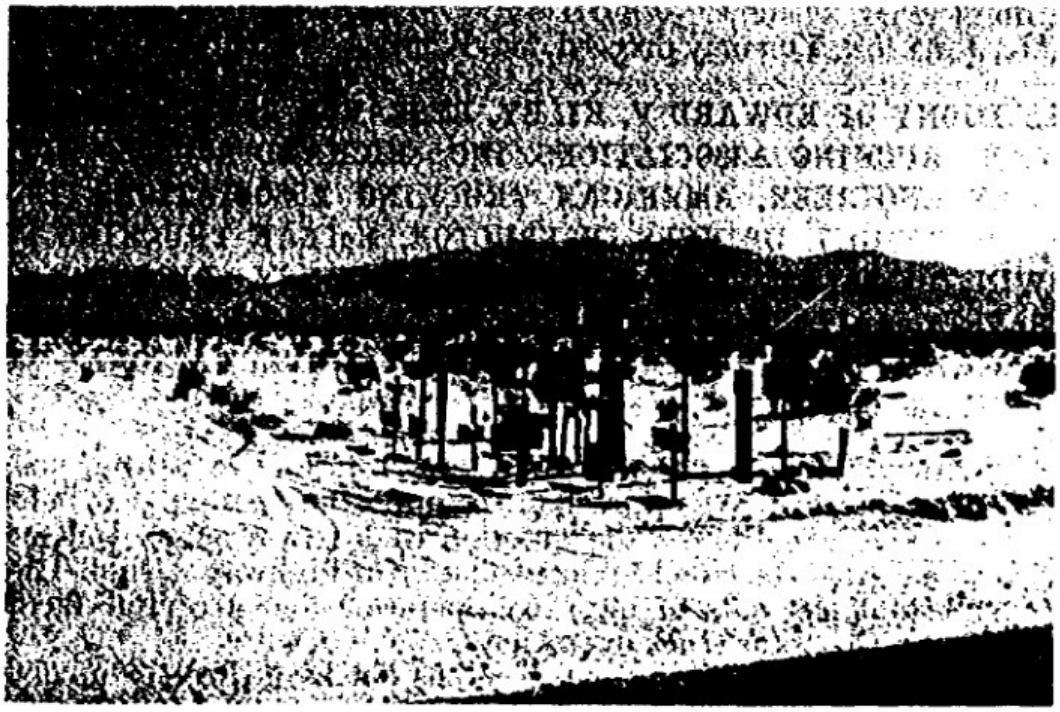
Mr. FOWLER. Yes. And at the present time there is a bill in the legislature to revise the existing law so that raised markers will be recognized in lieu of the painted line. Now, there is another collateral advantage to these raised markers, and that is that it offers the possibility of a bidirectional reflection, that is a two-directional reflection, so that the reverse side of those silver reflectors would reflect brilliantly red, as this sample shows.



In other words, a wrong-way driver would be confronted with the red reflector in front of him. Traffic coming to him would see silver; traffic going in the wrong direction would see red.



This is what it would look like to a wrong way driver at night. He has a double indication here. He has the red reflectors in the pavement; he also has, in this case, the double yellow painted line on the right-hand edge, which would indicate wrong-way movement, too. That completes my subject on roadway delineation.



I merely include this, once again as a little bit of humor, to indicate that highway signing problems occur everywhere. We call this the urban desert. You can see what civilization is doing to sagebrush country.

Mr. CONSTANDY. Each person that builds a house in the desert puts up his own sign?

Mr. FOWLER. He is entitled to his own sign.

Mr. CONSTANDY. I want to thank you very much, Mr. Fowler, both you and Mr. McDonald have been extremely helpful in our hearings. The material you presented will be very valuable to the committee, hopefully to the signing engineers throughout the country and their superiors. I thank you very much. It was a fine presentation.

Mr. JOHNSON. I want to thank you, too, Mr. Fowler, for your appearance here. Certainly the Automobile Club of Southern California has been a very active group. I can remember, from my days in the State legislature, when I served on the committee on transportation, that they were a very active group at that time. I was glad to have the opportunity to be here this morning to hear you and see your slides illustrating some of the grave problems we face.

Mr. FOWLER. Thank you very much, Mr. Chairman.

Mr. JOHNSON. Our next witness is Edward V. Kiley, research counsel, American Trucking Associations, Inc.; Richard A. Lill, highway engineer, American Trucking Associations, Inc.; Jack Knight, drivers instructor, McLean Trucking Co., Winston-Salem, N.C.; Michael Potochney, director of safety, Hall's Motor Transit, Harrisburg, Pa.; and Leo E. Wozniak, director of safety, D.C. International Co., Denver, Colo. Will you raise your right hands?

Do you solemnly swear that the testimony you will give before the subcommittee will be the truth, the whole truth, and nothing but the truth, so help you, God?

[Messrs. Kiley, Lill, Knight, Potochney and Wozniak answered "I do."]

Mr. JOHNSON. You may proceed, Mr. Kiley.

TESTIMONY OF EDWARD V. KILEY, RESEARCH COUNSEL, AMERICAN TRUCKING ASSOCIATIONS, INC.; RICHARD A. LILL, HIGHWAY ENGINEER, AMERICAN TRUCKING ASSOCIATIONS, INC.; JACK KNIGHT, DRIVERS INSTRUCTOR, McLEAN TRUCKING CO., WINSTON-SALEM, N.C.; MICHAEL POTOCHNEY, DIRECTOR OF SAFETY, HALL'S MOTOR TRANSIT, HARRISBURG, PA.; AND LEO E. WOZNIAK, DIRECTOR OF SAFETY, D.C. INTERNATIONAL CO., DENVER, COLO.

Mr. KILEY. Thank you, Mr. Chairman. I just have a brief statement for the record. We appreciate the opportunity to appear before the committee and discuss the question of highway signs and messages, along with the closely related matter of highway design. These are important elements of highway operation and are vital factors in efficient, safe motor truck operation.

Historically, the trucking industry has not been directly involved in questions of policy as to highway geometrics, marking or signing. We recognize that these details are properly the responsibility of the

various highway departments and agencies, including the Federal agencies that are involved.

The trucking industry believes the development of a modern highway system has been one of unusual success for all classes of highway users and for highway transportation in general. A modern, improved highway system designed to carry our growing highway traffic is essential to our national economy. The development of the trucking component of the highway transportation system has been and will continue to be tied to highway improvement and progress.

The trucking industry, from the outset, has been a consistent supporter of a modern highway system and a progressive highway program. We support the early completion of the National System of Interstate and Defense Highways within the capabilities of the current tax program and a continuation of progressive highway improvements to meet the country's expanding needs.

We believe the work of this committee, in following the progress of the highway program since its inception, has contributed immeasurably to the success of the program and to a more orderly and efficient carrying out of the program's objectives as laid down by the Congress.

To get to the specifics of this hearing, the trucking industry as a whole has not developed a general position on the questions of highway signing, marking, or geometric design. Of course, individual groups within the industry with specific problems have brought their positions to the attention of the Congress and the State authorities. Such an instance was the appearance of Mr. Leonard, president of Leonard Brothers Transfer, Miami, Fla., before this subcommittee on February 9, 1960. At this time, an industry position regarding minimum overhead clearances was presented.

In December of 1964, the highway engineer of the American Trucking Associations presented a statement to the Design Committee of the American Association of State Highway Officials entitled "The Geometric Design of Highways and Truck Operations." This effort was an attempt to develop a position which could represent the industry on this question.

The conclusions in this paper are not of a revolutionary nature; an indication in itself that the highway development has generally been consistent with the safe operation of trucks. Nevertheless, we did note the items of vertical clearances, grades, interchanges and intersections, and signing and road information, as being of special importance to truck operation. The items were discussed in the paper and we would be glad to make it a part of the record for background, if the committee so desires.

Mr. MAY. Yes, may we make that exhibit No. 3, Mr. Chairman?

Mr. JOHNSON. Yes. Without objection, we will make the paper described exhibit No. 3.

(Exhibit No. 3 was marked and placed in the appendix. See p. 654.)

Mr. KILEY. We do not present ourselves as experts in the field of signing messages or highway design. However, we recognize that the entire system of highway design, interrelated with getting needed information to vehicle operators, is vastly different than it was 10 years ago. We believe that the recent experiences of the trucking industry will be useful to those who are charged with keeping the

highways up to date. It was for this reason we have these gentlemen with us. These individuals whom you have introduced here have vast experience in this question of motortruck operation over the highways. We know their background and experience will be very valuable to the committee and will help you in your work. We would like to cooperate with you in every way we can.

Mr. MAY. Thank you very much, Mr. Kiley.

Mr. JOHNSON. Any further questions of Mr. Kiley? You have some, Mr. May?

Mr. MAY. Yes. We are going to shortly show some slides of locations and signing of highways, and we will listen to the comments of these people representing the truckdrivers of this Nation and learn their viewpoint. But first, Mr. Potochney, will you tell us a bit about your company, how many drivers are employed by the company and how they operate?

Mr. POTOCHNEY. I am employed by Hall's Motor Transit, of Harrisburg, Pa. We have approximately 2,000 employees, 350 road drivers and 750 city drivers. We operate in nine States in the eastern region here. We are in the top 10 category of common carriers.

Mr. MAY. Mr. Wozniak.

Mr. WOZNIAK. Yes, sir. I am the safety director for D.C. International Co., formerly Denver-Chicago Trucking Co. We have approximately 3,700 employees, and of this number 900 are what we call line drivers, who operate over the highways and preferably over the Interstate System, and about 500 city drivers. We operate over some 70 million highway miles each year. We are very happy to have this opportunity to discuss some of the problems that we are becoming increasingly faced with, insofar as poor identification on these highways, Interstate Highways, is concerned.

Mr. MAY. You can talk from a coast-to-coast viewpoint?

Mr. WOZNIAK. Yes, we do operate coast to coast.

Mr. MAY. Mr. Knight.

Mr. KNIGHT. I am Jack Knight, of the McLean Trucking Co., Winston-Salem. We are among the top 10 and we travel 20 States. We employ around 1,600 road drivers and about the same amount of local drivers. We operate mainly from the eastern seaboard, from Boston to Savannah, and as far as Kansas City and St. Paul.

Mr. MAY. Very good. Has each of you at one time driven trucks?

Mr. KNIGHT. Yes, I have.

Mr. POTOCHNEY. Yes.

Mr. WOZNIAK. Yes.

Mr. MAY. If you will dim the lights, we will proceed with some of these slides. We would like you to volunteer your comments as we proceed with these visual aids.



I might first talk just a little bit about the rules of the road. Now, there is a sign you showed yesterday, in the New York area, which pertains to trucks. What does it say, Mr. Kopecky?

Mr. KOPECKY. On this Interstate Highway, the volumes are 100,000 to 140,000 a day, and it says "Trucks over 5 tons maximum gross weight keep right."

Mr. MAY. Is it the law in a number of States that the trucks traveling on the various highways keep to the right? Is that the general law? Will one of you volunteer?

Mr. POTOCHNEY. That is right, sir. I would like to comment on this area. Unfortunately you see one of our units in the center lane there. You will note that this arch bridge will normally have a tendency for the driver to shy away from it. He is uncertain of his clearance, and this is part of the traffic pattern that he will avoid.

Mr. MAY. Would that happen on occasion—where the sign would direct the truck to stay right and if he did, he might strike the overhead?

Mr. POTOCHNEY. Yes. There are certain areas where, unfortunately, we have become involved.

Mr. MAY. Yes. I might point out, there is no sign on the left of this particular highway. Is that a problem sometimes for the trucker? They place "Keep Right" sign on the right and very few on the left?

Mr. POTOCHNEY. That is one of the problems, but you will also notice there is no clearance marker on the right.

Mr. MAY. I see.



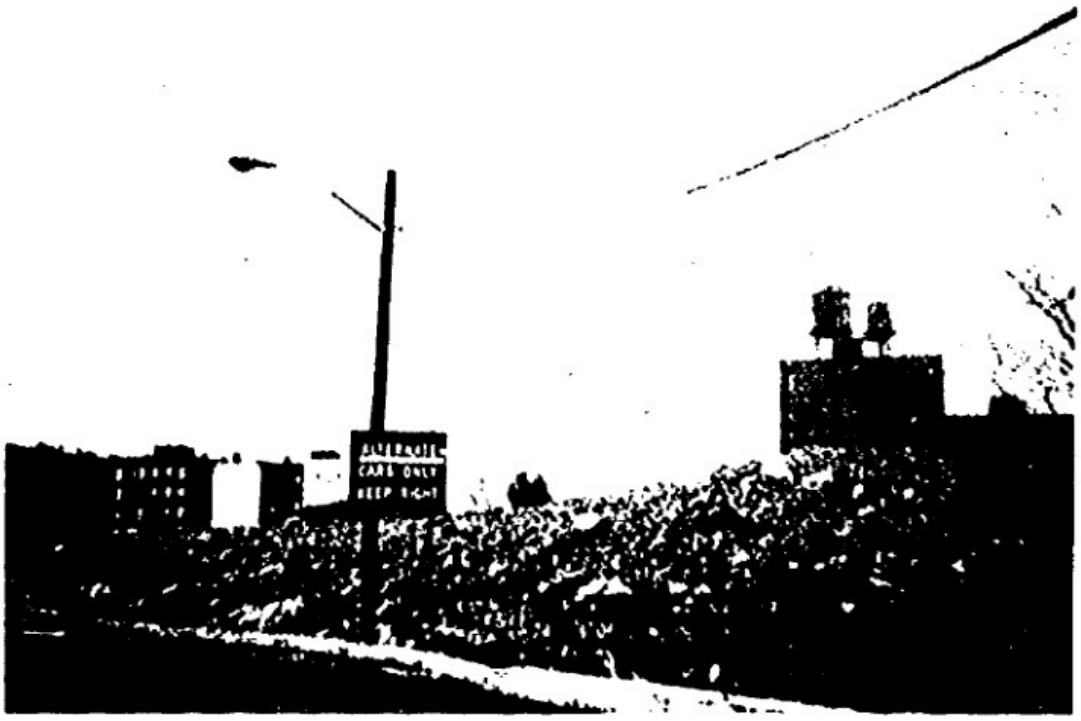
Because these signs are dirty, it is difficult to read them. We cannot make them out from this position. What does that sign say, Mr. Kopecky?

Mr. KOPECKY. "Speed limit 50." The sign underneath it says, "Trucks over 5 tons maximum gross weight keep right."

Mr. MAY. That sign is on the left.

Mr. KOPECKY. This one was on the left.

Mr. MAY. The position seems to be better, but if you cannot read it, it would not help you much.



We can read that sign. It says "Alternate—cars only keep right."

Mr. Knight, if you were driving a truck, what would you do at this point?

Mr. KNIGHT. Well, I would certainly be confused. That "Alternate", I do not know whether it means alternate cars are supposed to dovetail into traffic or whether that just applies to cars only, or what have you.

Mr. MAY. It would not help you much?

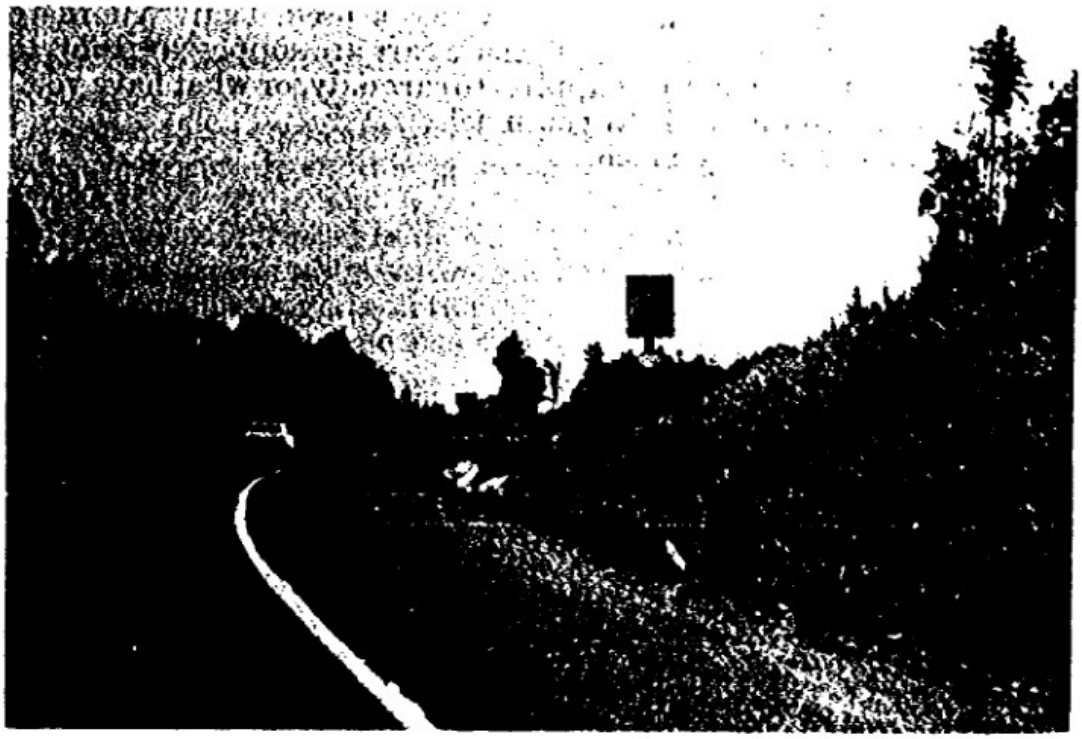
Mr. KNIGHT. Not very much.

Mr. MAY. That is on that same stretch of highway.

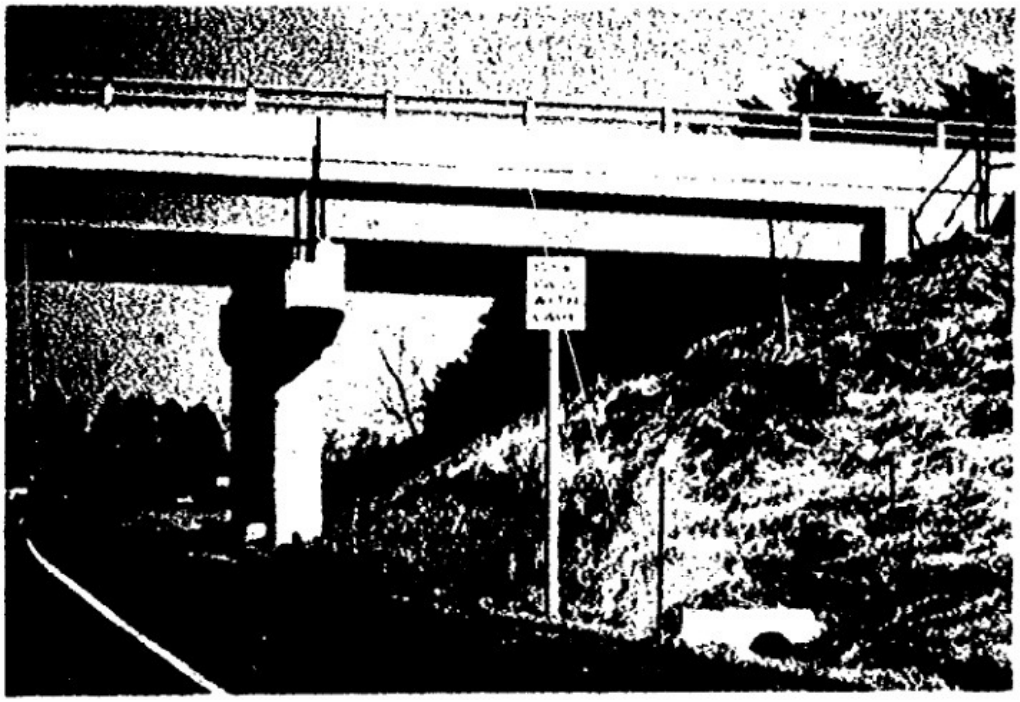


Mr. MAY. These are the common signs that you see, I suppose, in driving trucks: "Slower traffic keep right"; is that right?

Mr. KNIGHT. That is right.



Mr. MAY. "Trucks do not pass," going up a grade.



"Trucks pass with care."

(At this point Mr. McCarthy assumed the Chair.)

Mr. KNIGHT. This was brought out yesterday about these bridge abutments with no guardrail or protection. Something as heavy as a truck, of course, a guardrail in many cases might not stop him, but it could veer him away from this deadhead abutment, such as you see here, as well as passenger cars.

Mr. MAY. If that sign were not there, could you pass without care?

Mr. KNIGHT. I would not think so.

Mr. MAY. If a sign along a highway says "Keep Right" and there is no sign that says "Trucks pass with care," are you permitted to pass or do you have to keep right?

Mr. KNIGHT. I would assume so. I believe this sign here probably follows the one we saw in the previous picture, "Trucks do not pass." This just informs the driver that he can now pass.

Mr. MAY. I see.

Mr. POTOCHNEY. May I comment on that?

Mr. MAY. Mr. Potochney.

Mr. POTOCHNEY. Most States have "No Passing" zones which the driver is more aware of than in this case here. He knows whether he is in a "No Passing" zone, either by the State, where they have double lines—now, in Pennsylvania, a double line does not restrict you to no passing, it is merely a warning.

Mr. MAY. It does not?

Mr. POTOCHNEY No, sir. If you have 500-foot visibility, you are allowed to pass. However, the average motorist is confused and most truckdrivers are aware of where they can pass or cannot due to this fact.

Mr. MAY. Mr. Constandy will take over at this point. We now want to discuss the problem of the two-lane offramp as it applies to the trucker. Mr. Constandy.



Mr. CONSTANDY. This is on the Hollywood Freeway, Los Angeles. As we discussed yesterday in the presentation of Mr. Fowler, there are situations where the exit ramp from the freeway has two lanes. A truck wanting to go through the interchange that is obliged to stay in the right-hand lane has a problem as he nears this exit ramp, because the lane on his left is also exiting. So at some point he has to move over from the right-hand lane to the lane next to it, at least, in order to avoid crossing the stream of exiting traffic.

Now, in Los Angeles, they installed these signs in advance of this point to give the truckdriver an opportunity to change his lane before he begins to be affected by and begins to effect the exiting stream of traffic from the freeway. So this sign placed on a bridge structure over the freeway notifies him that it is permissive now for him to leave the right-hand lane in which he is otherwise obliged to drive.



So if we could just take a couple more slides and go down this Hollywood Freeway we will see how it has benefited the driver to know in advance, by proper signing, that he is permitted and expected to move into the other lane, and avoid a situation which would otherwise be troublesome. This is taken a little farther along and if you will notice, the left part of the sign on the next bridge structure reads "Pasadena Freeway," and the arrow hangs at the lane second from the right, which is now permissive for the trucks. In the center there is the shield for State Route 11, which is both the Pasadena Freeway and the Harbor Freeway. The Harbor Freeway legend appears on the right side of the sign and the arrow is over the right-hand lane. And the legend on that yellow panel reads "Exit Only." So by the time the truckdriver reaches this point, had he not been advised in advance, he would, at this point, have to move over to that center lane, unless he chose to exit at the Harbor Freeway from that right lane. But assuming he wants the Pasadena Freeway he is now in the second or center lane.



You will notice he is going up grade here. That might be another factor that the State took into consideration in placing the "trucks O.K." sign—to permit him to make the movement under the conditions which would be most favorable to him.

Now, clearly you can see the Pasadena Freeway and Harbor Freeway signs with the right-hand lane panel reading "Exit Only." Now we have the panel on the left side indicating "Interstate 10, Interstate 5," far in advance for the through traffic San Bernardino, Santa Ana.



As the driver comes down the road, being in the second lane from the right, he is in an alternate lane and can either exit to the Pasadena Freeway or continue straight ahead onto Interstate 10 and Interstate 5.



This is the Pasadena and Harbor Freeways just below that gore where, having been in the alternate lane and going to the right, he can now go to the Pasadena Freeway. Had he stayed straight ahead, he would be on that structure to the left on Interstate 10 or 5.



Beyond this type of interchange, they then will place this sign advising the truckdriver he no longer is permitted to remain in that center lane and must go back to the basic rule of staying to the right. In the double ramp exit situation, such as the one which we have just seen, it would seem to indicate that it is necessary to move the trucks from the right lane to the center to avoid the trapped lane and then to notify the driver when that zone is passed, so that he can go back again to the right lane. Otherwise he is apt to be in trouble.



This is another freeway in Los Angeles with a two-lane exit to the right and, in this instance, there is no advance sign saying, "Trucks OK." However, the geometrics and alinement of the facility would permit the driver to be able to see sufficiently in advance. If you notice, there is this sign in front of us [indicating], then there is the sign a little farther ahead at the point of exit, and there was a sign in advance of this one with similar message as this one [indicating]. So in this situation, it is not quite so critical.

In the other situation he was coming up a grade and about to descend upon a double lane exit ramp, which perhaps dictated the necessity for the sign there. But in this situation, he again would have the opportunity to move to the second lane from the right, to stay out of the "exit only" lane, and then at this point of the gore, where



that white station wagon is, he would have the option of either continuing on 405 in the direction of San Diego, or making an exit to Long Beach Freeway. But he would be out of the right-hand lane and not be an encumbrance to the exiting traffic from that alternate lane.

Mr. KNIGHT. Excuse me just a minute. I notice in that sign there, there is not an arrow, to San Diego.

Mr. CONSTANDY. I am sorry, I did not hear you.

Mr. KNIGHT. This sign to the left, 405, there is not an arrow there to indicate what lane you should be in.

Mr. CONSTANDY. No. As was explained yesterday, the State has found that it is not necessary for a sign to have an arrow when the traffic going straight ahead was going to that destination. They went through several generations of signs and have come to the conclusion this is the preferred sign, rather than an attempt to indicate to the driver that he must go in a particular lane to follow 405 to San Diego.

Would any of you care to comment on this problem of the two-lane right-hand exit and either the advantages of advance signing or the disadvantages that accrue to a driver not having it?

Mr. WOZNIAK. I might make a short comment on that. To the extent that it should be an advantage, double lane exits, for the one reason, if it is properly laned or marked and your traffic stays to the assigned lane, it will remedy the problem we now have where many exits are on ramps or are wide enough for two lanes but they are only one. And we now have traffic really, illegally, trying to pass each other, or go off together, or come on together. So legally designated double-lane entry and exit I think would be beneficial.

Mr. CONSTANDY. Yes; it would seem so. Is it a problem to a tractor-trailer driver if he were in this lane where the blue car is and he wanted to continue on 405?

In this situation, we have seen there is an "Exit Only" sign for that lane. That is the practice followed in California. However, in other places, they do not use that yellow panel, as extensively at least, and the driver has not got the advance warning that this type of situation is developing. What kind of driving problem does this present to him?

Mr. WOZNIAK. This compounds the problem, because if he is inadvertently in the exit lane and wishes to continue, he just cannot do anything about it now, because instead of one lane of traffic exiting, he has to cross over or he has two lanes crossing in front of him, or trying to. So this would be about as hazardous a situation as you could get into.

Mr. CONSTANDY. So without advance signing, he could, in effect, be trapped?

Mr. WOZNIAK. Exactly.

Mr. CONSTANDY. And be forced to exit or make a hazardous maneuver?

Mr. WOZNIAK. Correct, without any advance notification that the situation is developing.

Mr. CONSTANDY. There is another point to this. If he moves over to the left-hand lane, at a point of his own choosing, to be safe, because he understands the situation that is coming up in front of him, does he not in some places run the risk of being given a ticket for not staying in the right lane when staying in the right lane is required?

Mr. WOZNIAK. Well, if a truck is assigned to the right lane, which would be the right through lane, then, yes, he runs the risk of getting a ticket. But by the same token, he is definitely in a hazardous position there.

Mr. CONSTANDY. Perhaps the point of it is he has to make the election there, when it is not signed, as to what is the proper point to avoid a hazard?

Mr. WOZNIAK. Correct.

Mr. CONSTANDY. And also avoid the ticket?

Mr. WOZNIAK. Oh, yes. This actually happens this way in practice. I handle several accidents a year—I do not know the number—but on this very basis, that the truck was designated the extreme right-hand through lane and had to continue in that when someone in the left-hand lanes all of a sudden found that they wanted to exit; so they are exiting in front of him, and in doing so, they are cutting across in front of him. And we have these, as we call them, "fender benders"—not serious, but we do have accidents on that basis. Whereas, otherwise, if he was not restricted to the use of the extreme right-hand lane, I am sure he would have been positioning himself up the road somewhere so that he would not be involved in the hazardous situation of exit or entry traffic.

Mr. CONSTANDY. Do you find this to be a problem in the areas that you are familiar with, as far as the double-exit lane not being marked in advance to permit movement to another lane?

Mr. WOZNIAK. Well, as we discused yesterday, in California, of course, I must say, they are very far advanced in signing and what have you, and in the extreme East. This has been brought on, I suppose,

because of the heavy traffic conditions, density of traffic. But we definitely do have these problems in the Midwest, in the Chicago area and places like that; very definitely.

Mr. CONSTANDY. What about the other two gentlemen?

Mr. POTOCHINEY. I would like to comment that coming off I–83 into Baltimore, at the point where Towson is signed, you have a double exit ramp. However, 83 continues on in a straight line, but the sign does indicate a branch off to the right, which they call the "Fallsway." However, there is a double blinker amber light that goes under an underpass, and this highway now is divided by concrete medial strip into two on-ramps, going on to the Beltway, 695.

Now, the curve itself, the ramp, is of such nature that it just fades away to the right and the speed there, at that point prior to the ramps—the sign says "25 miles an hour." However, a truck entering this lane has a choice of two lanes suddenly in front of him. Now, if he unhappily takes the wrong lane—there have been numerous accidents; we have been involved in them personally, where the truck is overturned on both lanes and you have the additional mishap of a possible second car alongside of you. There is no advance warning that this lane does become two lanes on the ramp.

Mr. CONSTANDY. This type of situation you have found, in your own experience, creates problems for the truckdrivers?

Mr. POTOCHINEY. That is right.

Mr. CONSTANDY. Dual exit not properly signed in advance?

Mr. POTOCHINEY. That is right.

Mr. CONSTANDY. How about you, Mr. Knight?

Mr. KNIGHT. I think probably the two-lane exit ramp has advantages as well as disadvantages providing the driver—be it a passenger car, truck, or bus—is familiar with this area and knows whether he wants to make a right turn down on this ramp or left turn. Being unfamiliar with it, you find there is some passing from either the right side or the left side to get in a position at possibly a stop sign, which is below this.

We, too, have been involved in fender benders at exit ramps of this type, two lanes. It is actually wide enough for two lanes, but only marked as one. At times they will pass you on what is paved shoulder part, making two lanes of traffic.

Mr. CONSTANDY. Yes. So this type of a two-lane exit ramp almost demands, as far as the truckdriver is concerned, that it be signed enough in advance to permit him the option of leaving the right lane to avoid becoming a part of the problem at the exit?

Mr. KNIGHT. I think not only the truckdriver, but also the passenger car driver.

Mr. CONSTANDY. I am sure of that. We recognize the difference in maneuvering an automobile, though, and the problems inherent in a long vehicle. It does not have the handling capabilities of an automobile.

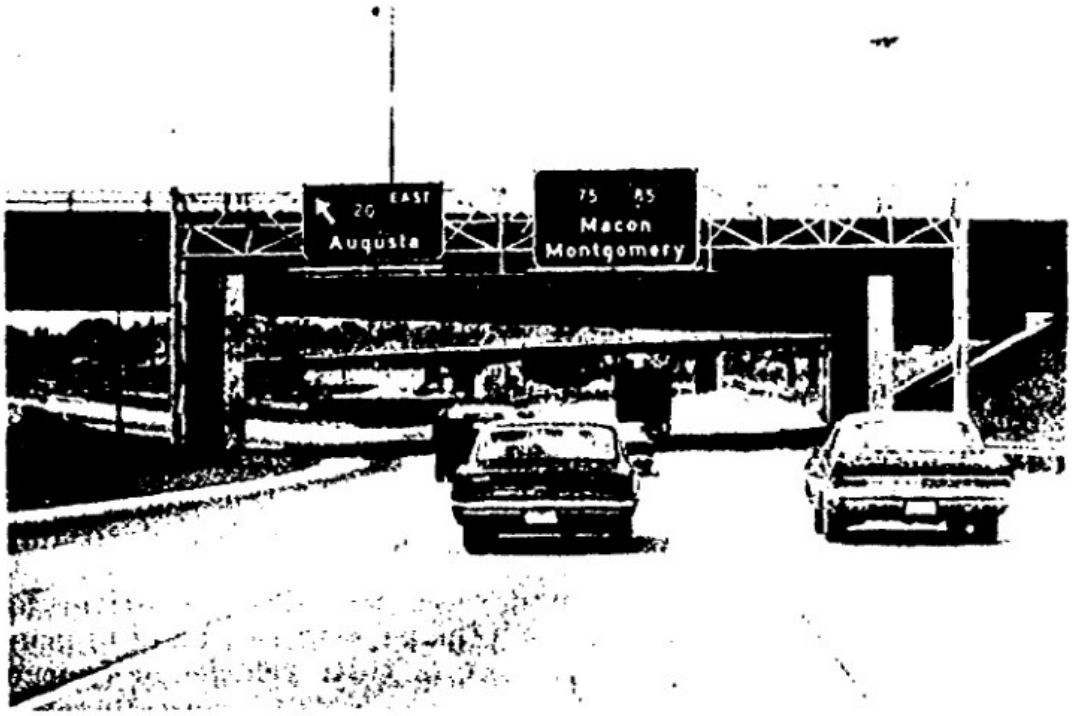
Mr. KNIGHT. Of course, in most cases, too, the truckdriver has better vision. He is much higher than the passenger car, and in many instances, he can see before maybe two or three vehicles in front of him can see them.

Mr. CONSTANDY. Yes.

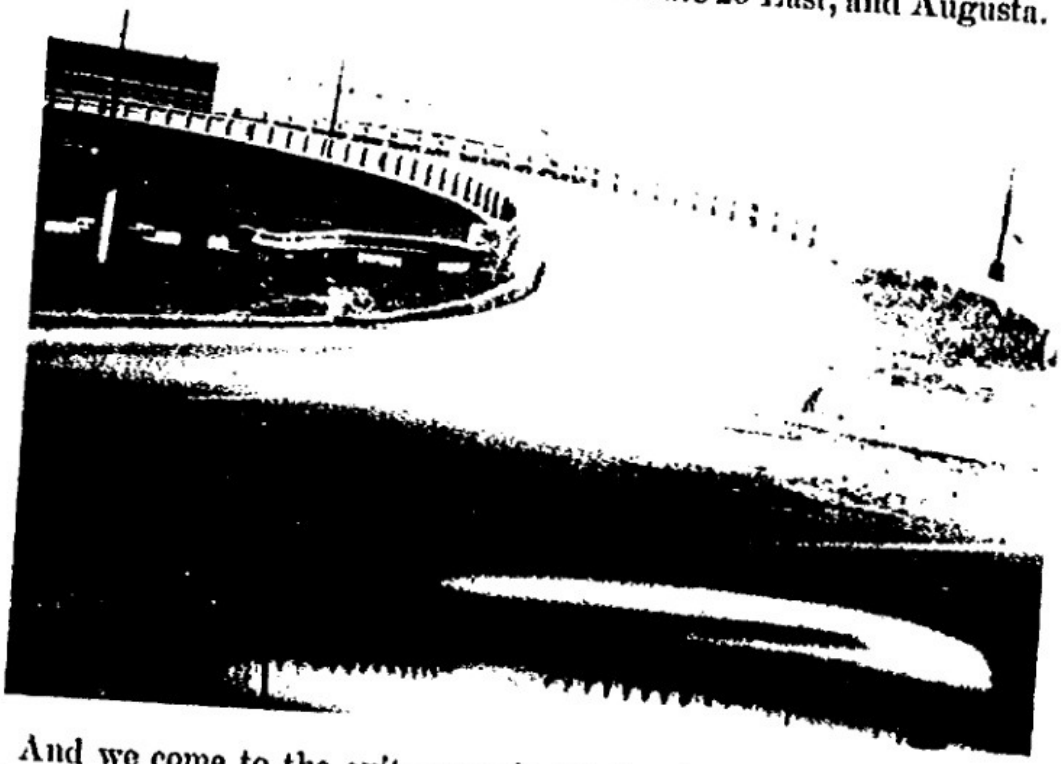


We come to the problem then of the left-hand exit ramp and the necessity for the signing in advance of it to acquaint the motorist, whether it be a private or commercial vehicle, that he will exit to the left.

You see this sign "Junction ½ mile, Interstate 20 East—Augusta." The sign is over the left lane. It does have an arrow directed to that lane. This is a half-mile from the point where you exit. It does not



specifically say it is a left-hand exit. As we go farther down this road—we see the deceleration lane added on the left and the sign in front of the structure indicating the exit to Interstate 20 East, and Augusta.



And we come to the exit ramp itself. I call your attention to the damage to the guardrail, the abutment, and to the bridge, plus the geometrics of the ramp itself.

In this picture, we see that the exit speed sign, which appears beyond the structure, and not very visible, reads—I can hardly make it out—"40 miles an hour." I know some of you are familiar with this location, are familiar with the problems here during the rush hour, and the difficulties in making a left-hand exit at this point. I wonder if you would care to comment on this?

Mr. KNIGHT. I am familiar with it. Our trucks use this. We actually are on I–85 before you exit on I–20. Most truckdrivers, or anyone else for that matter, who is going to exit on I–20 will get in this left lane several miles back.

Mr. CONSTANDY. Hopefully.

Mr. KNIGHT. Particularly during the rush hours, because it is almost an impossibility to get in the left lane from the right lane then.

Mr. CONSTANDY. He would be in the left lane in advance if he knew of the left exit.

Mr. KNIGHT. If he knew it.

Mr. CONSTANDY. The fellow who does not know it is left to find out about it only by signing such as this—I have been on this road during the afternoon rush hour and I think your point is well taken. I would not say it is impossible to cross over to that lane with a car, but it is done at some hazard and it is extremely difficult.

We have to avoid surprises, do we not?

Mr. KNIGHT. Yes. I have actually seen cars and trucks stopped there trying to merge to the left. I think all drivers of every type—some of them have a horror of getting lost.

Mr. CONSTANDY. I guess we all have that.

Mr. KNIGHT. A New York police officer asked our driver one time if he was lost. He said no, he still had three quarters of a tank of fuel left. [Laughter.]

Mr. WOZNIAK. Can you not just see in this particular situation where a driver that comes into the area occasionally, has been traveling on freeways where they have pretty well been directing him to keep to the right; he is going into Augusta, all of a sudden he is in the extreme right and he does have to make a swift and sometimes a seriously expensive decision.

Mr. CONSTANDY. Mr. Knight, on this road, are your drivers obliged to keep to the right in advance of this?

Mr. KNIGHT. I do not recall seeing any signs to that effect in Atlanta. If it is, if it does exist, they certainly do not enforce it.

Mr. CONSTANDY. So he has again, at his own hazard, to decide when he gets over in the left?

Mr. KNIGHT. I think the police officers realize the hazards out there and they do not get out there with them. [Laughter.]

Mr. CONSTANDY. But if you had a diligent police officer and you also had a driver who, in your opinion, is a good driver anticipating the heavy traffic during the rush hour, the truckdriver would move over to the left, as you mentioned before, a couple of miles in advance of this if he intended to make a left at the exit?

Mr. KNIGHT. That is right.

Mr. CONSTANDY. Is he not then vulnerable to being given a ticket for being in the left?

Mr. KNIGHT. That is correct. Our problem in this location will be eliminated in the very near future by a belt route that is being completed; it will eliminate us having to go through the heart of Atlanta. I forget the belt route number. It is several miles out of town.

Mr. CONSTANDY. I though you were going to say you were going to move your terminal.

Mr. KNIGHT. We just completed it about a year ago. We will exit several miles northeast of Atlanta to our left, which would bring us around to the same location where we are now and we have to be going to the right, down through I–85, down through the heart of Atlanta. In the background, the picture of the bridge; that is also the bridge to the Atlanta Stadium, which also increases traffic at this time of the year.

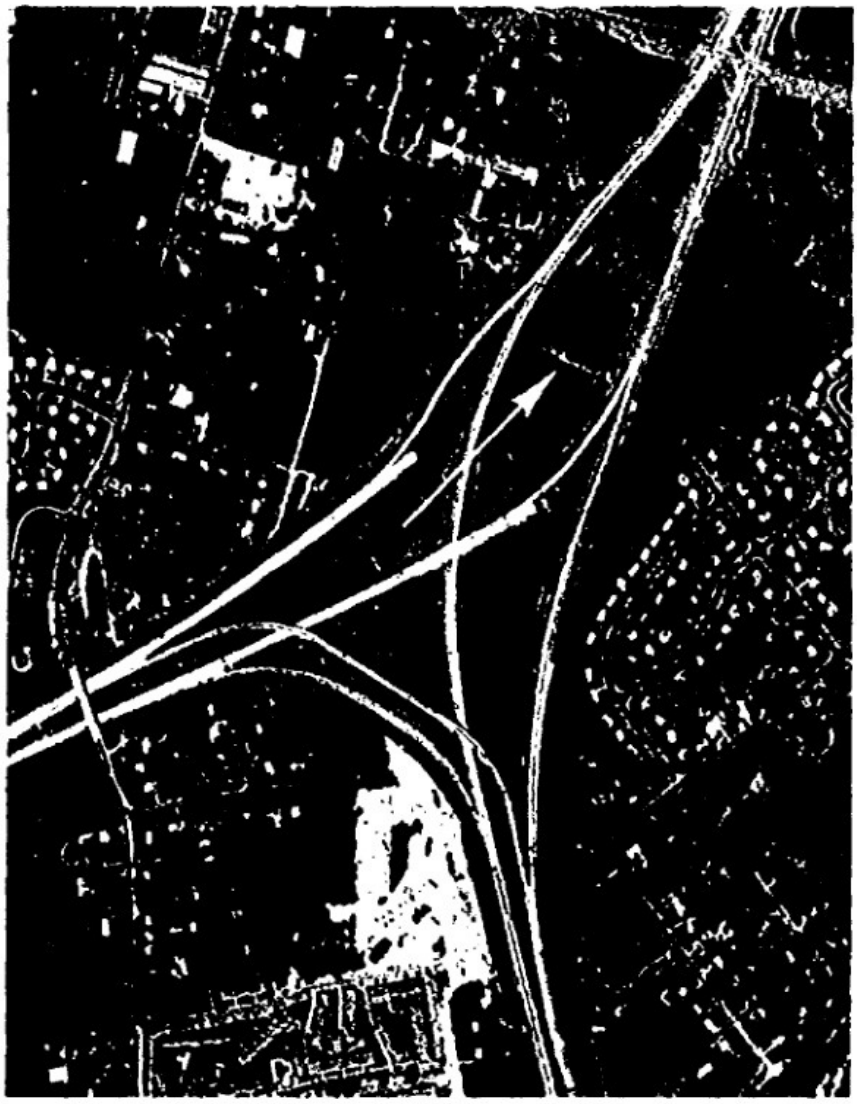
Mr. CONSTANDY. Is that it in this photo?

Mr. KNIGHT. It looks like it.

Mr. CONSTANDY. The slanted roof building?

Mr. KNIGHT. Just above the bridge rail.

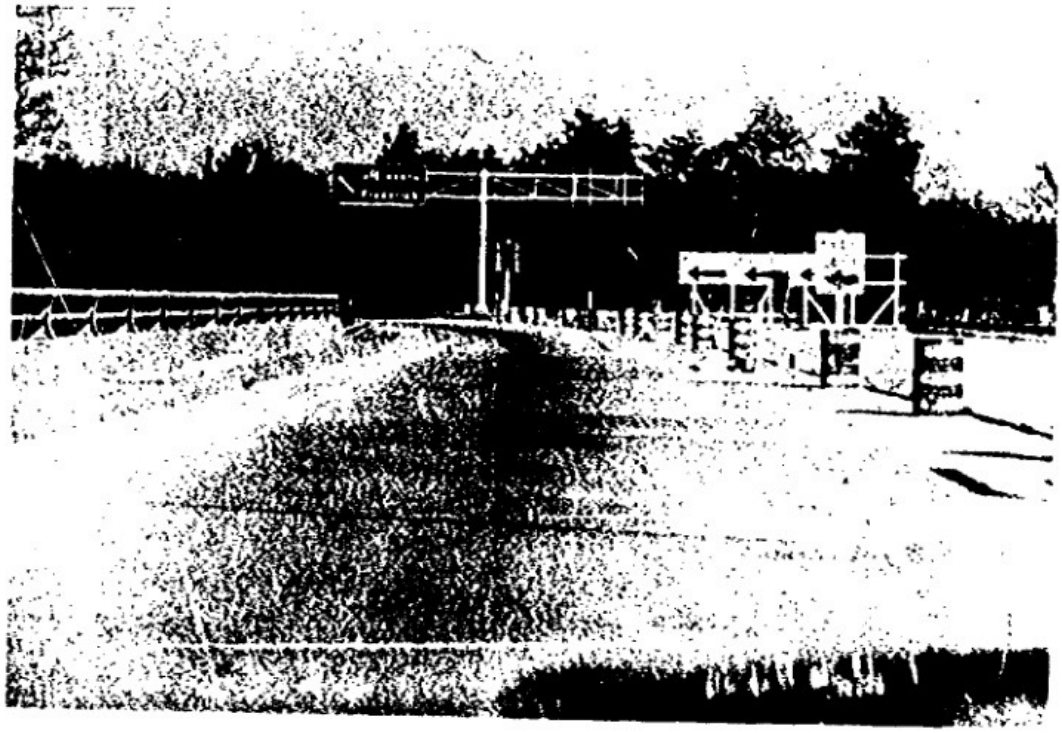
Mr. CONSTANDY. Yes.



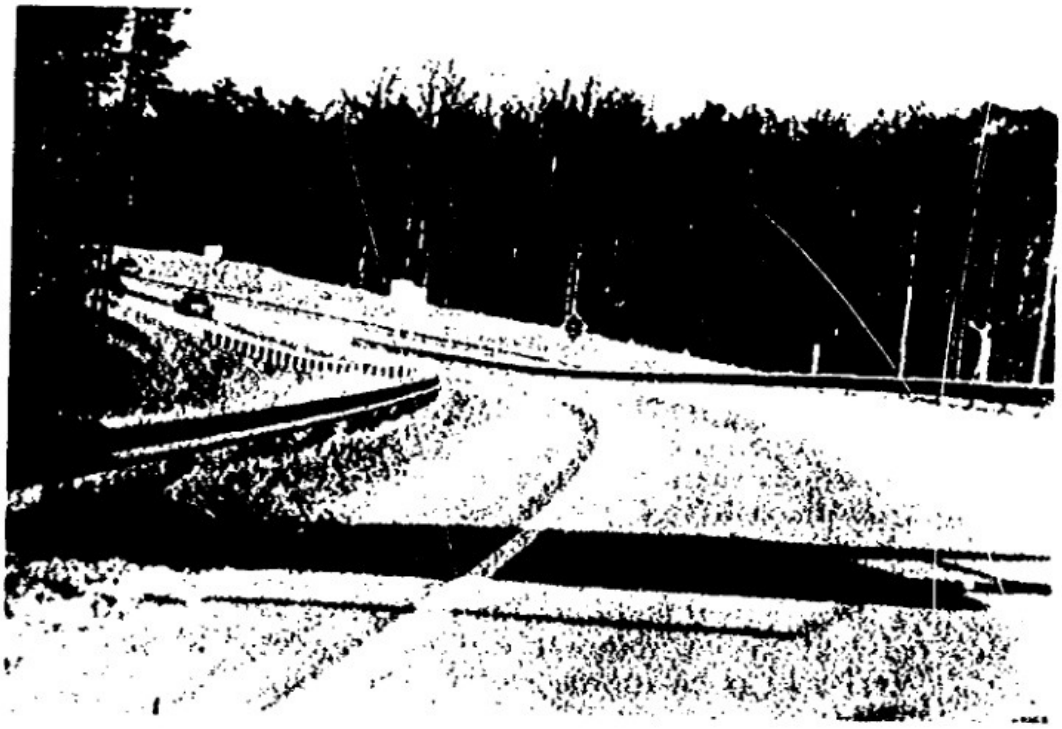
This is an aerial photograph of I–66 as it approaches the Washington area and as it terminates at the Washington Capital Beltway in Virginia. That is I–66 on the left of the picture proceeding across toward the right and abruptly ending with the smaller roadways being the ramps from it to the beltway, from the beltway to it.

The road running from the bottom of the picture to the top of the picture is Interstate 495, the Washington Beltway, and north is to the top.

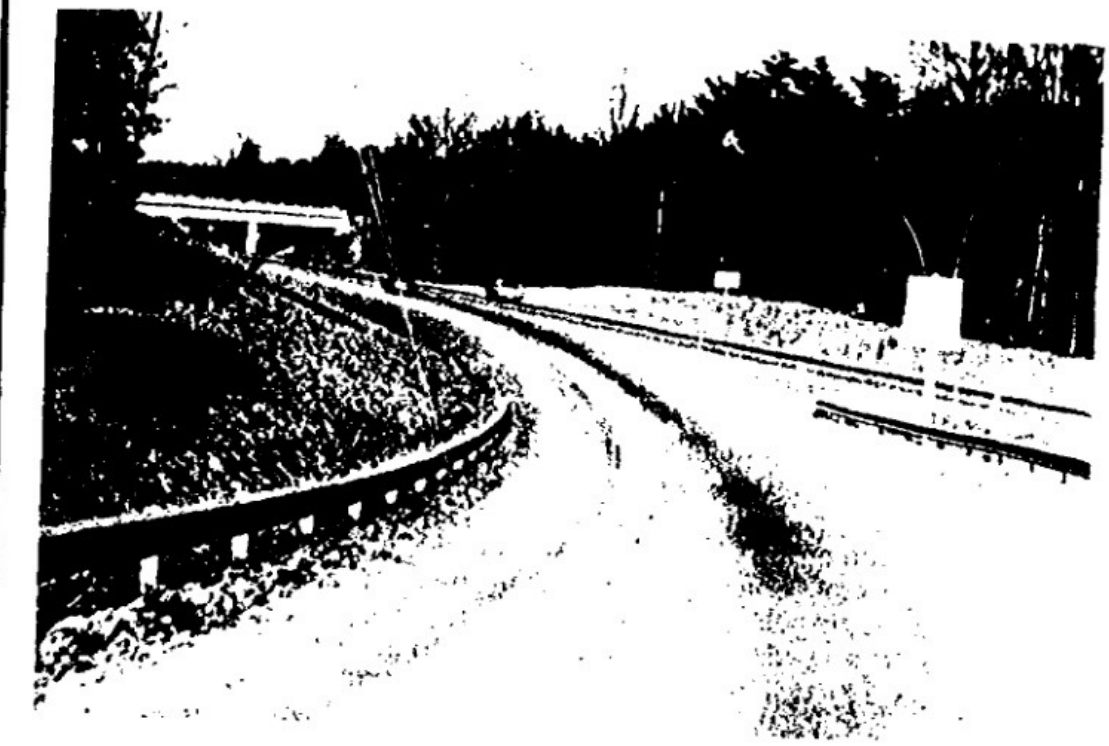
We are concerned here with the problems the truckdriver has in merging from the left to the high-speed lane of traffic on the beltway. This eastbound lane is the one we are concerned with. You notice it terminates right here [indicating] The ramp, however, takes off just before the terminal and continues on down and comes into 495 northbound from the left side. We will look at a series of slides to see what a driver sees as he approaches the beltway.



As you approach this ramp that takes you down to Route 495, you will note the speed sign, advisory speed sign which says, "Exit 35 miles an hour." You are being cautioned now to reduce your speed to 35 miles an hour. You go down the ramp and join the high-speed lane of 495 northbound going 65 miles an hour.



At this point on the ramp the superelevation of the ramp and the grade obstructs the view of traffic on 495.





You go down farther. Could one of you suggest whether the driver from his right-hand mirror in the cab is able to see the traffic approaching him in the high-speed lane of 495?

Mr. POTOCHNEY. His mirror is placed such as to view his rear; his vision is strictly to the rear. And as he is approaching this straightaway now, the only vision he has is through his right side of his cab, which

is the door window, and nothing to the rear. He will not be able to see to his rear until he is completely up in where that first car is on the left, where he will start to see to the rear of the traffic coming up from his right.

Mr. CONSTANDY. So he has to decelerate from 35 to come down this ramp, and at the point where he begins to see, he must accelerate to join the 65 miles an hour speed on the beltway?

Mr. POTOCHNEY. That is true. And if this traffic is moving very rapidly, or medium to heavy, he comes to the end of the ramp and he has no alternative but to stop or force somebody over.

Mr. CONSTANDY. As a practical matter, how does he merge then?

Mr. KNIGHT. Pray.

Mr. CONSTANDY. Pray?

Mr. KNIGHT. Pray that there is nothing that will overtake him, passing him on the right side.

Mr. CONSTANDY. That is what he is praying about?

Mr. KNIGHT. That is right.

Mr. POTOCHNEY. If he is aggressive, he will put his right turn signals on near the end of the ramp and start edging in.

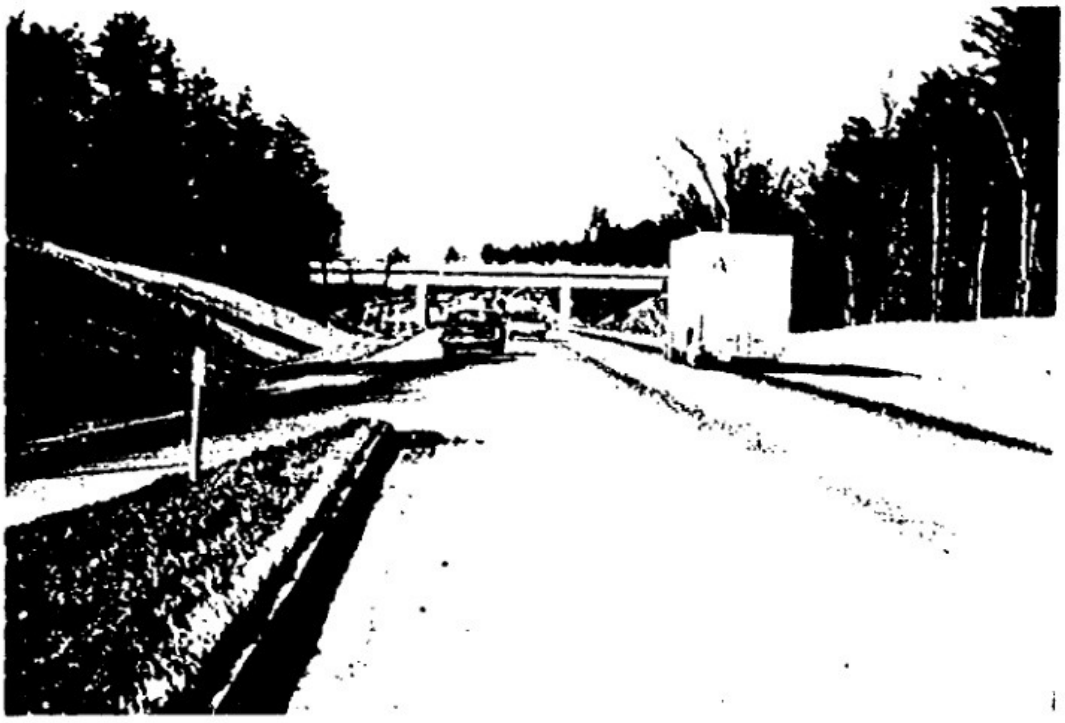
Mr. CONSTANDY. The day he is caught, he is in trouble?

Mr. POTOCHNEY. Right.

Mr. CONSTANDY. He could not see from here?

Mr. POTOCHNEY. No.

Mr. CONSTANDY. What we will see from these series of slides and film clip is that having actually reduced the speed going down the ramp, he is pretty much obliged to use the full length of the acceleration lane to get back up to highway speed; and he prays that when he gets to the end of the acceleration lane, there is room for him to merge. Hopefully, the drivers on the beltway are not competing with him. It would be nice if they were not competing with him. They sometimes are. People do sometimes make accommodations for other vehicles.

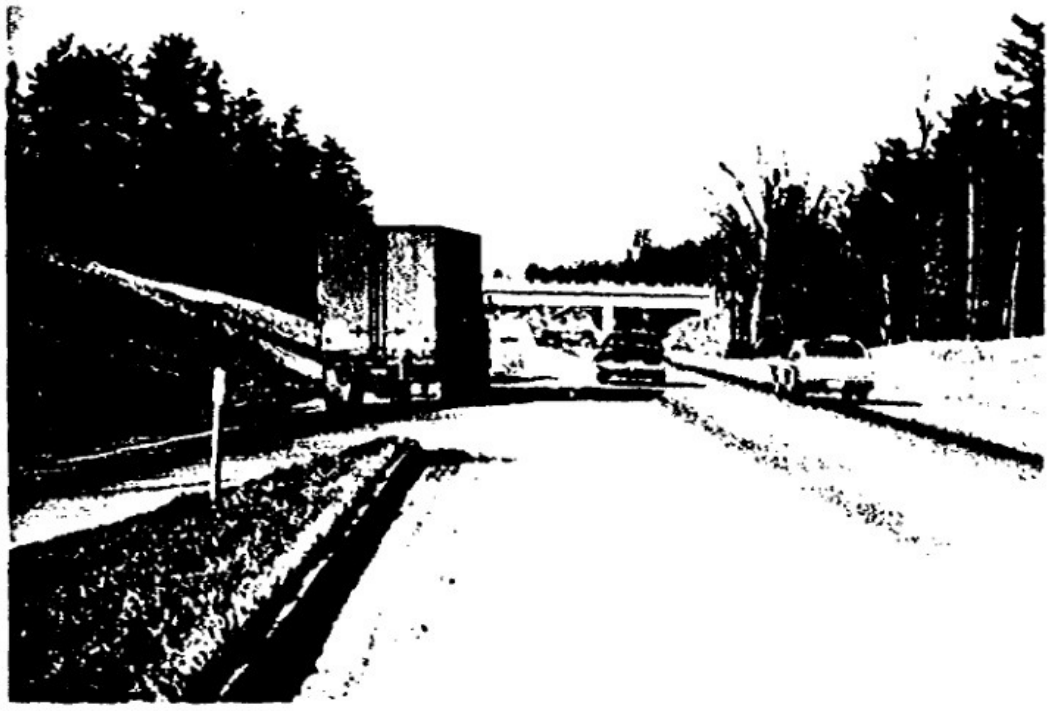


This is the view of that ramp—that red car is in the entry ramp—this view is along the beltway. Now, if you could just flick on that film clip, we will watch a truck coming down that ramp and see the difficulty that he has in making this manuever. This, incidentally, was just a coincidence. The vehicle with the camera taking these photographs was coming along the beltway and photographed whatever came down the ramp. As it happened, it was a truck; so we see something that was not staged; it was not waited for either. This happens all day long out there.

A film was viewed during which Mr. Constandy made the following comments: We are now going north on I–495, and I–66 is coming in from the left. We can see the ramp from it and you begin to see the truck as it comes down that ramp. You notice the traffic on 495. He still cannot see at this point. He continues along the acceleration lane, runs almost completely to the end. As you notice, the little car on the right-hand side is now going into the fast lane next to him. This almost resulted in an accident. It was not until this point the driver could actually see the traffic coming up from his rear in the fast lane.

[End of film.]

Mr. CONSTANDY. When you have this type of situation—which, as has been suggested by the people from California, is undesirable anyhow—at the very least, it seems it is necessary to make adequate provision for signing, both for the entering traffic and for the traffic on 495. There is, you notice in the film, the typical merging sign, but that is it. The problem thereafter belongs to the truckdriver. Now will you put the slides back?



This is the next truck. As a matter of fact, the other one is still in view ahead of us. But this is another truck immediately behind. Would you hazard a guess as to whether at this point he can see the traffic coming up behind him?

Mr. KNIGHT. Not to his right.

Mr. CONSTANDY. Not what?

Mr. KNIGHT. Not from the right side he cannot see, not as yet.

Mr. POTOCHNEY. Could I comment here? We imagine most companies, like ours, in order to assist the driver to have a better field of vision, have added a convex mirror to the mirror attached there; what they call a "west coast" it gives a wider range of vision to the rear and to the side. This could possibly help him in this situation, so that he would get a quicker view of traffic going up on his right.

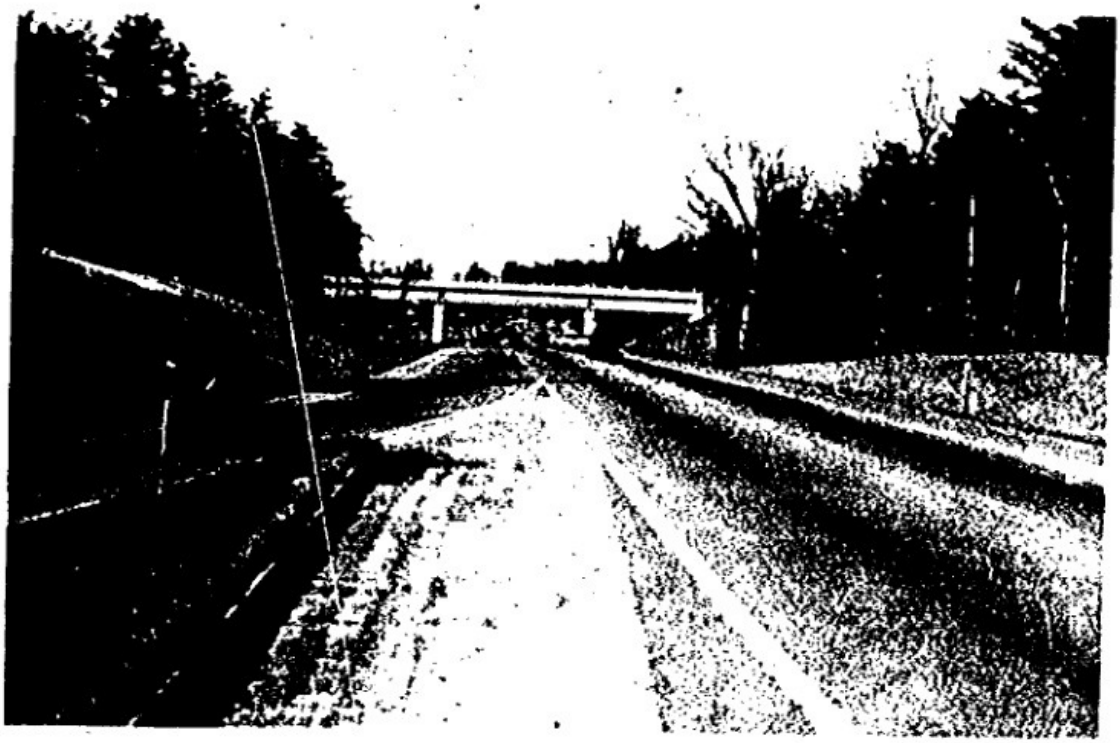
Mr. CONSTANDY. Yes.

Mr. KNIGHT. We have gone to a new type mirror in the last 2 years that will give us a wider range, and possibly you could pick this car up in that particular type mirror—this convex mirror that he just spoke of.

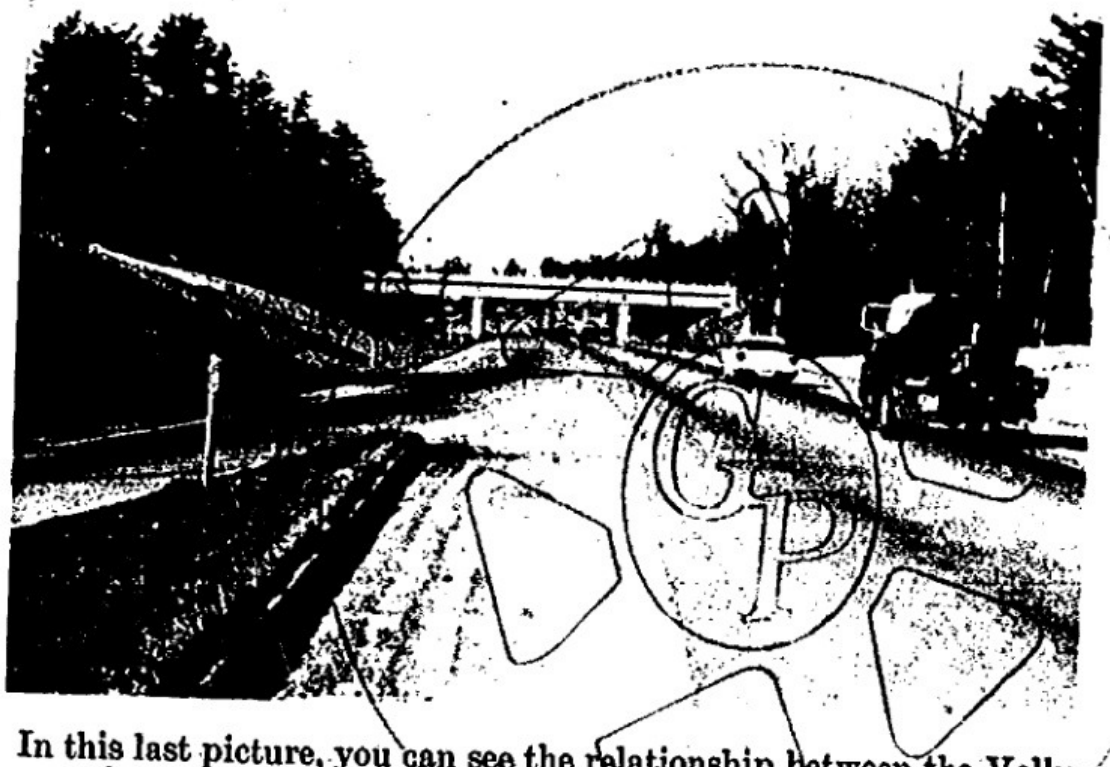
Mr. CONSTANDY. So perhaps things are becoming less of a problem of vision. He still has the problem of physically being able to merge from a 35-mile ramp into a 65-mile-an-hour traffic stream?

Mr. KNIGHT. That is right.

Mr. CONSTANDY. We saw in the film clip the truckdriver ran to the end of the acceleration lane and almost had an accident with a Volkswagen, and I assume that presents more of a problem—a lower silhouette car to the rear of the truck.



As we watch this truck, he is down now at the end of the acceleration lane, and again in this case another Volkswagen almost pushed him off the road. There are two of them in the photograph. I doubt that the Volkswagen would push him off the road. They are trying to occupy the same space.



In this last picture, you can see the relationship between the Volkswagen that attempted to pass him at the end of the acceleration lane as he attempted to merge. Now, again, it was almost an accident.

Mr. WOZNIAK. Without a doubt, this is probably the most hazardous blending situation you can have, and especially with trucks being involved because, let's face it, they are longer, and there are blind spots. When you mentioned Volkswagen, you would be surprised how many fenders we buy for Volkswagens. They just seem like little bugs; they get in around those trucks and no one sees them.

But this situation here, if it has not already done so, is going to kill people; there are just no two ways about it.

Mr. CONSTANDY. You known, the thing that happens to be more frightening is to project into the future, as the volumes of traffic increase, both on 495 and 66. This is a very common movement for trucks that come off 66 and go north on the beltway.

Mr. KNIGHT. With both pictures here, it looks to me like neither the Volkswagen driver nor the truck driver wanted to yield one to the other.

Mr. CONSTANDY. I think the truck driver—I took this picture, so I watched the thing happen. There is no more lane in front of him. He has the problem of either accelerating to 65 in order to merge or stopping before he runs out of pavement because he cannot merge. Once he had gotten to 65, he needs some additional room to stop; correct? I do not know whether he would have been able to stop. Yes?

Mr. KILEY. Mr. Constandy, I was going to remark, this is the beltway he was merging into. They do not require the trucks to keep right. Suppose this was a road and the main road itself required the trucks to keep right. He would be in a bad situation. As soon as possible, he would have to get to the right. He has trouble getting into the first lane; suppose he has to get over three lanes?

Mr. CONSTANDY. You remember, at the end of the film clip, that the tractor-trailer had to get over to the right-hand lane. Whether he felt obliged to, or preferred to, I do not know. But there are a lot of situations that we have seen and we will get into one in just a minute, where in addition to the left-hand entry the acceleration lane is not particularly long, and then you have a real problem: you first have to slow down to make the ramp, and then you have to accelerate to join the traffic flow; you have to join from the left, and all-in-all perhaps under even more restrictive circumstances than we have here.



This next slide is an aerial view of the interchange between 495, again the Washington Capital Beltway, and I–95. The north is to the top of the picture, and from the bottom to the top is I–95, proceeding north. The beltway runs across, from the right to the left-hand side of the picture, going in that direction, from east to west.

Now, we are concerned for the moment with just this movement from I–95 to this ramp [indicating], which will take the northbound I–95 traffic westbound on 495, and we will see what that looks like.

(A film was viewed during which Mr. Constandy made the following comments:)

Mr. CONSTANDY. We are going northbound on I–95. We are about at the point where we will separate from this traffic northbound on I–95, right here [indicating]. You notice there is a 25-mile-an-hour speed sign there [indicating]. We separate from traffic going east on 495, which will go to the right, come down under here [indicating]. There is a 25-mile-an-hour advisory sign, with a left-turn warning arrow, at this point here [indicating] I want you to remember. The police over in Virginia contend this is one of their most troublesome spots, because the radius of this curve keeps changing downward and they have had a great deal of difficulty with truck drivers making this turn. Now, as we go along, you will notice the two lanes coming in from I–95 join the main line of I–495.

Notice there are no signs indicating any lane drop. But at this point, this middle lane begins to disappear, and we now have, in effect, three lanes on 495: And at this point, the other lane begins to disappear. On the right-hand side is a two-lane entry ramp, the left lane terminates right at the main line pavement edge, and the other has a very short acceleration lane you see there from southbound 95 onto 495. You again have the problem of going from 25 to 65 as two lanes are dropped on the left side, and a ramp comes in with two lanes on the right side, both of which are immediately dropped.

(End of film.)

Mr. CONSTANDY. Before we get to the slides of this, what are your impressions of that maneuver? Perhaps you would each like to make some comment.

Mr. WOZNIAK. That is a classic example of getting caught between the devil and the deep blue sea.

Mr. CONSTANDY. That is right about in here [indicating]. You can see in this aerial photograph the relative short distance involved—remember the lane begins to drop right at this point [indicating], between here and here [indicating] both left-hand lanes are dropped. There is no sign indicating it whatever. And then we have the southbound I–95 traffic desiring I–495 westbound coming down two ramps, the left-hand lane terminates right there at the pavement edge of 495 and the right-hand lane has a very short acceleration lane up a grade. So all of that is taking place in a very short area right here [indicating], a matter of a few hundred feet.

Mr. KNIGHT. We travel this route frequently. Is this the cloverleaf they call the mixing bowl?

Mr. CONSTANDY. No. I think that is in another area. They each seem to have some name, though.

Mr. KNIGHT. I ride out trucks from time to time. I know, without doubt, the drivers come into this turn too fast, come up a ramp, down out under something over there. And all of this is taking place in just a matter of a few hundred feet.

Mr. CONSTANDY. Yes. Does that strike you, Mr. Knight, as being a hazardous maneuver, leaving 95 and joining 495 westbound?

Mr. KNIGHT. We do not travel 495 westbound from this point. Our problem is leaving 495 to go south on I–95. The marking to me is not adequate, what lane you should be in.

Mr. CONSTANDY. You mean over here [indicating] coming westbound on I–95 and then swinging up over I–495, then coming down to join southbound I–95?

Mr. KNIGHT. That is right. Again, you are coming in from the left, have merging traffic from your right.

Mr. CONSTANDY. Down here where you join the diamond ramp leading from I–495 eastbound to I–95 south? [Indicating.]

Mr. KNIGHT. That is right.

Mr. CONSTANDY. Yes. This is another difficult area.

Mr. KNIGHT. A little farther south there, you try to come in from your left on I–95.

Mr. CONSTANDY. Down there? [Indicating.]

Mr. KNIGHT. That is correct.

Mr. CONSTANDY. That is down at the Springfield Shopping Center, there is an interchange there?

Mr. KNIGHT. That is right.

Mr. CONSTANDY. We will be getting into this interchange in greater detail through a panel of experts that have some comments to make relative to both the design of it and the signing—to it or for it, however you say it.

Just looking at that, Mr. Knight, as an experienced truckdriver, the movie clip we saw, does that strike you as being the type of thing best avoided in the design of highways themselves?

Mr. KNIGHT. Personally I do not like it.

Mr. CONSTANDY. No, I would not think so, particularly if you had never ridden it before and suddenly find yourself with the two dropped lanes.

Mr. KNIGHT. You also see passenger cars at times enter that thing too fast and I think there are probably tire marks on the curve on the right going into that left-hand curve.

Mr. CONSTANDY. Yes, we have some slides that will show tire marks. Mr. Potochney, would you care to comment about this?

Mr. POTOCHNEY. I was going to say there actually are three hazards here. Immediately going into the ramp it states "25 miles an hour speed limit." However, this suggests to the truckdriver that it it a safe speed as far as he is concerned. To him, this 25 miles an hour is probably too fast to enter this fading out onto his left. He is going to lose his center of gravity and this is where you are going to turn a unit over or he is going to squeeze somebody, fighting it out, into the other lane.

Now dropping away, fading out for him, I think there should be some type of sign to warn of this, although we do have—it is a left, if I recall, it is a left angle turn there. It denotes a 90° turn actually. However, the curve is long and short in respect to fade out, I should say.

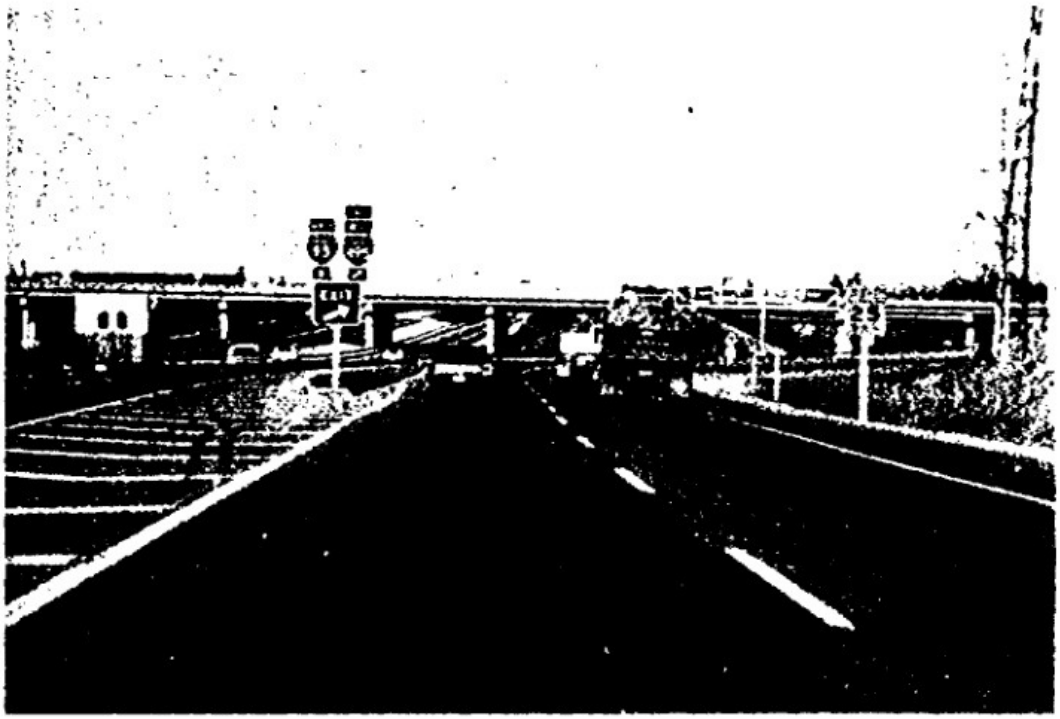
Now, the second one is when he starts merging into that first lane of traffic and then the lane drops off, and now he is again fighting traffic from his right, if he does negotiate the first turn.

Mr. CONSTANDY. Yes.

Mr. POTOCHNEY. And then last is when he is watching traffic, which is the least of the hazards, he can pick it up in his right-hand mirror then and avoid it.

Mr. CONSTANDY. Yes. That is a very busy place, busy in the sense of these movements you are talking about.

We will just run through these slides.



This is the point that the takeoff begins from the northbound I–95 to the westbound and eastbound 495. You notice the skid marks here in the foreground, some of them being double. They look like they are truck skid marks. This is the point at which we begin to leave 495, exit speed of 25 miles an hour from a 65-mile-an-hour facility. Did you want to say something, Mr. Knight?

Mr. KNIGHT. I think most any time you find skid marks, there is something wrong. Either the advance warning was not properly placed or these skid marks could be someone who came from the left lane, they were going north on 95 and at the last minute, they decided they wanted to hit 495.

Mr. CONSTANDY. Yes. Later we will get into the actual signing of this location.

Mr. KNIGHT. Not only this location here but I think most any exit or entrance ramp where you have road separation, the skid marks present—you see them about every day—there is something wrong somewhere, whether it is the marking of the roads or what it is.

Mr. CONSTANDY. One thing that impresses me is the skid marks disappear in a relatively short period of time, but they are always replaced by other skid marks. If you went out there today, these skid marks would not be there, but I guarantee there would be others. On the right, skid marks are actually on the shoulder. We go forward from here and come to the next divergence.



We must go either to the west or east to Baltimore. You notice again the presence of a large number of skid marks at this point. Is that a strange design, Mr. Prisk, while turning to the right you must take off to the left in the turn?

Mr. PRISK. The general layout is not so strange. There may be some details of it that are unusual. But the idea of complete service to all turning movements which have been worked out in this fashion is not particularly unusual.

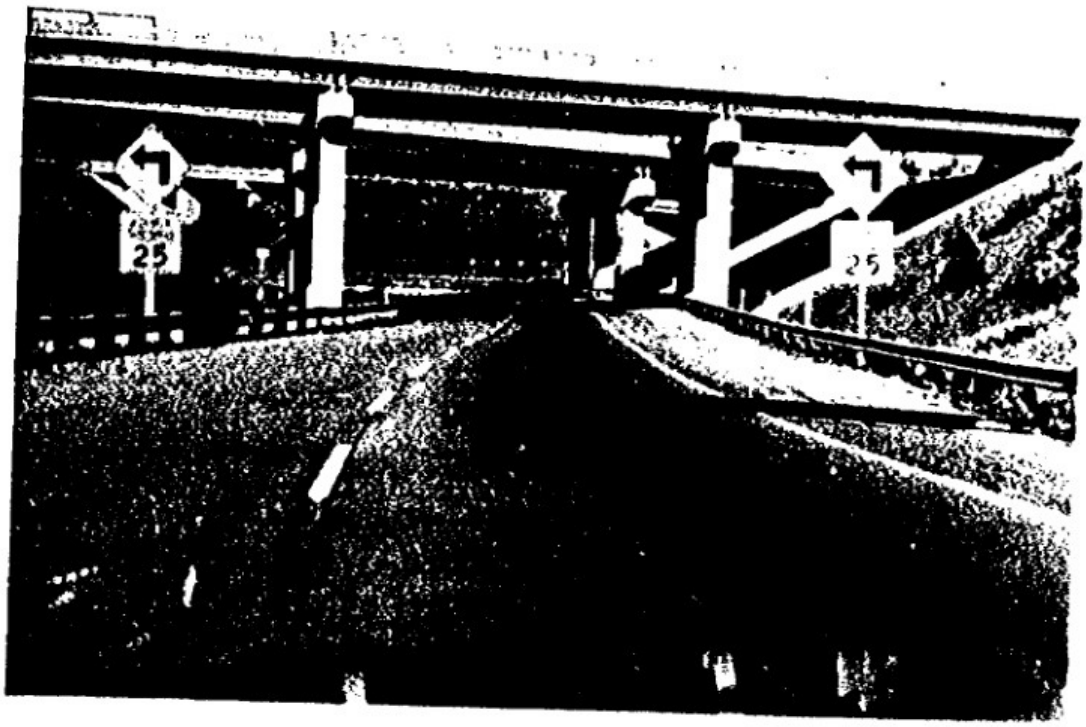
Mr. CONSTANDY. Unusual in that it is a design which is frequently followed for a directional interchange?

Mr. PRISK. That is right. Where you provide direct signing for turning to all movements. This is rather common.

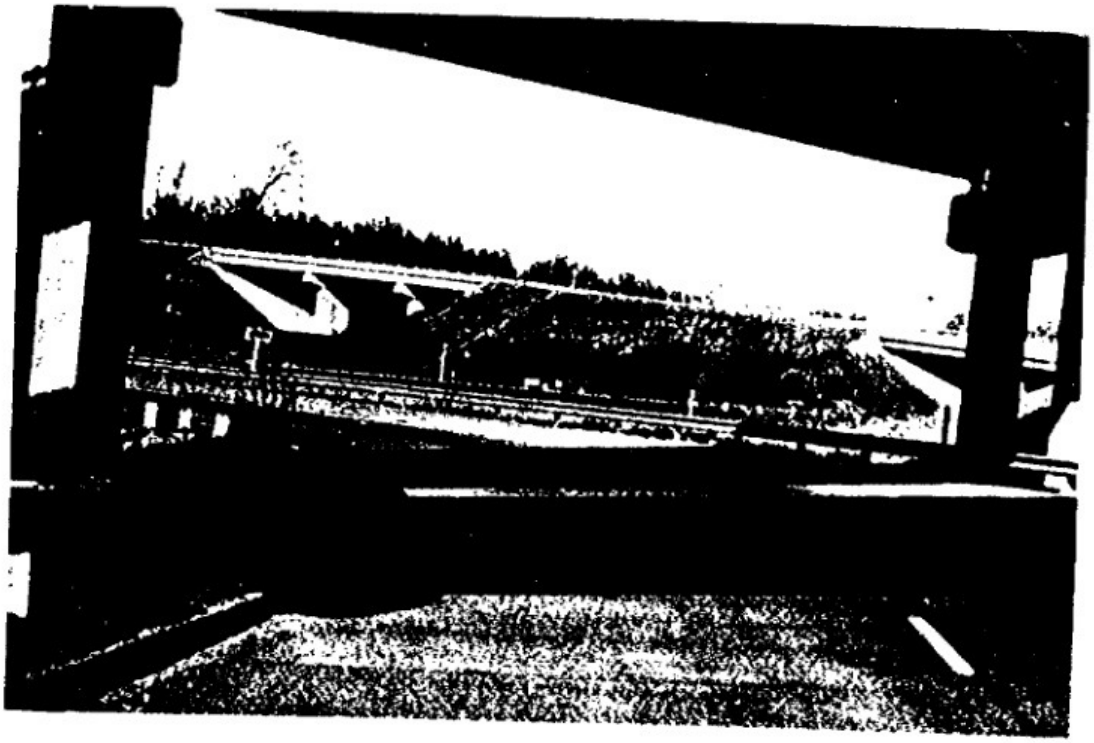
Mr. CONSTANDY. It is possible to design that and have the directional bring the traffic in from the right? It would be more expensive?

Mr. PRISK. It would be more expensive, because it would require more structures.

Mr. CONSTANDY. We will get into the design of the facility later.



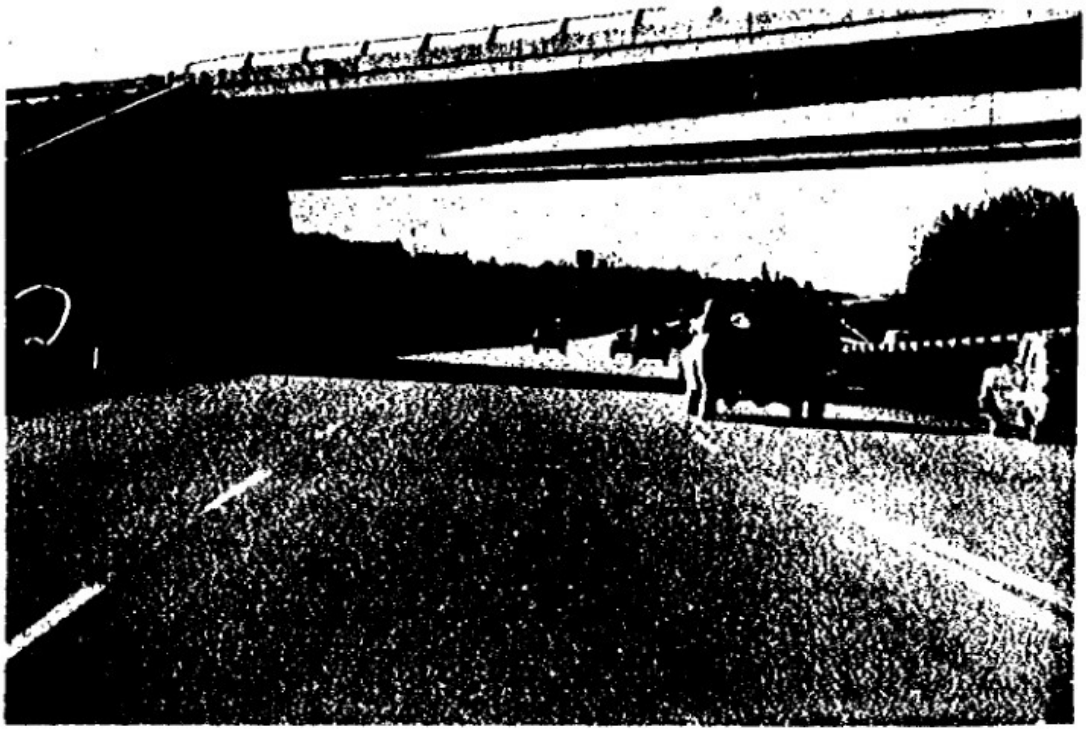
We go forward from here, as we enter this curve to the left, which is relatively short and with a changing radius of the curve.



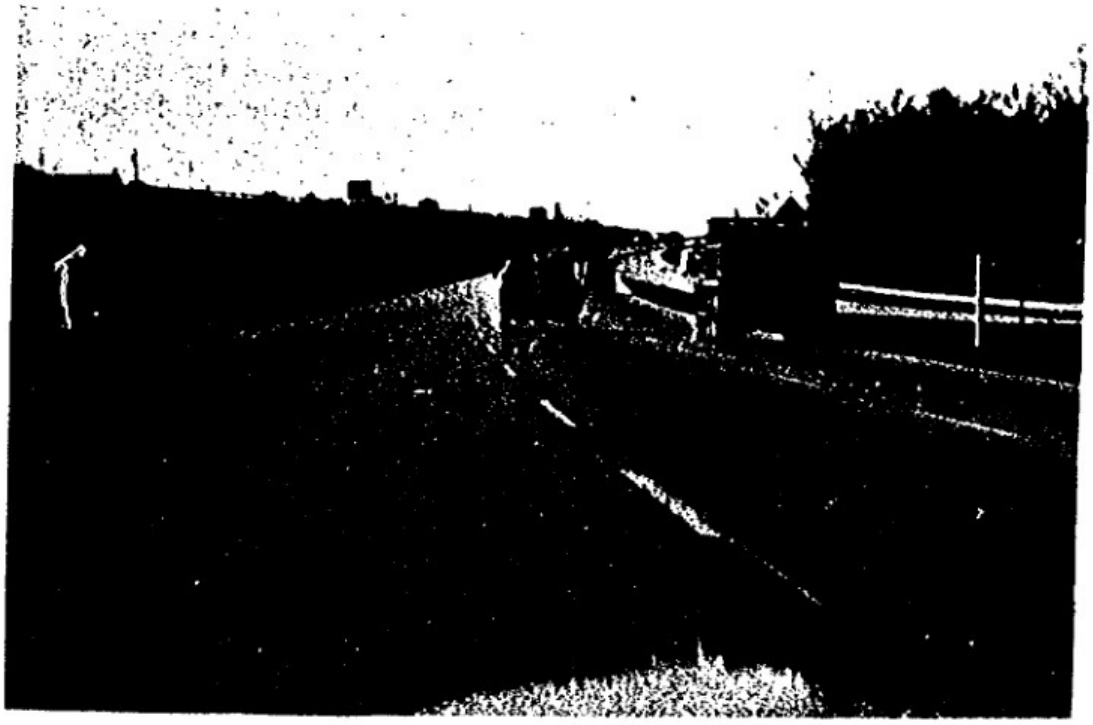
At this point, as we go around the curve, the State police claim they have a great deal of difficulty, particularly with trucks, in negotiating the curve. They have had some accidents there with trucks not able to negotiate it.



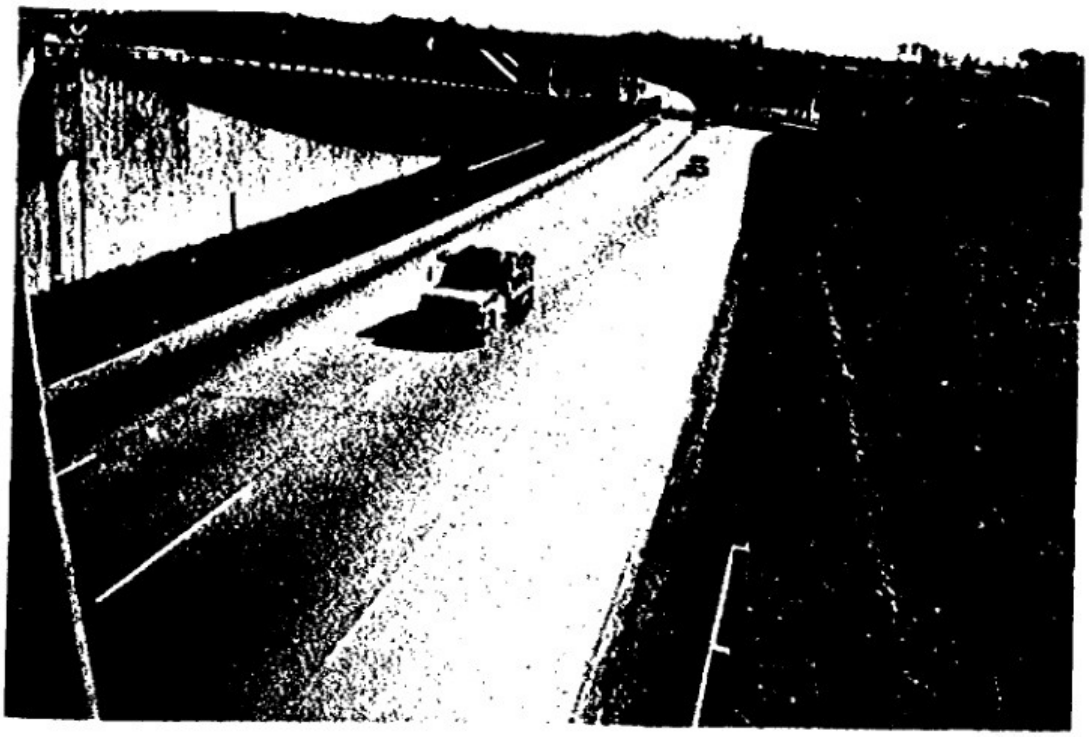
We come out of that ramp at this point and we see ahead of us the area wherein the two-lane drops occur. They begin on the other side of that bridge structure.



As we move along you will notice there is still no sign. I would suggest that if you drop a lane, you should have a sign to indicate it; and perhaps if you are going to drop two lanes, it becomes even more necessary to indicate the fact both lanes are going to be dropped. We realize, of course, that these two lanes being dropped are both the entry ramps, but there is nothing to indicate that to the driver. To him it appears he is on the mainline.

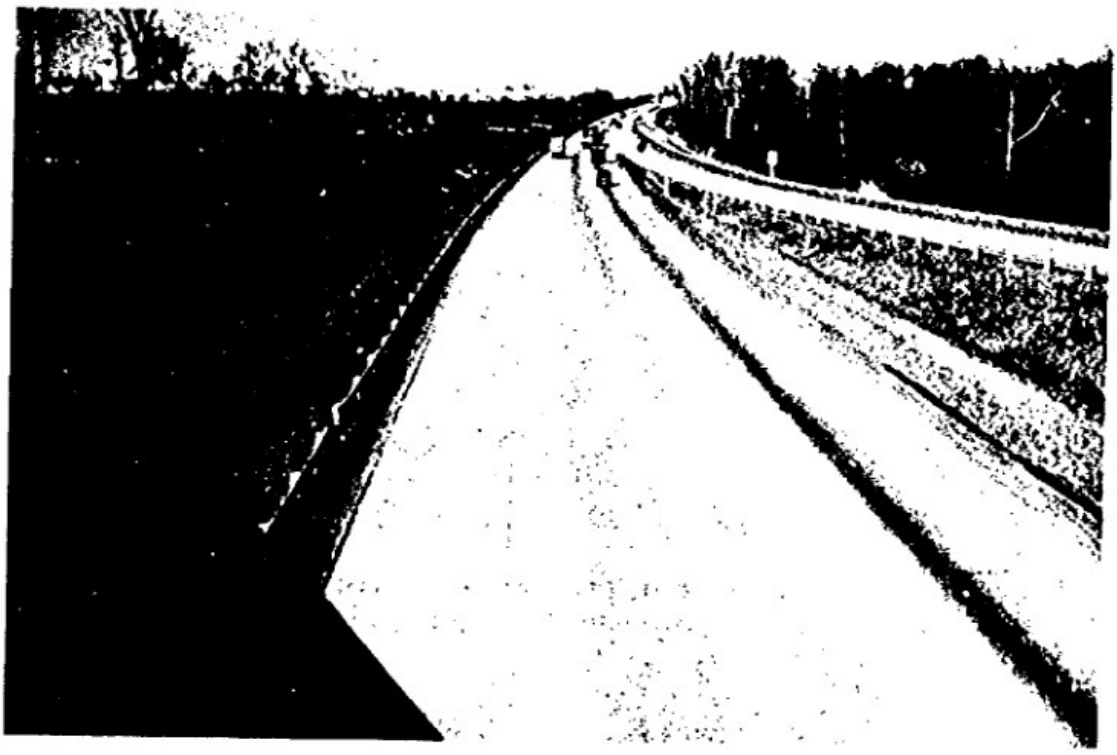


Now, we are at the point just under that structure where the markings for the first lane have been dropped, and the lane itself begins to taper as we go forward.

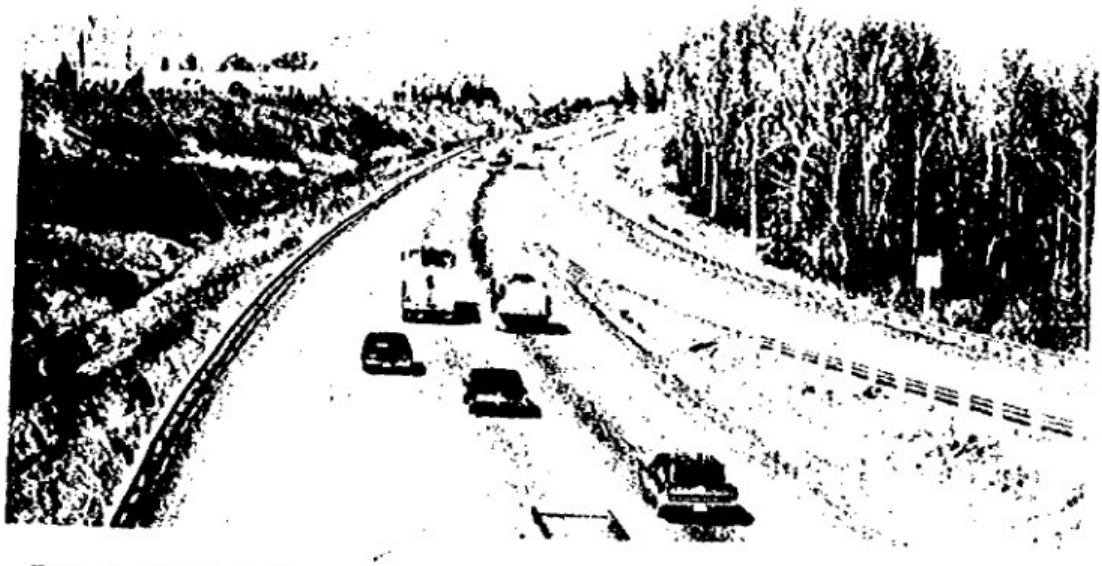


This is looking back to that area. Just before the lanes are dropped, you notice there are four full lanes at this point. Another thing I noticed while being there, some of the truckdrivers as this one seemed to be, are familiar with the area and make this trip regularly. These fellows, when they come out of that left-hand entry, get as quickly as possible over to the extreme right-hand lane. You can stand on this structure and almost guess whether the driver is one that uses this thing routinely or whether this is his first time.

Some of them come and stay in the extreme left-hand lane until it ends and then move over one; and then it ends and they move over another one. But by the time they move over to get in the right-hand lane, there is conflict with the traffic coming southbound from 95 to go west on 495.



This is looking from the bridge structure and in this view, we can see the termination of the lane; and up where that truck is, is the end of the second lane. You will note, too, in this picture, the two right-hand entry lanes come down from 95. We have a better picture of it. The left lane ends at the main line pavement—you can see in this view.



Just behind that car you can see that left-hand ramp as it ends abruptly right there. The two white trucks on the right, the one farthest away from us, is at the end of the acceleration lane. You see, it is relatively short, particularly considering all that is happening here. Do you care to comment about this particular feature? You are going up a grade, incidentally.

Mr. POTOCHNEY. I think the picture itself shows hazard there, the contention there for position in both clusters of vehicles. Up ahead you have the two trucks attempting to forge their way in, which naturally is going to force cars over or back. The same thing in this lower portion of the picture, you again have a contention for position. I think that the picture is well taken. It does show the hazard without even speaking of what is occurring.

Mr. CONSTANDY. It is kind of unusual in that the people in the foreground are attempting to get over as far away as they can, and they are immediately met by people who are attempting to come in from the right; so you do get conflict.

Mr. KNIGHT. I would think an added acceleration lane on the right would be desirable, an acceleration lane of a quarter of a mile. You would not very often have a double merger within a matter of a few hundred feet.

Mr. CONSTANDY. Yes.

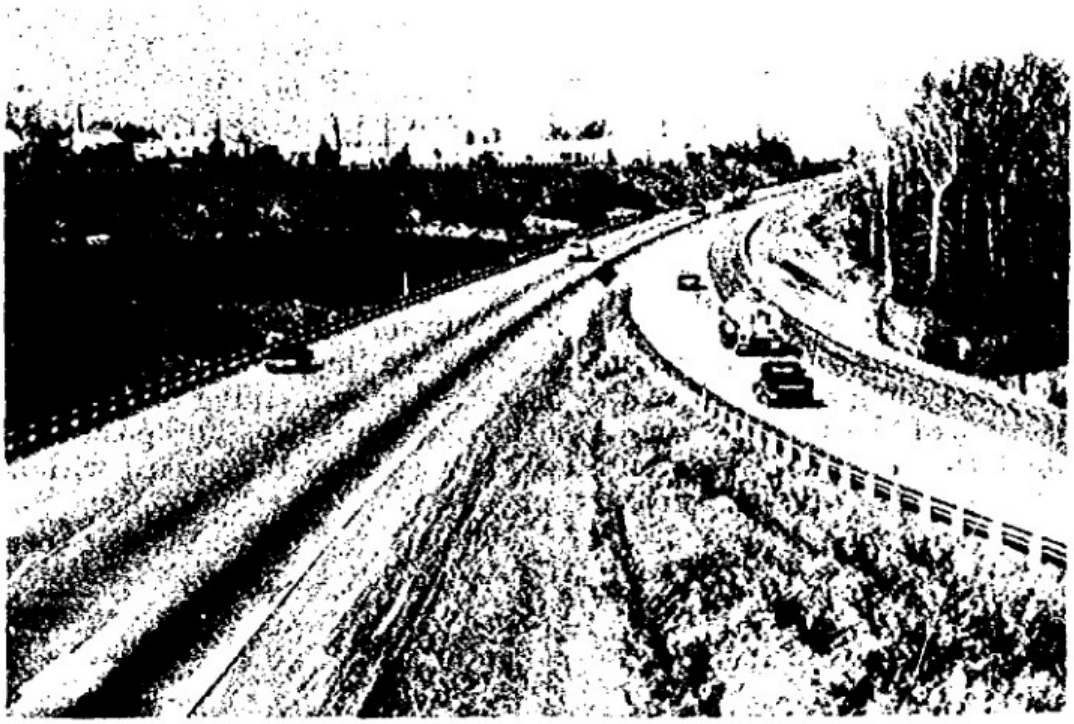
Mr. Prisk, would you want to comment about this, about the signing, the design?

(At this point Mr. Blatnik assumed the chair.)

Mr. PRISK. I suspect that some relief should be given to a situation like this through providing better information to the motorists than merging traffic signs. The diamond yellow sign at the very tip end of the triangular land on the right-hand side is too far along to be of much help, and there is no notice at all of the lane drop, which looks to me could be provided rather simply either by a roadside sign or probably more effectively by a sign on the overhead structure from which this picture was taken. You still have the second lane drop, which ought to be further identified.

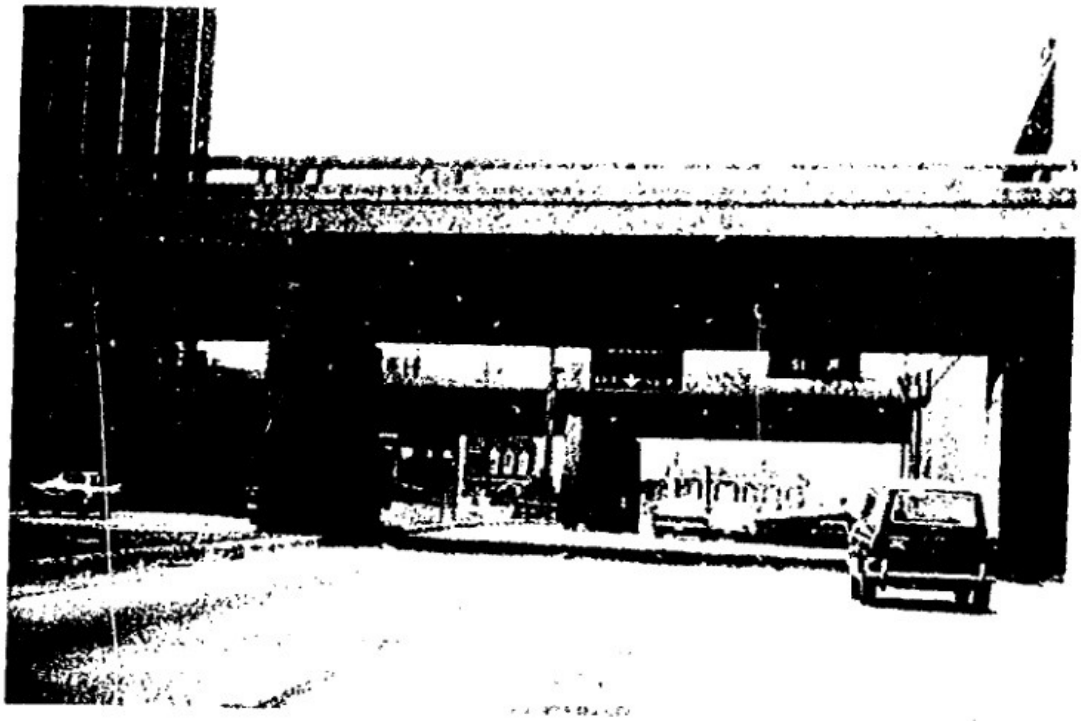
Mr. CONSTANDY. Could we conclude that there was something to be desired in the design? There is still something to be desired in the signing?

Mr. PRISK. I think both are weak.



For an acceleration lane on an upgrade, it does not appear to be very long.

Mr. CONSTANDY. No; that truck you see is just about at the end of it. In effect six lanes are being reduced to two in a matter of several hundred feet.



This is a view of an obstructed sign and I would guess that the truckdriver, seated higher than the automobile driver—this picture was taken from an automobile—has even more of a problem being able to see a sign like this?

Mr. KNIGHT. I would think he would. In fact, I know he would.

Mr. CONSTANDY. Sir?

Mr. KNIGHT. I know he would have more of a problem than a passenger car driver. All of our cabs are cab over engine.

Mr. CONSTANDY. Are what?

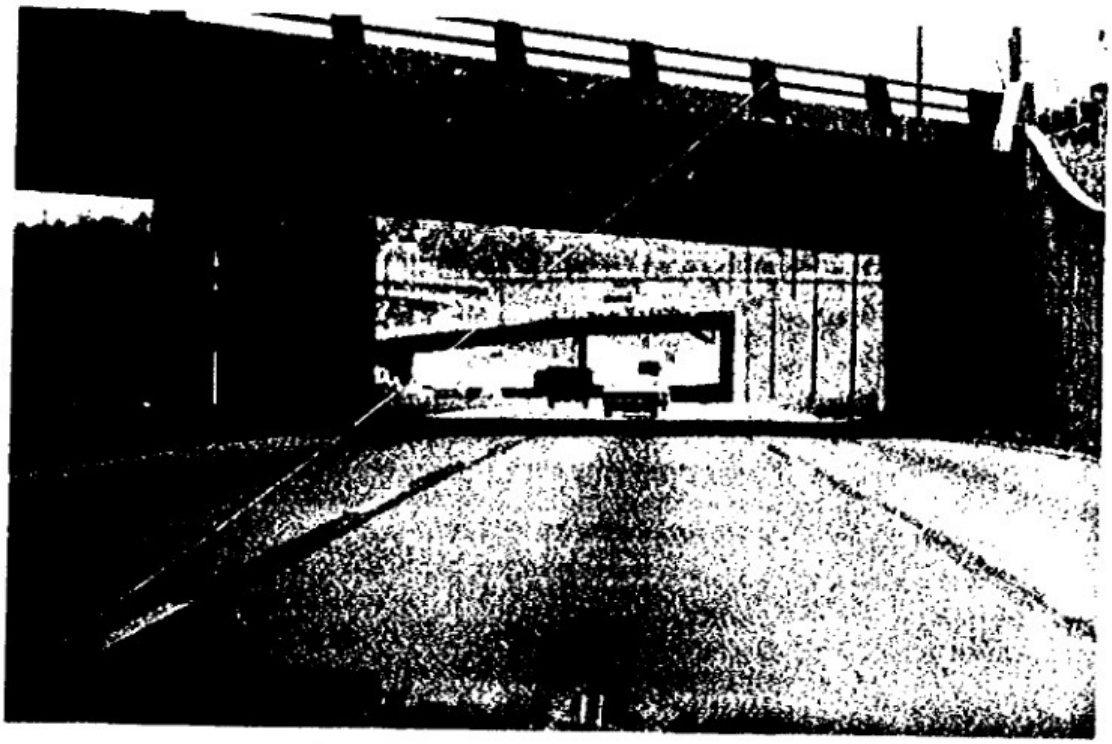
Mr. KNIGHT. I think the majority of the trucks on the road today are cab-over-engine trucks.

Mr. CONSTANDY. He would not see this at this point, would he? I mean, he would not see what we see?

Mr. KNIGHT. I would not think so.

Mr. CONSTANDY. He would be higher, and consequently he would see less.

This is back again in the area we discussed with the left exit in Atlanta. That sign which you cannot see entirely reads: "Decatur." It says "Exit a third of a mile." And you are going downgrade.



Then you come to this. Again, the left-hand exit with only the previous sign message that perhaps does not clearly indicate the left-hand exit.

Mr. BLATNIK. I hate to interrupt, but could you back up to the original sign? (Refer to previous picture.)

I meant to ask the question yesterday and the day before. We have seen similar obstructed views of signs by two adjacent bridges, or grade separations. I would like to ask Mr. Prisk, why would the signs be placed on the farthest bridge and not on the one in the foreground immediately ahead? Is there a reason for it?

Mr. PRISK. It is pretty difficult to determine what the reason was for that. Because pretty clearly the sign message would be obscured by the second bridge. We have made provision for a reduction in sign letter size and, hence, they think a somewhat smaller sign that could be positioned in a place that you see through a bridge in an emerging situation. In other words, if those signs—we see part of them now—were made with a somewhat smaller message and suspended lower on that second bridge, they would be visible.

Mr. Blatnik. It could be suspended lower on the second bridge. But you see no reason why it also could not have been on the first bridge, do you?

Mr. PRISK. My first thought was to get them on the first bridge.

Mr. BLATNIK. So obviously it should be on the first bridge and the second choice, if for some reason it had to be on the second bridge—and I would like to have that question answered; maybe the staff can

find the information on it later—if the signs have to be, for a good reason, on the second bridge, perhaps they could be lowered.

Mr. PRISK. In a few cases, Mr. Chairman, we have found altogether too slavish addiction, I might call it, to an attempt to warn drivers at one-half mile instead of perhaps holding to this bridge, which would be perhaps five-eighths of a mile more.

Mr. BLATNIK. You mean the fact this would be one-half mile and 200 feet—you think a motorist by driving can tell the difference?

Mr. PRISK. I have seen them put up that way.

Mr. BLATNIK. It has to be an even half-mile and cannot be 0.52 miles or 0.51 miles, or 0.509 miles?

Mr. PRISK. I rise to the defense of engineers to say not many of them do that. But I have seen that happen; yes, sir.

Mr. MAY. We have found that that is one of the things the engineers do quite well; they measure quite well. There is no reason under the sun that this sign has to be where it is; is that right, Mr. Prisk?

Mr. PRISK. I cannot tell, from the picture, that there is any reason why it should be.

Mr. MAY. I would suggest that there is nothing. No regulation would require somebody to put a sign up that cannot be seen too well, and this happens to be a third of a mile as a matter of fact.

I have read the instructions and regulations and am certain there is enough flexibility so that the engineers, using their judgment, could put the sign in a place where it can be seen.

Mr. PRISK. Once in a great while you find that situations like that develop because the far structure was built first.

Mr. MAY. Oh, yes.

Mr. PRISK. And the near one could be built second. That could bring the situation about.

Mr. MAY. Sure. That might have done it. But when that happened, they should have moved the signs so they could be seen.

Mr. PRISK. I agree.

Mr MAY. Mr. Knight, you are again familiar with this location and I think while we were talking yesterday, you mentioned there are times when the volumes of traffic on this road are quite considerable and you see people stopping and with great frustration trying to get over there to make the left exit; is that right?

Mr. KNIGHT. That is true. You see it every day, morning and afternoon rush hour, both directions. What the pictures do not show here, unfortunately, are the entrance and exit ramps in Atlanta which are very, very short, and you have a pile-up of traffic on the expressway or the interstate trying to get off, likewise those trying to get on.

Mr. MAY. That keeps people alert. Mr. Lill, you have some visual aids representing a couple of other locations. Would you go ahead with yours, please?

Mr. LILL. Yes, Mr. May. I would like to mention the special question of signing on ramps and some of the difficulties that seem to face

truck operation on ramps. Now, there is not really any way to separate this from the question of the geometrics, such things as the design speed and the deceleration lanes and this sort of thing. Now, in the past, the past practice has permitted the building of some loops which have a very low safe operating speed.

We have here in the area an interchange which, by virtue of chance, really has become an interchange in the main truck route north and south, because it is a link, an old route, which is serving as a link between completed sections of I–95.

Now I would like to show the committee some pictures. I have a series of six slides of the signing leading up to this interchange and some things that we have noticed around that.

Mr. MAY. Mr. Lill, before you begin, I would like to bring up this point. We do not intend at this hearing to present several thousand slides representing every project in this country. We are showing slides that we have concluded as a result of our inquiry are representative. So that if at any time today we show any location or any situations that you people consider untypical, unusual, peculiar in any way, I wish you would speak up for the record.

We would like that understood, that the type of situation that we have shown thus far, you people and your drivers have seen, and they would be fairly typical, would you gentlemen agree?

Mr. WOZNIAK. Yes.

Mr. POTOCHNEY. Yes.

Mr. KNIGHT. Yes.

Mr. MAY. Thank you.

Mr. LILL. I think this is an unusual situation. It is a situation which has developed and which represents a bad hazardous situation. I am presenting it because it gives the committee something that they can compare developments with, really.

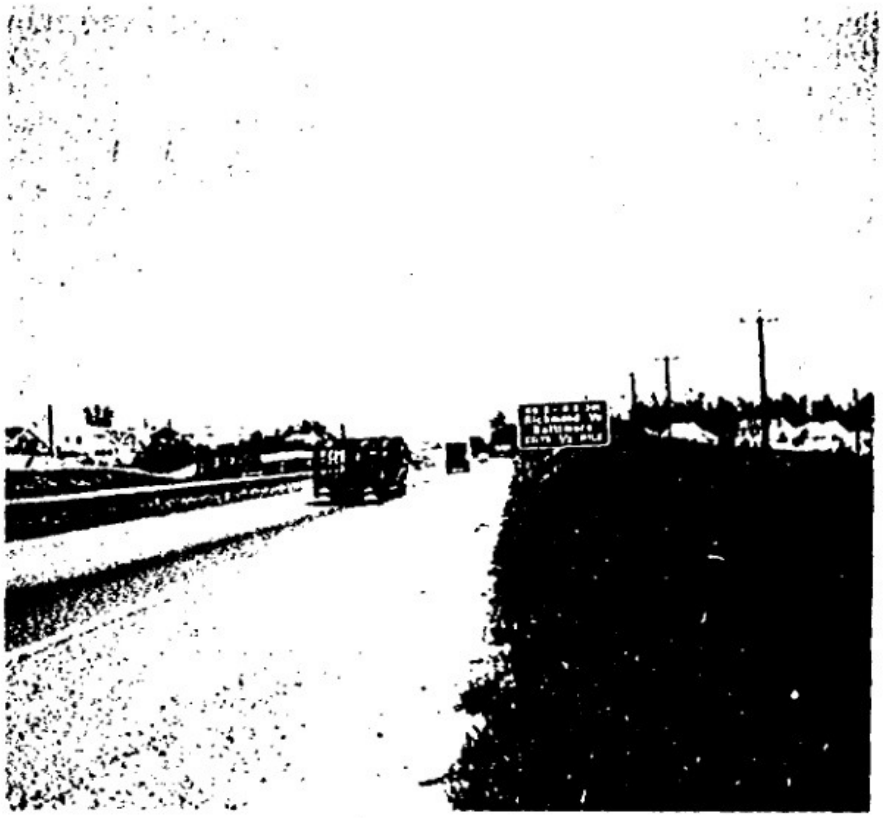
Mr. MAY. Yes.

Mr. LILL. But it does exist.

Mr. MAY. I appreciate that, Mr. Lill. I am familiar with the location and it is an older type road and represents an older type construction.

Mr. LILL. Yes.

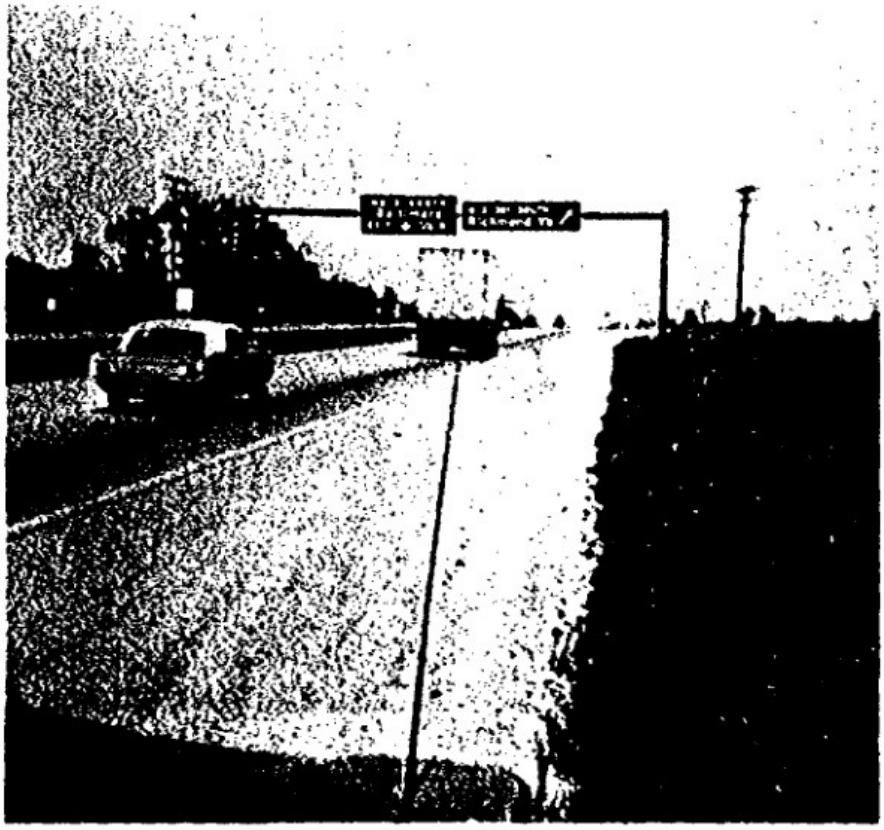
Mr. MAY. But I testify here today that we—the staff—have seen like locations in many States throughout the Union on new construction, and I would like the other three people to pay attention and suggest whether or not we are still seeing this type of construction around the country.



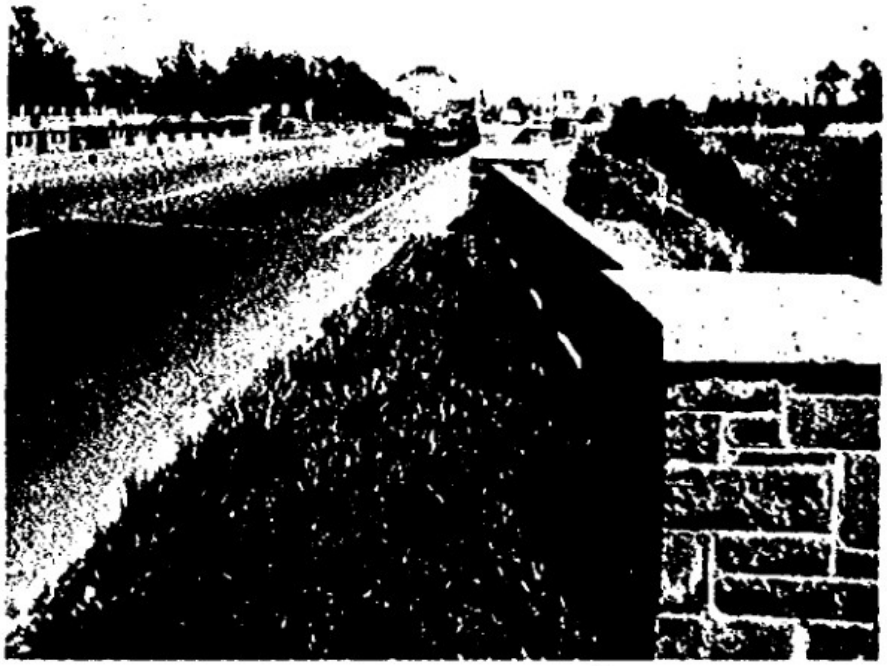
Mr. LILL. This is the first sign that alerts for this interchange. It is one-half mile ahead, I believe.



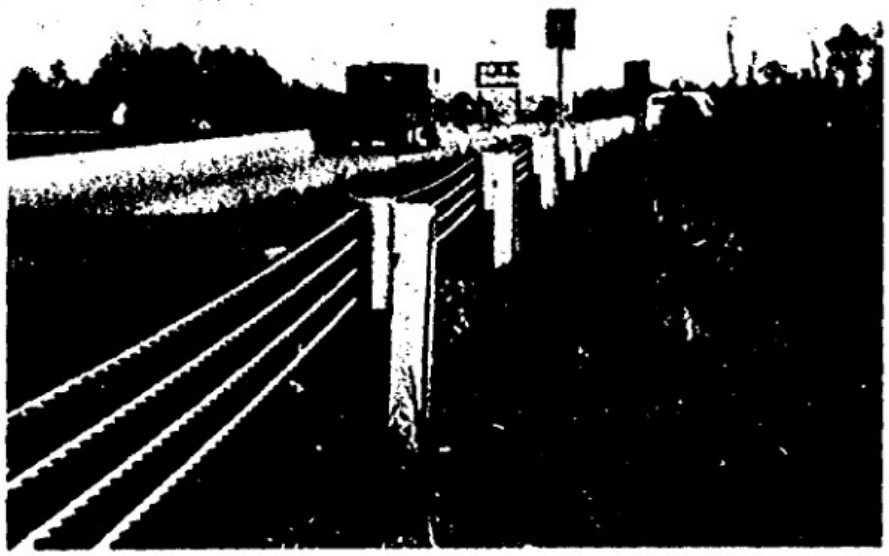
This is the second sign, which alerts to the right-hand movement for vehicles that want to take 301 south.



This is the third sign, which alerts for both movements which occur at this interchange, the left-hand lane signs for the route to Baltimore on Maryland Route 3, the right-hand lane for the ramp off to the right. Now, there is a geometric feature here that is important. Notice that this is on an up-ramp and that you have no visibility or no vision ahead of what is going to happen up at the interchange itself.

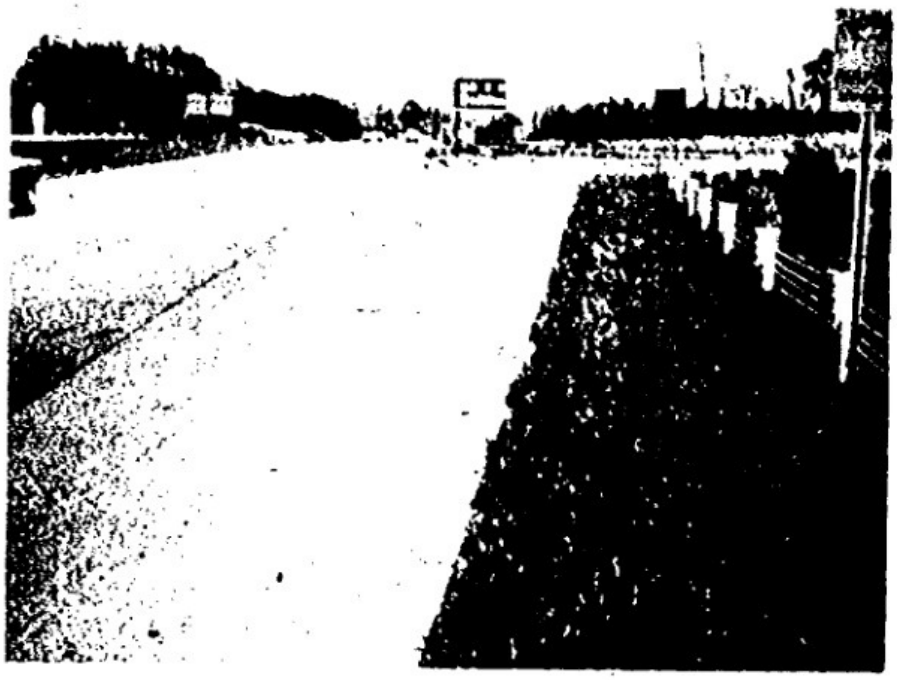


This picture is taken just at the overpass abutment. This is a two-lane highway. It has no room even for a deceleration lane, and you can barely see in the distance the sign in the gore which directs the traffic to the right for Maryland Route 3; you can see behind the shrubs a yellow sign, which would be a speed advisory sign. I did not notice any other sign, but there was no speed advisory sign on that previous overhead sign. The speed on the highway itself is 60 miles an hour.



This picture is taken at the other side of the overpass bridge. If you will look, this doesn't show too clearly, but if you will look at the sign in the gore, it is half gone. The speed limit itself is 20 miles an hour, and there is virtually no deceleration lane at this point.

There have been a considerable number of cases where the traffic has gone off of this ramp in attempting to slow down to get around this 20-mile-an-hour loop.



This is just another shot a little bit closer to this gore. You can see that just half of the sign notifying Maryland Route 3 is there.

Mr. MAY. This slide was taken recently?

Mr. LILL. It was taken about 2 weeks ago; yes, sir. If you get close to the gore area, you will see it is very well chewed up. When I was walking along on the grassed area here, the red fuses were present in great number, indicating there had been a lot of difficulties, accidents at this interchange, and the warning fuses had been placed out.

Mr. MAY. Yes; I think the staff checked to try to determine whether there was an accident analysis.

Mr. KOPECKY. In this immediate ramp area, in 1966, 1967, and the first quarter of 1968, there have been 19 accidents; 15 persons injured. Out of the 19 accidents, 15 involved trucks.

Mr. LILL. Did you say 15 out of 19?

Mr. KOPECKY. Fifteen out of 19 involved trucks.

Mr. MAY. Is that any surprise to you people?

Mr. WOZNIAK. No.

Mr. LILL. I think it is famous in the area, in trucking circles; this is a famous ramp, really. The surprise to an unfamiliar truck-driver passing over that overpass and suddenly being faced with a 20-mile-an-hour ramp can be quite disastrous. I think at the very least there should, well, be some sort of advance warning to the people to indicate they have to slow down to get around this loop.

Mr. MAY. What is the speed on the main road?

Mr. LILL. Sixty miles an hour.

Mr. MAY. Sixty?

Mr. LILL. Yes.

Mr. MAY. Again, is this an unusual situation? Are you people not confronted frequently with this type of situation?

Mr. POTOCHNEY. I have a situation I can quote in Pennsylvania on Routes 322 and 22 coming west; coming east to Harrisburg you are on a four-lane divided highway where it intersects on a cloverleaf with Route 15 going south. Now, the deceleration lane is long enough. However, the ramp is on a downgrade.

Now, if you are going to merge with traffic going south on Route 15, you can maintain a speed limit. However, when you get on the on-ramp to Route 15, it is a very short on-ramp and heads right into a bridge abutment that crosses the river there at that point. Prior to this, you have a right turn to go west on 15. Now, the lanes are such that if you do not slow down and orient yourself, you may get lost. So this, then, slows you down there. Because in the center of the island

are the white traffic lines in the triangle. You must bear to the left to go south; and you must bear right, make a sharp right turn to go back west on 15. This highway has just been opened within the past year.

Mr. MAY. Yes. Again, Mr. Wozniak, this is not an uncommon situation?

Mr. WOZNIAK. No; it is not uncommon insofar as these type exits and insufficient warning is concerned. Definitely it is not uncommon.

Mr MAY. Mr. Knight, would you agree?

Mr. KNIGHT. Yes, sir. We also travel this route here, too.

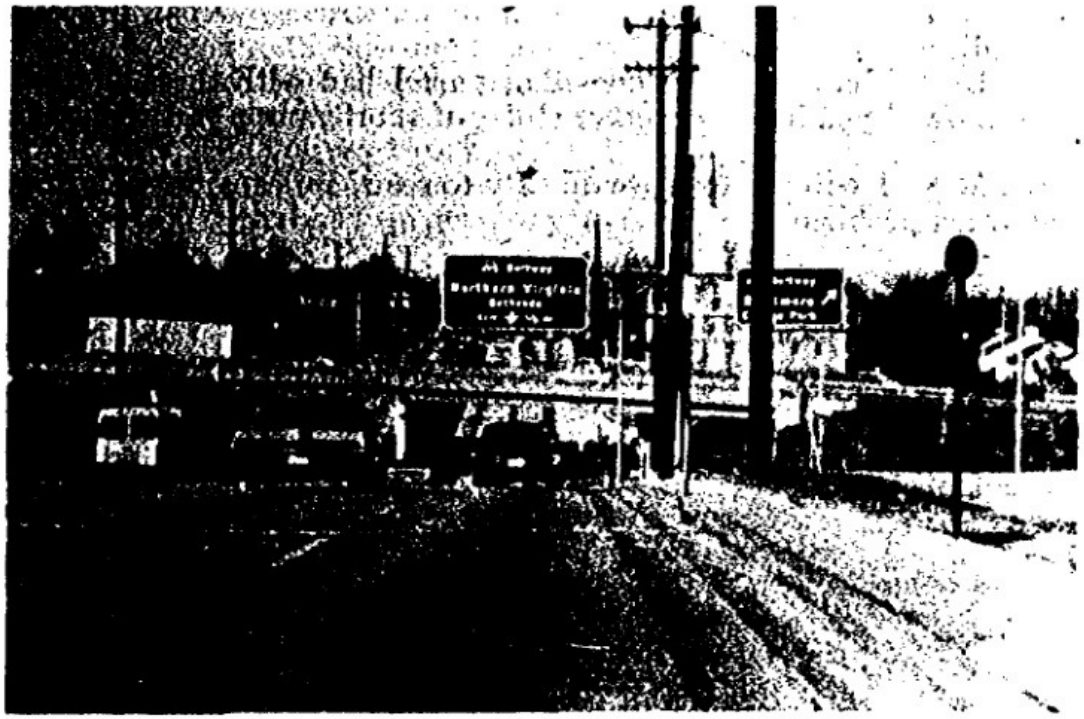
Mr. MAY. We only have about 10 more minutes; so we can proceed, Mr. Lill.

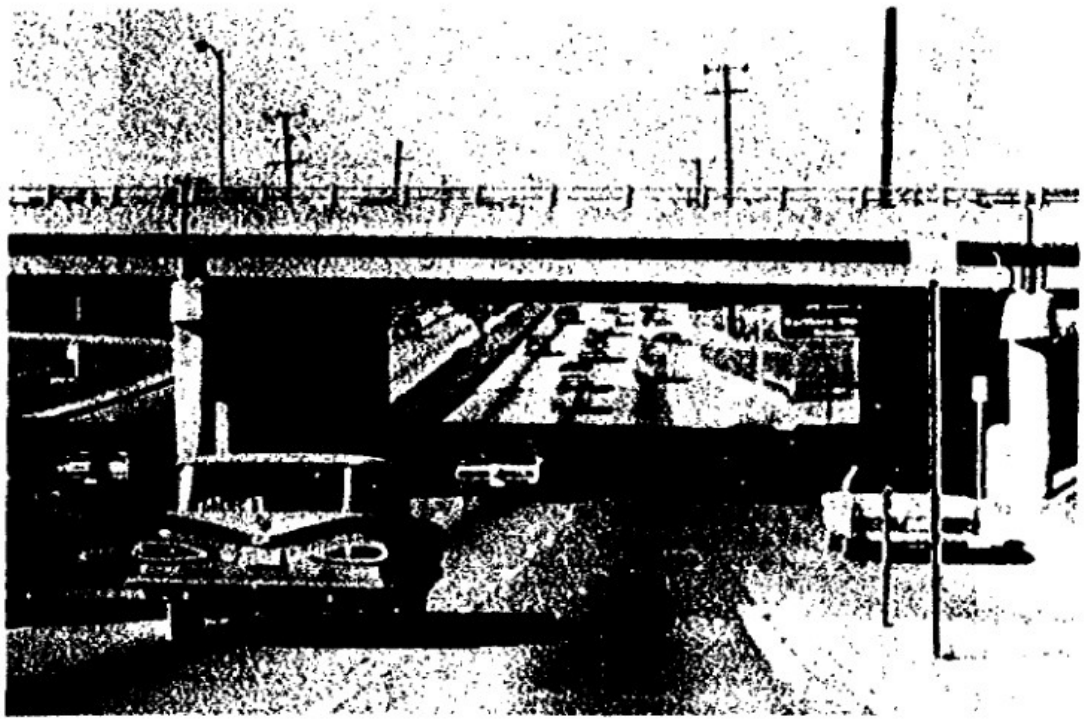
Mr. LILL. Well, that concludes that part I had with these slides. I don't know if you had some other slides of short ramps you wished to show.

Mr. MAY. I will try to move quickly to see if we can just point out some other problem areas.



Mr. CONSTANDY. This is the Washington Capital Beltway interchange with Georgia Avenue. The thing that is interesting here is the ramp in the northeast quadrant is the smallest loop, takes the northbound traffic from Georgia Avenue to go west on the beltway, I–495. It is a very tight ramp, and upgrade, to the bridge structure. From the nose of that entry ramp to the exit from I–495 westbound is the distance alloted for weaving. Remember it is upgrade all the way through the loop up onto the main line.





This is the view that one would get approaching that from the south on northbound Georgia Avenue to make that loop. You can't see the ramp in this view, and you just begin to see it as you come down.

Mr. BLATNIK. Is that the ramp immediately behind to the right of the bridge?

Mr. CONSTANDY. On the other side of the structure; yes, sir. You notice on this side of the structure the opposite movement of the vehicles coming down the grade from eastbound I–495 to come on Georgia Avenue must cross into this right-hand lane.

Mr. BLATNIK. Of the three lanes you see to the left side of the highway going north—if any of those vehicles want to get on that ramp, they have to cross?

Mr. CONSTANDY. They have to cross the exiting traffic.

Mr. BLATNIK. And their own lane, too. Let's see, the car partially visible in the extreme left, then, would have to move sharply and rather quickly to get to the ramp?

Mr. CONSTANDY. He would. There are two signs in advance of this that should alert him to be on the right side. Once he gets here, he has the problem with this exiting stream of traffic, to cross it, and then his problem really begins. He goes up that very tight ramp and between this point and the point roughly over here [indicating] he has to go up a grade of this very tight ramp and then come onto the freeway at that point [indicating], going up a grade again, over the structure.

Mr. BLATNIK. The reason I am asking these questions, counselor, is we have a similar type of thing on the 14th Street Bridge. Would you hold that slide again? On the 14th Street Bridge, traveling on an express route from the Capitol Building, from the site where we now are, and traveling toward the 14th Street Bridge, then going southwesterly toward the Potomac, toward the Pentagon, toward Arlington, your entry to the 14th Street Bridge is on the extreme left-hand lane—you cannot compete with these lanes coming from downtown Washington and 14th Street directly, express traffic where three lanes merge into one. You sort of sneak into this lane, but the two or three lanes to your right are solid traffic. So for the entire distance of the 14th Street Bridge, which is a considerable one compared to this short distance here to there [indicating], even though you have had advance warning, and you know exactly where you want to go, you want to go from this side over to this side, so as to turn off to the right and go into the area of North Arlington, and the Memorial Bridge, Fort Myer, or Arlington Cemetery, et cetera—well, it is worth your life to try to make it. And every once in a while you cannot make it, and you have to go straight ahead as far as you can, past the Pentagon, turn around and somehow come back through South Arlington, working your way back up to Glebe Road.

Mr. MAY. You are right.

Mr. CONSTANDY. Would you run that film clip? This next film clip will first show the beltway as it underpasses an intersecting road, and then in the second part of the film clip, it will come to this one we just have been looking at. Just run it through.

A film was viewed, during which Mr. Constandy commented as follows: We first go through interchange 23, Colesville Road, which we underpass while westbound on 495.

There is a truck, a tractor-trailer, we will see coming down from the right. He is entering on the first loop we come to. We are staying in the right-hand lane, he has now entered and he is on the weaving section. He would like to move left into the right-hand mainline lane before we cross in front of him. If we wanted to exit at the second loop we would have created a severe problem for him since we would both be driving the short weaving section at the same time, we slowing down downgrade to exit and he, in the same lane accelerating upgrade to merge and enter 60-mile-per-hour traffic.

This is fairly typical, is it not, of the problems of the cloverleaf interchange? The short weaving section between the loops?

You can let this run. We will see the second of the sequence, which is Georgia Avenue where in this case the Interstate overpasses.

Now, the slides you just saw represent this interchange. Those vehicles have just come up that tight ramp, up a grade over this bridge on the beltway, and need to compete with traffic exiting right at this point [indicating].

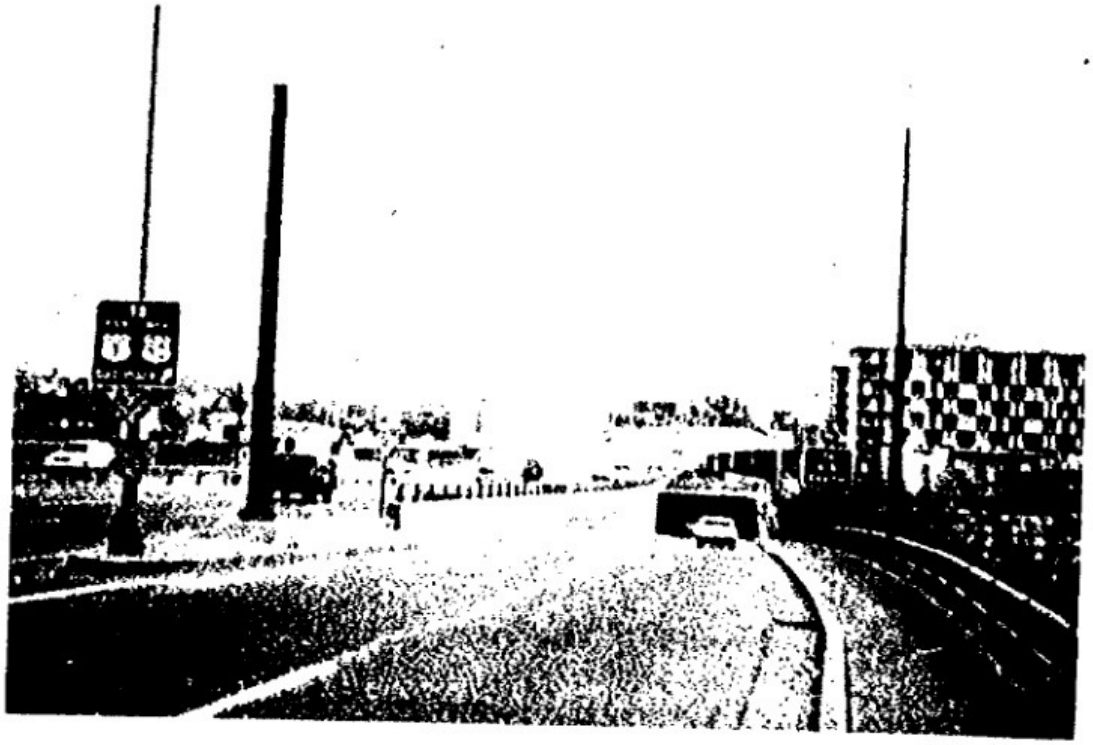
They have difficulty getting on, with traffic on the beltway, likewise the traffic on the beltway has difficulty getting off.

(End of film.)



Mr. CONSTANDY. This is the closest Interstate to the Capitol. We are looking east on the Southwest Freeway. We have vehicles entering from the right up a grade. That lane that the orange truck is on will exit to the Capitol, as will the extreme right-hand lane. Now, the traffic entering at that point has to cross over the exiting lane, going up the grade, to be able to continue east on the Southwest Freeway. That is a distance of 920 feet that all of this has to take place in.

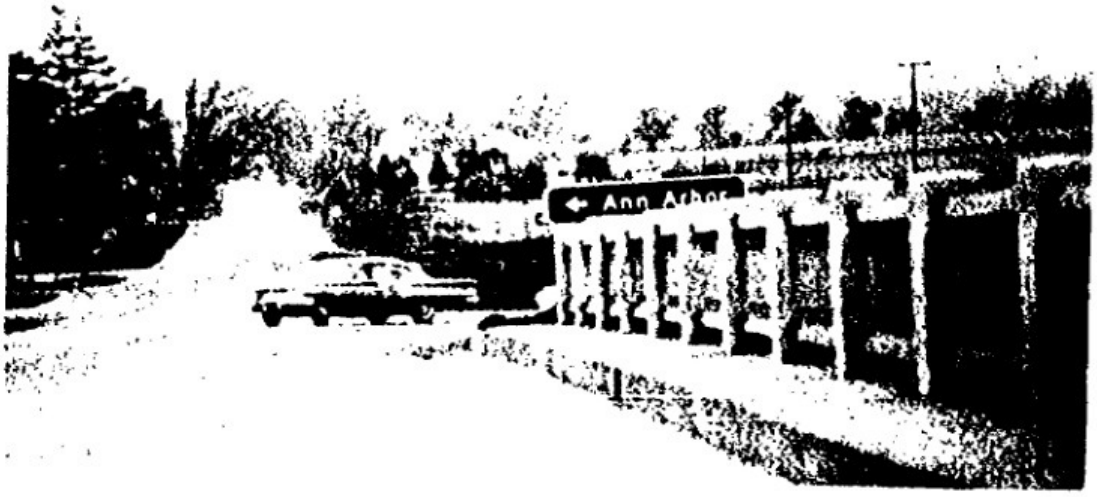
In addition, on the left-hand side, we just see the entry ramp from a left-hand entry. Behind that is the Maine Avenue entry ramp which has two more lanes coming in.



This is a view taken at the exit showing the two lanes exiting to the Capitol.



And this is part of what is left—actually you see an accident there very frequently, coming from and going to work using this road. Great deal of difficulty. A lot of it stems from the short weaving section; traffic entering on the ramp on the right to continue eastbound on the Southwest Freeway.



Mr. MAY. This represents another possible problem; the freeway passes underneath. This is a crossroad going up over the main line. This is an off-ramp from the freeway to the crossroad. We have a sight-distance problem. Traffic coming in this direction [indicating], heading northward over the structure, has great difficulty seeing the traffic coming off of the freeway. I wonder if you people run into this problem in a not uncommon way across the country? The sight-distance problem from the off-ramp onto the crossroad?

Mr. WOZNIAK. Yes. This, of course, is—we have many situations such as this. And with us, our problem is greater, again, because of the heavy truck and slow pickup speed when we do start out. So in this particular situation, you have a car coming across, and I would have to assume here you have a grade; so I presume he tops a crest not too far above there.

Mr. MAY. Yes.

Mr. WOZNIAK. And at any speed at all, a truck coming out there is going to be gambling. He has no way in the world of knowing whether he can clear that right-hand lane coming off of there.

Mr. MAY. Yes. In other words, instead of that vehicle we see in the picture a truck in that position making his left-hand turn?

Mr. WOZNIAK. This is correct.

Mr. MAY. He is really at the mercy of somebody coming down the road, which he really cannot see.

Mr. WOZNIAK. That is correct.



Mr. MAY. I guess this introduces the subject of vertical clearance, Mr. Constandy.

Mr. CONSTANDY. This is an old structure from what had been a U.S. primary route. Unfortunately, the lighting conditions here do not permit you to see the structure. There is no indication on the structure as to what vertical clearance is. Neither is there any advance notice. We find, surprisingly, a number of situations where the structure does not bear any legend indicating its vertical clearance. Does that present a problem to you?

Mr. KNIGHT. Very much so.

Mr. POTOCHNEY. We have had repair bills to show for it, too.

Mr. CONSTANDY. What seems to be the problem? There is no sign, or the signing is not enough in advance?

Mr. POTOCHNEY. In many cases you will find there is no signing. We have gone to the extent that we have mapped out each and every route we run through in our system. We have published a book to our drivers denoting clearances in certain areas. The only problem we run into now—this book has been out 2 years—is that we have not run a survey to see what areas have been resurfaced, particularly where you have a close clearance. We are running into that problem. The driver assumes, he passed through a year ago, he can pass through again.

Mr. CONSTANDY. You say run a survey. Do you measure it?

Mr. POTOCHNEY. Yes, we bought our own equipment, equipped each supervisor with a measuring stick and measured each underpass.

Mr. CONSTANDY. You published a book the driver reads as he goes along the highway?

Mr. POTOCHNEY. That is right, sir. Throughout our system, within our authority.

Mr. CONSTANDY. Yes. That is a fine state of affairs.

Mr. WOZNIAK. This is a very, very serious and expensive problem for the entire industry, and nationally. Not so much, of course, on the Interstate roads themselves; but getting to and getting off of the Interstate roads. And what Mike brought up, we run into, No. 1, the problem of no signing; No. 2, inaccurate signing. Or at one time, say your clearance was 13 feet 6 inches but 3 months a go they went in there and laid down 4 inches of new asphalt, so now you have 13 feet 2 inches.

Mr. CONSTANDY. Hopefully they change the signs.

Mr. WOZNIAK. This is what they do not do. Therefore, we also have to take the precautions that Mike's company does; we periodically go in and measure our own routes out.

Mr. CONSTANDY. Do you find the clearance may not be the same, both sides, both lanes?

Mr. WOZNIAK. Very definitely. We usually find out at the tune of $1,400, when we put a top into a new trailer.

Mr. CONSTANDY. That is an expensive lesson.

Mr. WOZNIAK. True.

Mr. POTOCHNEY. We were forced to do this as Pennsylvania, which was in our area, was the last State allowing the 13-foot 6-inch trailers; we had numerous highways that did not show clearances and they were under height. We then found out in our neighboring State of New York, they under-mark their underpasses.

You will find cases that mark 12-6. Actually it is 13-6. They have a tolerance on it, for what purpose I cannot tell you. This is the ceiling to drivers, because they really take precautions; they feel it is unsafe. Then they find out, well, I took a 13-6 foot trailer under here, there is something wrong. The next instance they bump into an underpass marked 12-6, they feel this will accommodate them, with the result that it did not and we pay for another roof.

Mr. CONSTANDY. They lose the integrity of the sign?

Mr. POTOCHNEY. That is right, sir.

Mr. KNIGHT. We had an instance in Charlottesville—I agree with these gentlemen—improperly marked "12 dash 6." Is that 12 feet plus 6 or 12 feet minus 6?

We found that was a football score—and we hit it.

Mr. CONSTANDY. It was "12 minus 6"?

Mr. KNIGHT. Someone beat the University of Virginia, playing at Charlottesville, some opposing team beat them 12 to 6. [Laughter.]

Mr. CONSTANDY. $1,400?

Mr. KNIGHT. $1,400.

Mr. LILL. Mr. Constandy, in 1965, ATA had the occasion to survey our Council of Safety Supervisors on this very question, this loss of clearance from resurfacing. We got something like 302 replies back to a series of questions; and out of this, 47 percent of the companies replied that they had had vehicles in their fleets damaged from this cause during the last couple of years, prior to that time. By count this amounted to something over 300 vehicles being damaged. Further, questioning about the signs themselves, asking their opinion of the legibility and accuracy of the signs, almost 75 percent of them said that they did not believe that the overhead clearances had been marked accurately, probably reflecting loss of clearance from resurfacing without signing being changed.

Mr. CONSTANDY. Thank you. This really represents a broader problem, does it not—that of giving advance notice of restrictions, either of height or width, bridge weights, or other prohibitions?

Mr. POTOCHNEY. I might inject here, going back, we cannot assume even the Interstate highways are sufficient in clearance for permit loads. When we call up and inquire, to give you an example, going out on 83, Harrisburg to Baltimore, it is our understanding that all underpasses are 14 feet or better. We have found in several cases where they are under 14 feet. And with a permit load, we instruct the drivers on the underpass—not only us, but numerous other carriers. There is one instance on 83 where the actual bridge itself was moved, it was hit with such impact. The northbound lane is much higher than the southbound lane.

You get a good indication of this if you go up the highway and check each underpass, look at the concrete. You can tell the close ones where the diesel smoke is hitting the concrete as it goes under. Where the underpass is of sufficient height, you do not see this.

Mr. CONSTANDY. You know this picture we have on the screen is not a heavily traveled route now, but you can just picture the fellow with a tractor-trailer who reaches the bridge and then finds out his rig does not fit. He has to back up a grade going around the curve. It is hazardous to him and hazardous to other people.

But it would seem to suggest there needs to be some advance signs for truck restrictions or prohibitions along the route; at a point where a man could take an alternate route at the point he is made aware of the restrictions ahead.

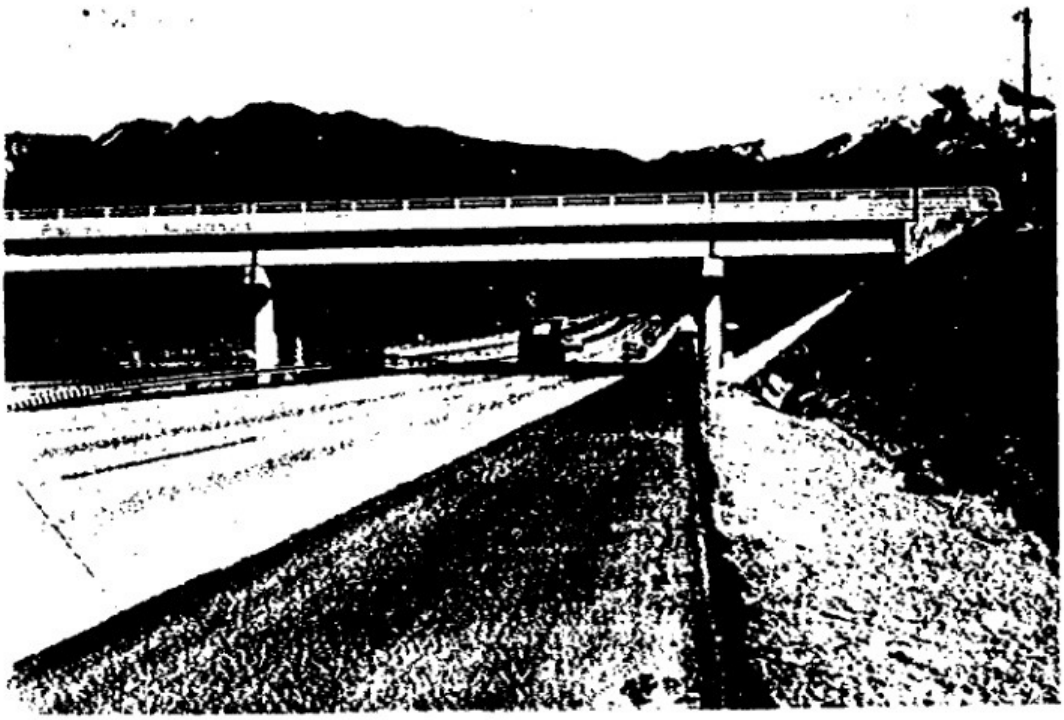
Mr. KNIGHT. I know of one location—I saw the sign at Elkins, W. Va., but I did not actually see the location—probably this sign was 5 to 6 miles from this overhead structure telling truck drivers what the maximum height was. I am not familiar with this location here in the picture, it could be he could have backed around or maybe it would be a couple of miles.

Mr. CONSTANDY. It is more than a couple of miles here. The problem does exist, the truck does become trapped. We are aware the manual makes provision for advanced signing. What we are beginning to recognize is the nonadherence to the manual. I believe it requires that at the closest intersection to the obstruction, signing be provided as to what alternate route may be available. At Washington, at the end of Virginia Avenue, it is not uncommon to find a tractor-trailer who has found he cannot cross Roosevelt Bridge; trucks are prohibited.

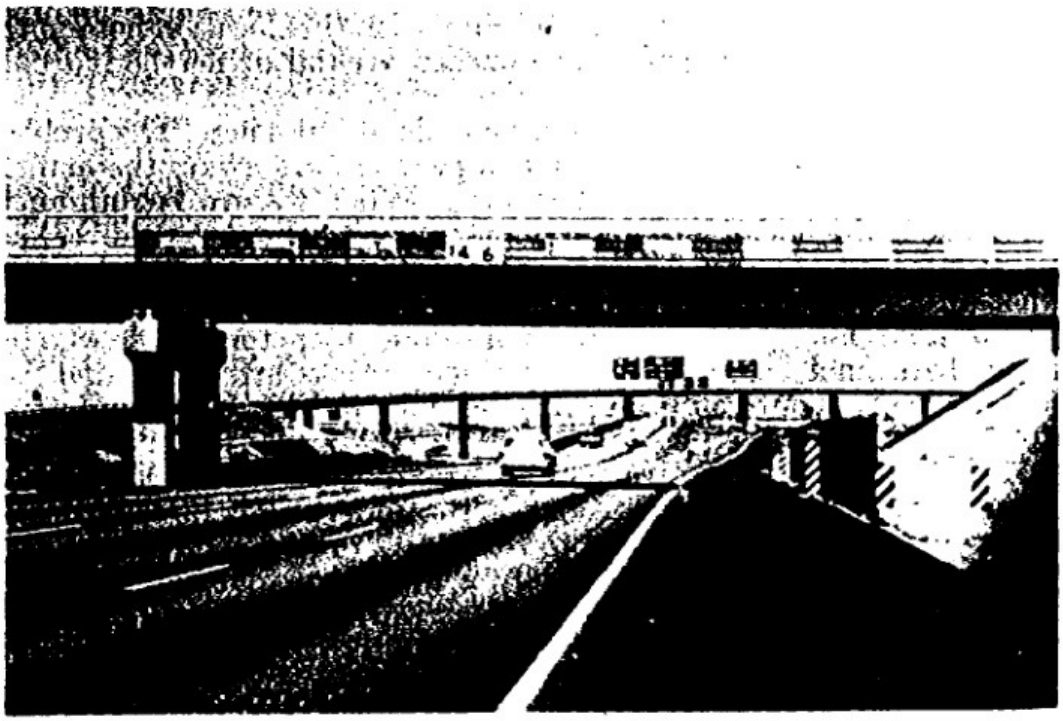
Mr. KILEY. You would be surprised how quickly you can convert vans into convertibles.

Mr. POTOCHNEY. To give you an example, on Route 17, in New York State going towards Salamanca, the underpass is 12–6. To detour this, you must travel miles back to Route 305, drop down into Pennsylvania, and you have approximately a 37-mile detour to get around this area. Had the driver been already warned these miles back, he would have been in a better position to avoid that. Our driver did not avoid it; he tried to get under it.

Mr. CONSTANDY. It is good to know enough in advance so you are not committed to something you cannot negotiate. This is a new bridge.



You mentioned about a new bridge on the interstate. It has no sign indicating the vertical clearance. And there are others like this.

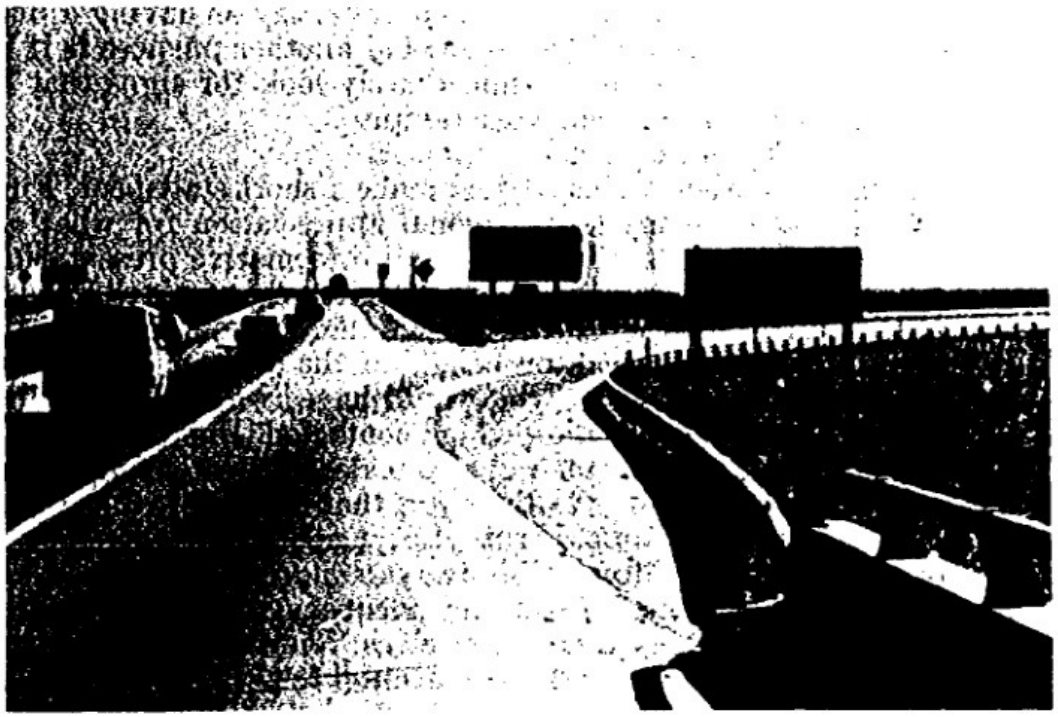


Here is one relatively new, 14–6. At least this one has the sign posted on the structure. It is questionable whether it is enough in advance for the driver to make use of it. Perhaps this bridge is high enough that it does not matter.

Mr. POTOCHNEY. If you look here, it is an optical illusion, but if you are riding that left lane, that left-lane clearance seems to diminish there and the driver could possibly veer over to the right hoping that it is higher.

Mr. CONSTANDY. It is not always the same clearance over all lanes, is it?

Mr. POTOCHNEY. No; it is not.



Mr. CONSTANDY. This is the type of thing that may be more desirable. This is at Telegraph Road interchange on the beltway. We see the sign at the right of the exit, which reads "Low clearance 11 feet 4 inches, on Route 241 north."

This is the type of information that would be helpful to the truck driver by notifying him in advance that he is being committed to follow a route on which there is an obstruction. I think this is not very often seen.

One other thing in this photograph, you will notice that the lane is dropped, the right-hand lane leaves at this point and is dropped from the main line which carries two lanes through to the diamond ramp on the other side, then picks up three.

Mr. MAY. May we have the lights, please. Just one more quick item. I understand that some of the commercial enterprises around the country, not wanting the truckdrivers to rely on conventional signing to bring them to their places of business, have handed out booklets with specific directions to guide truckdrivers to their specific business locations.

Mr. LILL. Yes; some of them provide complete guides with pictures of the interchanges, their location of their truck stops, and on the interchange they have arrows directing the person who is looking at the sketch how to get off of the Interstate highway and get to their truck stop. I think this is symptomatic. It is something maybe all of us

feel from time to time when we go into an interchange and are looking for an off ramp, we want to know ahead of time whether we should be left or right, or whether we should go off before the bridge or after the bridge.

Mr. MAY. Thank you very much. Thank you, gentlemen. We appreciate your help.

Mr. KNIGHT. I would like to make one more comment about this corrugated pavement just before you get to where your signs indicate exit and entrance ramps. It was discussed yesterday as having a dual purpose. A dozing driver would awaken; but another purpose is if he hits this corrugated pavement to immediately look for signs that he might be exiting or be near an entrance ramp.

Mr. MAY. Thank you very much.

Mr. BLATNIK. Gentlemen, may I just make a short statement. First of all, I want to express my true personal appreciation for what obviously was a very impressive, effective, and informative presentation, even though I saw only the latter part—due to what we are hearing just now, the bells, plus the meeting of another subcommittee of the full committee. I know I speak on behalf of the other members who could not be here this morning, who would have; we had a very difficult three-way split this morning which conflicted. But I do want to thank each and every one of you and also make this statement for the record: There is an old saying to the effect that the proof of the pudding is in the eating. It is an old truth, but it never was truer than in its application to the signing of highways; and certainly no one is better qualified to comment upon the adequacy of signs directing motorists than the highway users themselves. They are the ones, such as those of you who have testified this morning, for whom the pudding was prepared and they are logically the ones who are experienced in day-to-day use of it. That experience has been enlightening to all of us.

It has been most helpful to the committee to draw upon the automobile clubs representative whom we had yesterday and the day before, and the trucking industry today. The accumulated knowledge of these literally hundreds of thousands, if not millions, of members and employees, places them in a unique position to inform and guide the people who build and sign the roads on which these users travel.

The committee is grateful to these witnesses for drawing upon that knowledge and experience in our behalf. Their testimony documented by many interesting photographic slides and movie strips, forms a distinct and valuable contribution to these hearings.

The hearings will now recess, subject to the call of the Chair. When we next resume—the date has not yet been set—you will hear from experts in fields closely related to safe highway traffic design, including that of human factors, such as reaction speed, sight distances, et cetera.

Again I thank you gentlemen. The hearings are recessed until further notice.

(Whereupon, at 12:57 p.m., the hearings were recessed, subject to the call of the Chair.)

HIGHWAY SAFETY, DESIGN AND OPERATIONS
Freeway Signing and Related Geometrics

TUESDAY, JULY 9, 1968

HOUSE OF REPRESENTATIVES,
SPECIAL SUBCOMMITTEE ON THE
FEDERAL-AID HIGHWAY PROGRAM
OF THE COMMITTEE ON PUBLIC WORKS.
Washington, D.C.

The Special Subcommittee on the Federal-Aid Highway Program convened at 10 a.m., in room 2251, Rayburn Building, Hon. Arnold Olsen presiding.

Present: Representatives Olsen, Kluczynski, Cleveland, McDonald, and Zion.

Also present: Walter R. May, chief counsel; John P. Constandy, assistant chief counsel; George M. Kopecky, chief investigator; Robert G. Lawrence, associate counsel; Salvatore J. D'Amico, associate counsel; Paul R. W. Yates, minority professional staff member; Miss Agnes Ganun, Mrs. Mildred Rupert, Mrs. Shirley Knighten, staff assistants; and Mrs. Kathryn M. Keeney, chief clerk.

Mr. OLSEN. The subcommittee will come to order. Our subcommittee today resumes public hearings on signing and related features of highway design that affect the convenience and physical safety of the Nation's motorists.

Testimony thus far has shown convincingly that problems do exist in these areas which merit the urgent attention of those responsible for the planning and construction of our roads, including the Interstate System.

It will be the purpose of these hearings to identify these problems further and, where possible, point to solutions or improvements suggested or made available by experience and modern research. We anticipate that the testimony to be heard this week will concern information needs for highway users and concepts for transmission of such information.

Evaluation of the present highway information system in terms of motorists' needs will be afforded by witnesses who are specialists in the use of human factors research. These men are outstanding in their respective fields and each of them has much to contribute to our record.

The Chair wishes to publicly acknowledge the splendid cooperation of these witnesses, all busy men, in generously giving of their time and expertise for the worthwhile task in which we are all engaged in these hearings.

With our new witnesses we continue to have the knowledgeable and experienced Charles W. Prisk, Assistant Director for Safety, Office of Policy Planning, U.S. Federal Highway Administration, whose presence has been so valuable to us from the beginning of the subcom-

mittee's design safety hearings last year. We welcome you, Mr. Prisk, and we appreciate the cooperation of your agency in assisting us by making possible your continued presence as these hearings progress.

Our witnesses today will be Dr. Slade F. Hulbert and Dr. Albert Burg, both research psychologists attached to the Institute of Transportation and Traffic Engineering, University of California at Los Angeles. Dr. Hulbert and Dr. Burg, we welcome you. Now if you will raise your right hand, I will swear you.

Do you, and each of you solemnly swear that the testimony you will give before the subcommittee will be the truth, the whole truth, and nothing but the truth, so help you God?

Mr. HULBERT. I do.

Mr. BURG. I do.

Mr. PRISK. I do.

Mr. OLSEN. You may proceed.

Mr. CONSTANDY. If you could each identify yourselves for the record.

TESTIMONY OF DR. SLADE F. HULBERT AND DR. ALBERT BURG, ASSOCIATE RESEARCH PSYCHOLOGISTS, INSTITUTE OF TRANSPORTATION AND TRAFFIC ENGINEERING, UNIVERSITY OF CALIFORNIA AT LOS ANGELES, AND CHARLES W. PRISK, ASSISTANT DIRECTOR FOR SAFETY, OFFICE OF POLICY PLANNING, U.S. FEDERAL HOUSING ADMINISTRATION

Dr. HULBERT. I am Slade Hulbert.

Mr. CONSTANDY. And your address?

Dr. HULBERT. 10767 Rochester Avenue, Los Angeles.

Dr. BURG. I am Albert Burg of the University of California at Los Angeles. Home address, 3193 Federal Avenue, Los Angeles.

Mr. CONSTANDY. Mr. Chairman, we are indeed fortunate to have two such eminent gentlemen with us today. I have brief biographical sketches and I will ask that they be printed in the record, but I would first like to read a couple of excerpts from them.

Dr. Hulbert is a research psychologist; lecturer in the Department of Engineering; has been with the University of California since 1952. His major fields of interest are human factors research in transportation systems; engineering education; and psychological behavior theories. He is a member of the American Psychological Association, Society of Engineering Psychologists, Institute of Traffic Engineers, chairman of Road User Characteristics Committee, Highway Research Board, National Research Council; adviser to the National Joint Committee for Uniform Traffic Control Devices, and a certified psychologist in the State of California.

Dr. Burg is an associate research psychologist at the University of California. Dr. Burg has been with the Institute of Transportation and Traffic Engineering at UCLA since 1953. His present fields of major scientific interest include human factors in transportation, visual requirements of the driving task and accident prevention. Dr. Burg is affiliated with the American Psychological Association, Society of Engineering Psychologists, is a certified psychologist in the State of California and a member of the Road User Characteristics Com-

mittee, the Traffic Safety Committee and the Night Visibility Committee, all of the Highway Research Board.

I would like to submit these biographical sketches for the record at this point.

Mr. OLSEN. Without objection, so ordered.

(The biographical sketches of Messrs. Hulbert and Burg follow:)

October 1966

Slade F. Hulbert, Ph.D., Research Psychologist and Lecturer in the Department of Engineering. Born May 28, 1923, in Los Angeles, California. Received his Ph.D. in Psychology at the University of California, Los Angeles, in 1957. Dr. Hulbert has been with the University of California, Los Angeles, since 1952, as Research Psychologist. His major fields of interest are: Human Factors research in transportation systems, Engineering Education, and Psychological Behavior Theories. He has had extensive experience consulting in these areas with numerous national, state and local governmental agencies as well as with other departments of the University. He has authored and co-authored some 32 research articles and reports. He is a member of the American Psychological Association; Western Psychological Association; Society of Engineering Psychologists; Sigma Xi; Human Factors Society of America; Institute of Traffic Engineers; American Association for the Advancement of Science; Training Committee, SAE; Chairman of Road User Characteristics Committee, Highway Research Board (National Research Council); advisor to the National Joint Committee for Uniform Traffic Control Devices; and is a Certified Psychologist in the State of California.

November 1966

Albert Burg, Ph.D., Associate Research Psychologist. Born December 21, 1928, Kingston, New York. Received his Ph.D. degree in Psychology, University of California, Los Angeles, in 1964. Dr. Burg has been a Research Psychologist with the Institute of Transportation and Traffic Engineering at UCLA since 1953, and serves as consultant to member departments of the California Transportation Agency. His present fields of major scientific interest include Human Factors in Transportation, Visual Requirements of the Driving Task, and Accident Prevention. He has directed research on the USPHS-sponsored project "The Relationship Between Vision Test Scores and Driving Record" since its inception and currently is directing activities on a study which is an extension of this project and is sponsored by the California Transportation Agency and U.S. Bureau of Public Roads. Dr. Burg is affiliated with the American Psychological Association, Western Psychological Association, Human Factors Society, Society of Engineering Psychologists and Sigma Xi, and is a Certified Psychologist in the State of California. He is a member of the Road User Characteristics Committee, the Traffic Safety Committee and the Night Visibility Committee, all of the Highway Research Board (NAS–NRC). He has participated in numerous panels, conferences and symposia, and has authored or coauthored numerous research articles and reports.

Mr. OLSEN. Doctor Hulbert, you hear the expression "human factors engineers" more recently, quite frequently. I wonder if you could begin by explaining to the committee what that means—"human factors engineers."

Mr. HULBERT. First of all I would like to express appreciation for the opportunity to appear before the committee and I am aware of the responsibility that is represented here and the potential for change and improvement.

The term "human factors" is a relatively new one that speaks of a profession of persons who are usually mixed in their training. Behavorial science is represented and engineering is represented heavily in the members of the human factors society.

For example, the profession grew out of a need which became very apparent in World War II when systems were designed for the Navy that crushed the operators of a gun in a turret when they went

to full swing, and so on. Airplanes were designed that flew better when the pilots left their hands off the controls than when they had them on. There were notable examples of systems and devices designed and built that humans had to operate that didn't operate very effectively.

The human scientists are the behavioral scientists, psychologists and physiologists and medically trained people who were called upon to help in the design stage of systems, largely aviation and defense systems, and this grew as a profession; a mixture of trainings brought to bear on the design and operation systems that humans had to perform with, and in.

Mr. CONSTANDY. Is there an application for this in the highway field?

Dr. HULBERT. In my opinion, there is, certainly.

Mr. CONSTANDY. And how would that take form, in what way, generally?

Dr. HULBERT. Well, it would be application of what is known, and that is little enough, about the way humans perform. But there is a big gap, and several articles have been written attesting to this gap, between what is known and what is being applied in highway and traffic engineering.

Mr. CONSTANDY. Has there been application of it, then, in the field of highway safety or traffic, or design?

Mr. HULBERT. Well, not to my knowledge. I do not know of any human factors persons in the employ of any division of highways in any State, for example, or of any city traffic engineers, or engineering office.

Mr. CONSTANDY. You feel that there is a need for people with that training to be represented?

Mr. HULBERT. Yes, I think there is a definite contribution that can be made by having the design and operating engineer working with persons who would call themselves human factors specialists.

Mr. CONSTANDY. This would give the engineers some insight into the capability and limitations of the human being as part of the system then, is that true?

Dr. HULBERT. Yes, he has a good deal of insight already or he does not survive as a practicing traffic engineer. But his insight is largely that of the lay person plus what he has learned on a trial-and-error basis and it does not represent the scientific knowledge of human behavior or the particular research tools and approaches that have been developed by this profession to find out in any particular instance what it is that the human limitations are, what his needs are and so on.

Mr. CONSTANDY. Is there a thought that you have as to the reason why this has not been applied within highway departments, operationally that is?

Mr. HULBERT. Well, just another instance of an engineering endeavor that has not seen fit to involve this type of newly emerged, recently emerged professional help. There are many other examples of such engineering endeavors where human factors are not involved.

Mr. CONSTANDY. It has not yet been recognized, is that it?

Dr. HULBERT. Yes, I think that is a fair statement—has not been recognized. There are no positions available that have this title, and so on.

Mr. CONSTANDY. We are speaking in terms of an operational use, are we not?

Dr. HULBERT. Yes.

Mr. CONSTANDY. The application of that specialty in the highway departments.

Dr. HULBERT. Yes.

Mr. CONSTANDY. But there has been application within the area of research has there not?

Dr. HULBERT. Yes, there has been some activity. Very few persons, dating back to President Hoover's administration when there was a concern on the part of the Congress on highway safety and traffic safety matters and stemming from that, there was Dr. Lauer who I believe is still active at Iowa State. One of his students, Dr. Forbes also is still active. These men were the earliest human factors scientists in the field. There has only been a handful of persons engaged in this work since.

Mr. CONSTANDY. Both you and Dr. Burg have been, have you not?

Dr. HULBERT. Yes.

Mr. CONSTANDY. And you have conducted a number of research studies in the field of what we will call traffic safety?

Dr. HULBERT. Our institute where we both are staff members was created in 1957–58, when that session of the California State Legislature met this need to provide research advice to the operating agencies of the State highway department and department of motor vehicles and the highway patrol.

Mr. CONSTANDY. Just to illustrate how your specialty would be applied, perhaps we could touch on some of the research which I believe both of you have undertaken. There was one in 1957, the effects of underlining on the readability of highway destination signs.

Dr. HULBERT. Yes. This, as all of our studies are done, was done at the request of some of the operating people. In this case I think it was the State traffic engineeer at the time, to see if the layout of information on directional signs could be improved so that these signs would not be misread by the motorists. The misreading that I speak about, perhaps it would be best if we could show this. Is projection equipment available?

Mr. CONSTANDY. Perhaps you could pass it up here. Basically, the sign we are talking about would be one where there would be more than one destination with appropriate arrow indicating which road at an intersection would be taken to reach that destination.

Dr. HULBERT. That is correct.

Mr. CONSTANDY. And there also would be included the mileage, too, is that correct?

Dr. HULBERT. Yes. These signs show the direction the motorist should take at the intersection and gives the mileage to reach that destination. The contention as it evolved over the years has been that if there was a vertical or straight ahead destination that would appear at the top of the sign.

Mr. CONSTANDY. That would have an arrow pointing straight up?

Dr. HULBERT. That is correct, and if there was a left-hand destination it would come next and would have a left-hand arrow.

Mr. CONSTANDY. With left and right destinations, on which side of the destination words would the arrows appear?

Dr. HULBERT. Where the destination was to the left the arrow appeared on the left of the destination—where the destination was to the right the arrow appeared at the end of the destination, or to the right.

Mr. CLEVELAND. In going into this multiplicity of signs, did your studies ever bring you to the point where you found there was a political element here, with all communities wanting to have signs leading to those communities? Did you get into that phase of it?

Dr. HULBERT. Only indirectly in working with the traffic engineers. During the research we did not come directly into contact with that.

Mr. CLEVELAND. I would say this, Mr. Chairman, that if multiplicity of signs is a traffic hazard you are going to have some traffic problems and practical political problems in not putting signs up for some of these communities. Even if there are just 200 people in a community, they want the sign on the road. There is a problem that the multiplicity of signs is contributing to hazardous driving and I do not doubt that it is.

Mr. CONSTANDY. Dr. Hulbert, that sign as it would appear before this time would have simply been a panel with the words on it and no line horizontally separating the destinations, is that correct?

Dr. HULBERT. That is correct.

Mr. CONSTANDY. And the purpose of your study was to test the effectiveness of separating the destinations by a line?

Dr. HULBERT. That is correct; to prevent the eye from associating the wrong arrow with the destination that you had in mind.

Otherwise it is quite an easy thing, without the lines, for the eye to jump over and associate the wrong arrow with a destination.

Mr. CONSTANDY. The conclusion is stated in the report on the research project that underlining reduces the probability of the destination being associated with the wrong arrow in the unequal word length sign. Is that correct?

Dr. HULBERT. Yes.

Mr. CONSTANDY. I wondered about the use of the term "unequal word length." Is there not also the possibility of misinterpretation with words of equal length?

Dr. HULBERT. Yes; although the likelihood is greater when you have a short word and the motorist's eye must then associate this short word at the bottom of the sign with an arrowhead way over here at the lower right hand corner of the sign, which is the connection the traffic engineer intended to make, when actually there is another arrowhead pointing in exactly the wrong direction, almost contiguous with his destination, you see, and his tendency to jump and assume that that is the arrowhead that is appropriate is greater when the word is shorter than it is when it is longer because when it is longer, the eye reads over and gets closer to the appropriate arrow.

Mr. CONSTANDY. I see.

Dr. HULBERT. But we control for this factor and this is an example of a study done on the details of the sign, on the readability of the sign without regard to the destination itself and to the questions that Mr. Cleveland has raised as to which communities would be on the sign, and so on.

In other words, I would like to make that distinction because there is in my mind a clear distinction between research and improvement in

the readability, the legibility of the sign, the alphabets, the contrasts, the size of the sign, and so on; a clear distinction between that type of research and the other type of research which is more system oriented: what destination should be on the signs in the first place and how much time should a person have to make his decision, and so on.

Mr. CONSTANDY. A direct result of this project was that the California State Highway Sign Committee decided upon the principle of underlining or separation of these destinations on the signs; is that true?

Dr. HULBERT. Yes.

Mr. CONSTANDY. Beyond that is there not some additional recognition of it through the joint committee?

Dr. HULBERT. Yes; it was adopted by the National Joint Committee on Uniform Traffic Control Devices and included in their manual.

Mr. CONSTANDY. In the text it was included. Unfortunately in the illustration accompanying it they printed the wrong picture. I think it has one that has not got the distinct separation or underlining; is that true?

Dr. HULBERT. That is true, and my understanding is that in the forthcoming revision of the manual that will be corrected.

Mr. CONSTANDY. Yes. Are you prepared to give any indication as to the degree of acceptance and application of the principle around the country since it had been adopted by the National Joint Committee?

Dr. HULBERT. Well, I have not done too much driving in other parts of the country, but even in the areas where I do drive, it is certainly not uniformly being done, even on some new installations.

Mr. CONSTANDY. Of course, we have to recognize that frequently an improvement in a sign is not made until it is time to replace the sign.

Dr. HULBERT. That is correct.

Mr. CONSTANDY. So perhaps that accounts for some of them. However, in traveling around the country, one is not struck, even with signs just recently erected, that there is widespread acceptance of underlining as a standard.

Dr. HULBERT. Well, there is a communications gap, there is no question, a communications lag. Many times signs are ordered by a community and the producers of the signs will refer to an outmoded standard for that type of sign and go ahead on that basis.

Mr. CONSTANDY. Yes. I think in the last hearing we were quite taken by the fact that an excellent publication by the Highway Research Board on the use of W-beam guardrails, Report No. 81, which had come out several years before, by and large had been treated with indifference in the design of guardrail installations around the country. It is unfortunate because what was contained within that report was the result of very valuable research work that had been done and would have precluded the necessity today of going back and changing the installation of much guardrail that was put in after that bulletin came out. Here we have another example of it where research has been done and the research has not been applied. We will later get into some more classic illustrations of the same thing. It is unfortunate that this is true to the extent we see it.

Mr. MCDONALD. Mr. Chairman, I might comment on that to give an example of where it is being applied. I was very pleased to travel

I–96 in Michigan over the 4th and find that much of the work that we did last year, discussing the problem of off-highway safety is being put into effect now in that the ends of the guardrails all along I–96 in Michigan are being buried into the ground, thus preventing an automobile from impaling itself upon these guardrails. I think this has attributed to some extent to the hearings that we had with this committee last year, and I am very pleased to see that the safety things we talked about are being put into effect.

Mr. CONSTANDY. Yes; I think the thing that causes such concern to people like Dr. Hulbert is to know that much good work is being done in research on specific problems, solutions are being found, but without there being some way to implement them and bridge this gap to extend that knowledge to people who are applying these same things on a day-to-day basis, the research has been in vain.

If there is a hearing or some other event that causes a specific item to be highlighted, that apparently bridges the gap. But this approach is not adequate for the routine day-to-day work. A good deal of what is available is not being applied and won't be until some way is found to build this input into the normal operational structure of an organization.

Would you agree with me on that? I say that because of our past conversations where it seems to be apparent. When we get into a later study, "Driver Needs in Freeway Signing," that we will talk about more today, we again have in that situation a case perhaps more unfortunate than this one.

There was another study involving some principles of freeway directional signs based on motorists' experience, a 1956 project that you two gentlemen undertook with others, and this is what we were just talking about, the "1958 Motorists' Freeway Signs." This is a publication by the Highway Research Board, Bulletin No. 244; predicting the effectiveness of highway signs was another application of your human factors specialty in the field of highway signs. Could you tell us briefly about that?

Dr. HULBERT. This particular study—Al, do you want to talk about that one? It is the 1962 study predicting the effectiveness of highway signs.

Dr. BURG. Predicting the effectiveness study is another example of where we had been requested by the Division of Highways to do research on a specific topic. In this instance, they were concerned with the so-called lane drop situation; that is, in a highway situation where one lane is being dropped from the highway and the problem is one of warning the driver that he is about to lose a lane.

They were concerned with the proper way for the sign representing this to be most effective. There were several sign configurations which the Division of Highways had in mind and they wanted to know if we could, in a relatively short period of time, which was a critical matter, study these different configurations and compare them to see if perhaps one would be better than another.

Very simply, we designed a study which involved the use of groups of people instead of individual subjects in a study, presenting films of different sign configurations. Films were made on an open section of freeway. In other words, real signs on a real freeway, photographed from a moving vehicle and these films subsequently presented to large

groups of people simultaneously. Then the judgment of these people was solicited on specially devised questionnaires. These questionnaires asked their impressions of the sign and questions were asked to indicate or to elicit, perhaps, whether or not these signs were getting messages across.

Very simply, that is what it was, a group film technique in which we were, in a relatively short period of time, evaluating the effectiveness of several different types of signs for use in a specific situation. This was at the request of the Division of Highways and we gave them the results of the study in just 2 or 3 months, I believe. They subsequently used this information for their own signing practices.

Mr. CONSTANDY. It is a good illustration, is it not, of how the human factors-type person can apply his skill in the resolution of a specific problem for a highway engineer?

Dr. HULBERT. Yes, although the turn around time here, in order to be truly useful to the traffic engineering highway engineer, has got to be improved which really I think would call for some kind of an existing facility with a staff that was ready. You see, we had to think of the problem, think how we were going to approach it, get the equipment together and all of this; this takes too long. As a result of taking so long, there was a sign introduced at the very last part of our research which is a symbol. Now we had worked with words. These were legends, such things as "pavement narrows" on one sign and the next sign would say, "squeeze left." So you would come across two diamonds, one says, "pavement narrows," one says, "squeeze left," which is a legend used in New York State.

Then we had, "pavement narrows," and next time we say, "merge left." The word "merge" was used in the Western States. There was a combination symbol which says three lanes, where you go from four to three lanes. The sign would say three lanes, with a vertical arrow with a slash through it.

Then we had a symbol which is a version of those used in many European countries. This was introduced at the very end of our studies and we gave it some consideration but weren't able to give it the full treatment that Dr. Burg has explained earlier.

Now the way things stand is that the, "lane ends," "merge left," words were adopted by the State of California and were also adopted by the National Joint Committee as permissible, but the National Joint Committee has adopted the symbol sign.



Now, there is a great deal of controversy about this symbol sign. It has been put up and is sometimes referred to as the "rain ahead" sign. The European symbol looks like a milk bottle. You may have seen it driving through Europe when the road narrows. It is used customarily on narrow bridges.

The idea here was to have half of that. We are only dropping a lane on one side. It was thought they should have dashed lines to represent the dashed lines on the lane markings and this is where these dash lines are from in this symbol. This is not a very effective symbol in my opinion; so it became known as the "rain ahead" sign and it is still quite controversial.

One of the reasons is that in the diamond-shaped configuration which we use in this country for warning signs, it was really not possible to extend these outer lines long enough to give you the impression of its being a roadway. It looks quite strange and does not seem to fare as well as far as motorists' interpretation goes, unless as in the State of California, as allowed in the manual, it is accompanied by another sign further on which has the words on it which says "lane ends, merge left."

Mr. CONSTANDY. No one had ever known, until you applied these techniques of your own profession on a portion of the driving public, whether they do understand the meaning of signs; is that not true?

Dr. HULBERT. Not in any clear-cut fashion; no. The customary system is that letters come in, letters of complaint to the automobile clubs or to the traffic engineer in charge of an area, and so on. If this does not happen then there is very little information.

Mr. CONSTANDY. That is kind of the old style; is it not?

Dr. HULBERT. What?

Mr. CONSTANDY. You try something and you see if it arouses enough comment that indicates maybe it is wrong, or if it does not develop complaints perhaps it is right and you leave it up.

Dr. HULBERT. That is the current style.

Mr. CONSTANDY. Right. This is what you would replace with the scientific approach by actually testing portions of the driving public for their reaction.

Dr. HULBERT. Yes; hopefully before the sign had to be put out in the field. As I said, in order to have a short enough turnaround time, short enough cycle, the research cannot be dragged out. In order to not be dragged out, there must be some kind of an existing facility or group ready to do it. Now we in California, at our institute, represent this to a limited, but only a limited degree, this capability.

Mr. CONSTANDY. Is that partially true because you receive individual assignments for specific problems?

Dr. HULBERT. Yes.

Mr. CONSTANDY. On an irregular basis?

Dr. HULBERT. Yes.

Mr. CONSTANDY. You are not able then to maintain the capability to undertake something with a shorter turnaround time?

Dr. HULBERT. This is by and large the case.

Mr. CONSTANDY. There has been some suggestion that that lane-drop sign, if it is appropriate, perhaps lacks another bit of information that the motorists would like to know—that is, when does the lane drop? The sign is placed a specified distance before the lane drops, we realize that, and we realize it because we peeked into the book, but the typical driver on the highway doesn't have the book and has only the opportunity to learn that by the repetition of the experience and perhaps knowingly or unknowingly recognizing some time lag between the time he sees that sign and the time the lane actually terminates. This is another area that perhaps would prove fruitful for the application of human factors, engineering techniques, and study.

Dr. HULBERT. Yes, this entire question of how far ahead to place warning signs and whether it is really meaningful to the motorist to put some kind of number—say 500 feet. What does 500 feet actually mean? To the average, or to the cross section of motorists, including more and more older persons, what does 500 feet actually mean? To travel 500 feet at 60 miles per hour means one thing and at 30 miles per hour it means something else. It is not at all clear in our minds as to how best to get this information across.

Mr. CONSTANDY. This is something to be ascertained though, in the application of your techniques.

Dr. HULBERT. Yes, by a close working relationship between human factors specialists and the traffic and highway engineers who have had, as I call it, many, many years of experience on the firing line. It would not be as productive to give this problem to a university

group, an ivory tower type alone. It needs the experience and training of the traffic engineer together with the human factors specialists.

Mr. CONSTANDY. I think it is worth stressing that. In our conversations prior to today you have stressed the fact that it takes the effort of both of you; there is no intention of displacing the traffic engineer with human factor engineers?

Dr. HULBERT. No.

Mr. CONSTANDY. But what is needed is more coordination between them with the specialty each can bring to the problem.

Dr. HULBERT. Right. Initially, the human factors person could serve as an interpretor of the behavorial science information.

Mr. CONSTANDY. To then be used by the engineer?

Dr. HULBERT. Yes, it is written in a jargon, practically unintelligible, useless form for the practicing engineer to use. Of course, the converse is true. I cannot go and look at an engineering design manual for bridges and make any sense out of it either.

Mr. CONSTANDY. Working together can be very profitable.

Dr. HULBERT. That is right.

Mr. CONSTANDY. This suggests that while there is research being done on specific problems, there is a considerable need for a broader look at the human beings' capabilities, limitations, and needs than is currently being undertaken?

Dr. HULBERT. Yes, in many cases you have to have, I think, some sympathy for the task that is faced by the traffic engineer and particularly in laying out the signing on an interchange that is being designed. I brought along a drawing of an actual interchange layout and anyone who looks at this has got to immediately have sympathy for the job that this engineer has to do. He has to look at this drawing which shows in scale, a bird's eye view, a planned view of the interchange. Then he has to do some mental gymnastics and get himself down and try to imagine how any particular approach to this interchange is going to look to the motorist from his very low point of regard, only 4 feet off the roadway, and then put the sign up in an appropriate way.

This is really a difficult task and one of our research tasks, supported by the State of California with contributing funds, one and a half percent funds from the Federal Aid System, led to the development of what we call a sign testing machine. It is about half as big as this table in which a drawing on 18-inch-wide paper on rollers is moved toward the motorist who sits where Mr. Prisk is and looks through an aperture. He has the steering wheel in his hand and on this paper roller are drawings of the directional overhead signs at the appropriate spacings on the planned drawing. If it is 1,000 feet in front of the decision point, that is where it appears in the scale drawing. This was designed by us at UCLA to be a design tool that might be just as useful as a drawing board or a typewriter or any other tool that the design group would have available to them.

Mr. CONSTANDY. Just to make sure I understand that correctly, on the roller is depicted the alinement of the highway?

Dr. HULBERT. Yes.

Mr. CONSTANDY. It is to scale and includes the signs. Is there placed on the roller a little vehicle that the operator can move with the steering wheel?

Dr. HULBERT. No. Actually, the driver, when he turns the steering wheel, moves the paper mechanism side to side as though he were changing lanes, and again this research is focused, as was the previous study mentioned, on what is the meaning of these messages, not are they readable or legible. Assuming they are legible, what is the meaning? What is the meaning not only of a single sign but the signs in context and how well can a given set of messages direct the motorist through this complex interchange?

He has to make decisions as he is sitting at this little machine. The idea is to give the engineer the ability to take this plan drawing, lay out his signs, give it to his drafting people and then they will produce one of these drawings for him and then he can look at it, have his associates look at it and in fact if he had the human factors person there, he might say, "OK, we will have a few average motorists look at these configurations and we will see how they respond." Do they make the right decision at the right time with this given set of messages?

These decisions, gentlemen, are going on every day. While we sit here right now, a great many people throughout the country are scratching their heads and saying I wonder how we should sign this.

Mr. CONSTANDY. This is to bring the human being into the problem and the thrust of your effort is to give the engineer an additional tool.

Dr. HULBERT. Exactly.

Mr. CONSTANDY. There are many other projects you have had which are listed here which relate to the problems of traffic and highway safety: wrong-way driving, off-ramp study, nighttime effectiveness of two types of reflective stop signs, development of an expeditious method for offsite testing of freeway signs and other matters.

I would like to ask, Mr. Chairman, that this list of publications appear in the appendix of the transcript.

Mr. OLSEN. Without objection, so ordered.

[The above material appears in appendix "D" on page 660.]

Mr. CONSTANDY. There were other studies that had to do with vision and the driving task that were undertaken by Dr. Burg and you, Dr. Hulbert. These I think would be of particular interest to the committee, too, and perhaps Mr. May would ask about those.

Mr. MAY. Mr. Chairman, as the staff proceeded with this inquiry our observations caused us to become more and more concerned about the apparent poor legibility of many of the signs along the highway, and in the course of our studies we found that other people were also concerned.

Among them were some of the members and knowledgeable, cooperative Washington, D.C., staff of the American Optometric Association, of St. Louis, Missouri, who were most helpful to us. Their president, Dr. H. W. Hofstetter, who is director of the Division of Optometry, Indiana University, made an analysis of the standard highway signs, and in his May 1967 report he spoke of the distances at which the various signs could be read and the duration of visibility at 60 miles an hour for a person with 20/20 vision. What he did was to take the manuals and the standard signs and analyze them in a report. Portions of his report we think are pertinent; I quote:

. . . in general, the regulatory signs have the shortest distances and shortest durations of legibility and the warning signs the longest, though the two cate-

gories have approximately the same range of variance. The median distances for warning signs is just over 300 feet (3.5 seconds at 60 miles an hour) and the median distance for regulatory signs is about 230 feet (2.6 seconds at 60 miles an hour).

For all categories combined, in both samples, the median is under 300 feet (3.4 seconds at 60 miles an hour) and two-thirds of the signs have maximum legibility at less than 350 feet (less than 4 seconds at 60 miles per hour).

Remember that these computations represent *maximally* favorable circumstances in almost every respect. The computations do not allow for the fact that the signs are at the side of the highway whence the actual distance of viewing, the hypotenuse of a right triangle, is greater than the distance measured parallel to the highway. * * * These computations also assume absence of visual interference and ideal conditions of contrast and illumination, which rarely prevail on the highway. Perhaps the most deceptive factor of all is that this analysis is made in terms of central (foveal) visual acuity which would require continuous and direct fixation of the sign to utilize the full range and duration of legibility. This is, of course, impossible for one attending simultaneously to other visual clues while driving.

Such adversities are further compounded, at least doubly, if the driver has only 20/40 acuity, as is minimally required for driver licensure in most states. It may be conservatively estimated that for the average person with only 20/40 vision more than two-thirds of the standard signs would be legible at a maximum of only about 150 feet (approximately 1.7 seconds at 60 miles an hour).

We spoke with Dr. Hofstetter, and asked him to make an analysis of one of the signs in the standard highway sign manual; on page 41 there is a sign, Interstate shield containing the numeral 75. We asked Dr. Hofstetter to analyze that. He wrote back in this fashion:

This is in response to your inquiry, At what maximum distances, under optimum viewing conditions, are standard 12-inch and 16-inch highway marker numerals resolvable for a driver with 20/20 visual acuity, a driver with 20/30 visual acuity and a driver with 20/40 visual acuity.

For the purposes of my computations I made the following assumptions:

1. The numeral "5" on the Interstate marker on page 41 of standard highway signs, Bureau of Public Roads, 1961.

2. The placement of the sign 25 feet above street level, and the driver eye-height, 4 feet above street level.

3. The driver fixates the sign directly that is, he is looking slightly upward to see the marker with his fovea.

4. Atmospheric conditions are good, the marker is well illuminated and free of glare, and the contrast between the numeral and the surrounding marker surface is that of an undeteriorated sign.

5. The specified visual acuity (20/20, 20/30, or 20/40) is that obtained with the best lens correction in front of the eye.

A. Under these assumptions the maximum distance of resolvability of the 12-inch numeral "5" for the 20/20 eye would be 575 feet. At 60 miles an hour maximum possible legibility time before passing would be approximately 6 seconds. For the 20/30 eye the distance would be 380 feet (4 seconds). For the 20/40 eye the distance would be 290 feet (3 seconds).

Mr. Chairman, we on the staff have been concerned about the Interstate group numeral as an example contained in the overhead signs on the Interstate at some of our crucial areas, and we on the staff are concerned that a person with 20/30 vision has only 4 seconds maximum and that with 20/40 eyesight the distance would be 290 feet at 3 seconds. Mr. Prisk, is that a relatively short time for an average motorist to react favorably to some of these crucial points?

Mr. PRISK. At some places this would be very short; yes.

Mr. MAY. So we became concerned with legibility and vision and that is why we spoke at length with Dr. Burg. Doctor, would you discuss this problem a little bit more and tell us about what you have discovered in the course of your studies?

Dr. BURG. Yes. Several years ago we got involved in the area of vision and driving. We feel, of course, that it is extremely important and at the same time had been at that point quite underresearched, very little was known relatively speaking, and yet decisions were being made every day by driving-licensing officials and by signing officials. They were making decisions every day that needed information about vision and driving in order to be accurate. So we undertook a long range study of vision and driving supported by the U.S. Public Health Service initially, and subsequently by the State of California and the Bureau of Public Roads, to see if there was a relationship between how well people could perform other vision tests, standard and nonstandard and how well they drove.

Several years later we find ourselves with data accumulated from some 17,500 drivers studied in the State of California all over the State. This is by far the largest, most complex, most complete study of its type ever done and we have a tremendous amount of information coming from this study, some of which is yet to be analyzed, some of which is yet to be published, of course.

On the basis of what we have analyzed thus far we can make certain statements about the relationship between vision and driving, also about the range of capabilities—visual capabilities—to be found in the driving population. This is the type of information at the very least which should be taken into consideration by sign designers, by driver licensing officials, and so on.

With reference to some of the figures which you just gave that Dr. Hofstetter sent to you, our findings came from just looking at the range of performance on a simple test of static acuity or standard visual acuity and these people were tested the way they drive, the way they said they drive.

As you probably realize there are many people who have stamped on their licenses that they must wear corrective lenses, yet not all of these people do and then we have people such as my colleague, Dr. Hulbert, who wears glasses all the time. They do not have to wear the glasses to pass the test, yet they do. There are other people who do not wear glasses when they drive, yet it says on the license that they must do so. This is the way people drive. This is a random sampling of California drivers and there is no reason why one could not generalize from these people the application to other States.

We find that if we use the 1 inch of letter height for every 50 feet viewing distance rule of thumb that seems to be commonly used by sign designers, for example, but if we use this type of rule of thumb, by our calculations based on the distribution of scores of our samples, this means we are excluding perhaps 20 percent of our driving population.

In other words, in order to be able to see a letter, assuming this is the 5-to-1 ratio, one, the stroke width of the letter is one-fifth the height of the letter, assuming a letter of this type, the 1 inch in 50 foot rule means a person should have approximately 20/23 vision in order to perceive this and this excludes about 20 percent of the driving population according to the figures which we have developed.

How crucial this 20 percent is we never know. The point is the decision has to be made at some point as to how much of the driving population we can afford to exclude or how difficult for how

many people we can afford to make the situation. This is a decision which should not necessarily be in the hands of human factors specialists.

It is our position that we present this information through research and then the operational people have to make these decisions with our help perhaps, and with our advice, but here for the first time we have some information on the visual performance distribution, the range of visual performances of a large sample of the driving population and a representative sample, and now it is up to us, to the operational people with us, to help them to make decisions based on this information.

Mr. MAY. It seems as though the highway people have to give further consideration to this use of this rule of thumb.

Dr. BURG. Yes, I would say so, very definitely.

Mr. MAY. Because if you consider one out of every five cars approaching a crucial point has a driver that may be in some difficulty and can't see the sign, then we are in trouble.

Dr. BURG. Yes; especially in a situation like this where it is not a difficult situation to remedy. There are obviously many situations—signing, design situations and other situations where the remedy is difficult, very expensive, perhaps impossible to work with reasonably, but if you are just talking about simply the size of the letter, it would seem quite easy to remedy without a great deal of further research.

Mr. MAY. Yes. HEW made a vision study of some type. Are you familiar with that?

Dr. BURG. Yes.

Mr. MAY. Does your study vary from the results of the HEW study?

Dr. BURG. Well, I should point out that the U.S. Public Health Service study, the HEW study to which you refer, involved the testing of between 6,000 and 7,000 people ranging in age from 18 to 79. Incidentally, my study involving 17,500 people had an age range from 16 to 92, which pretty well covered the range of the driving population. In the HEW study I think they tested the general population, not the driving population. Even so, the figures which they obtained and distribution of scores that I obtained were quite similar except as is to be expected, of course, they had a larger percentage of people with poorer vision.

Obviously, these people exist in the general population but they hopefully do not exist in such large numbers in the driving population. They found, for example, that nearly 5 percent of the sample had less than 20/40 vision; 20/40 or worse, whereas in my sample only about half a percent had 20/40 or worse.

You must realize these are people who theoretically should have 20/40 or better having passed the vision test. But it is not unreasonable, I suppose, that we found a few people who slipped by, by luck or other means. The HEW study is very useful from a general standpoint, but my study which involves more than twice as many people and involves drivers, a random sample of drivers, is much more definitive and more useful for the purposes of which we are gathered here today.

Mr. MAY. You consider your sample would be applied on a nationwide basis?

Dr. BURG. I think it is the most definitive study of driver vision done to date, by far, and I think it can be much more safely generalized to the Nation as a whole than anything else that is available. Everything is relative, I would say.

Mr. MAY. Did your study contain more younger type drivers?

Dr. BURG. Yes.

Mr. MAY. Than the national study might?

Dr. BURG. Yes. In checking the sample distribution of ages against a random sample of the entire driving population of California, I seem to have slightly more under-25 drivers and slightly fewer drivers between 25 and 50; very slight differences, but this would imply that the average acuities we obtained would be, if anything, a little better than exists in the actual driving population.

Mr. MAY. We recognize that a person can get a license in any State with 20/40 vision.

Dr. BURG. Well, I do not have the latest survey, but 2 or 3 years ago when I did a survey of the licensing requirements, there is quite a range, as you know, and you find some States require a vision of 20/25 in the better eye. Some required at that time only 20/67. I must say in all fairness there is no evidence that it makes much difference in these ranges, or there was not any evidence up to 2 or 3 years ago. But I would say that in most States, 20/40 is probably the standard now.

Mr. MAY. Yes. Some of them range up as high as 20/70.

Dr. BURG. Yes.

Mr. MAY. Mr. Chairman, may we make Dr. Burg's study an exhibit?

Mr. OLSEN. Without objection, so ordered. That will be exhibit No. 4.

Mr. CONSTANDY. Dr. Hulbert, in the May 1965 issue of Popular Mechanics you were quoted:

> What we face is a problem in high speed semantics. In the early days you could stop and read signs at crossroads. Now with cars traveling up to 100 feet per second, you must know before reaching the intersection which way to go. You lose your way, your anger and worry tend to make you a dangerous driver. A moment's hesitation or misread sign can cost a life.

I wonder if we can pause there a moment. You had some interesting comments relative to the stresses on the human being as a driver and as they accumulate, the higher possibility or probability of his having some kind of an event that could result in an accident. Could you comment on that?

Dr. HULBERT. Well, we do not know nearly as much about behavior under stress as we would like to know as scientists, but it is coming under more and more study not only in the highway area, but other areas. We do not seem to perform very well under stress, humans just do not. We are essentially one channel systems anyway. By that I mean we appear to be able to do more than one thing at a time, but we really are just shifting rapidly back and forth, among alternate tasks; under stress we seem to lose that ability to shift.

We, in a sense, become fixated on one particular aspect of our environment and we, well, the extreme case would be that of a person under hypnosis. I mean you get so you are just receiving input of one type and you practically disregard everything else. Pilots land, for

example, with their wheels up which they are not, of course, supposed to do. With the control tower operator screaming over the radio to them and the warning signal on the airhorn blasting away in the cabin, and yet they will come right on down and land, you see.

Mr. CONSTANDY. Or crash.

Dr. HULBERT. Or crash, and they will say didn't you hear me screaming at you? He will say, "I don't know; that buzzer was buzzing my ear and I couldn't concentrate on what you were saying." In other words, these signals are designed to help in the situation, but sometimes hinder and a person under stress becomes very, very different in his capability to respond. The stress can come before, of course, from a variety of reasons, driving in fog for example, or any reduced visibility situation is an extremely stressful thing.

Mr. CONSTANDY. Doesn't just plain driving on a highway or freeway contain enough element of stress without adding other ingredients?

Dr. HULBERT. Well actually, the degree of stress is somewhat self-regulated. This is a self-paced task as we say, a person who feels that he is overstressing himself can slow down and will do so. In fact, this causes some troubles in the other end of the spectrum where a person who doesn't have much capability or confidence will go too slowly and interrupt the stream.

Mr. CONSTANDY. Transfer the problem to the next driver.

Dr. HULBERT. Yes.

Mr. CONSTANDY. You made some comment about the stresses on a motorist coming on a freeway at the point of merging.

Dr. HULBERT. Well, this was really not so much a research as a demonstration of some of these biological measurement packages for the aerospace effort and they did measure heart rate. Heart rate is known to be indicative of the degree of emotional involvement or stress, if you will, and they found heart rates taken from drivers merging on freeways to be even higher than those measured on the astronauts upon reentry.

Mr. CONSTANDY. That is a nice comparison.

Dr. HULBERT. Of course, you must understand that the astronauts are fine physical specimens and would tend to have a lower heart rate in general anyway, but these heart rates were found to be even higher than parachutists or a person on a roller coaster. So, merging is a stressful experience demanding a great deal of skill and I think it is a good testimony to human capability that so much of this is being done every day without accident.

Mr. CONSTANDY. You went on to say in our conversation about piling these elements of stress one on top of the other, to where finally it exceeds the capability of the driver to function.

Dr. HULBERT. Yes.

Mr. CONSTANDY. Correctly.

Dr. HULBERT. This is the inner actions among a series of events. Nearly always upon investigation of an accident, it is nearly always this chain of events and the unfortunate combination of two stresses that cause a failure on the motorists' part and if we could but break this chain anywhere along the line—we do not have to do away with all these stresses and so on, but just break the chain anywhere—we can prevent the accident associated with the chain of events.

Mr. CONSTANDY. We have to minimize those things in the normal function of driving which are apt to produce stress and to the extent we can, in the design of signs and highway, we should minimize the burden on the driver.

Dr. HULBERT. Yes; I do not think anyone would argue with this statement, that the confused motorist is a less safe motorist.

Mr. CONSTANDY. I would like to continue that quote, and I do quote:

> What we need are symbols that deliver their message instantly and that actually trigger your driving reflexes, signs that give you confidence that you really are where you think you are and you are headed where you want to go.

That is perhaps what we will be getting into now and raises the question in my mind whether you think highway signing as presently practiced meets the motorists' needs?

Dr. HULBERT. No; it doesn't as presently practiced. Of course, you must understand that no system will ever be 100 percent satisfactory, but there is a great deal of room for improvement.

Mr. CONSTANDY. You agree with that, Dr. Burg?

Dr. BURG. Very definitely.

Mr. CONSTANDY. So we can conclude that highway signing should and can meet the motorists' needs if the practices were changed.

Dr. HULBERT. Yes; this is an obtainable goal because there are many examples of highways that are functioning very well where the signing is appropriate and is apparently meeting the needs of the total stream of traffic.

The question of uniformity comes up here, the question of not only the uniformity of the actual signs, but the unformity of the engineering practice in the placing and design of the highway in the first place relative to the guidance aspect of the task.

Mr. CONSTANDY. What type of changes and practices would you suggest would more meet motorists' needs?

Dr. HULBERT. Well, the attainment of uniform practice so that no matter what the particular sign is, the motorists can expect to see the same sign in the same situation in his driving throughout the country as he goes from cities to the rural areas.

Perhaps the most difference occurs between the cities and the rural areas. I would hazard a guess. What would you say, Mr. Prisk?

Mr. PRISK. Well, there are some very substantially different needs I think in the urban areas as distinct from rural areas, probably greater attention and greater deficiencies in the urban areas.

Dr. HULBERT. Our 1958 study, for example, made it quite clear that the signing on the freeways, on the superhighways, is far superior to the signing that leads to it and leads away from it; the directional signing. This is not to say that I do not think there is room for improvement—that is, of the signing on the freeway. In fact, the 1958 study that we did, I thought, clearly showed that there was a good deal of room for improvement.

Motorists apparently do not have this confidence of knowing where they are in the network and whether or not they are, in fact, on the right road. There is this feeling of insecurity and this is quite often expressed by the motorist as not having enough advance warning.

This is the way the motorists express it, but our interpretation of it was, going under these particular examples, there were plenty of signs

giving advance notice, maybe six or eight signs. What he really was trying to tell us was that he did not know when to expect that he would see the signs for his exits or whether he might have already passed the sign that he was supposed to be tending to. It was this lack of confidence about knowing where he was in the system at any given time. We were bold enough, the group of us that did the study, to come up with six what we called basic principles.

Mr. CONSTANDY. Before you get into that, in general, freeway signing is to serve what purpose?

Dr. HULBERT. In general, freeway signing has two distinct purposes: One is to provide directional guidance to the motorist; and the other signs are used to control the traffic stream.

Mr. CONSTANDY. In other words, the "directional guidance" would be signs to a place?

Dr. HULBERT. Yes.

Mr. CONSTANDY. And signs that would help orient him within the system?

Dr. HULBERT. Yes.

Mr. CONSTANDY. And "control the traffic stream" would be such things as the caution signs, the speed signs, that type of thing?

Dr. HULBERT. Yes.

Mr. CONSTANDY. This study was made with reference to "Motorists Needs in Freeway Signing," and undertaken in 1957 and 1958; was it not?

Dr. HULBERT. Yes.

Mr. CONSTANDY. Who participated in that? Were there several organizations?

Dr. HULBERT. Yes. This was research done under contract to the State of California by the Automotive Safety Foundation. The university was asked to help in the conduct of the study.

Mr. CONSTANDY. Yes, we have had reference to this study during the last session by the gentlemen from the Automobile Club of Southern California. How many drivers were interviewed in the course of that study?

Dr. HULBERT. Some 12,000 drivers.

Mr. CONSTANDY. That represents people who actually had the experience of driving on the freeways, and your testing then was of the effectiveness of the signs, is that correct?

Dr. HULBERT. Yes, the bulk of these 12,000 were actually stopped at off-ramps and on-ramps and asked questions related to the directional signing. There were some 9,000 or 10,000. The others of the 12,000 were interviewed at greater length at the department of motor vehicles offices when they came to get their drivers' licenses.

Mr. CONSTANDY. This was an unusual type of project, was it not?

Dr. HULBERT. Yes.

Mr. CONSTANDY. In the scope of it and the techniques which were used?

Dr. HULBERT. Yes. It was different than had been conducted in the past, or since for that matter.

Mr. CONSTANDY. This, then, becomes something of a landmark; does it not?

Dr. HULBERT. Yes.

Mr. CONSTANDY. There are quite a few things which you learned from it which have application in signing throughout the country.

Dr. HULBERT. Yes.

Mr. CONSTANDY. You made reference to some of the consequences associated with confusion that occurs under high speeds and where there is limited movement such as on freeways. Could you tell us about that?

Dr. HULBERT. Are you referring to the consequences of freeway driving?

Mr. CONSTANDY. Yes.

Dr. HULBERT. Well, for example, drivers cannot or at least they should not, slow down or stop while making these decisions which is also true, of course, off the freeways but has much more serious consequences with the higher rate of speeds on the freeways.

Drivers should not make U turns to correct their mistake. You cannot go around the block on the freeway. In fact, a driver on the freeway must continue perhaps for several miles and I just did this down in Florida recently. I missed the turnoff and had to go 2 miles to where I could correct this mistake which happened to be associated with the construction problem, that particular problem.

There usually are not very many cues available to the driver to provide him with confirmation or reassurance that any decision that he did make was, indeed, the correct one.

Mr. CONSTANDY. What do we mean by "cues"?

Dr. HULBERT. Well, these are any aspect of your visual usage, visual field that we are talking about.

Mr. CONSTANDY. It might be a sign?

Dr. HULBERT. It could be a sign. It could be a landmark. They are visual cues. You might get it from noticing some other vehicle in the traffic stream that would give you information. You might get information just from the number of lanes, for example. You would assume that the majority of lanes would go in the direction of the heavy traffic on the freeway, whereas fewer lanes would be associated with a turnoff to a small community. There are many cues available to the motorist in addition to the signs and markings.

Mr. CONSTANDY. If there is an urban section that has some very-high-volume turn off the main line, the exit ramp is apt to take on the definition of carrying the major traffic flow of the numbered route when in fact it is not.

Dr. HULBERT. This can be misleading. Up in the Fresno study, a part of this study, we found motorists being panicked by the fact that the freeway alinement swung out away from the visible high buildings in the main center of town and so they would take off at the next ramp which was really not the correct one for them to take.

Mr. CONSTANDY. They had that belief.

Dr. HULBERT. They were panicked by the fact that the freeway seemed to be heading out in the open country and they thought they might have missed their opportunity to get to the center of town. They were actually taking a ramp many miles too soon.

Mr. CONSTANDY. This knowledge of what motivates the driver has ramifications well beyond the problem of signing. The signing has to be persuasive in such a case to overcome the apparent direction that is suggested by the alinement.

Dr. HULBERT. Yes; this is where again the human factors, or the behavioral scientist, takes a different viewpoint. His perspective is different from that of the practicing engineer.

Mr. CONSTANDY. With that perspective you could anticipate some of the problems that could then be minimized either through changes in design and alinement or overcome by signing.

Dr. HULBERT. Yes; by working together.

Mr. CONSTANDY. Yes. In that study you identified three different types of trips, did you not?

Dr. HULBERT. Yes.

Mr. CONSTANDY. Could you tell us about those, please?

Dr. HULBERT. Well, we identified "touring trips" between cities and "general touring," such as long trips from one city to another, and the interviews showed that motorists making this type of trip relied to a large extent on the route numbers to identify their route and place names to verify their decisions. For a long trip, most of them selected route numbers to identify their path and place name to identify control points, verify direction of travel and positioning them on the path. The distances to places along the route were used for orientation and for estimating times of arrival. The second type of trip——

Mr. CONSTANDY. Before you get to that, that raises another question. We frequently hear the comment, particularly by engineers, that the motorist is at fault when he gets lost because he didn't plan his trip sufficiently in advance. I was quite surprised in reading this study and the Bulletin 244 of the Highway Research Board report on that study, "Some Principles of Freeway Directional Signing Based on Motorists Experience," on page 64, on one portion of the study the report reads as follows: "The use of roadmaps varied according to the length of the trip; 86 percent of the motorists who made trips over 500 miles in length reported that they had used a roadmap."

I think in the different portions of your study the percentages vary a little but basically the vast majority of the people undertaking what you are calling here a touring trip between cities, did prepare themselves in advance for the trip and had possession and made use of a roadmap.

Dr. HULBERT. Yes, I think we could talk for a long time about what constitutes adequate preparation. You could say as the engineers say that if they got lost then it was not because the preparation was not adequate. I have a strong feeling about maps and their improvement and the training of drivers to use maps.

The Armed Forces training effort shows quite clearly that reading maps is not something that comes to us naturally. It takes a good deal of training and intensive training and some people have a knack for it that others probably never would have. This entire problem of maps and the relation of maps to trip planning and trip completion is something that is quite an area but we only touched upon here in asking some of these motorists whether they indeed used maps.

Mr. CONSTANDY. It was quite surprising that many of them, as you found out, did use maps.

Dr. HULBERT. It was not surprising to me, but it may be surprising to you.

Mr. CONSTANDY. It was to me. My surprise stemmed from the comments that I heard from other people to the opposite effect—that people

are poorly prepared and perhaps they are. As one indication of their interest in being prepared, they have taken the trouble to secure a map and have made some reference to it.

Dr. HULBERT. The second type of trip had to do with urban area trips using urban freeways which are quite different from the rural trips.

Mr. CONSTANDY. Different in the problems they present to the driver?

Dr. HULBERT. Well yes; and perhaps most different in the attitude that the driver brings to the trip. The metropolitan area movement, in the area that we studied in California, usually involved some of the freeway system. The paths in this case were not identified by route numbers. The freeway paths were identified by freeway names, and place names along the freeway assumed far less importance for either the verification of the route or the identity of the control point.

In other words, it seems to me that in the city trip the driver has carried over his attitude and his thinking from the prefreeway days into the freeway days. I think this may be one explanation of why drivers will drive so close together on the city freeway and the same driver, if you put him out on the open highway—the same standard of road and all—that he will not drive nearly that close to the driver ahead.

In one case, on a city trip, just going across town, going to or from work, he is used to driving close to the other drivers in the nonfreeway facilities, streets, and he apparently carries this over. His thinking in what he wants in the way of signing is quite different. We thought that this was, indeed, quite a different type of trip. It could be the same man.

Mr. CONSTANDY. And the third type of trip was what?

Dr. HULBERT. Well, urban trips not on freeways, consisting usually of shorter distances across town. We found that in purely urban travel control points along the path are almost invariably identified by intersections and not by place names. Highways and streets were identified by name and seldom by the route number that they might have on them. In other words, in the city, street names and addresses and things of that sort we really do not know. You could take almost anyone in this room and ask him, on a major thoroughfare which has a route number, and he probably could not tell you the route number, whereas if that same person comes into the city in making a cross-country trip and is new to the community, a route number is about all he has to go on.

Mr. CONSTANDY. It is necessary to recognize the types of trips and the requisites for them before we can begin to concern ourselves with what proper signing should be.

Dr. HULBERT. Yes; that is a fair statement.

Mr. CONSTANDY. You made some analysis of the types of motorists you find, too.

Dr. HULBERT. Well, this was I think referred to in the earlier testimony before the committee that the first-time user or the stranger is probably or should be our prime target. Then we have the repeat user.

Mr. CONSTANDY. Before you get into the repeat user, the stranger probably constitutes the smallest portion of the traffic stream, does he not?

Dr. HULBERT. Oh; I think that is true.

Mr. CONSTANDY. And yet, signing is probably most critical to him, is it not?

Dr. HULBERT. Yes.

Mr. CONSTANDY. Directional signing, certainly.

Mr. CLEVELAND. Mr. Chairman, I would like to inquire at this point. You say the stranger is the smallest user of the highway signing. Are there statistics to back that up?

Mr. CONSTANDY. That is based on the study of the 12,000 motorists you identified here, is it not?

Dr. HULBERT. Yes; and the other origin and destination surveys which in many communities are taken at least annually. Any cross section of the traffic stream has just a few people who are strangers.

Mr. CLEVELAND. This might not be true in all parts of the country. For example, in northern New England during the winter we have a good many people that come up skiing, and during the summer, we have a good many people that come up there for their summer vacations and traveling.

Dr. HULBERT. Yes, you are absolutely right. The national parks for example; almost everybody in the stream perhaps would be there for the first time.

Mr. CLEVELAND. So there would be some fairly substantial exceptions to the point just made.

Dr. HULBERT. Yes; I think that is absolutely right.

Mr. CONSTANDY. That only increases the problem. If you take only a small percentage of strangers in a traffic stream, and if a large percentage of them are confused they will disrupt the traffic stream, will they not?

Dr. HULBERT. It is a bad mix. If you have everybody that is a stranger, it might not be as bad as if you have only one-tenth, or something of that sort. You notice this in your own driving. If you see an out-of-State license plate on the car ahead you tend to expect some hesitation, perhaps some indecision on the part of that driver as compared with when the driver does not have an out-of-State license.

Mr. CLEVELAND. One other question, Mr. Chairman. I do not know if it is a development, but I wonder if in any of your studies either you or your associates have formulated any opinions on the relationship between the size of vehicles, trucks and buses and safety? Have you ever made any studies on that, or are you aware of any? This is not an issue directly before this committee, but the full committee has just passed an increase in truck weights and length and size of vehicles and I just wondered if you had any opinion on that.

Dr. HULBERT. I only recall to mind one study that we did on the effect of trucks on the traffic stream. One of the first major interchanges built in Los Angeles was constructed, as we call it, in a stack where they had all the levels coming together at one point and this meant depressing some of them.

In the part of the roadway that was depressed a great bottleneck developed which was apparently primarily related to the fact that the heavy vehicles, the trucks, loaded trucks could not maintain their speed up these grades and this I think—well, this was investigated and documented by a study we did at the institute, but it did not treat the safety aspects, per se.

Mr. CLEVELAND. Impeding the traffic flow, however, adds hazards to highway travel.

Dr. HULBERT. It creates turbulence and where you have turbulence, you have problems. It is relation of the grade, primarily, and the engine capability was the factor here more than the size, the bulk size. I have been wondering, and many of the movies we make from the driver's eye clearly indicate the fact that signs are hidden by large vehicles; therefore, this must be taken into account but we have made no real study of it.

Mr. CLEVELAND. Thank you. As I say, we just had this legislation before the committee and there was some testimony there was a safety factor involved and I just wondered if you had anything to add.

Dr. HULBERT. Well, in a current design by the California Division of Highways on a new interchange where there is a grade, and they expect this to be a problem, they are providing separate lanes for the trucks. In other words, it is a separate interchange within the interchange, and now the signing problem related to that is: what is the most appropriate signing to get the trucks to use those lanes and conversely, to keep the other motorists from using those lanes?

Mr. CONSTANDY. The fellow in the traffic stream who has the greatest need for signing is the stranger.

Dr. HULBERT. I think this is fair, although the second category, the repeat user who rarely makes the trip, may be more of a hazard. This is the fellow who thinks he knows where he wants to go because he went there maybe last year or last month or something. So he does not take the trouble to look at a map because he thinks he knows. This one I personally get involved in myself. Then I get there and I am out on the road and things do not look right. I do not see my familiar landmark and I do not see what I was looking for, and I wind up as many motorists did in the survey—we wind up going to the gasoline station to ask for directions. Of course, most of the motorists who do this are not making freeway trips, because it is quite a trick to get off the freeway and go to the gasoline station to ask for directions.

Mr. CONSTANDY. In a sense, this repeat user when he finds himself in that difficulty, the signing that would assist the stranger would then assist him. He, in effect, becomes a stranger.

Dr. HULBERT. Yes; you could expect that to be the case, but not completely, because again you have to refer to the amount of preparation the driver has made and this we can expect from the stranger who knows he is a stranger.

The third category, of course, was the repeat user who frequently makes the trip and almost any type of landmark will suffice for him. In making my familiar trips, I just look for the sign. I do not really read the sign.

Mr. CONSTANDY. Like a commuter going back and forth to work.

Dr. HULBERT. I just remember when I come to the interchange, I take the left hand ramp and then the right hand ramp and I don't refer to the legend of the sign. I use the sign as a landmark.

Mr. CONSTANDY. So what then is the goal of the directional signing?

Dr. HULBERT. Well, it would be to make a system that would be as effective and comfortable for the first-time user as it is for the repeat user. That would be probably an unattainable goal, but I think it is a worthy goal, something that we should try for.

Mr. CONSTANDY. Now, you say the human can learn to negotiate even complex systems provided certain basic principles are used to provide him guidance information?

Dr. HULBERT. Yes; these are the six general principles that we, the group of authors, including Dr. Burg, arrived at after over a year of work.

Mr. CONSTANDY. This is really the heart of the study, is it not?

Dr. HULBERT. Yes; I would say that is right.

Mr. CONSTANDY. They are general principles?

Dr. HULBERT. Yes.

Mr. CONSTANDY. Some people perhaps misunderstand that. If you were to accept these six principles you would have a foundation to guide you in making the decisions to develop effective signing.

Dr. HULBERT. That is right. These are not meant to be instructions in any sense of the word. We thought these were principles which if followed would help to meet the goal.

Mr. CONSTANDY. So they have to be coupled with something else before you have adequate signing?

Dr. HULBERT. Yes, they have to be put into practice.

Mr. CONSTANDY. I wonder if we could go over those six?

Dr. HULBERT. All right; the first one was: interpretation. All possible interpretations and misinterpretations must be considered in phrasing sign messages.

Mr. CONSTANDY. And by message you include words and symbols.

Dr. HULBERT. Included words and symbols and messages must be complete and clearly stated. Cryptic messages which are easily misinterpreted must be avoided.

The difference between two alternatives must be emphasized and where possible, choices offered must be between things of the same kind. For example, the choice between two route numbers.

Care must be exercised to avoid giving more information than can be read and comprehended in the time available.

There are two important general points to be remembered: The first is that motorists' interpretation of a sign's message is based not only on what the message says, but also on what it does not say. The second point to be kept in mind is that the literal interpretation results in the motorist doing exactly what the sign indicates at the sign's location. For example, drivers reported turning into alleys and driveways by mistake because the on-ramp sign appeared to direct them to do so.

This is a classic problem of the sign engineer. If he puts the sign far enough in advance of the turn point to give warning, and give the driver time to prepare himself to make the move, many times there will be another turnoff that is completely wrong and an incidental one. This is particularly true in the city.

Mr. CONSTANDY. There is a situation like that right here on the Baltimore-Washington Parkway. In advance of I–495 it says "East and West, next right," but that sign was placed almost directly opposite the exit ramp for Greenbelt Road and it is surprising to stand there and see how many cars go up that ramp in the belief it takes them to the beltway.

Dr. HULBERT. This negative reasoning, which is included in this first basic principle, is quite prevalent. The driver will say, "Well,

the sign did not say this was the way to Washington. Therefore, I assumed that the other way was the way I should go.

This is again quite a difficult task for the sign designer because of the knowledge he has in mind, he knows what the highway is and where it goes. It is very difficult for a person who knows a situation to do this mental trick of placing himself in the role of the naive person who does not know. In fact, it is well-nigh impossible for one person to do this.

This is where the trying out of proposed sign messages on persons who do not know is so critical. This trying out, of course, must be done in the most efficient way that we can do it and in a scientifically accurate way, not just on a casual basis, such as "we will put it up on the wall and see what it looks like." Shall I go to the second?

Mr. CONSTANDY. Yes, if we could move along here.

Dr. HULBERT. The second principle is: continuity. Each sign must be designed in context with those that precede it so that continuity is achieved through relatively long sections of highway. The driver should be expected to evaluate not more than a few alternatives at any advanced sign. At the decision point he should never be given new information about either the through road or turnoff.

For example, several communities or streets are served by one turnoff. The advance sign will say, "Orangeville Exit 2 miles." The next sign, "Orangeville Exit 1 mile." Then finally, at the exit the sign says, "Orangeville-Jamestown." The "Jamestown" on the third sign violates the principle of continuity and throws the driver for a loss.

He says to himself, "I wonder if this is the exit they have been referring to as the one for Orangeville, or is this just an alternate route to Orangeville."

Another example, the advance sign may say "Castro Boulevard, 1 mile." Then the next sign, "Castro Boulevard, one-half mile" and finally at the exit, "Castro Boulevard." Then a few seconds later, the driver may come upon a sign which shows another community such as Holtville and no mention at all of Castro.

Now he is totally unprepared for this new information which may have been put up to help motorists who were going to Holtville but because the continuity was interrupted and Castro was dropped from the sign it leaves our motorist following this sequence in a state of confusion.

The third principle is: advance notice. Signing must prepare the driver ahead of time for each decision he has to make. The term "advance notice" is frequently used by traffic engineers and motorists, but is frequently never analyzed. Essentially, when the motorist is surprised to find that he has to make a decision, he assumes that he was not told about it ahead of time.

In almost all of the cases investigated during this study where the motorist said he did not have advance notice, such signing, in fact, existed. This signing, however, did not adequately prepare the driver for his decision. The real point is that the motorist does not want to learn suddenly about the decision, regardless of how far ahead he is told or how vividly. He always wants to know where he is located in relation to the point of decision throughout the trip. This is the only advantage that repeat motorists have over unfamiliar motorists.

A single advance sign can easily be missed as one sign of any kind. Two advance signs can also be missed, although the probability is not as great. Of course, the size of the sign and the distance and advance have a bearing on this problem, but more advance notice cannot be achieved merely by increasing the size or the distance ahead or the number of signs.

The fourth principle is: reliability. Sign messages should be in the same terms as information available to the driver from other sources such as touring maps and addresses given in tourist information and advertising.

To insure this result, maps used by engineers as the basis for sign design should also include some which correspond in scale to the touring maps.

Outside of large metropolitan areas signs should relate to a State roadmap. In the city represented on the map by a small circle or dot, signs preparing the driver for an important junction within the city should take into consideration there will be many turnoffs from the main route to other streets while the map may show only one junction.

In metropolitan areas, he must be expected to receive more detailed information than a State map can show.

Mr. CONSTANDY. Would that suggest a sign that might say: "Whatever-the-name-of-the-city-is, Next Three Exits," or something of that sort?

Dr. HULBERT. This sign that you referred to was a sign that did receive support as a result of this study and is in practice in many States. The next, the fifth principle, is: prominence. The size and position as well as the number of times the sign and message is repeated should be related to the competition from other demands on the driver's attention.

These demands come from other visual aids, other signs or parts of the message as well as the task of driving. One huge sign in a group, or one huge word in a message, tends to attract so much attention that the other signs, or the rest of the message, may not be comprehended. Thus, it often happens that the sign designer defeats his very purpose.

When the road is very wide or the traffic very dense, or there are numerous competing, spectacular commercial signs or buildings, as is typical of a downtown urban freeway, the directional signs must be correspondingly large and well illuminated and well placed, even if this means costly overhead installations. There is no certainty that a motorist will, in the face of such competition, see a given sign no matter how large it is. Repetition suggests itself, not only for "advance notice," but for initial notice.

On the other hand, the use of a gigantic sign in a sparsely settled rural area will serve to lessen the impact of using extra-large signs where they are really necessary. This statement relates to uniformity. It is not necessarily so that signs giving a particular message should always be the same size.

What we are saying here is that what needs to be taken into account is the competition that that sign has for the attention of the motorist.

Mr. CONSTANDY. Speaking of the uniformity in the publication of the report of this project, "Driver Needs in Freeway Signing," I think there is a portion that is certainly pertinent and worthy of inclusion. It says:

The freeway user can be served best by signing designed to fit individual conditions at each location encountered by the motorist and further, that the design of such signing should be governed by a few basic principles * * *—

Those things we have been discussing—

That concept may appear to some as inconsistent with the principle of uniformity. Actually, the reverse is true and rather usual situations can be covered by standard methods of signing developed in accord with the basic principles. Flexibility is essential, however, so that unusual situations not covered by the standards can be treated individually while keeping within the framework of the basic principles. By definition, uniformity means treating similar situations similarly, and different and novel and unique situations must be treated individually.

Dr. HULBERT. This is something I have been striving toward in mentioning before the National Joint Committee on Uniform Traffic Control Devices that we should try to avoid a cookbook type of uniformity. Unfortunately, the legal hazards associated with civil suits resulting from traffic accidents are tending to push the traffic engineer in the opposite direction, and this is the point that I wanted to be sure to bring to the committee's attention: that perhaps some aid can be given to the professional traffic engineer so he can act as a professional without the fear of lawsuits which in some States are actually threatening his own personal property.

In other words, not only is the city or county or State being sued, but in some States the individual who authorized that sign is also being sued.

Mr. CONSTANDY. He has to have the latitude to custom design the signing for a unique situation.

Dr. HULBERT. Exactly.

Mr. CONSTANDY. In spite of the fact that it is different than others.

Dr. HULBERT. What we are striving for is uniformity of principles, not necessarily a slavish conformance to a sign manual.

Mr. CONSTANDY. That is a message well worth getting across.

Dr. HULBERT. There was the sixth and final principle which we have called unusual maneuvers. Signing must be especially designed at points where the driver has to make a movement which is unexpected or unnatural.

The driver's natural inclination to turn a certain way frequently will lead him to do the wrong thing. Clarity in signing wins the driver's confidence and helps him avoid mistakes resulting from instinctive movements.

Although interchanges are becoming more prevalent, the unfamiliar driver never knows whether or not the next interchange is a cloverleaf or whether it has a collector-distributor road. Standard directional arrows used for near-side turnoffs cannot be used successfully to prepare a first-time user for the series of decisions he must make within a short time interval if his proper course of action is to take the far-side turnoff.

Where the driver is asked to do something contrary to his natural inclination or his learned reaction, the signing must be specifically designed to overcome his natural inclinations. An example of this was found in the Fresno area where the southbound motorists turned off because they could see the large city downtown area on the left, but the freeway alinement was taking them off to the right. Additional instances were recorded in Los Angeles, particularly where circuitous, unnatural routes had to be followed in order to reach a freeway entrance.

Mr. CONSTANDY. Dr. Hulbert, we find that it is necessary to suspend the hearings for today. The balance of your presentation, is most worthwhile for the transcript, and I wonder if I could ask you to prepare that in a written form, so that it might be included in the record at this point?

Dr. HULBERT. Yes; that would be fine. I will be glad to do that.

Mr. CONSTANDY. I ask permission, Mr. Chairman, at this point in the record, to insert the balance of the testimony of Dr. Hulbert.

Mr. OLSEN. Without objection, so ordered.

(The remainder of Dr. Hulbert's testimony follows:)

ADDITIONAL OBSERVATIONS OF DR. SLADE HULBERT AND DR. ALBERT BURG

(1) In addition to the basic principles already described, it was learned that many motorists had prepared for their trips by using a road map: For example, "In San Luis Obispo, 71 percent of all motorists interviewed were using a road map, while 97 percent of the motorists from states other than California were using road maps. In addition to using road maps, 50 percent of the out-of-state motorists had obtained directions either on the road, or before starting, or both. Only 18 percent of California drivers had obtained directions, probably because of their greater familiarity with the area and the signing system.

This same group of 246 interviews with motorists revealed the following preferences for route numbers over place names: "53 percent of the motorists indicated they preferred route numbers, while 18 percent said they preferred place names. Twenty-nine percent replied that they had no preference.

With respect to the adequacy of their conducting their trip, it was found, "At off-ramps, 17 percent of the motorists interviewed were taking an indirect route to their destination, while 5 percent actually were taking a route which would have put them in such a position that it is unlikely they would have reached their destination without considerable difficulty. At on-ramps 15 percent were using a ramp which would have put them on the freeway in such a way that they could not have reached their destination."

Three comments or suggestions from these motorists were repeated with the frequency noted: "more advance notice" (15 percent), "more or larger route shields: (5 percent) and "larger signs" (4 percent).

At the first off-ramp where interviews were conducted, 16 percent of the motorists interviewed should *not* have been leaving the freeway at all.

An interesting finding from these motorists who were interviewed in San Luis Obispo, which is located well over 100 miles north of Los Angeles, was that 10 percent of them volunteered the comment they had experienced trouble finding their way into Los Angeles. Fifteen percent of drivers who were unfamiliar with the area commented that they wanted more advance notice of turnoffs.

Interviews with 224 motorists at the California State Fair indicated that 86 percent of the motorists who made trips of over 500 miles in length reported that they had used the road map.

Slightly less than one-half (48.5 percent) of the persons interviewed said they could recall looking for a sign they could not find. Four types of signs, all of which had to do with route confirmation, reassurance, or directions, accounted for 70 percent of these cases. Of those making trips over 500 miles in length for the first time, 51 percent reported thinking they were on the wrong road at least once, and 34 percent actually were. For trips between 200 and 500 miles in length, 53 percent thought they were on the wrong road and 20 percent were. For those making trips under 200 miles in length, 43 percent thought they were on the wrong road and 13 percent actually were.

For 991 usable interviews in the Los Angeles area, a total of 23 percent of the drivers who said they used the freeways infrequently said they did not use the freeways more often because traffic is too fast, too heavy, or too dangerous. These infrequent users constituted only 7.1 percent of the total drivers interviewed.

"The number of motorists who had troubles attributed to signing at entrances or exits they had used before, while significantly less than for first-time users, is still surprisingly high. Apparently these troubles are not exclusive to first-time users. In fact, finding that motorists who have used a ramp before still have difficulty attributable to signing may indicate a greater deficiency than the fact that the first-time users have such troubles.

Of these motorists who all used an exit ramp for the first time, 70 percent were expecting to recognize their exit by signs alone. However, only 43 percent found the particular message they were looking for. The others found some other cue or never found their exit at all; in fact, about three percent were looking for exists which did not exist.

Of all the adverse comments made, "not enough advance notice" was most frequently mentioned by 159 respondents which was 16.6 percent of all those answering the question. Almost as many, 154, drivers commented "not enough signs." Only 19.5 percent of the respondents found fault with freeway turnoff signing. Nearly half of these complained of the lack of advance warning, a criticism which consistently appeared in the other sub-studies. A relatively new sign at that time, which gives the names and distances to the next three exits, was specifically praised by seven respondents, a surprisingly large number, considering the few such signs in use at that time. This sign probably was singled out for favorable comment because it fulfills the need most commonly expressed in the various studies, namely, more advance warning.

(2) The presentation of guidance information *interacts* with the presentation of control information and these are both subject to human limitations and capabilities as follows:

(a) Man is a single-channel system with almost 100% memory for about one second.

(b) This memory allows him to shift his single channel (i.e.; his attention) rapidly from one point to another and back again, thereby creating the impression that he is "doing two tasks simultaneously."

(c) Man can make simple decisions once every one-half second.

(d) A one-half second view is sufficient for him to take in all he needs to know to guide his vehicle, and he needs this one-half second peek more or less often depending on the density of traffic and his own individual make-up.

(e) The driver relates to a "committed zone," extending fan-shaped in front of his own and other moving vehicles.

(f) He makes a never-ending series of provisional commitments regarding his own path relative to roadway and traffic events.

(g) The most efficient driver makes the maximum commitment from each (one-half second) unit of input information, and systematically refines his path projection and evaluation as additional information becomes available. Example—Underline Sign Study.

(h) What he perceives is greatly dependent upon what he *expects* to perceive.

(i) Many drivers are not well oriented to the compass.

(j) Accurate and efficient map reading is not a "natural skill"; it requires extensive and specific training as in the armed forces.

(3) The application of signing principles with due regard for human limitations cannot be accomplished by "cookbook" adherance to formulae. Engineers must be allowed and encouraged to use their design skill to apply basic and general principles in the most appropriate configuration for each individual traffic situation. This will require:

(a) Human factor training of engineers—at least enough to create a common language.

(b) Legislation exempting traffic engineers from lawsuits for damage claims resulting from accidents.

(c) Availability of research results and access to a well-equipped and staffed TRAFFIC CONTROL DEVICE EXPERIMENT STATION.

(4) It must be recognized at the outset that improvements in traffic control devices cannot always be directly related to reduction in the number, severity or cost of crashes. This is particularly true in the case of guidance signing. Therefore, if an improvement is based upon basic principles of human performance, it should be expected and accepted that the following short or long-range benefits will accrue:

(a) Improved traffic flow and, therefore, less congestion, less smog and less inconvenience to drivers.

(b) Fewer crashes, not only at the sign locations but elsewhere as well.

(c) Reduced stress on drivers, due to reductions in indecision and congestion.

(d) Improved public confidence in highway designers and government in general (a long-range but potentially very significant benefit).

Mr. OLSEN. The subcommittee is adjourned.

(Whereupon, at 12:05 p.m., the subcommittee adjourned, subject to the call of the Chair.)

HIGHWAY SAFETY, DESIGN AND OPERATIONS

Freeway Signing and Related Geometrics

WEDNESDAY, JULY 10, 1968

HOUSE OF REPRESENTATIVES,
SPECIAL SUBCOMMITTEE ON THE
FEDERAL-AID HIGHWAY PROGRAM
OF THE COMMITTEE ON PUBLIC WORKS,
Washington, D.C.

The Special Subcommittee on the Federal Aid Highway Program convened at 10:05 a.m., in room 2251, Rayburn Building, the Honorable Arnold Olsen presiding.

Present: Representatives McDonald and Olsen.

Staff present: Same as previous day, and John P. O'Hara, associate counsel; Sherman S. Willse, professional staff member.

Mr. MCDONALD (presiding). The Special Subcommittee on the Federal Aid Highway Program resumes this morning its public hearings on highway safety, design, and operations. We continue today our inquiry into a second phase of highway design, that of signing and related features, and their effect on the efficient and safe use of the Nation's roads. The initial phase of these continuing hearings which began last year emphasized road hazards. Our present interest in highway signing was a natural outgrowth from the testimony presented at the earlier hearings.

Our witnesses today are Mr. Gerhart F. King, senior transportation and traffic engineer, Airborne Instruments Laboratory, Deer Park, Long Island, N.Y., and Mr. Gerson J. Alexander, research psychologist, Airborne Instruments Laboratory, also. I am going to ask that you both raise your right hands and be sworn at this time. Do you solemnly swear that the testimony you will give before the subcommittee will be the truth, the whole truth, and nothing but the truth, so help you God?

Mr. ALEXANDER. I do.

Mr. KING. I do.

Mr. MAY. Mr. Chairman, I have here some background information on both of our witnesses today and I would ask that it be printed in the record at this point.

Mr. MCDONALD. Without objection, so ordered.

(The biographical sketches of Messrs. Alexander and King follow:)

GERHART F. KING

Mr. King holds a Bachelor of Civil Engineering from Cooper Union in New York City in 1950; M.S. degree in Business and Engineering Administration from the Illinois Institute of Technology in Chicago in 1960; and did other graduate work in Transportation at New York University and at the Polytechnic Institute of Brooklyn. He is a registered professional engineer in the State of Illinois.

Mr. King joined AIL in 1966. He is a Group Leader and Senior Transportation and Traffic Engineer in the Transportation Research Department; is currently engaged in highway research projects especially in the area of techniques for the transmission of information to motorists.

From 1954 to 1966, he was with the Illinois Division of Highway District 10, Chicago, Illinois; last assignment was as Assistant District Traffic Engineer (Civil Engineer IV) in the Bureau of Traffic. His work required special emphasis on the design and operation of traffic signal installations and systems, traffic engineering and safety aspects of intersection and roadway designs, accident records, investigation and analysis, preparation of signing and pavement marking plans including interstate signing, general traffic operations including speed zoning, complaint and hazardous location investigations, sign fabrication and erection, and application of pavement markings.

Prior to 1954, Mr. King also worked with Porter-Urquarhart, Skidmore Owings and Merrell, working in Casablanca, French Morocco on a major airport construction project and as a traffic engineer of the City of New York.

Mr. King is a Member of the Institute of Traffic Engineers, and an Affiliate of the Highway Research Board. He is currently serving as a member of HRB Committee TO-10 "Freeway Operations."

GERSON J. ALEXANDER

Mr. Alexander received a B.S. degree in Psychology from the Pennsylvania State University in June 1957. He has recently completed course requirements for his M.A. degree at Temple University.

From 1957 to 1962, Mr. Alexander was employed as a Training Analyst for Burroughs Corporation, Military Field Service Division. With RCA from 1962 to 1963, Mr. Alexander performed the initial "characteristic study" for the Personnel Subsystem of Multi-system Test Equipment (MTE), an Army development contract. This study, a type of operations analysis, was concerned with identifying operator functions, testing sequence, mission profiles, and task and skill analysis.

Prior to joining AIL in April 1965, Mr. Alexander was employed by ITT Federal Labs as a Human Factors Analyst. In this capacity he was responsible for the human factors design and development of the CAPE Subsystem of the Naval Shipboard Advanced Communication System (NSACS). This task entailed design for present state-of-the-art systems, as well as functional design for more advanced systems.

Mr. Alexander was responsible for the human factors considerations of NCHRP Project 3-12 "Development of Information Requirements and Transmission Techniques for Highway Users." This responsibility included performance of task analyses used to develop an inventory of information needs required by the driver, and other analytic techniques to derive the principal factors underlying the selection and form of information transmitted to the highway user. Mr. Alexander is now serving in a similar capacity on the follow-up to this project.

In the past ten years, Mr. Alexander has conducted or participated in several experimental research programs. Among the areas of research are space perception, target discrimination, and verification of design efficiency.

Mr. Alexander is a member of the Human Factors Society and a member of the Road User Characteristics Committee of the Highway Research Board.

Mr. MAY. I will identify them briefly, Mr. Chairman. Mr. King was educated at a number of our colleges and universities and is a registered, professional engineer. For some 12 years up to 1966 he was with the Illinois Division of Highways and his last assignment was as assistant district traffic engineer. He now serves as a group leader and senior transportation and traffic engineer with Airborne Instruments.

Mr. Alexander received a B.S. degree in psychology from the Pennsylvania State University in June 1957. He has recently completed course requirements for his M.A. degree at Temple University. He has had considerable experience as a human factors analyst, is a member

of the Human Factors Society and a member of the Road User Characteristics Committee of the Highway Research Board.

Mr. Chairman, before we begin with the testimony of these witnesses, we have a short film prepard by the staff which illustrates the type of movements made by some motorists at some of the locations on our freeways.

Could we run that film now, Mr. O'Hara?

(Showing of film.)

Mr. MAY. Mr. Chairman, the point we are looking at is I–95 coming north approaching the Capital Beltway, I–495. You will recall the expert witnesses yesterday suggesting that at no time should a person slow down, or hesitate, or stop on a freeway.

Mr. MCDONALD. May I ask over what period of time these films were taken?

Mr. MAY. Mr. O'Hara, do you recall how much time you spent taking these films at this point?

Mr. O'HARA. We shot eight rolls of film, a total of 800 feet, in about 5 hours at this location. That involves loading and unloading the camera after each film.

Mr. MCDONALD. You have seen several automobiles stop there and back up. At what interval did this happen while you were there—5 minutes? 15 minutes?

Mr. O'HARA. As you watch the film, you will see in some instances the events occur one after the other, and in some cases where the car is still in the film you will see another car do the same thing.

Mr. MAY. As an example, there are three cars stopped right now. You will see in a moment why they stopped. They are heading in the wrong direction. At this point where the car is stopped, if he swings right he would go east on the Capital Beltway; left, he would go west on the Capital Beltway.

Mr. MCDONALD. How did you happen to take this area at the intersection?

Mr. MAY. These locations were selected because these are the major interchanges for north and south from the Capital Beltway. Later in the film you will see the connection between the Baltimore Parkway and Interstate 495. This is just a sampling of the films that will be shown this week and particularly next week on various locations. We would like to stress the fact that these are not, in our judgment, unusual locations.

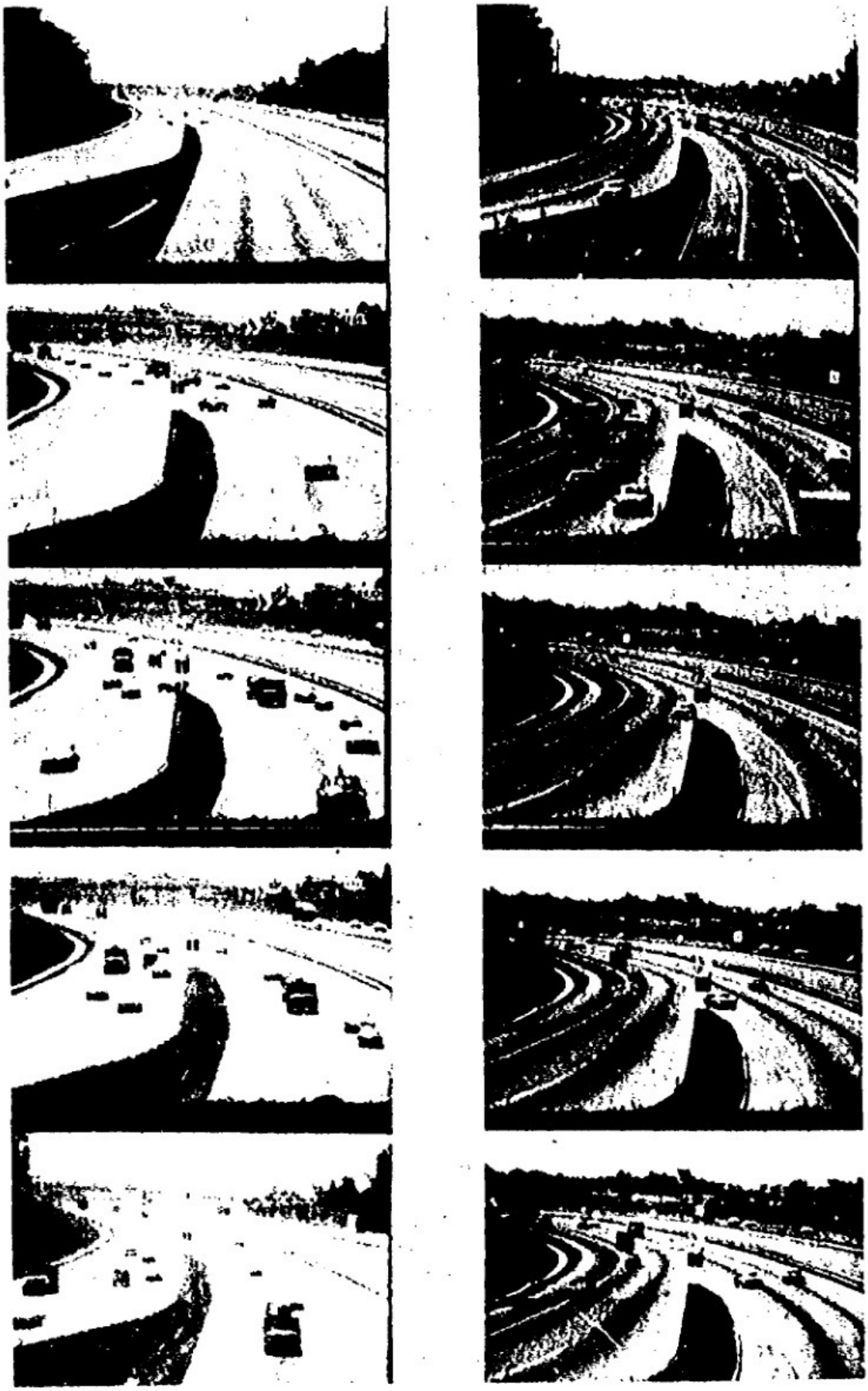
This is another location, looking west from the Capital Beltway and that ramp to the right swings out and joins I–95, heading south to Richmond.

Mr. MCDONALD. Where are the directional signs that control this area?

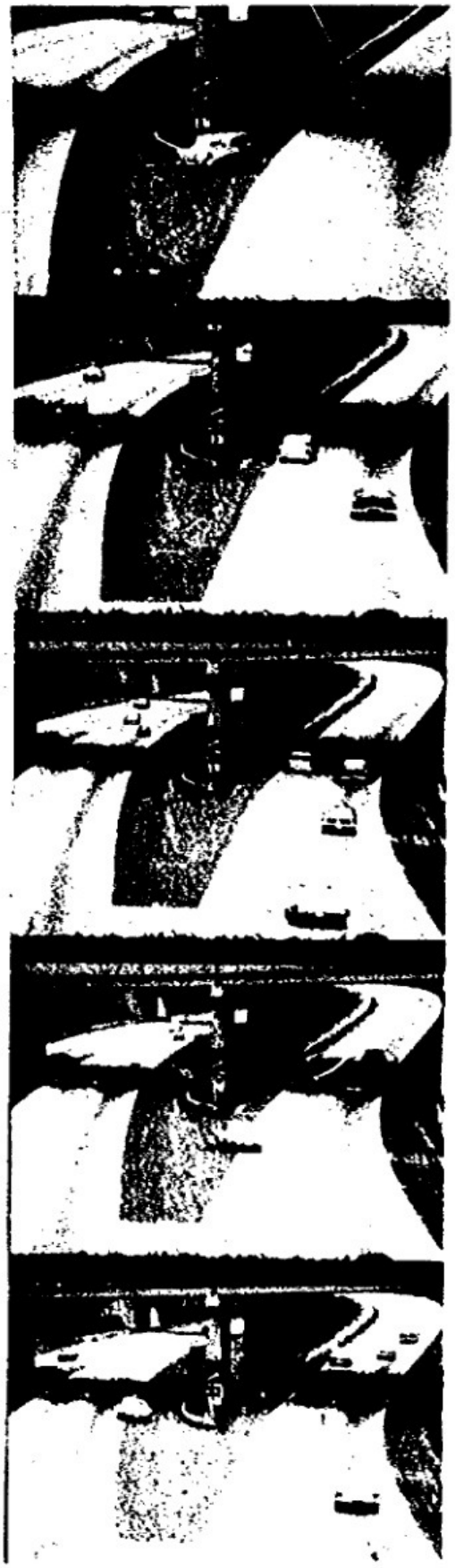
Mr. MAY. There are signs east of this location on the beltway. They are not convincing to everybody. Next week, Mr. Chairman, we will have a panel of experts who will be analyzing these locations and like locations.

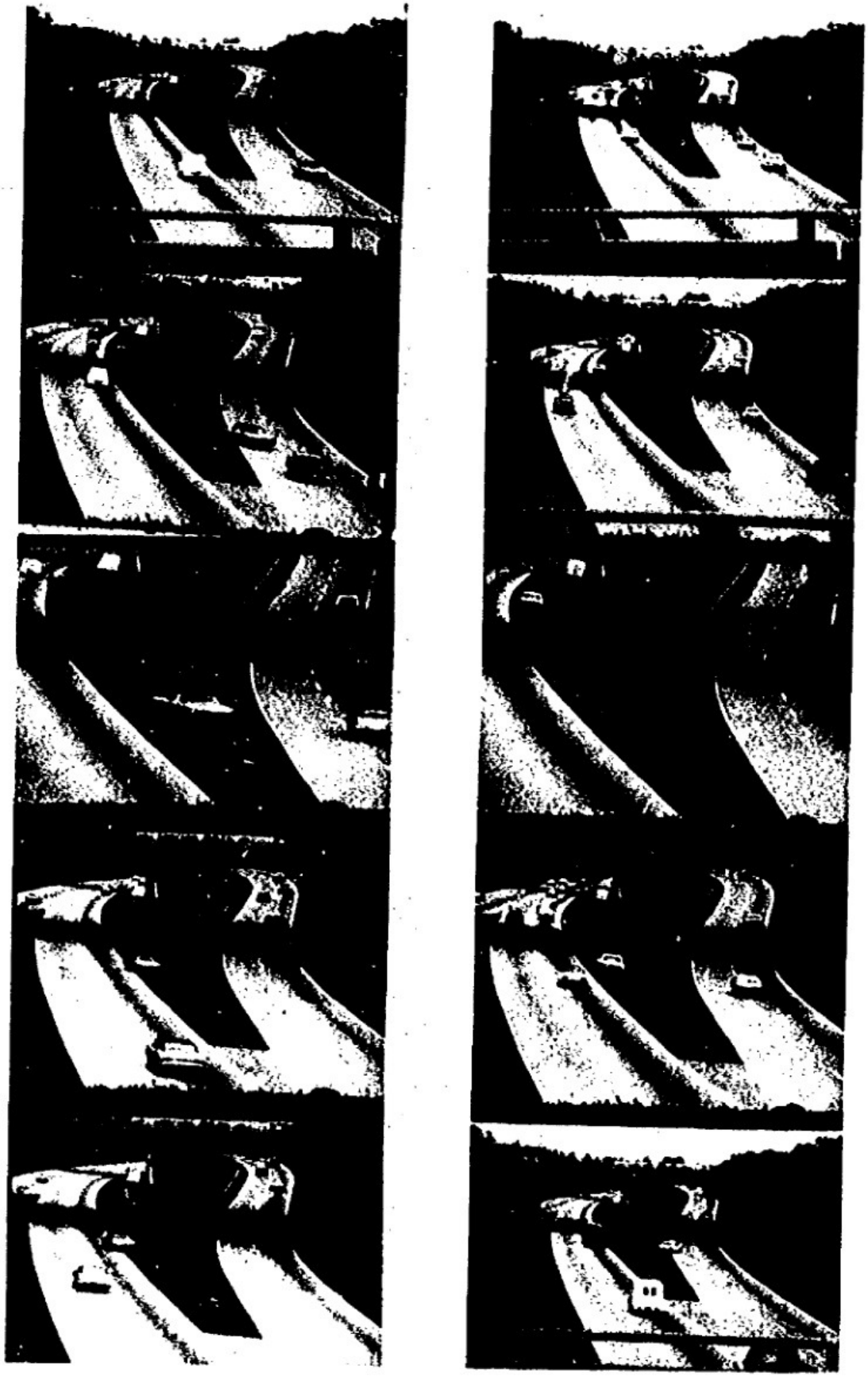
You will recall last year's testimony, when during the roadside hazards hearings we learned that four times as many cars run off the road in the gore areas as any place else on the highway, and we are beginning to see some of the reasons why that takes place.

I think we must stress the fact that the staff, as they were taking









these films, had no knowledge what the cars were going to do. They just ran the film.

This is the Baltimore-Washington Parkway heading south, and the ramp to our right is the ramp that we take to go west on the beltway. You can see here where the cars have made their own roadway in the grassy area beyond the gore area. You can see where the highway people have put steel "I" beams in the ground to prevent the cars from doing this. Yet, the cars keep on going beyond them. This is a 60-mile-per-hour highway.

Mr. MAY. This is the next ramp on this highway; swing right on this ramp and you swing around and join the beltway heading east. Mr. Prisk, would you consider the meaneuvers we are seeing to be hazardous maneuvers on our freeway?

Mr. PRISK. Very definitely. They could be classed as near misses. Where you find this type of action, you find concentrations of accidents.

Mr. MAY. Yes. Later in the hearings there will be an analysis of the accidents at these locations.

What we are looking at is the stuff accidents are made of. There you can notice, just below the road area, cars have again made their own road.

(End of film.)

Mr. MAY. Mr. Alexander, we understand your organization has engaged in certain projects which bear directly upon the subject matter now being studied by the subcommittee. Would you begin to brief the committee on what you have learned?

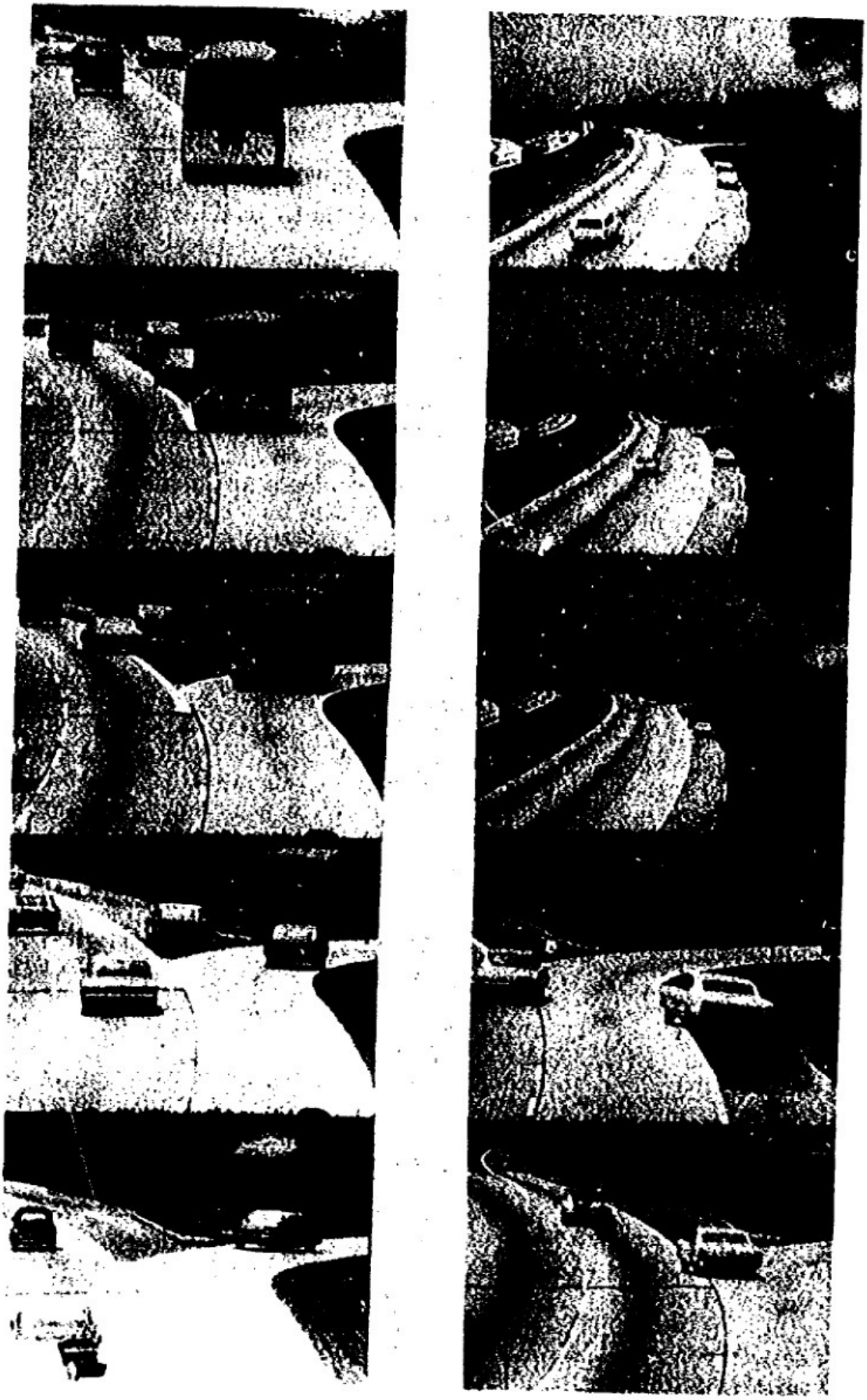
Mr. ALEXANDER. Thank you. In October of 1966, Airborne Instruments Laboratory was awarded a contract to study and determine motorists' information needs, the means of effectively handling these needs, and of transmitting them to drivers in order for them to conduct the driving task in a safe, efficient, and convenient manner. This work was sponsored by the American Association of State Highway Officials, in cooperation with the Bureau of Public Roads, and was conducted in the national cooperative highway research program which is administered by the Highway Research Board of the National Academy of Sciences—National Research Council. The personnel assigned to lead and conduct the research were primarily Mr. King and myself. Mr. King's background is in civil engineering with an emphasis on traffic engineering. My own background is in the area of human factors psychology and engineering.

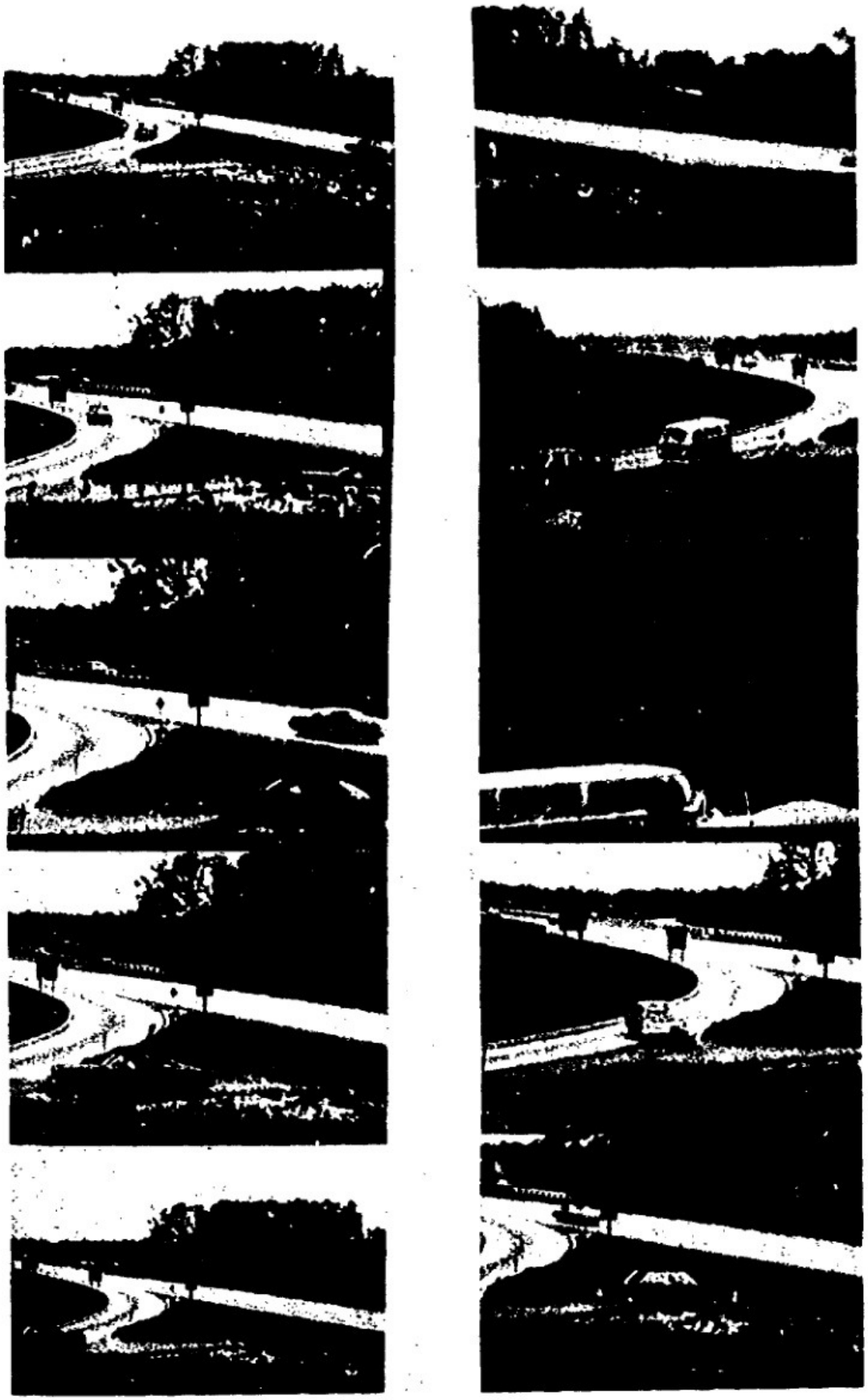
Consequently, our approach to the problem was two-pronged. It was: One, from the human element side, and two, from the more pragmatic engineering side.

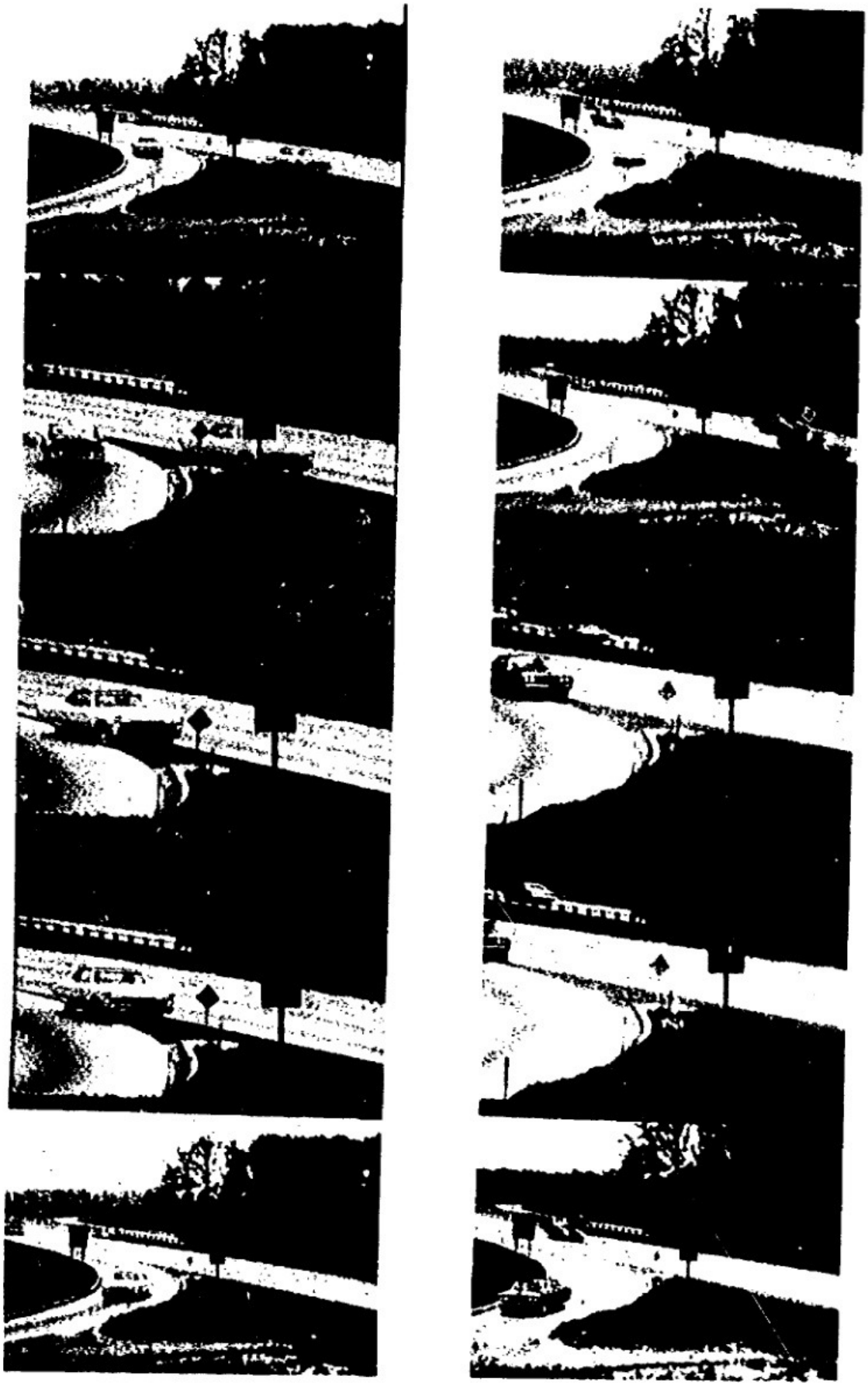
Mr. MAY. This is the coupling together of the disciplines that Dr. Hulbert spoke about yesterday?

Mr. ALEXANDER. Yes. In Dr. Hulbert's remarks yesterday he did indicate that it would be better in State highway departments and most situations where you are talking about signing to have this cross-discipline, this interdisciplinary approach. We did apply this interdisciplinary approach, I might add, with what we consider a lot of success to the problem of determining information needs and means of satisfying them.

I might say at the outset that during the course of the research we visited, Mr. King and myself, either officially or unofficially and drove







through some 30 States in the United States. The trips through these States were quite valuable to us in terms of understanding the kind of situations that exist on the Nation's highways.

The things that we found in the States, some good and some bad, were characteristic of all States, we feel. We did not find anything particularly poor about New York that we did not find in Ohio or Michigan. We did not find anything particularly bad in the District of Columbia that we did not find in the State of Washington, for example.

Mr. MAY. You may be in a position to comment on what we have just seen, those unusual maneuvers at those places. Is that atypical?

Mr. ALEXANDER. Well, it is our opinion that they are not only typical, but very common. Part of the technique that we use to get at the driver's information needs entails the use of a tape recorder.

We rented a car and drove from Long Island to Lansing, Mich., in order to collect data on the information needs we were talking about, and for the technique we took a tape recorder and the driver recorded everything he saw or did or thought about that related to what he was doing.

In playing these tapes back for the members of the staff here and for our own people, frequently what was said was spontaneously humorous, and they said, "Come on, you are putting us on. It is not that funny." The fact is that we can go to almost any State and almost any locality and make a very funny tape of things that occur on the highway system.

Well, to take that point of the 30 States and apply that to what we are talking about here; again, our purpose was to define what information drivers need for the safe, efficient, comfortable conduct of the driving task and determine those principal factors of reception and transmission that influence how drivers do conduct the driving task.

As I indicated, we planned a trip using maps that were available of the States involved from New York to Lansing, Mich. The States were New York, Pennsylvania, Ohio, and Michigan and we planned and undertook that trip, which was a 2-day trip, and used the tape recorder.

I might say that in the conduct of taking this data we used well over 1,000 feet of tape and this tape was reduced onto what we call data sheets, and an analysis was made of the driving task on that trip. In addition to that we, on another trip, went to the city of Seattle and took additional data there on direction finding and trip planning, and this was also incorporated into our analysis data.

From the two types of analysis we did, we derived a list of about 140 information needs. We did not mean to imply that all drivers are faced all the time with 140 needs, information needs, and we did not mean to imply these were the only informational needs that he has. However, there are identified on our trip at least that many, and what with combinations of needs, there are probably a good many more.

In analyzing these needs and the other work that followed it, we defined seven areas or seven factors, if you will, that affect and are affected by these needs. Let me tell you briefly what they are and what we will do is discuss each of them in more detail.

First, we have a factor that we call a priori knowledge. This consists basically of three parts—a driver's general background, his edu-

cation, his driving experience, and how many years he has been on the highways. Then what he knows about driving on the highway system, and a particular piece of prior knowledge is that of his trip planning and preparation for a specific trip.

The second factor we call levels of performance. One of the things we found that was kind of interesting and very important to the conduct of the driving task was that there are basically three kinds of things that drivers do.

The first thing that he does is he steers and controls the speed of the vehicle. We call this level of performance microperformance because it consists of very small corrective behaviorial units, the minute steering, minute changes on the accelerator or brake.

Another level of performance is what we call situational because it refers to the ability of the driver to get along in the traffic stream. What we saw here on the film was a very good example of situational performance on the part of the drivers involved.

A third level we call macroperformance which is the strategy of driving, the trip planning and preparation phase of driving.

There is another factor, the third factor here, that we call primacy and this is perhaps the most critical of the human factors part of the analysis. Primacy refers to the fact that at any given point in time there is some information that is more important than other information. A driver who is giving his attention to a sign that says "New York, 600 Miles" on the Ohio Turnpike and runs up the rear-end of the guy in front of him who stops short, has shown that he is not attending to the most primary information that is available, and we found that this primacy exists throughout all of the needs and we will say more about that later.

A fourth factor that we called spreading which is an attempt to even out the information challenge on the highway. There are certain areas like in the Mohave Desert where the driver can drive for miles and miles without seeing a thing, and there are certain areas like what you saw here on the beltway where the driver has so much information to look at, and sift through, that he just cannot handle it all in the time he has available to him.

The concept of spreading would take some of the information from where he cannot handle it and put it where he can handle it with a greater degree of facility.

A fifth concept that we call coding and recoding refers to the attempt to put more information into a given source so that drivers are better equipped to handle it at the time it is given to them.

Mr. MAY. On that coding and recoding, would you give us a couple of examples on that?

Mr. ALEXANDER. Yes. A very good example, and I will say more about this example later, is the Interstate shield. The Interstate shield has the State and a number on it and a couple different colors, but in itself tells you a lot more than that. It tells you the kind of road you can expect to be on and it tells you there is not going to be any cross traffic. It tells you that it is in a certain part of the country, and the number tells you certain things about the kind of road it is, whether it is a mainline road, whether it is predominantly north or south travel, or east and west and things of that nature. Unfortunately, not

too many people know the code; but it is, as a matter of fact, a good example of what coding is.

Mr. MAY. This is a point I would like to stress. It tells you what part of the country you are in. How does it do that?

Mr. ALEXANDER. Well, there is a method in the Interstate numerical system. The numbers that are even, like Routes 40, 80, 60, 32, are east-west routes primarily. That is not universally and totally the case because in some areas, they go north and south to get east and west through an area, but they are primarily east-west routes.

Mr. MAY. Does the motorist know that?

Mr. ALEXANDER. I would say not. I think if you took a vote here you would find in addition to Mr. Prisk, Mr. King, and myself, maybe three or four other people, if that many, who did know that. Well, to continue—the numbers that end in an odd number, are primarily north-south routes.

Mr. MAY. Also, they start with the lower numbers on the west coast and the higher numbers go to the east coast?

Mr. ALEXANDER. Route 5 which is a North-South route in California, Oregon, and Washington is the extreme western route and Route 95 which is down the east coast, the extreme eastern route. Route 55 is in the middle of the country, starting in Chicago and ending up in New Orleans.

In addition, there are two-numbered routes and three-numbered routes. There is Route 95 which is the major north-south east coast route and there are several 495's. There are a couple of 195's, 295's, and 395's. These latter numbers refer to an association with the principal route. The 495 near Washington, for example, is the Capital Beltway; there is a 495 in New York which is the Long Island Expressway.

There is also a 495 in Boston and several other States. These routes with the even first numbers, first of the three numbers, refers to the fact that the route is a loop, and presumably it connects at both ends with the route that it is looping to and from. For example, 495 should connect at both ends with Route 95. Route 195, however, is a spur because it has an odd number before the 95. Therefore, Route 195, or 395, or 595 will only connect that one point to the 95.

I want to say more about this later. The concept of coding is terribly important, and this is a very good example of coding because you get an awful lot of information from it; but you have to know the code.

Mr. MCDONALD. The numbering system is new and forever in the future will be confusing to me.

Mr. ALEXANDER. Well, you can get familiar with it as I have. I thought that I knew all there was to know about the numbering system until the day before yesterday when I found out that routes that end in a zero go from coast to coast and routes that end in a five go border to border. I did not know that. I have been working in and around the system for awhile, and it was just when we were preparing for the presentation today that I found out about that. I do not think that any body ever really gets totally familiar with the system.

Mr. MAY. Do you know what an amber delineator means on the Interstate?

Mr. ALEXANDER. I know, for example, in some States there are

delineators that are certain colors that lead you off the route and delineators of other colors that lead you onto the route. I am not sure I know what they are. Mr. King does and that is important as far as I am concerned. I do most of my traveling with him. I do not really mean to make light of this. This is his problem. But like we are saying, it is a good practice to code information because you can get more information to the driver if it is coded. The problem is, and it is a serious problem, that drivers do not know the code. There is no communication, if you will, between the people who are making these systems and the people who are using these systems. I cannot emphasize that too strongly.

Mr. MAY. The engineers have talked to one another. The motorists do not know it.

Mr. ALEXANDER. Most engineers know it. At any rate, that is coding.

The next, and sixth factor we call redundancy and this refers to putting more than one kind of information on a single source. The stop sign is an example of that, where the octagonal shape of the sign, the color red, and word "Stop" really all convey the same message.

The seventh and final factor we call expectancy, and this factor of expectancy, together with the levels of performance and the factor of primacy are really the basis from which most drivers conduct the driving task.

Drivers expect certain things to happen at certain times. They expect information to be presented to them in certain ways and when these expectancies are met, then drivers are more likely to drive OK.

When these expectancies are violated or not structured properly, then we have a vulnerable situation. I might say in terms of a vulnerable situation I do not necessarily mean a catastrophic situation.

In our work on this project, we considered the system as a total system: the man that operates on the system, the vehicle he uses to operate, the highways that he uses to drive on the system, and the environment. These all form this system and the failure of any part of that system is a failure of the whole system.

Let me show you what I mean. We are saying that when a system fails, it can fail either catastrophically or noncatastrophically. We are saying a catastrophic failure is an accident where people are hurt and/or there is property damage. However, there are many kinds of noncatastrophic failures which, when taken collectively, may cost the country, in terms of dollars and time, as much money as the catastrophic failure. Two weeks ago I was on the Southern State Parkway going home and there was a 40-mile-long bumper-to-bumper, nonmoving mass of traffic. That is system failure when you consider all the cars involved sitting there on the Southern State Parkway waiting; that is system failure.

Here, on the film we have just viewed, where a driver stops and then backs up and takes the route and it turns out to be the wrong route and he gets lost somewhere in Fairfax, that is a system failure.

What we are saying in effect is that if we were to treat safety not just in catastrophic failures, but recognize the whole as a system and then devote time and energy to understanding the system as a total system, then we will get at things that are today in the field of research and in the field of operations only to some extent.

Let me talk about specific examples. These are the seven factors that we talked about and let me go over each one with the exception of coding maybe, and talk about what it means. The first one was a priori knowledge as I say and it consisted primarily of three parts: a part that was general background on the part of the driver, his knowledge, his education and so forth; the driving experience; and finally his pretrip plan, his strategy to get from Joplin, Mo., to Milwaukee, Wis. Most drivers, if they are going to take a long trip, and Dr. Hulbert indicated something of this nature yesterday; 80 percent I think was the figure, if they are going to take a long trip will get a map and plan the trip.

Well, we got a map and we planned our trip also. We planned the trip from Long Island to Lansing. We planned our trip in Seattle and to North Carolina. We plan most of the trips that we take. One thing is apparent. Most of the maps that are available today just do not prepare drivers adequately for the trip they are going to take. For example, we were in North Carolina a couple of weeks ago on the follow-up to this particular contract, and we were looking for a route that we could apply our application procedure to and decided to check Route 1 that runs out of Raleigh.

Well, we got two oil company maps. One of the maps showed that Route 1 was an expressway-type road and one of the maps showed it was not. This is the same road. We got in the car and we drove down to this part of the area and said OK, the Esso map is right. It is not an expressway, it is a two-lane highway and we drove it for a couple of miles and we did not see a sign that said Route 1.

We drove for a few more miles and still did not see anything confirming the fact that we were on Route 1. Well, we wound up driving 25 miles on this highway and we had hints it was Route 1. For example, there was an old Howard Johnson's sign that looked like it was not maintained in the last 10 years that said Route 1, Howard Johnson's, 59 miles ahead on Route 1. Hints like that, but no sign that said we were on Route 1 until we got 25 miles down on this highway and we saw a sign that said Route 1, turn left. Well, we turned left and went about a mile down and there was Route 1, an expressway type road that had been running parallel to the highway we had been on. We had been on the old Route 1.

What I am saying, gentlemen, is that mapping—and it is not just the maps in North Carolina that are bad—it is that maps all over need work. They do not adequately prepare drivers for what they are going to see out on the highways.

Many comments have been made to us and I am certain to you and other people as well that the problem with maps is that people cannot read them. I think I am willing to admit that is true. However, I am not so sure that I am willing to admit it is the people who cannot read them who are at fault. Maps today that are currently available, I think, are not designed for the reader much the same as many of the signs on the highways are not designed for the user.

Maps do not correlate what is on the map with what is on the highway. In the course of our research on this project, we wanted to find out just how much correlation there does exist between State highway maps and the State highways. We sent a questionnaire to each of the 50 States and got responses back from all of them.

One of the questions that we asked was by what means they attempt to show the motorist traveling through the State what is on the map and what is on the highway. What means is used to correlate one with the other.

The fact is, though, that no State correlates what is on the map with what is on the highway to any extent that a reader, that a user, that a trip planner, can count on. For example, if I got a map of Long Island, and in looking at the map of Long Island I might conclude that when I get out this far on the expressway I should see a sign for Copiague. While Copiague is a big area, there is no sign for it on the expressway.

Mr. MAY. As an example of that Mr. Kopecky and I went up to New Jersey to ride a freeway looking for Route 525 and we never did find it. So we went on to New York and later on we came to appreciate the fact that the sign at the crossroad, 525, did not say 525. It said Possumtown Road. Would that be an example of failure?

Mr. ALEXANDER. It certainly would. When Mr. Petrillo was here, he indicated that some of the problems they are having in New York are with drivers being familiar with the road by name and then getting out on the highway and seeing it by a number.

Well, this is a kind of a priori information I am talking about. When they plan a new road, they might call it the Queens Midtown Highway and then when that road is actually built and is signed, the number only is placed on the signs. They may call it Interstate 296 which is strictly fictional, but that is the kind of thing that we are talking about. It is a violation of the factor of a priori knowledge. You have to treat the driver on the highway the way he thinks you are going to treat him and unfortunately, we are not.

This factor is very important. I have discussed only one of the three areas. There are other points about it, that I do not really wish to belabor at this point.

Again, it is indicative of the system failure; failure in the system to treat the driver correctly. This is a case of noncatastrophic failure. The worst it is going to do to somebody is get them lost. It might make them vulnerable to other things such as you saw on the film, but in and of itself it is a noncatastrophic failure.

Mr. MAY. Would it help if the highway departments and the oil companies would go to some uniformity of scale?

Mr. ALEXANDER. Well, uniformity helps, but I think the problem with most mapping is that they try to do too much. They try to be all things to all people and there is so much information on maps that drivers do not need or could care less about. I do not have to show you a picture of a map to have you say, gee, it is cluttered. There are very few that are not cluttered.

The AAA's Trip Tik is an example that is not cluttered. But just about every other map available to the driving public is pretty much cluttered, and it is not reasonable to expect that drivers are going to be able to look at the conglomeration of these lines and letters all bunched up in one small area and make rational decisions on the basis of that.

If we are going to spend money making the highway system better, we ought to spend money making the total highway system better and this is the a priori part of it.

I would like to combine the next two factors, that of the levels of performance and the factor of primacy that we mentioned, because they are very much intertwined.

Levels of performance; you will recall we talked about three levels—the microperformance which is the steering and speed control, the situational performance which consists of surviving in the traffic stream and the macroperformance, which is the strategy of trip planning.

When we combine this with the concept of primacy, one of the things we found in our research that struck us like a bolt, and we think is very important, is that these levels of performance are arranged in an order of importance.

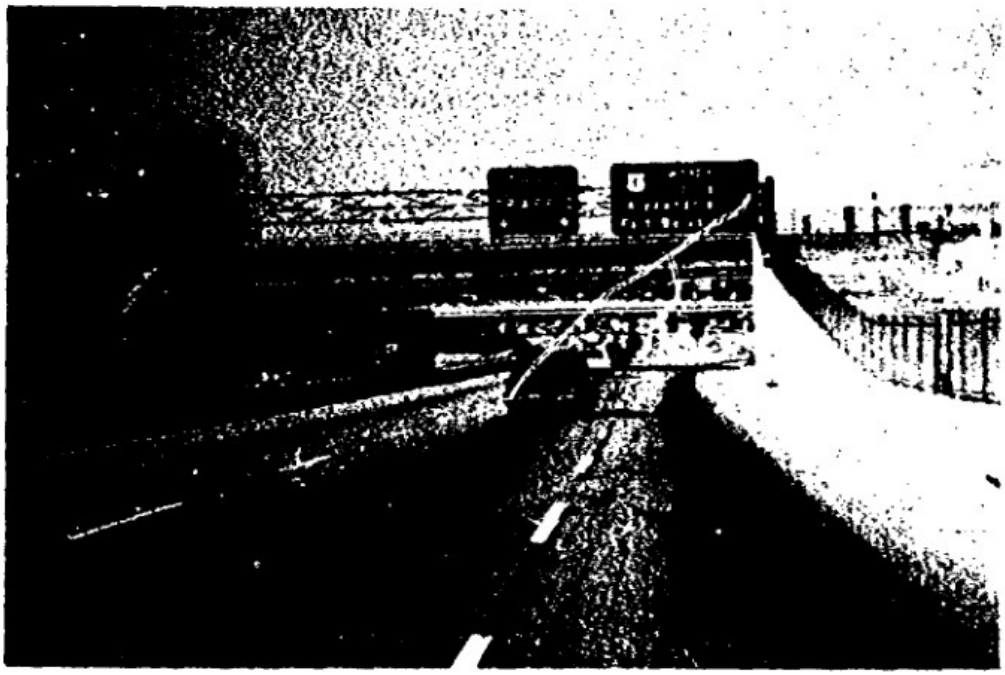
We found that the microperformance—the steering and the speed controls—is the most important a driver can have at any given point in time.

If you took a cross section of a typical trip you will find many needs competing at one given instant in time and these needs line themselves up in a hierarchy of importance with the microperformance being the most important, the situational performance being next and the macroperformance being the least important.

What does this mean? Well, for one thing it means when you are negotiating a complex urban interchange, that is not the time to put up a sign that says "East Podunk 48 Miles" because drivers cannot attend to that information at that point because they are too busy doing more important things.

The driver who is in the process of being cut off on a 65 mile an hour highway does not care about a sign that says "Gas, Food and Lodging, Next Right." It is just not as important.

Well, these levels of performance and the primacy factor are something that I would like to show you in the first of these slides. Can I have that turned on, please?



Mr. ALEXANDER. This is a picture of Interstate 495, the Washington Capital Beltway. As you can see here, it is a three-lane highway. There are overhead signs and I will read them to you. "Thru Traffic" on the left, and on the right, there is a shield of U.S. 1, "North/South, Alexandria, Fort Belvoir" with an arrow to the right.

The signs at the top show macroperformance information. They tell you something about direction. However, there is a very important piece of situational or even macroperformance information that the driver must have, especially if he is in the right lane that he is not given. If you will look further down the road you will see there is a lane drop. We talked about that yesterday and we spent time on it.

I mean to tell you that it is important that the driver know beforehand that there is a lane drop coming up. This is more important information than the signing that says "Thru Traffic, North/South, Alexandria, Fort Belvoir."

If the driver does not want to go there, if he does not know there there is a lane drop, he runs a pretty severe risk of getting to the gore and coming to a dead stop. It was a lane drop.

I might say this particular lane drop is not as bad as some others are. Here, if the driver decides to stay on the right and the heck with the consequences, he can eventually get back to the beltway. In many areas, he cannot do that when he is faced with a lane drop. The lane is dropped and he is off in some direction that he does not know where it will take him.

This happened to me in Seattle on the reverse lane of freeway I–5. There was a lane drop, and it was not signed for; there was nothing to tell me about the lane drop. The next thing I knew I was off the main road in a direction heading east, and I wound up on the University of Washington campus. While it is an attractive campus, that was not where I was heading.

The point I wanted to make with regard to this lane drop and the importance of that information is that in many cases drivers will come to a dead stop in that gore because they were in the right hand lane and had not been informed they should not be there and are going to wait for the traffic to pass them by so they can get back to the left. Sometimes they make it successfully and sometimes they do not.

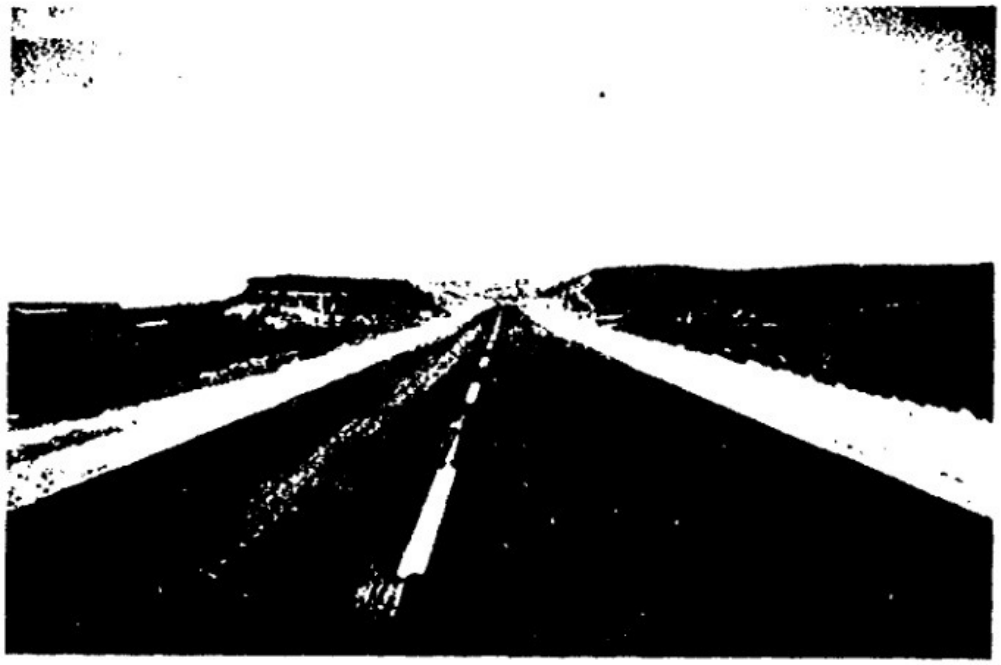


Mr. MAY. Mr. Alexander, in this slide you see a black and white sign, just beyond the "Exit 1" sign, that says "Hooved Animals Not Permitted on the Interstate." Is that the place for a sign like this?

Mr. ALEXANDER. That is not the place and I discount it anyway because of the speed people are traveling by. If a guy really wanted to read it, he stands a rather good chance of getting killed I would say—primarily because of its low priority.

Mr. MAY. There is another sign hanging up above that which says "Speed Checked by Radar."

Mr. ALEXANDER. OK, it is nice to know when a highway is being checked by radar, but unfortunately, this is not the place to put those signs. I am not exactly sure where they belong at this point, but I am pretty sure they do not belong there.



The next factor that we are talking about is the factor of spreading and this slide will show you pretty much what I mean.

Almost as far as the eye can see in this slide there is a straight road with very little on it in the way of informational challenge to the driver. It is in situations like these where vigilance problems exist—drivers falling asleep. Single car accidents are typical, if not high, on highways like this.

I am not saying this particular highway is typical, but highways where there is no informational challenge, especially at night where it is straight as an arrow and with nothing to keep the driver awake represent a bad situation.

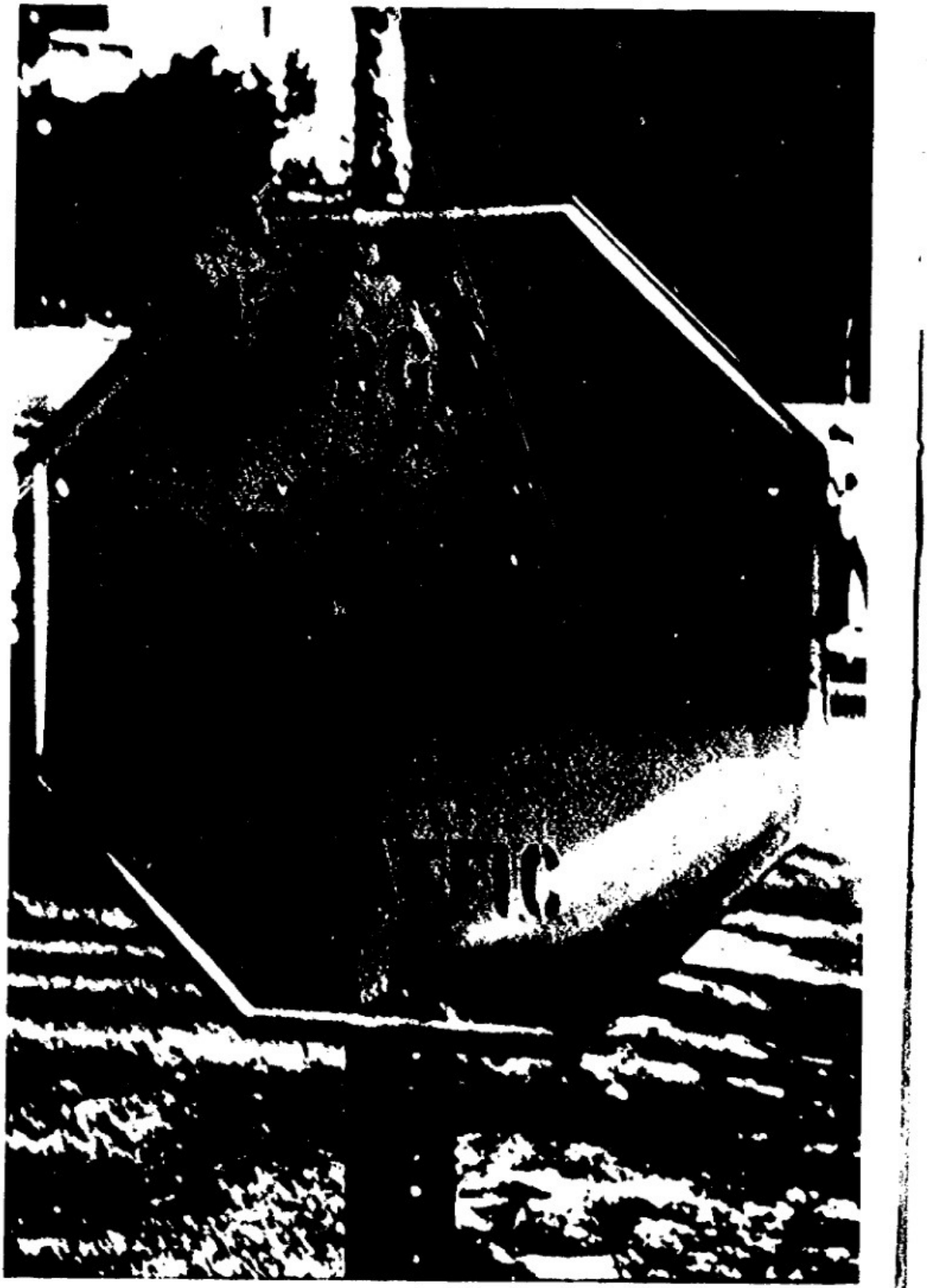


This next slide is a bad situation also. This is taken somewhere in a small city in the State of Pennsylvania and a driver coming upon this traffic circle is faced with numbers, directions, cities, and he has to make a choice which way to go around the traffic circle. He may go around three or four times and he may come to a stop in front of the sign and say, OK, where am I going.

The point of spreading is to take the information that is very high, the information challenge which is very high, and spread it out to those points where the driver has the time to be able to read it and to comprehend it and get meaning from it.

In discussing spreading we should recognize coding. But drivers must know the code in order for it to be meaningful. Drivers have to know that I–5 is on the west coast, that I–405 is a loop from I–5. They have to know that Interstate 40 is an east-west route. They just have to know the code and the only way the drivers are going to know the code, whether it is the interstate code or any other code, they are going to have to be taught either through the media or their educational

processes or training processes. Drivers must be treated with respect; they are intelligent; they are, at worst, uninformed. An informed driving public is going to be a better driving public, and of that I am convinced.



The last of the factors is redundancy and for redundancy we use the example of the stop sign.

There are a couple of reasons why you use redundancy. First of all, when information is given in different forms on the same source, you can attract more people to obey that information. For example, if a driver is driving down a street and he sees a stop sign and he misses the word "stop," if he sees the octagonal shape and the color red, he is going to get the same message. So the driver is more apt to conform or to get the meaning from the sign if there is a redundancy built into it.

So another reason for redundancy is to have meaning to more people.

Now, we have spoken about roads having names and numbers and termini and some roads are known by each element. The driver who is coming down to Washington for the first time has heard about the beltway and he looks for signs to the beltway, and he does not see them or maybe he does. Maybe he sees them, Washington Beltway 495.

The fact is that there are some drivers who will recognize the number 495 but not the word "beltway" as being that road they want. There are some drivers who recognize the word "beltway" but not the number 495 as being what they want. By building in redundancy you are increasing the potential audience of people who can glean use out of the information presented.

Expectancy is the last factor and here again I would like to divide it into the three levels of performance we were talking about.

You can see microperformance information creating certain expectancy and by "expectancy" again I mean the driver anticipating certain things about the driving situation. If a driver is going down a highway and for some reason or another he expects that the highway is going to turn in one direction and, in fact, it turns in another direction he is more vulnerable. If the driver is expecting a clear, dry roadway and he hits a patch of ice he is more vulnerable. A driver who expects an icy highway is much better equipped to handle it because he is prepared for it. He is ready.

This is typical of microperformance kind of expectancy. There are also expectancies that relate to traffic control. For example, we said in discussing redundancy that you present information like the stop sign. Well, that sign is octagonal in the slide. The word used here is very similar to the word "stop," the first and third letters being identical and drivers do not expect this sign to say "slow." They expect it to say "stop" and this is a violation of expectancy at the traffic control level.

Mr. MAY. This is a misuse of the octagonal shape.

Mr. ALEXANDER. It certainly is. There are other examples of this, even with the word "stop" on it. There are other examples, of course. Stop signs I have seen that have said things more than just the word "stop" convey other information.

Mr. OLSEN (presiding). They say four-way stop.

Mr. ALEXANDER. Exactly. This is also a very good way of expectancy being violated. When you drive up to the stop sign you expect the crossroads to have the right-of-way. You expect they do not have to stop and you consequently get accidents at four-way intersections. I

believe, and I have no data to back this up, it is because drivers do not expect what is going to happen and you get two cars sitting there, one saying OK, I will go through, and there he goes. This, as I say, is a violation of expectancy.

Another example, in terms of a traffic light, you come upon a red light; you know the cross traffic is green. If you happen to see that cross light in its green stage and you see it turn yellow, the anticipation is that within the next couple of seconds your light is going to turn green. It might not, but that is your expectation and if it turns green for pedestrians and not for vehicular traffic, or turns green for a left turn, there are many drivers who are sitting there with their foot on the gas waiting and will not wait for the green and will take off like a shot, not wittingly and not maliciously, but they just expect their light is going to turn and they go whether it turns or not.

This again is a violation of expectancy. You certainly form expectancies with other vehicles. Driving behind a car, when you see a signal for a left-hand turn, you expect it to turn left. If it turns right there are troubles.

You can glean information in somewhat more subtle instances than that. You will expect, while driving behind a car, if you see a small puff of smoke come out of his exhaust that he has let up on his accelerator. Sometimes that is true and sometimes it is not, but this is the kind of expectancy that drivers with a lot of experience will form.

Sometimes these expectancies are encouraged and they are rewarding because you are more efficient in your driving. Sometimes they are discouraged because you might have an accident.

The microperformance expectancies relate also to the maps. Drivers expect if they plan a trip to Long Island or Joplin, Mo., or to Rapid City or somewhere, or anywhere, they are going to expect that they are going to see the sign that says what their destination is.

As a matter of fact, drivers who expect to see, when they leave their house, a sign that says Pasadena, especially if they live in New York, are unreasonable, and such expectancy is unreasonable. However, it is the purpose of maps to structure expectancies on highways. Drivers will be better equipped if they know what they will see upon the highways. That is, not only maps but all traffic control. It is to structure what you are going to see. It is to prepare you.

What we are saying here is that attention to these factors—the various factors I have talked about—such as expectancy, levels of performance, et cetera, must be considered at the design level. They must be considered at the sign-design level, at the mapmaking level, and certainly at the research level.

It is not until you give attention to these factors, along with the principles that Dr. Hulbert talked about yesterday, that you are going to get a decent system of man, machinery, and environment and this is what human factors people push, and this is what I am here today to push, a decent system of all three elements.

Mr. King will take the discussion from here on out. He will talk primarily about the principal factors aiding the transmission of information and the reception that I have been talking about and how this thing can be applied.

Mr. MAY. Thank you, very much, Mr. Alexander. Shall we put the lights on for a bit?

Mr. KING. Mr. Alexander pointed out we are reporting here today on just some of the highlights of a large study that took a year in time, and I do not want to leave the impression that the two of us did it all. Other people in our organization were involved and great help was obtained from other people throughout the country. I am going to mention some of them later.

I would also like to say at the beginning that as Mr. May mentioned, I spent 12 years as a working traffic engineer and any criticism that I make of traffic engineers and any examples that I point out, undoubtedly are types of mistakes that I have made myself at one time or another.

We started off in the study to find out what is being done at the present time. We made a sample of 16 States in the United States, and I visited these State highway departments personally to find out what they are doing and what their problems were. I would like to say that I was very impressed with the level of awareness of problems and the desire among the people, especially the younger people, to do something about it and the frustrations they had at times when they were forced into methods or means which they knew were inadequate but with no remedy available to immediately correct it.

There were problems in almost all of the States, that they were willing to admit; the signing situations that they just could not handle with the tools at their command, either because the manuals were too restrictive or because they had been saddled with highway design decisions that no amount of signing could correct. They were just beyond human capacity to navigate.

Mr. MAY. Do you have any idea how that comes about? Why do we end up with a section of highway that is designed and built in such a way that the signing people cannot sign it?

Mr. KING. It is money.

Mr. MAY. Money?

Mr. KING. Yes. Always they are afraid of doing what you might say is the right thing and spending the amount of money that is required. Take one example such as the left off-ramp which is a very common problem in the United States. It is recognized by people at the operating level, and that acceptance is coming up in the echelons now. If you will look through the various issues of the AASHO design policies, you will gradually see how the left-hand off-ramp has changed from a recommended solution to a barely tolerated expedient. But you have a left-hand off-ramp in a certain situation as a possible solution since to put a right-hand off-ramp at the same location may involve building two additional bridges and tearing down a couple more houses. The people who will decide where and how the money is going to be spent are going to get a lot of comments before they do that.

Mr. MAY. This really represents a severe problem in the Nation right now?

Mr. KING. Yes.

Mr. MAY. What we so frequently end up with is a design of a location that turns out to be cheaper initially but something we have to live with for another 50 or 60 years that will not work, is that correct?

Mr. KING. That is right. Take a left-hand off-ramp on a high speed multilane expressway, one where you have a large amount of commercial traffic; operationally you just cannot make it work properly

because you force a big truck, and the situation is going to get worse as trucks get bigger, to accelerate and decelerate in the high speed lanes.

Mr. MAY. As a committee, should we not be wondering where has the signing person been in the highway department? Why has he not gone into operations and design and said this will not work and that we must spend more money?

Mr. KING. He has.

Mr. MAY. He has?

Mr. KING. He has. The people at his level, on the design end, will agree with him but then it gets up to the top and you get your plans back and they will say there is $1 million more than we have budgeted for this job. Cut it $1 million and there you are back where you were.

Mr. MAY. Would you be prone to agree with that, Mr. Prisk?

Mr. PRISK. I think it is very largely true. It is not so much a lack of technical competence as a decision of money, sometimes perhaps rationalizing that as the traffic load stands today this may work, but not appreciating as traffic volumes grow this would become an intolerable situation.

Mr. MAY. We saw a slide of the Route 1 interchange on the beltway here where they dropped the lane. Now, that is a good example because certainly the operational people knew that it would be safer to carry the lane through.

Mr. PRISK. Exactly.

Mr. MAY. But they recognized it would cost more money to carry it through. Since they did not build the extra lane, we suffer today, and day by day people have accidents and are having difficulty in that area.

Mr. PRISK. Imbalance in design brought about by that particular decision.

Mr. MAY. If there are enough of those type locations on the highway, I wonder—do you end up with a highway design for 65-mile-an-hour traffic?

Mr. KING. You have a great problem for instance where you have expressways, multilane expressways, where, in a great many urban situations—you restrict trucks to the right-hand lane or the right-hand two lanes and then you introduce a left-hand exit. It is usually in urban areas where you have tight right-of-way conditions or trying to weave your way between structures. What do you do? How do you tell that trucker that now if he wants to use that exit he can get over to the left-hand side, and where do you tell him? Take a big semitrailer in the afternoon rush hour. It may take him 3 or 4 miles to move over three lanes.

Mr. MAY. It turns out to be a saving of money but really it is not economical.

Mr. KING. Personally I would say it is not a saving of money in the long run.

Mr. MAY. No.

Mr. KING. If you take the total cost of the time lost and the accidents into your cost-benefit balance, it is no saving.

Mr. MAY. No.

Mr. KING. In our survey of the States, I spent some time in each State talking about three specific situations. The left off-ramp is one;

the lane drop at the exits is the second, and the third one is the tangent off-ramp; that is a situation where at the exit the main road, the continuing road, turns and the ramp itself continues in a straight alinement. Your natural path would lead you off the route, but it takes a positive maneuver to stay on the route.

Most of the States admitted that they had problems and they were very unhappy with the solution they had adopted. In some cases using the manual solution, having finally gotten approval from AASHO if it was interstate, departing from the manual, or interpreting the manual so as to allow something else; or in some cases just throwing the manual out the window and saying we do not care what you do. We cannot live with it and we are adopting something else.

Take a lane drop at the exit. The standard treatment in the manual for a lane drop, and that is another example of coding incidentally, is by pictorially showing how many lanes you have now and which lane is going to be dropped. It has one disadvantage: I have yet to meet a layman who knows what it means. It has been called the rain-ahead sign, or chicken tracks sign. It is a very good sign if somebody would take the trouble to explain what it means. So the States have adopted various expediencies; in California the standard accepted expedient is to add the word "only" to the "exit" message on the sign.

Some States found that this treatment had insufficient impact and have used the word "only" on black and yellow panels affixed to the sign which, incidentally, introduces a subsidiary problem. Where you have a two-lane exit ramp in urban areas, one lane of which is dropped and you adopt the expedient of using the word "only" you will find a situation in which people misinterpret the word "only" not to mean that this lane only goes to the exit, but to mean that this is the only exit lane; even though they may be in the proper lane to exit from the second lane from the right which also goes to the exit, and so they weave over in an unnecessary driving maneuver to the extreme right lane because they think only that lane will go out.

The left off-ramp is a problem of operation even if you tell the motorist. You can tell him by using the word "left" on advance warning signs, by using overhead signs, by lane assignment techniques, or by using pavement markings. The problem is you tell the motorist but if he is in the wrong lane on freeways such as the Kennedy Expressway in Chicago at 5 o'clock in the afternoon, and if he doesn't expect the left-hand off-ramp but is expecting a right-hand off ramp and remains on the right because he is still a couple of miles away from his exit, there is often no way he can get over there even if he knows about it.

A tangent off-ramp violates expectancy. The driver expects not to have to make any change of direction to stay on the main road. He expects to make a positive change in direction to get off the road which means the signing must be emphatic enough to overcome his expectancies. You have to go in for more advance warning signs, bigger signs farther ahead. But, you run into another problem in that the type of signing, for a given interchange on the Interstate depends solely right now on the amount of the cross-street traffic. If it is classified as a minor interchange, you have one advance warning sign or maybe no advance warning sign. It does not matter how complex the maneuver is; that is all you have.

I am not sure the Bureau of Public Roads would pay for additional

signing because you have a different road configuration; so the problems are recognized in the States, at least on the working level. I did not find anybody who told me he had no problems, or anybody who did not hope for some help in the solving of these problems.

One major problem is communications. In order, right now, for a sign to get paid for I believe the letter of the law is for any voucher to be approved by the Bureau. The entire road, including signing, must be up to standard which means the signs must conform to the manual. It takes, I would say, 3 years to change a manual right new.

Mr. MAY. How long?

Mr. PRISK. Well, I think 3 years is what the history shows it to be.

Mr. MAY. The joint manual, 1961, that is the current manual today?

Mr. PRISK. He is talking Interstate I believe.

Mr. MAY. What is the date of the Interstate?

Mr. PRISK. 1958 and 1961. That is 7 years there.

Mr. KING. So the problem is apparent. There is no way you can open up a highway in the next 3 months and you are going to have a problem. There is no way you can legally, almost no way, get permission to use something different because you happen to need it there.

Mr. MAY. So we are going to have to come up with some more expeditious way of making changes, wouldn't you say, Mr. Prisk?

Mr. PRISK. This has been the subject of a good bit of consideration in recent months and I believe that a more satsfactory and more expeditious way has been worked out, just within the past 30 days.

Mr. MAY. When they do come up with a new manual and it is adopted, it is going to be a looseleaf manual, I hope.

Mr. PRISK. We should like for much of it to be a looseleaf-type document that could be improved from time to time. Whether it will take this form I cannot say. It is an AASHO publication and I do not work for AASHO.

Mr. MAY. It seems that if something is bound there is a natural reluctance to change it 90 days later or even 6 months later.

Mr. KING. The one problem that flows from the lag time and from the fact that as individual States run into problems which are not covered in the manual and have to adopt their own solutions is that you lose uniformity; the man in Utah who runs into a problem with left-hand exit ramps may not know what the man in North Carolina, who 6 months ago had the same problem, came up with and he had one kind of solution and he may find his own solution and maybe they will be the same, and maybe not the same.

Mr MAY. And you mentioned coming out with a new manual will not solve it all because there has to be a certain flexibility at some locations.

Mr. KING. There is a mechanism set up. There is an AASHO interpretations committee to which you can direct a request for an interpretation or permission for a departure from the manual.

The problem is one of administration within the highway departments. You have to convince the chief highway engineer there is a problem first of all. You, as the working engineer, cannot request the change directly.

Mr. MAY. Mr. Prisk, you have something to do with the interpretations committee?

Mr. PRISK. Yes; I am the secretary.

Mr. MAY. How does it work?

Mr. PRISK. In the main, it has worked reasonably well. Of course, I have a biased opinion, but it handles—under recent assignments of enlarged authority from the executive committee of the American Association of State Highway Officials—not only handles the interpretations but it also handles requests for authority to experiment; and I think this is going to get a great deal more use in the situations that come up that are, indeed, unique or novel or not properly treated in the manual.

This committee may by its own action give the authority necessary to modify the standard so that the State can use a particular thing for a trial period on the condition that a report is made.

Mr. MAY. This is a committee that should act very expeditiously. There should not be much of a time lag.

Mr. PRISK. No, this worked quite rapidly. No necessity for a national ballot, State by State, which is cumbersome procedure under the normal standards.

Mr. MAY. But Mr. King, as you were suggesting, if the signing engineer, for example, cannot get it through the top echelon people of the highway department, it will never get to Mr. Prisk.

Mr. KING. I have been involved with this problem personally where I had the standard manual, where I had to do the planning, and where I had to meet a certain situation. I asked him to get a ruling on it from the national joint committee. He refused. There was no way for any forcing of the issue at the time. I got a ruling informally from Mr. Howie who at that time was chairman of the subcommittee, and even that did not convince the people in the central office to get a formal ruling. It is an administrative problem inside the highway department because there is a generation of differences between the chief highway engineer and the people making the decisions at the local level.

Mr. MAY. Is there an interpretations committee for the Joint Manual?

Mr. PRISK. This same committee now serves the Joint Manual as well as the Interstate Manual.

Mr. MAY. Is that a new move?

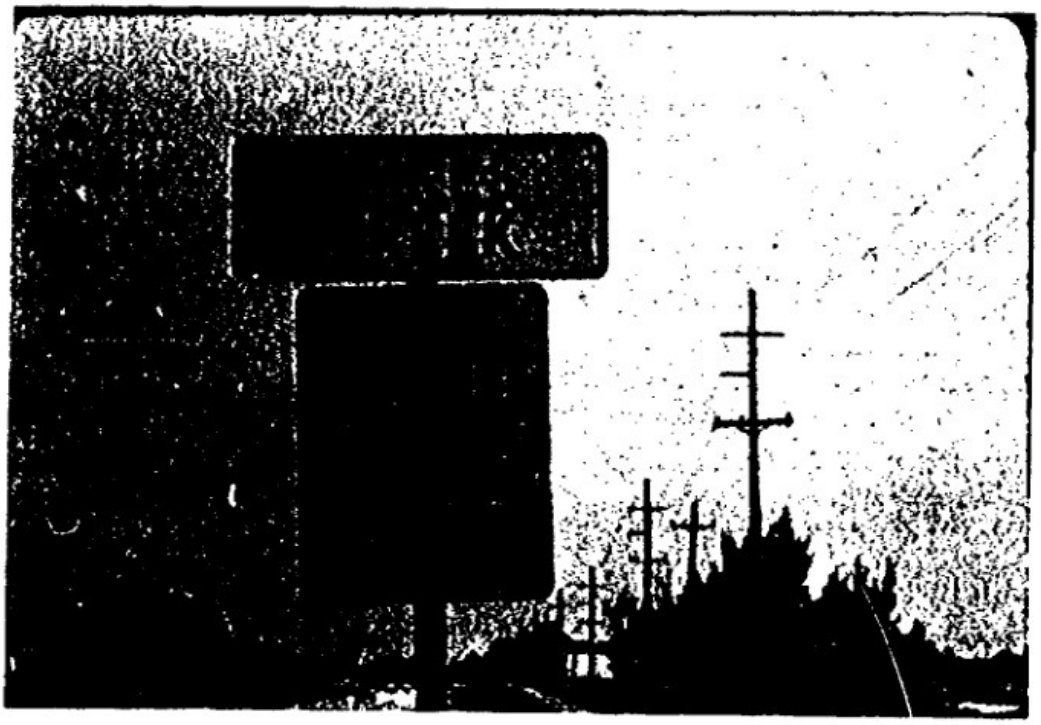
Mr. PRISK. Yes, about a year ago.

Mr. KING. This forms the background. Based on our survey of current practices and upon our own experience from talking with other people in the field, we came up with some considerations concerning signs. I would like to illustrate this with slides if it would be possible, and to leave one light on so I can read from my notes.

Mr. Alexander pointed out that we cataloged 140 driving needs, or more, if you start talking about combinations. Most of those needs exist at one time or another, but they all do not have to be met by signing.

As a matter of fact, the greatest part of the information a motorist gets is by means other than signing, and this we call informal aiding; that is, looking at the highway and following a pavement joint, and the motorist gets more information that way than he gets from formal signing.

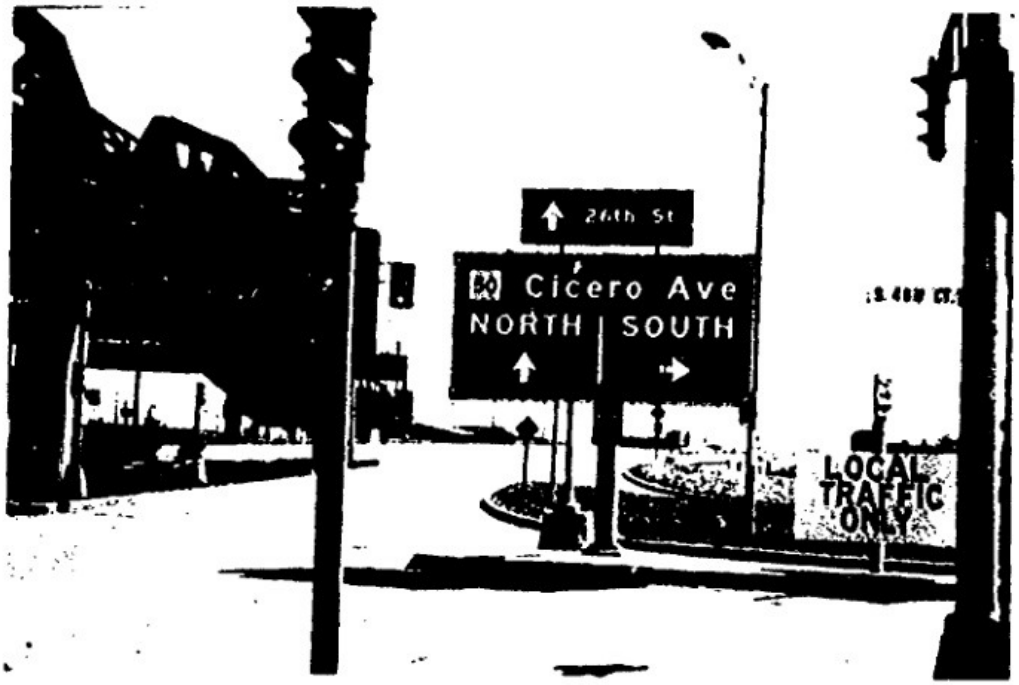
Also, a lot of the information that is very high on the primacy scale, according to our study, will fall into this unaided category.



If you put up a sign not high in primacy scale, the man must take his eye off the road to read that sign and you are violating primacy because he is getting situational microinformation from watching other cars or watching the road. This slide will ilustrate this when he takes his eyes off the road to get sign information which is not quite as important.

So, the first of the rules or principles; any sign must satisfy an information need of the highway user, and this need must have a place on the primacy scale for that particular location and the message must be received by the driver and understood in a form that can be the basis of some action which he must take. It must therefore be unambiguous and not contradict other information.

Mr. MAY. It seems clear if a fish fell out of your car you had better pick it up off the bridge according to that sign.



Mr. KING. You have a situation here, a rather complex directional decision point where you are carrying a ramp of a major interchange of two Federal highways through a local street system.

You have a major directional sign informing people which way to follow a certain route and this is suppplemented on the lower right by a sign erected by local authority because of complaints of noise, saying "local traffic only."

Mr. MAY. What does that mean?

Mr. KING. "Local traffic only," as defined by the laws of this particular location which happens to be one of the suburbs of Chicago, means only traffic that has a destination in that area of the next few blocks.

Mr. MAY. If I were a stranger driving here and I wanted to go south on Cicero Avenue I might be perplexed by the local traffic sign.

Mr. KING. Yes, you would not know what to do. You have one sign telling you to go that way and another sign that tells you you cannot go that way.

Mr. MAY. I would not be perplexed by the yellow sign underneath because it is so small I cannot read it.

Mr. KING. The yellow sign says "no trucks," if I remember correctly.



This slide shows another situation where the driver is faced with two different pieces of information.

Mr. MAY. That black on white sign is a regulatory sign?

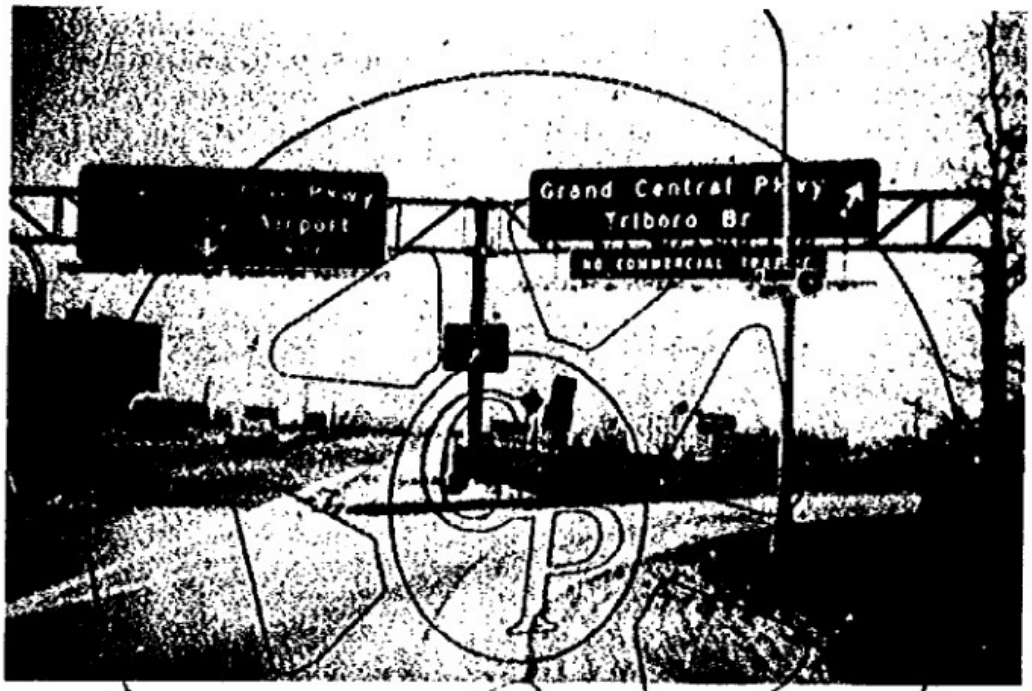
Mr. KING. The black on white is a regulatory sign.

Mr. MAY. If I go over 25 I am subject to arrest; yet a few feet away, it says "Safe Speed 30 Miles an Hour."

Mr. KING. The yellow sign that says 30 miles per hour is the recommended speed to go around that curve.

Mr. MAY. How would this come about?

Mr. KING. This came about by efficiency when this particular route was being re-signed. The speed limit was raised from 25 to 40. There was no advisory speed limit sign initially. They were going to be very efficient here. They were going to put all the curve signs up at one time and all the regulatory speed-limit signs up after that.



Something happened because this situation existed for 6 weeks.

Mr. Alexander talked before about reception characteristics. I am talking about transmission. In order for a motorist to react to the information in a sign he must understand the message as quickly and as clearly as possible.

In many cases there will be more things to look at than he has time or capacity to look at, so I would like to illustrate a series of factors which tend to enhance quick and clear understanding. The first of these we call comprehension. The message on the sign should minimize all potential sources of misinterpretation or ambiguity. It should not depend on the high order of logical deduction to be comprehensible. The amount of prior knowledge necessary for comprehension—and that includes knowledge of the coding system should be that which you can reasonably expect a motorist to have. Here, we have a signing situation which tells the motorist that the road that he will get on is called Grand Central Parkway. The word "Parkway" in New York has a coded meaning. It means it is an express-type road on which commercial traffic is prohibited. To any New Yorker that is a nice road to get on.

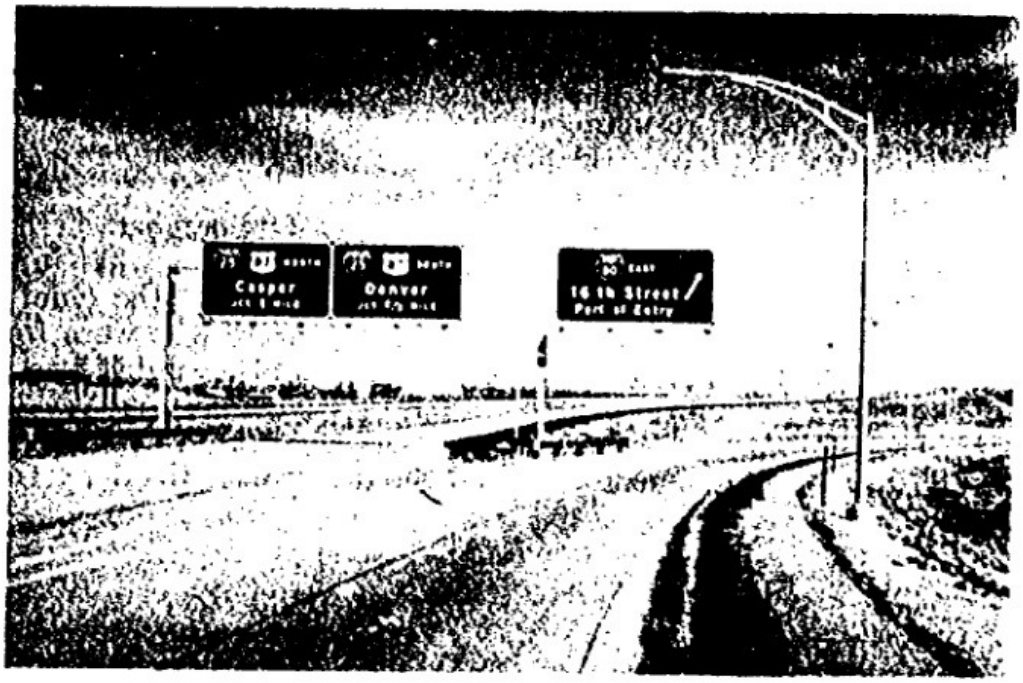


Now he gets out to this particular location and sees the word "Parkway" again.

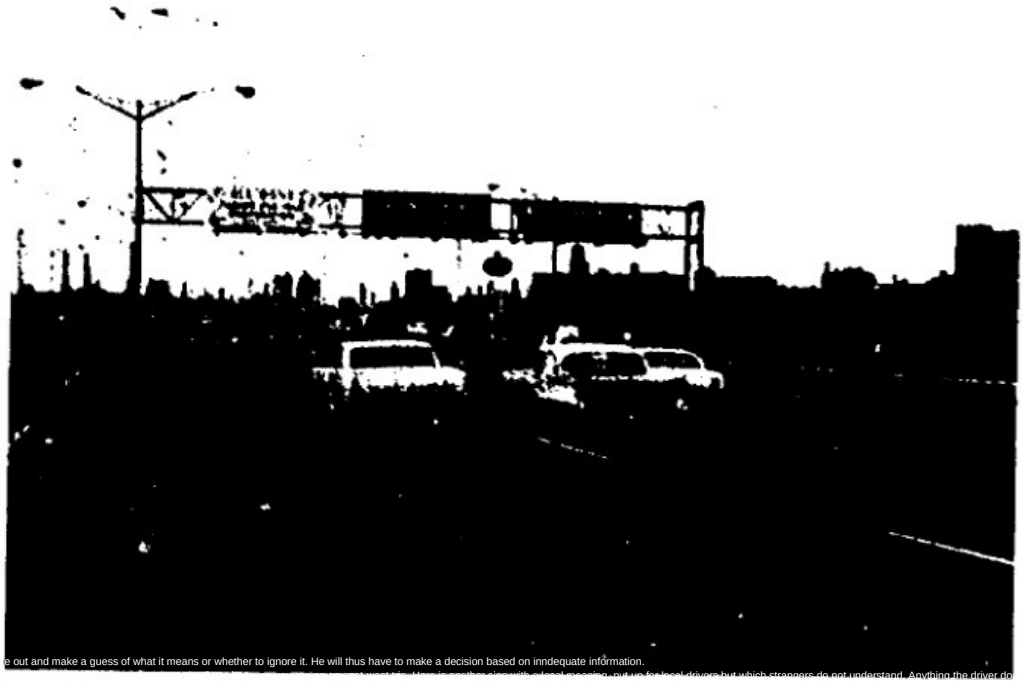
Mr. MAY. Which way does he go?

Mr. KING. In this particular area the word "Parkway" means median. One thing that traffic engineers have to realize, and they are beginning to, is that local areas are beginning to lose meaning. You may not have uniformity of signing yet, but due to the Interstate System we have uniformity of highway travel. Due to longer vacations and more affluence, the man who is driving in Oregon is just as likely to have learned his driving in New York as in California and words do not mean the same thing in various parts of the country.

Any word that is likely to have different interpretation, like "Parkway" has here, has to be avoided or some other means found to explain it.



This happens to be in Colorado. I took this picture and I have yet to know what "Port of Entry" means. I think it means a truck weighing station, but I am not sure. This is not the first exit you encounter as you enter the State because you are on an east-west trip. Here is another sign with a local meaning, put up for local drivers but which strangers do not understand. Anything the driver does not understand is going to lead to trouble because he is going to have to make a decision and try to figure out and make a guess of what it means or whether to ignore it. He will thus have to make a decision based on inndequate information.



e out and make a guess of what it means or whether to ignore it. He will thus have to make a decision based on inndequate information.

The next principle is one we call "emphasis." That is, the most important information needed by drivers and requiring the most immediate decision or which could have the most adverse affect should be emphasized by either size or location.

In this particular case we have one sign in bright colors. It has been erected as part of a directional assembly and has nothing to do with the driving task.

There was a major resurfacing job at this location and had been finished. There is no place in the primacy scale for that.

Mr. MAY. How long did they leave that up?

Mr. KING. It was up about 3 or 4 weeks, if I remember correctly.

Mr. MAY. "All done, thanks for your cooperation" is what it says.

Mr. KING. That was done at the personal order of the chief administrative officer over the protest of the engineers who were forced to put it up. But for any drivers, the natural impulse would be to look at that sign first and not the others.

Mr. OLSEN. Does it have the Governor's name on it?

Mr. KING. No, as I remember it had the director of the department of public works.



The third principle we call "rejectability." Any comprehensive signing installation should be so designed that the motorist, with other things to watch, should be able to reject that information which he does not need as soon and as easily as possible.

Here you have a lot of information and there is no differentiation. You have information on how to get to Detroit. This happens to be in Chicago. You have the name of the cross street, which is strictly information on which you cannot possibly act, but it is all in the same type face, the same size. There is no way at one glance you can pick out the most important piece of information for you.

Mr. McDONALD. Does that say Interstate 90 to Detroit?

Mr. KING. Yes.

Mr. McDONALD. It is not correct, to my knowledge.

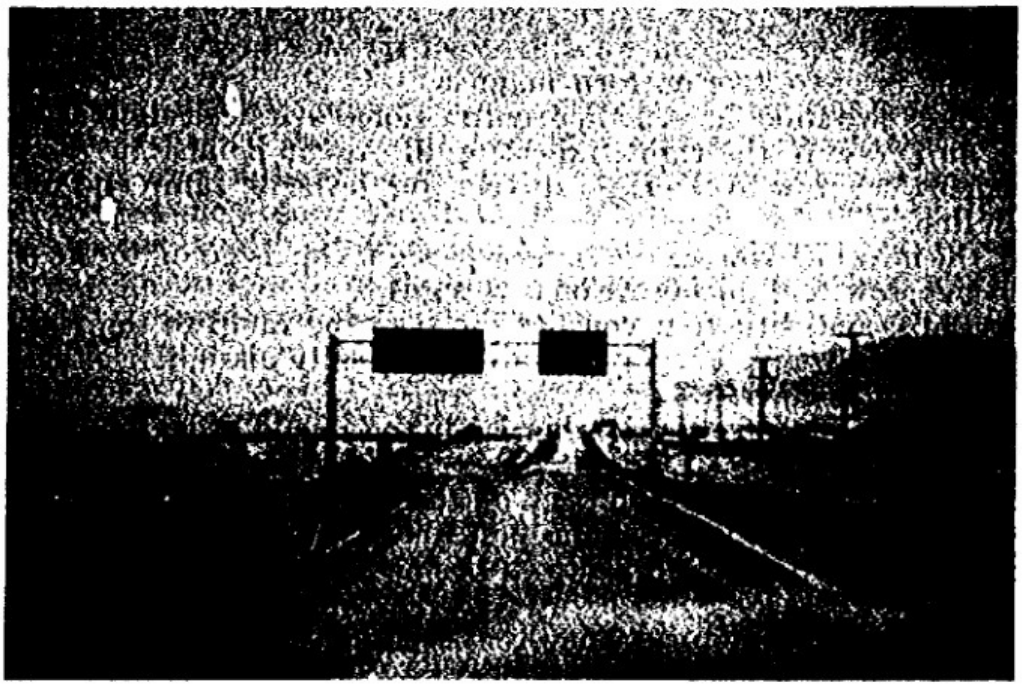
Mr. KING. It is not. This is a commercial advertising message for Chicago, where tolls have been running slightly below expectations. If you will follow this sign, it would lead you on to the Chicago Skyway.

Mr. MAY. Are you in good shape if you are looking for 67th Street because it is shown four times?

Mr. KING. I could talk for a half hour on this particular slide because it shows an awful lot. Garfield Boulevard happens to be 55th Street. You have Marquette Road which is 67th Street. You will see Garfield Boulevard up on the sign. The next one says 55th Street.

Mr. MAY. Should the overhead signs and ground-mounted signs be together?

Mr. KING. Well, the overhead signs have a certain design load for this truss. The Chicago area design criteria say you have to design for 100-mile-per-hour winds, which means for a given size sign bridge you allow just so many square feet of sign panel. If more information is required you have to put it somewhere else or scrap your $10,000 investment in your sign bridge and put up a bigger one.



The next principle relates to "expectancy." Mr. Alexander has covered this already. The legend and location of a sign should conform to what the driver expects it to be.

Another principle is "uniformity." Furnish similar types of information in similar decision situations. This is one principle the traffic engineering profession has accepted and is at the same level as motherhood, so nobody talks against it.



The opposite of this is just as important but is not as widely accepted. Dissimilar, unusual, and unique situations could be indicated in a different manner and we should not try to squeeze them into the available, or nearest, or uniform manner.

In these two slides here, standard directional overhead signs are used with an arrow to the right indicating divergent points. In the first instance the arrow to the right directs you to the off ramp and off the main line.

In the next one you see the same type sign. One is going to the right with an arrow, and shields are on both signs.

In the second situation you have to take the ramp to the right to take the main route. They are handling basically dissimilar situations in a uniform manner.

Mr. MAY. You have another burden in the second slide. I notice that both routes say "83."

Mr. KING. Yes. The green back on the Interstate shield, instead of the regular blue means it is a business route. If you follow it, you will presumably get to some downtown business district and in this case it would be York, Pa.

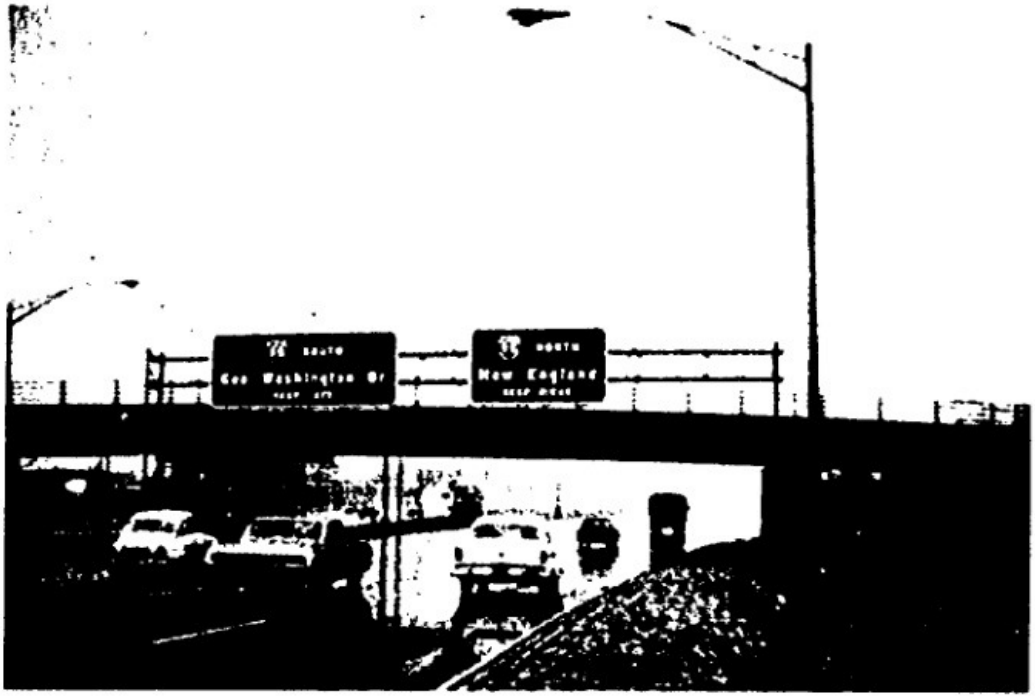
Mr. MAY. If the motorist knew that, it might help him in a situation like this.

Mr. KING. If the motorist did his homework and wrote away to AASHO for the listing of all Interstate routes for mileage and terminology—there is a three-page introduction which explains all those fine points to him—and he takes the time to read it, he will learn it.

Mr. OLSEN. The other goes straight ahead. Here it looks like a left.

Mr. KING. This is a combination of a tangent off ramp at the same time, two bad ramps.

Mr. OLSEN. You better stay on the right lane to stay on the highway and make a right turn. Well, they will have to get more money.



Mr. KING. The next one I call "sign consistency." There should be some consistency to the information that you are giving and to the words used, and to the arrangement of the information that makes it easier to read and absorb. For instance, on this one you have two signs showing a major fork ahead at Interstate 95. They are very consistent in arrangement. You have a shield with destination on the top line. You have a message on the next line, but to look at it, you are mixing apples and pears. You are comparing in one case on the right sign, a destination which is six States. In the other case your destination is one very specific place.

Also, as Mr. Alexander points out in this particular location, the George Washington Bridge is slightly north and west. It is also a misnomer, because if you want to go to Vermont, or western Massachusetts, which are definitely parts of New England, you will be going out of the way going to the right because that would lead you to Boston. If you go to the left, it leads you straight up the Hudson Valley. While I have this slide on, I can anticipate something I want to cover in detail which is a question of emphasis.

The most important thing to the motorist on a sign is that which tells him what to do. This is called an action message. After he has absorbed the information as to what the road is called and where does it go, the important thing that he has to react to is, what do I do about it? In this case, do I keep to the right or keep left, and these messages are the smallest things on the sign. This sign tells him "95 North" and which is a coded message which tells him it goes to New England—if he has done his homework. Incidentally, it does not go north until after it has gone east for about 100 miles to New London, Conn.

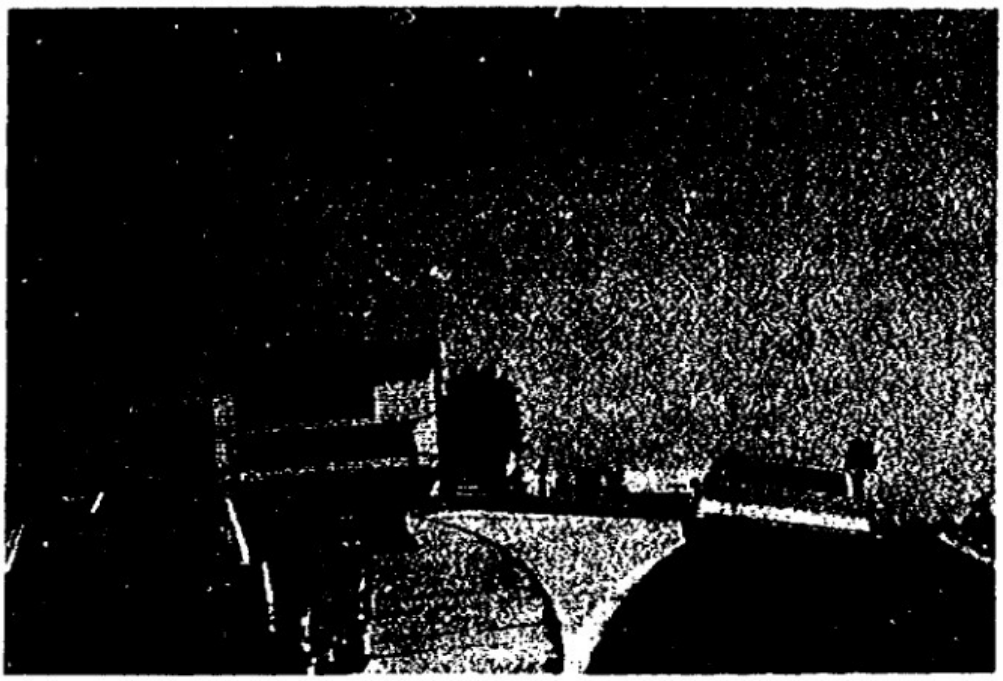
It does tell him New England, which is slightly inaccurate, but which information was given by "95 North" previously. You are giving him two pieces of information twice. If he wants to go there, he better stay right.

These six factors apply to individual signs, any sign, any situation. There is a series of other factors which apply if you have a series of signs to give a continuous message. One of those is "repetition." It is necessary to repeat information. First of all, the driver may miss it the first time. He may be looking at something else, or be telling the kids in the back to shut up, or be asking his wife if she is ready to stop for lunch.

The sign may be physically blocked from view or he may forget it between the time he first sees the sign and the time he gets to the decision point.



This slide shows a situation coming off an Interstate with a temporary end of an Interstate. Driving around a rather sharp curve all of a sudden you hit this situation. You have one chance to decide among nine or 10 different possibilities which one you want to take. It is possible if you are a fast reader and are vigilant enough to know which route you want exactly. Under this situation you could probably do it.



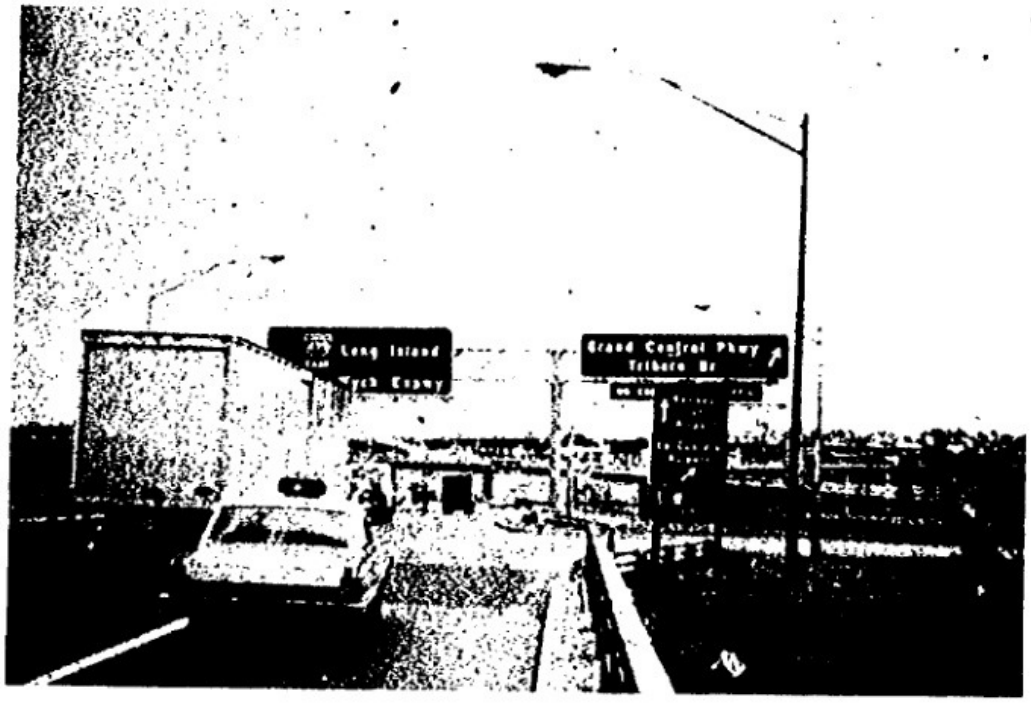
But take the situation in this slide where you are driving the blue station wagon shown there, and coming around the curve, you have no chance to find the direction unless you pull into that gore area and read the signs because the truck happened to be there in front of you.

The next principle is what we call "consistency of legend." What it means is that if you are telling somebody a piece of information and if you repeat it, you should call it by the same name. If you say "Exit 19 is one mile ahead," the next sign should say "exit 19 one-quarter mile;" it should not say 1,500 feet. You are asking the driver there to make one more mental maneuver to translate those two items of information. I do not have a slide for the point.



The next principle is "exclusiveness." Do not tell or give the driver any information beyond the point where he can safely make a decision based on that information. If you have decided in signing that a half-mile before the exit, the driver must commit himself to that exit to be able to make the exiting maneuver safely under all conditions, do not then tell him more about the exit.

This is the same area we illustrated in the ninth slide of our program. Here is an advance sign that says "Grand Central Parkway, Triborough Bridge, keep right." Anybody looking for the Grand Central Parkway might not know that the Grand Central Parkway goes in one direction to the right and another direction straight ahead, at the area ahead.



This next slide, illustrating the same point, is the exit for the Grand Central Parkway and the Triborough Bridge. He is suddenly told now that he can get to the Kennedy Airport which a lot of people out of town may be looking for.

Mr. MAY. You are looking at two airports and signs there.



Mr. KING. Another situation, not to be hard on New York, for you can find it across the country. Here you have a bifurcation and are told to go right for 85, and left and straight ahead to get to Interstate 25 which happens to be a connecting link between incomplete sections of 25 and 87.



This is fine except that this sign a half-mile downstream, an advance warning sign, tells you about 85 or 87 but does not mention Interstate 25. In order for a man to understand and to be able to act and choose an alternative at a decision point he is going to have to know what each alternative implies.

On the next slide you see an intersection of two roads, a U.S. highway, and you are told to go on 57 and 86 you go left; and 57 and 86



you go right. You have to go around that little island to get where you are going. It does not tell you one thing. It does not tell you how to stay on U.S. 70 which you happen to be on.

Mr. MAY. How do you go?

Mr. KING. You go straight ahead.

Mr. ALEXANDER. You go right.

Mr. KING. You go around the island and make a right in the same general direction you have been going.

Mr. OLSEN. Where is that?

Mr. KING. In North Carolina. It does tell you a half mile before on the advance warning signing, to go straight ahead in an an area where about six places converge but you happen to miss it there.

Those are the factors which we have to consider with a sign message, a sign location, a sign sequence to get the message as comprehensible, as quickly and as accurately as possible. The next big aspect is to make sure that once the man can see the sign and read the message that he can detect the sign itself and read the message.



This slide is a situation where it is hard to detect the sign. You have a situation where you are coming down a hill around another sharp curve. You have a driver coming out in front of you. Just before you get to this situation, you are faced by a large sign which says "Road Slippery When Wet." You see the road ahead of you. Then you see a series of signs which blend very nicely with the landscape. You have a divided highway which is an important piece of information. You have a stop sign which is another important piece of information.

You have a sign in the middle which says "End 30-Mile Speed Limit" which is interesting information. I do not know what the motorist is supposed to do about it because he is coming to the intersection and he has to stop and one moment after he turns in either direction at the cross street, the speed limit is immediately 50 miles an hour.

Mr. MAY. If he is lucky he will not see it.



Mr. KING. There might be other things to look at like on the next slide you have a whole lot of things to look at, not the least of which is a girl standing there. Here you have a big Gulf sign. You have a cleaner. Gas at 31 cents and you have three other numbers which again blend very nicely into the surroundings. This is in Florida.

Mr. OLSEN. What is the other sign on the sign post, at the bottom? Is that some type of code number?

Mr. KING. I believe that is the sign to tell the highway foreman what to charge his maintenance to.

Mr. MAY. What is that number 55020, on that sign?

Mr. KING. It is undoubtedly some administration designation, construction or maintenance. I do not know what it is.



Before going into the next subject I would like to show two more slides and signs which represent a sort of pet beef of mine. Signing engineers and the traffic engineer really are not in the entertainment business and they are not supposed to distract the motorist. I have not played this on the piano, so I assume it is correct. I do think Mr. Alexander's analysis would show that configuration on this sign is not necessary except possibly the fact that it was Suwannee River.



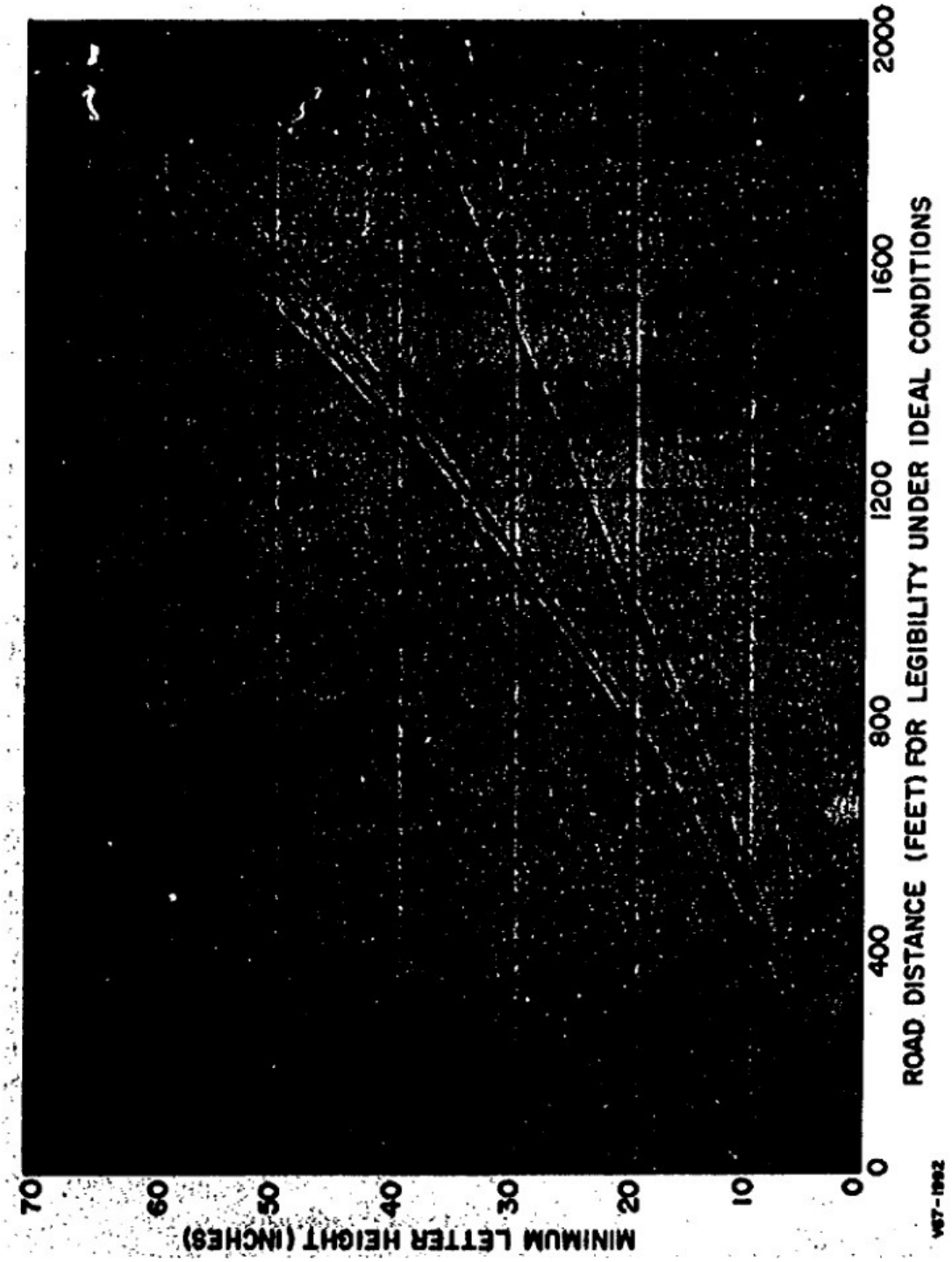
Another example is that people try to get cute to attract the driver's attention. This probably might save a child from injury, though I doubt it; but I am willing to bet that for every possible injury to a child you are going to have five rear-end collisions by people who jam on their brakes because they do not believe what they have seen. Turn the lights on now.

Mr. KING. I do want to touch upon legibility. Since Dr. Hulbert went into this extensively I will only speak briefly. The traffic profession uses sort of a rule of thumb, that is they use 50 feet of distance for every inch of letter height in signs, which is fine if everybody has 20/23 vision or higher. In three States of the Union you can get a driver's license with 20/70 vision and they are not small States—two of them are Pennsylvania and Texas. So, 50 feet to the inch is slightly on the skimpy side, shall we say.

On the other hand, if you design for 20/70 vision or as Dr. Hulbert once proposed in a private conversation if you really want to allow 20/70 people to get licenses you take into account the degradation of vision since the man got his license and should design for 20/100. This means the sign now designed with 24-inch letters is going to have 10-foot high letters for the same visibility.

To really make this a usable system, the letter sizes now used are too small. They are especially too small if you start talking about night visibility. Nighttime your sight is generally limited to the distance provided by the headlights in most cases, but there are some internally illuminated signs or externally illuminated but they are in the minority.

As part of our research project we have made an elaborate and extensive computer analysis of the night illumination and signing problem. I do not want to discuss this in detail because I was only in a consulting capacity, but Mr. Adler from Airborne Instruments and Dr. Straub from Clarkson University conducted most of the work. What we did in this computer, we actually simulated the road and the headlights of a vehicle approaching and the amount of light that gets reflected back from the sign to the driver's eye. They compared the amount of light that gets back to the driver's eye with some previously published work on how much light he needs to see and here is a set of curves for ideal conditions. On the left is letter height in inches.



Now, across the bottom is the point measured upstream from the sign at which the sign becomes legible and you will see a curve for high-beam illumination. This is for a sign that I will come back to, which is placed 2 feet off the edge of the shoulder of the road as used to be the standard.

On the top are the curves for low-beam illumination and those three curves represent signs that are respectively 20, 40, and 60 feet wide.

You see, for a sign supposed to be visible at 1,200 feet, for high beam it becomes visible if it has 24-inch letters, but for low-beam driving, the same visibility requires 35- or 36-inch letters.

There are people, including traffic engineers, who still assume that

most rural driving is done with high beams. There has only been one study made to my knowledge of that, in one of the Dakotas, and it showed that even on a rural highway in light traffic conditions at night high-beam usage was less than 50 percent of all drivers. People just do not want to bother with switching back and forth and they forget what beam they are in.

I think it is a mistake to design for high-beam users. In designing for low-beam users you either get into completely unmanageable letter sizes or you have to resort to external or internal illumination of the sign, which is quite an expensive proceeding.

This is especially true of overhead signs which often are not readable under low-beam conditions. The headlight beam just does not get up that high. When we made our survey of the States we got varied responses. Some States have uniform rules, illuminate all overhead signs. Other States say only in rural areas. Others say, "Well, it is nice, we will illuminate it when we have convenient access to power sources." Those places having convenient access to power sources are generally in urban areas. It is out in the country where it is pitch dark that they need it the most.

Here is another thing where you have to decide to spend money and sometimes bringing in a line 10 miles long costs a lot of money in order to do the job properly.

Before the next area I want to cover one specific application of this. The human factors analysis and list of principles I have gone through just now are applied to the problem of the directional signing; what do we come up with?

We are talking about macroperformance needs, and before you do any signing you must be clear and certain about the information given to the motorist; what are the purposes?

Let me illustrate. What are the purposes of directional information? You have three main purposes. You tell the motorist where he is, you tell him which way he is going, and you tell him the proper way to where he wants to go. These are the main or primary purposes; then you have a set of alternative, secondary, purposes which are things he would like to know.

PURPOSES OF DIRECTIONAL INFORMATION

A. PRIMARY

- WHERE AM I?
- WHICH WAY AM I GOING?
- IS THIS THE PROPER WAY TO MY DESTINATION?

B. SECONDARY

- WHAT ALTERNATE ROUTES GO TO MY DESTINATION?
- WHAT ALTERNATE DESTINATIONS (INCLUDING SERVICES) CAN BE REACHED FROM HERE?
- WHERE CAN I GET THIS INFORMATION IN MORE DETAIL?

For instance he would like to know, Is there a different way of going to my destination? Is there a different place I could go to from this particular point, say, like a service facility, and where I can then get more information?

What this amounts to is that if you are taking a trip from beginning to end, the information the driver needs during his trip is a description of his trip from its origin to its destination.

Now you can describe a trip in a lot of different ways. There are two main classifications: one we call a goal-oriented trip. That means you are going from and to. You are going from New York to Washington, from Scranton to Cleveland let us say. The other way of describing a trip is you are going on a certain route. You are taking a trip on Interstate 95 or the Pennsylvania Turnpike.

This becomes very important when you decide what or how to give that information to the motorist because if you start figuring out the number of possible trips passing through a certain point or a given point on the highway where you are going to put up a directional sign like we talked about before, such a point on the beltway, and you want to try to sign this to conform to the driver's prior information, that is, to the way he has made his trip plan, if you sign it, and if you train the driver or expect the driver to have made a goal oriented trip line—the number of possible trip plans that you have becomes almost infinite.

I do not think that anyway of determining how many possible destinations and origins there are for trips is possible. There are approximately 20,000 different places listed by the Census Bureau. I assume at least every one of those could be a destination or origin. As Mr. Alexander points out, if you want to conform to the expectancy that as so on as you leave your house you will find a sign to the destination, that means 20,000 destinations. Then if you combine that with the fact that you really should have letters 20 feet high so that the worst vision driver can read it, the United States would become one big billboard.

On the other hand, if you go into a route-oriented trip plan, the people at that same point on the beltway who may have any origin or destination to their trip have one thing in common—somewhere on that trip plan it says use beltway, and that is the element in common to their trip plan.

Of course, the bureau has an extensive research effort underway. This is moot. Under this concept you will just punch your destination into your little gadget on your dashboard and at every decision point it will tell you where to go, straight, left or right. It is nice, but it is some time away, and in the meantime we have got to make sure the people can find their way to where they are going without backing down ramps on the way.

If we go on the premise that you cannot tell the driver how to get to any possible destination you have to restructure his expectancy and that goes into the area of education, driver training, driver licensing. You must tell the driver that it is physically impossible for us, the traffic engineers, to tell you how to get to your destination but if you know how to get there, and if you know which route to take, we will tell you exactly where that route is and how to get on it.

If you do your homework, then you will be able to get to anywhere in the United States. Of course, you are talking about education, you are talking about training, you are talking about mapmaking again.

Mr. MAY. At the moment, none of these things is being done.

Mr. KING. There is no State that requires map reading as part of driver licensing requirements. There is one State of the 16 that I went to where they sent somebody from their State highway department to a driver training class to give them some idea about what interchange configurations are and how to follow what the highway signing means and how to read it.

I think that it is time that we stopped this guessing game that has been going on ever since national signing started.

Mr. MAY. Excuse me, Mr. King, we are going to have to conclude today. Mr. Chairman, I would ask permission for Mr. King to set forth the rest of his testimony in writing to us for inclusion in the record at this point.

Mr. OLSEN. It will be entered into the record at this point as though it were actually recited.

(The supplementary testimony of Mr. King follows:)

If we tell the driver that all directional signing will be in terms of routes and not in terms of destinations we can stop the traffic engineers trying to guess where drivers want to go and drivers guessing where traffic engineers think that they want to go. The purpose of signing will be to help a driver follow a previously made, route oriented, trip plan. We have worked out some of the practical implications of this. It takes up over forty pages in our final report and I will try to summarize it briefly here.

To implement a route-oriented trip plan, the driver must be able to match potential highway links with desired ones. He will therefore, require information concerning the link he is on (designation of route and direction of travel). At each decision point, he will also require this same information about any other route he could take. These information requirements will be identical for all drivers passing a given point, independent of origin, destination, or premises controlling the choice of route. For the standard case of the intersection or interchange of two bidirectional routes, this involves the description of three highway links, by designation and direction, together with an "action" message.

The term "action message" is used here to include all the information required by the driver to place his vehicle on the proper link after this link has been selected as proper from among all possible alternates. It includes such elements as arrows and verbal descriptions, right or left, which denote a path as well as, in the case of advance signing, information on the distance to the divergence or junction point and mandatory or recommended lane assignment. The action message thus satisfies the situational needs of macroperformance as well as structuring the driver's expectancies in this regard.

Without considering factors of possible descriptive systems, redundancy, repetition or attenuation, it can be seen that this information requirement can be met by displaying or transmitting four message units. This falls easily within the limitations of the sign channel. This channel can, therefore, continue to be used as the principal means of transmitting this type of information.

With this principle established, its implementation depends on answers to the following questions:

1. How will a route be described?
2. How will a direction of travel be described?
3. How will an action message be given?
4. How will these elements be arranged?
5. Where will the information be given?
6. How often will the information be repeated?

The first three questions deal with the "language" in which the transmitter of information (the traffic engineer) communicates with the receiver of information (the driver). If questions one through three are described as dealing with the "language" of the communication, then questions four through six can be described as dealing with the "efficiency" of the communication.

There are many different systems by which routes can be described, these fall generally into one of three categories: by some meaningful name, by an arbitrary designation such as a letter or a number, or in terms of its endpoints.

It is open to question whether any effort aimed at standardizing these nomenclature systems is worthwhile. The many arguments in favor of the exclusive use of a basically arbitrary system, route numbers, are well-known. Experience has shown that this system has not found full acceptance by the driving population. Whether this lack of acceptance is a basic fault of the system or a fault of the method of implementation (especially the lack of any meaningful and far-reaching public education and information campaign), or consistency of implementation, has not been determined. The difficulty of redesignating routes, and obtaining public acceptance of the new designation, has been demonstrated in many cases.

However, especially in view of the advisability of redundancy in the presentation of information discussed previously, this decision does not have to be made. The partial popular acceptance of route numbers, the undisputed advantages of this system, and the fact that this system is the one that lends itself most easily to computer coding and routing are sufficient reasons to retain it. On the other hand, local, meaningful names which have achieved popular acceptance, cannot be eradicated especially since these names will continue to be used for all nonhighway description purposes.

It is therefore recommended that a route be described by both its numerical designation, if it has one, and by a local, meaningful name. This does not mean that there should be no changes in the present nomenclature systems. Inconsistencies and ambiguities that have arisen must be eliminated. At least five numerical systems now coexist (Interstate, U.S., state, county, and city streets) to which must be added interchange numbering and mile posting. The highway user cannot be expected to absorb the information that U.S. 45 and State Route 50, running concurrently along 40th Street, interchange with Interstate 55, at exit 35, which falls near mile post 30.*

There are a number of possible methods to denote direction. Three of the more prevalent ones may be characterized as common reference, compass reference, and map reference. Common reference direction designations use such common terms as up, down, right, left, clockwise, etc. Compass reference direction designations use some variations on the compass rose ranging in complexity from the four cardinal directions to compass bearings given to the nearest degree. Finally, map reference direction designations use some geographically determined location and are of the "to . . ." type. Currently, all three types of designation are used interchangeably, explicitly in some cases and implicitly in others, such as the use of destination on directional signing.

Compass directions obviously represent the most universally applicable system since they can be used to denote almost any possible direction or configuration. They have the further advantage of being an integral part of existing sign messages. Difficulties are encountered, however, in those cases where a compass direction is an integral part of the name of a route and the true compass direction, to be used in signing, is at variance with this. For instance, an existing expressway exit, in Illinois, is presently signed "East—Northwest Highway."** A current proposal to replace East with eastbound might alleviate this difficulty. There exists no definite body of knowledge delineating the driving public's actual understanding of compass directions, an its ability to use this type of direction designation in route planning and following, especially insofar as compass points other than the four cardinal directions are concerned.

Most common reference direction designators (right, left, straight up, down, etc.), suffer from the fundamental defect that they are subjective; that is, they have no absolute meaning of their own but their meaning is defined only in terms of the driver's instantaneous position and direction. Trip planning using such a system would prove to be extremely difficult and require an extremely high

*While this example is, admittedly, fanciful and exaggerated, it should be pointed out that every individual designation used does exist within the city of Chicago.

**Similarly, the Maine Highway Department has reported some difficulties with motorists driving to Portland avoiding the proper exit, signed South—Portland, by reasoning that they did not want to go to South Portland, a well-known suburb.

degree of ability in spatial perception. Furthermore, this type of designation has, traditionally, been reserved for information on the situational level and should continue to be reserved for that purpose.

Map reference direction designations are in extensive use, either by themselves or, more commonly, supplementing compass directions. This type of designation works only as long as the map reference used is the final or intermediate destination of the driver, or the driver knows the geographic relationship between the map reference and his final or intermediate destination. In a system relying on map references to denote direction, the driver, when preparing his trip plan, is placed in the position of trying to outguess the sign designer so that he can anticipate the cues that he will receive enroute. Map references, however, are valuable as redundant sources of directional information, especially when some ambiguity exists as to the "real" direction of the intersecting route (curvilinear routes or highway grids not oriented to the cardinal directions).

The above argument, obviously, does not hold in the case of signing for intersecting routes whose major or only purpose is to serve as a feeder to a single major traffic generator. Airport lead-in roads are prime examples of this and there is no reason that the name of such a major destination should not continue to serve as a designation of both the intersecting route and its direction.

A different approach to eliminate the necessity of guessing is in effect in some European countries where the lists of "official" destination designations are published (Germany, England). It is doubtful, however, whether such a method would be feasible in larger and less-density settled countries.

It can thus be seen that none of the three systems mentioned presents an absolutely clear-cut case for either adoption or rejection. In view of the restricted alphabet available in the common reference system and the need to use this system for the presentation of information on the situational level, and in view of the difficulty encountered in using a map reference system for pretrip planning, it is recommended that primary reliance for directional designations should be placed on compass directions.

Route and direction descriptions, discussed in the previous paragraphs, can be considered as defining a coordinate, or grid, system. They are sufficient to answer the question, "Which way am I going?" However, in order to answer the question, "Where am I?," another element is required. This element consists of a clear, consistent, and unequivocal method of defining points along the route. A clear method of defining individual points on the highway system is of utmost importance to the highway operating agencies, touching all facets of operation, maintenance, emergency services, and cost accounting. Furthermore, to reduce the physical requirements for information transmission to a minimum, a system should be adopted which can be used by both the driver and the highway operating agency.

A study by the Insurance Institute for Highway Safety concluded that "For maximum general public usefulness, as well as for continuous surveillance of traffic by official agencies, the physical existence of some standardized mile posting on the roadside seems unavoidable." A mileage marker system has the advantage of being easily understood, having a natural relationship to the physical features of the highway system, being useful and usable for pretrip planning, and being directly related to the odometer installed in every vehicle. The system currently in use, however, also has several disadvantages. In this system, as applied to Interstate highways, mileages are assigned on a statewide basis with the zero marker being at the South or West state line, or at the beginning of a route if it starts within the state with mileage figures increasing in a northerly or easterly direction.

Three distinct difficulties arise. The first of these is the fact that 50 percent of all trips will be made in the direction of decreasing mileage numbers. The second difficulty arises from the fact that a change of reference is encountered every time a state line is crossed. Finally, it is extremely difficult to apply this system to beltways and to loop, spur or connecting routes. These three factors, while detracting only slightly from the ability of the system to denote unequivocally the location of a vehicle within the highway system, do seriously impair the usefulness of the system in pretrip planning and in checking adherence to and progress along the planned trip.

The current system need only be modified to minimize the difficulties which now exist. Basically, the recommended system consists of initiating mile-posting for each roadway, independently and independent of state lines. Under this pro-

posal I-90, for instance, would have mile-posting ascending from 0 in Boston to 3000 in Seattle for the Westbound roadway and ascending from 0 in Seattle to 3000 in Boston for the Eastbound roadway. Each trip would then be taken in the direction of ascending mileage numbers and the travel on each highway link would be from one mileage point to another, on the same scale, with the distance traveled along that link represented by the arithmetic difference between the entering and departing mileage figures.

As far as the special connecting road configurations in urban areas are concerned, we have considered this problem in detail in our report and have arrived at, what we believe to be, workable solutions to them. These are quite detailed and technical and I won't go into them now.

The elements necessary to place a vehicle within the highway system, route direction, and location along route have now been defined and discussed. The next subject area to be discussed is how, when, and how often this information is to be given to the driver. In this connection, it must be made clear that the driver needs the information for three distinct and separate purposes as follows:

1. Pretrip planning,
2. Trip plan following (direction finding),
3. Trip plan validation (orientation).

A hypothetical trip plan will consist of a sequential list of route links defined by designation and direction which may include the length of each link (this could be in terms of gross qualitative terms, actual mileage, or driving time). It probably will not include, at least in the case of first-time trips, any information on how to transfer, physically, from one link to the next; that is, the micro and situational implementation of the micro need.

The directional information system, insofar as route following and orientation is concerned, must:

1. Inform the driver of the designation and direction of the link on which he is traveling.
2. Inform him of his location along that link.
3. Inform him of the designation and direction of all links to which he could transfer.
4. Inform him of the driving maneuvers required to accomplish each transfer.

Items 1 and 2 represent the orientation portion of the system and are accomplished by displaying route, designation, direction (except in the case of circumferential routes), and mile posts. The frequency with which this information should be given depends on such human factors as short-term memory, processing load, vigilance, and others which vary from one location to another. No strict rule can, therefore, be made as to spacing except to state that the spacing should be uniform and probably should not exceed five miles.

Mile posts, by definition and to make them usable for operating and administrative purposes of the highway authorities, should be given every mile. Where link designations are given, they should coincide with mile posts to take advantage of expectancy factors, minimize signal searching, and reduce the total number of different signs. Link designation should be repeated at every mile post to maximize consistency and minimize the demands placed on short-term memory, However, economic consideration may require a tradeoff in this area and the route and the direction designation can be shown only at every "nth" milepost as long as "n" does not exceed 5.

To meet the requirements of item 3 requires the display of the designation and direction of all highway links on which a driver could be depending for the decision he makes. Item 4 requires the display of information previously defined by the term "action message." A driver approaching a decision point and engaged in a route-following task must:

1. Recognize that this is a decision point,
2. Identify all alternate highway links emanating from this point.
3. Determine which of these links is contained in his trip plan.
4. Determine the necessary driving maneuver to place his vehicle on the selected link.

A decision point occurs every time a driver is presented with more than one possible path of action and is forced to choose one alternative. In its simplest aspect, the decision will be between two alternatives: (1) to continue on the same highway link, or (2) to transfer to a different highway link. Every interchange or intersection is thus a decision point for every driver approaching it. Therefore, the recognition that a decision point exists or is approaching follows directly from the information that more than one travel path is possible.

Usually, the class of all alternate highway links will include the continuation of the highway link by which the driver is approachng the decision point. However, the continue-diverge decision can be made only on the basis of identification of the diverging routes, since one of these must appear on the trip plan in order for the decision to be made to diverge. The information called for under item 2 must be presented to the driver at a point so that the determinations called for by items 3 and 4 can be made in sufficient time to perform the necessary driving maneuver under all expected road and traffic conditions. This driving maneuver consists essentially of adjusting the tracking and speed control performance so as to be at a given point at, or below, a given speed.

How long this will take, in terms of both time and distance, depends on a number of factors. The speed and density of traffic, the number of lanes to be crossed and the individual driving habits of motorists are some of the most important of these. No hard and fast rules can therefore be made concerning the proper location of the necessary signs. The traffic engineer must use his experience, and his knowledge of the worst traffic and climatological conditions that can be expected, in choosing the location. The present Interstate signing manual allows little variation in this placement and the only variable considered, affecting only the number of advance guide signs to be placed, is the classification of the interchange, that is, the number of vehicles using the exit. Little allowance is made for traffic conditions on the main road or for the number of lanes.

Experience, analysis of pertinent huamn factors principles, and the influence of additional factors such as attenuation and the possibility of sign blockage strongly indicate the desirability of presenting this information at least twice in separate locations. The critical sign location, as discussed before, will be the location of the second (or repeat) sign in the series. The optimum location of the first sign, with reference to the location of the second sign, is a function of short-term memory. Quantitative evaluation of short-term memory is, however, not available in the literature. Pending empirical evaluation, it is recommended that an average distance of 1 mile, in accordance with current practices, be used. This distance should be adjusted if the speed limit varies appreciably from 60 mph.

The information transmitted by the signs will have informed the driver of the possible diverging links at the approaching decision point and of the proper lane to be in to implement a decision to continue or diverge. Theoretically, no information shuold ever be presented to the driver which might influence a decision on his part, beyond the point where this decision can be implemented safely and conveniently under all conditions. According to this principle, directional information should not be repeated past the safe location. Information presented as to the beginning of the deceleration lane and the location of the exit should be kept on the situational level without designating the diverging links. In the case of single-exit interchanges, this is a feasible procedure unless the distance from the decision point, previously determined for the proper location of the main directional sign, exceeds the short-term memory span. In this case, a tradeoff will be required between the need of reinforcing the previously given information and the disadvantages of presenting what may be new information to the driver at a point when he may not be able to use it safely and conveniently.

However, a serious problem is introduced by the fact that a single decision point on the macro level may include plural decision points on the situational level. A decision to diverge from a given highway link at a given interchange is not uniquely determined; it may be possible of implementation in more than one way. Any multiple exit interchange (a simple clover leaf) is a case in point. Also included in this discussion, though somewhat different, is the case of closely spaced interchanges or other highway configuration, where the spacing between successive situational decision points is smaller than the exit-to-main-directional-sign distance.

A conflict thus arises between the need to show specific directional information to drivers in the proper lane and the hazard inherent in showing this information to drivers not in the proper lane. There are two basic methods presently available to handle this situation. The first (and preferable) method is to display this information in the normal manner that is visible to a certain extent by all drivers but at the same time making lane changes in response to this information impossible. In other words, construct a physical barrier between the existing lanes and the through lanes thus, in effect, creating a collector-distributor road simulating the single-exit case. While it is theoretically possible to

approximate this condition with regulatory signing and pavement marking, most traffic engineers would agree that a relatively low degree of observance of such a regulation is to be expected. If the method of creating a single exit configuration is used, then the beginning of the new collector-distributor road becomes the decision point and all critical distances for sign placement are made from that point.

Where physical, or other, considerations prevent adoption of this expedient, at least in the short run, and vehicles are left free to change lanes, then this directional information must be made invisible, and therefore, unusable to drivers not in the proper lane.

A sign can be "seen" but still be "invisible" if, by some coding techniques, its message is made unintelligible to all but a certain group of drivers. For the subject of the present discussion, the drivers to whom the sign applies is defined as those who have read the main directional sign. Color, shape, or verbal coding for the various distinct exit possibilities may thus be included in this sign message. The subsequent situational decision point signing will use this coding. If, as frequently occurs, the two possible diverging highway links represent two directions of the same route, then the cardinal direction, used without link designation, would be adequate coding. If different highway links, or more than two links, were involved, then a different coding system would have to be used. Color appears to be an obvious choice for this purpose. However, in view of the primary role of color as a coding device denoting class of information and in view of the problem of color blindness, it appears necessary to relegate color, in this connection at least, to the role of a secondary, redundant, coding device and to rely on primary coding of a verbal or symbolic type.

Basically, the requirement is for a consistent and comprehensive system to code all roadways usable by traffic within an interchange or within a group of closely adjacent interchanges. Interchange numbers represent an existing coding system which, in certain areas, has been amplified to cover coding of individual exit roadways.

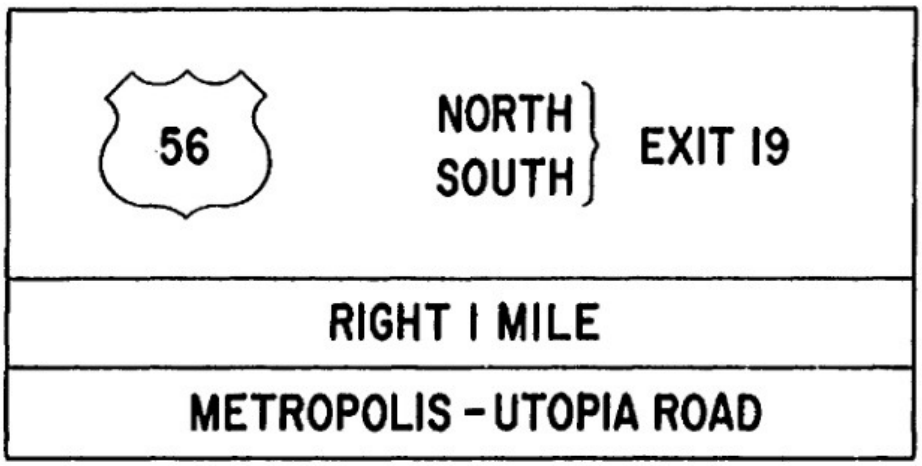
If all interchanges are numbered it then becomes possible to use a suffix to clearly identify the separate roadways within the interchange. Furthermore, this coding system would serve as a clear indication to the driver as to whether he is approaching a single- or multiple-exit interchange. As mentioned at the beginning of this discussion, the primary reason for this exit coding is to prevent reactions by the driver to information received past the "point of no return." For this reason, the code should be as arbitrary as possible and not usable by any driver who does not have the key; that is, any driver who has not read the principal directional sign. Therefore, and in order to use a coding system usable irrespective of the number of ultimate direction of exit roadways, it is recommended that the coding consist of the letters in alphabetical order starting with A, rather than a coding system tied to cardinal directions. Color, probably in the form of a background panel for the code letter, may represent a desirable degree of redundancy especially in the case of complex interchanges, using systems of collection-distribution and connecting roadways, where more than two situational decision points are encountered by the driver while transferring from one link to the next. In effect, then, the route through the interchange leading to a given highway link going in a given direction becomes a subtrip, which can be trailblazed. Care will have to be taken to ensure that all roadways leading to the same link receive the same coding.

The key element in the convenient and safe navigation of the interchange thus becomes the coding system of the individual ramps and the driver's

understanding of this system when perceived from the directional signs. This comprehension will be increased if the driver realizes the importance of this information and if his expectancies have been structured to expect this information. For this purpose, an advance directional sign is proposed whose purpose will be to alert the motorist that a macro decision point is approaching and to present him with some warning of the degree of complexity of the situational decisions that will be required. This sign, as will be seen later, will also serve the secondary purposes of identifying the through direction and, if required, showing some destinations or synonyms for cardinal directions.

Summarizing the preceding discussion, it is seen that the recommended signing for a directional decision point consists of an advance directional sign, two main directional signs, and a series of coded situational decision signs. The next subject to be discussed is, logically, the message content and arrangement of these various signs.

It is more important to show all the information than to repeat some of it for greater comprehension, and therefore, the action message on the sign should take precedence over redundant route descriptions. The interchange number, with suffixes, represents the coding key for plural-exit interchanges and can be considered part of the action message. In the case of single-exit interchanges, where such coding is not required, the interchange number becomes redundant route designation information except insofar as the absence of suffixes indicates to the driver that he is approaching a single-exit interchange. A possible layout for a main directional sign, for a single-exit interchange, is shown in Figure 10.

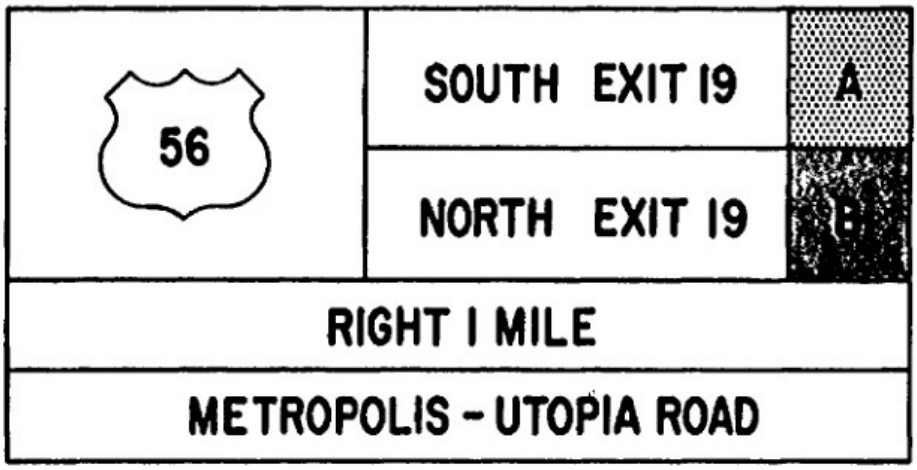


MAIN DIRECTIONAL SIGN -- SINGLE EXIT INTERCHANGE

V68-1287

FIGURE 10

Figure 11 shows a possible layout for a main directional sign for a double-exit interchange. The exit coding is contained in the suffix to the interchange number which, in addition, are recommended to be color-coded as shown. It should be emphasized that these sketches, and all other proposed sign designs in this section, show only one possible approach toward presenting the needed information. Considerable additional research will be required before these designs are finalized.



MAIN DIRECTIONAL SIGN -- DOUBLE EXIT INTERCHANGE

V68-1286

FIGURE 11

The advance directional sign is designed to structure the driver's expectancies of the driving task that will be required of him and of the information he will need to accomplish this task. This is done by a schematic representation of the interchange configuration, which will permit him to relate the approaching interchange to his past experience with similar configurations. Figures 12 and 13 show suggested designs for this sign for diamond (single exit) and clover leaf

(double exit) interchanges. As mentioned previously, this sign also identifies the through route and gives synonyms for the cardinal directions in the guise of principal destinations.

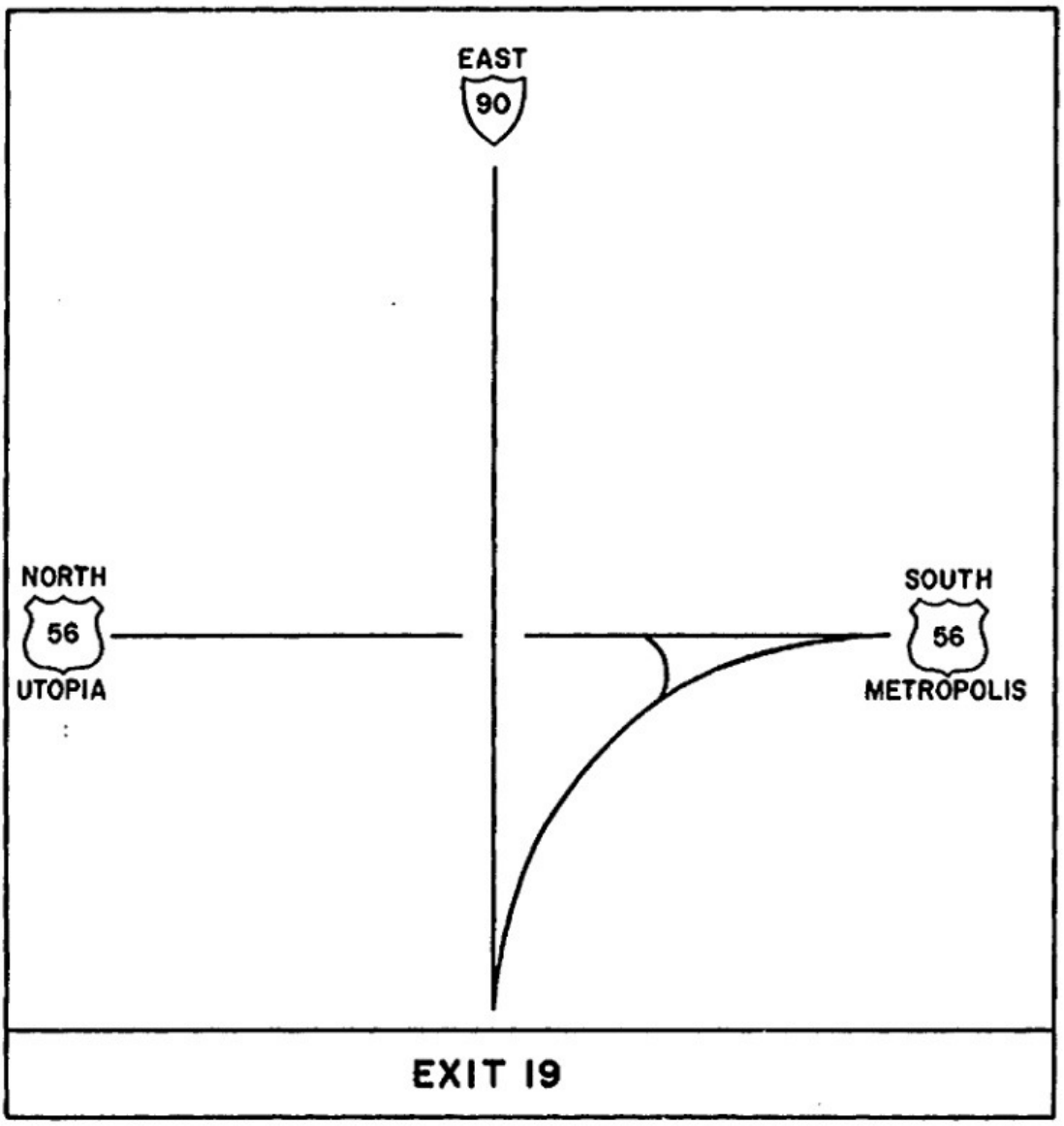


FIGURE 12.—Advance directional sign—single exit interchange.

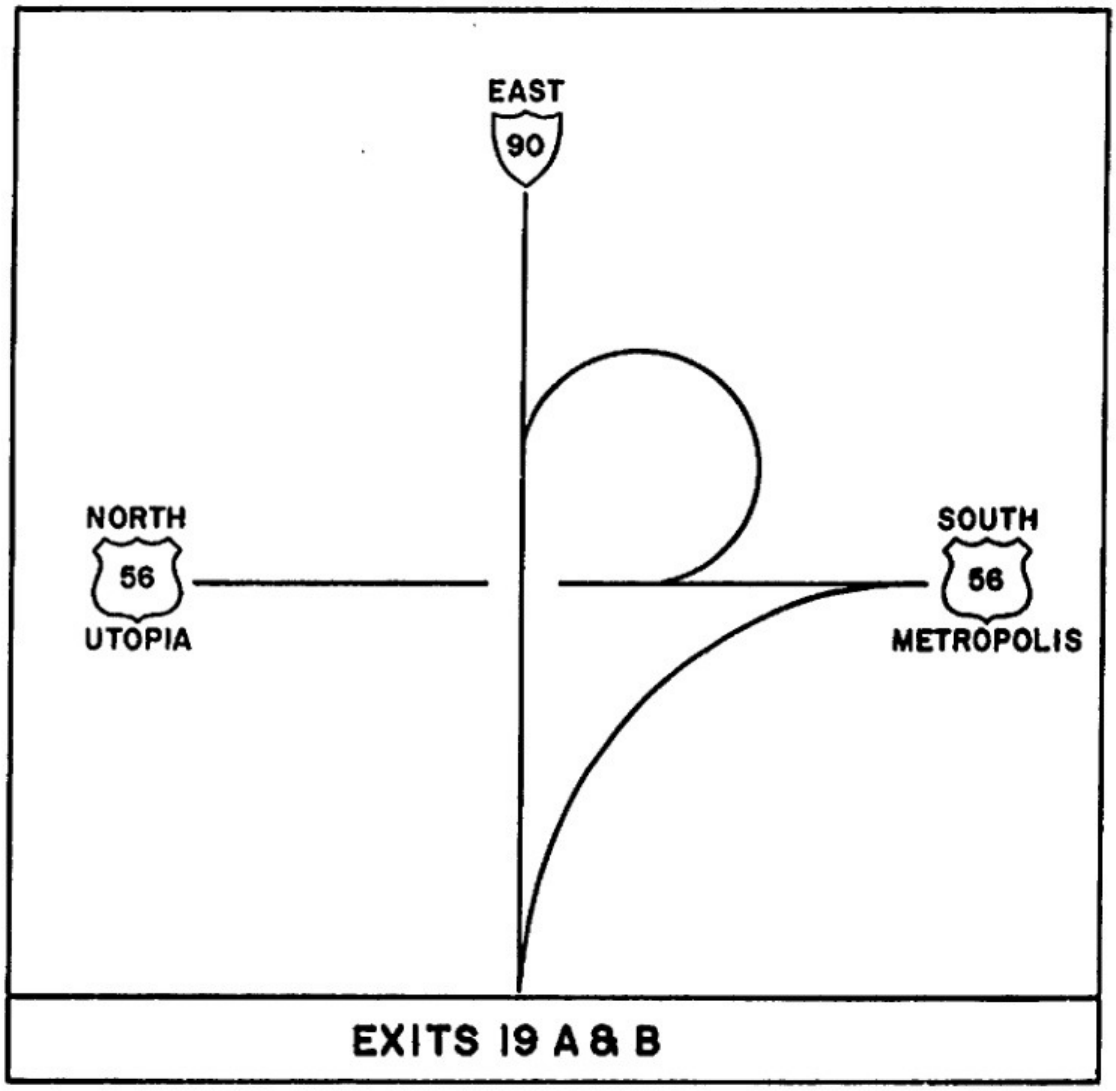
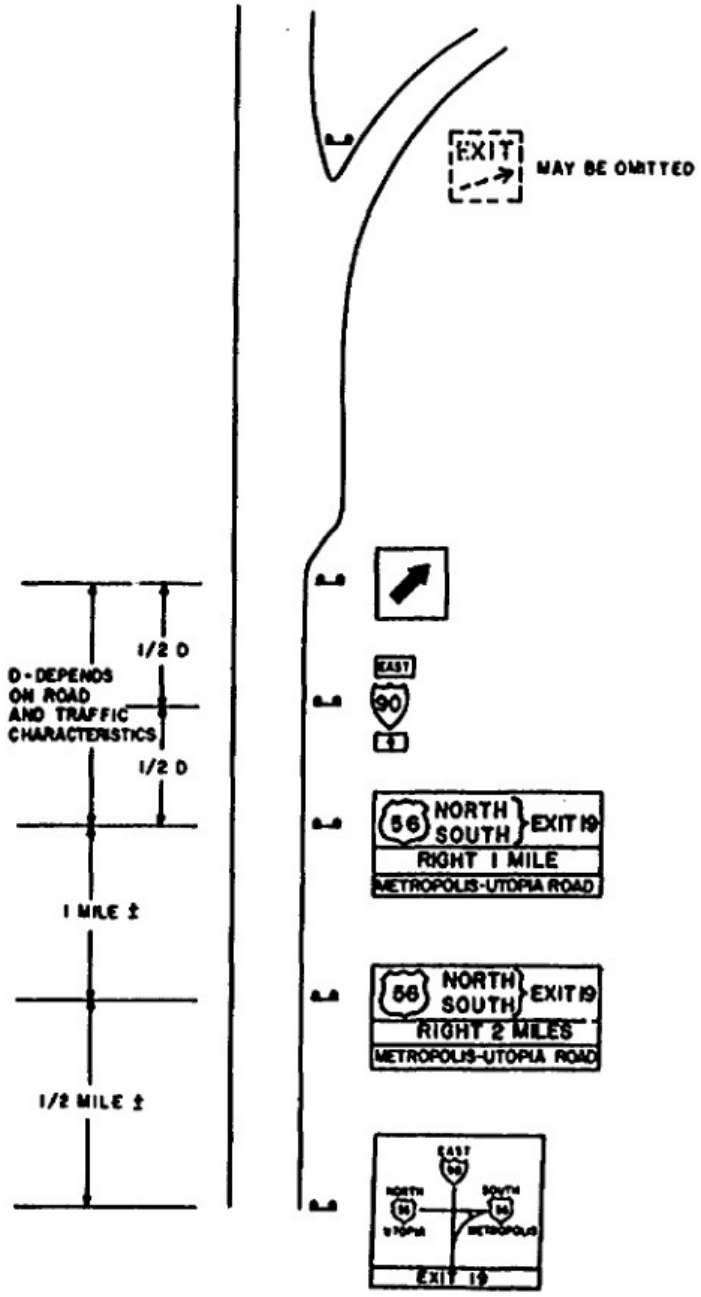


FIGURE 18.—Advance directional sign—double exit interchange.

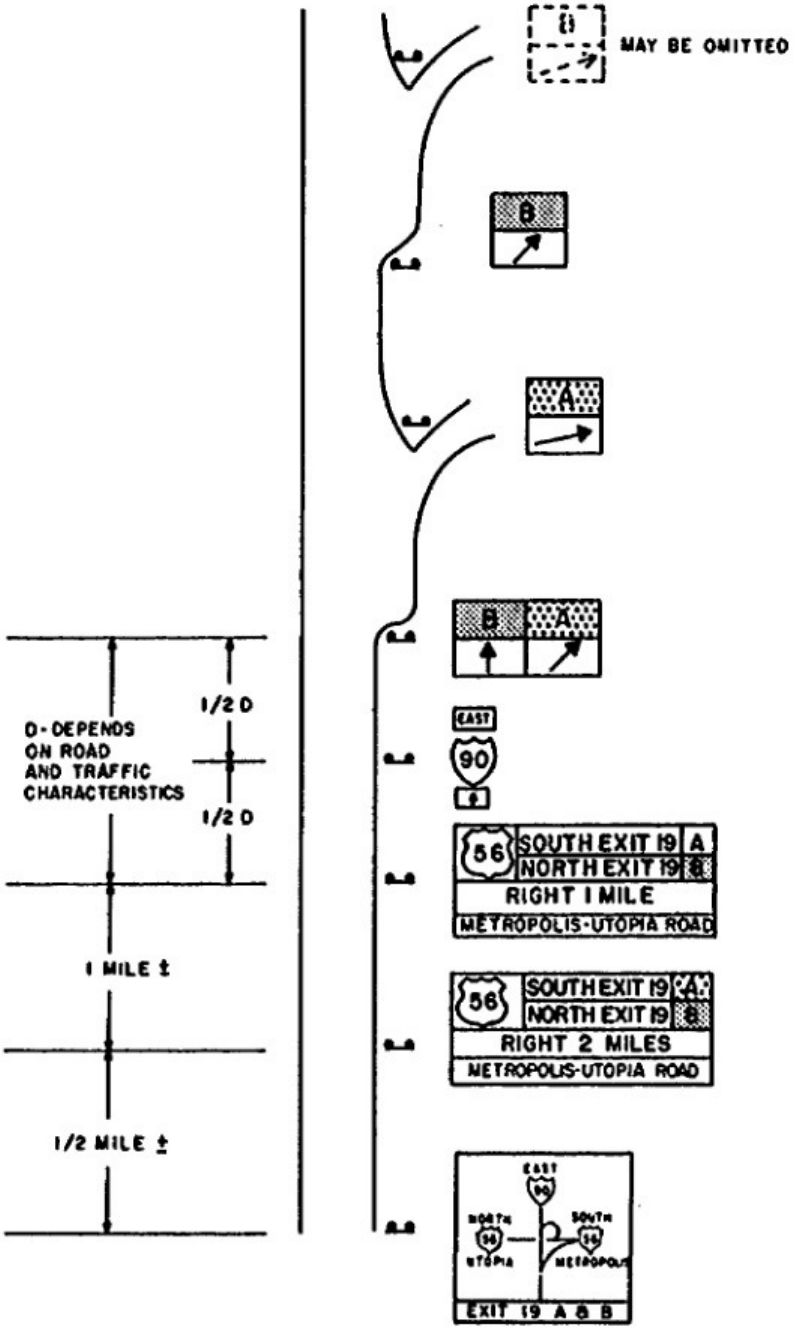
Past the location of the main direction sign ,at the decision point, no further directional information is given. All other signs contain situational information coded in accordance with the previous discusion. The situational decison points occur at the beginning of the deceleration lane, at the gore of the ramp and, in the case of complex interchanges, at subsequent exits from or intersections of collector-distributor and connecting roadways. The signing at the beginning of the deceleration lane is fairly simple and obvious and in accordance with current practices. The gore signing, however, raises some questions. Any sign located in the gore is in an exposed position and contributes to the severity of accidents involving vehicles leaving the roadway at this point. From the standpoint of highway safety, the elimination of any fixed signing in the gore, and the consequent possibility of using this location as a recovery area, is desirable. The question is whether this can be done while still meeting the information needs of the driver and without introducing uncertainty.

In the case of single-exit interchanges, any driver in the deceleration lane presumably wishes to use the ramp and, therefore, adequate delineation of the gore is all that is required. However, in the case of plural exits, the gore sign becomes more important and is essential where a common deceleration lane serves more than one exit roadway. Color-coded delineations, which have proven effective in similar applications, can be used in those instances where it is decided that the gore sign can be omitted, and would also prove beneficial as a redundant source of information even when the gore sign is erected.



V68-1291 **DIRECTIONAL SIGNING--SINGLE EXIT INTERCHANGE**

FIGURE 14



V68-1292 **DIRECTIONAL SIGNING--DOUBLE EXIT INTERCHANGE**

FIGURE 15

Figures 14 and 15 show the proposed arrangement of the signing discussed above for one approach to a diamond and clover-leaf interchange, respectively. An extension of the principles and applications already discussed would be used to develop signing for other interchange and ramp configurations. If the interchange configuration requires more precise lane assignment than can be achieved with roadside messages, then overhead sign placement must be used. This will

also be the case where lateral restrictions or sight distance limitations prevent the use of shoulder mount signs. The message content and arrangement for overhead signs will remain the same except that the through highway designations and direction should also be shown on the same structure. If lane assignment techniques are used, care must be taken that no lanes remain unassigned and that all possible alternates are clearly identified.

The type of directional signing proposed complements a previously made trip plan and, therefore, succeeds only insofar as the trip plan is correct and relatable to the signing. However, there will be times when the trip plan proves inadequate or when the driver, deliberately or inadvertently, departs from it. For the purpose of this discussion, any such occurrence will be considered a termination of the trip. Since the driver has not yet arrived at his ultimate destination, he must prepare a new trip plan to his ultimate destination, using the point on the highway system at which the previous trip terminated as the new origin.

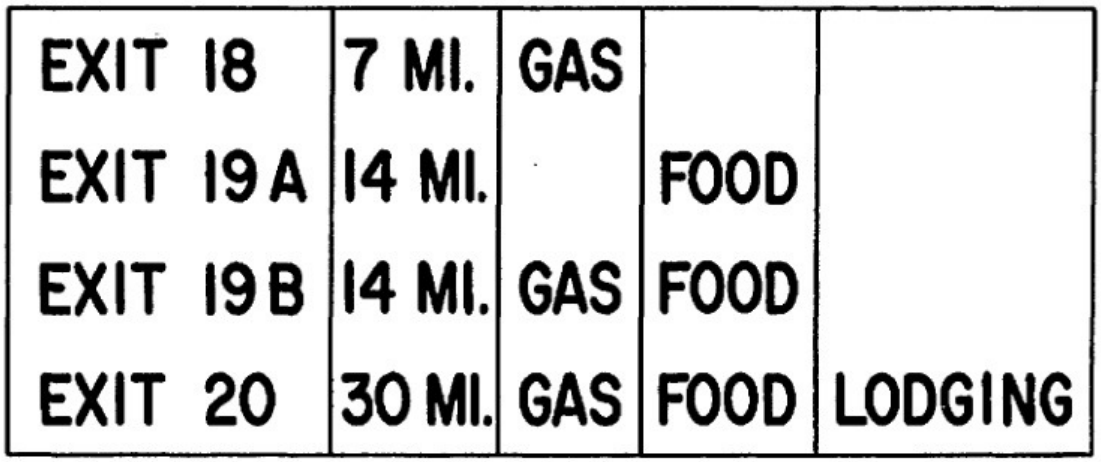
The opportunity and physical facilities to make this new trip plan can thus be seen to be an integral and indispensable part of the proposed directional information system. These facilities can run the gamut from a widened shoulder sufficient for a vehicle to stop to consult a map, to a completely staffed information center with trained personnel ready to assist in trip planning and route selection. The type of facility provided depends on economic considerations balanced against the probability of need, which is a function of average trip length, volume, trip purpose distribution, and percent repeat trips. For any location, apart from strictly urban commuter highways, the minimum requirement is probably a permanently weatherproof, mounted highway map and a telephone. Further sophistication might involve the availability of more detailed trip planning aids, from direct-line telephone service to such trip planning agencies as a motor club, up to elaborate electronic devices which, upon demand, would display or print out the desired trip plan. The last of these appears to be a natural outgrowth of automatic, demand directional information systems now in the development stage. The map, other information display, and telephone are now provided in Interstate highway rest areas in several states.

These informational rest areas or turnouts would, in turn, become important services to the motorist, their location clearly identified, and the route thereto easy to find. Some standard method of signing or trailblazing will have to be developed. At these information sites there would also be found motorist service information.

The availability of services, when set against actual or expected needs therefore, is one of the inputs to the trip plan. In the case of predictable needs such as lodging, service availability may directly influence the choice of an intermediate destination. The need for this information, having been satisfied in the pretrip phase, will no longer exist in transit. However, most service needs are less exactly predictable; even those which are predictable will sometimes occur at times or places other than predicted. However, even if not always predictable in the pretrip phase, normal (as opposed to emergency) services are either predictable in the short run (such as the distance a vehicle can travel after the fuel gauge shows empty) or postponable to a certain degree (such as the case of food). If, in accordance with the scheme of analysis followed here, the need for services is considered as the generator of a revised trip plan, then service information is one of the inputs to this revision and, as discussed previously, the predictability or postponability of these needs allows time to make such a trip plan.

Making a trip plan entails choosing a destination and then making a sequential list of the highway links (by designation, direction, and length) which make up the route to this destination. In the trip plan being discussed here, the destination will be chosen by the availability of needed services. This will be either the next destination along the old trip plan where these services are available or another point, usually also on the old trip plan, expected to be passed by the time the service needs must be satisfied. In most cases, except for long-range planning for major meals and lodgings, the revised destination will be the same highway link (in the same direction) on which the driver was traveling when he revised his trip plan. The link designation and direction will, therefore, already be con-

tained in the old trip plan and the revision will consist of determining the new intermediate destination and the link length intercepted between his current position and the intermediate destination.



PROPOSED SERVICE INFORMATION SIGN

V68-1293

FIGURE 16

The information required consists, therefore, of a listing of approaching intermediate destinations where various services are available and the distance thereto. A possible method of presenting this information is shown in Figure 16. Since the need for normal services is either predictable or postponable, and since the sign, in the form suggested, does not depend on identification with any particular interchange, the spatial location of this sign is not critical. Therefore, it can be located at any point on the roadway where analysis shows a relatively low information processing load exists.

It should be emphasized that the suggested sign shown in Figure 16 is more an indication of required information than a definite method of displaying this information. It is realized that, from the human factors aspect, the suggested sign contains a great deal of information and, therefore, presents the driver with the necessity of making complex choices between alternates at a level which may be beyond his abilities. This underscores the difficulties inherent in presenting adequate information for, upon analysis, it can be seen that the sign contains a minimum of information; namely, the location of the next service facility for each category and the consequence of not using this facility. The necessity of information presentation and processing off-line, in the pretrip phase or during stops along the trip, cannot be overemphasized.

Service needs have been analyzed in the guise of creating alternate destinations. Other factors may have the same result. There exists what may be called a class of "intervening opportunity" destinations. These, applicable mostly to recreational travel, or mixed purpose travel with a recreational element, consist of attractions unknown at the time of preparing the trip plan (which would have been included if known), attractions which, though known, were omitted because they did not fit into the premises (such as expected travel time used), and attractions that fall somewhere between these extremes.

Similar in nature are major traffic generators (airports and stadiums) which are either difficult to relate, from existing maps, to a definite highway approach, or one so well-known and frequented that there is a population expectancy of their being shown on highway directional signs. A third class of information needs includes secondary highway links within the influence of interchanges which physical limitations do not permit to be shown on the main directional signs.

In view of the desirability of having the decision to use an interchange depend solely on recognizing which interchange it is, and not on an analysis of information describing attributes of the interchange presented at the same time, all information which might affect this decision should be available to the motorist well-before the actual interchange signing begins. The types of information discussed in the preceding paragraphs all fall within this category and should, therefore, be presented well in advance of the interchange. Using interchange and exit numbers as coding devices, this information should be presented, as in the case of service information, at locations of low information processing load. This type of information is especially adapted to use at locations where some information should be presented for the purpose of raising the driver's level of vigilance.

Mr. OLSEN. There is a quorum call and we have to adjourn for now. The committee stands adjourned.

(Whereupon, at 12:30 p.m., the subcommittee adjourned, subject to the call of the Chair.)

HIGHWAY SAFETY, DESIGN AND OPERATIONS

Freeway Signing and Related Geometrics

THURSDAY, JULY 11, 1968

HOUSE OF REPRESENTATIVES,
SPECIAL SUBCOMMITTEE ON THE
FEDERAL-AID HIGHWAY PROGRAM
OF THE COMMITTEE ON PUBLIC WORKS,
Washington, D.C.

The subcommittee met, pursuant to adjournment, at 10:07 a.m., in room 2251, Rayburn Building, Hon. John A. Blatnik (chairman of the subcommittee) presiding.

Present: Messrs. Blatnik, Cleveland, Duncan, McCarthy, Howard, and Zion.

Staff present: (Same as previous day.)

Also present: Charles M. Harrell, visual information specialist, Federal Highway Administration.

Mr. BLATNIK. The Special Subcommittee on the Federal-Aid Highway Program of the House Committee on Public Works will please come to order. The special subcommittee resumes hearings on highway safety, design, and operations. This week we have been hearing witnesses who have testimony to offer on the signing of highways and other related features of highway design that so directly affect the safety of motorists.

In testimony yesterday and the day before, we heard from witnesses who are research psychologists, specializing in the field of traffic engineering and whose particular field of research had been the study of human-factor concepts.

Today's witness is Mr. Jack E. Leisch, vice president and chief highway engineer, De Leuw, Cather & Co. of Canada, Toronto, Ontario. Mr. Leisch was, for some years, I believe about 20 years, associated with the U.S. Bureau of Public Roads and has excellent credentials, which will speak for themselves, as he makes his presentation. He is highly renowned in highway circles as an expert in the field of highway design.

Mr. Leisch, we are indeed indebted to you for the splendid contribution you are making to the hearings and the excellent cooperation you have given all of our staff to make more informative and more meaningful the body of evidence and testimony which we are compiling. At this point, I recognize Mr. Constandy.

Mr. CONSTANDY. At the conclusion of yesterday's presentation we had wanted to include, as exhibit No. 5, the transcript of the hearing, the reports of the Airborne Instruments Laboratory, entitled

"Development of Information Requirements and Transmission Techniques for Highway Users."

That was the basis of the testimony yesterday. We would like to have it incorporated in the record as exhibit No. 5.

Mr. BLATNIK. Without objection, so ordered.

(Document referred to was marked exhibit No. 5 and filed with the committee.)

Mr. BLATNIK. I would like the record to show that we have with us a very impressive looking group from the General Accounting Office training program, and made all the more good looking by a very attractive young woman with them. Is Mr. Fred Thompson here? Could you give us a word or two; are they as bright as they look?

Mr. THOMPSON. We think so, Mr. Chairman. This is part of our training program for newer employees. These boys have been with us for 3 to 6 months, and this is just one facet of the training program. We would like to give them a little flavor of the Hill operation, since GAO is an arm of the Congress; and in the future they will be doing quite a bit of work.

Mr. BLATNIK. We are very familiar with GAO. It has direct relationships with the Congress. It is an instrument of the Congress. I happen to serve also, in addition to being on the Public Works Committee, this being one of its special subcommittees; I also serve on Government Operations' Executive and Legislative Reorganization Subcommittee, and GAO works closely with us. So we are quite familiar with your operations. We would like you also to know that our staff right here, Mr. Walter May on my extreme right, and his assistants, Mr. Constandy and Mr. Kopecky—you work quite often, do you not, Mr. May, with General Accounting?

Mr. MAY. Constantly.

Mr. BLATNIK. In investigative work in the field; in different aspects of accountability of the highway program, which is the largest multibillion peacetime program in the history of the whole world. It also involves the largest peacetime multibillion-dollar tax program in the whole world.

I would also like to have Mr. A. E. Johnson stand, just so these young people can see him. [Mr. Johnson arose.]

This man is one of the most respected and authoritative people in the highway field. For many, many years he was Executive Director of the AASHO organization, the American Association of State Highway Officials, which works directly with all the highway officials and the Governors of the United States, works very directly and intimately with the Bureau of Public Roads and the Department of Transportation on the Federal level and with the House Subcommittee on Roads, as well as this investigating committee on highways.

We can proceed, Mr. Constandy.

Mr. CONSTANDY. Mr. Chairman, before we proceed to take Mr. Leisch's testimony, we have a film which we showed at the session yesterday, and we would like to show it again. It is a film that was made by the staff, and it is an assemblage of footage taken at four different ramps, showing the activities of the vehicles at those points. Our concern through these hearings will be to determine, to some extent, why it is that the drivers are doing what they are doing, and the effect of signing and geometrics on what they are doing.

Mr. BLATNIK. May I ask first, primarily for the visitors here, can you locate or identify the ramps in the immediate vicinity of the Washington area?

Mr. CONSTANDY. The first scene is a view of I–95 northbound, at the junction with I–495, both east and west. In that particular movement appear two gores, one is the takeoff from I–95 northbound, and the second gore is the splitting of the traffic to go east or west on I–495. The second scene is westbound 495 at the gore of the exit for I–95 southbound, which would be the Richmond exit.

The third scene is taken on the Baltimore-Washington Parkway for that traffic entering the beltway to go westbound. The fourth scene is on the same road with the traffic leaving the Washington-Baltimore Parkway to enter I–495 to the east.

Mr. BLATNIK. As a prebriefing statement, just to give you a little advance notice of what you are to see—Mr. Constandy, is this the film that will show the driver behavior and driver patterns when there is uncertainty as to what his anticipated next move will be, due to lack of clearcut road design or clearcut informational signing on the road?

Mr. CONSTANDY. Yes, sir. It is exactly that. I think it is worth pointing out, since some people raise the question as to how many of these movements there are in the traffic stream, we have made no effort to prepare this as a research project to show that *x* percent of traffic in the stream has difficulty at these points. It is simply to demonstrate what the drivers of vehicles will do when they are uncertain, when they reach a point where they must make a decision, and there is not sufficient information being given to them, soon enough, in a way that they can grasp and comprehend it and react to it to continue their forward motion.

We will see that some of them do not have forward motion, they have reverse motion.

(At this time a film was shown, with the following oral description:)

Mr. CONSTANDY. This driver is on the exit ramp from 95 northbound to the beltway.

Mr. BLATNIK. What time of day was this?

Mr. MAY. This was taken in midday.

Mr. CONSTANDY. He is backing up.

Mr. BLATNIK. It looks like Russian roulette.

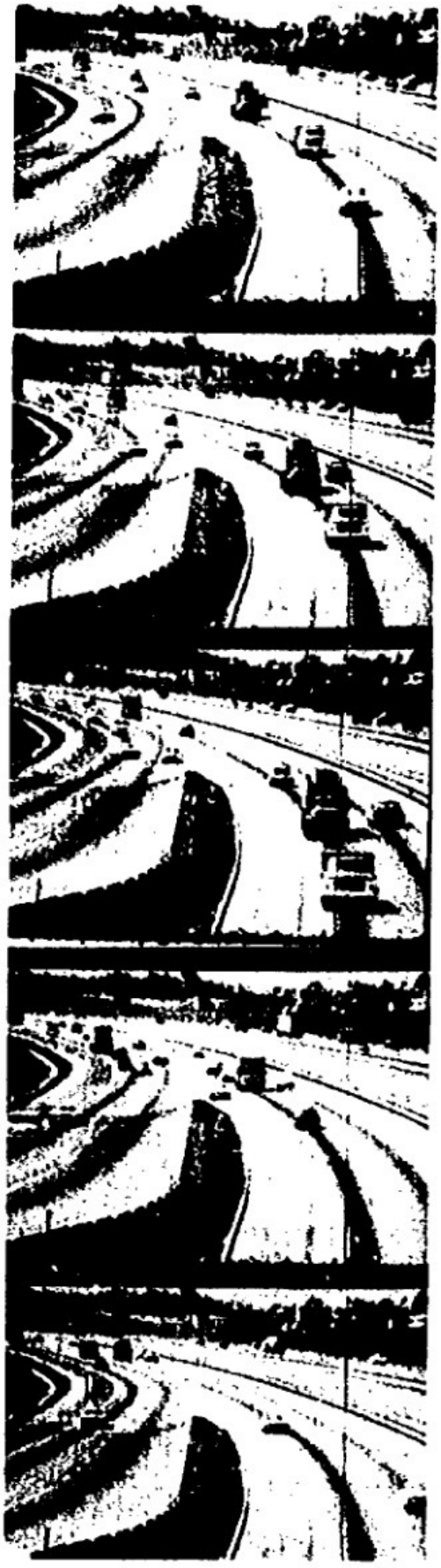
Mr. CONSTANDY. Here we have another vehicle stopped on the main line at the ramp, again backing up. You will notice, behind the sweeper, another car pulled up and stopped behind him. If you watch closely, as this car pulls behind that sweeper, the third car comes along, begins to go up the ramp and changes to go back to I–95 and swings back again toward the ramp, as the other one leaves the sweeper and comes out on I–95. Any one of these situations could create an accident. Now we have on the shoulder of the ramp two vehicles, and a third one pulling in behind them.

Mr. BLATNIK. On the left side of the picture?

Mr. CONSTANDY. Yes. This is fairly common. One man gets out of the car and goes up and asks another one who is stopped—it is like the blind leading the blind.

You will notice the signs in the gore are simply an assemblage of Interstate route shields.





If you watch the car with the lights blinking, he will cut across two lanes of the ramp, across the gore and out on I–95. The back end of the vehicle stays out in the lane. It is a pickup truck. Now the man behind him with the trailer does the same thing.

Incidentally, it did not take long to take this footage. We have some 2,500 feet——

Mr. BLATNIK. All in about the same period of time?

Mr. CONSTANDY. Well, it was generally midday, but we did take them on more than one occasion. The whole thing was done over a matter of a few days at all of these locations.

The same thing happens at the second gore, which is where that second car stopped, going east or west. You see two cars in the gore area.

There is a man backing up along, he is not even on the shoulder, he is off the side of the shoulder. You will notice that that shoulder frequently is used as a lane. It is probably just as well that he is off the shoulder; now he cuts across the two lanes over to I–95 lane.

Now, we have a house trailer coming into the second gore and several cars pull behind him. There is a near miss.

Now he crosses there. He is perpendicular to the traffic stream.

Now we are looking westbound on I–495, and the ramp to the right, the ramp lane, is the exit from I–495 westbound to I–95 southbound to Richmond. You will notice a car on the right-hand shoulder—incidentally, in the last hearings, Mr. Prisk had something to say relative to the necessity of providing shoulders on ramps, and in these series of pictures we see that they certainly do get used.

If there was no shoulder there, this driver would be apt to back up on the mainline traffic lane.

Incidentally, these are silent pictures, so you do not get the full flavor of this. But in taking the pictures, there was the usual accompanying sounds of the brakes screeching. Many of these situations looked, when we viewed them in real life, a good deal more hazardous than they look here in the room on film. I think they perhaps were more hazardous.

Mr. BLATNIK. That arrow says exit, and below it says 45; so the exit speed is 45 miles per hour?

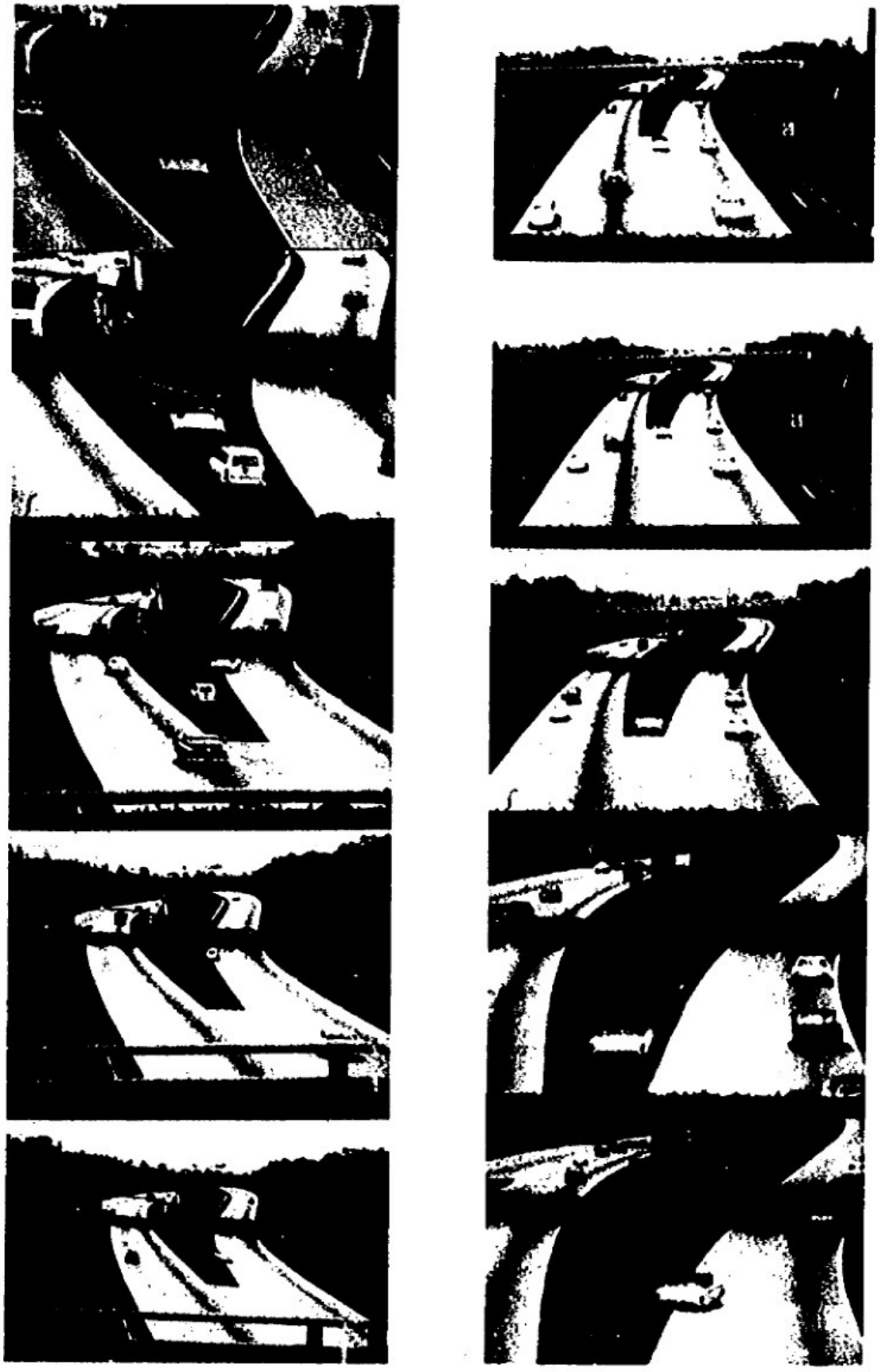
Mr. CONSTANDY. Actually that says 4S, meaning exit 4 to the south. I think some people read it as 45. The highway speed is 65 miles an hour.

You see now the car on that partial shoulder on the median side, backing up, taking another shot at the ramp. You will notice the car is out in the mainline fast lane. But he survived.

Now we are looking southbound, on Baltimore-Washington Parkway, at the first ramp to the beltway going west.

You will notice the car driving up in the area behind the gore, where enough people made this movement that they created a dirt road. As they have done that, the Park Service has come along and put I-beams, or the State of Maryland—I do not know which—to prevent them from doing that. They keep doing it anyway by driving around them and the maintenance people have extended it. You can see how far they have gone. People still do it and it has been extended twice.

They go down the ramp, realize they have made a mistake, and come



back on the Baltimore-Washington Parkway, and do as that man has done, go beyond the ramp and turn behind those I-beams and get back on the ramp again.

You will notice in this scene there is a station wagon backing up the ramp onto the Baltimore-Washington Parkway. In a moment he will disappear to the right, but if you watch closely, you will see him again. This is called guts driving. * * * Here he comes back again, around those I-beams, on the road——

Mr. BLATNIK. He did not want to give up, did he?

Mr. CONSTANDY. I think there is a certain degree of desperation on the part of a motorist in this situation. If he goes down a road and it takes him—he does not know where, he then does some foolish thing to get back to the road he wants.

Now we are looking at the second ramp. The traffic comes from the left or southbound on the Baltimore-Washington Parkway. There you see a red Volkswagen who just took this ramp cut across to go the other way. That man cut across two lanes of 60-mile-an-hour traffic. That sign facing him simply says exit.

Here is a car going down one ramp, changes his mind and goes over a dirt road motorists themselves made there, and goes back on the other ramp to return to the beltway.

Mr. PRISK. No shoulders.

Mr. CONSTANDY. Good point. The Baltimore-Washington Parkway has no shoulders, and some of the cars that stop are actually out in the traffic stream.

You will notice in the foreground there is another dirt road that has been created by people who have missed their turn at the ramp and cut across the grass to get back on the ramp.

This last man, getting out of his car and looking around, typifies the frustration that many of the motorists out there feel. This is not uncommon to see, either.

[End of film.]

Mr. CONSTANDY. Mr. Chairman, if we could now call Mr. Jack E. Leisch, and ask him to stand and be sworn.

Mr. BLATNIK. Please take the witness stand. Do you solemnly swear to tell the truth, the whole truth, and nothing but the truth?

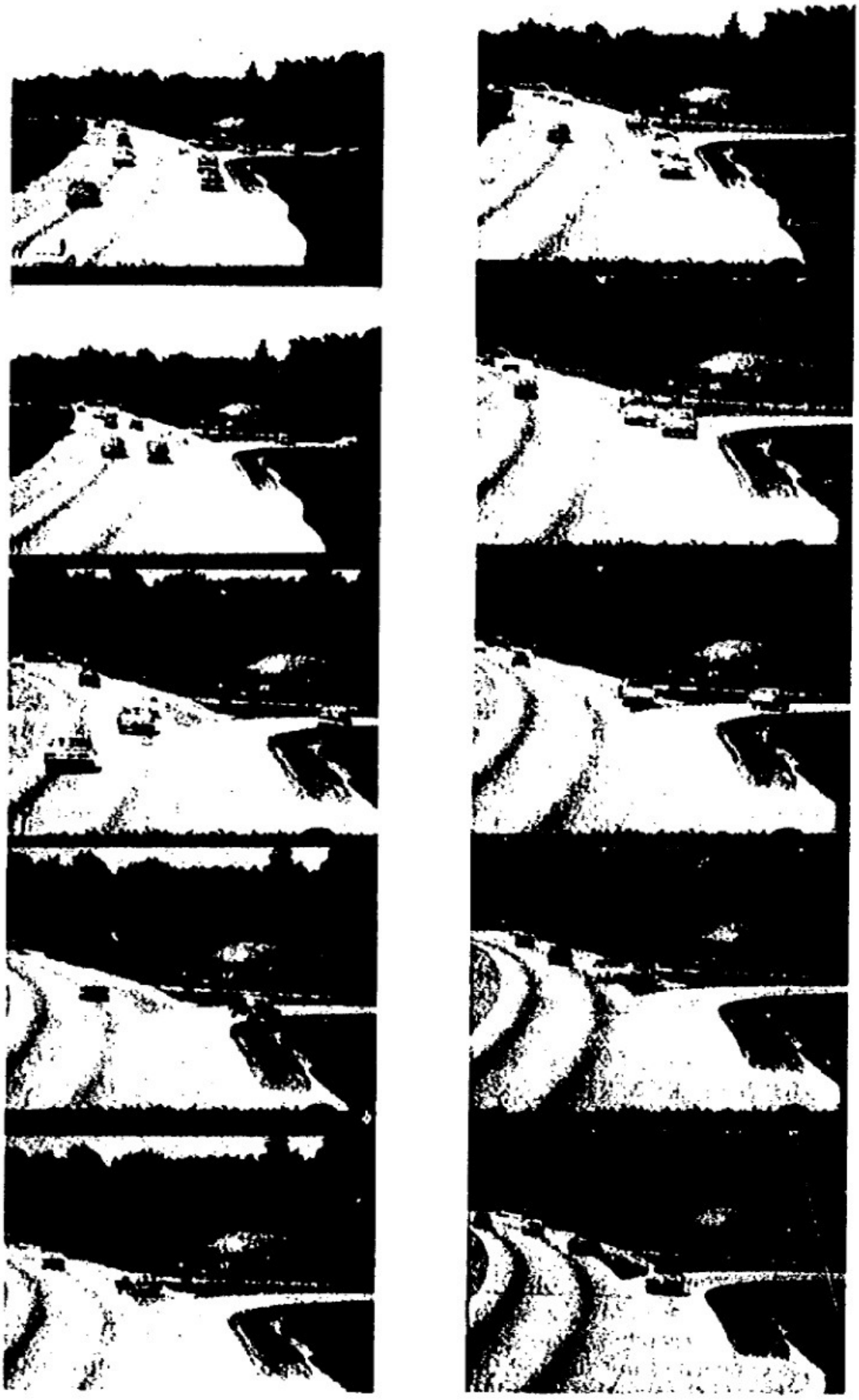
Mr. LEISCH. Yes.

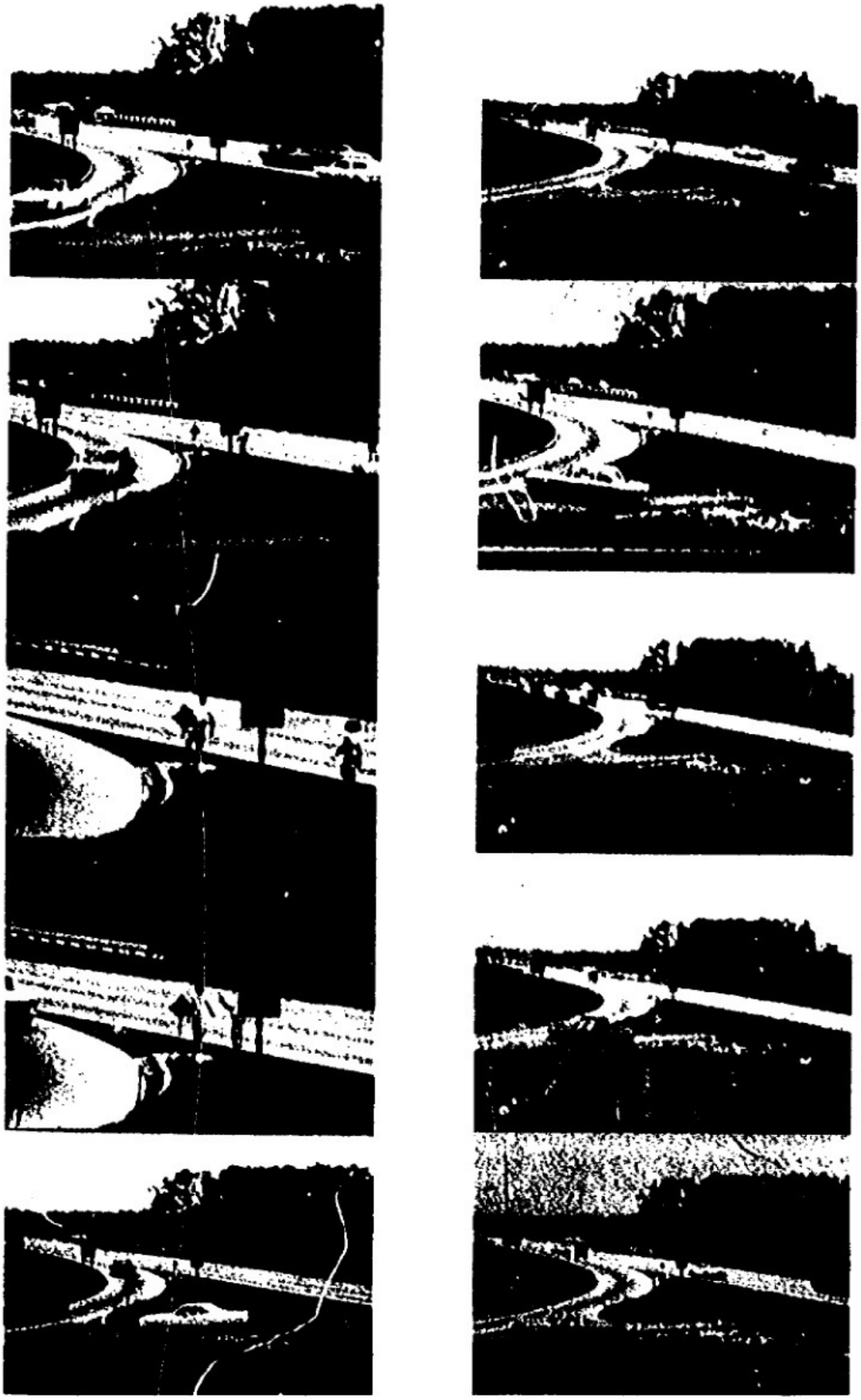
TESTIMONY OF JACK E. LEISCH, VICE PRESIDENT AND CHIEF HIGHWAY ENGINEER, DE LEUW, CATHER & CO. OF CANADA, LTD., TORONTO, ONTARIO; FORMERLY ASSOCIATED WITH U.S. BUREAU OF PUBLIC ROADS

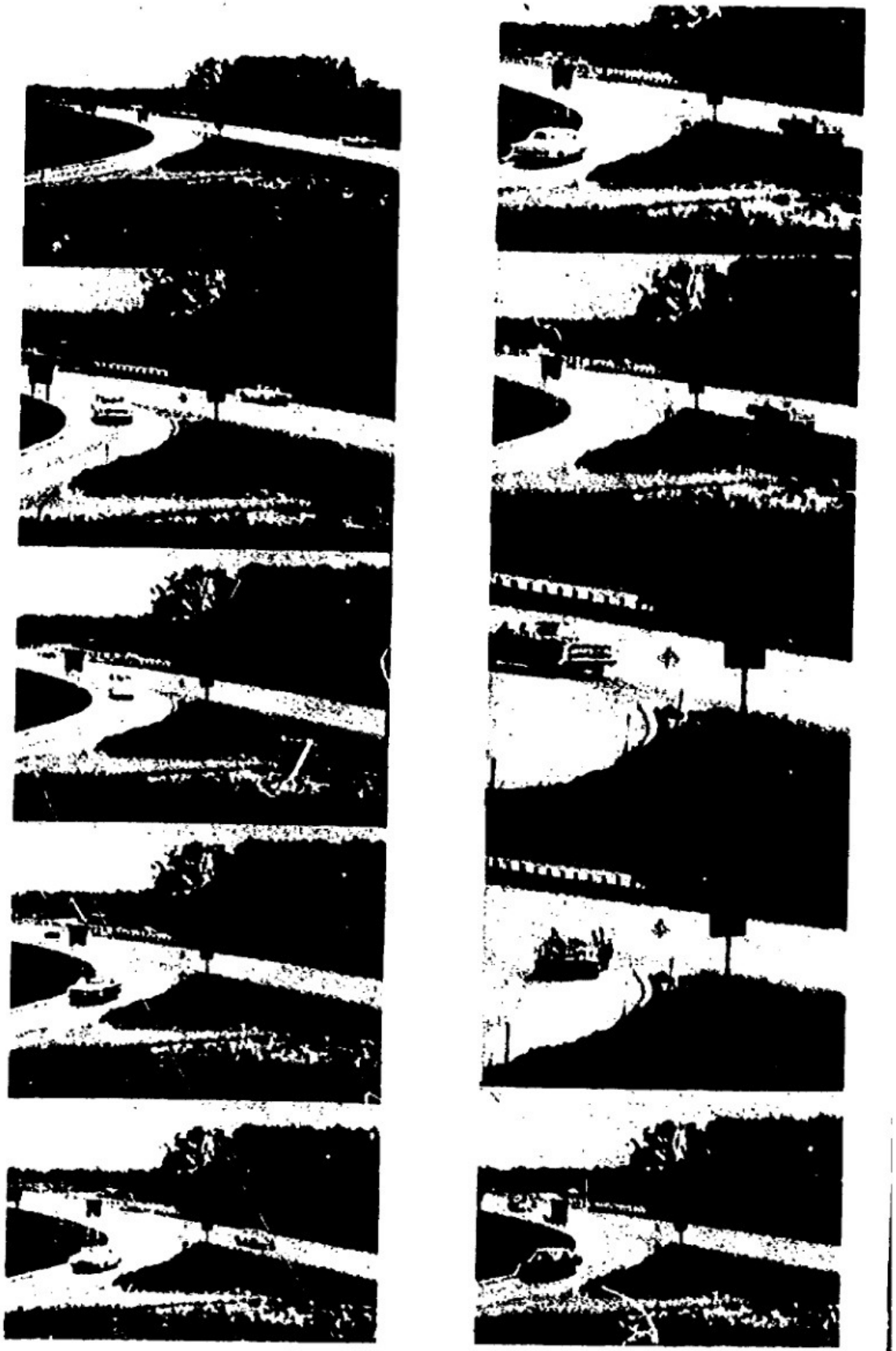
Mr. CONSTANDY. Mr. Chairman, I think the committee is indeed fortunate today in having Mr. Leisch with us. He enjoys an excellent reputation, with good reason, particularly in the field of design.

The position that he holds in his present employment, I think, gives some indication of Mr. Leisch's capacity and broad interest in the general field of transportation; is it not correct, Mr. Leisch, that your firm is concerned not only with highway transportation but with mass transit and other modes as well?

Mr. LEISCH. That is true.







Mr. CONSTANDY. And you have a very deep interest in urban planing, do you not?

Mr. LEISCH. Yes.

Mr. CONSTANDY. Especially its relationship to highway design, planning, and location.

Mr. Leisch was, for 20 years, from 1936 to 1956, with the U.S. Bureau of Public Roads. In the latter part of that period he was Chief of Design Development Branch; principal author in the development of the AASHO publications, "A Policy on Geometric Design of Rural Highways" and "A Policy on Arterial Highways in Urban Areas," which received the Department of Commerce Meritorious Service Award, silver medal, "for very valuable contribution to highway engineering through the development of geometric design guides and design capacity charts."

I would like to offer, to be printed in the record, a brief, but lengthier than I have mentioned here, biographical sketch, portraying Mr. Leisch's background.

Mr. BLATNIK. Without objection, it will appear in its entirety at this point in the record.

(Biographical sketch follows:)

JACK E. LEISCH

EXPERIENCE

1963 to Date: De Leuw, Cather & Company of Canada Limited. Vice-President and Chief Highway Engineer responsible for all planning and design of expressway and highway projects in the firm's offices of Toronto, London and Ottawa, Ontario; Montreal, Quebec; Edmonton and Calgary, Alberta; St. John's, Newfoundland; and overseas. Some of the projects under direction include: design studies, preliminary engineering reports, and final design on freeways and major highway improvements in Toronto, Ottawa, London, Niagara Falls, Edmonton and other cities in Canada; metropolitan transportation study in Ottawa. Special Consultant to De Leuw, Cather & Company of the U.S.A., including metropolitan transportation studies in Sydney, Australia and Auckland, New Zealand. Director of Highway Research Board project dealing with intersection operational characteristics, controls and capacity. Special Consultant to the Department of Highways Ontario, and to the City of Edmonton, on highway planning and design matters. Responsible for advanced design methods and maintenance of quality standards for highway and expressway functional planning and detailed design, and for personnel training in the company.

1956 to 1963: De Leuw, Cather & Company, Illinois. Chief Highway Engineer responsible for the planning and design of major streets, expressways, freeways, interchanges and arterial street systems in urban areas, capacity investigations, applications of user-benefit analysis. Projects included sections of National System of Interstate Highways, also sections of freeways and major interchanges in Miami, Milwaukee, Denver, Salt Lake City and Washington in the U.S.A., in Toronto, Canada, and in Sydney and Perth, Australia. Conducted training courses in Advanced Highway Planning and Geometric Design to personnel of the Department of Main Roads, Australia, and to special groups of the South African Road Federation.

1936 to 1956: U.S. Bureau of Public Roads. Latterly as Chief of the Design Development Branch; principal author in the development of the AASHO publications "A Policy on Geometric Design of Rural Highways," and "A Policy on Arterial Highways in Urban Areas," received the Department of Commerce Meritorious Service Award (silver medal) "for very valuable contribution to highway engineering through the development of geometric design guides and design capacity charts."

PUBLICATIONS

"Capacity Analysis Techniques for Design of Signalized Intersections," Public Roads, Vol. 34, No. 0, August 1967 and No. 10, October 1967.
"New Techniques in Alinement Design and Stakeout," Journal of the Highway Division, ASCE, March 1966.
"Lane Determination Techniques for Freeway Facilities," CGRA Proceedings, 1965.
"Determination of Need and Geometric Requirements for Guardrail—A Design Guide," HRB Special Report 81, 1964.
"Designing Operational Flexibility Into Urban Freeways," ITE Proceedings, 1963.
"Interchange Design," 1962.
"Design Geometrics for Diamond Interchanges," ITE Proceedings, 1960.
"Spacing of Interchanges on Freeways in Urban Areas," ASCE Transactions, 1960.
"Developing Tools and Techniques for Geometric Design of Highways," HRB Proceedings, 1959.
"Adaptability of Interchanges to Interstate Highways," ASCE Transactions, 1959.

SPECIAL ASSIGNMENTS

Mr. Leisch currently is a Lecturer on Advanced Highway Planning and on Geometric Highway Design at Northwestern University, Illinois, at the University of Waterloo, Ontario, and formerly at the University of California, Berkeley. He is a past member of the Technical Council of the Institute of Traffic Engineers, and served as Head of the Institute's Department 5—"Geometric Design of Traffic and Terminal Facilities." He has been the Director for Highway Capacity Seminars presented to the Pennsylvania Department of Highways, Department of Highways of Alberta, Department of Highways of Manitoba together with Metropolitan Winnipeg, Quebec Department of Roads, Department of Highways Ontario, and South African Road Federation.

EDUCATION

B.E.C.E., Johns Hopkins University, 1935
Maryland Institutes of Art—Graduate in Commercial Art

SOCIETIES

Association of Professional Engineers of the Province of Ontario
American Society of Civil Engineers
Institute of Traffic Engineers
National Society of Professional Engineers
Highway Research Board:
    Committee on Geometric Highway Design
    Committee on Guardrails
    Committee on Highway Capacity
Canadian Good Roads Association:
    Committee on Highway Engineering Education
Tau Beta Pi

Mr. CONSTANDY. You were in a fortunate position during the very critical years of development of standards for the Interstate system.

Mr. LEISCH. Yes. I was involved in development work and was privileged to see what was happening and just how it developed.

Mr. CONSTANDY. And you participated in the development, I believe?

Mr. LEISCH. Yes.

Mr. CONSTANDY. Mr. Leisch has authored a number of publications dealing with highway designs and geometrics, and has been a lecturer in the field of engineering at several universities, have you not?

Mr. LEISCH. Yes.

Mr. CONSTANDY. They being Northwestern University, the University of Waterloo, Ontario, and the University of California at Berkeley.

Mr. LEISCH. That is correct.

Mr. CONSTANDY. I wonder if you could begin by just making some reference to the necessity for concern with geometrics as a part of the signing problem we are presently concerned with here.

Mr. LEISCH. Yes. Mr. Chairman, I think the film is an excellent lead-in to what I would like to discuss. It certainly points up the necessity to better inform the driver. The signs, in themselves, do not do the complete job.

Of course there may be a problem with signing, per se; but much of the problem also lies in the design of the highway facility itself. So from that point of view I would like to discuss, or direct my remarks to the coordination of highway geometrics and signing.

The purpose that an engineer has in designing the entire highway, the entire facility, is to design these two features: the highway (the physical facility), and the signing—to design them harmoniously, so that one complements the other. Together they produce a facility which can be operated over, so to speak, with clarity, with ease, with confidence.

Thinking of the driver, I think it is important that there is little harassment, that there is little or no worry on his part as he operates over the facility, and there is no particular tension. I am sure that in the film that we saw there was a great deal of harassment, worry and tension.

Mr. CONSTANDY. Could I throw in frustration?

Mr. LEISCH. Frustration. I think that is even more significant. That is very good. In bringing this discussion to the committee, I have prepared a series of slides, and would like to develop my discussion around these slides, if I may.

Mr. CONSTANDY. That will be fine. Before we begin that, Mr. Leisch, we have heard the expression, "If you can't sign it, don't build it"; would you agree with that?

Mr. LEISCH. I certainly do. And I think one test of a design is the signing. If the facility can be signed properly, then you have an appropriate design, and this indeed is a test itself. And I believe that the design engineer is now becoming aware of this, and that this type of test is being incorporated in the design process.

Mr. CONSTANDY. That presupposes knowledge on the part of the person making the test--that he has a complete understanding of what constitutes proper signing, does it not?

Mr. LEISCH. Yes, it is quite essential that the designer has that knowledge, very essential.

Mr. CONSTANDY. That axiom, "if you can't sign it, don't build it," would further suggest that the point at which signing consideration should be taken into account would be fairly early in the development of the project, is that not so?

Mr. LEISCH. Yes, that is true. In the conceptual design of a facility and the interchanges, which you might say are some of the key points along the facility, signing must be examined and related to the facility in this conceptual layout of the facility.

Mr. CONSTANDY. At the very beginning?

Mr. LEISCH. At the very beginning.

Mr. CONSTANDY. Signing considerations, for example, might affect location?

Mr. LEISCH. Yes, they could very well. Because we have visibility and spatial considerations, and that in turn, to make the necessary

room or space, to give necessary distance, certainly can have a profound effect on the location of the facility.

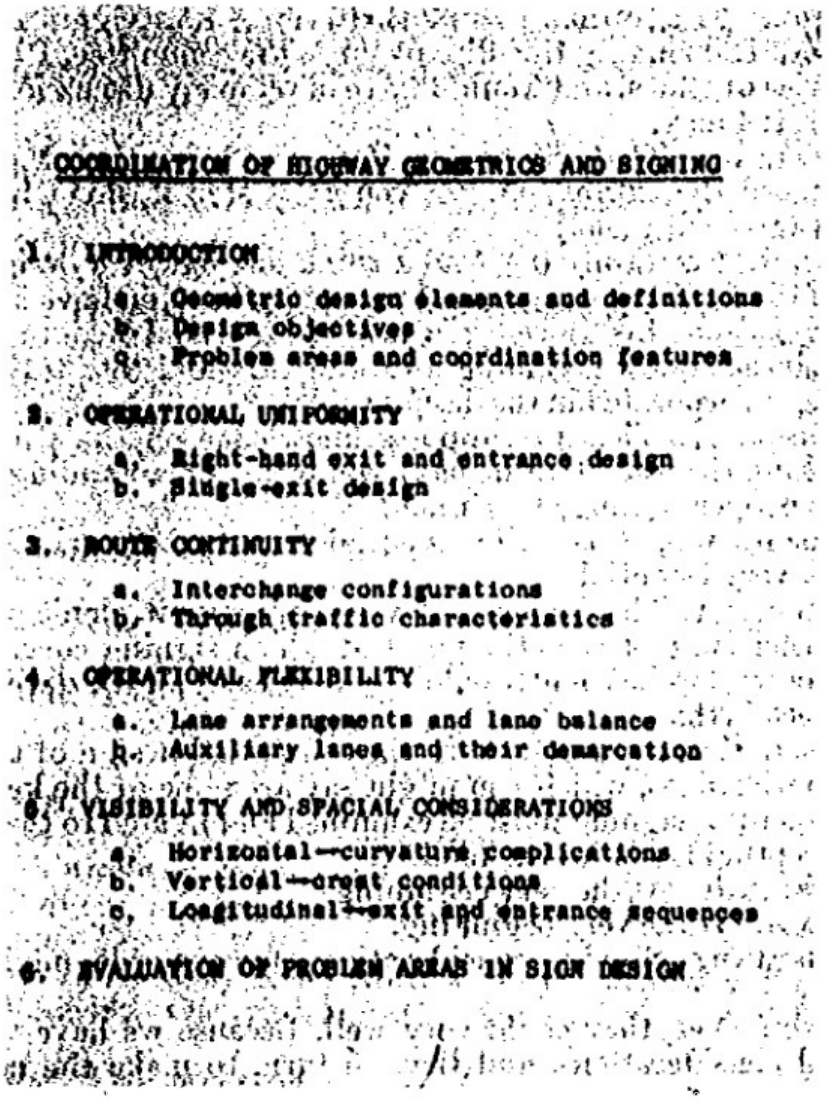
Mr. CONSTANDY. Sometimes in the initial stages of design, the centerline would have to be adjusted to permit proper signing?

Mr. LEISCH. Yes, quite true. And I am quite aware of this. In many projects that I have had something to do with, there have been instances where it was necessary to adjust and readjust the facility in order to allow for proper signing; so that the location, then, you might say, is very much affected in the very initial stages of designing.

Mr. CONSTANDY. We have learned of some situations where projects have been completed before a contract is let for the design of the signing.

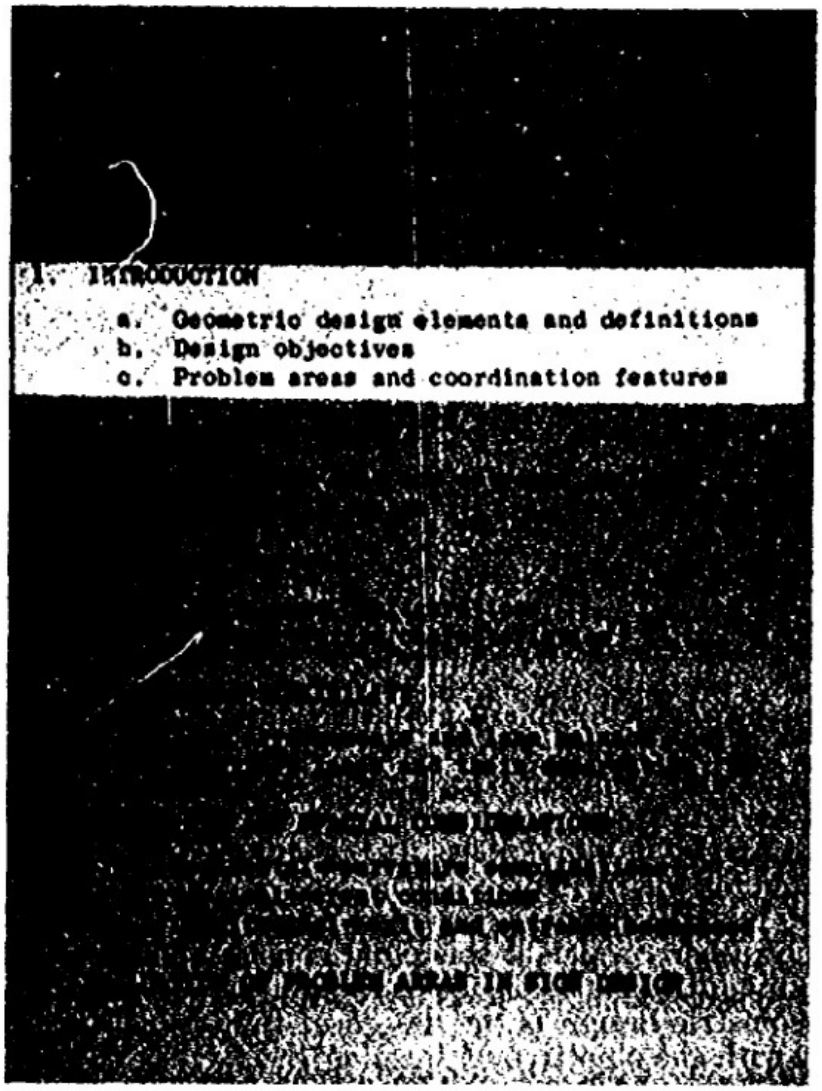
Mr. LEISCH. Yes. Well, as a matter of fact, of course the whole field of geometric and traffic engineering has been—is a growing field. They are both relatively new. Of course, geometric design, we will talk about that a little bit later, is very much a part of traffic engineering as well as highway engineering. And being relatively new and dynamic fields, in the process of development, there has not been the awareness of the necessity to coordinate them.

Mr. CONSTANDY. We would like now to begin to cover your own material, so perhaps we should not belabor this. Can you turn the lights off?

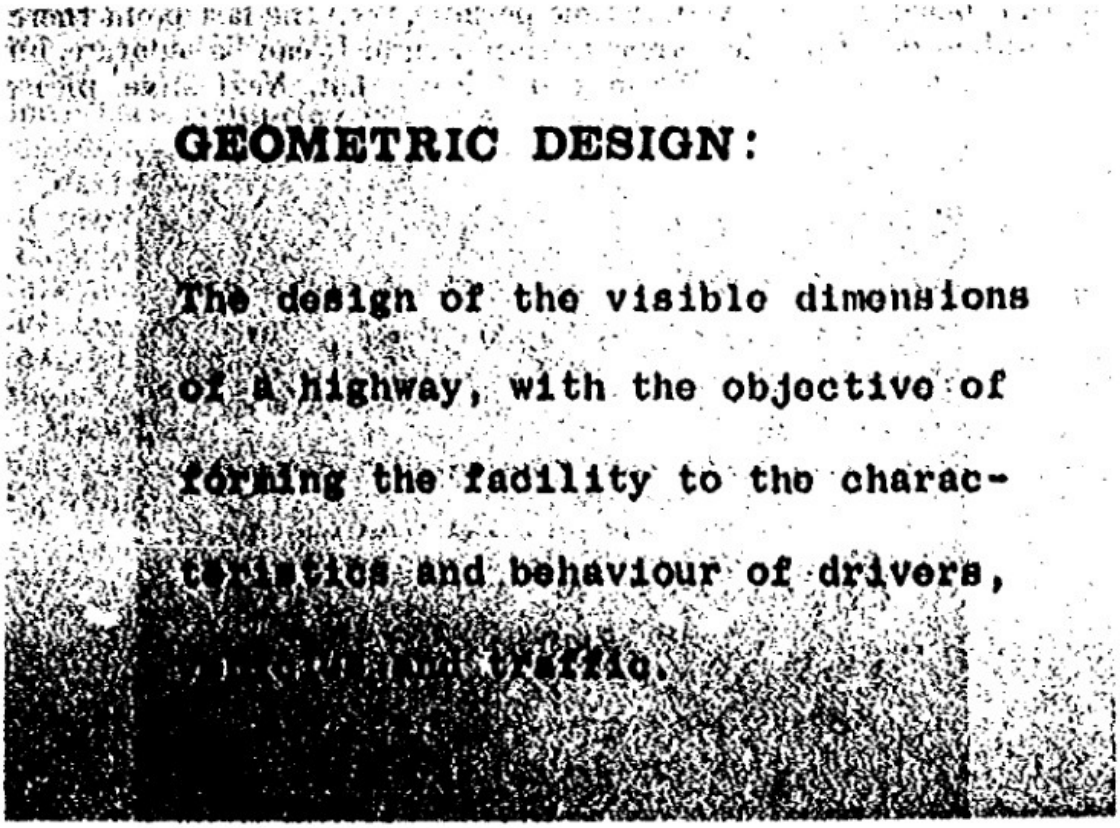


Mr. LEISCH. I would like to develop a subject here with respect to several points, so I am putting on here an outline that I would like to follow.

I would like to introduce the subject, then discuss what I call four areas of coordination of design, geometric design, and signing. I would like to attack this from the point of view of: operational uniformity; route continuity; operational flexibility; and visibility and spatial considerations. And, if time permits, then the last point there: the evaluation of problem areas in sign design. It can be separate, but it is very much related. We may just leave that. Next slide, please.



So, in introducing the subject, I think it would be necessary to define what we mean by "geometric design" or "geometric design elements," which is very much related to the signing problem. Then discuss the design objectives as related to geometric design and to signing, and to then set the stage to discuss problem areas and some of the coordination features that will follow. Next slide, please.



Here we have a definition of geometric design. First I would like to read only the first clause, which says, "geometric design is the design of the visible dimensions of a highway." We might put a period there. As a matter of fact, that much of it is the official definition, as we have it in the AASHO design policies. It is a correct definition, but it actually does not tell the full story.

In order to really describe geometric design, the rest of the definition that is shown here, which at this point is not an official definition, but in my opinion it is the definition; so I would like to read it in its full form, "geometric design is the design of the visible dimensions of a highway, with the objective of forming the facility to the characteristics and behavior of drivers, vehicles, and traffic."

Now, this is a very dynamic definition. It is a very dynamic situation. It gives purpose to the designer. The first part of the definition is cold; it is static; it does not really tell the story. And this spells out a whole philosophy which I think is necessary for the designer to follow; and if he does follow this philosophy, then perhaps many of the

problems that we have on our highways will be overcome in new designs.

GEOMETRIC DESIGN is a new and dynamic facet of highway and traffic engineering. In its proper application, it is a highly sophisticated and specialized discipline. It translates research and operational experience into a physical highway plant, considering driver comfort and convenience, safety, and operational efficiency.

I think the next slide pursues this a little bit further. Here we have a statement which says that, "geometric design is a new and dynamic facet of highway and traffic engineering."

It is both; both highway and traffic engineering.

In its proper application, it is a highly sophisticated and specialized discipline. It translates research and operational experience [that is, in its proper form] it translates research and operational experience into a physical highway plant, considering driver comfort and convenience, safety, and operational efficiency.

So that if we take operational experience, and benefit by it and benefit by the research that is going on, then we can translate all of that into the highway plant, and we can make the highway more efficient. We can make it a safer highway. I think this certainly is the objective.

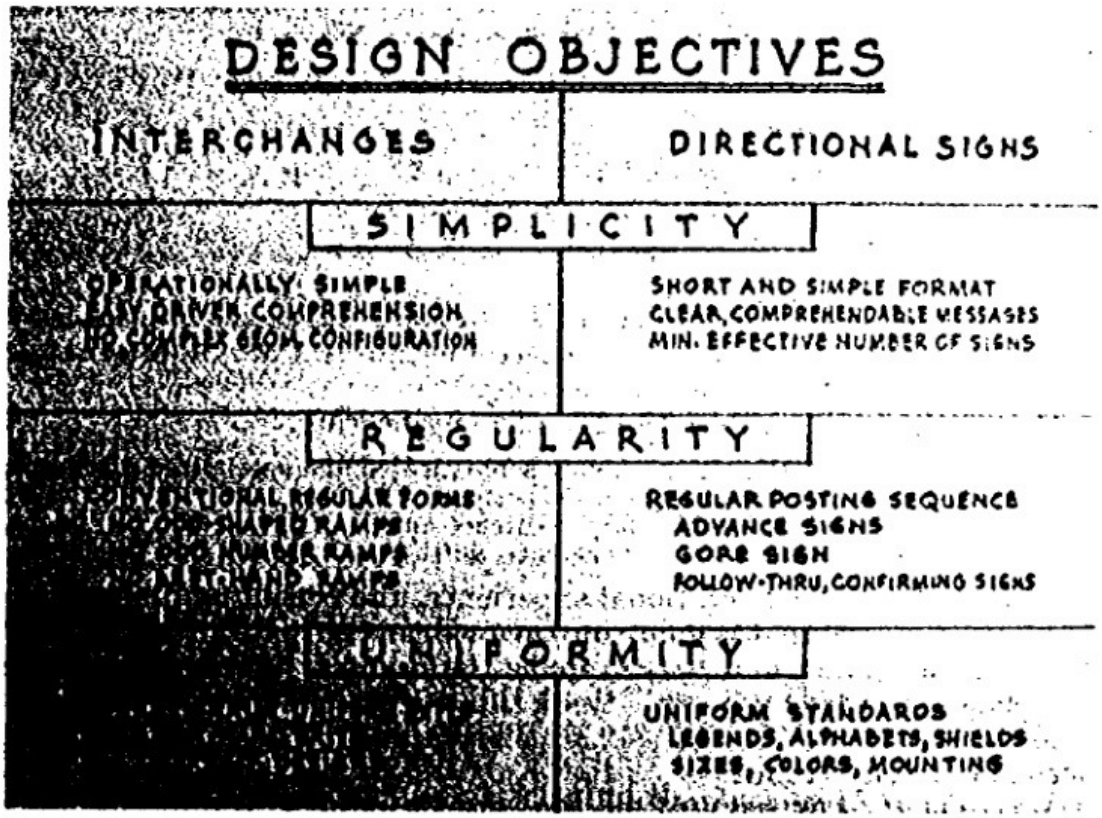
Mr. CONSTANDY. Could I ask, Mr. Leisch, about the use of the words, both new and dynamic?"

Mr. LEISCH. Yes. First of all, highway design is a field of engineering that, you know, dates back perhaps centuries. And it came into its own perhaps with the advent of the automobile, but in the broad field of highway engineering. And highway engineering has many facets to it. Some of the facets, you know, grew and developed with the development of the highway, with increase in travel; and geometric design, as compared, for example, or opposed to, you might say, structural design and material design (they are entirely two different things) came in as a recognized discipline recently.

In fact, the term "geometric design" probably was coined sometime in the 1940's, and then it had become, at that time, recognized as a part of highway and traffic engineering. Traffic engineering in itself is a new field which perhaps came into its own during the early 1930's. Of course it was practiced before that, but recognized as a full profession probably in the early 1930's. So we are dealing with very new concepts; and by "dynamic" we mean that they are in a state of flux, that we are learning all the time. We can criticize some of the situations we have on our highways, but this is part of the development of this discipline.

Mr. CONSTANDY. I think that is worth keeping in mind.

Mr. LEISCH. They are not mistakes, necessarily. They are just lack of knowledge and lack of recognition and lack of experience, and we are arriving at the point now; however, there is a lag, there is a tremendous lag, and I think this is one of the problems—there is quite a lag between research and operational experience, between that and its translation into a physical highway plant. I think that is one area that has to be plugged.



Now I would like to speak of design objectives with relation to signs, but we cannot divorce that from its relation or the objectives of interchange. An interchange is a crossing of—it is a facility which allows for the crossing of two highways with a grade separation, and with interconnecting roadways to allow for turning movements to be made. I think we all know what an interchange is, but just as a matter of record here.

Signing and interchanges are very much related. You cannot separate the two. And the design objectives, in a broad sense, are the same.

And I would like to think of those objectives as being: simplicity, regularity, and uniformity; and they apply both to interchanges and directional signs.

Let's look at the left-hand side of this illustration. And with regard to interchanges first.

Simplicity: that means that the interchange should be configurated or designed so that it is operationally simple; that there is easy driver comprehension; that there is no complex geometric configuration.

Regularity: that it is a conventional form and a regular form, meaning that there are no odd-shaped ramps, no odd number of ramps, no left-hand ramps. These are some of the main features of what is meant by regularity.

Mr. CONSTANDY. What do you mean by no odd number of ramps?

Mr. LEISCH. Meaning that the complementary movements are provided, and also that it is configurated in such a way that there are natural movements available. Sometimes an actual odd number of ramps provides for an irregular type of operation to complete all the movements.

Mr. CONSTANDY. I see.

Mr. LEISCH. Then uniformity: there must be operationally uniform exits. This is where the driver makes his decisions. All right-hand exits, all one-exit designs—these all make for uniformity. We will discuss each of these as we go along. This is just to introduce the subject and to emphasize here the need for simplicity, regularity, and uniformity.

With regard to directional signs, we might say that simplicity deals with short and simple format; it deals with clear, comprehensible messages, minimum effective number of signs. Regularity deals with regular posting sequence; that is, advance signs, gore sign, follow-through, and confirming signs.

And then uniformity deals with uniform standards of legends, and alphabets, shields, sizes, colors, mountings, and so on.

Now, obviously these objectives are carried out in essence in the signing manual, this was followed right down the line. But a set of standards in themselves really is not enough. It is a tremendous beginning.

A designer must follow a set of standards. It gives him direction. But then the philosophy behind it or how he applies it makes a tremendous difference. That is why the definition of geometric design is so important. It can make a tremendous difference——

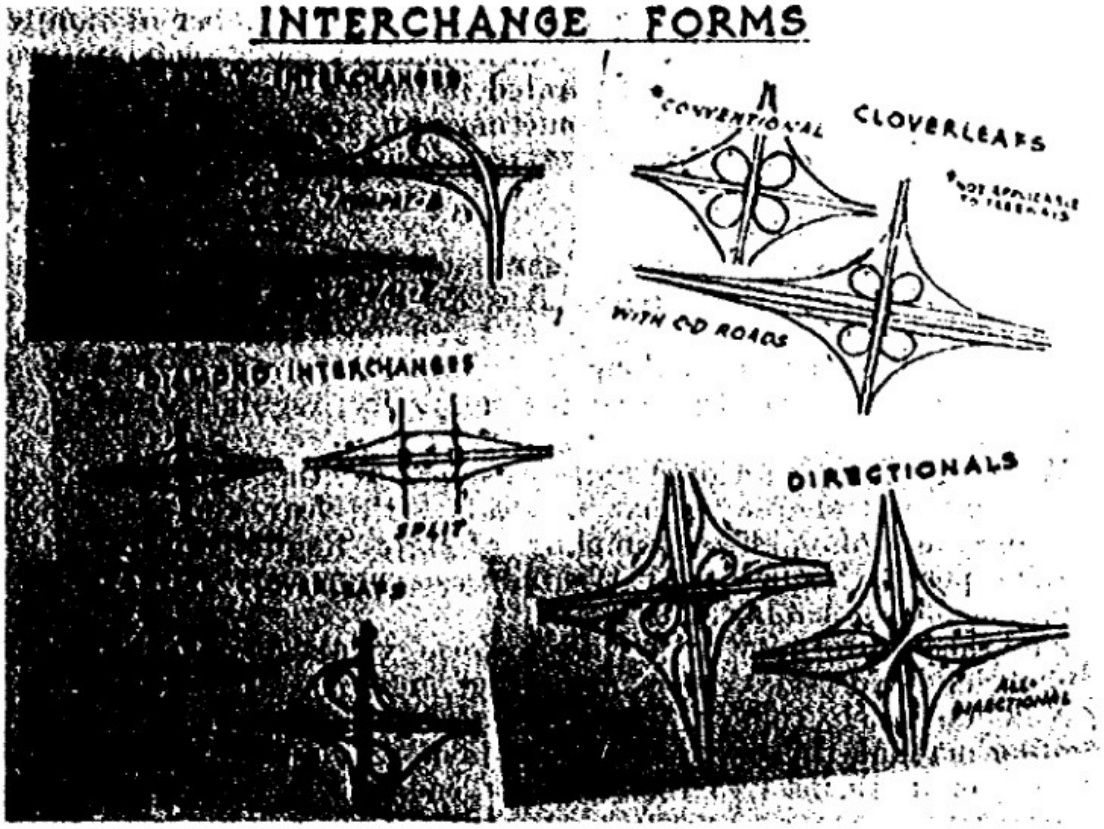
Mr. CONSTANDY. Could you give an example?

Mr. LEISCH. Well, let us think of it this way: this philosophy, of course, applies to any design. It does not even have to be a highway. Certainly it applies to the design of the freeway, of the interchanges, and also applies to the signing itself.

You can follow a set of standards, for example, for an interchange; you can put in the correct curvature, and you can put in the correct superelevation, and you can put in all the standards called for with respect to the basic geometry; but then how it is put together, and also the conceptual aspects of it, which are not clearly defined or spelled out in the standards, may be—the designer may miss this. He may miss the point and actually come up with a beautiful design from one point of view, as a design having all the correct curvatures,

superelevation, and so on; but conceptually it may be poor because he did not rely on certain operational experience or research, perhaps, that he could have drawn on, or that he should have been aware of, or could have been aware of.

And I think the same thing is true of signing, where he has to really put himself in a position of the driver. He has to have a certain attitude, an awareness, he must have a concern for the driver. This is part of the same philosophy, and if he applies that together with the direction which he receives from standards, he is then able to do a complete job, which can then become a good and adequate and safe design. May we have the next slide?



Now, in order to discuss signing and its coordination with geometric design, I think we have to look at some interchange forms and look at some terminology here. Most of us might be familiar with this. In the upper left we see T and Y interchanges, and sometimes they are referred to as trumpets or directional types. This is when one facility is intercepted by another. This may involve the junction of two freeways, or it may involve a freeway and some other type of highway that is being intercepted.

Then the second one on the left, diamond interchange perhaps the most simple form, and the one that is quite easily understood, deals primarily with only four ramps and requires intersections at grade on a crossroad. The left-to-right facilities, there is a freeway there, as we see it, the one running up and down, north and south, is intersecting a road. A diamond interchange requires signalization in urban areas. This on the left is a conventional diamond.

The one to the right is a split diamond, which involves one-way movements on cross facilities, and provides more freedom, higher capacity. A very common type of interchange.

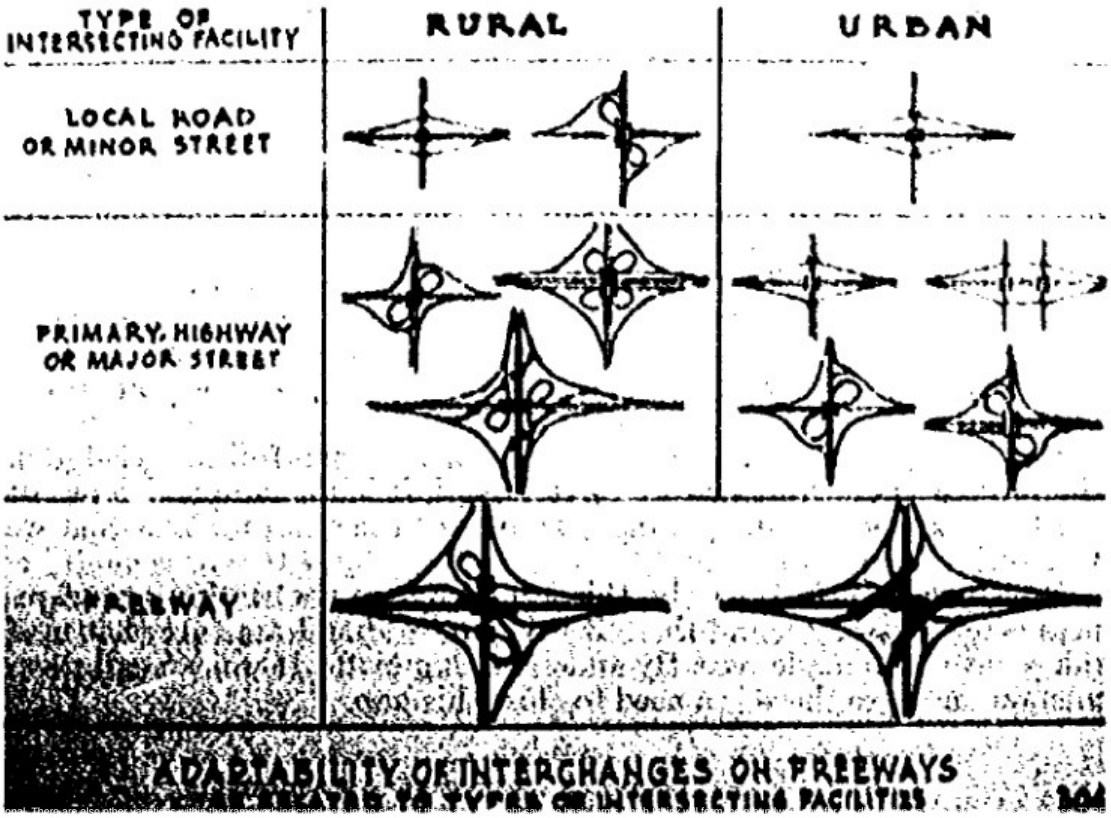
Then going down to the more complex forms, what we call partial cloverleafs, sometimes referred to as parclo forms, an A or B type. They operate a little differently. And they are very popular forms, as well as the diamonds. They are primarily used with crossing facilities which are not freeways in themselves. They are the type of facility which has no control of access or partial control of access on them.

In the upper right-hand corner, cloverleafs; we are all familiar with that term and the configuration. There is the conventional type, which actually are not applicable on freeways, and the cloverleaf with C–D road, meaning collector-distributor road. They are short, parallel roadways as we see within the interchange, parallel to the freeway, along which all the action, you might say, takes place on terms of exiting, making certain decisions, and weaving actions that take place between the entering and exiting traffic, free up much of the operation among the facility, the main facility itself. That is applicable to freeways.

And then the highest form of interchange—referred to as directional interchange or interchanges. And there are two basic varieties. One on the left is a directional interchange with loop ramps, the rounded, circular type ramps, or an all-directional interchange which does not use loop ramps, but allows for more sweeping and direct-type movements. There are many varieties of each of these, that is directional type with loops and all directional.

There are also other variations within the framework indicated here in the slide, but these are, you might say, the basic forms which I think will form the groundwork now for the discussion as we go along.

Next slide, please.



At this point I would like to say that interchange design involves a great deal of effort. It is very time-consuming. It is the key to the success or failure of a facility. The interchanges along a freeway either make it or break it. It requires a lot of knowledge. The profession grew into it, and there is still a great deal to learn, and again this is why we say it is a dynamic field.

Mr. CONSTANDY. Is it true, too, that there is a great deal to be applied that has already been learned?

Mr. LEISCH. Pardon me?

Mr. CONSTANDY. Is it true, too, that there is a great deal to be applied from what has already been learned?

Mr. LEISCH. Oh, yes, very much so. This is the lag that we have between the experience, the research, and its application. So there is much to be applied in what has been experienced, but also there is still much to be learned in itself. There is additional experience to be gained and additional research to be performed, which will further improve the techniques being used in design.

Well, the process of interchange design grew and changed very rapidly. It was not too many years ago that it was a real chore, a real task, a very difficult thing to come up with what was considered to be the right form of interchange. We labored over it.

(Mr. Howard assumed the chair.)

Mr. LEISCH. We attempted to configurate the interchanges to fit what was the apparent traffic pattern where there were heavy movements in certain quadrants. We attempted to configurate the interchange to favor those. There were other aspects that we need not dwell on now that merely complicated the process of selecting the interchange to be used in any one location.

Mr. CONSTANDY. This is one of the major problems, is it not, deciding which of the configurations available would best suit the purpose?

Mr. LEISCH. Yes, very much so. And this is what really determines the success or failure of a facility. And much of it is done in its conceptual stage, and even with some very fine standards and some very fine guides and policies we can still miss the boat. That is why the designer himself needs to have this philosophy that we talked about in the application.

Mr. CONSTANDY. Are there some things which are common mistakes, not to suggest the frequency of them, but the type of mistakes that people make in the selection of interchange configuration?

Mr. LEISCH. Well, there have been mistakes all along over the years, and of course the forms now being selected are extremely improved. I think some of the mistakes—they might not be mistakes in a sense——

Mr. CONSTANDY. I do not mean that in that way. I hope you appreciate that.

Mr. LEISCH. In other words, we did not have the full knowledge in the past of such things as we have now, left-hand ramps, the use of multiple exits at one interchange, or some of the real problems that we face today.

Now, again, unfortunately, this knowledge or realization or awareness is not universal, and there is this lag, so that I am sure that mistakes have been made recently and are being made, if we can call them mistakes now, so there is a need to close this gap.

Mr. CONSTANDY. If I understand this correctly, there are some things being done today which you would suggest experience has shown are undesirable, as an example, left-hand exit?

Mr. LEISCH. Yes.

Mr. CONSTANDY. Are there other situations where there is not a fundamental error in the conception, but it is a misapplication, perhaps, more a mistake in choosing the wrong type of interchange to solve a particular situation?

Mr. LEISCH. Yes. I am glad you asked that question, because this is the objective. This is the objective of this particular illustration, to show that there are certain types of interchanges that are adaptable to certain situations. And not everyone in the field is fully aware of this. Therefore, we might say certain mistakes are being made and certain forms of interchanges are being used improperly, because everyone is not aware of these adaptability features, as we have illustrated here.

There are many, many interchange forms fundamentally. There are literally hundreds of interchange configurations. There are only a very few that we need to actually use.

Mr. CONSTANDY. Would you elaborate?

Mr. LEISCH. Yes.

Mr. CONSTANDY. Could all the situations which have been developed in the use of hundreds of types of interchanges be more successfully satisfied with fewer types; is that your point?

Mr. LEISCH. Yes. You can operate more successfully with fewer types, which are more appropriate, and which operate with the objective we have exhibited of simplicity, regularity, and uniformity.

This is what we are after. If we follow that objective in design, and with the experience that has been gained, we find that there are only very few interchanges that need to be applied, and many of these other forms actually make for problems. Before we had this experience, they were considered to be reasonable. They appear to give certain advantages, but experience has shown that they really do not. They tend to complicate matters, so that there is need to achieve simplicity and uniformity and regularity.

This is what we can do by choosing the forms of interchanges that can be signed quite clearly and that can be comprehended and operated efficiently, and perhaps more safely than some of these other forms.

So we have screened all these possibilities, and here are some of the interchanges, the primary ones, that might be used, and they are few indeed. So we need not belabor this idea of trying to fit the traffic pattern itself and achieve the forms that will really do a proper job. Now, let us see what this really means here, this picture.

The left-hand column indicates the type of intersecting facility. First of all we have the left-to-right facility on each interchange, which is the freeway. The one running up and down, north-south, is the crossing facility. The crossing facility is spelled out in the left-hand column. That is the crossing facility—it may be a local road or a minor street. It might be a primary highway or a major street; it might be another freeway.

Mr. CONSTANDY. It is the characteristics of the intersecting road that dictate the form of the interchange?

Mr. LEISCH. Yes. These are the primary points that give direction to the form. What type of intersecting facility—the type of intersecting facility; and then the environment with respect to whether it is a rural facility or urban facility, and of course it might be suburban, which is in between. These are the driving forces, so to speak, which indicate or allow one to pinpoint the interchange.

Of course, one other ingredient is there—there are a number of others. These are primary. Of course, right on the heels of these is traffic itself, not only the volumes that are involved, but the actual pattern of traffic that is to be accommodated. And then, of course, the site itself, the physical site.

Mr. CONSTANDY. Such as topography?

Mr. LEISCH. Property and topography, the general environment, the type of land uses and so on, all have effects.

But these other, except for the type of facility, the type of crossing facility, whether it is rural or urban and the traffic, these are prime movers. And then all of the other factors actually then to pinpoint the exact interchange that might be within each block. You see, there are several.

Mr. CONSTANDY. I see.

Mr. LEISCH. So we position ourselves in one of those blocks. Just as an example, suppose it is an urban situation. We have a major street in an urban area. We basically have four interchanges to choose: One of two diamonds and one of two partial cloverleafs; and that is all. We really need not look further. It is true we have borderline cases. We might get into a situation where it could become one of the interchanges from an adjoining block. But usually that is where it falls.

Then we consider traffic and the general environment, the topography, space, so on, and then we are able to pinpoint one of these interchanges. And then we apply all the geometric standards, and we apply the signing techniques before we even decide which one, and we test it. And then the facility can be designed in its detail. This is the process now. It is very simple.

It used to be very complicated. It is very simple now. So, by reducing the number, we are simplifying the problem in terms of signing. We are simplifying the problem in terms of operation on the driver's part.

Mr. CONSTANDY. May I ask what type of thing would suggest a choice between a straight diamond and split diamond?

Mr. LEISCH. That is mostly the question of capacity, the ability to handle traffic. Under certain situations, the conventional diamond, the one on the left, may not handle the traffic. The one on the right has a very relative high capacity and could, but then also there is the problem of whether you can physically make, or environmentally make, two streets one-way streets and operate them that way. If you cannot, you cannot incorporate an interchange of that type.

Mr. CONSTANDY. This would suggest the necessity of very close coordination, and perhaps the willingness to make an adjustment on the part of the city, if, for other considerations, the split diamond would be preferable, as you say, because of volumes. You could not use it unless the city was able to one-way the two streets.

Mr. LEISCH. Yes. There may be a very good reason why you cannot make those one-way streets, and you would not be able to make that

interchange. Still, if you could not handle the traffic with the conventional diamond interchange, then you would have to look to those other two forms, two partial cloverleafs.

Mr. CONSTANDY. If a design team for the State highway department recognized the volumes in an urban area that would suggest a split diamond, but as a matter of fact the city does not have one-way streets that design team or someone has the chore of inducing the city to change its traffic pattern?

Mr. LEISCH. Yes; very much so. And sometimes that is a very good thing, if that change in the traffic pattern on the street system can be accomplished. On the other hand, it may be a poor situation to change. So it requires that type of investigation and coordination, you know, of all the agencies involved.

Mr. CONSTANDY. I just wondered to what extent, in a typical situation, a design team has that much force or coordination with the city to induce them to adjust their street system for the design of a new freeway?

Mr. LEISCH. This is one of the problems. This is another area where it is necessary to work together with not only the various agencies, but the various disciplines that are involved of bringing in economists and sociologists and so on.

Perhaps not just on one interchange alone, but thinking of the facility as a whole, we know that is necessary. And it is very encouraging that this type of approach now has been introduced and is being followed. So it is certainly a step in the right situation.

Mr. CONSTANDY. To some extent it will depend on the willingness or the ability of the city to make the expenditures that may be necessary to adjust its city street traffic?

Mr. LEISCH. Yes.

Mr. CONSTANDY. To accommodate a new highway?

Mr. LEISCH. Yes. This is a very good point, because the design of a freeway, if this is what we are talking about here primarily, does not stop with where the ramps touch down on the street system.

Mr. CONSTANDY. No, but the finances might.

Mr. LEISCH. The finances perhaps do. And this suggests the need to look at the whole problem and somehow to coordinate all aspects, including that of financing. But certainly the problem of design and location does not stop with, you know, the right-of-way or limits of work, so to speak, with regard to the freeway. And so it is quite necessary to take a look then at the broader problem.

Mr. CONSTANDY. Looking at that in reverse, we may have one of the explanations for why so many of the designs are not appropriate.

Mr. LEISCH. Very much so. I think you have hit on a very good point, that the designer or perhaps the agency that is, say, the one that is primarily the one concerned with the facility, is trapped to a point where, at the time of design and decisionmaking, the problem has not been resolved with respect to the broader problem, and, as an interim measure which becomes a fact, the facility perhaps in some instances is not appropriate, and it is not the optimum because of the fact that it was not possible to take a full look at the total problem.

Mr. CONSTANDY. Does that suggest that the design is dictated sometimes not by the technical considerations for the facility's function,

but, rather, it is forced by political decisions, however good or bad they may be——

Mr. LEISCH. Yes.

Mr. CONSTANDY. Which in turn turn dictates design. This may cause to be built into the facility a feature which is disruptive to a free-flowing facility?

Mr. LEISCH. Very much so. That certainly has happened, and is happening.

Mr. CONSTANDY. If you could not get, then—if your appropriate choice was a split diamond, and you could not get this coordination with the local community, you would then go to the parclo A or B?

Mr. LEISCH. Yes, the one on the left is A, and the one on the right is B. The one on the left, A, has a very high relative capacity. It is approximately the same as a split diamond. In fact, it has operational features that are quite similar, although it is configurated quite differently, and that would be, say, the next choice if you can get the necessary space for it. It requires additional space.

Mr. CONSTANDY. Can we pursue that for a minute? If you can, does the parclo cost more than the split diamond to construct?

Mr. LEISCH. Yes. The parclo could very well cost more, because of the extra space required, and the property that has to be taken.

Mr. CONSTANDY. So then you find yourself in the peculiar position of having to spend more money for the facility to accomplish the same purpose?

Mr. LEISCH. Yes.

Mr. CONSTANDY. It is just that the highway constructing agency is spending the money and not the local community?

Mr. LEISCH. Yes.

Mr. CONSTANDY. Or if they cannot get approval for the added right-of-way space for either of the two parclos, to accommodate the same function as the split diamond, what option do they have rather than to unwillingly accept the straight diamond, which is not functionally correct?

Mr. LEISCH. That is right, this would be the situation where no agreement could be reached, and the conventional diamond is the only one that is feasible under the circumstances, and it would have to be recognized that it is an inadequate design. I think certainly every attempt should be made to provide the adequate design, even with some relocation possibly, or even readjustment of interchanges along the route. There are other alternatives that might be pursued.

Mr. CONSTANDY. If this city has the option of preventing the construction of the facility through its boundaries unless they get the surface street connections they want, and they demand a connection with that intersecting street, you can very easily then be left with no choice of a configuration, but must build the straight diamond, which is functionally inappropriate?

Mr. LEISCH. Yes.

Mr. CONSTANDY. And before it is even built, you know that you will have an operational problem in this place?

Mr. LEISCH. Yes.

Mr. CONSTANDY. And yet it is the one that is accepted?

Mr. LEISCH. Yes.

Mr. CONSTANDY. I think, myself, maybe we have pursued this far enough for this hearing, but personally I feel that this is a major area for consideration.

Mr. LEISCH. It certainly is a very major area. I agree with that.

Mr. CONSTANDY. The professional with the technical skill is being forced to do something that he knows will not work, to accommodate other considerations—granted, that in the proper definition of facility for public use, it is probably a necessity to balance these needs. What worries me is that you frequently find a facility which, while it is still on paper, is expected to not work, but it will be committed to concrete and in use for 40 or 50 years into the future, and in turn may then develop enough pressure through its inability to work and cause the expenditure of additional funds and perhaps the taking of even more land, which would not have been necessary if it had been done right in the first place.

Mr. LEISCH. We are faced with this where facilities have failed prematurely and failed for one reason or another, and now the expense is huge.

Mr. CONSTANDY. To go back and renovate it?

Mr. LEISCH. Yes, to renovate these facilities.

Mr. CONSTANDY. And sometimes renovate it with the result that you never really get the thing you wanted, and the cost might well exceed what you would have built correctly in the first place.

Mr. LEISCH. Yes. In other words, the design, the new design still might not be what you would like to have, because there are still certain limitations, because of course you are going into the new design because of the sheer necessity of handling traffic, and you carry out this type of an improvement.

Mr. CONSTANDY. Can this not come about in another way—with a fascination for first cost, building the project within some frame of cost, rather than some frame of need?

Mr. LEISCH. Yes, that is true.

Mr. CONSTANDY. We digressed. Maybe if you could go back.

Mr. LEISCH. These are very good points, and they are certainly very much related, since we are trying to point up some of the problem areas, and perhaps why some of the things are happening.

The objective of the slide here is to show, first, that the interchanges from a technical point of view should be correct or appropriate, but then you bring up the problem, Mr. Constandy, that there may be an associated problem in that it might not be feasible for political reasons to achieve what we might call the optimum design. These are true problems.

In my own practice I find this problem, and I also find that by making an economic analysis you can show the wisdom of perhaps even taking certain property or even changing streets, street operations, in order to fit into one of these interchanges. And the way some of this is being accomplished—I think the key to some of this is the approach through stage development. I personally would not like to be put in a position, and I do not know that I really, fully, ever have been, that is in recent practice, of going along with one of these interchanges that is a wrong form.

My attempt has been to pinpoint the interchange that would do the job, even with some compromise perhaps—it is not necessarily just one—and then program it or propose a staging development which will allow eventually for the proper form to go in, so it is not a complete loss. And you do not have the huge cost later, and all the problems to overcome, in order to replace that interchange in the future.

So you might actually initially wind up with a form that is not fully adequate for future traffic, but one that can be converted. This is the approach, and you can achieve quite a bit of sucess and overcome, to a large extent, this problem that you have brought up with regard to political situations.

Mr. CONSTANDY. You at least have flexibility here.

Mr. LEISCH. Yes. I think this should be the objective on the part of the designing agency. I think this speaks for itself in the slide, just to point out that we can make it simple, that we now have a reasonably direct approach and relatively few interchanges. Actually, with regard to the crossing of two freeways, there are more than those two; those are only representative, and they just indicate varieties. But there are not very many of each.

For instance, there may only be about a half dozen of one on the bottom left, and perhaps four or five varieties of that directional form on the lower right. And that is the lot. That is pretty much the interchanges we need to look at. We need not look any further. If we do, we will be in trouble.

Mr. CONSTANDY. These, with the few additional suggested for directional interchanges, could replace the several hundred variations; is that true?

Mr. LEISCH. Yes. They definitely do. Now that we have gained this experience, there is no advantage to some of these other configurations, which do not satisfy the three objectives listed: uniformity, regularity, simplicity.

So if you consider that, and with it, of course, signing—that is a true key to it all—we wind up with relatively few interchanges.

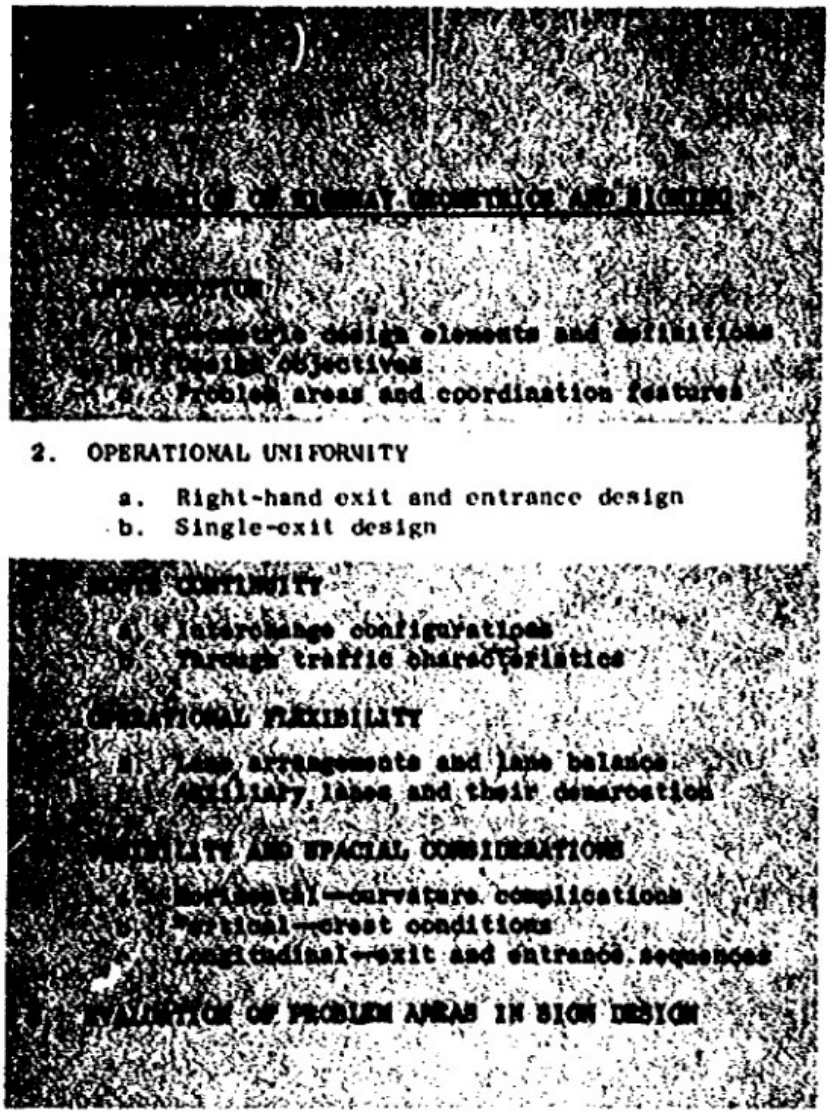
Mr. CONSTANDY. If we had an honest appreciation for the signing problem, that in itself would exclude many of several hundred?

Mr. LEISCH. It definitely would. I think this is part of the evolution that the signing was taken into consideration in this type of analysis and selection, as we see it here on this slide.

Mr. CONSTANDY. I think I should keep quiet more, and maybe you can go on. We do not want to miss any of this.

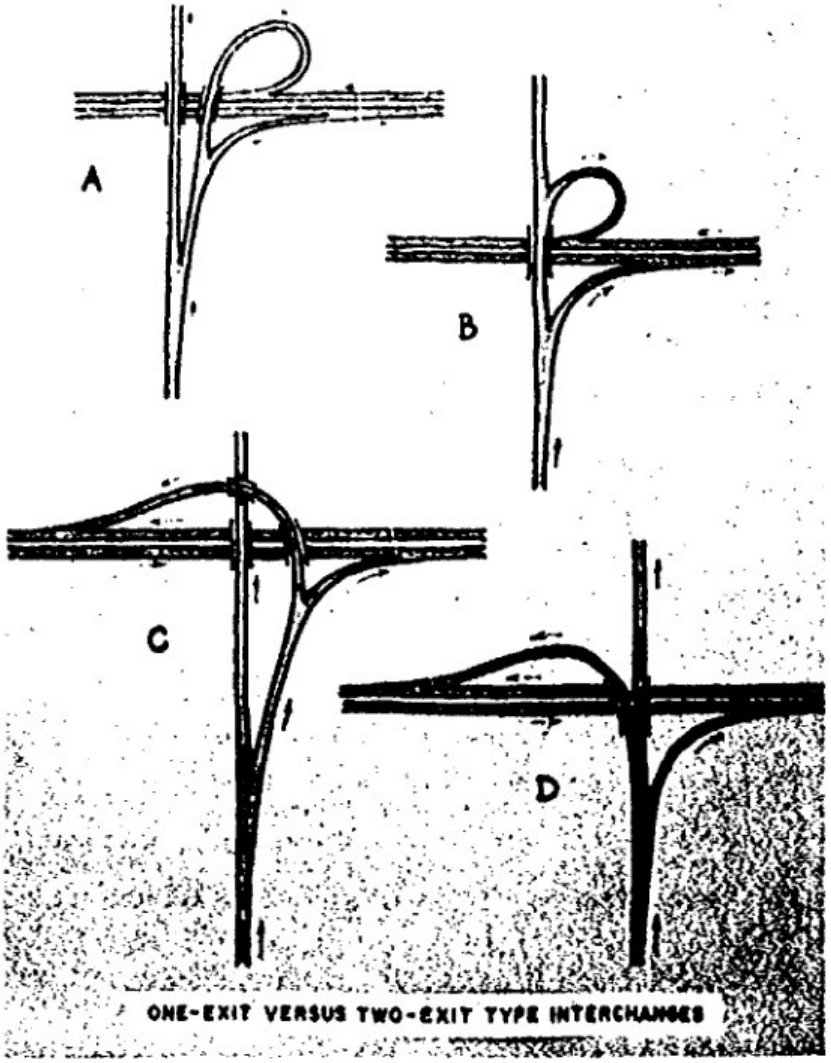
Mr. LEISCH. These have been very good questions, and observations, on your part.

Next slide, please.



We now come to the next point, and here is where we have those four areas of coordination between highway geometrics and signing. And the first of these is what we may call operational uniformity. And this will deal with a subject of right-hand exits and entrances. Along with it, the use of the left-hand ramp, and also the use of a single-exit design.

Next slide, please.



ONE-EXIT VERSUS TWO-EXIT TYPE INTERCHANGES

Now this points up the use of the left-hand ramp, as well as it makes a comparison between a two-exit and a single-exit design. Let's start with figure B, upper right. Here we have the familiar configuration. It is only in part here. It is not a full interchange, and it shows the two-exit design. The person proceeding on the north-south road, wishing to interchange with east-west road, will exit in advance of the crossroad to go right or to go east; or, if he wishes to go to the west, he then proceeds over or under the structure—in this case over the structure—and takes a second exit, also on the right, and then proceeds to the west.

There are two decisions that are to be made by the driver on that facility. Now, let us compare that with diagram A in the upper left-hand corner, where the same basic movements are accomplished

through a single exit. This particular exit is in advance of the interchange. The driver makes one decision to leave the freeway that he is on——

Mr. CONSTANDY. Would you like to point at this as we go along?

Mr. LEISCH. Here in this upper diagram the driver makes a decision—first, one decision that he is to transfer to the crossroad. After he has left the freeway, and being on the auxiliary facility now, roadway, he makes a second decision—either to go right, east, or to go left, west.

The second decision is made away from the high-speed traffic, and it is made on a narrower roadway. And I think this, too, points out, as the film pointed out, the movie earlier, the tremendous advantage and need for shoulders on these ramps. In the event the driver does have to stop, if he is confused, at least he is stopping on the ramp. We would like for him not to stop at all. We would like to make these signs very clear; but even clear signs in themselves might not do the full job if the interchange, even though it is a single-exit design, is not designed properly from the point of visibility and spatial relationships—well, he must be able to make proper decisions and to position himself into proper lanes through the design itself, even if the signing is excellent, and he can still be in trouble if the geometry of the facility is not correct.

That is where the coordination comes in. So, first, the facility is simplified geometrically through the use of a single exit, and then it is improved upon by the use of proper or appropriate visibility and spatial requirements.

Now, in the lower diagrams we have the problem with a directional interchange, where the flow of traffic is heavier, where the interchange's turning movements are much larger, we find even greater complexity, where a two-exit design is used, such as appears in the lower right.

It is quite common, and in the earlier endeavors the attempt was made to allow the driver who was going right to bear right and proceed right, and the driver that was destined to the left, to bear left and turn left, and that was considered to be a natural movement.

That was considered to be sort of the optimum. And it was quite natural at that time to consider that was the way to design a major interchange. It is quite natural, at an intersection at grade, for a driver to perform in that fashion. It is entirely different, we now realize, at a major interchange where the driver does not have any concept of how the interchange itself may be configurated. He is only following what he sees in a fashion, where he makes progressive decisions, and he is not aware of the configuration. It is not necessary for him to bear left to go left. There are other aspects which are much more important, and which we will also bring up in succeeding slides.

But let's examine the problem here, the lower diagram D. It shows the approaching driver on the freeway, and he is intersecting with another freeway. If he wishes to go right, or to go east, he has to position himself in the right-hand lane, and also he has to make a decision at this time, not only that he is going to—that this is the right facility for which he must exit, but he must also make the second decision that he is going to the east or whatever the destination that

is designated there. If he is not quite sure, he might be sure he wants to interchange with that freeway, but he might not be quite sure that he wishes to go east or that he wishes, let's say, to go toward Washington; because he doesn't want to go to Washington, he wants to go to Bowie, for example, and the other sign says to Baltimore.

And you have to be in the left-hand lane, but he is out of position at this moment, and he doesn't want to go to Baltimore, he does not want to go to Washington, he wants to go to Bowie. He does not know whether it is east or west. He is in a stream of traffic with four, five, or possibly six lanes. It is not uncommon today to design with five or six lanes in one direction. That may be the maximum.

Here he is caught in a tremendous stream of traffic, 60 miles an hour, may be six lanes abreast, and he is on the right-hand side and wants to be on the left, and he does not know where he is going. He knows, but the signs and the highway itself, the way it is shaped, patterned, do not tell him.

Now, that is a tremendous source of hazard right there. Certainly there is evidence of it in the films that we saw today, a real problem. Now, this problem can be largely overcome with appropriate design, both geometrically and in signing and in coordination of the two, and this can be accomplished through a single-exit design.

Now, I know that we have many single-exit designs that are giving us trouble. In fact, the film that we saw is a single-exit design of this order, and was giving us tremendous trouble. So we have to find out where the problem is. Perhaps that was more in the signing, the confusion that was given to the driver by the signing, but I suspect there was also a geometric fallacy in that design, perhaps not when it was first conceived, but from the experience we have now gained we know it is a fallacy.

And I believe what it is is what we call lane balance, the arrangement of lanes, which allows a driver to position himself in a certain way. And that, in combination, the lack of lane balance, the combination with perhaps poor signing in terms of informing the driver, I imagine, is causing the problem there.

Coming back to the single-exit design now as it appears in the lower diagram C, let us see the difference operationally. Here the driver is proceeding on the freeway. He is approaching this crossing freeway. He knows that he is destined for a certain freeway, say it is an Interstate highway, maybe it is Interstate 50. The sign here tells him Interstate 50. The sign also gives him some destinations: Baltimore and Washington. He happens to be going to Bowie, but he does not have to worry because he knows he has to use Interstate 50. He also knows it is somewhere between Washington and Baltimore. Those are identifying points of some sort, so he leaves on the right.

Now, if all the interchanges are of this form, where there is absolutely no such thing as a left-hand ramp, if he knows, and he had an advance sign a mile or two miles before, that Interstate 50 is coming up, he would not have to think twice. All the drivers who want to reach Interstate 50 would be in the right-hand lanes; so he would be not out of position when he got to this point; he would not be causing trouble; and he sees the exit, the gore sign, and he knows he wants Interstate 50. He leaves, and with appropriate dis-

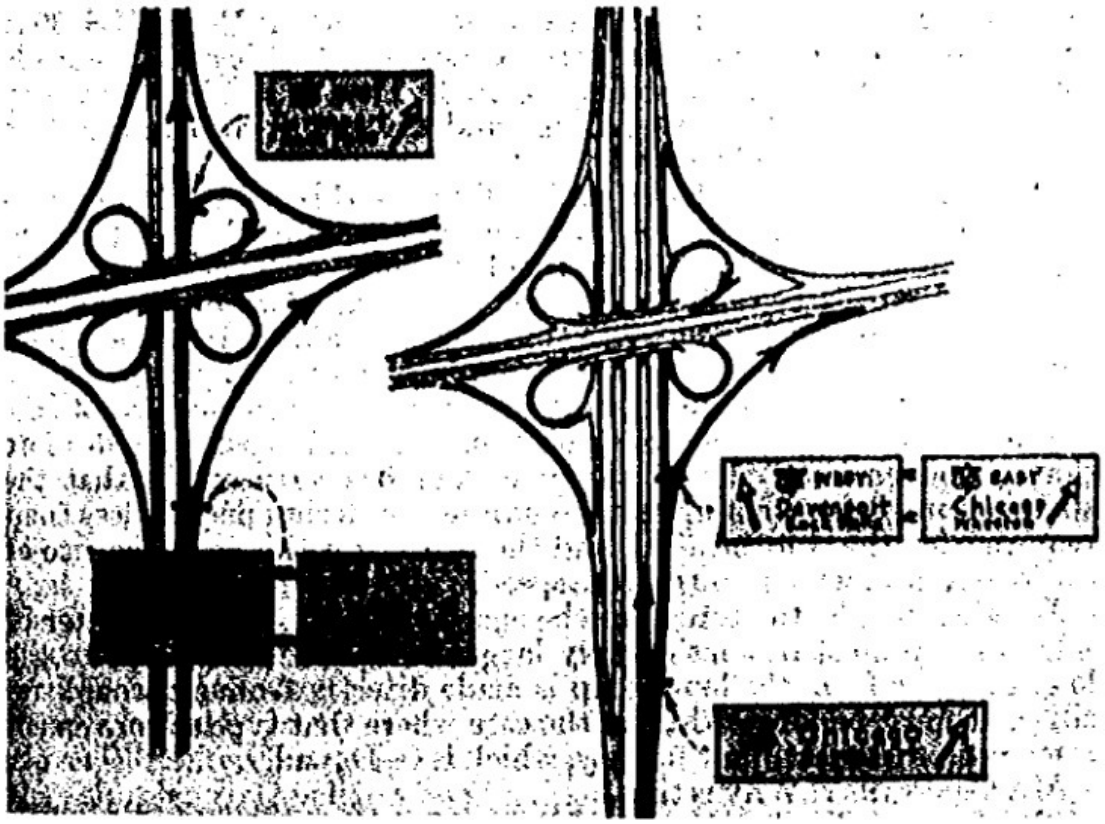
tance and appropriate number of lanes, and appropriate lane balance, which would facilitate his exit, appropriate visibility, he will then perceive two signs here for a secondary message, which supposedly will help him to make that second decision.

With these signs being off the main lane, they can actually show more information. They cannot only show Baltimore and Washington, it could also list other things. It could possibly list Bowie, Laurel, or College Park, or something, which would be an additional clue to the driver. And chances are, with the two destinations noted, he will go off then with confidence.

If not, he probably only has two lanes here on the ramp, compared with four, five, or six, on the mainline, and the speed is much lower. If he wants to actually stop on a shoulder, which is not a good thing to do, but you might not prevent that, he only has to slide off a very short distance. He is away from all the hub-bub of the traffic.

In any event, this is the simplicity of it. So it has to do with having a consistent pattern, let us say: right-hand exits and single exits. Then the driver can be relaxed; and this is one way to accomplish it. We want the driver to relax.

Next slide, please.



First, consider a freeway which is running north and south, and let us say some primary highway running east and west. This east-west facility happens to be U.S. Route 30. This is a hypothetical case. But it does fit in geographically with a route and the destination points here, and let us consider the design of the conventional cloverleaf on the left, which inherently is a two-exit design. Let us see what the signing is like. I am only considering the signing directly associated with the interchange.

Here the driver is approaching, and in the mainstream of traffic, in advance of the exit points, he has to make a very important decision. Is he going to go west or is he going to go east? He has made his decision, he is going to leave at Route 30. That is pretty definite. But he might not be sure whether his destination is to Davenport or to Chicago, or to Rock Falls or to Wheaton. It very well could be one of these, and this may be enough of a clue. But look at all he has to read while in the high speed of traffic.

He has to read and comprehend all that is there, make his decision, and then position himself in the appropriate lane. That could be a real source of hazard, real source of frustration. He is not going to Chicago or Wheaton, and he takes the next exit, which then gives him the direction to go to Davenport or to Rock Falls.

It is quite common, it is a very common type of situation we have along the highway. But then let us examine, on the right of this illustration, the use of a single-exit design which can be accomplished with a C–D road, a collector-distributor road, that is introduced through the interchange along the freeway, which converts this cloverleaf pattern to a single-exit design. Look at the simplicity of this design, a single sign. With this one all the driver has to read and comprehend, make his decisions upon, fits into a pattern of all right-hand exits, and he has made his decision in advance from advanced signs that Route U.S. 30 is coming up. He is going to exit there. As he comes to this point, he reads the very simple message which says U.S. 30. He does not have to worry about east-west. And it says Chicago and Davenport, just to give him some target places; and he is off.

Mr. CONSTANDY. Could we just briefly raise this point, because this is one we have discussed. The question has come up whether the configuration on the right, the collector-distributor road, is not appreciably more expensive than the straight cloverleaf. I think at one earlier meeting you explained to me that that is a fallacy, to some extent, and I wonder if you could just briefly explain that?

Mr. LEISCH. Yes. A cloverleaf design with a C–D road may not cost any more under some circumstances, or may only cost a little more than a conventional cloverleaf for a very basic reason, in that the space occupied for what appears to be a larger design may be less than required for the conventional, and the reason for this is in the size of the loop ramps, which controls the speed.

In other words, the radius or the space occupied or the diameter of a loop ramp must be considerably larger where the movement to the loop ramp or from the loop ramp is made directly from a through facility. It must be larger than in the case where that type of movement is made from an auxiliary facility, which is C–D road.

Mr. CONSTANDY. Why is that?

Mr. LEISCH. Well, there must be some compatibility between the speed of traffic on a freeway, for example, and that on the ramp. There is a certain relationship. There is a certain basic inherent relationship

between the two that we must maintain. The loop ramp directly from the freeway may be more on the order of 230-, 250-foot radius, say, for a fully modern freeway, to make it compatible with the speed on the freeway, which allows for 30-mile-an-hour operation on the loop proper; whereas on a C–D system, the loop ramp itself might be reduced to 25 miles an hour, and the radius is substantially less, being 150 feet.

So let us compare the two diameters. Here is a diameter of, let us say, 460 to 500 feet compared with a radius or diameter of only 300 feet; so obviously even though the structure is larger and there are more roadways here, the entire facility can be compressed into a smaller area. And in those places where space and right-of-way is a costly proposition, this more expanded type of interchange might actually cost less than the lower form, the less desirable form, which is one of the conventional forms.

Mr. CONSTANDY. Could we raise one other point there: Do both of them do the job or does only the collector-distributor actually and properly do the job?

Mr. LEISCH. Well, in terms of achieving uniformity, this does not do the job because of the two-exit design.

Mr. CONSTANDY. The straight cloverleaf?

Mr. LEISCH. Yes.

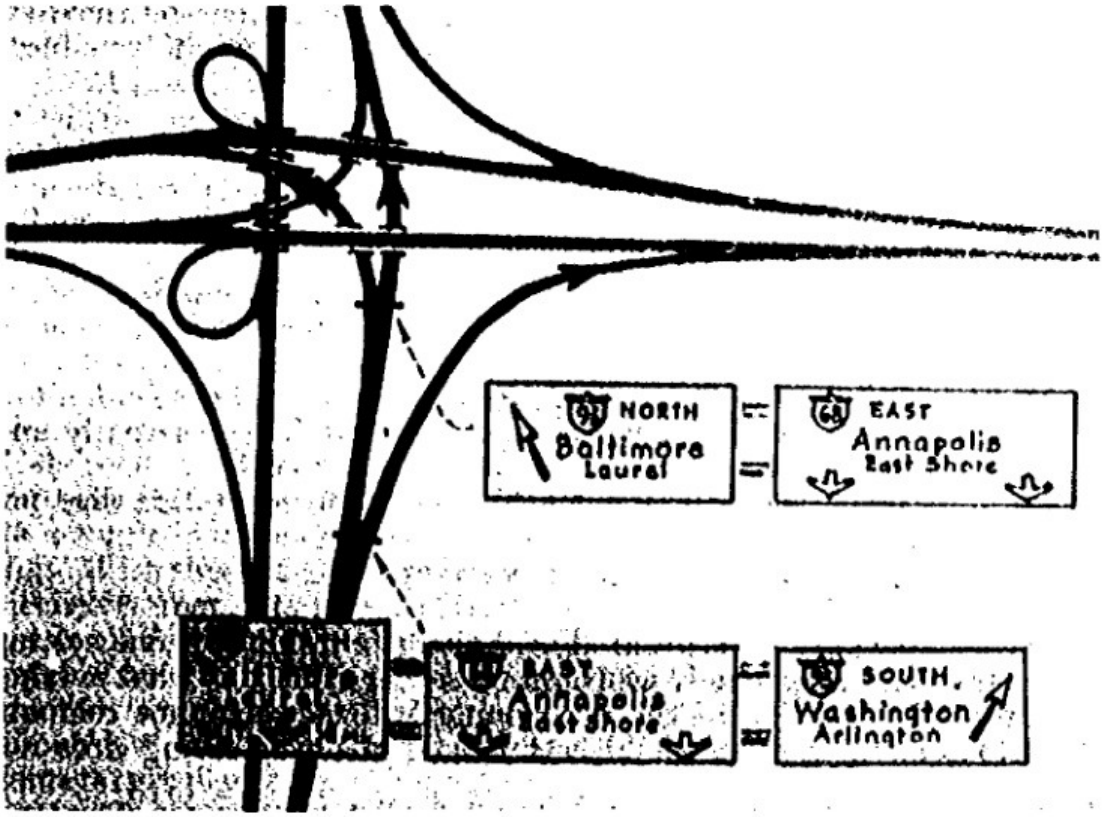
Mr. CONSTANDY. Is it not kind of difficult to talk about one costing more than the other one if we begin by saying: "This is what it takes to fulfill the function of the interchange"; then we cannot compare that to something that would cost less, if that something does not do the job?

Mr. LEISCH. No; the two are not comparable, let us say. They are two different things. They give you a different operation. If you set up a certain criteria or certain standard or certain need here, this one does not do the job [indicating the left diagram]. It is not even in the running. This is the interchange, then; if it is going to be a cloverleaf type, this cloverleaf with the collector-distributor has to be the interchange.

I think this is the way the approach would be made. No more would we put a diamond there—we would not put a cloverleaf, if we adopt the philosophy that we are going to have this uniformity, we are going to simplify signing, but it is more than that. We also find that this particular feature operationally, the particular weaving section, which occurs directly or contiguous with the two travel lanes, is very hazardous, and reduces speed and is not compatible with the type of operation that we desire or is required on a freeway itself—so from an operational point of view, this straight cloverleaf interchange has no place on a freeway [indicating]. It is that simple. So this has also a breakdown potential here [indicating] and its capacity is lower than with the collector-distributor.

Mr. CONSTANDY. That is the one that you referred to as the straight cloverleaf?

Mr. LEISCH. Straight cloverleaf has lesser capacity than the one on the right. Next slide, please.



Examining signing now, again with directional interchanges—this particular message is presented on two slides. The first one here is a two-exit design. This is the one we say that is complex, the one that we would like to eliminate from consideration in terms of freeway operations and design.

Look at the complexity of the signs. In reality there are three signs required. You will notice there were only two signs at the cloverleaf form at this point. Both exits were on the right. And this particular case, with Interstate 93 being shown to the extreme right and the other one shown at the extreme left, I think it is necessary to give the driver some idea of what is straight ahead. For that reason it is necessary to put three messages across to really tell the story.

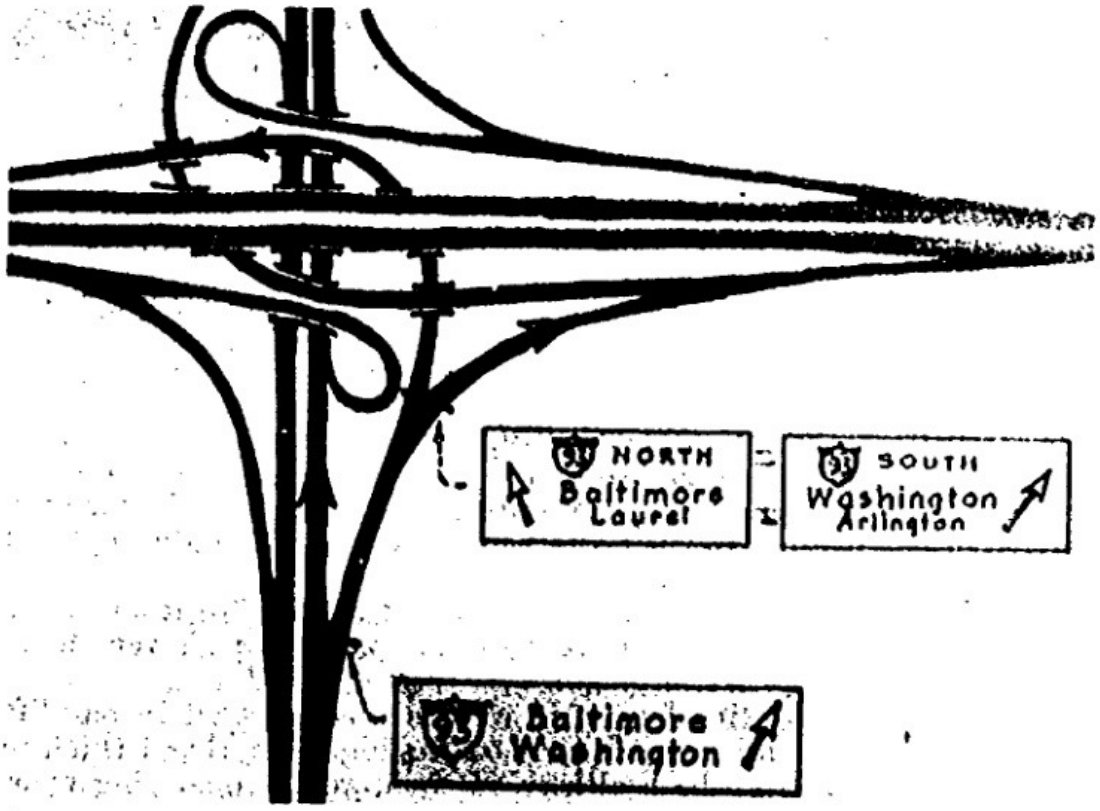
So what we have here is Interstate 93 running east and west and Interstate 68 running north and south. I do not know whether there are any such facilities as that. As far as I am concerned, this is hypothetical, although these numbers would fall in, I think, in the general area of Maryland. Of course if there were such routes—there may be; I do not know—well, let us look at it as being purely hypothetical. This is not a real case. Look at these signs. Again, six lanes on the approach, and the driver has to comprehend, he has to read all of that, and just count the units. Count all these units on these signs.

I would panic, you know, if I was going to Laurel, if I knew where I was going, I think just the mass of signs before me would be enough to panic me. But I would panic even worse if I did not recognize some of these places, I am going somewhere else, but definitely I want Interstate 93, but I really do not know exactly where I am going here. In high-speed traffic you may be way out of line. It is a terrible situation.

You might read this sign first, and you might be happy and you are on your way; but if you get by this point all right and your car is in motion, you make your second decision here [indicating]. And then you actually are turning left. You have been accustomed to turning right at some of the other interchanges. You also do not know in advance which side you ought to be on.

To me that frequently is a tremendous worry. I will drive through a city on a freeway, and while I should know how some of these things are designed, I have a fear, I worry. I do not know whether I should be on the right or left. I know a couple of interchanges later I am going to be making an exit, but I have no idea, I cannot tell from the map whether it is a right or left exit.

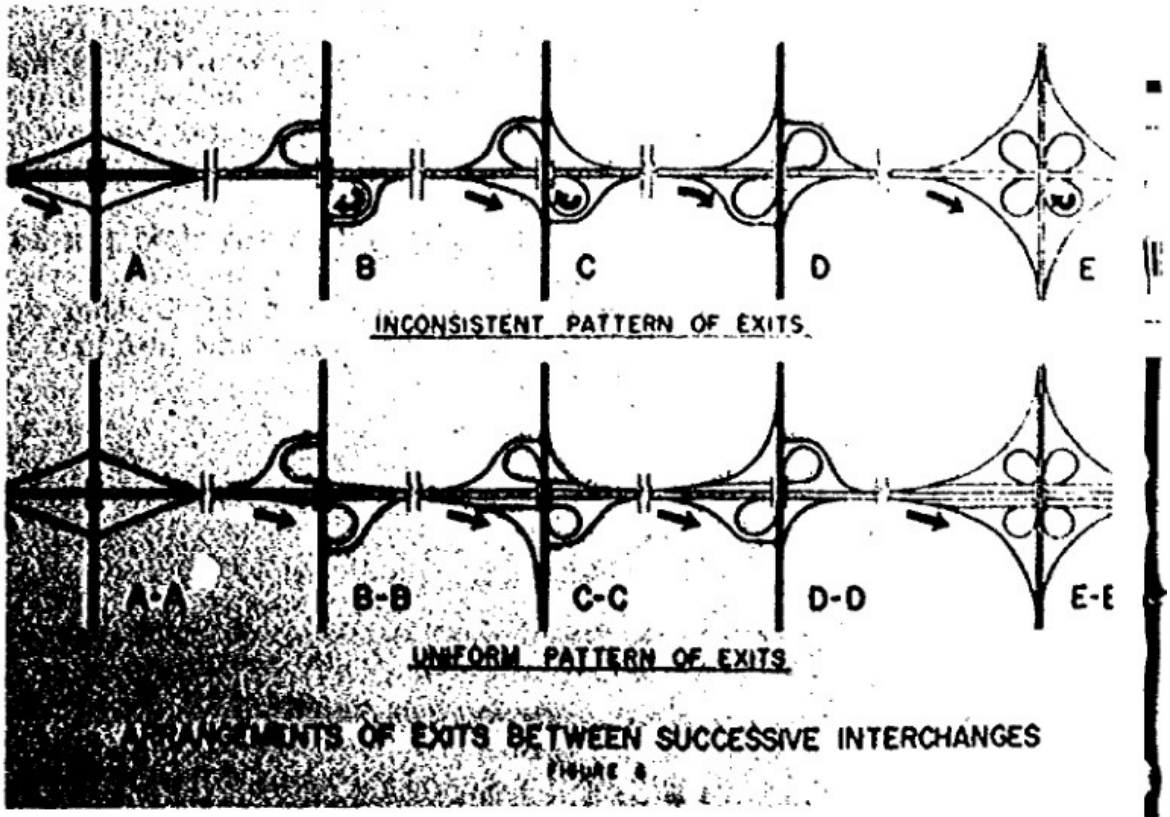
It is rush hour, driving through the city, and I just had this experience driving from Detroit recently, and it really was a very harassing experience. Anyway, the driver has to make another decision down here. Look at all these signs, five signs, and just look at what it says. Now, let us go on to the next slide.



Beautiful simplicity, when you stop to think about it. This is what the driver sees first when he is approaching. First of all, we are talking about a situation now where we have converted our entire system in the United States to this right-hand single-exit business. The driver is relaxed. He is approaching, and he knows it is on the right. He is going to leave at Interstate 93. No problem. He can read this sign with his eyes half closed. Just a few little units on this sign, very clear, he is off. He is off five lanes, let us say, onto two lanes now, and has got good visibility of the signs. The signs themselves are quite simple, and he has to make this decision whether he is going to go north or south, left or right, and a decision whether

he is going to go to Baltimore or Washington. He does not have that much to read now. Approaching at a lower speed, lower tempo, and he probably is able to sort it out—it is very simple. Next slide, please.

This brings us, then, hopefully, to a conclusion that this incon-



ARRANGEMENTS OF EXITS BETWEEN SUCCESSIVE INTERCHANGES

FIGURE 4

sistent pattern that exists, let us say, on our systems today, actually could be converted, or certainly the new highways, to start with, could be constructed with a very uniform pattern. I would say at no extra cost, basically. Maybe a little more. Very little additional cost. But the cost is not at all significant here.

It is what the objective is that we are after here, in terms of the simplicity and safety, the well-being of the motorist; his very life is involved here.

Now, I guess we live longer if we are less harassed in our life, and I think we spend so much time on the highways that I think we can prolong our lives, be healthier, if we were not operating under such tension. This is one way to achieve a certain amount of relaxation along our highways.

Let us look at the upper diagram where they have this inconsistent pattern of exits. The heavy arrow shows the movements that the driver would make along the freeway at every one of these interchanges. Let us consider that this is one freeway, let us say, to a city, with a whole series of interchanges along it. There are cuts indicated here, there may be miles between these interchanges, but they are all successive interchanges along the freeway.

If the driver is exiting here at the first one, he leaves on the right, in advance of the structure. If he should exit at the next interchange, he passes through the structure and then exits on the right. He is making a different type of movement.

But then at the third interchange, if he were to exit here, he would have to exit at one of two points, depending on whether he is going north or south. So the operational pattern is different. All three of these are different.

Then we come again to another situation at D here, which is similar to the first one. It is a different type of interchange. Here again it is a single advance. Here we come at E to another interchange where we again have two exits, two decisions, one before and one after, a very inconsistent pattern.

[Mr. McCarthy assumed the chair.]

We can worsen this situation tremendously if he were also to incorporate along this highway some interchanges which also had left-hand exits. We do not even have that shown here. It would be much worse, so the situation is very serious.

Now, you might say, well, no one person ever leaves two interchanges at the same time. But the same person, even if he is a familiar driver, can become an unfamiliar driver. If he uses this interchange for the first time, he may live just a few miles from here, and he may have been living there for years and never had occasion to use this interchange, and has always used this one or that one [indicating]. And here, for the first time, he is using this interchange. Do you think he has read the signs, when he drove along that road day after day? No.

For whom are we signing? We are signing for the unfamiliar driver. Now, we can brush that off and say, oh, gosh, the old unfamiliar driver, stranger, that is only 5 percent, 3 percent, whatever it is, say, through the peak hours of the city; it is negligible. No, it is not.

If you consider you might have 3,000, 4,000, 5,000, 6,000 vehicles in one direction on one facility, and then 5 percent of that is a very large figure; and if you then calculate how often an unfamiliar driver passes down the highway—well, you find he is there all the time. It only takes one driver in one lane to cause havoc in five or six lanes.

Mr. CONSTANDY. Mr. Leisch, you have been advocating this uniform pattern of single right-hand exits for some years, have you not?

Mr. LEISCH. Yes, I have.

Mr. CONSTANDY. Since about when?

Mr. LEISCH. Well, in fact, this slide comes from a 1958 publication.

Mr. CONSTANDY. You had the idea some time before, though?

Mr. LEISCH. It was a few years before; yes.

Mr. CONSTANDY. Has there been acceptance of it?

Mr. LEISCH. In a few areas, but really not nationally, I would say.

Mr. CONSTANDY. We have to recognize that if the concept is to develop its greatest benefit, it has to be accepted everywhere——

Mr. LEISCH. I think so. This again is the uniformity that is so important. Unless we can achieve this uniformity, then we still leave the driver guessing.

Mr. CONSTANDY. Now, 10 years later, does it look as though there is a greater possibility of the acceptance of this as a standard?

Mr. LEISCH. Yes; I think so. I think it is very encouraging in a few areas that I have worked; I think this idea is being picked up. And I know for sure that my most recent experience, and quite extensive experience, has been not in the United States, but just across the border in Ontario, and the highway department there has adopted this

as a policy. And it is absolutely no problem. They are elated over it.

Mr. CONSTANDY. Is there any reason way it has not been adopted as a policy here?

Mr. LEISCH. I think probably it was considered that this would be additional cost.

Mr. CONSTANDY. We are back to that again.

Mr. LEISCH. And it is a small cost. Let's compare—you see, what we have here is each one of these interchanges now can be converted to a simple system. I have not even explained this. For example, compare this third interchange C; then in order to convert it to the single exit, it is necessary to extend the structure and to provide a stem road or piece of C–D road to accomplish it. And this also applies to this configuration [indicating].

It might not cost any more. As a matter of fact, that same idea of smaller loop applies here, as well as here [indicating], and we actually have evidence on some of the interchanges that I have had experience with in design, where we found that this cost was actually less, because of the reduced space.

Mr. CONSTANDY. In other words, the improved design costs less?

Mr. LEISCH. Yes. This is not always the case. You get out into the rural area where land may be very cheap and then your structural elements make up a big part of the cost, and in that case it might cost more. However, you know these are only certain forms. As a matter of fact, the two most popular interchanges are the diamond or the parclo A, as we have them here. They already have inherently the single-exit feature.

The cloverleaf is not a popular interchange any more. It still has its application in many areas.

Mr. CONSTANDY. Then only when it has collector-distributor road?

Mr. LEISCH. It should be only with a C–D system when on the freeway. This is what I believe should be the standard, and I think most highway engineers and traffic engineers would agree that on a freeway you not build a cloverleaf without the C–D system.

But still a cloverleaf is not that popular today. So even if we were in an area where the land is cheap, we might not necessarily build it anyway.

Mr. CONSTANDY. It is not a question of the better design costing more, it is the better design that is necessary to make it functional; that is the base cost, is it not?

Mr. LEISCH. That is the point. And this is part of our philosophy. It is necessary to have this design philosophy. Who are we designing these facilities for? If it is inappropriate design that costs less, it is just something else.

Mr. CONSTANDY. Are you not also then, by adopting the same appropriate design standard on the interchange as you have adopted on the overall design of the facility, insuring the investment you already have made? By making the proper expenditure, you insure the system functioning correctly?

Mr. LEISCH. Yes.

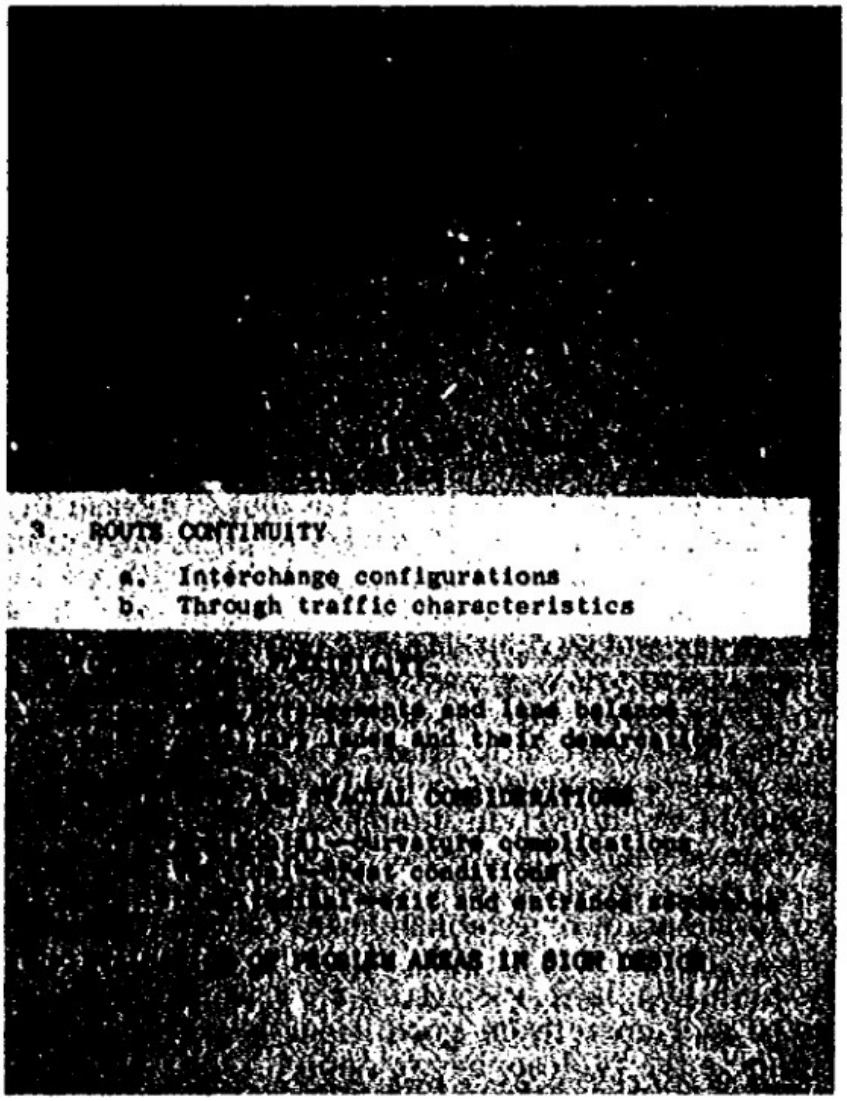
Mr. CONSTANDY. There is not any point in investing a great amount of money in a facility that operates at less than its potential because of an inadequate but less costly interchange, because in effect you have wasted some of the money you have invested in the balance of the system.

Mr. LEISCH. Yes. In other words, for some of these designs it is not the economical thing to do. Your initial cost may be less. But in the end it is going to cost more to put in the proper design. We have got to adopt this approach.

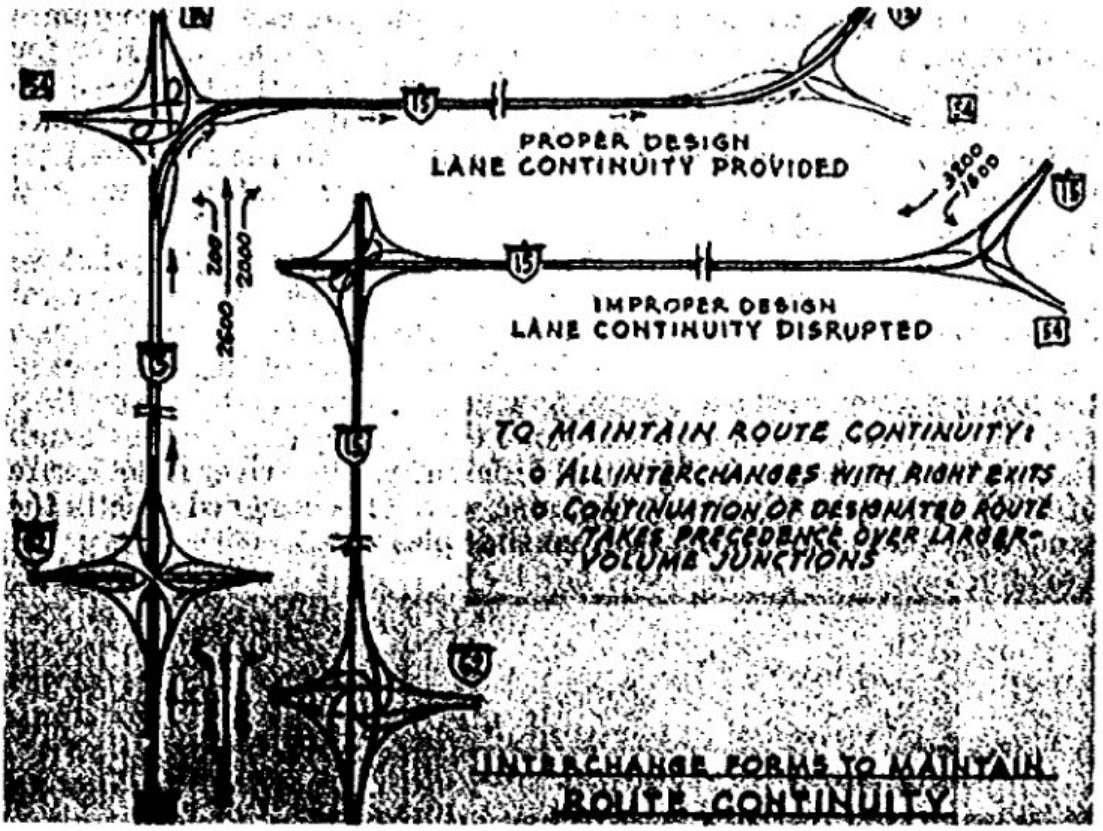
Then again I would like to emphasize this point of stage development, where there are not funds available and you cannot program a facility, where programing and financing situation does not allow for full development; where apparently it costs more, the thing still to do is to design for that appropriate facility, but stage it and reduce it down initially, so you can finance it and have all the elements provided for, so that it can be converted economically in the future, and not have to be completely rebuilt.

This is really false economy. We have to face up to the fact that we only have so much money to work with—fine. But let us make the total design stepdown and have interim design that can be converted later.

So here we have a conversion. You see every one of these arrows in the lower portion of the diagram, how nice and neat and uniform they are. The driver does exactly the same thing every time, even though those interchanges are configurated differently. The driver is not aware of it. They are signed exactly the same way. This is signed exactly the same way. This is the objective. Next slide please.



Now we come to the question of route continuity, and we want to deal with the interchange configurations themselves, which might provide for route continuity and also the through traffic characteristics of a route. Next slide.



Now, for whom are we signing the facility? Are we signing the facility for the unfamiliar driver? The unfamiliar driver is not necessarily one who is from out of the State. The unfamiliar driver may be a local person who is, for the first time, performing a certain type of maneuver. Let us recognize that.

The familiar driver does not need signs, and chances are he does not read them. He knows they are there. He looks at them blankly. He cannot tell you what is on them; if you try to pinpoint, corner someone and ask them what is on the sign, he probably will not know what is on a certain sign. He just relates the highway to what he sees.

He does it day in and day out. He does not read the signs. Also many of the drivers operate in very heavy traffic streams. He knows where he is going. There is very heavy movement. He follows that road with the rest of the traffic with no problem. The unfamiliar driver does not know which is heavy movement or light movement. He does not know.

So why should we, in certain interchanges, favor the configuration to the heavy movement? That used to be our philosophy in design. But really it is not right.

We have to maintain or establish route continuity, and something has to give way, if we are to consider the unfamiliar driver. But we use sufficiently high standard geometrics that we allow for the heavy movements to still operate on good, smooth curves, and reasonably direct. So this is the philosophy we apply.

For example, an illustration of route continuity. This is Interstate 15. It crosses Interstate 62. It has interchanges in between, which we

do not know. The driver comes to another major interchange, and there is a big city here [indicating].

Mr. CONSTANDY. That is at the top or north of the diagram?

Mr. LEISCH. North and west of the diagram is a very large city and very heavy movement is going in. For example, if you look at this traffic diagram here, and these are, let us say, peak-hour movements, we find that the movement through to the city is heavier than the movement proceeding on Interstate 15.

Now, the old philosophy, as shown on the right, is that if that is a heavy movement we try to favor it, and we allow it to go in as through movement. But if we are to maintain route continuity, we take that movement off on a right.

First of all, the driver that is following Route 15 is following Route 15, and we are applying now the right-hand exit principle throughout. We are trying to get this uniformity. Therefore, it must be exit on the right, even though the movement through is the larger movement, perfectly all right; let it go off on the right.

The driver is changing routes. That is commuter traffic. That is the familiar traffic.

The unfamiliar driver is following Interstate 15, and he does it to the left of every exit. He is relaxed. He is operating to the left. And here, in the opposite direction on Route 15, is another example where, for example, there is a very heavy movement in this direction, again heading for that city. This is the same facility, here on the left except this is route continuity. And this, on the right, is lack of route continuity. [Indicating.]

This traffic applies to both interchanges. Here, on the extreme right of both diagrams, we find a very heavy-turning movement. The through movement is still heavier, tremendously heavy, turning movement of 1,600 vehicles. It would be natural, and this is the way it was done and possibly still being done to some extent, that you provide for directional movement for this very heavy, very large traffic segment [indicating the lower drawing].

Mr. CONSTANDY. That results in a left-hand exit?

Mr. LEISCH. That results in a left-hand exit.

Here is route continuity [indicating the upper drawing]. Also the exit is on the right. But this form and this curvature is just as good as that [indicating]. The signing is very simple. The driver is relaxed. The driver has route continuity.

Now, let us look at this interchange between I–15 and I–62. Here again is a very large through movement. The turning movement is even larger. Again, the city is a very large city over here [indicating to the left]. Now, this on the right used to be the approach, and perhaps it is in some agencies, because it is a very heavy movement, a direct left ramp is provided. That is a left-hand ramp. It should not be that way.

In the proper design, if the driver is changing from Interstate 15 to Interstate 62, he does so by leaving on the right—as it should be. That ends confusion.

We come to this point because, just because the movement is through, you allow the driver to come on through, and the Interstate route actually follows what, in a sense, is a ramp. It has got all the speed and curvatures all there, and the comfort is all there, but it is configurated improperly, particularly for this return movement.

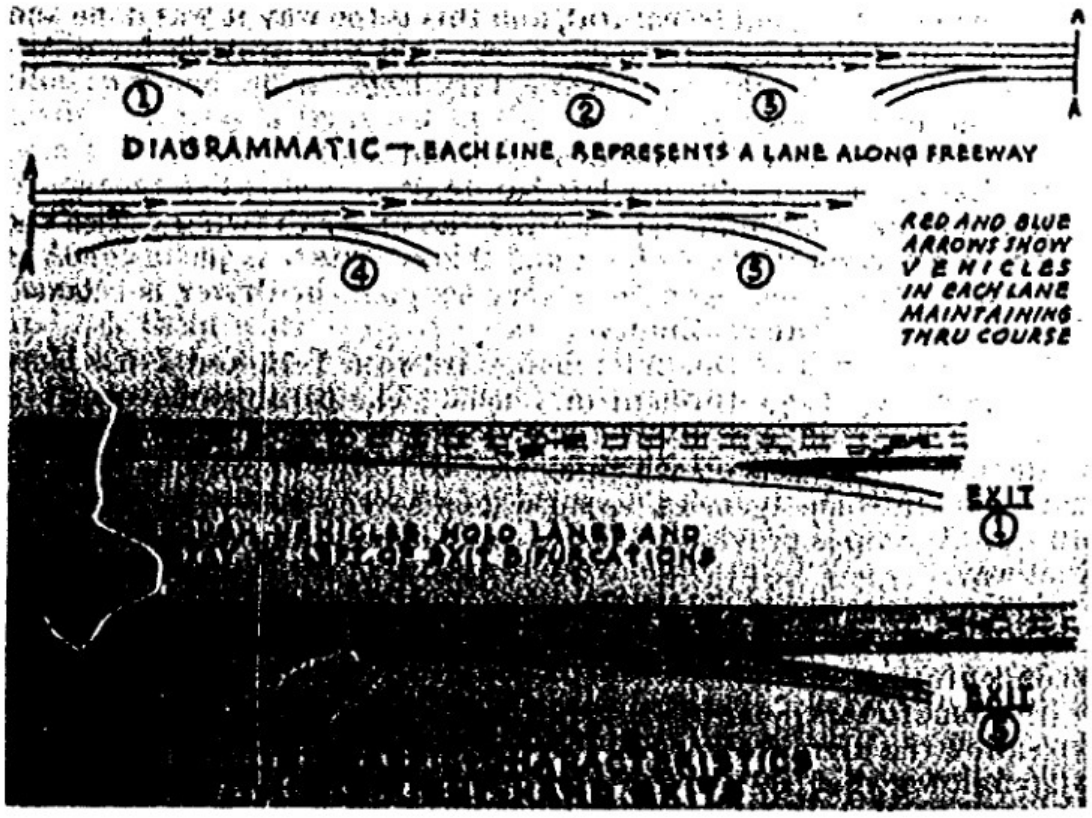
Mr. CONSTANDY. The improper design is very commonly found, is it not?

Mr. LEISCH. I think it is very commonly found. And again it might not be the fault of anyone, because again we learn from experience. These are the things that we just became aware of just very recently. And in many cases these facilities were designed out of the knowledge of the routing itself. And I find that this is a big problem in urban freeway design. The Interstates are generally pretty well designated.

You take other freeway routes in a city that make up the city and frequently the city or the State might not know at the time of the analysis, or the transportation study that is being made in the city, they do not know at that time what their routings might be; so this is a very essential part, just like signing is a very essential part of design of interchanges. The designation of routes is a very important part of the planning of the system. The designations are needed in the process, not later.

Mr. CONSTANDY. You say this has been done in the past. You are not suggesting, are you, that the philosophy which you are espousing has been that uniformly accepted? There are still people building it the way you have marked as the improper design?

Mr. LEISCH. It appears that way; yes. But I think we are becoming quite conscious—as a profession we are becoming quite conscious of this route continuity. But my observation would be that there are some places where perhaps this is, in my opinion, being done improperly. So we wind up, then, to maintain route continuity, all the interchanges have right exits and the continuation of designated route takes precedence over larger volume functions. It is just that simple. Next slide.



Let us put ourselves in the position of the driver who is proceeding through the city. He might be on a circumferential route. He might be on a beltway route. It is the same thing. He is bypassing the city or driving through the city. He is not going to stop there at all; he is going to stop on the other side of the city. Leave the freeway on the other side of the city. Let us see what the driver does if we have route continuity, if we have this characteristic of right-hand exits.

The upper diagram here, this is one diagram on the first and second lines, one route continued, from this point on the right at "A" fits onto that on the left of the second line also at "A." It is diagrammatic. It shows exits and entrances; exit, entrance, so on. In fact, there are five exits designated along this freeway. Each single line represents a lane of traffic. It is just diagrammatic. We have blue arrows, the upper ones, which are carried down this facility, and red arrows, the lower series, and those are through drivers. They do not wish to exit along this portion of the freeway.

If we have route continuity, which, of course, is accomplished by right-hand exits, and if we have lane balance, this is something we are going to discuss in the next heading, time permitting, we can relax the driver. For example, if our entire system is a right-hand exit system—if our entire system in the country has route continuity, then look what happens to this driver, the blue driver, who approaches here, who knows he is going through. Therefore, he probably does not want to be in the right-hand lane. He picks the middle lane or the second lane over. He knows all the exits are on the right. He knows he is going through. He has looked at the map. He is going to leave much, much later. He positions himself in this lane, and look what happens to him: he follows right on through.

Also, there is the fact that there is lane balance, which we will explain. Once he gets into a lane, that lane progresses through, and his relative position with respect to the other through lanes is exactly the same throughout the entire system. This is the use of, or the application of, the basic number of lanes which we are not going to discuss here, but this again is part of route continuity.

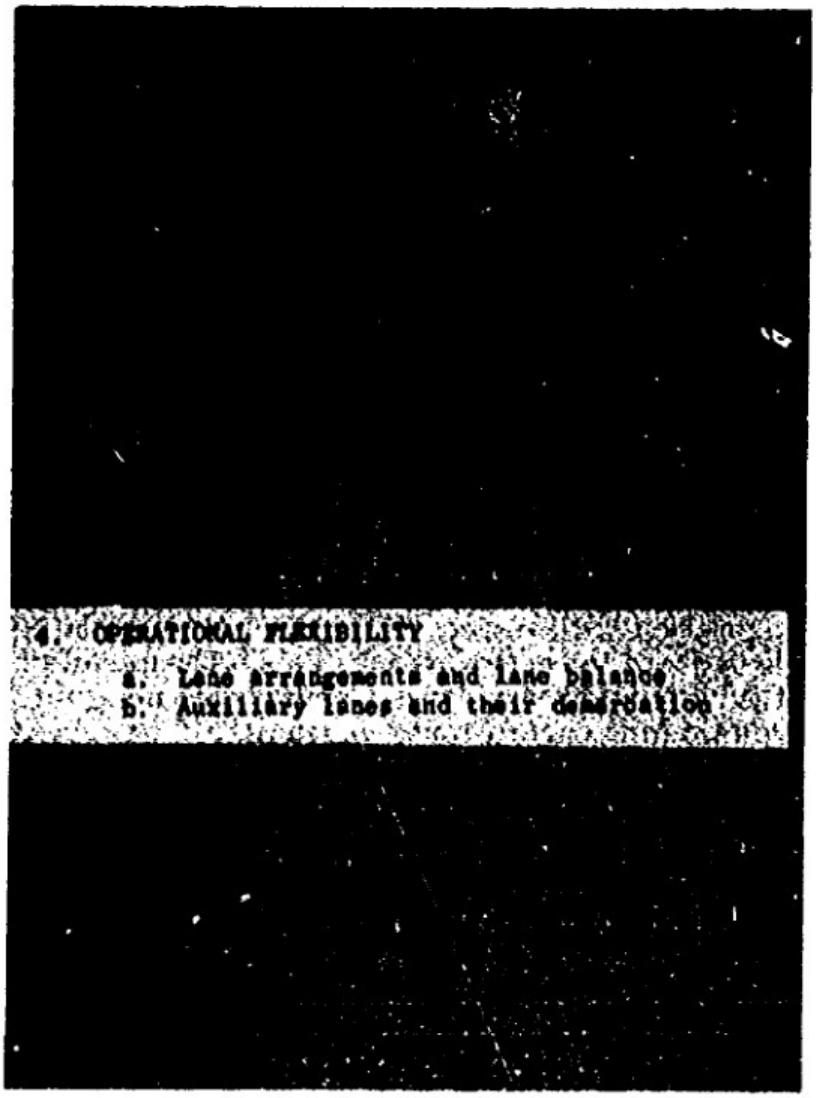
These other lanes are auxiliary lanes that have come-on/come-off. Some of these are two-lane exits, and two-lane entrances. Sometimes three-lane facility in one direction, builds up to four lanes, and occasionally can build up to five, but never more than two auxiliary lanes. These come on and these drop off.

If the driver positions himself, he comes out the same lane he went through. The driver can relax himself. This diagram, third from the top, is a blowup of exit 1, which shows the blue driver, for example, in the middle lane, and every time that he comes to a bifurcation, he stays to the left of it. He does not have to read any signs. He does not have to worry. He is relaxed.

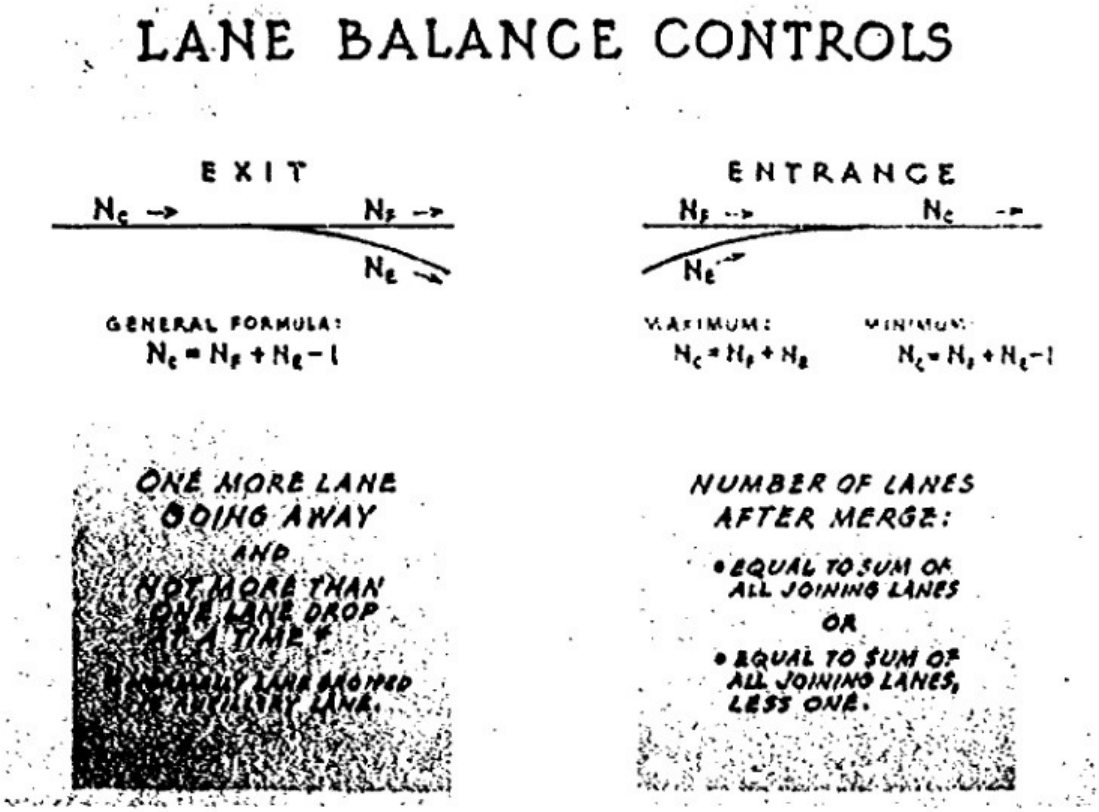
If he should be a timid driver, and he is not taking any chances, and, of course, he might be getting himself a little more in trouble, staying in the right-hand lane, with all the trucks and traffic exiting, that is all right; he still carries through. This is a normal, single exit off of a three-lane facility. There are four lanes here and the outside lane is the auxiliary lane. In fact, it is marked a little differently here, which is another subject in itself.

There is a need to demarcate auxiliary lanes, if not to have another color, but we could introduce and standardize a lane marking that would definitely indicate this is the auxiliary lane. And if the driver is in that lane, the driver knows that lane is going to go off on a ramp or is going to be dropped. And that again is giving the driver confidence and peace of mind and permitting him to relax.

The blue driver is keeping to the left. Also it is significant here that by having lane balance, which we will discuss in the next slide, there is always an optional lane. This one lane in which the driver always has the option of either exiting or going straight through. It is a very important feature. It relates directly to signing. Next slide.



Now we have operational flexibility. This deals with lane arrangements and lane balance. We just mentioned that, and it also deals with auxiliary lanes. This is just a followup which leads right on from route continuity.



Here we have lane balance, and this looks highly technical. But we will not stop to look at these formulas, which are very simple. What we are trying to indicate here is the number of lanes combined or "Nc", approaching the exit, and this is the number of lanes on the freeway after the exit or "Nf," number of lanes on the exit itself or "Ne." These are the number of lanes required, expressed by a formula.

This is the same formula for an entrance, but with this "E" being the number of lanes on the entrance, and the "F" is the number of lanes on the freeway, and this is combined volume, in this case after the merge, and you can rate what we call the lane balance relationships at these forks by a very simple expression.

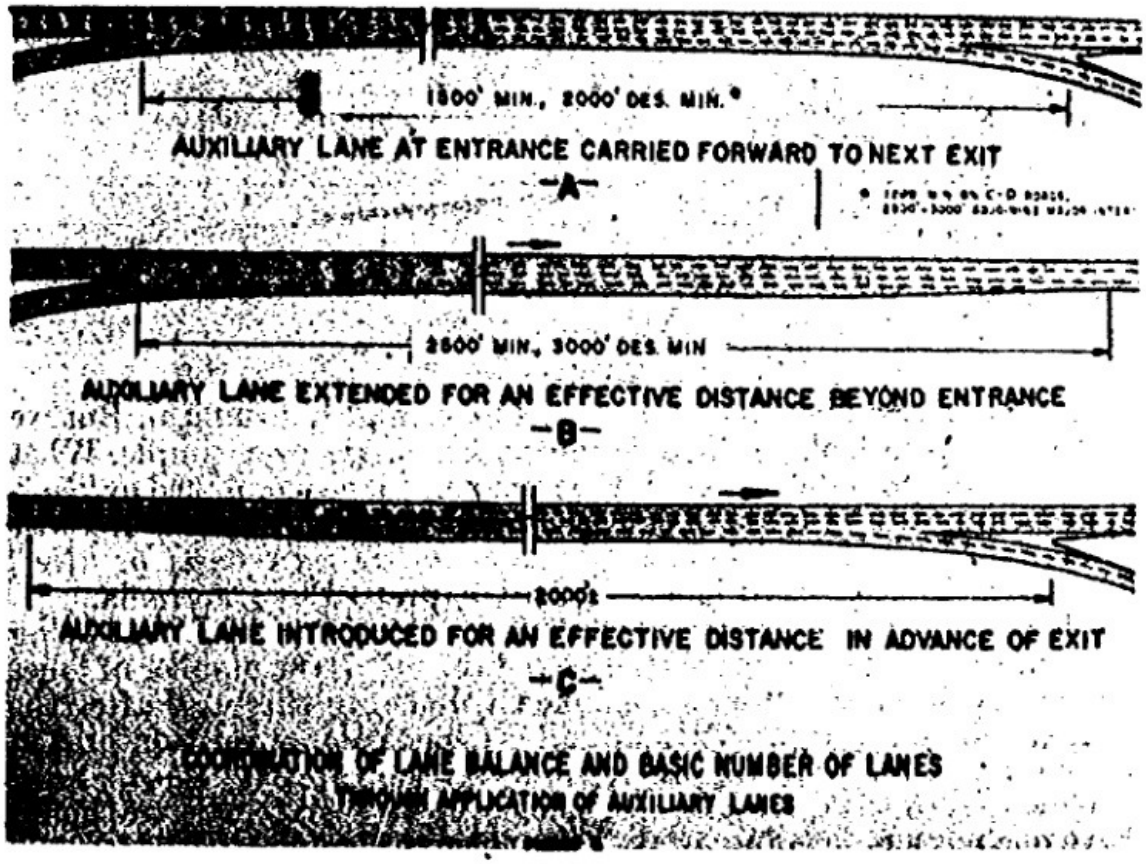
However, this is what it means. Whenever we have an exit, we should have one more lane going away, and not more than one lane drop at a time. This lane drop applies normally of course to auxiliary lanes. At

this point you do not dare drop a basic through traffic lane. There are situations where you do have to reduce the basic number of lanes but that is a separate problem and must be treated in a special manner. I think having one more lane going away is a very essential feature.

Then, in terms of entrance, again it is very simple; the relationship of numbers of lanes after the merge must either be equal to the sum of all joining lanes—in other words, this must either add up to the sum of all these joining lanes, or the number of lanes after the merge must be equal to the sum of all the joining lanes, less one.

Either one is lane balance. And that depends on the actual volume, the relative volume of the joining traffic. This is what we call lane balance. This is a very fundamental principle. This is applied to keep ourselves out of trouble.

We improve the relationship between signing and the physical facility, and we also allow for this continuity, routine continuity. We enhance it with this [indicating], and at the same time we improve tremendously the operational features of the interchange itself. Next slide.



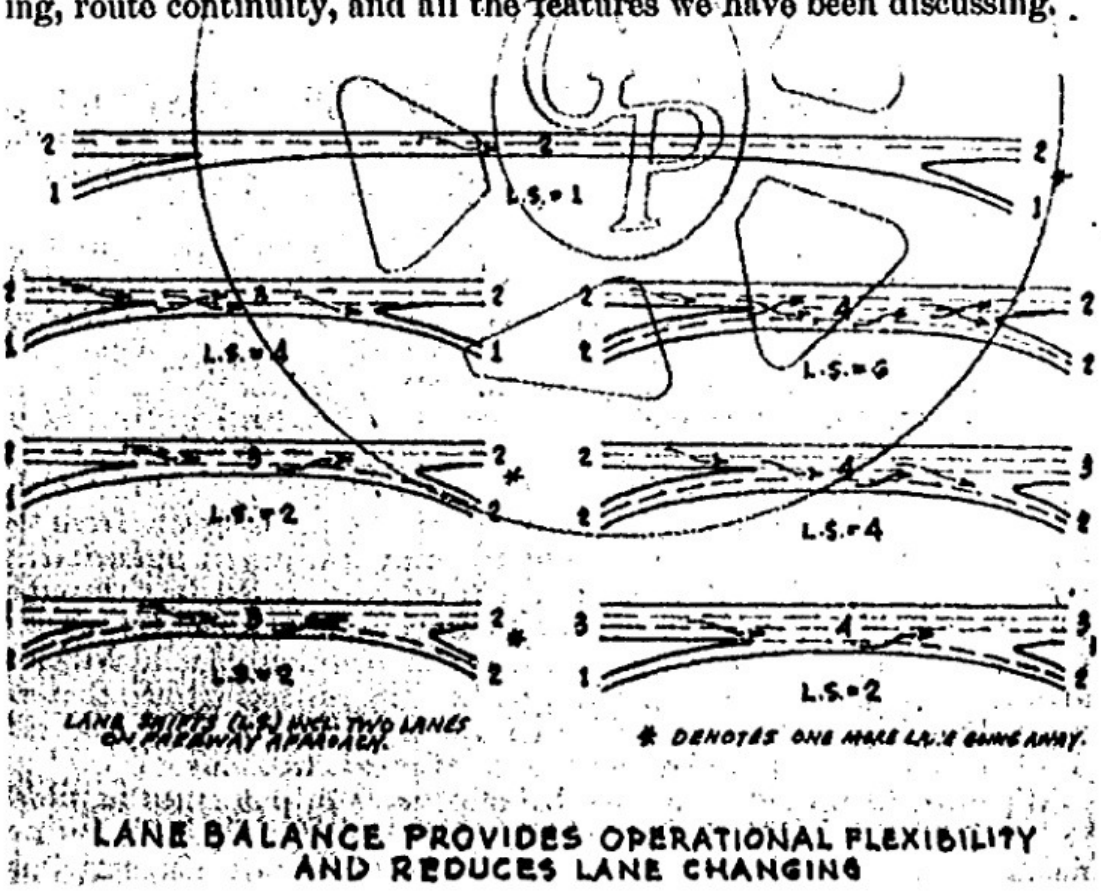
This slide shows the treatment of auxiliary lanes. If we have heavy volume on a two-lane entrance, we must always add an extra lane. We apply the principle in the previous slide. This is what we have done. The length of this has an effect on the operation and has an effect on signing and the ability of drivers to position themselves in lanes [indicating], and we do have several controls, one of which is capacity, the ability of traffic to proceed through this segment of road.

This is a weaving action that takes place. There is traffic entering, which is crossing the path of traffic exiting over a distance.

Now we can perform a capacity analysis here, and we might come up with a distance of 800 feet as being satisfactory, but that should not be the criteria. That is one criterion, but the total criteria should also include this operational feature of the length of lane required to perform proper mergence, divergence, and weaving; just purely from the operational point of view which does not come directly, mathematically, say, from a certain amount of research, statistical information; but at this point it is only a matter of operational experience. And at these distances it would have to be not less than 1,500 feet, if it is this kind of configuration, preferably 2,000 as a minimum.

There are places where interchanges are far apart. Then we could use an auxiliary lane in order to achieve lane balance. As we just mentioned we have to add an extra lane, which might have a different kind of lane marking. So these auxiliary lanes are a feature which allows for this lane balance, allows for the necessary capacity to be developed.

The use of the auxiliary lane is a relatively new principle, but it can make a tremendous difference in terms of positioning drivers for exits and bringing them onto the highway; it is very much related to signing, route continuity, and all the features we have been discussing.



LANE BALANCE PROVIDES OPERATIONAL FLEXIBILITY AND REDUCES LANE CHANGING

The next slide points up the importance of lane balance which provides for greater operational flexibility and reduces lane changing. For example, here on the first diagram, is a basic situation of two lanes in one direction. We have an entrance to a speed change facility and an exit. We have indicated a star here. That denotes one more lane going away—three are going away from two. There is only one lane change, potentially, that is required for a driver to exit.

Now, let us look at three lanes. These are three-lane situations, and there are four-lane situations [indicating]. Let us look at three-lane situations on the left. We can start with the third diagram from the bottom on the left.

There is no balance here, because there is not one more lane going away. Look at the lane changes that take place. The exiting traffic is diagramed with a red arrow; entering traffic is with a blue arrow.

We count those, and there are potentially four lane changes that take place. Now, when we provide lane balance on this three-lane facility—as in the second diagram from the bottom on the left—one more lane is going away, four going away from three, the lane changing reduces down to two.

That makes a tremendous difference in the way drivers operate and the way they may maneuver in a situation along the highway; it is very critical where the drivers are making their decisions, where they are reading signs. Traffic is crossing each other's path, and so on. We reduce the number of lane changes by half, potentially.

Here in the bottom left diagram is another configuration where we have again one more lane going away, four going away from three, but slight arrangement on this end—this is also lane balance on this end—again only two shifts.

Let us come to the four. Now, this is really difficult, and I believe what we see here at this exit, I may be wrong, is what we saw in the film earlier, where we had a four-lane approach that splits off into two and two.

This is not lane balance. It is very rigid. Every one has to position himself accurately within a certain lane, compared with this or with this [indicating] or with any of these diagrams that have a star by them, and we see there is always one lane that is operational. The driver, as a whole, need not position himself as accurately.

That one optional lane makes a tremendous difference in the case of operation and last-minute decisions.

But look at this, six-lane crossings. If you change this to this fashion, by adding a third lane right here—in the second diagram from the bottom of the right—making one more going away, you immediately reduce it to four. And if you pass the third lane all the way through, even though it might not be required for capacity reasons—you can reduce the lane crossing to two. This is one of the problems. We have always so designed our highways, being very cost conscious, that we figured the number of lanes required theoretically to handle the traffic; but it did not take care of the operational situations.

We now, to provide this lane balance, have to put lanes in which theoretically, from the point of capacity, are not required, but are definitely required in order to allow traffic to operate efficiently and with greater ease.

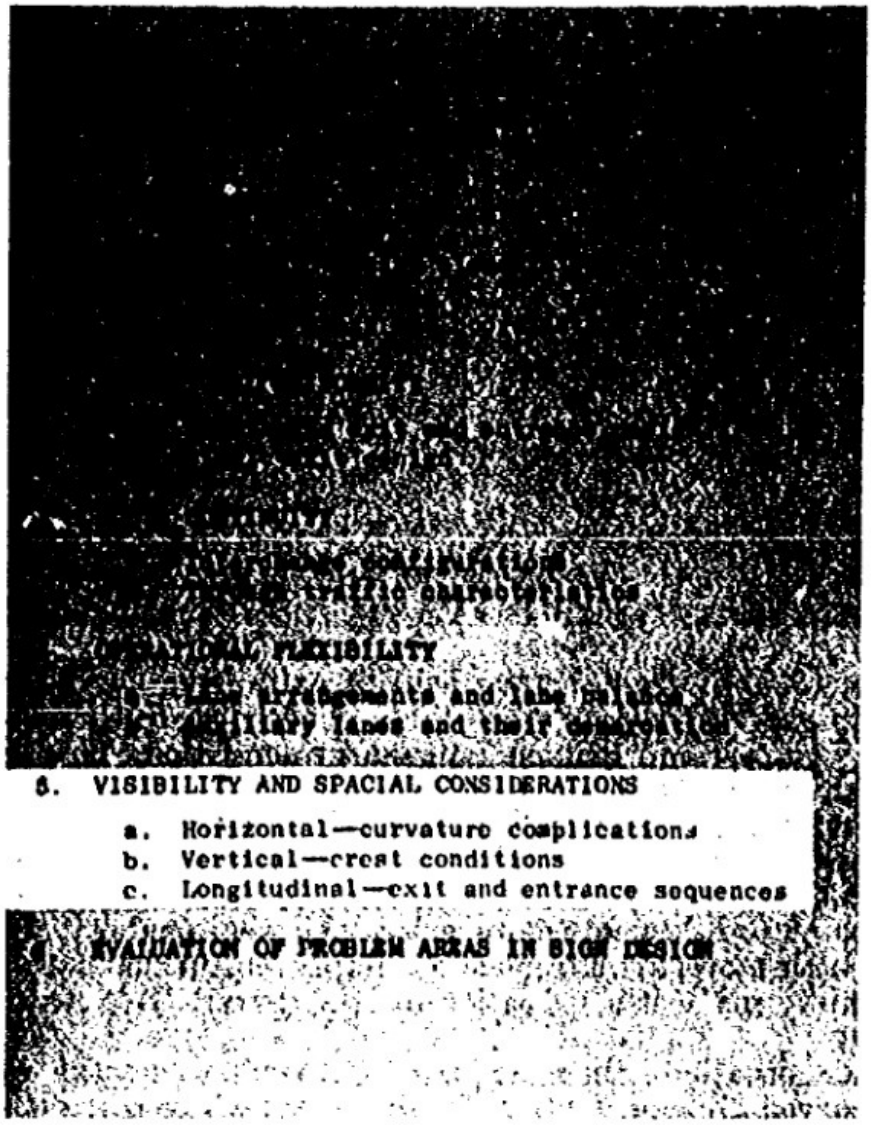
So this third lane (in the bottom right diagram) might be put right through there, even though we do not need it for capacity reasons, but we have improved the operation tremendously. We have reduced the number of lane changes from six to two, absolutely no comparison between them.

This one also could be a two-lane entrance, as shown by the dotted line, and it would have exactly the same number of lane changes.

It is all uniformly based on two lanes up to the exit, as far as lane changing is concerned.

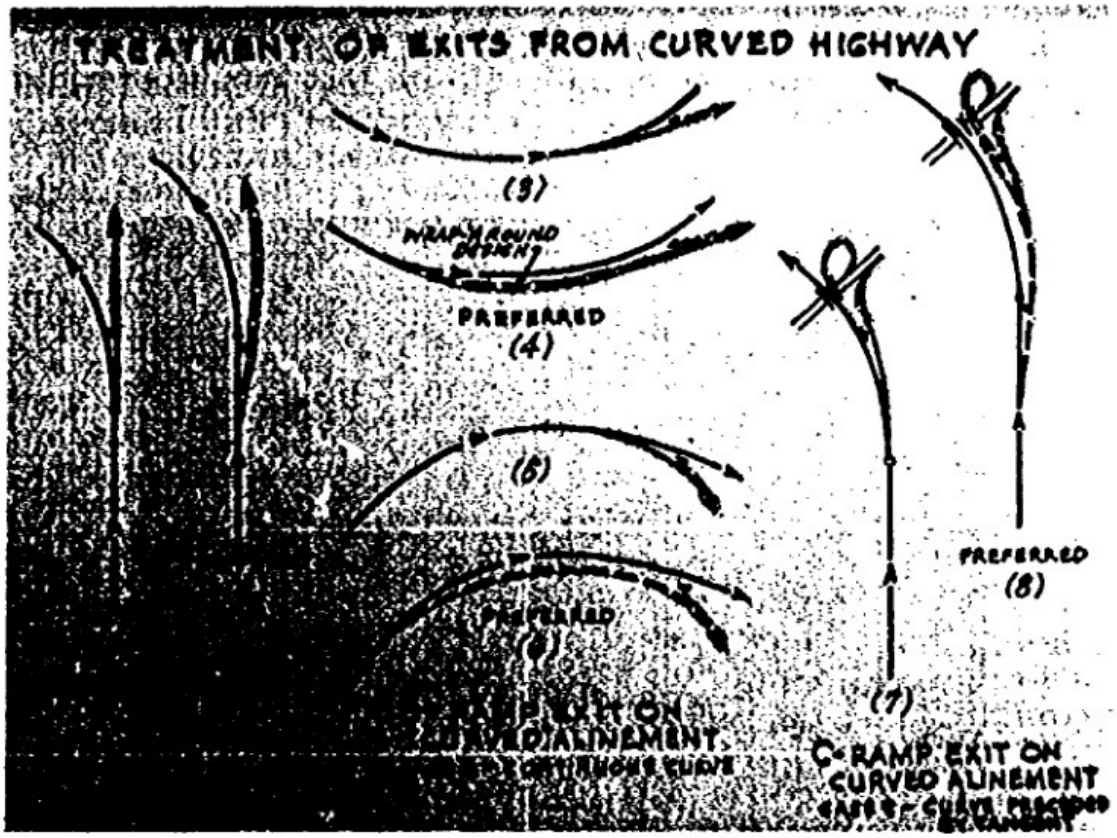
I think this gives a better picture of what is happening and how this relates to signing and the operational ease that can be provided through lane balance.

Next slide please.



Now we are on the last point, visibility and spatial considerations. I will just touch on those very quickly. In terms of visual and spatial considerations, I think there are three aspects: one is horizontal, which deals with curvature complications; vertical, which has to do with crest conditions primarily; and then longitudinal situations, which has

to do with spacing or sequences of exits and entrances. These three. And I have an illustration for each one very briefly. Next slide.



This one has to do with treatment of exits from curved highway. We can improve situations along these. And here are three examples.

First, "A", a ramp exit on tangent prolongation. This is a very difficult situation. This can mislead the driver. We must make it look like the main highway is really where it belongs, and the exit is a little more secondary to it. This can be accomplished by extending the ramp farther back and making the exit on a tangent before the curved point, so it becomes more or less a conventional exit. It is going to cost a little more, but a tremendous improvement that can save lives, and certainly make it a lot easier for the driver. Give him peace of mind.

Another situation—there are two of them—where the ramp exit is on a curved alinement (B). The first case: where there is a continuous curve, the curve is very long, and the interchange occurs along that curve, and the ramps, of course, take off on curved highway, either curving to the right or curving to the left. If they have exits on the right, we have got two situations, as we see here. The less desirable conditions——

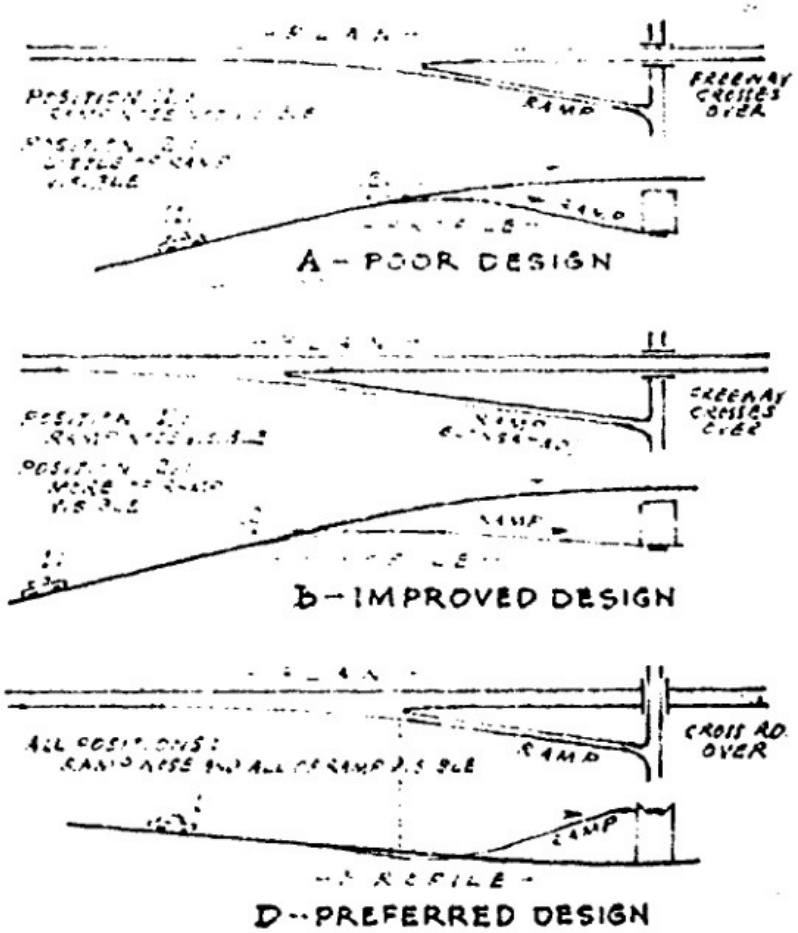
Mr. CONSTANDY. That is in figure 3?

Mr. LEISCH. In figure 3, yes. Figure 3, the less desirable situation, is where the ramp just takes off on a curve. Now, that can be a surprise. I know you have warning signs, but it can still be a surprise. We can improve that situation by extending that lane around the curve. We call it a "wraparound design," and particularly if we use the auxiliary lane symbol here, lane line, even to the point, under some circumstances, of using overhead signs on along it, to designate "Exit Only."

We have an opportunity here to eliminate some of the surprise elements; we have an opportunity—by lane designation and by signing—to position the driver into the proper lane and then take off. You see, the point of bifurcation is in the same place. This is a contiguous lane. In reverse order, this can be a real trap.

Sometimes through traffic will get trapped into a lane going on the right. There is not enough visibility. A truck is in front of the other drivers, and so on. Again a wraparound or wrap-in, where this is a parallel lane, can be of some length, as developed in a similar fashion, bifurcation point here [indicating], and if necessary the use of an overhead sign and a proper sign for the auxiliary lane—you give the drivers an opportunity to get into that lane or get the through traffic out of or away from it.

Then we come to curved alinement, which is a case where the curve is preceded by tangent, and the interchange itself occurs on the curve, and this can be curved either to the left or to the right, and the ramps exit off the curve, a similar problem we described in the other two cases. But this can be improved by extending the ramp, since it is preceded by the tangent onto the tangent and producing a more conventional type of exit. It is a tremendous help in terms of the driver having to comprehend the situation. Next slide.



TREATMENT OF EXITS
PROFILE CONDITIONS

This slide is the vertical situation, treatment of exits for profile conditions. Here, for example, is a ramp exiting from a freeway. This is part of the diamond interchange. Here is the profile situation, just below, freeway profile, and the ramp profile, and the structure that we see here. So this gives a graphic picture of operation in the vertical plane. Here we have a vehicle in position 1, where, if there is a crest curve, and this is a common situation, in advance of this bifurcation, the driver actually, from this position—the driver will not see the point of bifurcation. He will, if he gets close enough; but at this distance he will not see it. His sight-line is intercepted by the crest in the profile.

That is a poor situation. A driver would like to see where he is going. Even though you sign it, and that helps a great deal, he would still like to see where he is going. When he gets into position 2, although he sees the nose and he knows he is going off now, he sees very little of the ramp. The driver would like to see the ramp and would like to see what is happening there. It makes a big difference in his peace of mind, in the way he reacts.

It is important. This situation should be improved. Sometimes it cannot be obviated, but it can be improved, and every attempt should be made.

That may be done in this fashion, in figure B, where here we have exactly the same profile [indicating].

But the ramp has been elongated to the point where at the same relative position from the nose, the driver can now see the nose at that distance, that selected distance that has a meaning; and then when the driver gets closer to the ramp itself—even before he leaves he sees much more of the ramp. And once he gets on the ramp, he will see the entire ramp and that makes a tremendous difference in the way he operates.

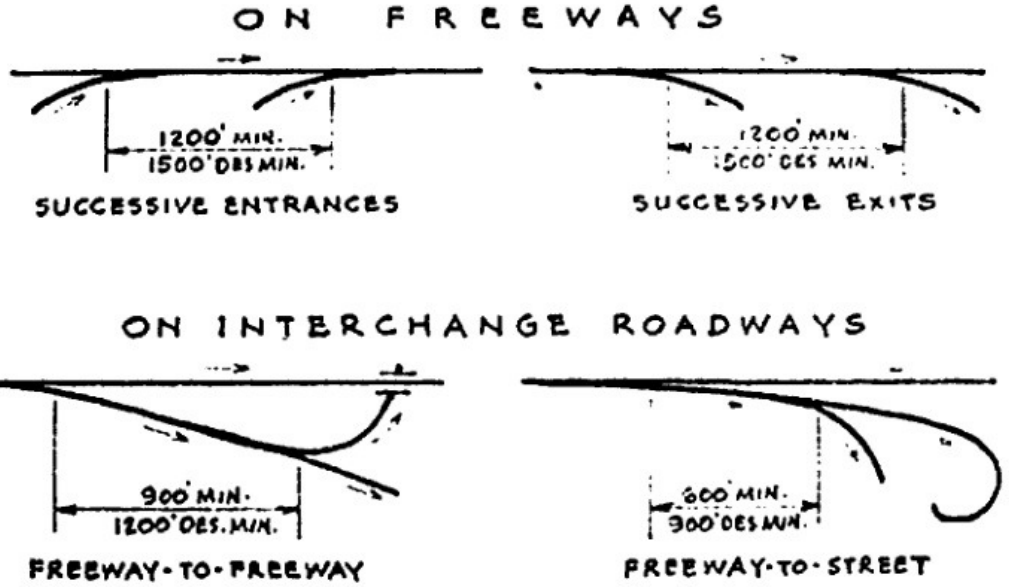
The ideal condition, and we cannot always achieve it, shown in figure C, is to reverse the profile and have the main lane of the freeway go under the crossroad, or in other words, the crossroad over, and then we can see the beauty of this relative operation between this case then and the other two cases, where from all positions the ramp nose and all of the ramp—or practically all of the ramp—is visible. The driver has confidence. He can see where he is going. And what he is going to do next; except possibly on this last position point, on where he is going to go right or left.

Many of the design standards are still written today which say that in terms of choosing over and under at a crossroad for an intersection, that the overcrossing of the main line is preferred, because that is the predominant route. It sort of takes over and goes over [indicating]. From an operational point of view, it is actually the reverse, and this is what should be practiced. I think this is largely recognized, and more emphasis should be placed on configurating or relating the profile through alinement of the ramps in this fashion.

Also we can see that this assists the driver to decelerate. But what is more important, the entering driver, on the down-ramp, has full view of the freeway. He is in command. He watches for the gap. He picks his gap. He goes more safely into the stream, more confidently, more relaxed. Whereas, with an up-condition ramp going up into the freeway, he does not see the highway that well in advance and the operational problems are much more difficult.

Mr. CONSTANDY. Mr. Leisch, we have noticed that frequently in the third one, third illustration lettered D, that the end of that ramp is too close to the structure overpassing the freeway, which would result in lack of sight distance for the exiting driver.

Mr. LEISCH. Yes. This of course is a related subject which also has to do with perhaps the depressed profile situation, and also spatial considerations for proper signing, visibility and so on. It is very much a related problem to it. It is on the same subject, but a little different variation of it. That is correct.



DISTANCE BETWEEN SUCCESSIVE RAMPS
SUGGESTED CONTROL DIMENSIONS

Now, the final slide has to do with spatial consideration; this is the distance between successive ramps. This is recognized design. I believe some of the standards that we are using today, which are published, are a bit low. Here are some values which are being used by some agencies, which are much improved. I dare say they could stand even further expansion; but these values are distances between successive ramps entering or exiting.

In terms of exiting, there is need for drivers to sort themselves out. There is need for drivers to maneuver into proper lanes. And if the ramps are very closely spaced, some of the maneuvering for the second ramp takes place in advance of the first ramp, and that is a very difficult situation.

Mr. CONSTANDY. The sign is apt to say, for that first exit, for traffic to keep right, and it may also then sign for the second exit for the traffic to keep right.

Mr. LEISCH. Yes; that is correct. So that we do have the inherent signing designations that go along with this, besides the fact that it makes for difficult operation.

Mr. CONSTANDY. Is that 1,200 feet the current policy?

Mr. LEISCH. No.

Mr. CONSTANDY. Or something you would recommend?

Mr. LEISCH. No. I would recommend that it is really an absolute minimum, and I think we ought to have 1,500 feet as——

Mr. CONSTANDY. What is the common standard?

Mr. LEISCH. Common standard actually goes up to 1,200 for 80 miles an hour.

Mr. CONSTANDY. Up to what?

Mr. LEISCH. On 80 miles an hour; and when it reduces down to, say 60 miles an hour, it probably reduces down to about 600 feet. I am not sure of the exact figure, but it might be 600 or 900 feet.

Mr. CONSTANDY. Your 1,200-foot minimum would be an absolute minimum at what speed?

Mr. LEISCH. Any speed. I think a freeway is a freeway. I think we have to get away from the idea that some of our urban freeways are designed for 50 miles an hour. I think the nature of freeways is such that it is designed for very high speed, and design speed is not the speed necessarily the driver will operate on. It is the quality of the highway.

So a full freeway must have certain quality. And even though in the city, potentially it should allow for 70-mile-an-hour speed. It does not mean the driver will go that fast, but it gives certain features, provides certain features which are safety features in themselves, and allows for greater tolerance in operating, and certain ease and comfort than is embodied in 70-mile-an-hour design.

Mr. CONSTANDY. Do I understand correctly that their maximum is your absolute minimum distance?

Mr. LEISCH. Well, this is the way the policy still reads. But there are certain highway distances that are used in these higher figures. I think it is still in the stage of transition, that idea. This would be considered a very high standard in terms of, I think, general practice.

Mr. CONSTANDY. In your opinion, it is necessary?

Mr. LEISCH. In my opinion I think these are the figures.

Mr. MCCARTHY. I wonder if I could ask something? You know, the department has supported a bill that would be coming out on the floor any day now; it will remove the limit on the weight of trucks and substitute a formula. The effect of this will be to have trucks with three and even more trailers, wider, there is no limit on length. Do you think this is going to be a factor that should be considered in designing freeways, these very long trucks?

Mr. LEISCH. Yes, certainly the size of vehicles and their operating characteristics have a tremendous effect on the geometry of the highway, and it has always been recognized as an important element in design. And whenever the size of the vehicles has changed, weight has changed, I think that always has been scrutinized, and it required, I think, compensation—compensation was made for it. What effect that may have, I am not sure. There are larger vehicles, and they are more obtrusive, and they could be an element that would reduce visibility more on a highway, where decisions must be made with regard not only to following certain lanes, but reading signs.

The lower diagram here indicates the same sequence, but perhaps with slightly lower dimensions, which have to be applied at major interchanges and at lower interchanges.

This more or less completes this discussion and brings out these various points which relate geometric design to signing.

Mr. CONSTANDY. Is there anything you care to mention in closing, Mr. Leisch, beyond what you have said? Anything further? You will be back with us next week.

Mr. LEISCH. Yes. I am looking forward to that very much. I talked a long time here. I do not know whether there is anything else I need to say, unless there is a specific question, which I would be pleased to answer.

Mr. CONSTANDY. You have covered all the material that we had anticipated. Your testimony has been of considerable help, and I think it will put a great deal of the testimony that we have had, and will have in the future, in a much better perspective; and for it we are most grateful.

Mr. MCCARTHY. I want to thank you very much, Mr. Leisch.

The hearings will stand in recess until next Tuesday, July 16.

(Whereupon, at 12:50 p.m., the subcommittee recessed, to reconvene on Tuesday, July 16, 1968.)

HIGHWAY SAFETY, DESIGN AND OPERATIONS
Freeway Signing and Related Geometrics

TUESDAY, JULY 16, 1968

HOUSE OF REPRESENTATIVES,
SPECIAL SUBCOMMITTEE ON THE
FEDERAL-AID HIGHWAY PROGRAM
OF THE COMMITTEE ON PUBLIC WORKS,
Washington, D.C.

The subcommittee met, pursuant to adjournment, at 10:15 a.m., in room 2167, Rayburn Building, Hon. John A. Blatnik (chairman of the subcommittee) presiding.

Present: Messrs. Blatnik, Cleveland, McCarthy, McDonald, Schadeberg, and Zion.

Staff present: (Same as previous day.)

Mr. BLATNIK. The Special Subcommittee on the Federal-Aid Highway Program today resumes its public hearings on highway signing and related features of highway design.

The present subject is a phase of the subcommittee's overall study on highway safety, design, and operations which commenced last year with hearings on roadside hazards and was subsequently expanded and broadened pursuant to the needs made plain by the earlier testimony.

Our witnesses today are Mr. David W. Schoppert, vice president of Alan M. Voorhees & Associates, Inc., transportation and planning consultants. With us we have also our good friend and authoritative standby, Mr. Charles W. Prisk, Assistant Director for Safety in the Federal Highway Administration's Office of Policy Planning.

Along with these witnesses we are privileged to have with us a panel of gentlemen who are of national repute in highway traffic and engineering circles. They will analyze and comment upon the safety aspects of highway signing and its relationship with the design and geometrics of our Federal-aid highways. These men will be further detailed as to their professional and technical competency and experience and reliability. We will read their names for the record at this time. They are Mr. Jack E. Leisch, Dr. Slade F. Hulbert, Mr. William R. McGrath, Mr. Ellis L. Mathes, and Mr. James E. Wilson.

Gentlemen, will you please stand and raise your right hand? Do you solemnly swear that the testimony that you give before this subcommittee will be the truth, the whole truth, and nothing but the truth, so help you God?

The WITNESSES (in unison). I do.

Mr. BLATNIK. Please be seated. Mr. May?

Mr. MAY. Mr. Chairman, I would like to identify the witnesses. Let's begin from left to right for the aid of the members and the re-

porter. From my left, Mr. Prisk. Will you identify yourself, Mr. Prisk?

Mr. PRISK. I am Charles W. Prisk, Assistant Director for Safety in the Federal Highway Administration's Office of Policy Planning.

Mr. MAY. Mr. McGrath?

Mr. MCGRATH. William R. McGrath, traffic commissioner of the city of Boston, Mass.; also here at the request of the Institute of Traffic Engineers.

Mr. WILSON. James E. Wilson, Chairman of the National Joint Committee on Uniform Traffic Control Devices and currently the deputy director of the Highway Safety Programs Service, National Highway Safety Bureau.

Mr. LEISCH. Jack E. Leisch, chief highway engineer and vice president, De Leuw, Cather & Co. of Canada, Ltd., Toronto, Ontario.

Mr. MATHES. Ellis L. Mathes, State Highway Engineer, Idaho Department of Highways, and chairman of the AASHO Operating Committee on Traffic.

Dr. HULBERT. Slade F. Hulbert, USCA Institute of Transportation and Traffic Engineering.

Mr. SCHOPPERT. David W. Schoppert, vice president and director of the Department of Safety Planning for Alan M. Voorhees & Associates, Inc.

Mr. MAY. Thank you, gentlemen. Mr. Chairman, I will identify some of these witnesses in a little more detail. Dr. Hulbert, Mr. Leisch, and Charles Prisk have testified previously at these hearings and their background and qualifications are set forth in the record.

Mr. McGrath has been a professional traffic engineer since 1951, when he graduated from the Traffic School at Yale University and for 8 years he was responsible for all signing and marking and traffic control and highway planning in the city of New Haven, Conn.; transportation coordinator, Boston Redevelopment Authority; director, Institute of Traffic Engineers; chairman of the I.T.E. delegation to the Joint Committee on Uniform Traffic Control Devices, and within the past few days he was appointed commissioner of traffic for the city of Boston.

Mr. Wilson is an old friend of the committee. He testified last year at the roadside hazards hearings and we know of his qualifications.

Mr. Leisch's qualifications are in the record.

Mr. Mathes is State highway engineer for the Idaho Department of Highways, a registered profesional engineer. He has served with the department of highways in the capacities of traffic engineer, planning engineer, testing engineer, maintenance engineer, and assistant State highway engineer over the past 35 years. He is presently serving in AASHO as the chairman of the operating committee on traffic. He is a member of several other AASHO committees. He is a member of the AASHO delegation to the National Joint Committee on Uniform Traffic Control Devices. He is a member of the highway research board, department of traffic operations.

Mr. Mathes has kindly submitted a statement setting forth information about AASHO's Operating Committee on Traffic; before identifying the remaining witnesses I would like to ask that the statement be inserted in the record at this point.

Mr. BLATNIK. Without objection it is so ordered.

STATEMENT BY ELLIS L. MATHES, CHAIRMAN, AASHO OPERATING COMMITTEE ON TRAFFIC

The American Association of State Highway Officials is an organization of the fifty agencies of the State Governments, the District of Columbia and the Commonwealth of Puerto Rico who are charged with the administration, development, operation and maintenance of the highway systems of these units of government.

Active members of the Association are the duly constituted heads and other chief officials of the member departments who work together to develop and improve methods of administration, design, construction, operation and maintenance of highways; to study all problems connected with highway and street transport; to develop technical, administrative and highway operational standards and policies; to cooperate with other agencies, governmental and in the private sector, in the consideration and solution of highway matters; and, to counsel with the Congress, as appropriate, on highway legislation at the Federal level.

Most of the actual work of the Association is accomplished through two basic Standing Committees and numerous sub-committees, operating committees and special committees who have specific assignments within the basic Association framework.

I am presently serving the Association as Chairman of its Operating Committee on Traffic, which is one of ten operating committees of the Standing Committee on Standards. Because of this assignment, I also represent the Traffic Committee in several other areas of related activity in the Association.

The Operating Committee on Traffic has been assigned functions and responsibilities as set forth in the Association's current directory. This assignment is stated therein as follows:

"To investigate available data, pursue studies to develop, publish and keep current (1) the principles of the operation of traffic on highways and streets; (2) traffic performance as related to the design of streets, highways and terminals; (3) survey techniques and procedures for obtaining factual operational data; (4) improvements in the use of traffic control devices and safety measures; and (5) relation of accident experience to physical features of the highway."

The Committee membership is in general composed of the Traffic Engineers of the several member State Highway Departments. Many of these men have been engaged in areas of work related to traffic operations for fifteen years or more.

The Traffic Committee develops recommendations regarding the five areas listed above for presentation through the Standards Committee to the Executive Committee and the member departments. In this respect, correlation with the other Operating and Special Committees on all items relating to traffic operations is important. This correlation is accomplished both directly and indirectly through joint membership on other committees of the Association.

Of particular importance in this effort are the Operating Committee on Planning and Design Policies, the Operating Committee on Research Activities, and the following Special Committees: (1) Cooperation with the AASHO-AAR Committee; (2) AASHO Representation on the National Joint Committee on Uniform Traffic Control Devices; (3) AASHO Representation on the National Committee on Uniform Traffic Laws and Ordinances; (4) AASHO Special Committee on Sign Manual Interpretations; (5) AASHO Special Committee on Signing and Marking the Interstate System, and (6) AASHO Traffic Safety Committee.

An example of one area requiring very close committee coordination is that of sign manual interpretations and signing and marking for the Interstate Highway System. Here a Special Committee of AASHO with a specific assignment is involved. Relationships with other units of government are also factors which require considered and judicial handling.

Requests from the States, usually originating from the membership of the Traffic Committee, are reviewed and processed by this Special Committee before being forwarded through the Executive Committee to the member departments.

Procedures for handling such requests from other units of government are more cumbersome because of the very large number of jurisdictions involved. The many problems associated with this particular activity are recognized by the Association, the National League of Cities and the National Association of Counties, however, and sincere efforts are being made at all levels to clarify and expedite this function.

Hopefully, some improvement in this particular area will result from the efforts of the National Joint Committee on Uniform Traffic Control Devices when

the new addition of the "Uniform Manual" becomes available. Undoubtedly some procedures will still be rather cumbersome and time consuming, however, since, under the democratic process one governmental unit cannot speak for another.

Other activities of the AASHO Traffic Committee for the past few years have centered about the following items:

1. Development of guidelines for a Traffic Records System—a complete inventory of physical and operating conditions including highway, driver vehicle and accident report data. A subcommittee report on this subject was completed in October 1967.
2. Development of improved route marker shield designs, standards and policies for more uniform route marking of the Interstate, U.S. and State Highway Systems.
3. The Committee is currently working on criteria and guidelines for speed control zones on the Interstate and other U.S. and State Highways.
4. The Committee prepared an Information Guide for Traffic Engineering performance in State Highway Departments. This report was completed in June 1961.
5. The Committee reviewed proposals for signing for motorists services on all systems of highways on several occasions and has submitted recommendations on this subject.
6. The Committee has cooperated on approved research and limited experimentation relative to traffic engineering items in many areas of signs, signals and markings.
7. It has assisted other Committees of AASHO in the development and review of geometric design standards.
8. The Committee continually assists Highway Department Traffic Engineering personnel in keeping informed and knowledgeable on recent technical developments, policies and procedures relating to traffic engineering functions and responsibilities.

The broad field of traffic operations, and especially those areas involving communications with the motorist, is a constantly changing one. The AASHO Operating Committee on Traffic has attempted to continuously analyze and evaluate the many facets involved in the varied patterns of highway transportation.

Some of these efforts, I believe, have been reasonably successful. Others, it seems, have sometimes not produced to the extent hoped for.

In cooperation with the several levels of government and the various environments involved, however, the Committee will continue to explore all suggestions in those areas assigned to it by the AASHO Committee on Standards.

Mr. MAY. Dr. Hulbert we know very well.

Mr. Schoppert is vice president and director of safety and planning, Alan M. Voorhees & Associates. He was formerly on the staff of the Oregon State Highway Department, has been associated with the Automotive Safety Foundation in Washington, D.C. He spent 1 year with the Department of Commerce and Transportation during its organization of the National Highway Safety Bureau. He was a consultant to the California Division of Highways on the 1959 study of directional signing. He was principal investigator on the beltway signing study. We will hear more about that. He is a member of the Institute of Traffic Engineers and the Highway Research Board Committee.

Mr. Chairman, during the next 3 days we shall be using the Capital Beltway as a laboratory. The panel members will be analyzing the signing and related design features and other problem areas in an attempt to evaluate what has been done and to suggest where improvements might be made.

It has already been established that there is little that is unique and peculiar about the beltway. Much is representative of what can be found in other areas of the country.

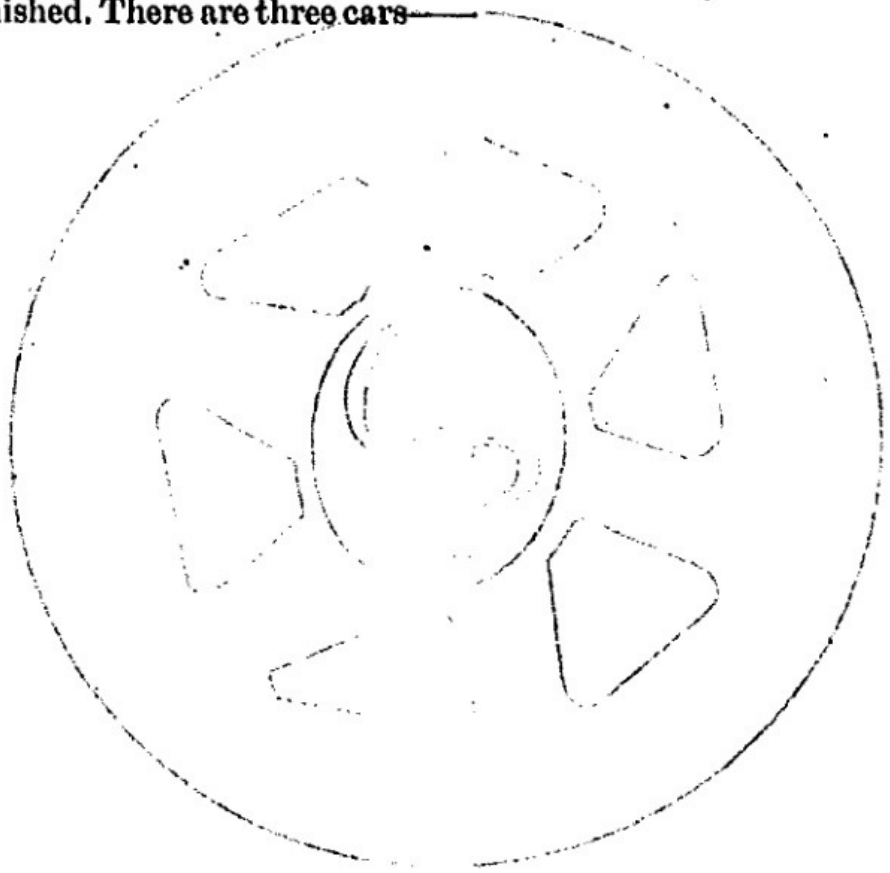
We have several films to show during these sessions, and this first

one is a sampling which illustrates the type of movements and actions which the motorists make on our freeways at decision points. May we run that first film, please?

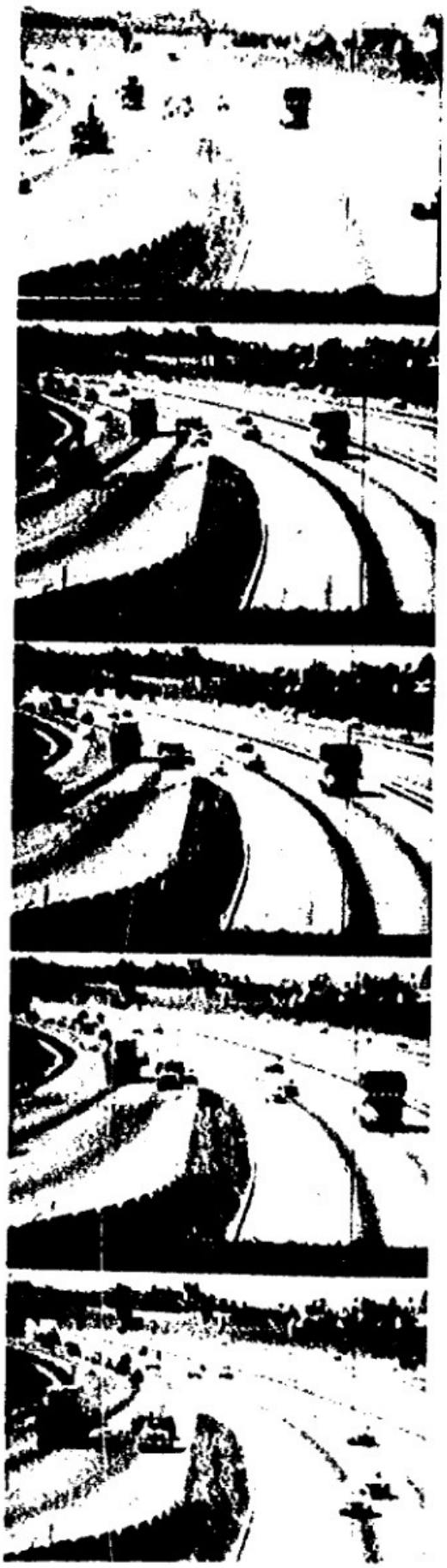
(Movie.)

Mr. MAY (commenting on the movie). We are looking south on I-95 at the moment. Traffic is coming up I-95, heading north, and this is the junction of I-95 and the Capital Beltway I-495. Traffic is swinging to our left and can join the beltway going either east or west.

Possibly, Mr. Chairman, we may be asked the question, "How frequently do these strange movements take place?" If you watch the film closely, you will see some of these situations develop before the last one is finished. There are three cars——

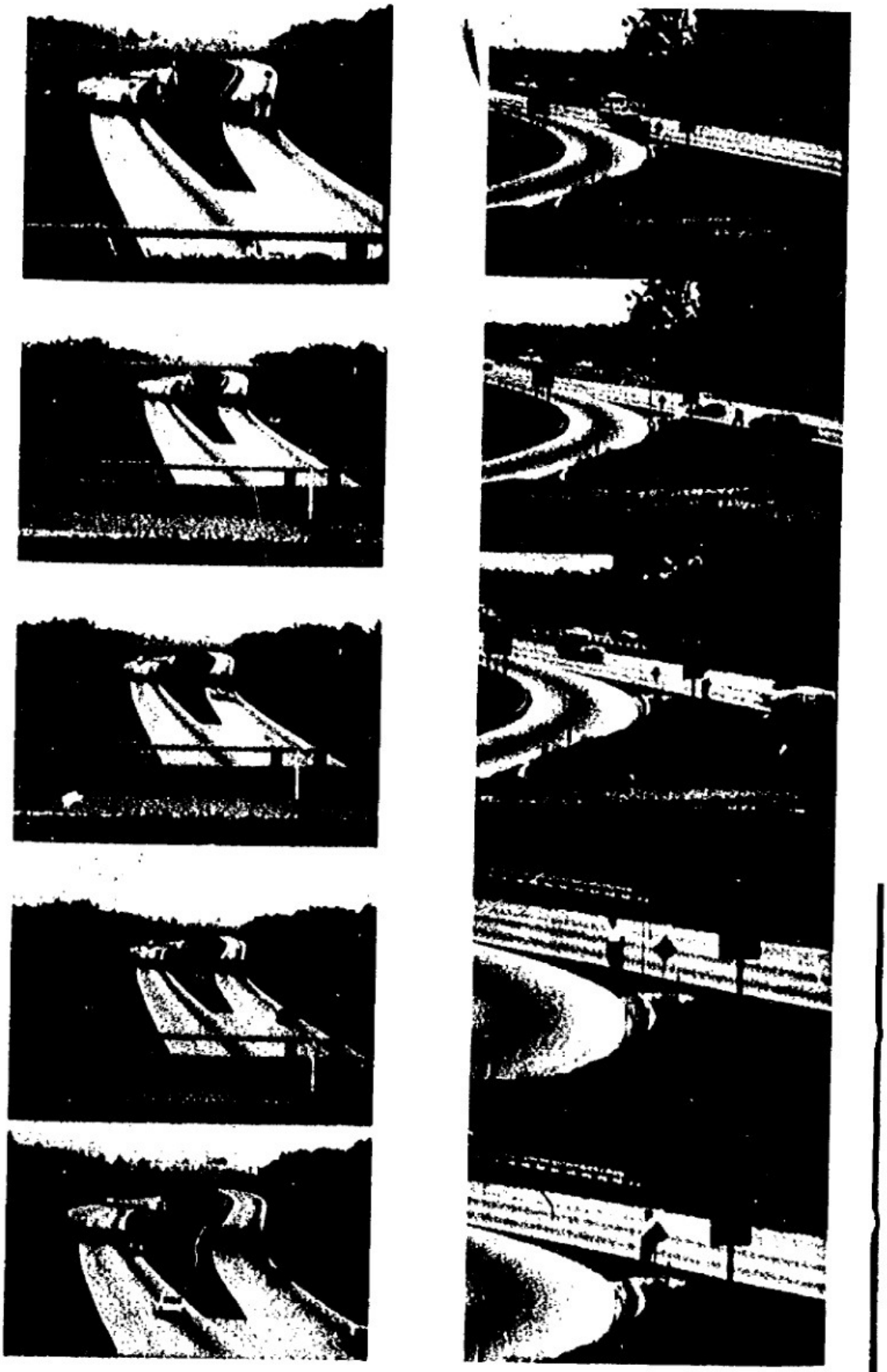






Mr. BLATNIK. Is that the shoulder or a lane?

Mr. MAY. That is the shoulder. This is a 65-mile-an-hour highway. We are on I–495 looking west where the ramp to our right takes off from the main line and swings around to carry traffic south on I–95 toward Richmond.



Now we are on the Baltimore-Washington Parkway looking south with the ramp to our right carrying traffic to westbound I–495.

Traffic which has missed the ramp or taken it when they didn't want it has made its own road there behind the gore. You will notice that the highway people have put up these steel posts to our right to prevent the cars from making that crossover, but the cars keep going around them and extending the road.

There is a station wagon backing up the ramp on our right. He is hesitating at the moment and in a moment it will appear that now he knows where to go. If you will watch, however, you will see him come back.

It is very common to find that the traffic has made a road beyond the gores.

Our concern this week, Mr. Chairman, will be to try to determine what it is about signing and design that seems to cause the motorists to hesitate. This seems to us to be the stuff that accidents are made of. Later we will point out the high accident locations.

This is the next ramp, still coming south on the Baltimore-Washington Parkway, and this ramp swings around and joins the beltway to go east. It is a 60-mile-an-hour highway.

Here is another road that the motorists have made, Mr. Chairman. You will notice the dirt road, beyond the gore, connecting the highway with the ramp.

When this man gets back to where the sign is and can read it, he will only see the word "Exit." I understand he is still there.

I wonder if any of the panel members have any comments to make on that film. Dr. Hulbert, using the psychological approach, maybe you could tell us why the motorist, recognizing that it is so dangerous to stop and back up, will do it in such numbers.

Dr. HULBERT. I am not so sure they recognize it as so dangerous or they wouldn't do it. I have observed an ambulance driver—and you may think of all the drivers who would know better—doing this in the Los Angeles Freeway area, backing up to correct a mistaken turn. I think we have to consider what are the consequences of making a wrong move.

These consequences amount to bargaining. The driver says, "I will take the chance because the consequences of my taking the wrong turn are pretty dramatic and I will be lost. I won't know how to get back again." So this is something that was considered in the 1958 study that we mentioned during the testimony earlier; namely, to take account of the consequences of errors. I believe this is a major factor in causing drivers to do this.

Mr. MAY. Thank you. May I ask this, Mr. Wilson? You have been a traffic engineer for so many years. Is what we just saw peculiar to the beltway?

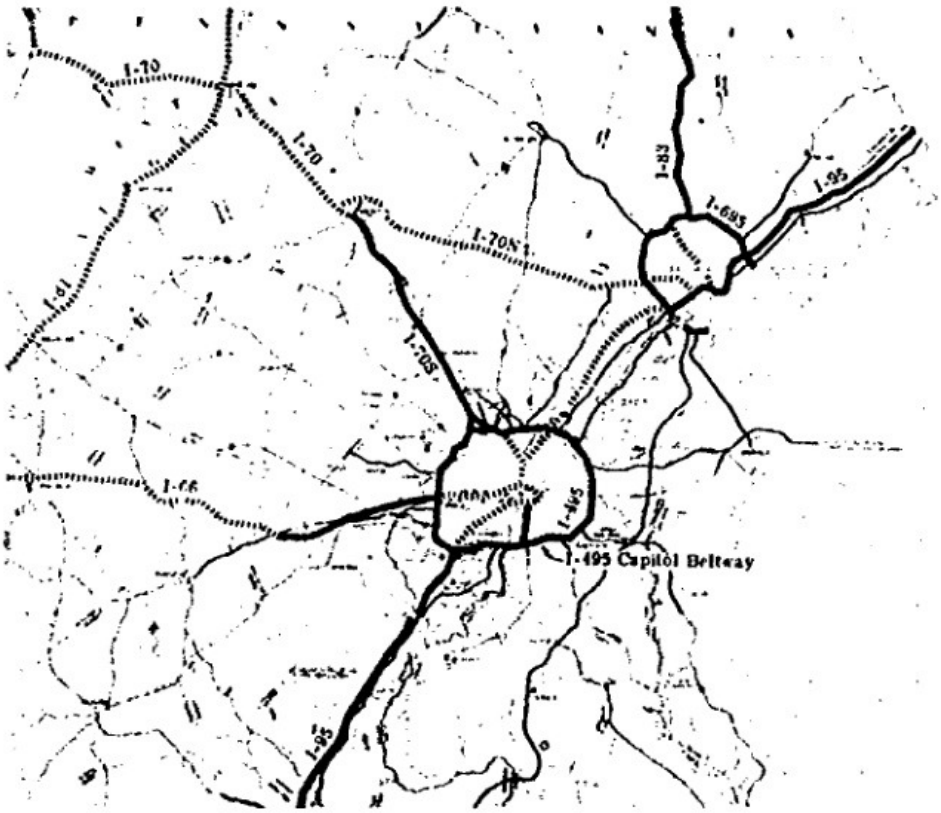
Mr. WILSON. I am really not familiar enough with the total beltway to say whether that is peculiar. You must keep in mind that these have all been compressed into a very short time frame. But this is the sort of thing that can take place around exits or splits of one major highway with another.

You can expect a certain amount of friction of this kind. However, I think the degree of this is based on many factors. They are factors of design and how much of a clear view you have ahead, the amount and adequacy of the advance notice in signing. There are a lot of things that could be pointed out here. In one instance, the first gore did not have an overhead sign. The second one did. There are reasonably short distances between decision points. I failed to see in one instance any sign closer than a thousand feet in front of the gore area at all.

At this split point where the decision has to be made whether you are going right or left, about the only thing I could see and I could only see the back of it were a series of route signs.

Mr. MAY. As we move along in the hearings we will take our time and step by step analyze the signing and the design as they approach these particular points. Mr. Schoppert, maybe we can turn it over to you now and you can lead us through a more detailed analysis of some of these beltway problems.

Mr. SCHOPPERT. Thank you very much. About 3 years ago our firm undertook a study for the Bureau of Public Roads of directional signing. We chose the Capital Beltway and the freeways which intersect it as the laboratory for that signing. It was our purpose in making this study to determine the extent to which motorists do have trouble at interchanges, the extent to which the signing may have figured in their troubles, and to propose some solutions to the signing system, some changes which would help them to find their way more conveniently and safely. I would like just for the orientation of the panel—some of you may not be fully familiar with the beltway—to show you a slide of that system, as of the date of our study.



The beltway is about 66 miles in length. It is on about a 7 to 11 mile radius around the center of the District of Columbia. As soon as the lights are down, you can see how it relates to the regional system. I think this might help you to some extent in the discussion we just had about why motorists have trouble with some of the interchanges where these films were made.

Here is the Capital Beltway, here. Running south from it is Route I-95. The first series of motion pictures you saw were made at this interchange.

There is another Interstate Route, 70–S, completed off to the north and another one completed from the beltway toward the west, Interstate Route 66. It will later be completed on this approximate location shown by the dashed line.

The Interstate System is not complete along the eastern seaboard. Baltimore is up here with its beltway and the harbor tunnel. The Baltimore-Washington Parkway, which is where you saw the last series of motion pictures, intersects the beltway here. That is the common route for the long distance traveler moving north and south in the eastern part of the country. They intersect here. It is important that they make this move around this way. They intersect again here, and going on south to Richmond it is important that they make a correct decision here.

I would say the beltway is about 66 miles in length. There are 38 interchanges provided for, although two of them have not as yet been built. They are to be part of the completion of the system.

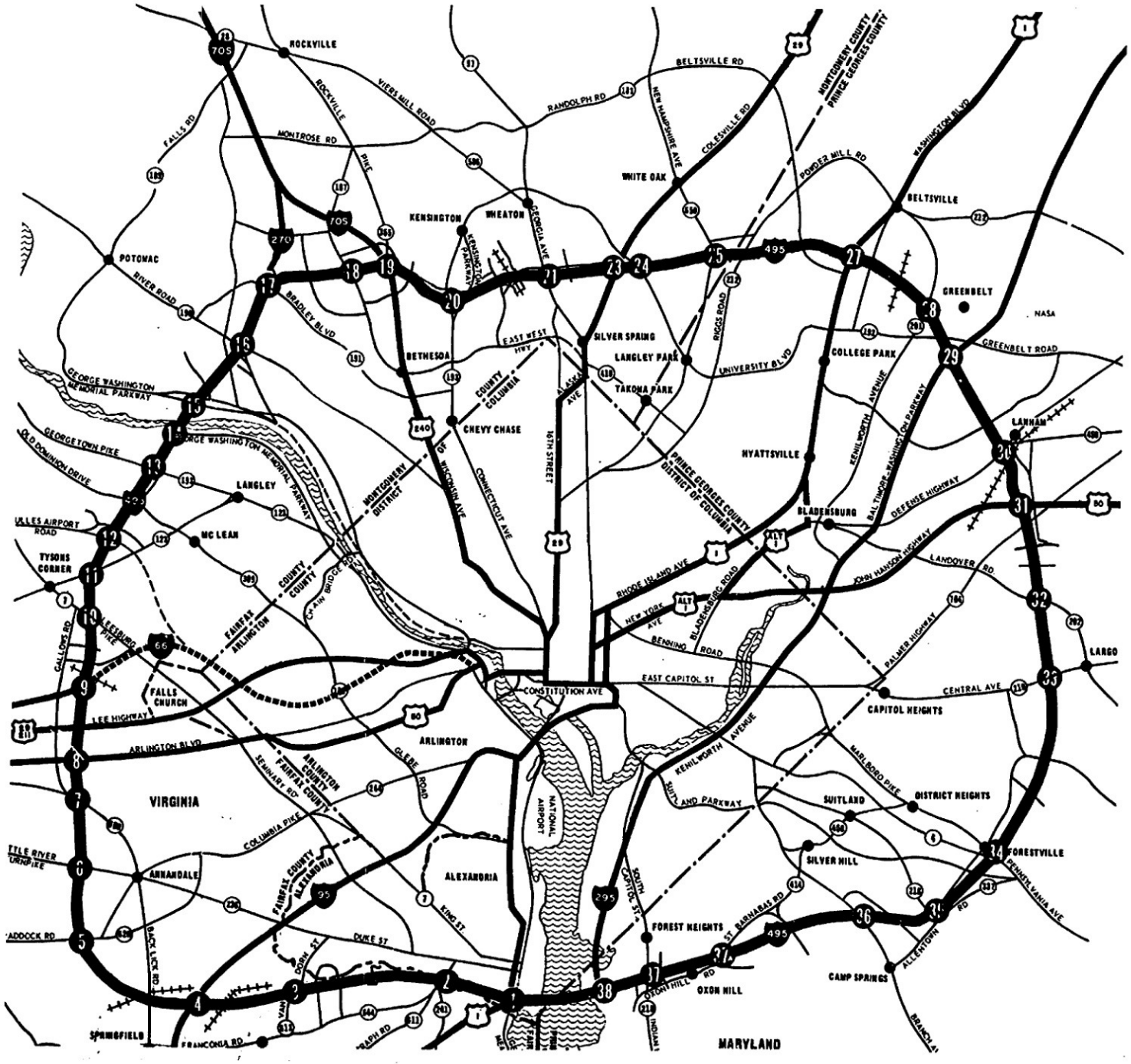
We have prepared a little handout for you, a map reproducing this slide you just saw, a map of the beltway with the interchange numbers and a tabulation of the types of interchanges which occur at the different exits, and another tabulation showing the street names, the route numbers for each exit number, and the distance to the next interchange, so you can have this for reference as you proceed with the panel discussions today.

Mr. MAY. Mr. Chairman, may we make those four items exhibit 6?

TABLE I
LIST OF INTERCHANGES ON CAPITAL BELTWAY (I-495) BY TYPE

	Interchange Number	Cloverleaf			Diamond			Direct or Semi-Direct	Incomplete[1/]
		Full	Partial	w/C-D Road	Full	Partial	Trumpet		
VA.	1			X					
	2			X					
	3						X		
	4							X	
	5				X				
	6			X					
	7					X			X
	8			X					
	9							X	
	10		X						X
	11		X						X
	12							X	X
	13				X				
VA.	14						X		
MD.	15							X	X
	16		X						
	17							X	X
	18				X				
	19							X	X
	20	X							
	21	X							
	23		X						X
	24		X						X
	25	X							
	27			X					
	28		X						
	29	X							
	30		X						
	31	X							
	32		X						X
	33	X							
	34	X							
	35				X [2/]				
	36	X							
	37A					X			X
MD.	38							X	
TOTALS		9	8	5	4	2	2	7	11

NOTES:
1. Incomplete is defined as an interchange where one or more of 8 possible turning movements is omitted.
2. More accurately - a split diamond.


ROCKVILLE
BELTSVILLE RD
RANDOLPH RD
VIERS MILL ROAD
ROCKVILLE PIKE
MONTROSE RD
FALLS RD
NEW HAMPSHIRE AVE
COLESVILLE RD
MONTGOMERY COUNTY
PRINCE GEORGES COUNTY
WASHINGTON BLVD
POWDER MILL RD
WHITE OAK
BELTSVILLE
KENSINGTON
WHEATON
GEORGIA AVE
KENSINGTON PARKWAY
POTOMAC
RIVER ROAD
BRADLEY BLVD
GREENBELT
NASA
SILVER SPRING
EAST WEST HWY
RIGGS ROAD
LANGLEY PARK
UNIVERSITY BLVD
COLLEGE PARK
GREENBELT ROAD
BETHESDA
COUNTY COLUMBIA
TAKOMA PARK
ALASKA AVE
GEORGE WASHINGTON MEMORIAL PARKWAY
CHEVY CHASE
LANHAM
GEORGETOWN PIKE
OLD DOMINION DRIVE
16TH STREET
HYATTSVILLE
KENILWORTH AVENUE
BALTIMORE-WASHINGTON PARKWAY
LANGLEY
MONTGOMERY DISTRICT
PRINCE GEORGES COUNTY
DISTRICT OF COLUMBIA
DEFENSE HIGHWAY
ULLES AIRPORT ROAD
MC LEAN
BLADENSBURG
TYSONS CORNER
COUNTY
COUNTY
MEMORIAL BRIDGE
RHODE ISLAND AVE
JOHN HANSON HIGHWAY
LANDOVER RD.
LEESBURG PIKE
FAIRFAX
ARLINGTON
NEW YORK AVE
BLADENSBURG ROAD
BENNING ROAD
PALMER HIGHWAY
LARGO
GALLOWS RD
FALLS CHURCH
EAST CAPITOL ST
CENTRAL AVE
CONSTITUTION AVE
CAPITOL HEIGHTS
LEE HIGHWAY
ARLINGTON BLVD
ARLINGTON
KENILWORTH AVENUE
MARLBORO PIKE
GLEBE ROAD
SUITLAND PARKWAY
DISTRICT HEIGHTS
VIRGINIA
ARLINGTON COUNTY
FAIRFAX COUNTY
SEMINARY RD
NATIONAL AIRPORT
SUITLAND
COLUMBIA PIKE
FORESTVILLE
SILVER HILL
ANNANDALE
FAIRFAX COUNTY
ALEXANDRIA
ALEXANDRIA
KING ST
SOUTH CAPITOL ST.
FOREST HEIGHTS
ST BARNABAS RD
DUKE ST
DOMINION HILL
OXON HILL
CAMP SPRINGS
ALLENTOWN RD
PENNSYLVANIA AVE
BACK LICK RD
SPRINGFIELD
FRANCONIA RD
MARYLAND
BRANCH AV

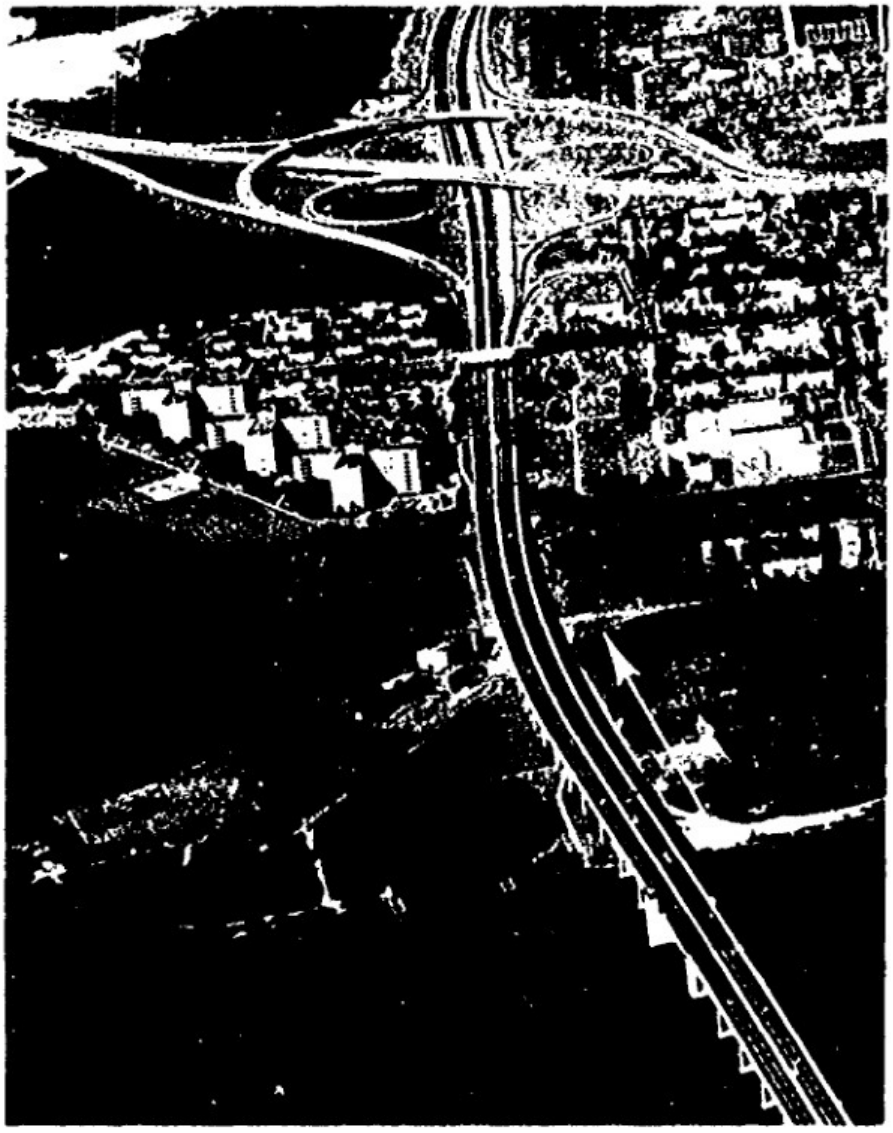
CAPITAL BELTWAY (I-495) INTERCHANGES

Interchange No.	Intersection: Named street	Intersection: Route No.	Distance (miles) to next interchange
	VIRGINIA		
1	Patrick St. (northbound) [1]	U.S. 1	1.4
2	Telegraph Rd	Va. 241	3.4
3	South Van Dorn St.[1]		
	(Signed only to Franconia)	Va. 613 [1]	2.0
4	Shirley Highway [1]	I-95	2.8
5	Braddock Rd	Va. 620	1.7
6	Little River Turnpike [1]	Va. 236	1.4
7	Gallows Rd	Va. 650	.8
8	Arlington Blvd.[1]	U.S. 50	1.3
9		I-66	1.7
10	Leesburg Pike [1]	Va. 7	.8
11	Chain Bridge Rd.[1]	Va. 123	.6
12	Dulles Airport Rd		1.8
13	Georgetown Pike [1]	Va. 193	.8
14	George Washington Memorial Parkway (Virginia)		.7
	MARYLAND		
15	George Washington Memorial Parkway [1] (Maryland)		1.9
16	River Rd	Md. 190	1.6
17		I-270	1.7
18	Old Georgetown Rd	Md. 187	1.0
19		I-70S	1.5
	Rockville Pike	Md. 335	
	Wisconsin Ave	U.S. 240	
20	Connecticut Ave	Md. 193	2.0
	Kensington Parkway [1]		
21	Georgia Ave	Md. 97	1.4
22	(Provided for but not constructed)		(2)
23	Colesville Rd	U.S. 29	.6
24	University Blvd	Md. 193	1.6
25	New Hampshire Ave	Md. 650	2.7
26	(Provided for I-95 but not constructed)		(2)
27	Washington Blvd [1]	U.S. 1	2.2
28	Kenilworth Ave	Md. 201	.1
29	Baltimore-Washington Parkway		2.5
30	Defense Highway	Md. 450	1.0
31	John Hanson Highway	U.S. 50	2.9
32	Landover Rd	Md. 202	1.8
33	Central Ave	Md. 214	4.0
34	Pennsylvania Ave	Md. 4	1.1
35	Allentown Rd. (partial)	Md. 337	1.8
	Suitland Rd. (partial) [1]	Md. 218 [1]	
	Forestville Rd. (partial) [1]		
36	Branch Ave	Md. 5	3.0
37A	St. Barnabas Rd	Md. 414	1.6
37	Indian Head Highway (partial)	Md. 210	1.1
	Oxon Hill Rd. (partial) [1]	Md. 414 [1]	
38		I-295	2.0

[1] Denotes named street or route number not part of signing message.
[2] Not built.

Mr. BLATNIK. Without objection that will be done.

Mr. SCHOPPERT. With that introduction, unless there are some questions about the general location of the route and the intersecting roadways, I would like to begin by showing some slides of exit No. 1.



This is on the outside of the city of Alexandria at the intersection with U.S. Route 1. It is on the west side of the Potomac River. In this oblique view you can see the bridge in the foreground coming across the river and the interchange near the top. To the right lies Alexandria. To your left, which is south, is U.S. 1 proceeding on down toward Fort Belvoir.



This is an overhead view of the same interchange. As you can see, it is a partial cloverleaf with one semidirect movement in it. There is a collector-distributor road on the right side. It would be for westbound traffic. But there is no similar collector-distributor road on the left for eastbound traffic.

Mr. MAY. Mr. Schoppert, could you point out the different movements heading westbound?

Mr. SCHOPPERT. Westbound traffic coming across the river on the bridge can take an exit here. All exiting traffic must leave the through roadway here and one lane is dropped at this point. There are three lanes here, two for through traffic and one for exit traffic. There is a ramp which comes around here in connection with this street signed "Mount Vernon Highway." Mount Vernon is on down the parkway to the south.

This is Route 1 with an exit off here and another loop on up above to go south.

Coming from the other direction there is a ramp directly to the south and to the north. There is a lane drop here, three lanes coming in and one of them is dropped approximately at that point.

Mr. MAY. Can we drive through that interchange?

Mr. SCHOPPERT. Yes; we have a drive-through movie.

(Movie.)

Mr. MAY. Mr. Chairman, this is the movement of the traffic coming across the Woodrow Wilson Bridge heading west on the beltway.

Mr. SCHOPPERT. This being the State line, there is a sign, "Entering Virginia."

This is now on the collector-distributor road.

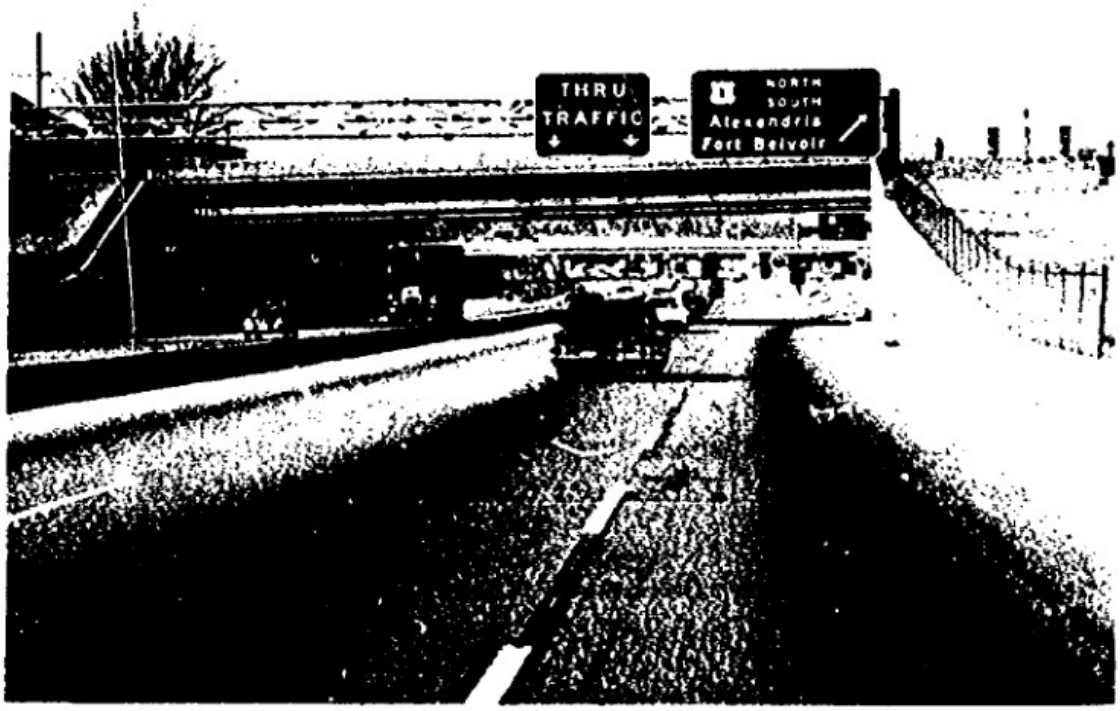
There is where the loop goes off to the south.

Mr. SCHOPPERT. Do you have a question on this?

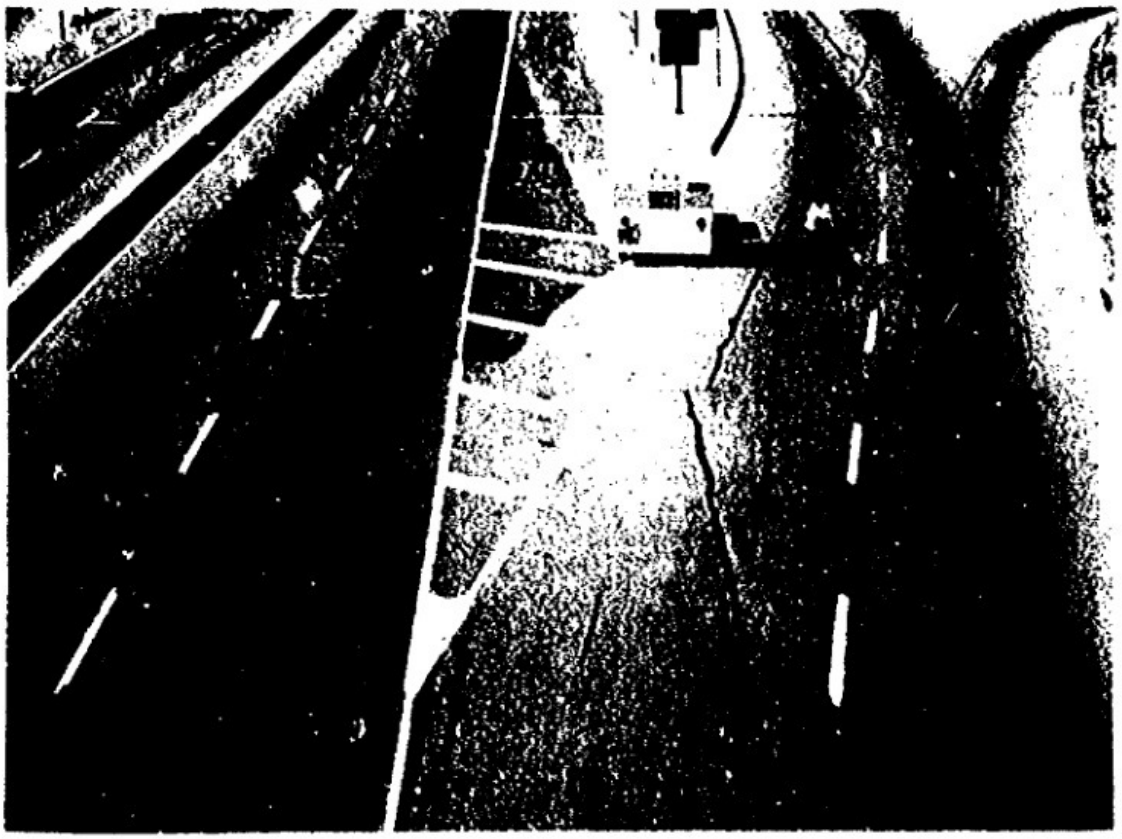
Dr. HULBERT. How do you make that semidirect move?

Mr. SCHOPPERT. That is for traffic coming out of Alexandria on Route 1. They take a right here and then there is a position up here to go either east or west. They can come around the big loop and around this way to the east. There is an additional lane at that point for the entering traffic from the three ramps. If there are no further questions, I think we might go to the slides on signing. Do we have some slides here, Mr. May, of some unusual movements?

Mr. MAY. I believe so. Could we show those now?
Mr. SCHOPPERT. Yes; let's show those.

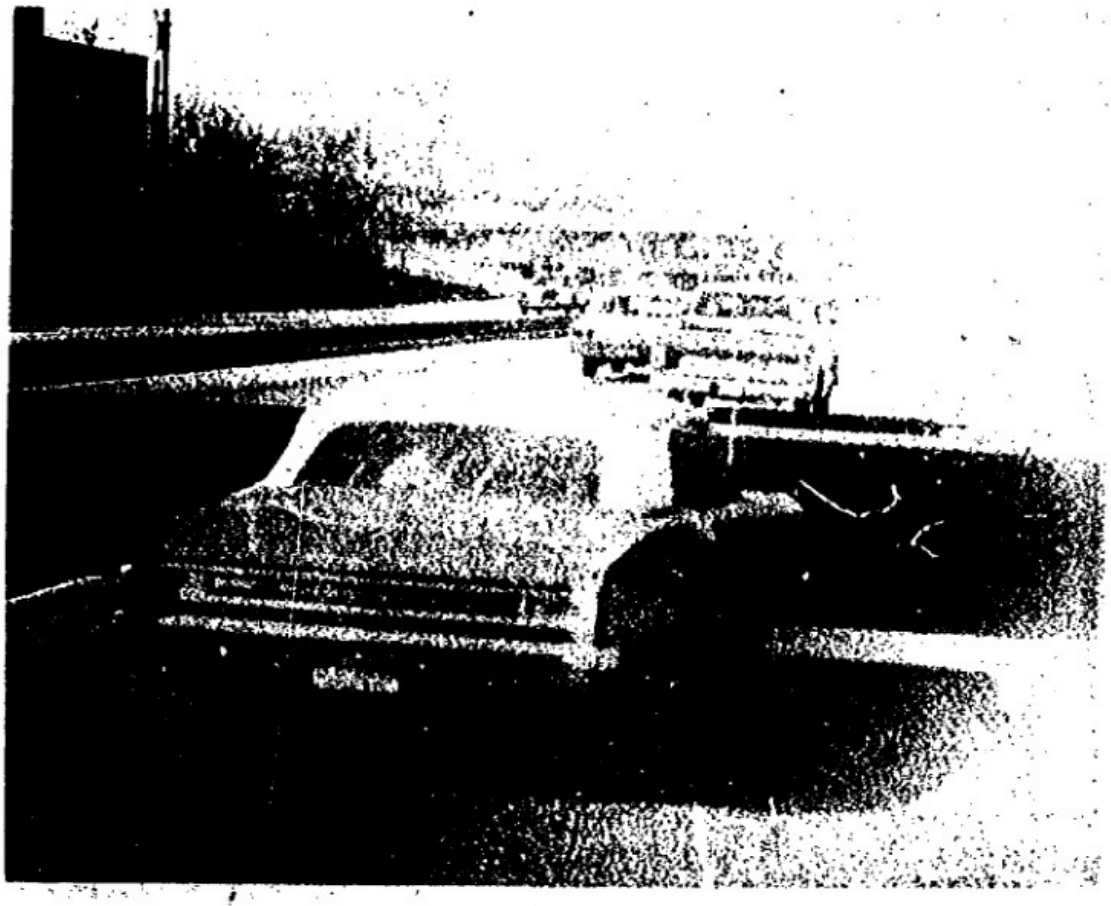


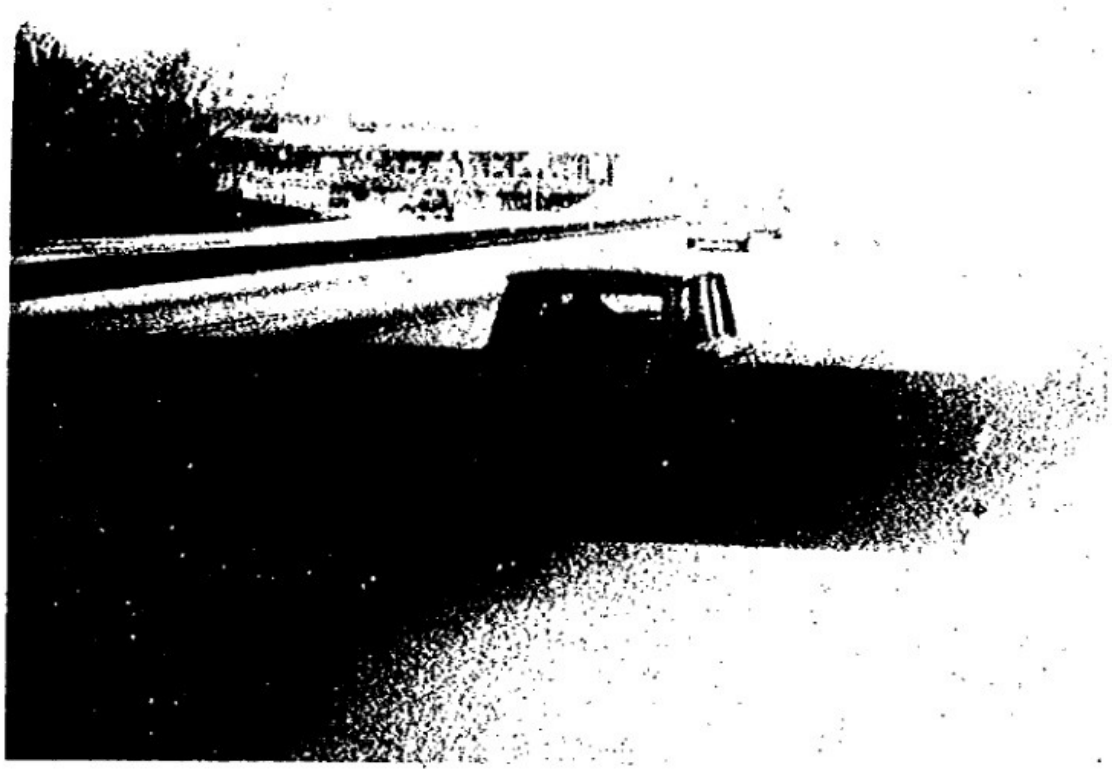
Mr. MAY. This is what the motorist will see as he approaches that first gore area.





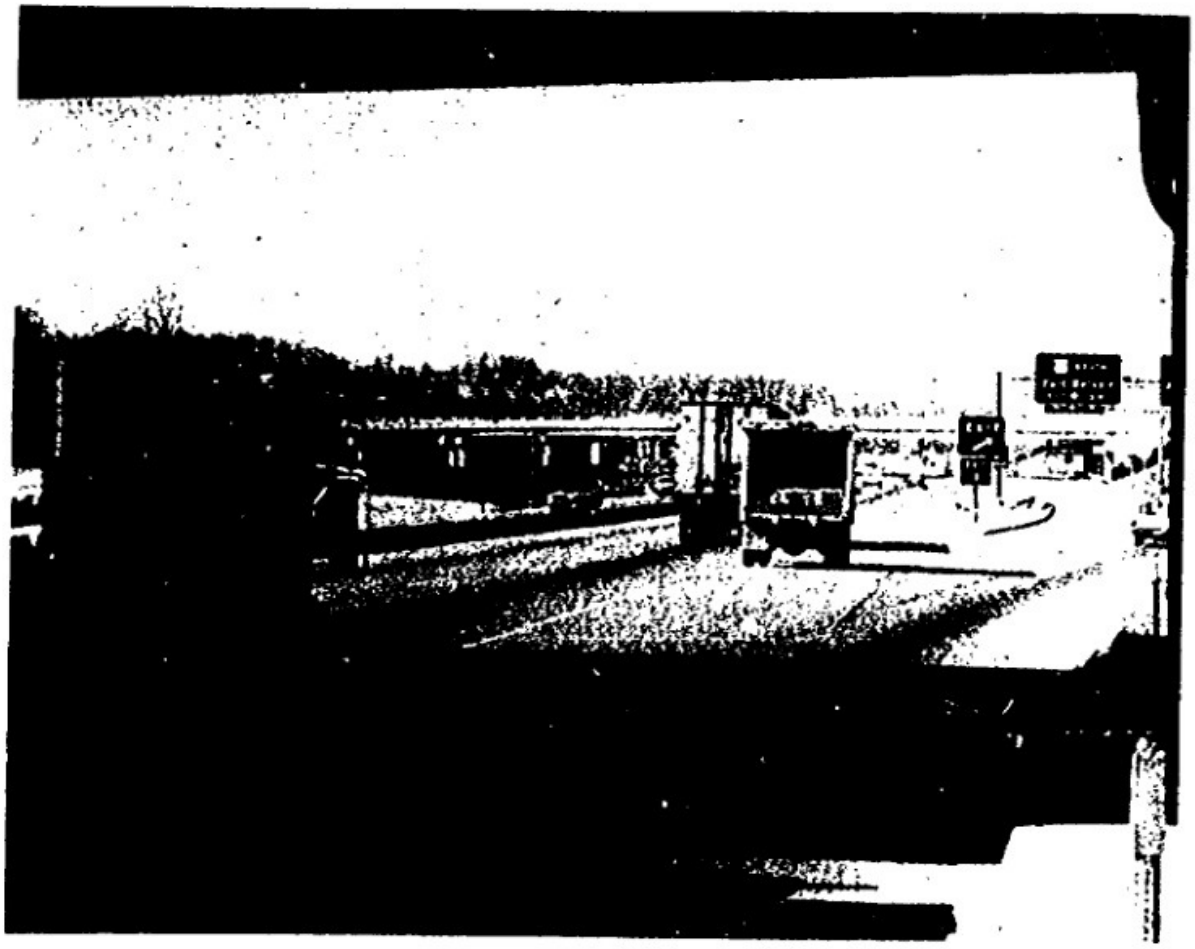
These were taken by the staff a number of weeks ago. Again, it is a difficult location but this is what happens. This trailer has stopped there for a few moments and then continues on his way.



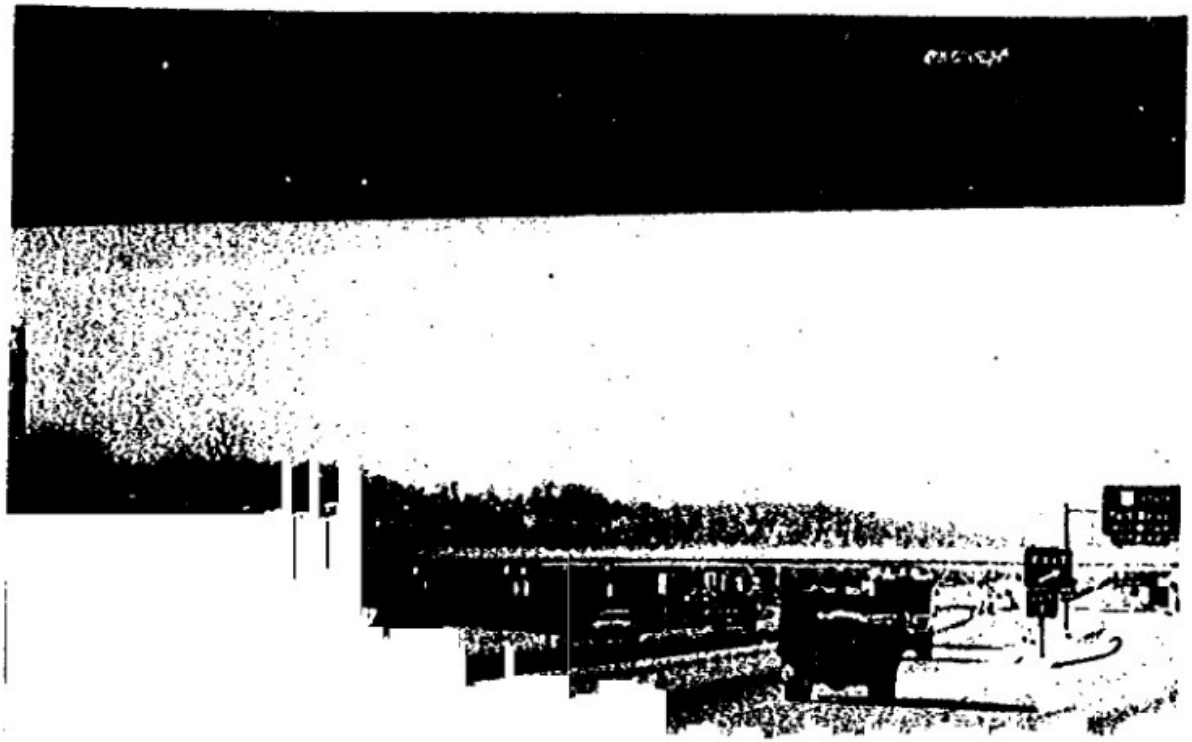


Mr. Chairman, these next slides will give some indication as to how frequently this kind of maneuver sometimes take place. We will watch the same cars go through here and you will see that it happens one after another. The right lane becomes an exit ramp at that point and the vehicles which do not want to exit here continue on down the shoulder until they can move into the lane next to it.

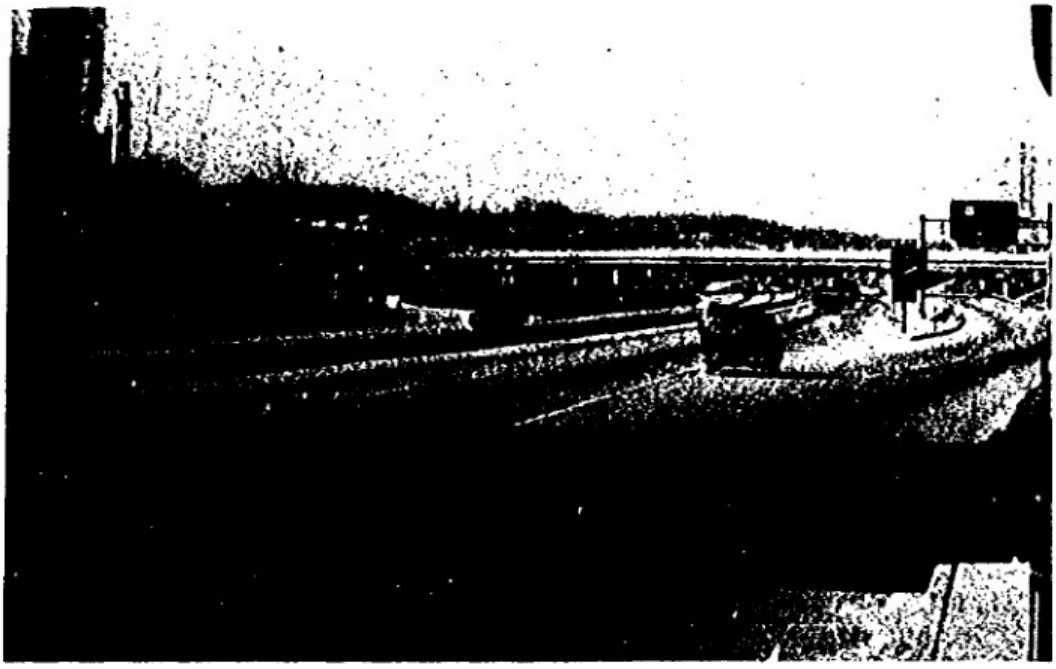
This man is still on the shoulder. The red truck has pulled abreast of him.



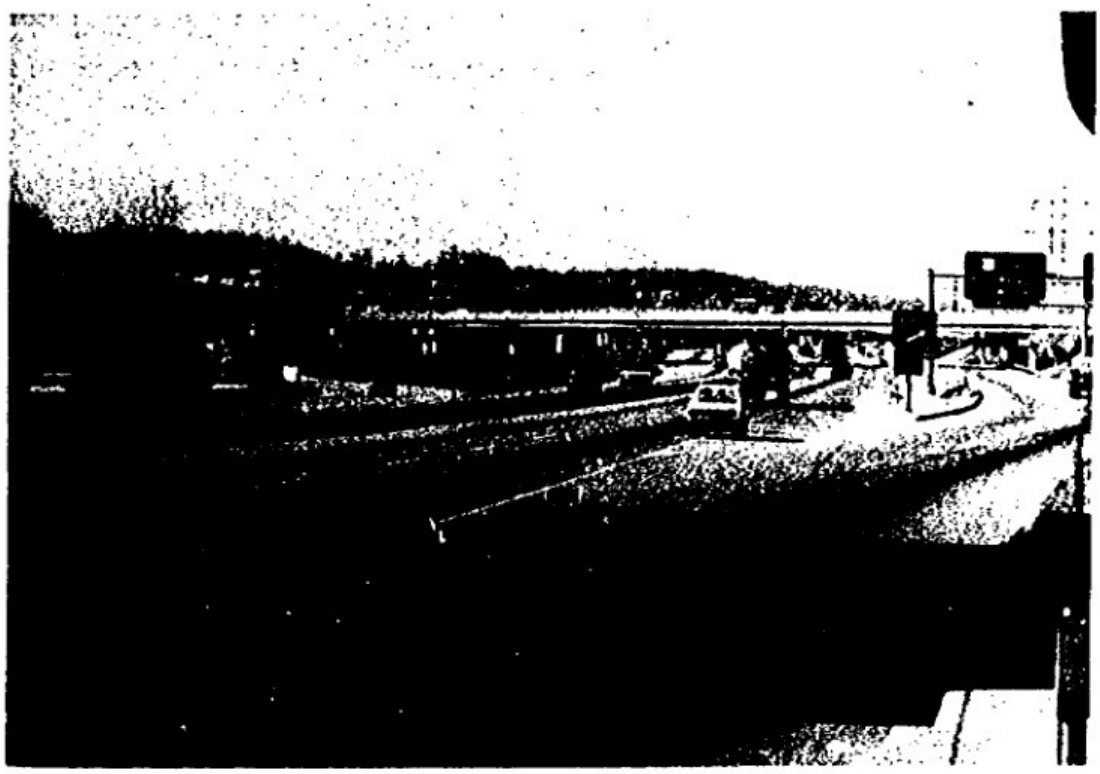
He is still on the shoulder in this next slide. In the foreground there is a truck moving over into this lane.



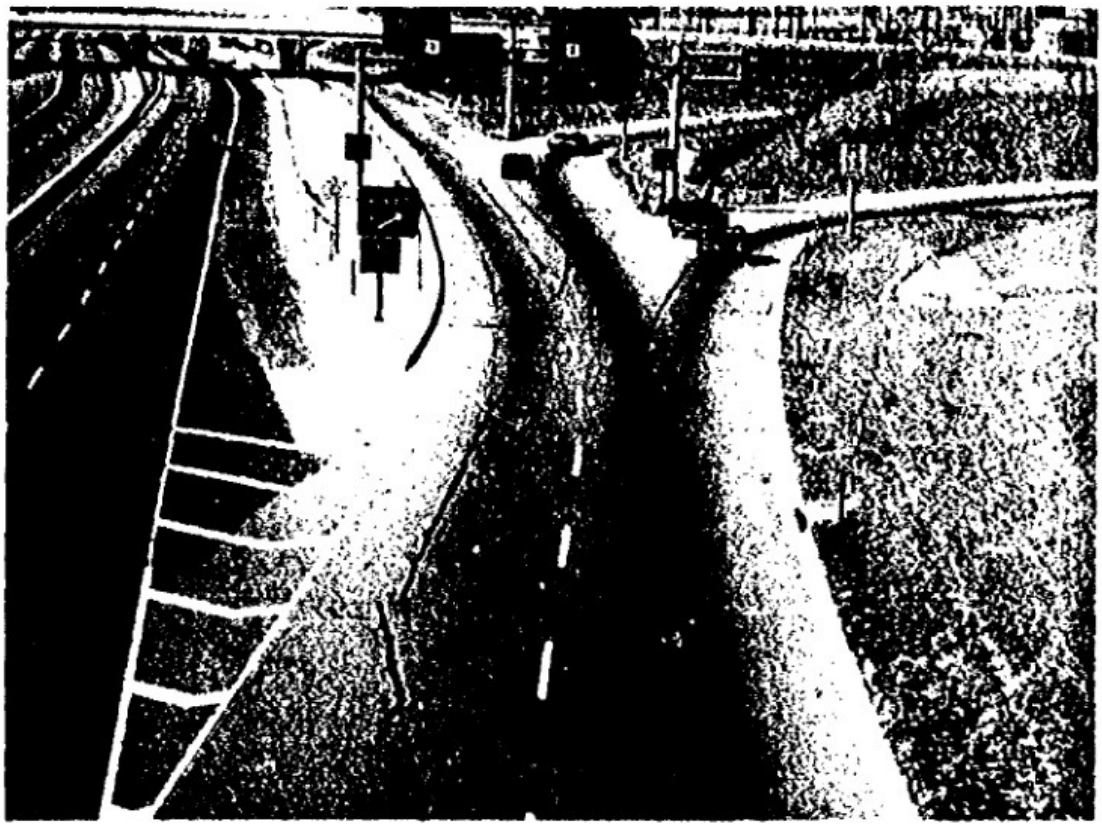
Now there is another truck in the slide.



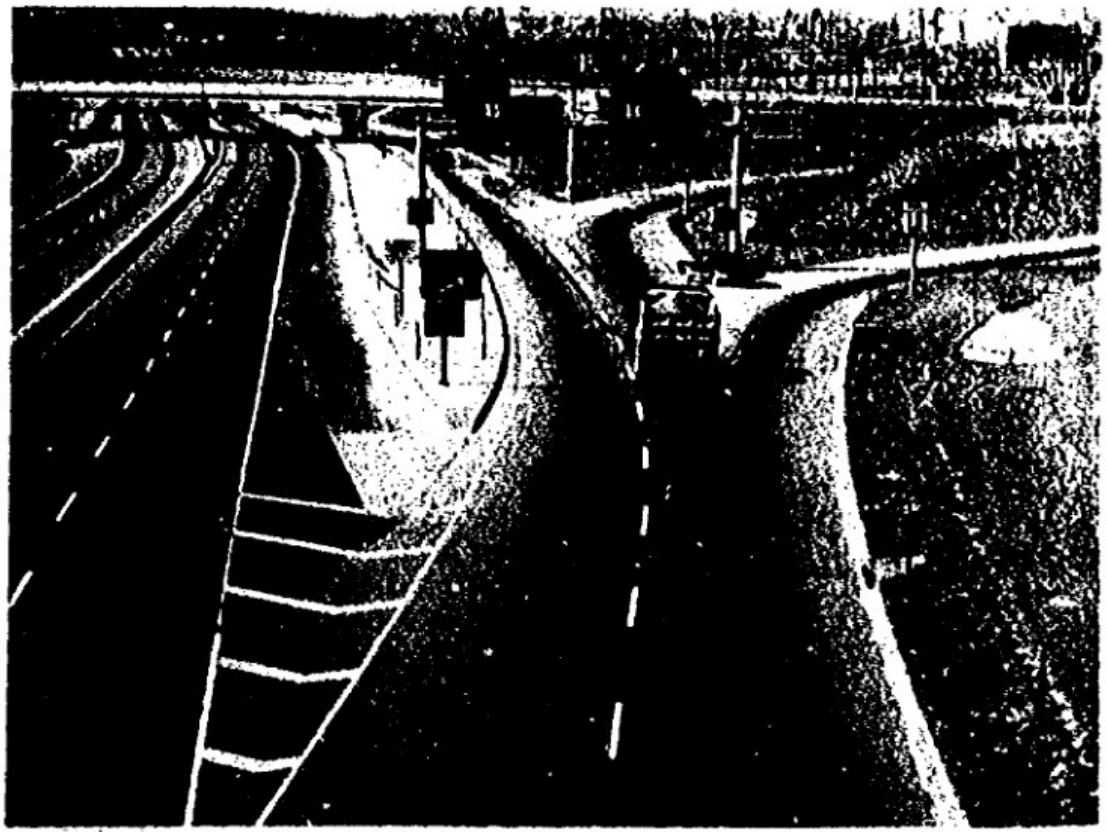
You can still see the two trucks and yet another car does it. When the volume increases, this maneuver becomes quite hazardous.



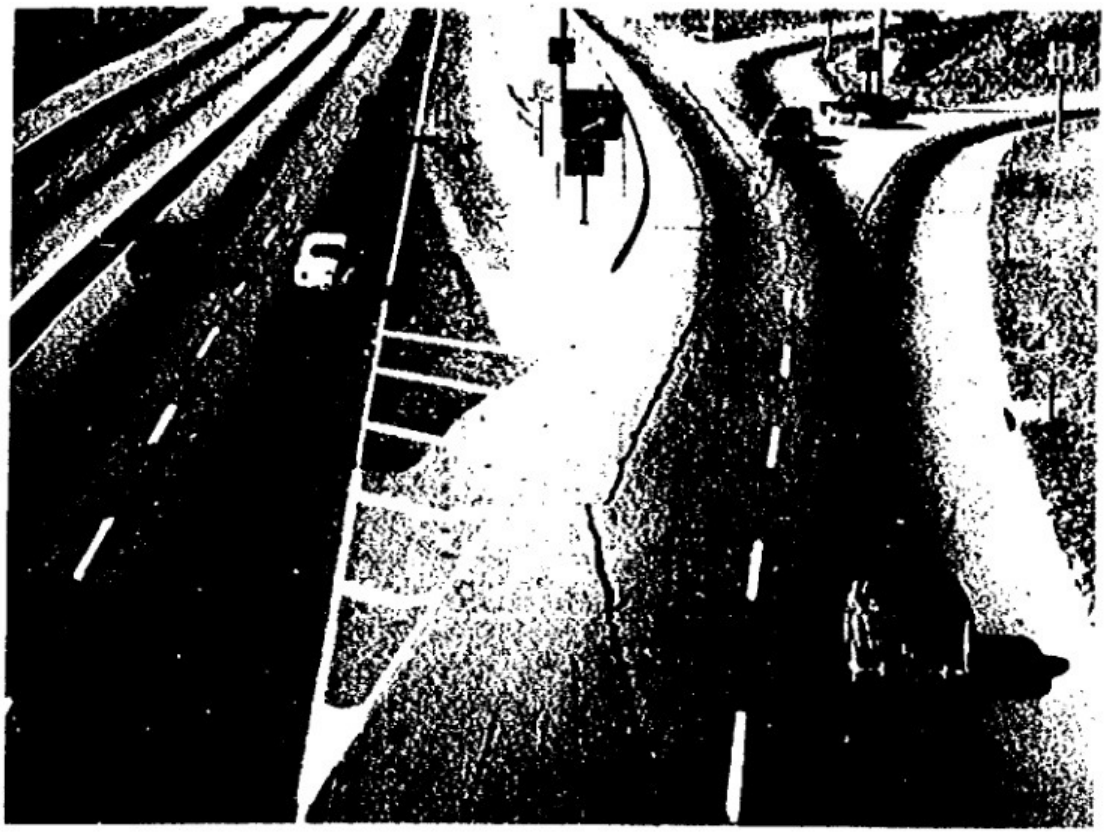
Here they are all still in the picture as another does it.



This is the second gore area and although this is not a movie film, we are seeing here in the slide a man who is confused and has stopped in the gore.



In the next slide, he is still there and a truck bears down on him.



The truck is gone and he is still there. There are two more cars now being affected by him.

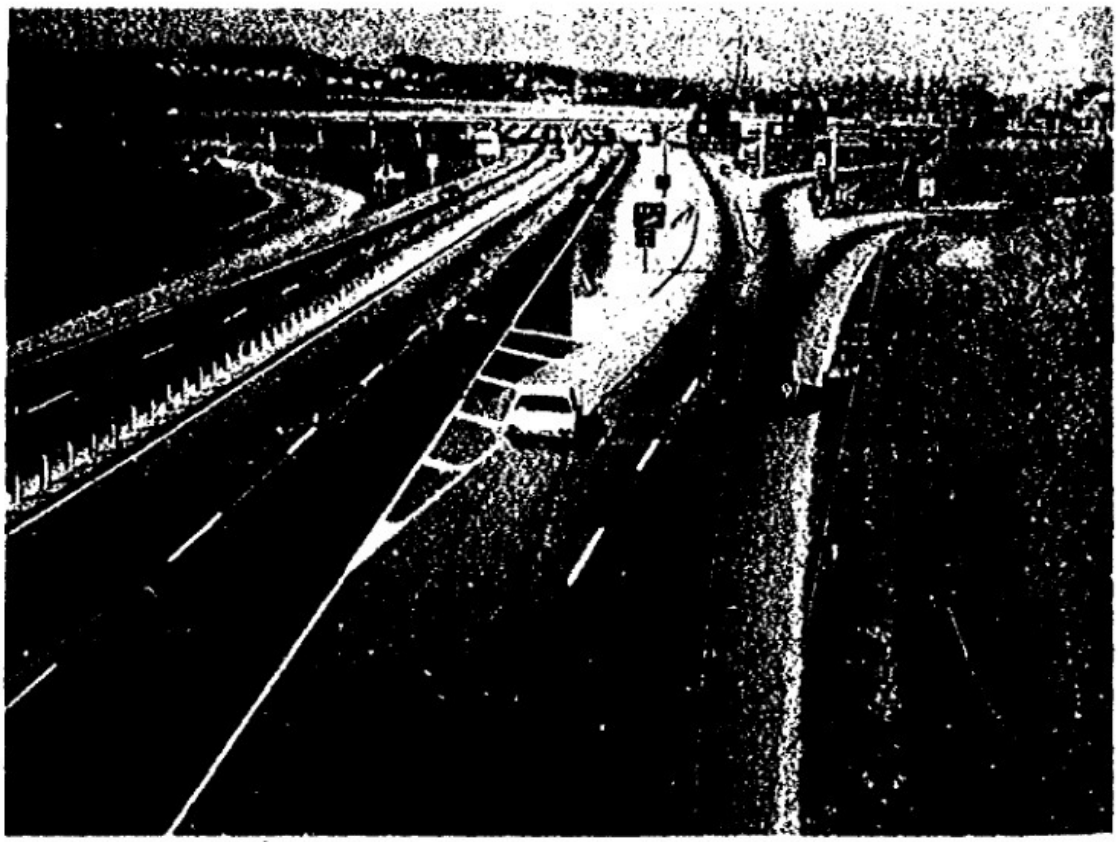


Now it is beginning to affect traffic in the lower part of the screen. you will notice the brake lights.

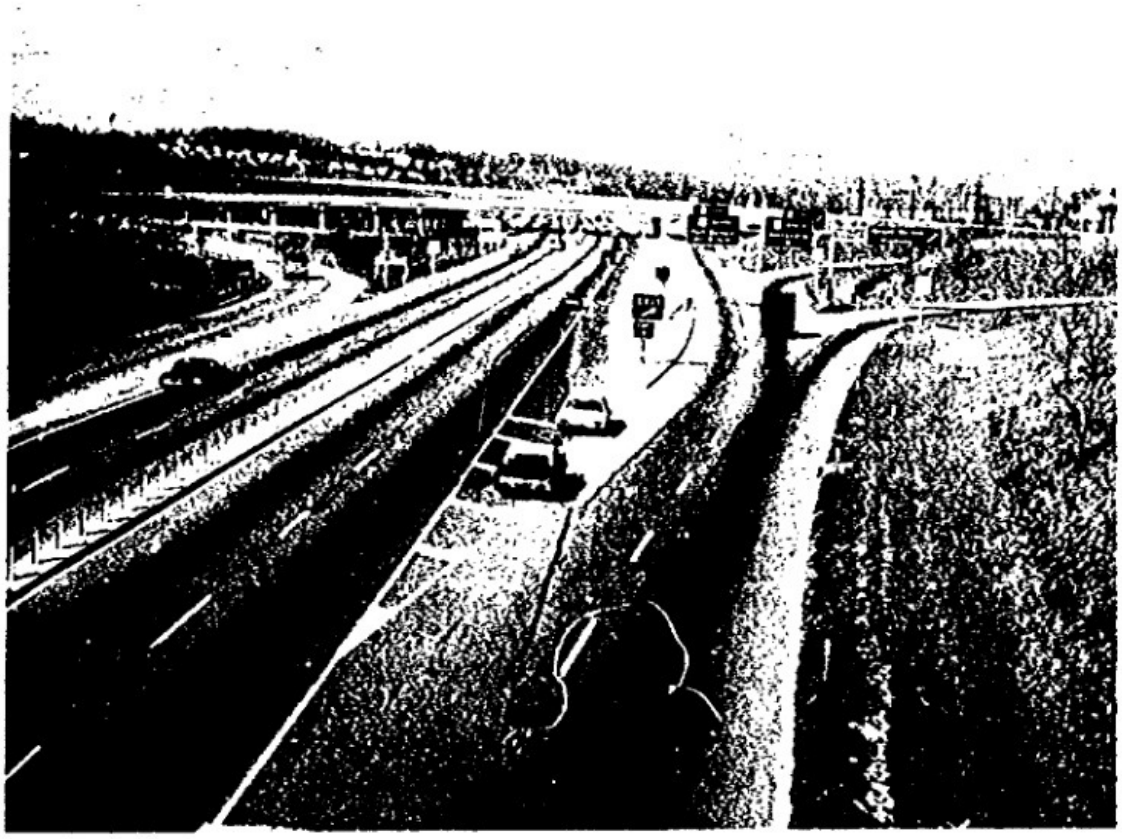
In this slide, he pulls down to the next gore.

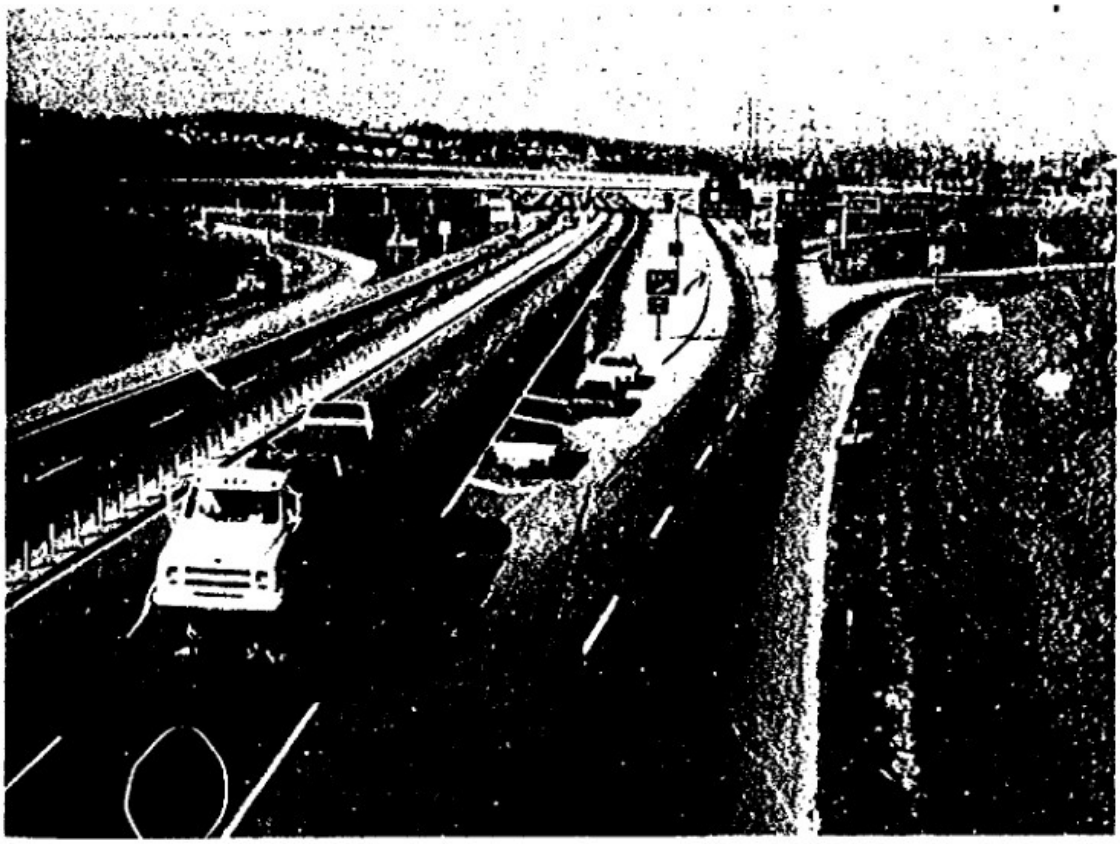


Here we have another car pulling into the first gore.

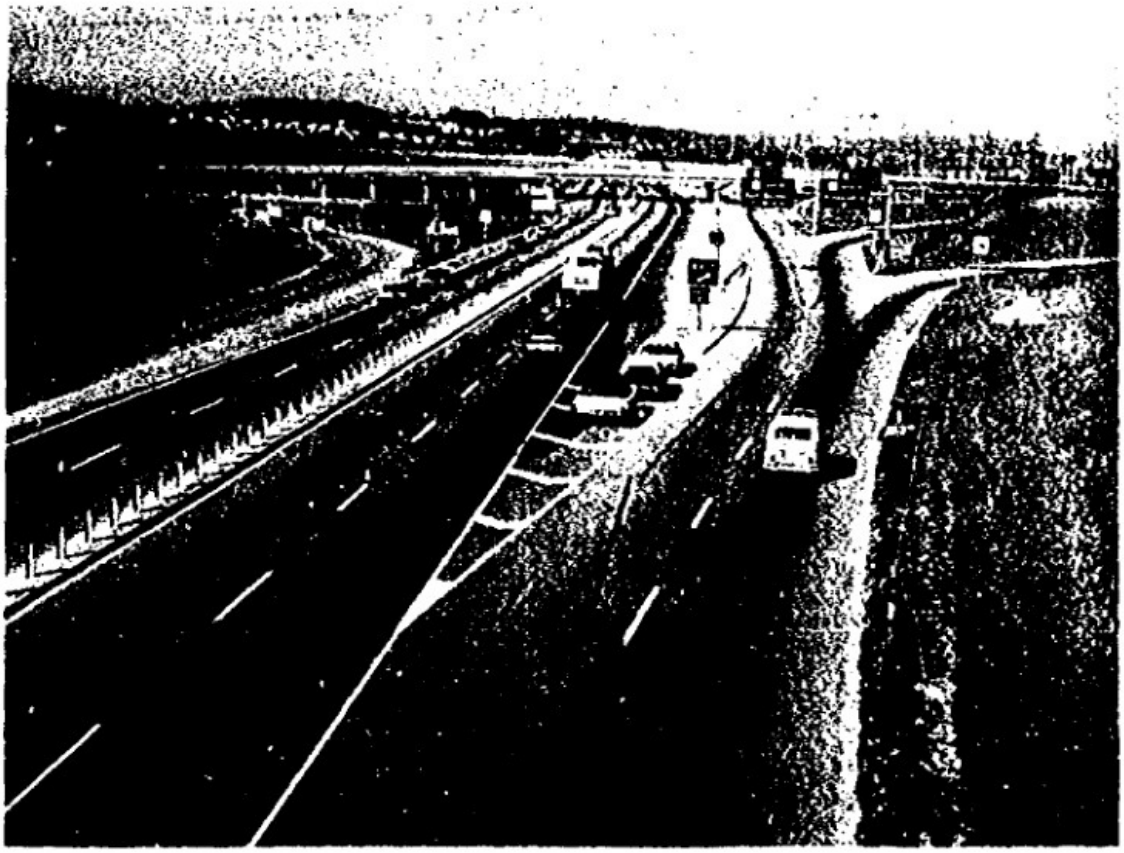


Now there are two cars stopped there. In the next slide there are three.

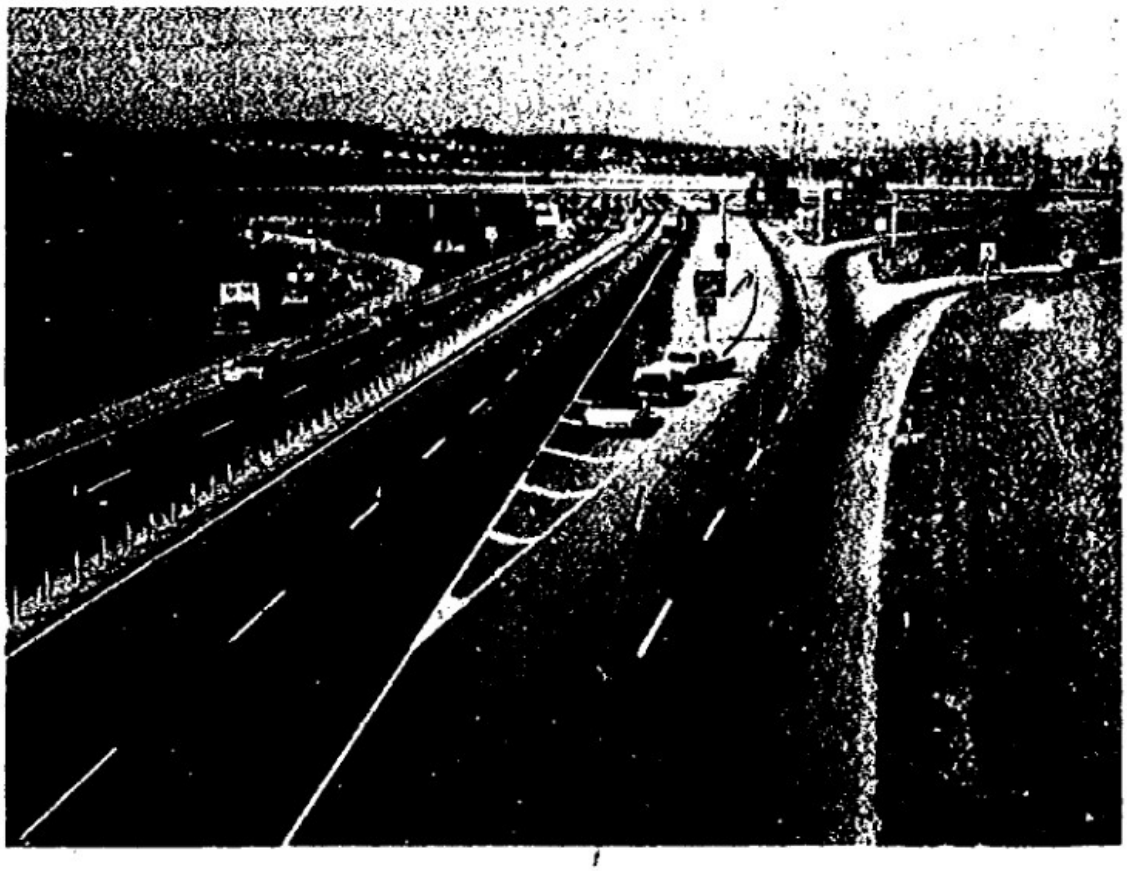


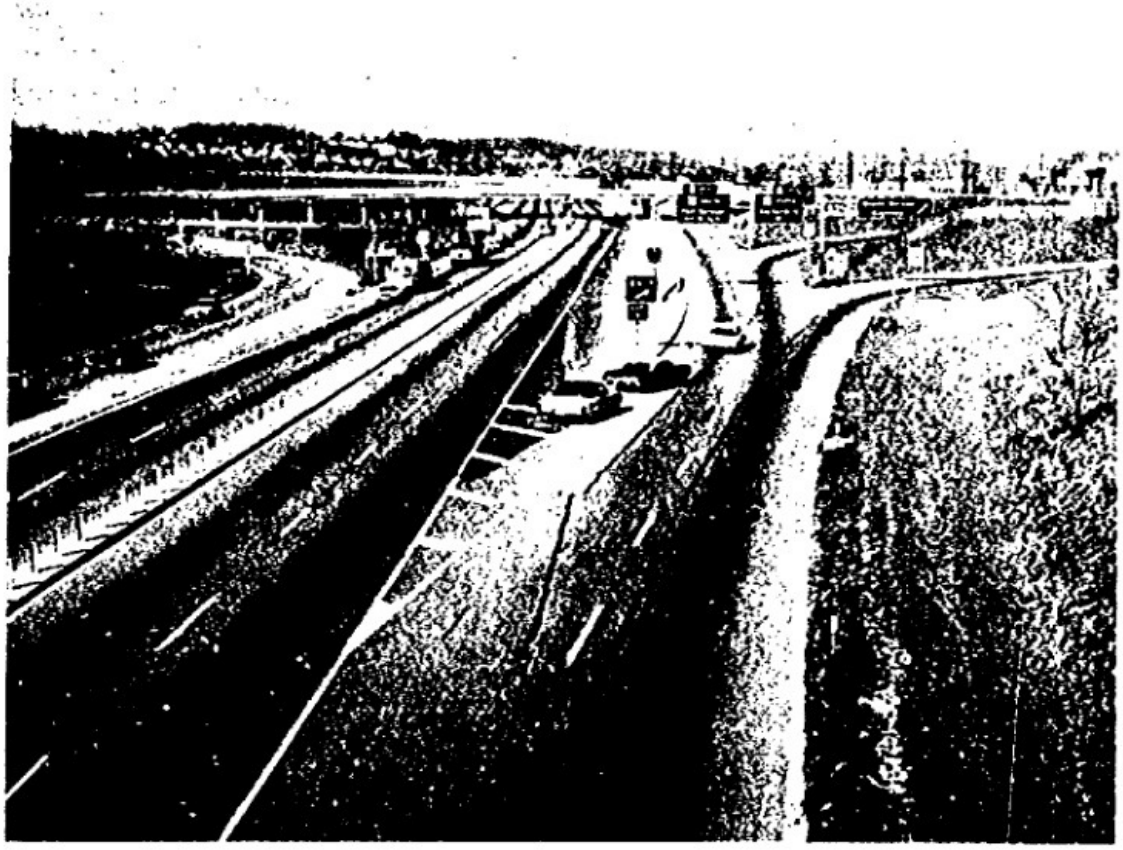


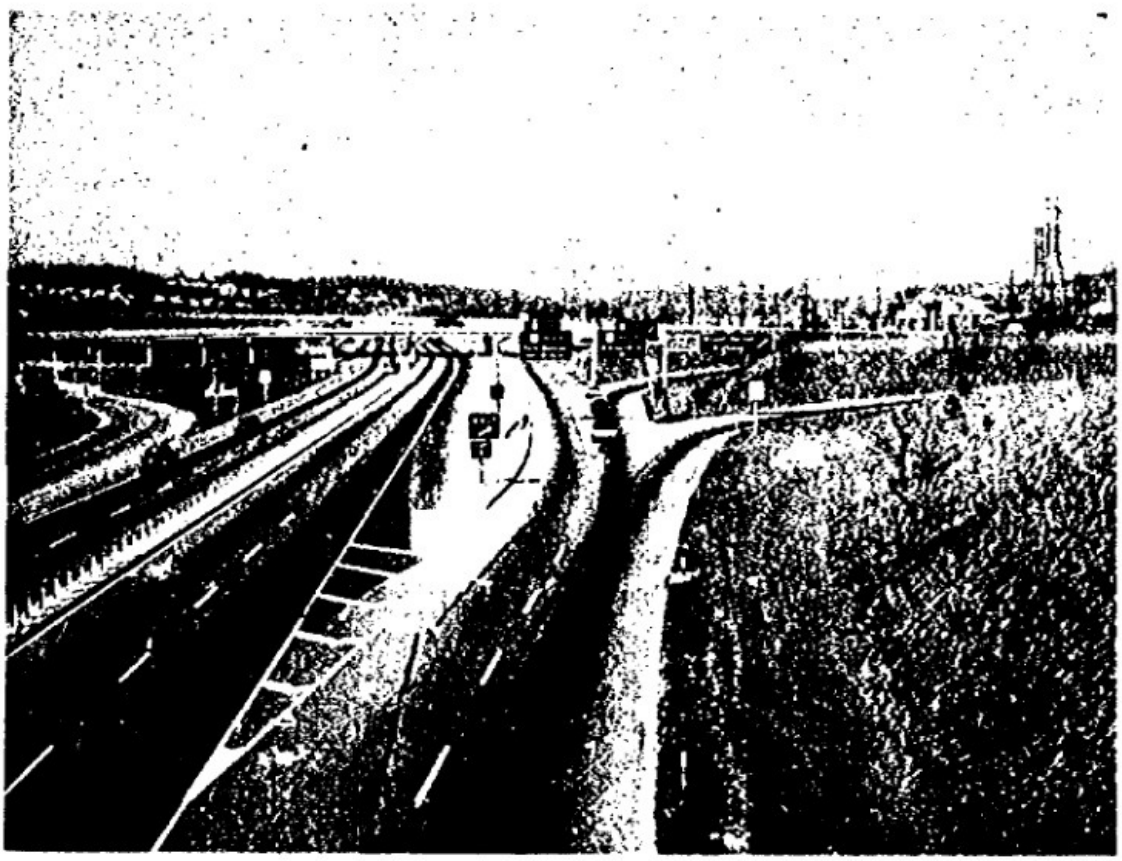
And the same three cars are still there.



Now they begin to move in the other direction.



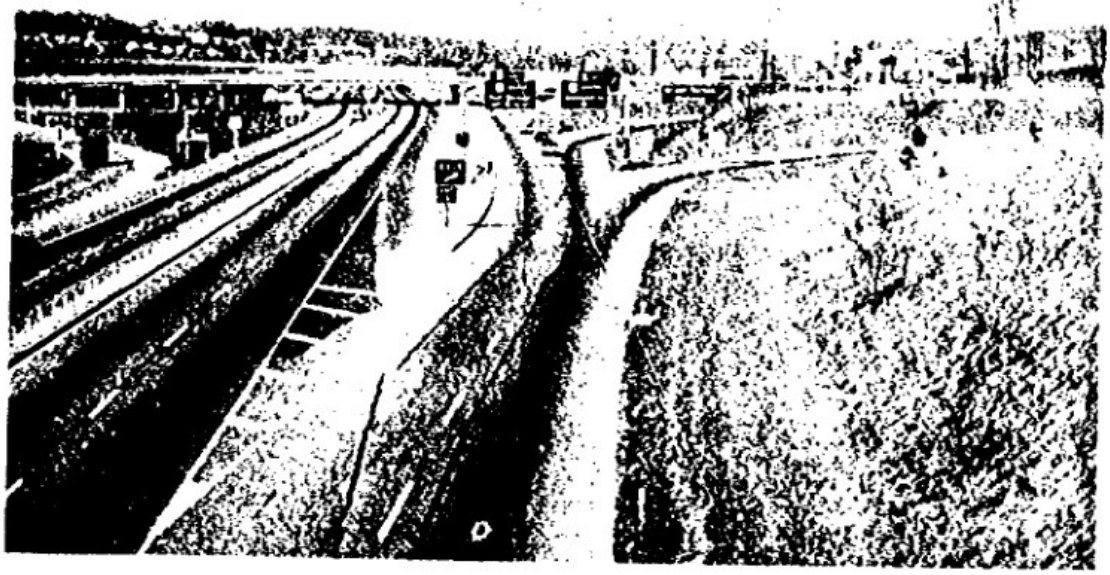


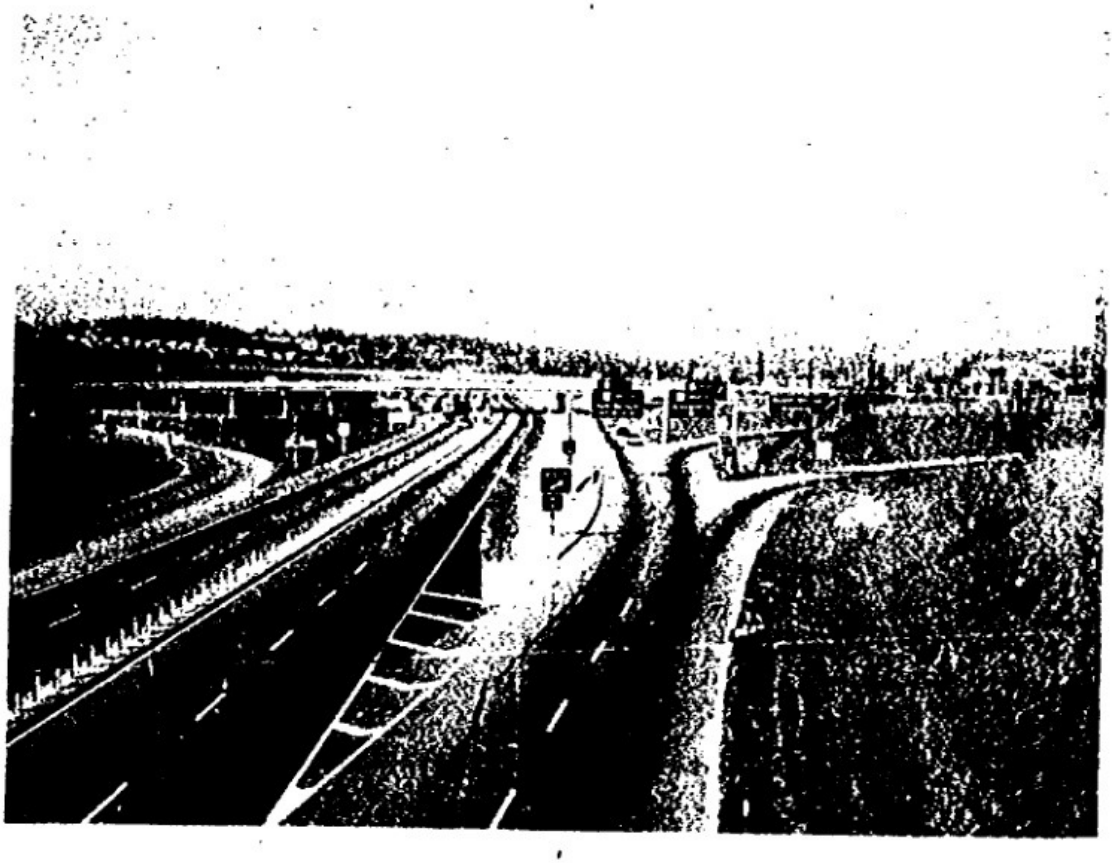


Here they stop at the next gore area.

Mr. BLATNIK. Did all three stop at that gore area, too?

Mr. O'HARA. Yes, they did. All three of them stopped at that second gore as I was changing film. I missed a little bit of it.





Mr. MAY. Now they are stopped on the shoulder beyond that gore. That is all the slides of unusual maneuvers at this point. What we would like to stress to the panel and the highway engineers is that in our observations around the country, in Utah, Massachusetts, and New York, it doesn't matter a great deal where you are. These things happen at these types of places. It is a matter of degree sometimes, but if there is enough volume of traffic and enough unfamiliar motorists, these things go on, and you don't have to wait many minutes before you see them. All right, Mr. Schoppert.

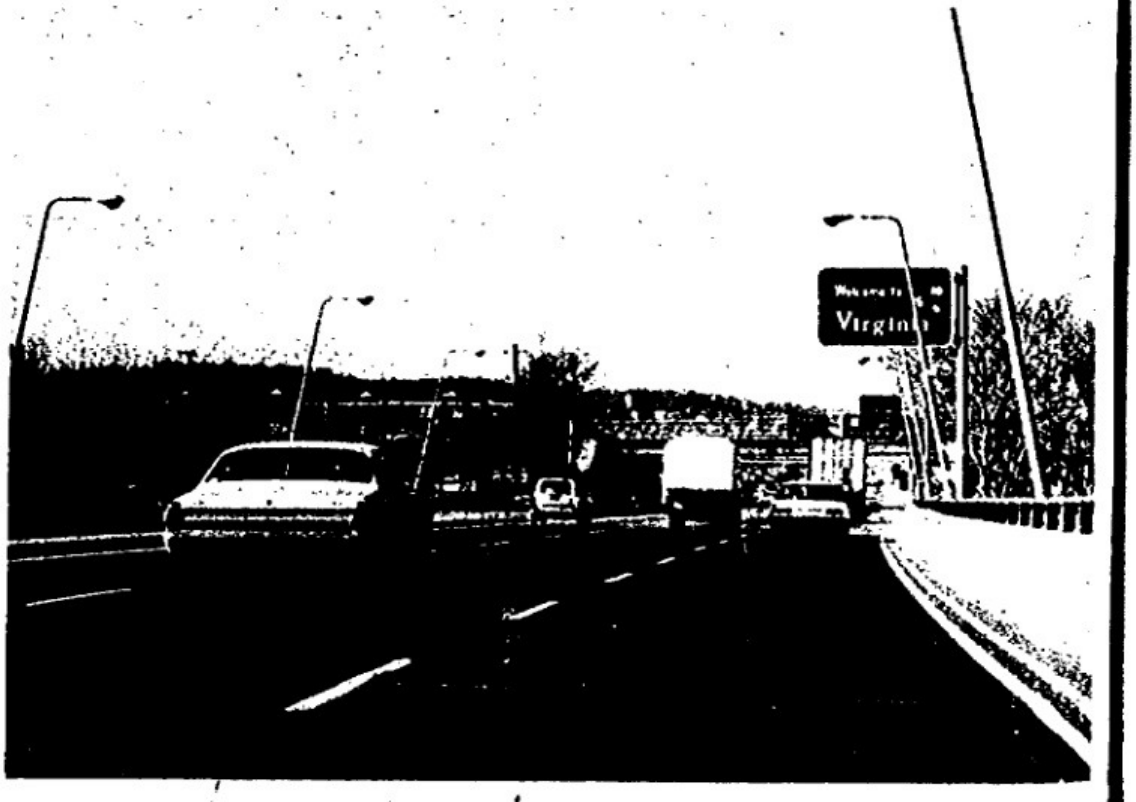
Mr. SCHOPPERT. I would like then to go to the slides of the signs at this location. I think you are familiar with them now and with some of the problems that occur there through the slides we have seen. We would like to begin by showing you what a motorist westbound on the beltway would see, and I would hope the panel would comment and raise questions about these as we go along.



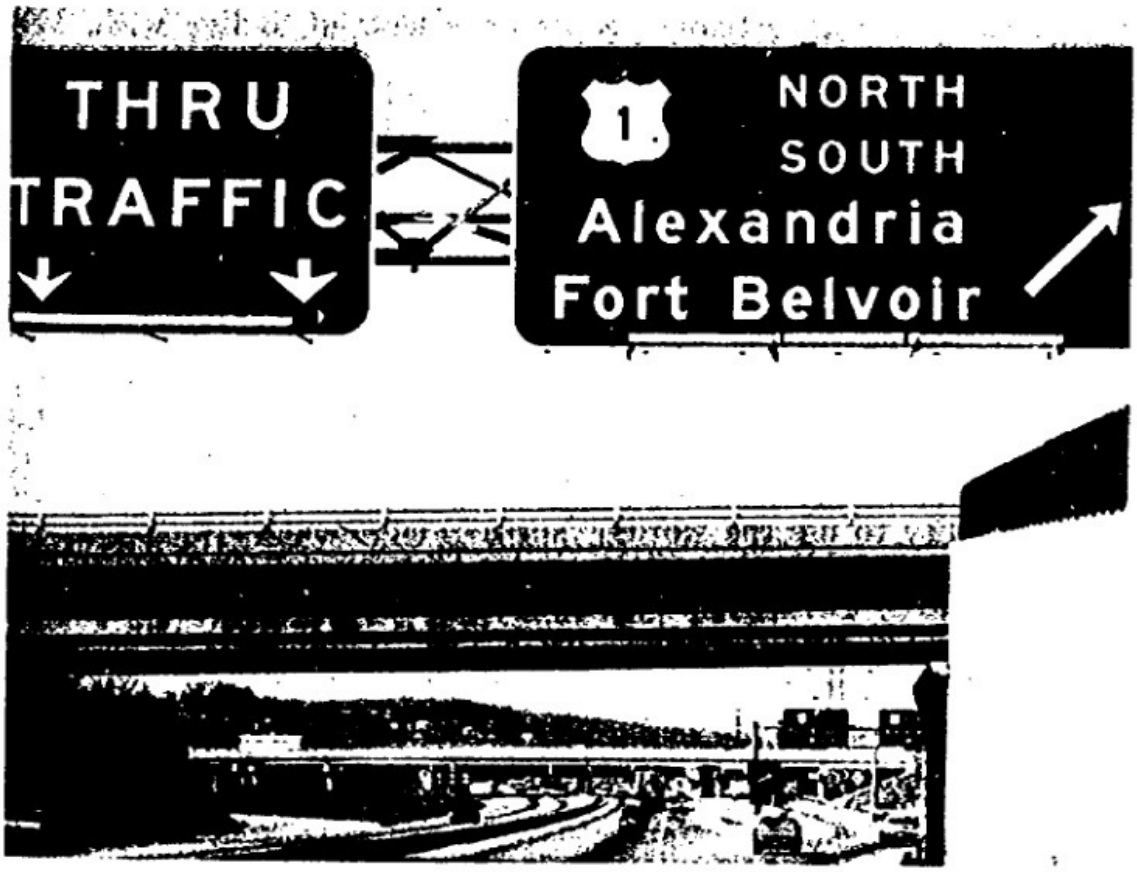
This is on the bridge approaching the interchange. As you can see, there is no advance notice yet at this point. This will give you an idea of what a motorist might see as he approaches. He has no notice up to this point.



As he moves around the curve, the signs begin to become visible. The first is, of course, the State line sign.




GAS - FOOD
LODGING
NEXT 3 EXITS
THRU
TRAFFIC


THRU
TRAFFIC
1
NORTH
SOUTH
Alexandria
Fort Belvoir

Next is a gas, food, and lodging sign, and then the signing to the interchange itself with a message for through traffic and for Alexandria and Fort Belvoir.

Mr. MAY. Those are all the signs the motorist will see up to this point to help him.

Dr. HULBERT. Do you want us to break in here?

Mr. MAY. Anytime.

Mr. SCHOPPERT. Please do.

Dr. HULBERT. That green sign, I think, is an example of brevity. There is something to be said for brevity, certainly in not putting too many elements on the sign to be read and having confusion. In fact, the early study that we reported in the previous testimony, the underlining signing study, indicated that as the number of lines of information went up from two to three to four, that the percentage of errors in reading those signs also went up, which is what you would expect to happen.

On the basis of that study and the commonsense involved, there has been a tendency to limit the number of lines on directional signs to no more than four. Here we see four lines and two symbols. It seems to me that here we are being a little bit cryptic, or the authorities that directed the signs were being a little bit cryptic, and have left out what I would call the connective tissue. In other words, that sign might say, "Northbound and southbound Route 1."

You see the route shield is so far over to the left, there is a spacing. There is a layout and there is a choice of words and letter sizes here that I think the advertising people have learned to live with. Perhaps some of the graphics people that have been called in on the graphics task force, Highway Graphics and Communications Task Force of the Federal Highway Administration, can help us a little bit. I think here is a good example where layout on some of these smaller words and appendages to other words could make it more clear.

Mr. LEISCH. I would like to comment also here. The use of north and south, of course, tells the driver that he can go in either direction on Route 1. The other day we discussed one exit versus two exits designs. Perhaps it is essential here to have both north and south on a sign, because there is a mixture of types of interchanges along the route. Some are two-exit and some are one exit. But if a one-exit design were adopted universally, it would never be necessary along the high-speed facility to use the words "North" and "South" or "East" and "West." You would only use the route. Thereby you would eliminate two words.

Another suggestion I might have here is the word Alexandria, perhaps could be larger and Fort Belvoir subordinated. I am not sure

that is really correct, but the idea is that frequently when one destination is more important than another, that technique helps toward comprehension. Even on a sign at a distance, the larger word would come into focus first. I think it helps the approaching driver to sort out the messages. Then I have a question. How far is this sign from the actual gore point?

Mr. MAY. Mr. Schoppert, could you estimate that?

Mr. SCHOPPERT. It is really quite close. It is probably on the order of a quarter of a mile. No more than that, I would say.

Mr. LEISCH. I would like to comment on this point, too. I believe that some of the destination signs are entirely too far away from the gore point and probably so in the film that we saw earlier—I am not sure because I did not see the signing there. But frequently the destination signs are too far in advance of the actual gore point. The driver, when he finally reaches the actual physical exit point, 10 or 15 or 20 seconds later, may have forgotten or he is not quite sure whether this is the point of exit and all he sees is the word "Exit" or some shields. I think that can be very distressing.

I believe, particularly in the urban areas, that the destination signs should be right with the exit itself, just above the gore point where the driver can see the destination and at the same time he can see the word "Exit" framed in below it. He has his confirmation right there, assuming, of course, that he had received an advance sign of a very similar nature which did the job for him. I don't think the sequence here is exactly right, and I personally believe this is where some of the problems are.

Mr. MCGRATH. Mr. Schoppert, if I remember the description of the interchange, that ramp is the only way out of this main highway in this direction. It leads to both directions on Route 1 plus a minor road. I see no evidence that this is the fact. I see a traffic sign that doesn't tell me what highway that is.

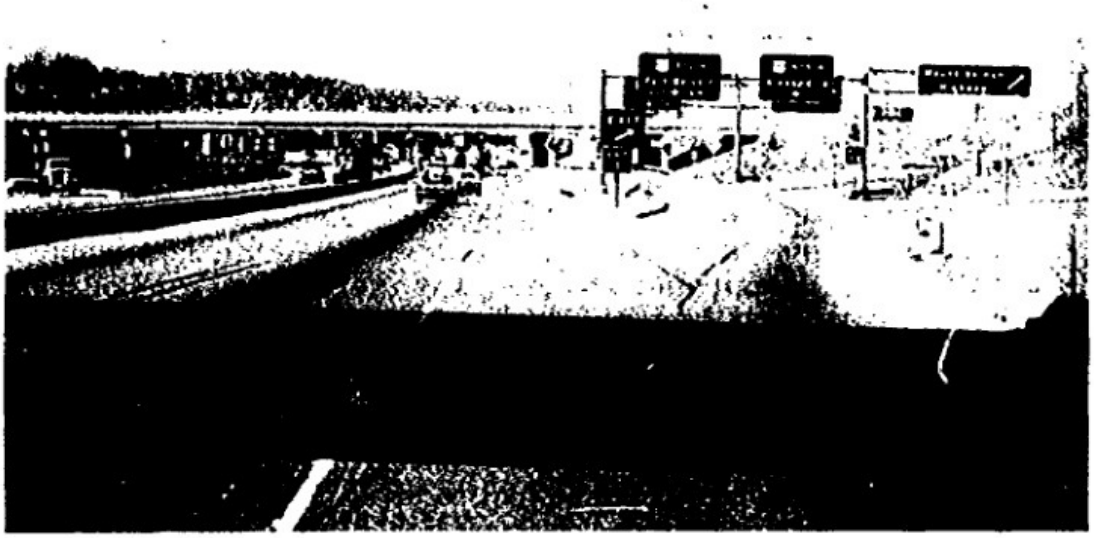
Mr. SCHOPPERT. That is U.S. Route 1.

Mr. MCGRATH. I think the combination of all those signs gives both misinformation and then insufficient information. In fact, it is no wonder somebody doesn't know what to do when he reaches the gore.

Mr. SCHOPPERT. It is also a problem for the fellow who doesn't want to get off here and happens to be in the right lane when he passes at this point. I think someone might comment on that. There were a number of unusual maneuvers that we saw of people trying to get through, not trying to exit.

Mr. LEISCH. With regard to the lane trap, I think there is a problem of sight distance. The driver isn't completely aware that there is that lane drop. Another problem is lane balance that we discussed the other day.

Mr. MAY. Yes. Could we go to the next slide? I think we get a better view of that area.



Mr. LEISCH. Here we see the actual lane trap. The right hand lane isn't trapped. The middle lane should be an optional lane. The striping doesn't seem to be correct or conventional at this point. So the right-hand lane could be a drop and the middle lane would be an optional lane, but I think the drivers are forced into a situation where some of them are required to cross from the middle lane a sort of barrier line when that really isn't necessary if it were marked another way. Then also there is need to designate the lane drop in a more pronounced fashion in advance.

Mr. MAY. Up to this point, there has been nothing, signwise, to suggest to the motorists that they are going to drop their lane or that they are in a trapped lane.

Mr. WILSON. Since that was designed and built there have been a lot of improvements in basic highway design. You could continue on this lane here, the one that drops, for another half mile.

Any highway department—in fact, probably all of them—would now be designing this on the basis of taking this lane on down at least a half a mile and then merging it in with the right-hand lane of the through road here. However, there is no indication as far as the average driver is concerned that there is a lane drop here at all. In fact, that through traffic sign doesn't tell me, in my opinion, that there is a lane drop here. That would be only subtle indication there is.

There is a way to handle this. It is not the best way in the world, but it seems to me to work better than nothing. That is the use of "Exit Only" and the use of a yellow panel in connection with the green background sign overhead. In my previous experience we had, I guess, a dozen of these situations in California and we improved them drastically by the addition of a plate that said "Exit Only" with a yellow background. This could be done here.

I agree with Mr. Leisch that that sign there, the action sign, should be somewhere between the beginning of the taper which normally would be around 270 feet from the gore area, say the next hundred feet up the road. But the fact that there is no advance notice here at all, other than this sign, is quite a deficiency, I would say.

Mr. SCHOPPERT. We have a slide showing that "Exit Only" panel, if you would like to talk a little more about it.



Mr. WILSON. As a little background, we are experiencing problems with some of the same type of designs where we actually dropped the lane at an exit. California does not do that any more in their new designs, but they had a few of them they had to handle.

We made some observations beforehand as to what kind of maneuvers were taking place similar to what you have experienced in the films on this earlier this morning. They put up these signs here and there was a considerable improvement. This became a standard method of handling that situation out there.

Dr. HULBERT. At UCLA, as you know, we tried to generally indicate the effectiveness of this "Exit Only" sign in a very crude simulation device called a sign tester where the driver looks at an 18-inch-wide roll of paper that is moving toward him over about a 4-foot-wide travelway, and he has a little steering wheel. Our study was not conclusive. We didn't have the color on the drawings at that time. We do have it now and we will be doing that again.

I interrupted here only to mention that in the field studies that Mr. Wilson referred to, conducted in California, as a criterion of the movements of the drivers, they adopted an approximate 700-foot distance from the nose of the gore. Any lane change within 700 feet of the nose of the gore was deemed a last minute lane change, which I

thought might be useful. This was just their opinion from standing up on an observation point and looking down at the traffic, in much the same way as your earlier films showed.

Mr. McGRATH. Mr. Chairman, I would like to amplify what I said about the other sign. This sign setup shows Interstate 405 in San Diego. I think the driver knows that he is on 405 and wants to use it. But he knows he is heading toward San Diego. He doesn't know and he doesn't care whether it is through traffic or not, especially in an unusual situation. I doubt that anyone going to San Diego who desired to use 405 would get lost here. That other sign reading "Thru Traffic" would be meaningless and wouldn't help.

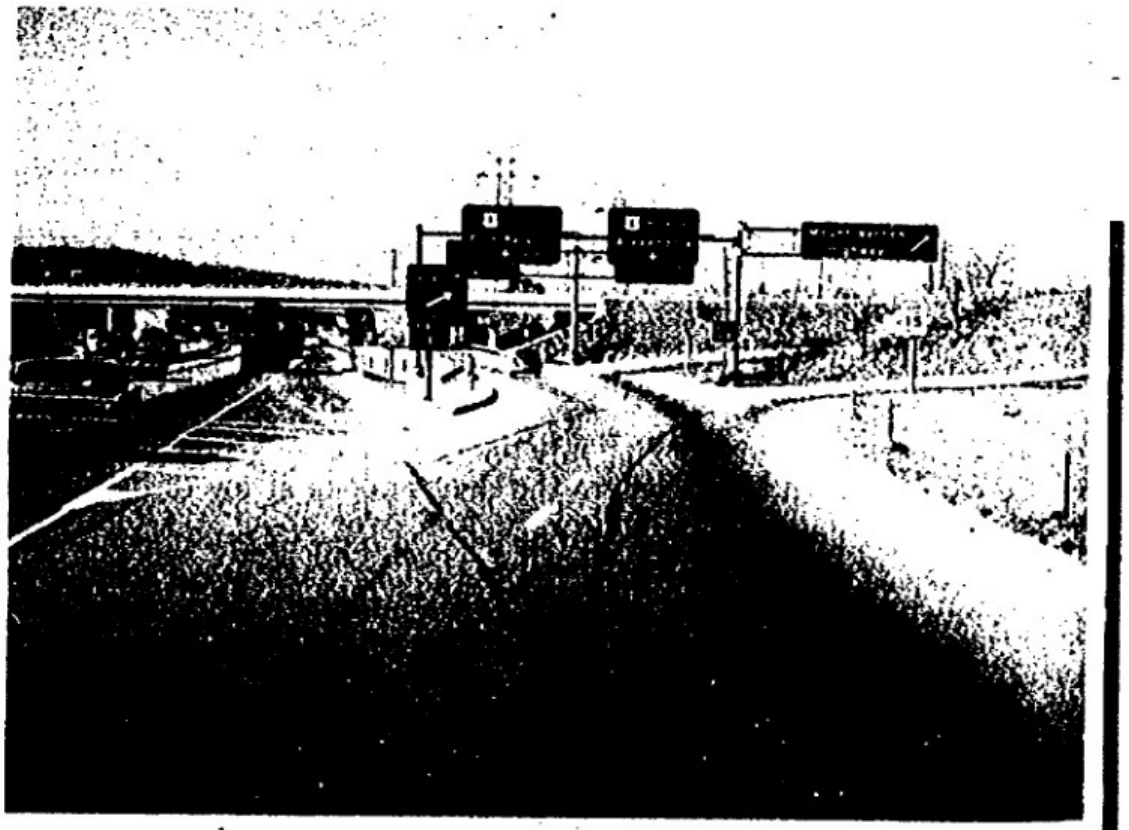
Mr. MAY. That seems to the staff to be an excellent point. I guess your suggestion, Mr. McGrath, on that other sign, would be that it should say 495?

Mr. McGRATH. That is right. Tell the drivers something. Why use up the sign on a couple of words when you could tell him something while you are at it?

Mr. MAY. If, instead of saying "Thru Traffic" that said 495, that would satisfy you?

Mr. McGRATH. Yes. He may not know what through traffic means. Maybe the other traffic is through traffic.

Mr. SCHOPPERT. I think one of the principals we developed back in 1958 is appropriate here. You have to think about what the driver might interpret that to mean, both positively and negatively. He may very well interpret that sign to apply to people who are going on to Richmond or to some sort of remote place, whereas he is really through traffic, but in this one mile of the road he is local traffic in his own mind. And so you have to consider before you say anything whether they will interpret it right or wrong, positively or negatively.



Let's look at the signing at the gore itself. This is exit 1. The advertising in the area, particularly by real estate people, by car salesmen, and by any number of commercial enterprises, will give directions to their locations saying, "Take the Beltway and exit 1 or take exit 12." Then it will give more detailed instructions from there. This is a very common use in this area because all the exits are numbered. A number is one thing that many strangers, as well as local people who were looking for a place for the first time but live in the area, are seeking, and it appears here on the gore itself.

Mr. MAY. Mr. Mathes, perhaps you can help us. We have noticed so often that a lane was dropped at the gore area. Has a change taken place in the thinking of the highway engineer when it comes to a dropping of a lane at the exit point?

Mr. MATHES. Yes, I think so, as Jim Wilson mentioned a little bit ago; for example, in California and other States, too, they have changed their designs now, I believe, so that there is an extension of the lane that feeds the ramp through the gore area for some distance. I believe a distance of 600 or 700 feet is mentioned. This particular distance would have to be varied, I am sure, depending on the interchange type and the area in which you might be operating.

Mr. MAY. Could we say that it should be a cardinal rule in highway building that you should never drop a lane at that point, that you should always provide an optional lane?

Mr. MATHES. Yes, I think so. You might have an unusual circumstance somewhere, where you would be unable to do it. If this is the case, then I think you have to go far enough in advance of the interchange and in some manner make it very clear that the lane which you are in must exit. This has been done in those cases, as was illustrated in the slide on California, where at least for the present they are unable to modify the interchange itself to take care of this. I think there should definitely be an exception and you would have to correct it through other communications means, signing, so the motorists could know.

(Mr. McCarthy assumed the chair.)

Mr. LEISCH. Mr. Chairman, I think we have a problem before us. We are required to have two-lane exits under some circumstances, in fact, under many circumstances today. In urban areas there is a need for two-lane exits. There is a need for two-lane exits in conjunction with two freeways intersecting, particularly the use of the single exit design as California uses, and which I think would be desirable if it were used universally. Whenever there is a two-lane exit, there must be a lane drop. There is no other way in order to achieve proper operation. It is first of all to develop the full capacity, and secondly to allow the junction or the point of diversion to operate smoothly.

The need to build up an auxiliary lane from time to time is essential for capacity reasons and operational reasons as traffic builds up. And that particular lane is dropped. The through lanes or the basic lanes are maintained throughout.

Those are the ones that must not be dropped under any circumstances unless it is a very special case. But auxiliary lanes must be added and they must be subtracted. There are only two ways of doing it. One is to take it off at a ramp exit and another way is to actually pull it in, and drop it completely out in the open with proper notice. In

order to achieve this type of balance it is necessary to do this dropping with the auxiliary lanes.

Mr. MAY. At this point, then, we should approach this area with an added lane?

Mr. LEISCH. No not necessarily. If we had approached it with three, that is fine, and then you have four going away. You have one more lane going away. That isn't balanced.

The only difference here that would need to be made to conform to that is that the middle lane of the three approach lanes would be purely an optional lane where the driver would have the full freedom of either going strictly through or going onto the ramp. The extreme right-hand lane would go right off on the ramp. However, it has to be sufficiently flagged in advance and then the signing has to indicate as well that that lane is going off.

Then also the lane marking, or some indication on pavement, must indicate it. Since we are not using contrasting pavements for auxiliary lanes anymore—it is a difficult thing to do—then I would suggest that an additional type of lane marking be introduced which would always designate that it is an auxiliary lane. This additional lane marking may be of a different character than our 25–15 spacing of the regular lane lines. It may be a stubby line, but perhaps 12 inches wide rather than 4 or 6 inches wide.

Mr. MAY. That probably is a real need that still exists in the Nation in an attempt to identify for the motorists that optional lane, is that right?

Mr. LEISCH. I think so. I think one of the worst things we can have is a single lane that traps or goes right off, and then I think there must be a recovery at some point to carry that traffic through. I agree with Mr. Mathes on that situation.

But where there is a need for two lanes, there is no other way out. A lane must be dropped to achieve proper balance and to develop the necessary capacity at those points. So we have to figure out just how to do this, but not arbitrarily dropping it because I think we will get ourselves into trouble in some other way.

Mr. MAY. What would have been the philosophy behind this lane drop? Was that based on projected volume of traffic leaving the freeway at this point?

Mr. LEISCH. Yes, let us say a two-lane exit is required for capacity reasons. In other words, a normal single-lane action which does not drop a lane, may be inadequate in terms of handling the amount of traffic that is exiting. So in order to provide a much larger volume to exit—that is, the need—then there is a requirement for a two-lane exit. To have a two-lane exit there must be a lane dropped, or so to speak. But that lane that is dropped is purely an auxiliary lane and is not a through lane.

Mr. MAY. You would carry a basic three lanes?

Mr. LEISCH. In this particular case I don't know what happened on the approach. I don't know whether that third lane approaching the interchange was sort of a through lane.

Mr. MAY. Oh, yes.

Mr. LEISCH. Then it should never have been dropped. Then three lanes should have carried right through and a fourth lane should have built up here if a two-lane exit is really required for capacity reasons.

Mr. MAY. Mr. Wilson?

Mr. WILSON. The problem of signing an optional lane certainly still exists. I know of one thing that has been tried and I don't know how successful it was. That is, at several points in advance indicating the exit by two down arrows, either in a sloping fashion or closing together. It would indicate that you could either exit from that lane or go through from that lane. I don't know whether you have any photographs of that or not. This has been tried on a highway leading into the downtown Los Angeles area.

As far as the two-lane exit situation is concerned, if you add to the two lanes that are going through, then at a sufficient advance distance, you have to have the proper signing to assure that everybody that is going to exit will be in one of those two lanes that you have added. If not, then you have to drop the right-hand lane in that situation, but you could certainly carry the one that is nearest the through traffic on through, as Mr. Leisch has suggested.

It looks to me like this whole design was built around some rather cramped conditions. The structure that you are standing under in this picture is rather short but it looks to me like they tried to fit this thing in here under rather close conditions.

Mr. SCHOPPERT. I think that is true.

Mr. MAY. Dr. Hulbert?

Dr. HULBERT. I have asked Mr. Schoppert, and he says this is the first time that the motorist sees any sign telling him that there is a turnoff to the Mt. Vernon Highway.

Mr. MAY. Yes.

Dr. HULBERT. For the stranger who is looking for that, that seems like kind of a last-minute notice. Of course, the decision points here are very close together, certainly much closer than would be desirable from what we know about the time it takes humans to make up their minds and execute their decisions once they have made up their minds.

Mr. MAY. Yes, this is a 60-mile-an-hour highway up to this point. It is about to become 65 miles an hour. You will notice a sign on that exit ramp saying 15 miles an hour. You take a truck moving 60 at this point and he has great difficulty getting down to 15 to take that ramp. Continuously we see the delineators there have been struck down.

Mr. MCCARTHY. Speaking of trucks, Mr. Wilson, as you know, large trucks are involved in over 10,000 of the deaths on our highways each year. Of the 53,000 deaths, in over 10,000, trucks were involved. That is close to 19 percent even though they represent only 7 percent of the registered motor vehicles. Here is a question I have had.

I am not alone in this and I have had people say this to me within the last several days when publicity about these hearings was issued in connection with another bill that is pending before the House, passed by the Senate and by this committee, with the endorsement of the Federal Highway Administration.

That is a bill that would permit tripling the size of trucks and doubling their weight. The question is, how can your Administration be serious about safety when you come in here and endorse a bill like that? Could you answer that?

Mr. WILSON. That is a difficult situation, Congressman. I understand truck drivers have very good driving records, but when they do get

into a problem it is generally a serious problem. I personally am a little apprehensive of the lengthening of vehicles on the highway. Of course, from the standpoint of being an engineer, I am very concerned about the destruction to the pavement itself from heavier loads. That is about all the comment I would care to make on that question, Congressman.

Mr. McCarthy. You personally. That doesn't represent the views of the Federal Highway Administration.

Mr. Wilson. I am here today, Mr. Congressman, as a representative of the National Joint Committee and a representative on that committee of the American Association of State Highway Officials.

Mr. McCarthy. You are not here in your official capacity?

Mr. Wilson. No, sir; I am not.

Mr. Schadeberg. What would you consider an ideal exit?

Mr. Schoppert. From my own point of view, from the studies we have made, I would consider an ideal exit one where all the traffic leaving the freeway for that particular interchange would leave at one point, and one point only, and that there would then be, beyond that point, adequate time between the successive additional decisions a motorist might have to make, as in this case whether to go north or south on Route 1. This would be adequate spacing of those points out of the main roadway on some kind of collector-distributor road or auxiliary road, or whatever you want to call it, where you make those decisions one at a time.

Mr. Leisch. I would strongly endorse that, Mr. Chairman.

Mr. Schadeberg. I think that is a good suggestion. It seems that when you go off the main road you should have the opportunity and the time to turn off to your right, or another opportunity to go back onto the highway. It would be very helpful.

Dr. Hulbert. Speaking from the viewpoint of the motorist, which is what my profession is all about, I would say that the concept of an ideal interchange should be ideal to the motorist. There may be many configurations that would make it ideal to him, but the criteria should be things such as this, that the motorist makes his moves with confidence. Many miles prior to this—in fact, through his entire trip, he should know where he is relative to where he wants to go.

We have seen the motorist display a lot of skill in avoiding some of his confused fellow motorists. He can learn to live with a great many systems, but he must have this confidence as to where he is relative to where he wants to go.

Mr. Schadeberg. Would you think it would be advisable to have a safe way of correcting a mistake?

Dr. Hulbert. Yes; a safe way of correcting a mistake or, as I mentioned earlier, the consequences of a mistake would not be as horrifying as they are now in terms of the terrible uncertainty. A driver who makes a mistake will make it, let us say, confidently. Then he will find out about it and he will be able to correct that mistake without having to go many, many miles out of his way or get into several other areas of indecision.

Mr. Schadeberg. At that point, instead of having to back up he should be able to either go ahead and go back on the highway or make a correction by going back off.

Dr. HULBERT. I am confident the drivers will not back up and then do those hazardous things if they have a safer alternative.

Mr. SCHOPPERT. I think it takes a good deal more than just the opportunity at that particular interchange. I think one of the things that makes signing inadequate is a lack of confidence on the part of motorists in what it says and a lack of confidence in their ability to correct if they do make a mistake. Dr. Hulbert very accurately says that the consequences of error are what makes them do things that seem to us to be irrational, to take risks that are out of all proportion to what appeared to be the gains they will get.

You can't solve it by one intersection alone, but by making every intersection have these opportunities to correct, having every interchange complete so that people can turn around and go back if they make a mistake. There are a great many places in this country where you can get off the freeway and you can't get back on in either direction. There are a great many of them where you get off and you can't get on to continue on in the direction you came from. So I think it takes more than just the design of each interchange. It takes a system.

Dr. Hulbert says motorists can learn to live with a system, almost any system, and they probably can, but I don't think they can learn to live without any system at all, and I think we are sort of getting close to it now in the way the system is developing and the way the signs are being placed. There is really some lack of system here. The system isn't complete. That is what is throwing them.

Mr. WILSON. This system starts back when the strange motorist starts planning his trip. He should be able to look at maps and make some reasonable determination when he gets to a point where he wants to make a change in his direction that he will find what the maps say he will find. I think the performance at any one gore area starts back then, and it certainly starts 1 mile or 2 miles in advance of the actual exit point when he starts to pick up the signs that he expects to see, the signs that he is not familiar with.

Mr. MAY. We have had previous testimony stressing how important it is that the motorist be able to relate what he sees on the map to what he sees on the highway. Here is a situation where a motorist might have looked at his map, and he knew he was going to cross the Woodrow Wilson Bridge and he wants to continue on I–495 but there is nothing on the map or on the highway to tell him they are about to drop the lane. All he saw on the signs was "Through Traffic" and "Alexandria," so he is confused, even though he prepared for the trip properly as we would hope he would.

Mr. SCHOPPERT. In connection with this beltway study, we collected a good many maps from various sources and examined them to see how good a job a motorist could be expected to do in preparation for a trip. I must say he can't be expected to do very well if the maps we collected were at all representative of what is available. They are inaccurate, incomplete, and out of date. They are at such scale that, very frankly, it is impossible to determine from them what you might encounter on the trip. They show interchanges as though they were complete interchanges but in fact they are only parts of interchanges. They show roadways under construction which are complete. They show roadways complete which are actually under construction. It is really a very difficult thing for a motorist looking for the information he has

at hand to plan a trip and to understand what he is encountering as he goes along.

Mr. MAY. We add to the motorist's uncomfortable feeling when we put up signs saying "Food, gas, and lodging, next three exits." A person coming down from New York can just about reach this point in certain types of cars on one tank of gas. The motorist is about out of gas and he goes up the first ramp and into Washington Street in Alexandria and he gets gas. Now he has great difficulty in getting back to continue west on the beltway. There are no signs in Alexandria on Washington Street today which would guide the motorist back to the freeway.

Mr. LEISCH. The system could be very greatly helped, of course, by utilizing more or less a single exit always on the right. That being the basis, then the driver in planning his trip would always know; always if there are full interchanges of the same kind except in very special cases. Then the driver would know he would always exit on the right; he only has one exit and when he reads the map he would automatically get into a right-hand position as he knows he is coming to an exit, I think that would alleviate many of the problems that we have today.

Mr. MCGRATH. Mr. Chairman, I sympathize with what Mr. Leisch just said, and Mr. Schoppert said it, too. But we aren't going to have a system of perfectly designed interchanges. Fellows who work in cities know too well that there isn't the money for the land area to give us perfect design. That is why we are interested in signs.

The signs are what we have to use to make the system work. It would be nice to have perfect interchanges, because if we did, there might be no signs, but just numbers saying this is the interchange you are looking for. But it doesn't come out that way. So I just wanted to suggest that signing is all important because the system of highways will always be imperfect from a design standpoint.

Mr. MAY. What do you have to say about that, Mr. Leisch?

Mr. LEISCH. I wouldn't quite agree with that. I think we do have problems in prban areas where space is very tight and it is very difficult so that we do not get ideal interchanges. From that point of view I agree with Mr. McGrath.

But as to getting a uniform single-exit design, I believe that can be gotten under any circumstances if you really want to do it. To me there is no excuse today, if we want to put our minds to it, for not doing so. We can do it.

Mr. MAY. This was the thrust of your testimony the other day.

Mr. LEISCH. Yes.

Mr. SCHOPPERT. In operating on that for a minute, we are certainly going to have to live with the system we have now for a long time. Signing is going to have to be adequate to serve motorists on that system. In addition to that, I think gradually we are going to cease thinking of interchanges as such, at least in the central cities. As we get more and more into very intensively developed areas and into designs which are combined freeway and private development or public development, either beside, above, below, or all around the freeway, we are coming more and more to a simple ramp connection.

Nonetheless, I think we can still have certain principles which would apply and they wouldn't necessarily produce a design which looks like an interchange today but they would always have right-hand exits and anyone exiting would be able to find his way back onto the through lanes, either in the reverse direction or in the continuation of his past direction.

Signing is going to have to be capable of serving that purpose. It is almost going to be beyond our capability if we go into complex urban systems if we don't have some basic principles to stick to.

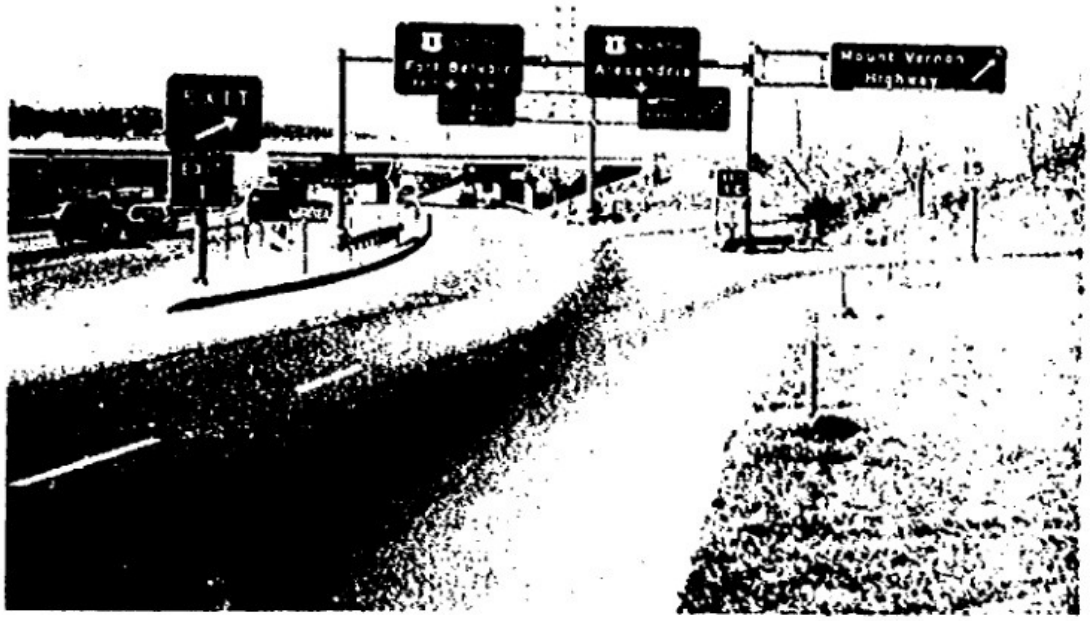
Mr. PRISK. I wonder if we might talk just a moment about the point made very briefly by Mr. Læisch concerning the relative importance of certain destinations on signs. It strikes me that if there is a case, as this appears to be one, where design is in a sense neglecting some of the fine points that might have been introduced under ideal conditions, we might consider here the matters of uniformity and the matter of tailoring the sign to give particular emphasis to the points drivers are required to make judgments on. In other words, if these specific sign installations are signed according to the book, if I may say so, they would be of a particular size and a particular character all the way through. I think we might argue that uniformity in the treatment of particular types of interchanges is desirable and does have value in being recognized.

Especially at this time, where the distances that you have to deal with are short, and where we must have additional emphasis, would it not be wise in such a situation, to increase letter size and to add legibility through that device rather than staying with the standards that we have now?

Mr. MATHES. I might make one comment here. The basic question originally asked was what is a good exit or what should an exit be. I think Mr. Læisch has pointed out that he believes the single exit is the best. I am convinced that if you can have only one exit, this is the best that you can get. I don't believe that you can get it in all cases. I guess I would disagree with him a little bit, although I think you could probably generally do this and it should be done at complicated interchanges.

This is the thing I wanted to comment on particularly. I want to point out that even after you have taken a particular exit, you have three more exits coming up beyond it and I believe you have to give considerable attention to those so they don't come too fast, one upon the other, or you have same same situation that you had before, where a motorist might have to take two separate exits from the travelway itself. I think this is something that does need to be kept in mind.

I think this is perhaps what Charlie was referring to with his signing. After you have entered the collector-distributor road, which you have here, then you have introduced in the signing sequence a destination which you have not seen before, and this causes some confusion.



Mr. MAY. Thank you.

Mr. SCHOPPERT. Here we have a little closer view of the same series we were looking at a few minutes ago. You will notice that this sign says exit 1, but just beyond you can see the sign which says exit 1–E. That is in relation to the Mount Vernon Highway signing which has already been mentioned. I wonder if the same sort of principle holds here about not changing messages. Is it the same to show exit 1 and exit 1–E? On down, I believe it shows 1–N and 1–S. Or is this a new message, in effect, this 1–E? Does anyone care to comment on that?

Dr. HULBERT. It sounds like you were referring to one of those basic principles in the 1958 study, but it is not a good idea to introduce new information at the point of decision. Looking strictly at the signs, this is new information. The Mount Vernon Highway exit sign itself is new information.

Referring to the maps, if the maps were to say that there were such exits as 1–E and 1–N and 1–S and the motorist had some prior information about it, then in some sense of the word this may be what he is looking for. It would seem desirable to give him some advance information about the fact that he was coming up to this choice between 1 and 1–E, if that could be done.

Mr. MAY. Mr. Schoppert, I have a question. What does "E" mean?

Mr. SCHOPPERT. It is intended to convey that it is exiting to the east. The system as it is used is one plus the initial letter of the general direction in which that ramp goes.

Mr. MAY. That is interesting, because at the moment we are heading directly west. That in itself may confuse the motorist.

Mr. SCHOPPERT. The ramp in this case doubles back and goes back toward the east. Actually, I think it was a very complex situation for the people who had to choose the letters here. They do have one they like to call 1–N, northbound Route 1; one which they would like to call 1–S, which is south Route 1, and then they have one left over.

Mr. MAY. There is no motorist who would want to go east at this point. He would have to go back across the river.

Mr. SCHOPPERT. If he really went east, he would come back across the river; yes.

Dr. HULBERT. Mr. May, that is why I was talking about this appelation of the little word "bound." Eastbound, northbound, southbound, have a different meaning from north, east, south and west. In many highway alinements you are driving into the sunset and you do believe that the sun still sets in the west, but yet according to the signs you are northbound.

One of the arguments against such a long word as northbound and southbound is that it takes up too large a space on the sign. I think that certainly is something to be considered, but that little bit of added material on the sign doesn't necessarily have to be in the same size letters.

Looking at the signs we are looking at here, I can imagine laying out a sign where the word "north" was in the same size letters as you see it, and alongside it in much smaller letters is the little word "bound." Then you would say, what about the legibility? You can't read those little letters from the same distance.

That is not necessarily true because a motorist would soon come to learn that that is what that little appelation means.

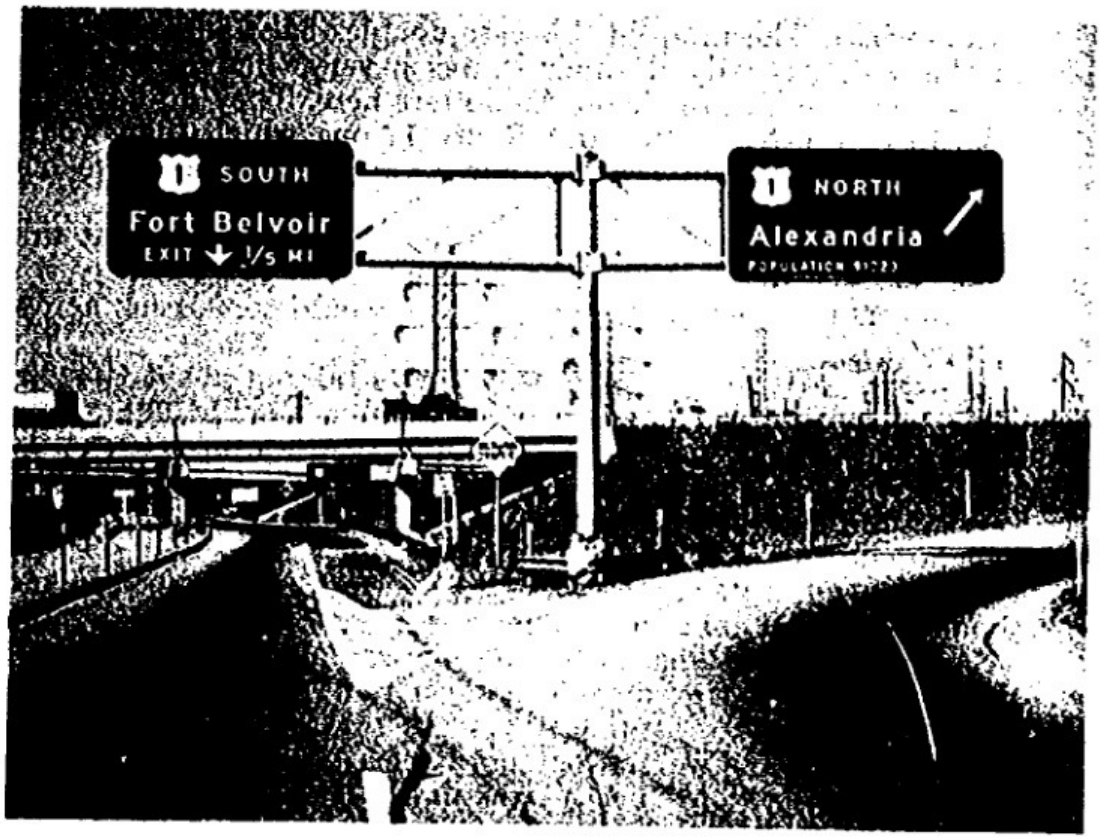
Our study in 1958 indicates that a great many people are confused by cardinal directions, anyway. When the cardinal directions they do see—as in this case—don't agree with what they know to be the location of landmarks or with the sun or with the river, then there is another bit of confusion which I think might be gotten around in this relatively easy way.

What needs to be done is in some way finding out what does that sign mean to the motorist. This is where we get to research and not to just research in an ivory tower way but research closely associated with the decisionmakers, the highway designers, the traffic engineers who do this signing and so on. It should also include the police officers who have to operate this system. They all have inputs and there is really no way of getting a consensus at the present time.

Mr. WILSON. One of the things a traffic engineer should ask himself every time he puts up a sign is what good is it going to do and who is it going to serve. I can see the logic in putting exit numbers on fully controlled access highways and having these numbers here on maps so that he can probably plan his trip, but in this particular case I think the most important thing that faces him at this junction is, is he going to Mount Vernon or not.

I think this section 1–E is some information that is not necessary. Besides, I think the next exit down is not marked and I think there is a third exit here and you can also go east on this. I don't know what they do at that point. Maybe we will find out a little later.

Mr. SCHOPPERT. Let's move ahead and see.



This view is exit 1–N, although I don't see the exit number there. I believe it was there but it may have been removed.

Mr. MAY. Must we put the population upon that sign? It must change. Mr. Mathes?

Mr. MATHES. No, I think the population is entirely unnecessary. I believe that the standards which have been adopted indicate this. It might be useful information somewhere else, but I don't believe at this point it should be up there.

Mr. SCHOPPERT. This might be a good time to point out that signing isn't simply a technical problem, as is the case with building highways and many other things we try to do. It divides itself into the technical considerations and the sort of institutional, legal, and other problems which are attendant to it. Those are not always easy to resolve or even to identify and analyze. Some of the things that you see as you move around on the highway system come from forces completely outside the technical area and are not always possible to deal with very effectively. I imagine Mr. Mathes is very well aware of that in his present position as director of a highway department.

Mr. MATHES. Dave, I missed hearing what you said.

Mr. SCHOPPERT. Sometimes signs say things not because publicly they need to say them, but because there are other pressures. Sometimes signs are located at particular points because there is some legal requirement that they be located there. There are all these other factors that get into the signing problem just as they get into highway location and design problems.

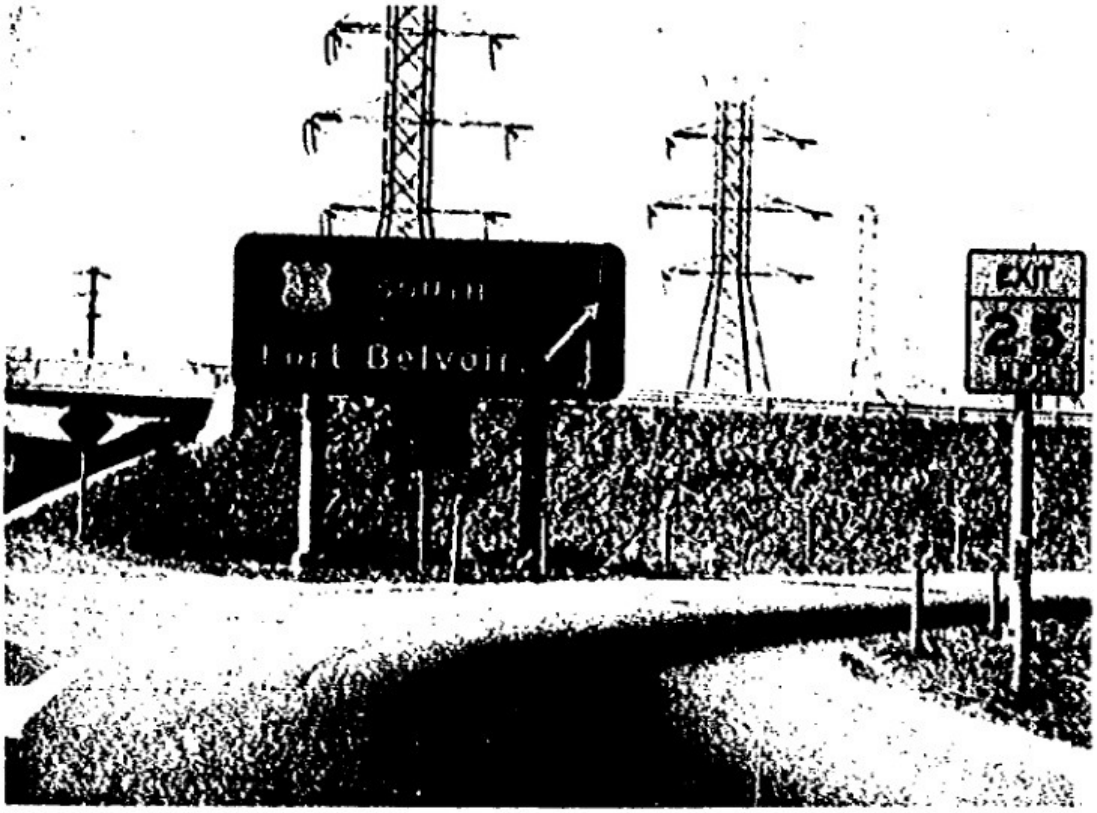
Mr. MATHES. Yes, I would agree with that, and this may be one of those cases.

Mr. LEISCH. This certainly will be the case where the standards wouldn't call for anything like that.

Mr. Prisk made a statement before. The only thing I meant when I suggested using larger or smaller letters is that kind of consideration be given allowance in the standard where it might help to clarify it.

Mr. PRISK. I might point out, Mr. Schoppert, that this is just a chance here that we have U.S. 1 on the first exit on the circumferential figure and they happened to coincide. The figure 1 on the exit and the figure 1 in the U.S. shield have nothing to do with each other. But it is bound to be those factors that help to confuse the motorist.

Mr. SCHOPPERT. Does anyone care to comment further on this? If not, we will move along.



Dr. HULBERT. Can you return to the throughway if you bear to the left here?

Mr. MAY. Straight ahead.

Dr. HULBERT. That is, in a sense, a recovery, isn't it?

Mr. MAY. Yes.

Dr. HULBERT. Is this a collector-distributor with an access to the freeway at the other end?

Mr. MAY. Yes.

Dr. HULBERT. Which isn't always the case. First of all, that should be the case, and secondly, if it is the case, the motorist should be so notified.

I noticed some room on some of the earlier sign bridges for some other panels, and going through my mind as to what might constitute a notice of this sort, I get some kind of wild ideas. Of course, that is the first time I thought about that.

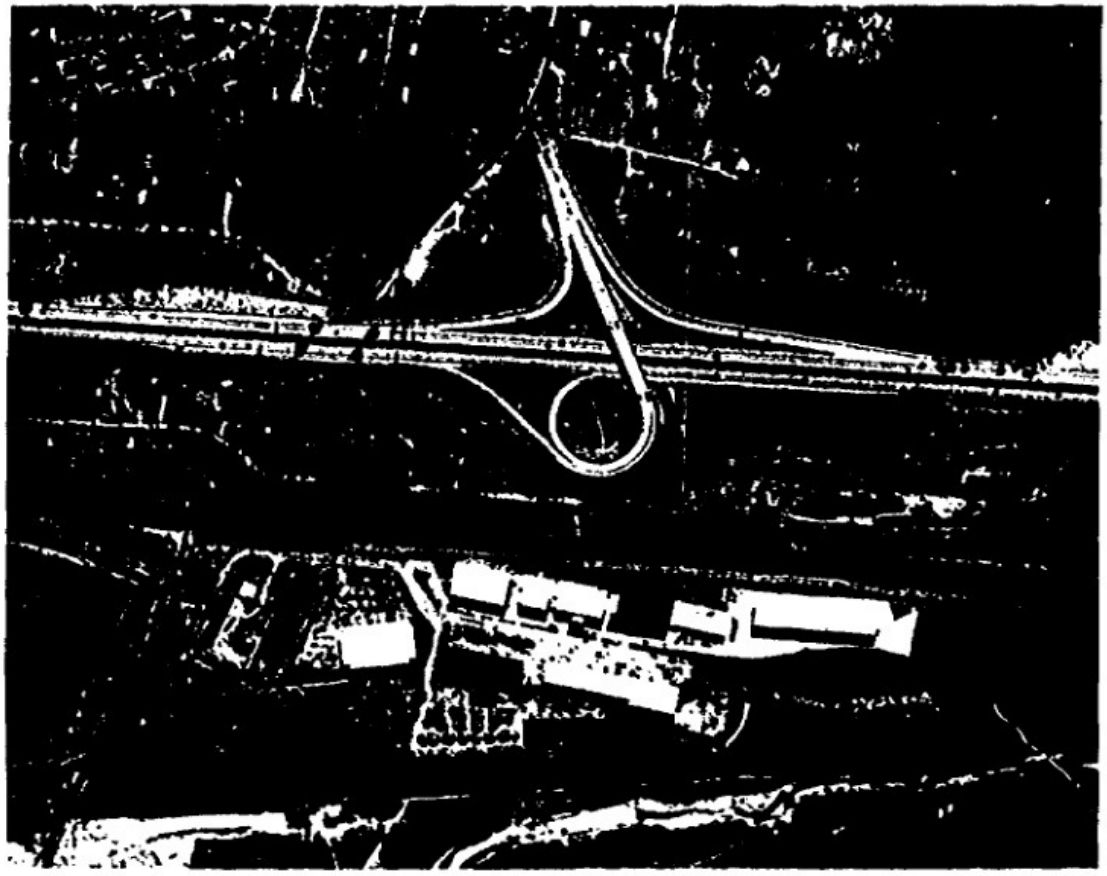
This large sign bridge here has room for one other panel that might bear some kind of notification to the motorist that once he is out here he can get back to I–495.

Here again, just saying that it might be a good idea "to put something up" is not the way to do it. There must be some means for trying it out in a safe way, perhaps in a laboratory first and later on in some more realistic ways; some research tools made available to the engineer. He doesn't lack imagination. He doesn't want to be slavishly conformed to uniform manuals and so on, but what is his option?

Mr. SCHOPPERT. That completes the signing on interchange No. 1 westbound. We have talked a good deal about the relationship of design and ramps and so on to signing and the need for signing to be capable of dealing with a number of situations. I think it might be worthwhile at this point to just look at some slides of the succeeding interchanges and let you see ahead on the beltway what tourists would encounter beyond this point.



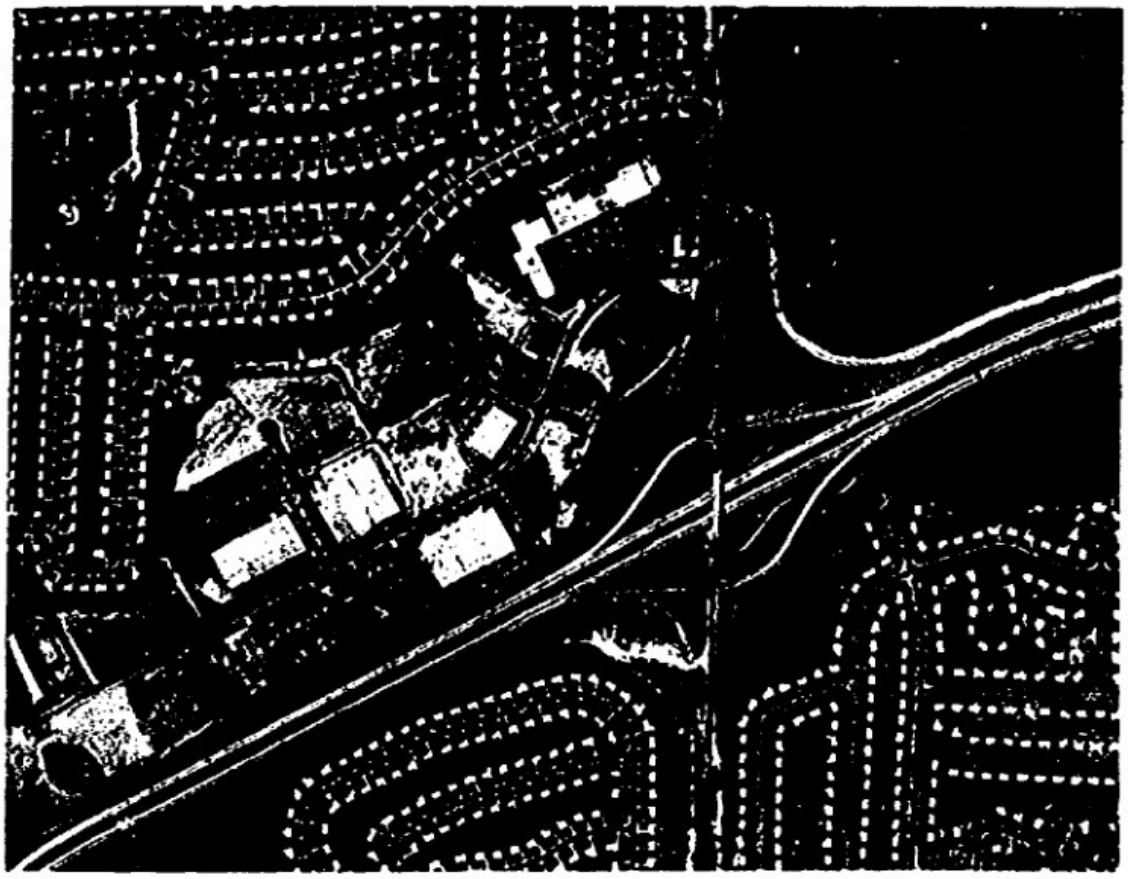
This is an overhead view of the second interchange on the beltway. Like the first, it is a cloverleaf with some modifications. It has a collector-distributor road for westbound traffic just like interchange 1. For eastbound traffic there is no collector-distributor road, but there is a lane drop in that direction and there is a lane drop for the westbound as well.



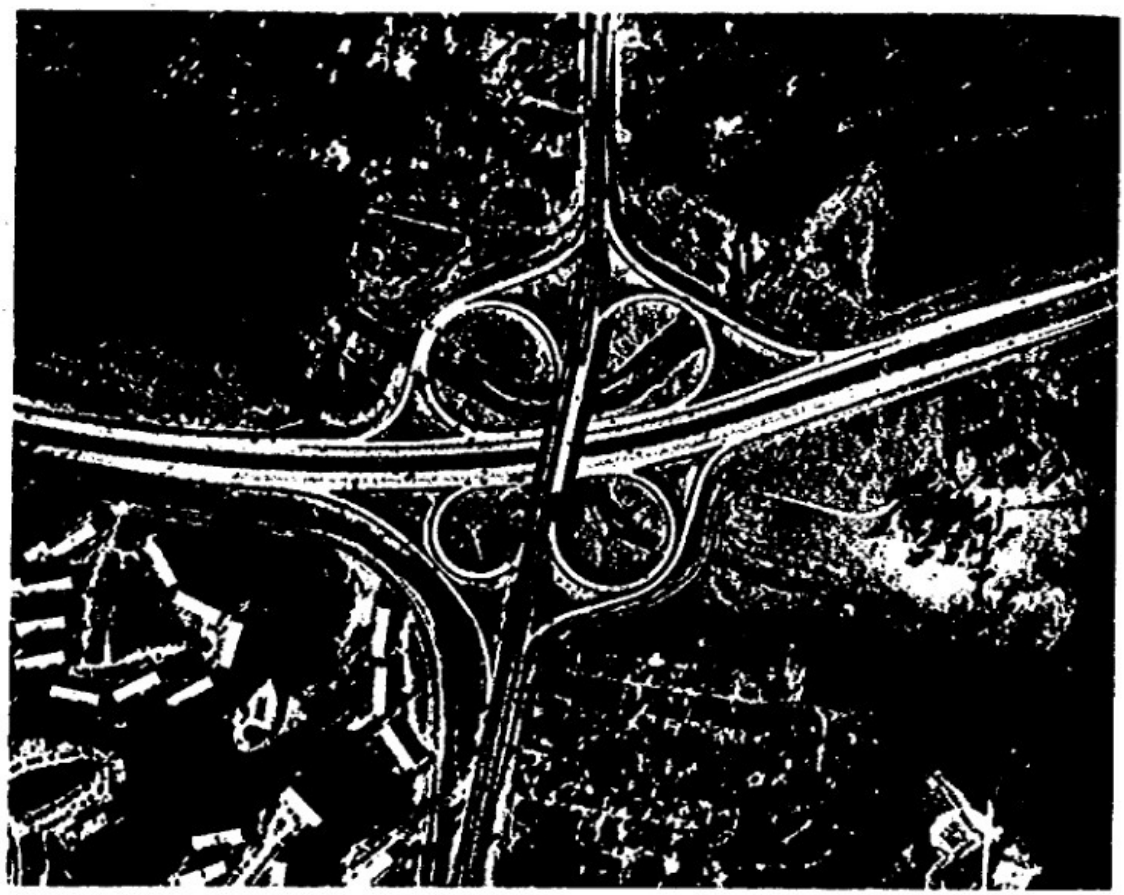
This is interchange No. 3 and it is a trumpet design. In this case it connects to a major street. Due to the topography it is offset from the street it actually serves. In this case everyone does leave by one exit in both directions.



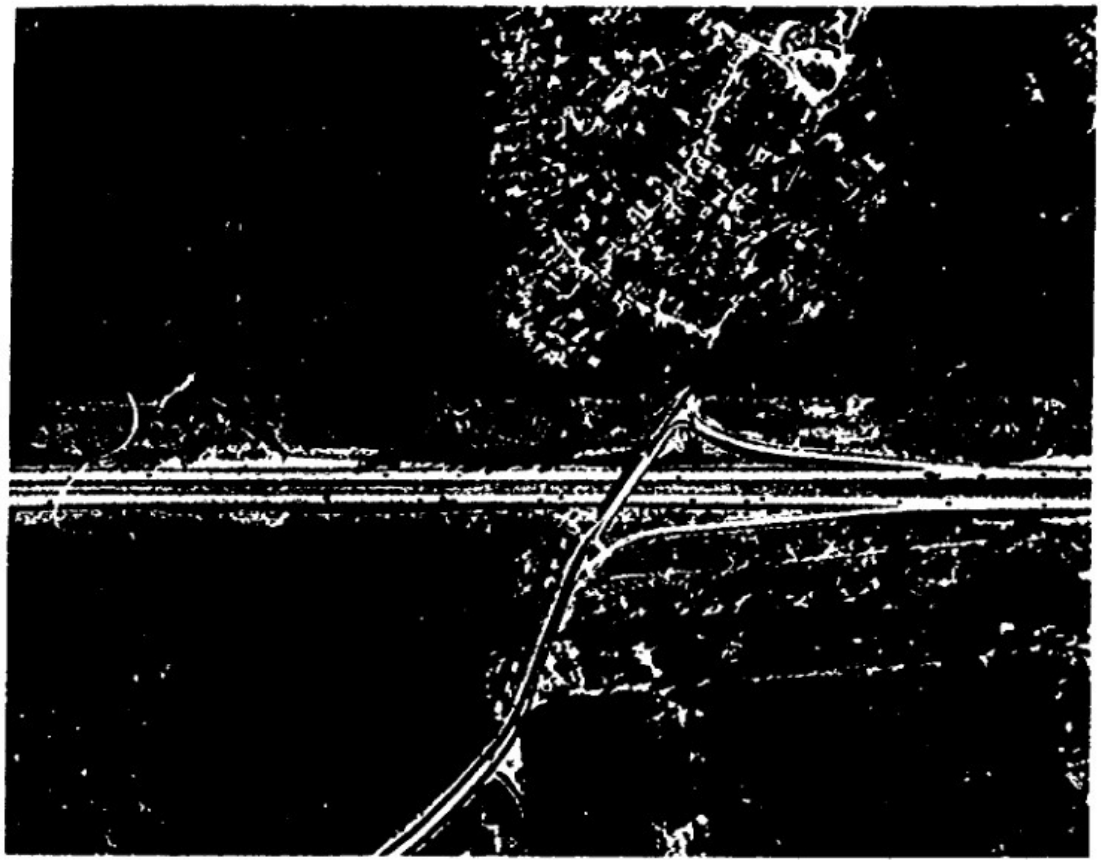
This is the fourth interchange. It is the one from which you saw some movies earlier. It is a freeway-to-freeway interchange. It has some right-hand ramps, some left-hand ramps, some where all traffic exits at one point and some where they exit at different points.



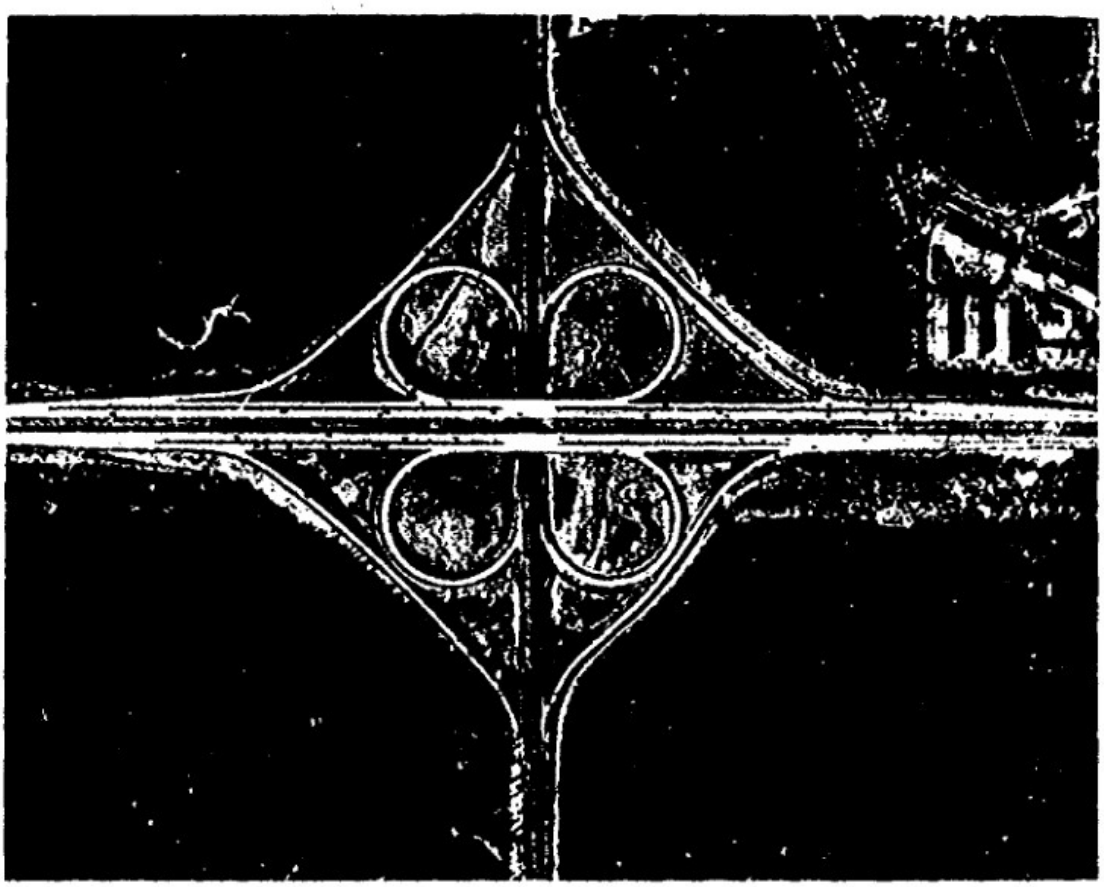
This is the fifth, Braddock Road, a major street in the area, with a diamond interchange. In other words, all traffic exits at one point.



Here is a cloverleaf at the sixth interchange with collector-distributor roads in both directions. All traffic does exit from one point in either direction on this route.



This is a partial interchange, a half diamond to Gallows Road.



There is another cloverleaf, and this is the first time that we have really had a repeat of interchange types in every detail. This is a cloverleaf with collector and distributor roads. All traffic exits at one point.

Mr. MAY. Is that interchange 8?

Mr. SCHOPPERT. Yes; this is interchange 8.

Dr. HULBERT. Interchange 7, the one before that was a half diamond, and what does the motorist do who mistakenly or purposely gets off at either one of these ramps? He can only get off going in one direction. So if he gets off, what does he have to do to get back on? What is the consequence of a mistake, in other words?

Mr. SCHOPPERT. In that case he would have to proceed off to the left on Gallows Road, on up to Route 50, turn right on Route 50, and come back to interchange 8 which we were just looking at.

You mean if he got off coming from the south and wanted to continue toward the north?

Dr. HULBERT. Yes.

Mr. SCHOPPERT. That would be what he would have to do. There may be another way you can wind your way around and get in from the other side.

Now we are coming back to interchange 8 where you can get on in any direction.

Did you have a question about this, Mr. May? This is Route 50.

Mr. MAY. No.

Mr. SCHOPPERT. Let's see No. 9.

Mr. WILSON. Could we wait just a minute and look at that freeway-to-freeway interchange? You mentioned that there were some left-hand exits.

Mr. SCHOPPERT. Yes.

Mr. WILSON. Were there exits inside the freeway ramps? I look upon a freeway-to-freeway interchange as being a branch connection and really you have got a choice to make of right or left, but I don't consider them exits. I just wondered if the exits were mixed up in there.

Mr. SCHOPPERT. Would you like to go back and take a look at No. 4?

Mr. WILSON. Yes, I would.

Mr. SCHOPPERT. All right, back to No. 4.

Mr. WILSON. Are there, in fact, left-hand exits mixed up in this?

Mr. SCHOPPERT. The one from the traffic moving from the top of the picture to the bottom of the beltway, and there is the left-hand ramp, as you can see.

Mr. WILSON. But you don't leave a freeway environment? You remain in a freeway environment all the way around?

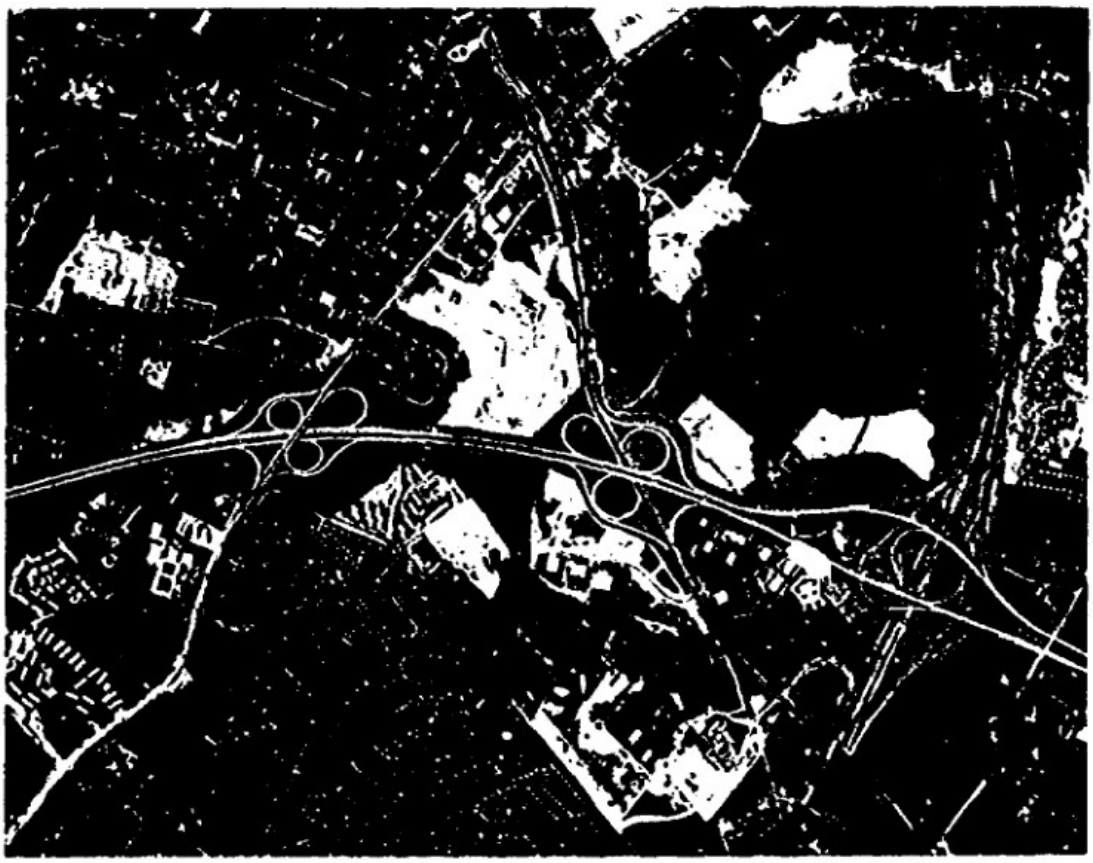
Mr. SCHOPPERT. Yes; they are all freeway-to-freeway.

Mr. WILSON. There have been times when there would be a demand to put in surface street connections inside a freeway-to-freeway interchange, and this can complicate movement of traffic.

Mr. SCHOPPERT. This one just to the south has an interchange very close, just to the left.



In intersection No. 9, as I mentioned earlier, is Route 66 connecting to the beltway. It will ultimately proceed on. It is coming in from the left and will proceed on across the beltway. The beltway is running from top to bottom in the picture. There is a left-hand connection, as you can see, from the beltway to Route 66 and a left-hand entrance as well for the northbound traffic from 66.



Nos. 10, 11, and 12 are shown together. These three interchanges come in very close sequence. This is another design problem of interchanges coming in very rapid order. It also brings out the question about the ability to get on and off in all directions.



Here is a closer view of Nos. 10 and 11. In this case if you were coming south on the beltway, which is the one up and down in the picture, you can get off to the right on Route 123, moving sort of diagnally across, but you cannot make a similar right turn into Route 7, which sweeps across the picture from upper left to lower right.

If you were proceeding down the beltway here and you wanted to get on Route 7 to go off to the northwest, you would have to make your exit at this point because there is no ramp to Route 7 to allow a right turn westbound.

Similarly, were you on Route 7 west of the beltway and you wanted to go north on the beltway, there is no loop in the southeast quadrant so you would have to move on down to the intersection of Routes 7 and 123 and come back down and do that. These pose some very serious problems for motorists, as we discovered by interviewing them in our beltway study. If they were in fact looking for Route 7 and they intended to make this kind of a maneuver, they had to make it back at Route 123. Then if they get to Route 7 without being aware of that, there was no easy way to correct for that problem.

In some cases they go to the eastbound traffic and turn around and we made some counts and found that there was a good deal of that occasioned by the missing ramps. So the ramp that serves the movement which is westbound comes before the point and this makes it very difficult for the driver to correct.

Similarly, initiating a trip here, near Route 7 wanting to go up on the beltway, requires some understanding of the whole area so you wouldn't go clear around Route 123, and come back. When a motorist misses a movement that he might want to make, the idea is that he should be able to go on to the next interchange, turn around and come back—a very simple correction. In this case, if you were to miss this move coming northbound on the Beltway and going west on Route 7, you couldn't go to the next intersection at Route 123 and get off again. This sounds like you are reaching for problems, but in fact this is the kind of thing that builds confidence in motorists, and, as Dr. Hulbert says, let them make their mistake confidently, knowing they can recover at the next interchange.

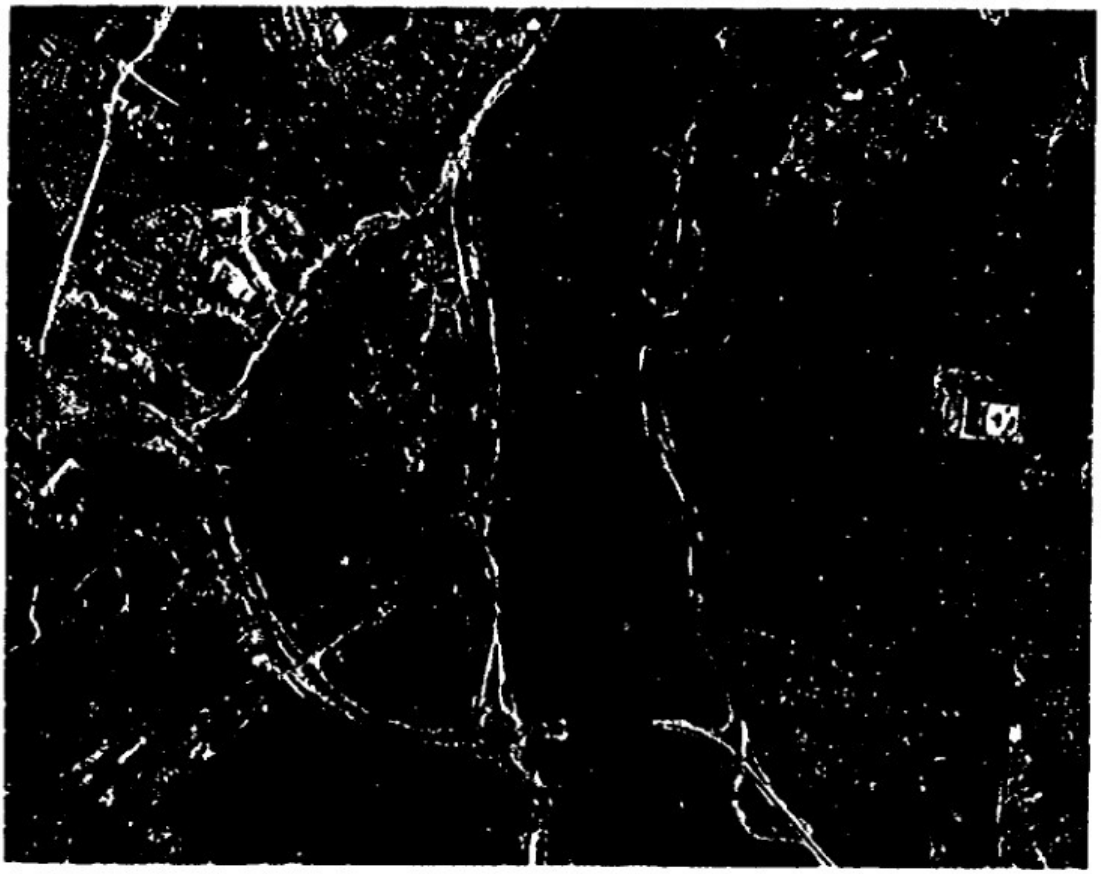
Here is a situation which is not dissimilar from many around the country, where they can't easily recover from errors. They get disoriented. Some of us can remember as children that we played blind man's buff, or you played pin the tail on the donkey. If you wanted to get the fellow disoriented you turned him around about three times and he didn't know where he was going. But when they aren't blindfolded, and you put a man through about three of these loops

he is lost for a long time until he can find a friendly service station or another motorist, or someone who can help him out of his problem.

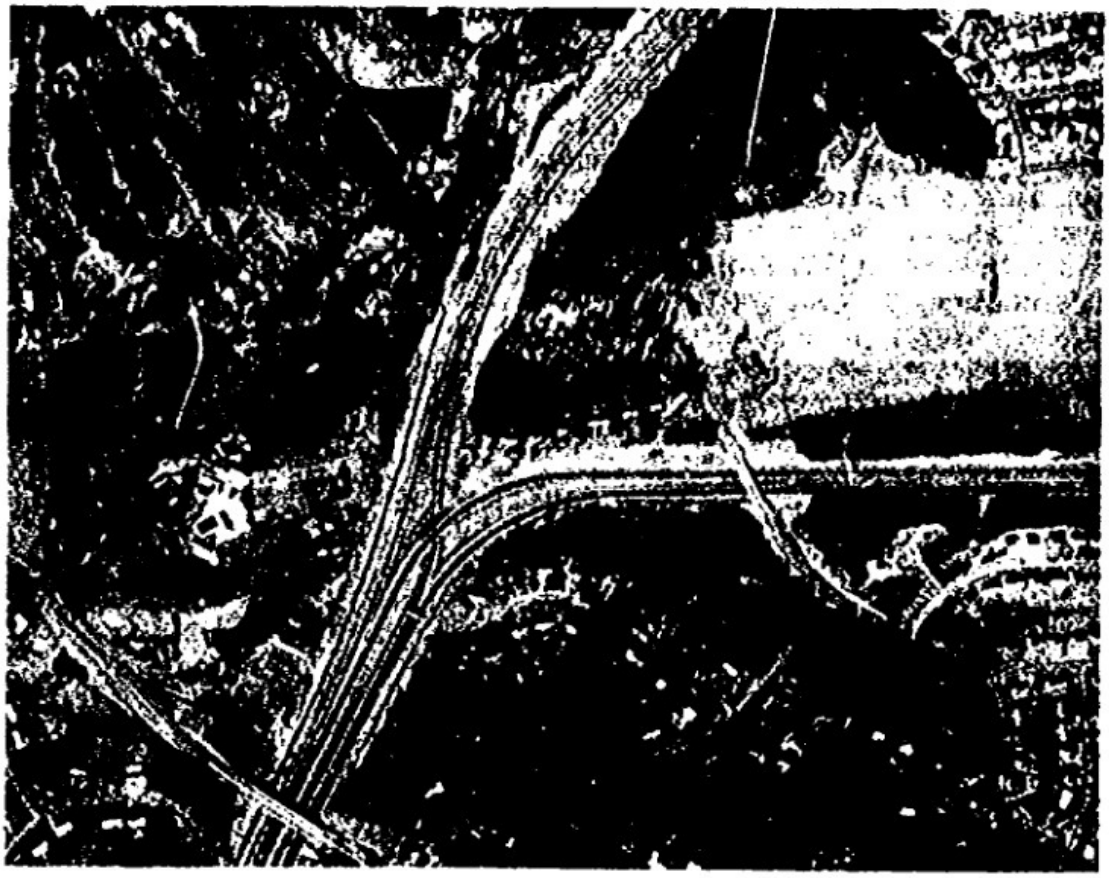
Here, I think, is a classic example of some of the problems we are talking of—ramps missing, and of the burden this places on the driver not to make any errors. If he does make an error, he knows the consequences are very serious. Knowing that, he actually seems to be more inclined to make an error because he is under pressure. I think this is an example of some of the things we talked about earlier.

Dr. HULBERT. Just briefly, there is another very good reason for making full connections at interchanges, particularly in urban areas, and that is that if we are going to talk about alternate routes in the event of congestions or breakdowns of any links in the network, then you almost of necessity have to have all of the movements possible in order to make an alternate route system work.

Mr. SCHOPPERT. We might move around and show some of the other interchanges.



We have skipped a few. We don't have slides for all of them, but here are three interchanges, really, up near the Potomac River, the boundary between Virginia and Maryland. One is a trumpet. One is a rather unusual configuration where motorists actually have to make decisions a long way removed from the Beltway in order to go in certain directions. It doesn't really fit any classic pattern.



Here is a freeway-to-freeway connection, up near the northwest corner of the beltway, with left ramps.



This slide shows three interchanges. Here is the one we saw just a moment ago with left connections. This is a connection with Interstate 270, going up to 70S, with left connections up there. Then there is one in the right-hand corner, at Pooks Hill Interchange.



Here is a closer view. It involves Interstate Route 70–S and Route 495 and the local major street connection.

We can go on around the beltway and look at these and we can talk about this in great detail, but the point is that there really is no similarity to these interchanges with regard to what the motorist has to do as he approaches. They may be complete or partial, they may be left or right, they may be one or two exits and so on. I don't want you to think that this is unique to the beltway, because it isn't at all.

(Mr. Blatnik resumed the chair.)

Mr. SCHOPPERT. We counted some 200 interchange types in Los Angeles, for example, just to see how consistent they are in their designs. We found that there are more cases of partials, mixed things like half diamonds, half cloverleafs, single ramps, in some 22 out of 200 cases. Fourteen of them were freeway-to-freeway interchanges with a great deal of ingenuity and imagination in their design. Although we found a good many diamond interchanges, we found that they all weren't really diamonds in that they had branches and connections, and so on.

I think that makes the point that it is not just here on the beltway that you encounter these things. It is pretty much all over the country. There is an extra burden on signing brought about by this lack of uniformity in design.

Mr. MAY. Do you think we could quickly move into interchanges 10, 11, and 12, Mr. Schoppert?

Mr. SCHOPPERT. Yes, we will be glad to do that. Those, you will recall, were the three where there are some missing ramps. You might want to take a look at them.



This area is known as Tysons Corner. The intersection of the two main roads off to the left of the beltway is Tysons Corner. The white graded area in that triangle is a new shopping center which will shortly be opened for business and the roadway up to the top is the Dulles Airport access highway. This is a freeway which goes only to the airport; there are no ramps to local roads after you leave the beltway. Now we will take a drive through starting from the south at the bottom of the picture.

Mr. BLATNIK. Is that the Leesburg Pike at interchange No. 10?

Mr. SCHOPPERT. That is right.

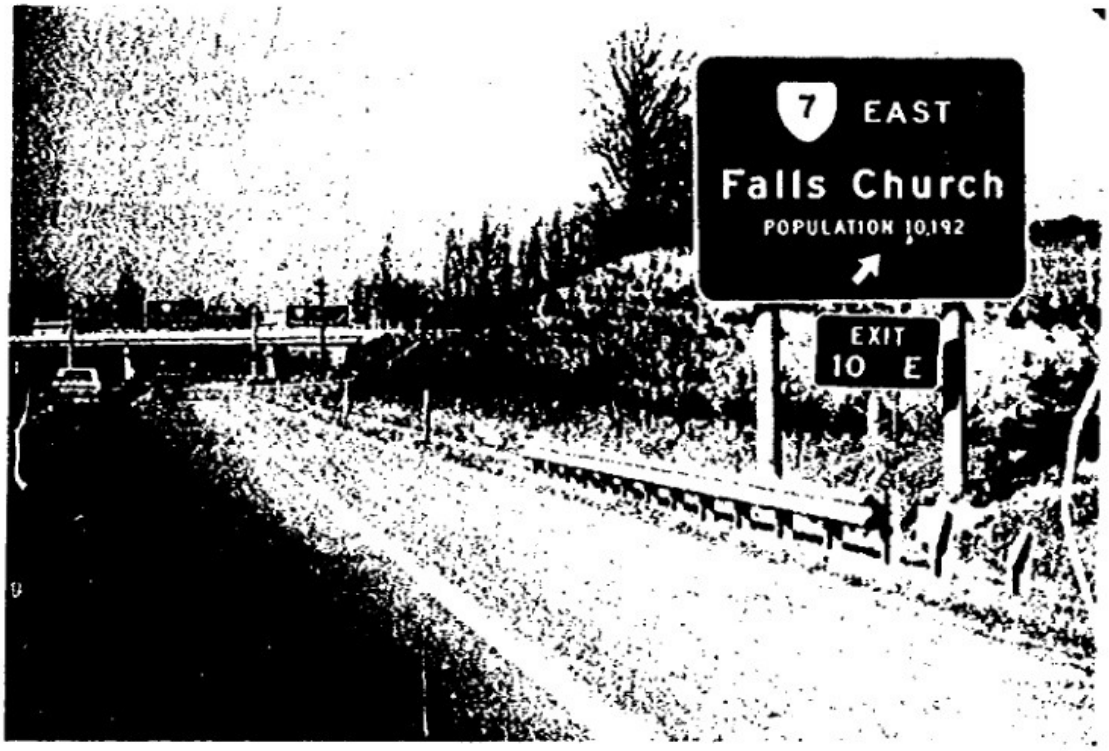
[Movies.]

Mr. SCHOPPERT. The movie we are now showing is moving along the beltway, coming to Route 7, Leesburg Pike. There is the loop up to Tysons Corner. Then you will see a ramp coming in from the right. Very shortly after that ramp ends, the next ramp begins. This will be to Route 123, also called Chain Bridge Road. It begins here and there is a sign off to McLean. You can only go to the right here. This is not a diamond ramp.

Then you pick up the traffic coming onto the beltway from Route 123. Here is the other ramp from Route 123 coming up. There is the sign to Dulles Airport, which is a left exit from the beltway. Here is the Dulles Airport exit. This is the end of the drive-through in that series. You might want to take a look at the signs that you would see in a little more detail.



This is the first notice of the Route 7 interchange, 1 mile in advance. The first exit is to Falls Church, which is off to the right. That is exit 10–E, as you will see here.





Then at the gore there are these signs, Falls Church to the right, Tysons Corner being the next exit, and Frederick being the city off the beltway on Route 70–S. Does anyone care to comment about this?

Mr. WILSON. Not about the exit signs, but about that arrow under Frederick. You don't have to be under that arrow to be going to Frederick. You can be in the other lane. I think the arrow is a piece of information on that sign that is not necessary. It might introduce some lane changing that isn't necessary.

Two slides back, I wondered if everyone got the message that there were two exits. It says "Exits."

Mr. MAY. It is somewhat subtle.

Mr. LEISCH. May I comment on a previous slide? Referring to this first exit sign, which is probably a thousand or 1,200 feet in advance, the use of an arrow on a sign of that sort, to me, might be distressing to the driver, particularly in a rural area where there is no gore sign and the destination sign appears at the beginning of the interchange facility which may be 800 or 1,000 feet in advance with an arrow in it.

I wonder whether we should use an arrow in that form that far in advance of the exit, or whether the arrow itself should not be reserved for the actual exit point. This type of arrow appearing that far in advance may cause confusion. One time I—because there was a small bridge and just the way the shoulder was paved, and a few other things—I almost turned off the road, because I thought that was the exit. I have noticed this many other times and to me this is a bit disturbing. Somebody else might want to comment on this.

Mr. PRISK. It might be worth pointing out, Mr. Leisch, that the philosophy behind the use of the arrow on a sign of that sort is tied into the use of the ramp. In those cases where the ramp is easily visible, it was thought that the use of a sign of this sort with an arrow on it is being proper at the beginning of the taper. Where you cannot distinguish the ramp's location well on the approach, then the sign is dropped back a little farther and the driver is directed to keep to the right.

Dr. HULBERT. Instead of an arrow, you could say "Next Right," perhaps.

Mr. PRISK. That is right.

Dr. HULBERT. It is not so hard to find, in some areas in the State of California, where it was the practice in earlier years to have an up arrow this far in advance, to see the tire tracks off in the citrus orchards and things. Wasn't that discontinued, Jim?

Mr. WILSON. I want to point out here, too, that there are two basic types of exits. One is strictly a taper where you would leave the highway at a certain degree from the main line and the other is adding on a parallel facility for some distance in advance. The kind of exit used in California was strictly the taper. I think it was a diverging angle of 4 degrees and 46 minutes. This sign would appear at about the beginning of that taper, which would place it somewhere about 270 feet from the gore area. We thought that was close enough. It wouldn't turn you into the field, so to speak.

I think here there could be some real problems if visibility is bad or if you are driving with headlights on dimmers at night as most people do. You might not see the gore that far away and it could mislead you.

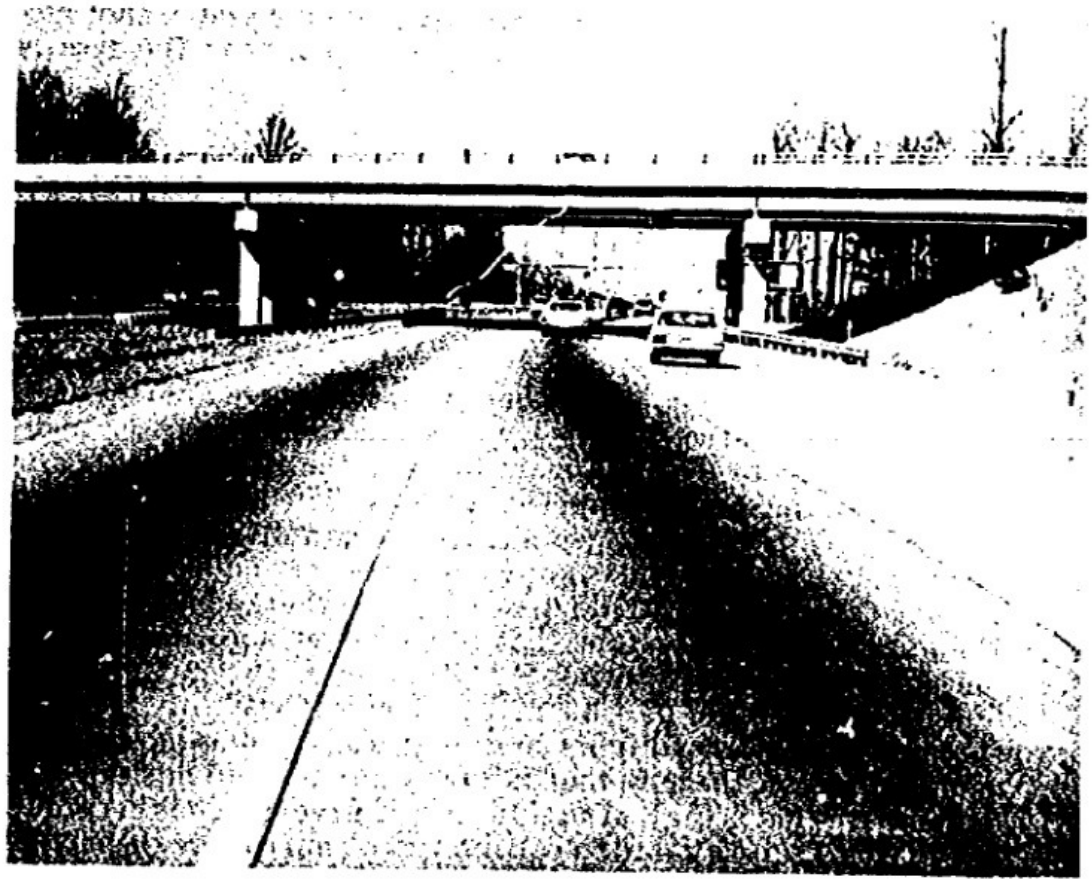
Dr. HULBERT. What is the real significance of Frederick on this group of signs? Is this a substitute for a cardinal direction to give the motorist some reassurance that he is not only on I–495 but is headed in the general direction of Frederick, or is this a major traffic generator? I am somewhat confused because I am not from this area.

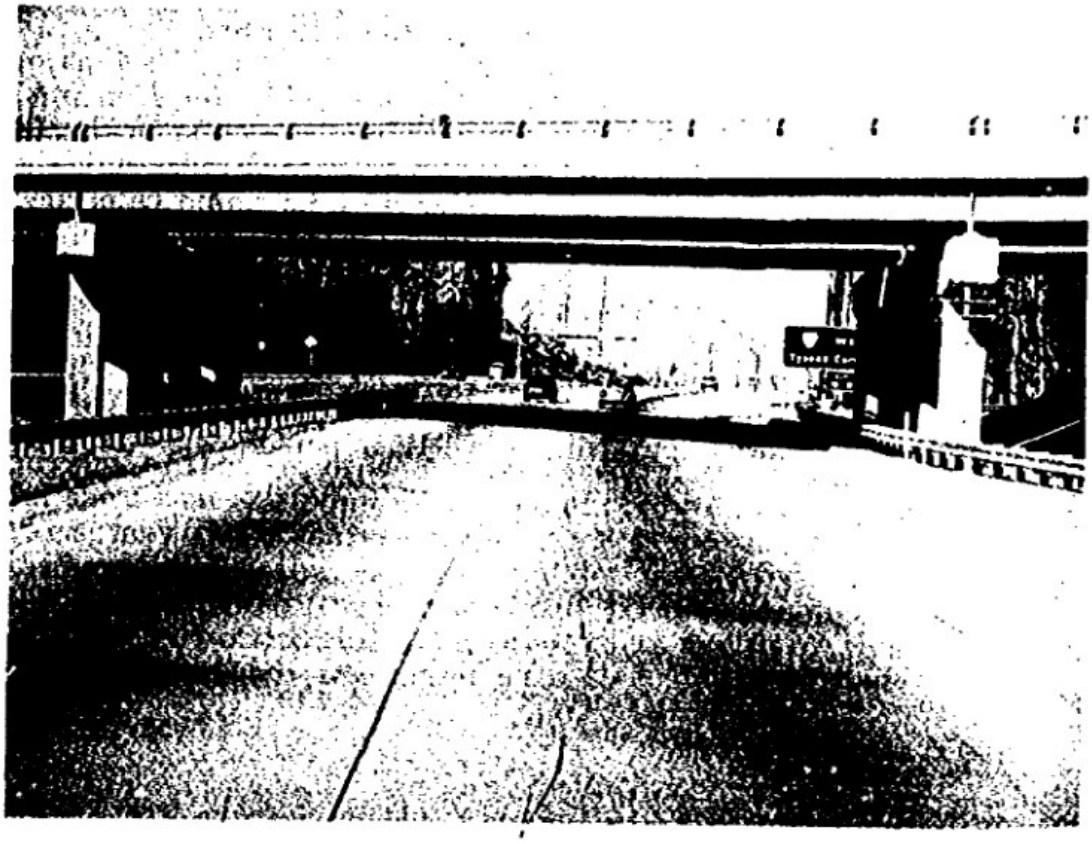
Mr. SCHOPPERT. I don't think you can classify Frederick as a major traffic generator. It was intended as a substitute, really, for a cardinal direction. After all, the beltway has no cardinal direction in that it goes all the way around. Frederick is on Route 70–S. Frederick is the control point for the long-distance traveler since he would be headed in that general direction and this substituted for that reason. I believe it is substituted for a cardinal direction.

Mr. MAY. Mr. Schoppert, we have only a few more minutes left to us this morning. I wonder if we could try to get to these three interchanges, at least northbound?

Mr. SCHOPPERT. All right. If you will recall, from a map of the interchanges we showed that this is where a person who is going

to Route 123, off to the left, would get off because he can't do it at the next interchange. I don't really believe that Tysons Corner represents adequate notice that there is a ramp missing at the next interchange.







This is the loop beyond Route 7. You can see the sign behind the bridge structure. This is the one you would take if you were going to turn left to Route 123.

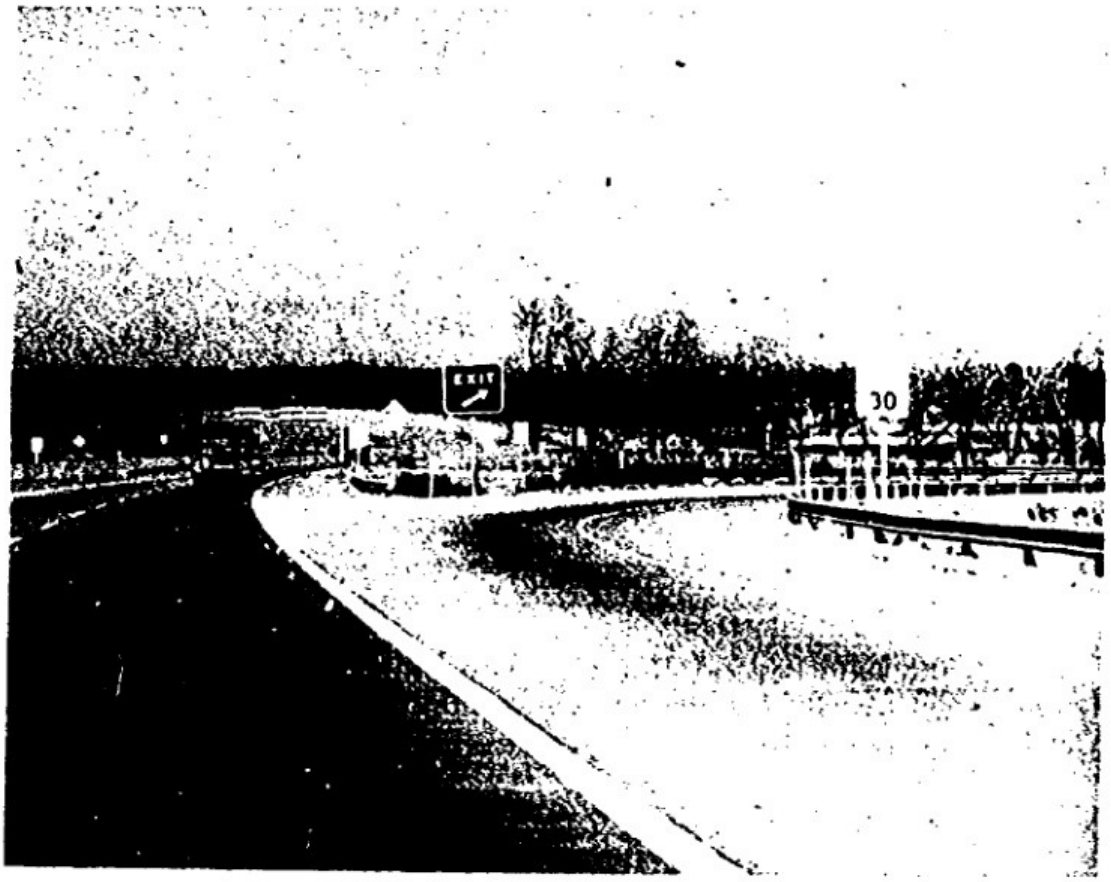


Here is a sign for Route 123 in the direction of McLean, which is not a city but a place on Route 123 not far distant from the beltway.

Mr. MAY. This is the only sign we have for this particular movement, is that right?

Mr. SCHOPPERT. That is right.

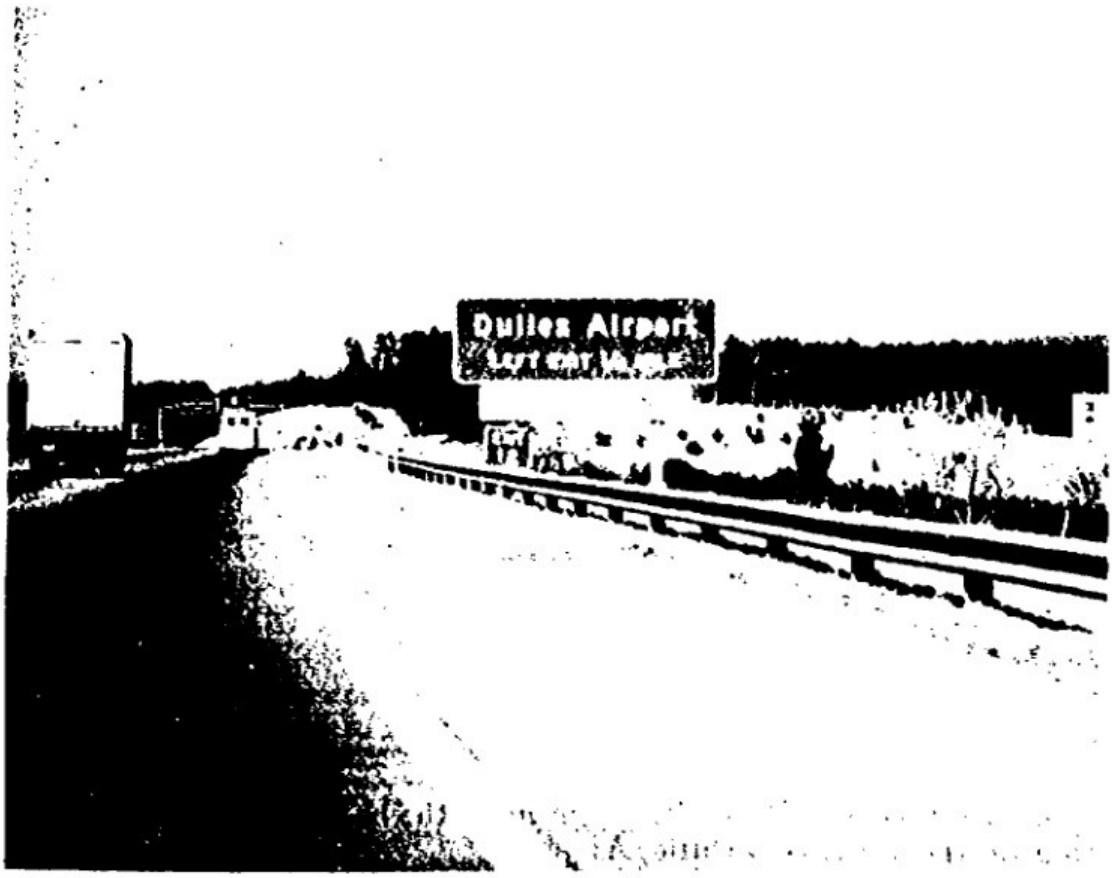
Mr. MAY. It is the only sign saying McLean?



Mr. SCHOPPERT. Yes. It is at the beginning of the taper, as you see. Here is the exit itself.

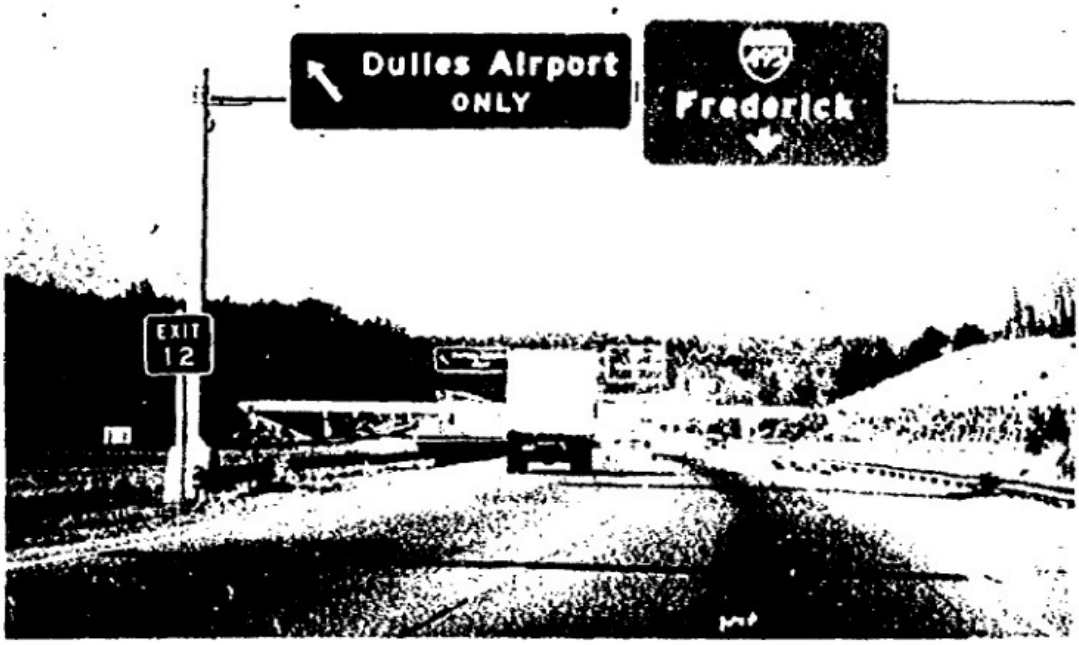
Mr. MAY. Mr. Schoppert, back there where it said McLean 1.3, is it a point where you can't go in both directions on Route 123?

Mr. SCHOPPERT. That is correct, you cannot. You can only continue in a right turn here on Route 123. This is not a diamond interchange ramp. It leads directly onto Route 123 and puts you on it going away from the beltway.



This is the advance sign for Dulles Airport. As you see, it is a left exit and it comes up a quarter of a mile from this point. It goes only to the airport. There are no ramps leading from it to the local street system.

Mr. MAY. That exit 12 is not displayed too prominently.



Mr. SCHOPPERT. Here is the signing at the beginning of the deceleration for the left exit to Dulles Airport.

Mr. MAY. Mr. McGrath, you are somewhat of a stranger here. What does that sign "Dulles Airport Only" mean to you?

Mr. MCGRATH. It means Dulles Airport only. I am not sure if you know what you are getting into. Well, I don't know. I guess what your question is, Do I think I can get anywhere else other than Dulles Airport; I think I might. I suppose, if I know the airport was quite a distance away, that there were some other local connections. This would just mean that making this turn meant I couldn't stay with the highway, that I was just going toward Dulles Airport.

Mr. MAY. It would also mean if you get in that lane, that you have to go to Dulles Airport.

Mr. MCGRATH. Definitely; I think so.

Mr. MAY. All right.



Mr. SCHOPPERT. This is an interesting sign saying "No Trucks," but it wasn't being well observed on this particular day.

It was sort of interesting to me, as you will notice, that this exit sign is 12–W. Coming back up it says only exit 12. I don't like to keep coming back to these things, but it does seem to me there ought to be some rationale, some system, to the exit numbering since it is so heavily used, particularly in this area, as a means of identifying the place you are to turn from the beltway. Has anyone had any experience with these in other locations or would anyone care to comment on them?

Mr. WILSON. I would like to comment, but not on that.

Mr. SCHOPPERT. Go right ahead.

Mr. WILSON. I noticed in the last two or three slides the exit speed signs as you leave the freeway to go into a ramp are on a white background. In previous slides they were on a yellow background. Is there an explanation for it? I believe the uniform manual requires that they use the yellow in this case as an advisory speed sign. This is in nonconformance.

Mr. SCHOPPERT. We have been in Virginia so far, so I think they are all under one jurisdiction. I don't really know why they have chosen white in some instances and yellow in other instances. Mr. Prisk may have some information on it.

Mr. PRISK. I have no information on this particular point except to say I think there was some divided feeling for awhile that since they used yellow advisory speed signs in the State of Virginia quite widely, much more so than in many other States, that it would be preferable on some of these ramps to put in the regulatory speed limit type signs. I think there are divided views on that point.

Mr. MAY. Mr. Schoppert, we are going to have to halt for today.

Mr. BLATNIK. Thank you gentleman, very much. I am sorry we must cut short somewhat abruptly the tailend of the second meeting. The hearings for today will be adjourned, and we will resume at 10 o'clock in the morning. Thank you very much.

(Whereupon, at 12:30 p.m., the hearing in the above-mentioned matter was adjourned, to reconvene at 10 a.m., Wednesday, July 17, 1968.)

HIGHWAY SAFETY, DESIGN AND OPERATIONS
Freeway Signing and Related Geometrics

WEDNESDAY, JULY 17, 1968

HOUSE OF REPRESENTATIVES,
SPECIAL SUBCOMMITTEE ON THE
FEDERAL-AID HIGHWAY PROGRAM,
OF THE COMMITTEE ON PUBLIC WORKS,
Washington, D.C.

The subcommittee met, pursuant to adjournment, at 10:15 a.m., in room 2167, Rayburn Building, the Honorable John J. Duncan, presiding.

Present: Messrs. Duncan, Clausen, Cleveland, Howard, and McCarthy.

Also present: Representative James R. Grover, Jr., and Representative W. J. Bryan Dorn.

Staff present: Same as previous day.

Mr. DUNCAN. The Special Subcommittee on the Federal-Aid Highway Program will now come to order. I would like to introduce to the subcommittee about 60 4–H Club members from my district from Tennessee. I would like them to stand and be recognized.

We will turn the meeting over to our General Counsel to proceed from here.

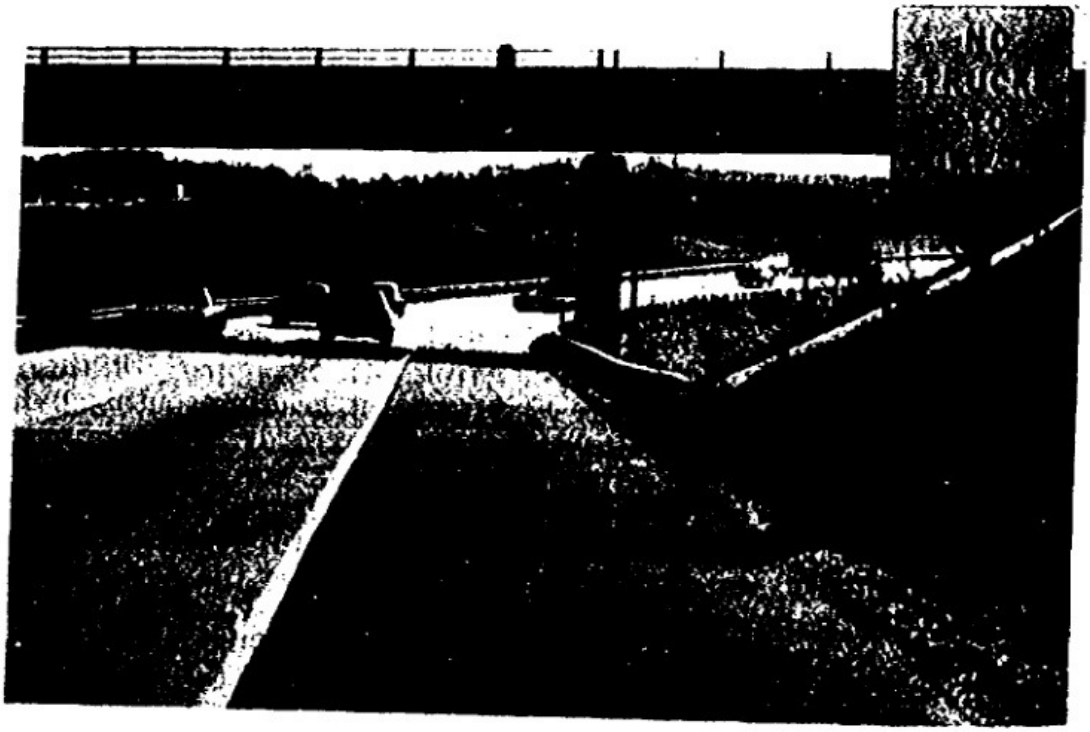
Mr. MAY. Mr. Chairman, we fininished up yesterday by analyzing interchanges on the beltway, Nos. 10, 11, and 12, heading northbound. We would like your permission to include in the record the slides, together with the pertinent comments from Mr. Schoppert, on those same interchanges on the beltway 12, 11, and 10, heading southbound. May we have your permission to do that in the record?

Mr. DUNCAN. Without objection, it is so ordered.

Mr. SCHOPPERT. This series of slides shows the signing in the reverse direction or the southbound direction of the Capital Beltway for interchanges No. 10, 11, and 12. We saw the signing for the northbound direction of these interchanges earlier and it should be of interest to see the type of signing which is in place for the southbound traveler.

The first slide shows the advance sign 1 mile from the Dulles access airport road. It carries the message "Dulles Airport Route 123 North exits 1 mile" and the exit number sign has been added later showing "Exit 12."

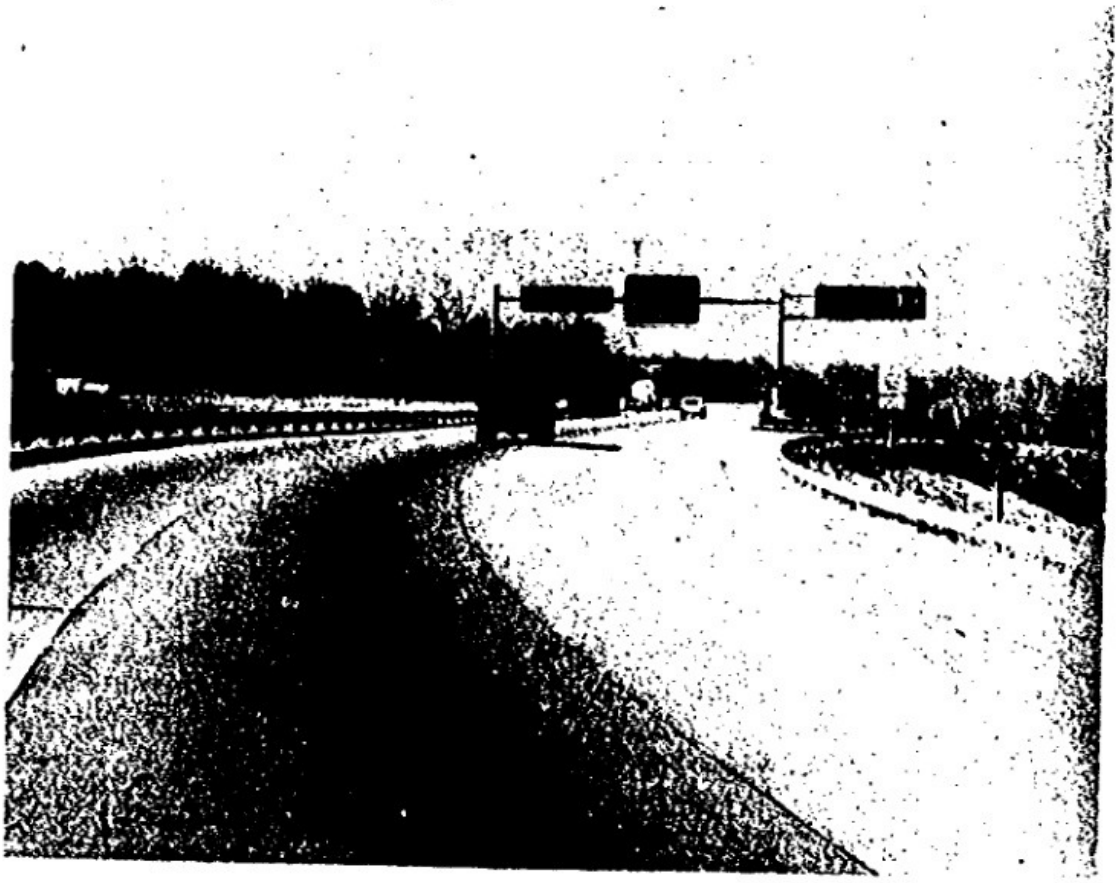




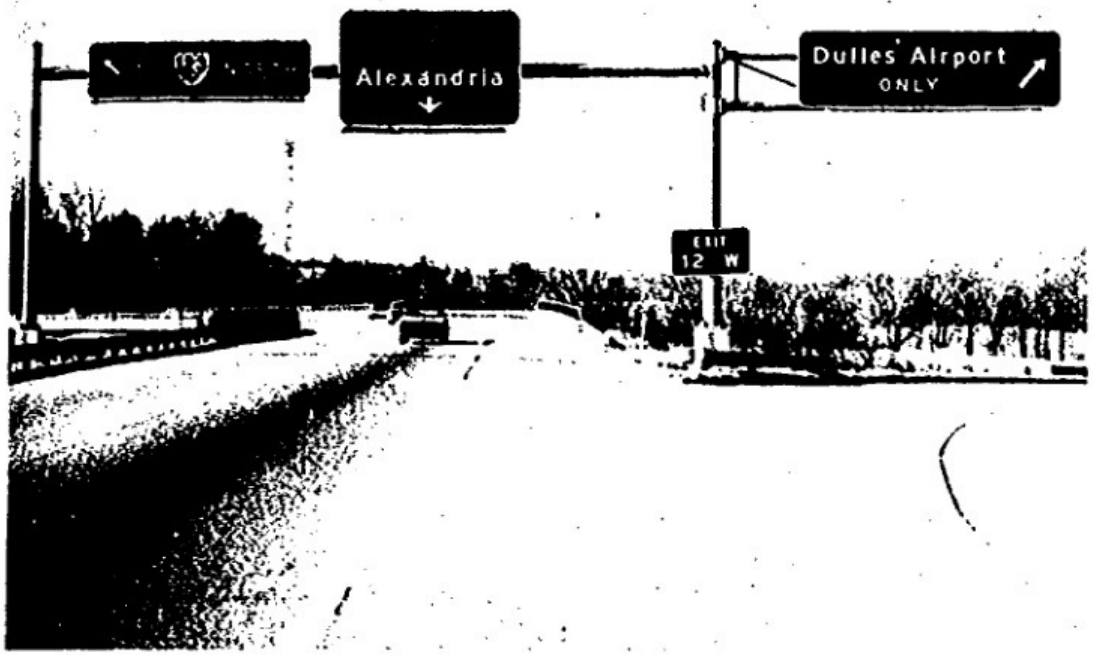
A little farther on there is a sign which says "No Trucks to Airport." This has been installed because the airport access road is limited to private vehicles and buses.



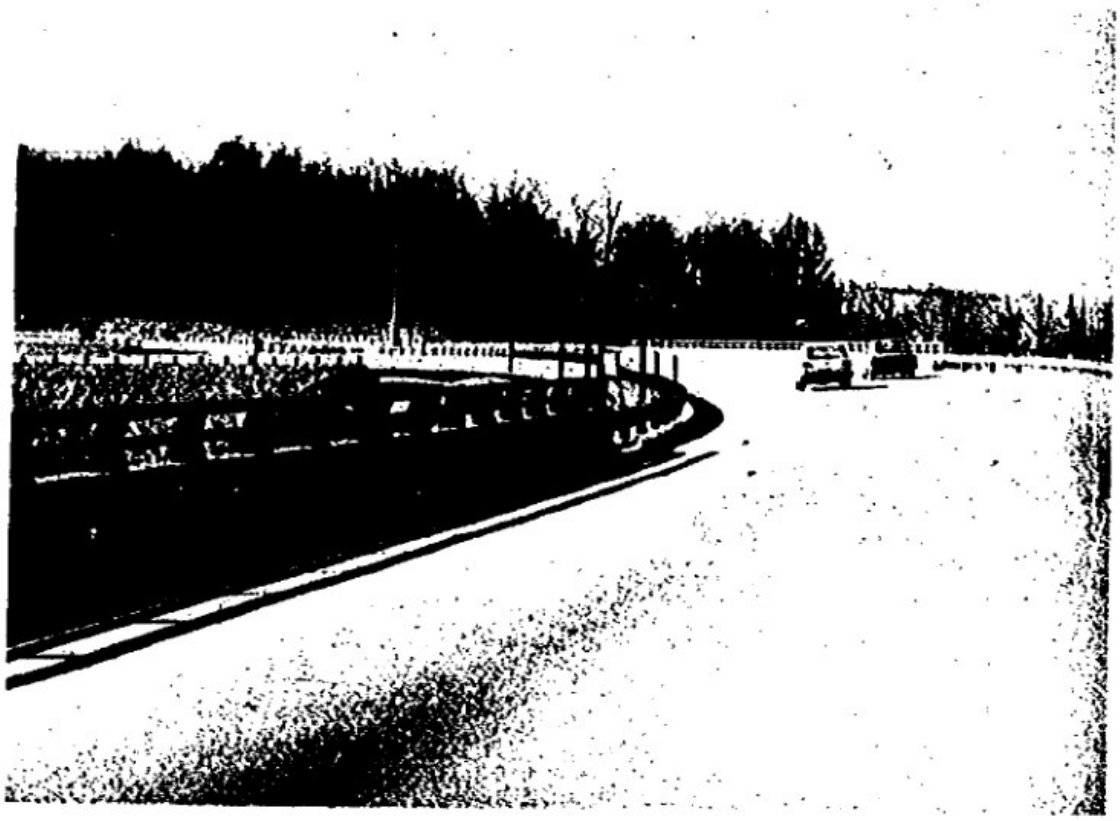
At the point where the deceleration lane begins for the ramp to the right to Dulles Airport, there is a sign saying "Dulles Airport" and under that "To Airport Only." Now that sign is necessitated by the fact that there are no off ramps from the access road to any of the intersecting roads along the way.



At the actual point of exit there's an overhead sign—the one on the right showing Dulles Airport—the one in the center over the through lane Alexandria, and the one on the left to Route 123 North.



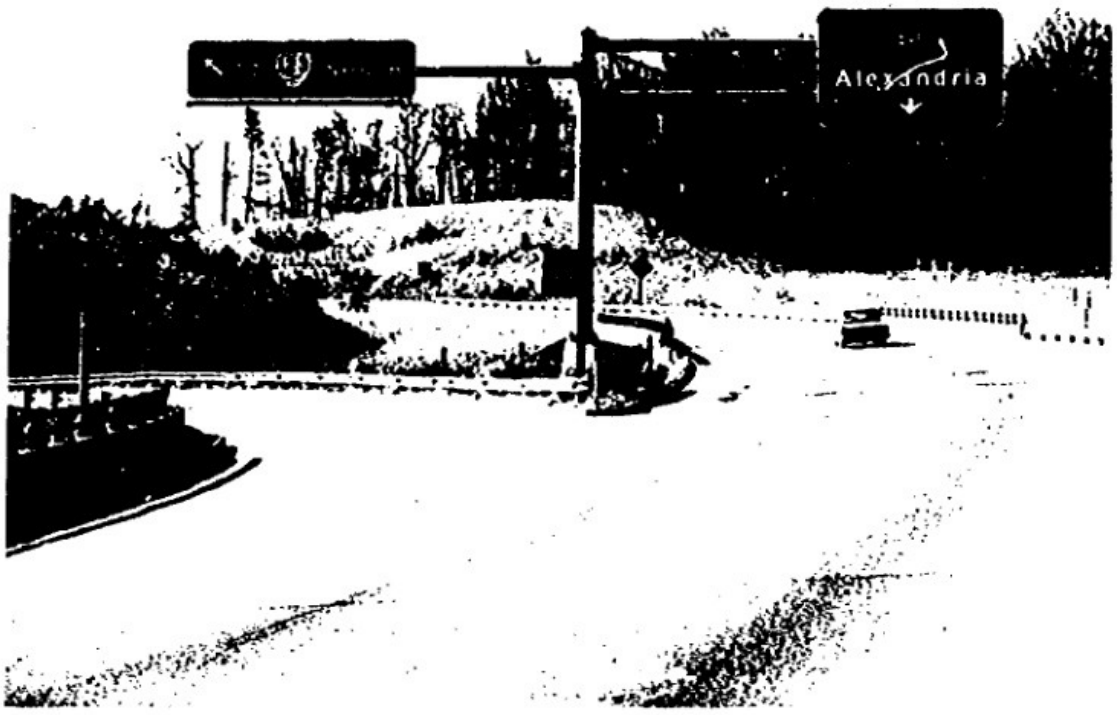
This same sign is shown more clearly in the next slide. The exit to Route 123 is a left exit and it's on a curve.



Here is a view showing the curvature of the beltway and the off ramp in the background and in advance of that three signs mounted on the left which say "This Lane Left Turn Only."



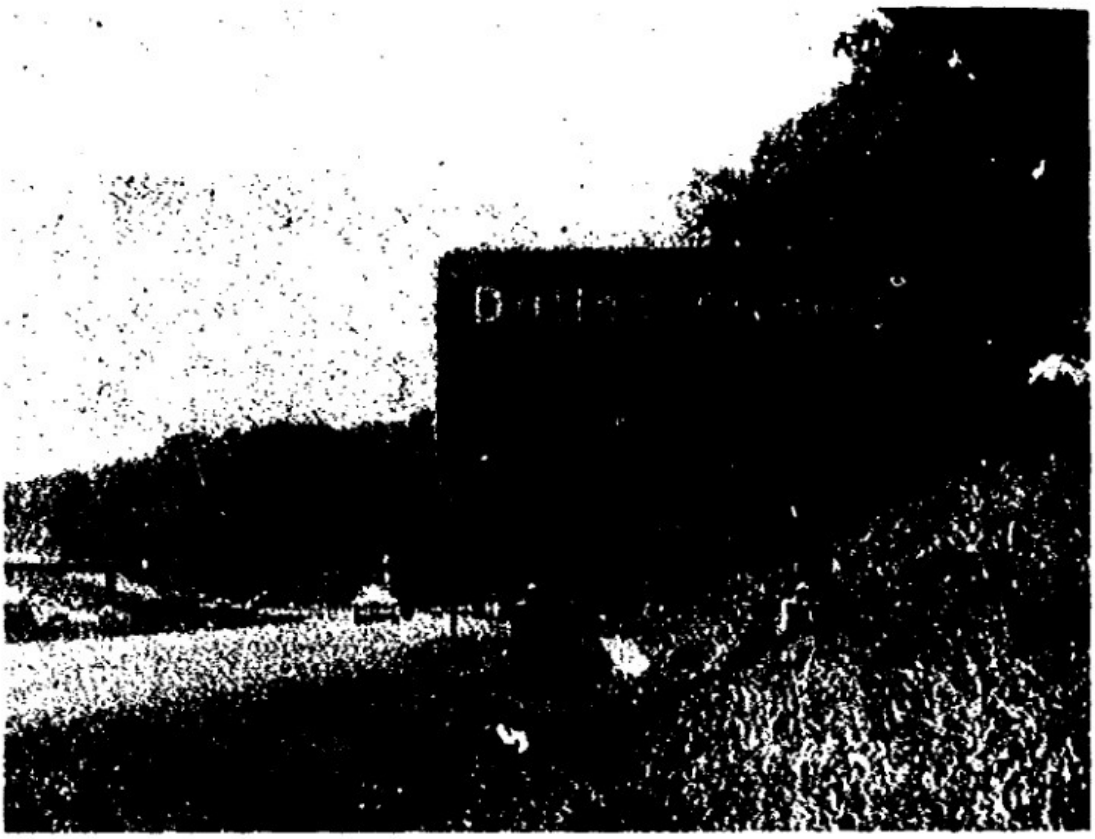
This is a closer view of that series with the overhead signs at the gore in the background.



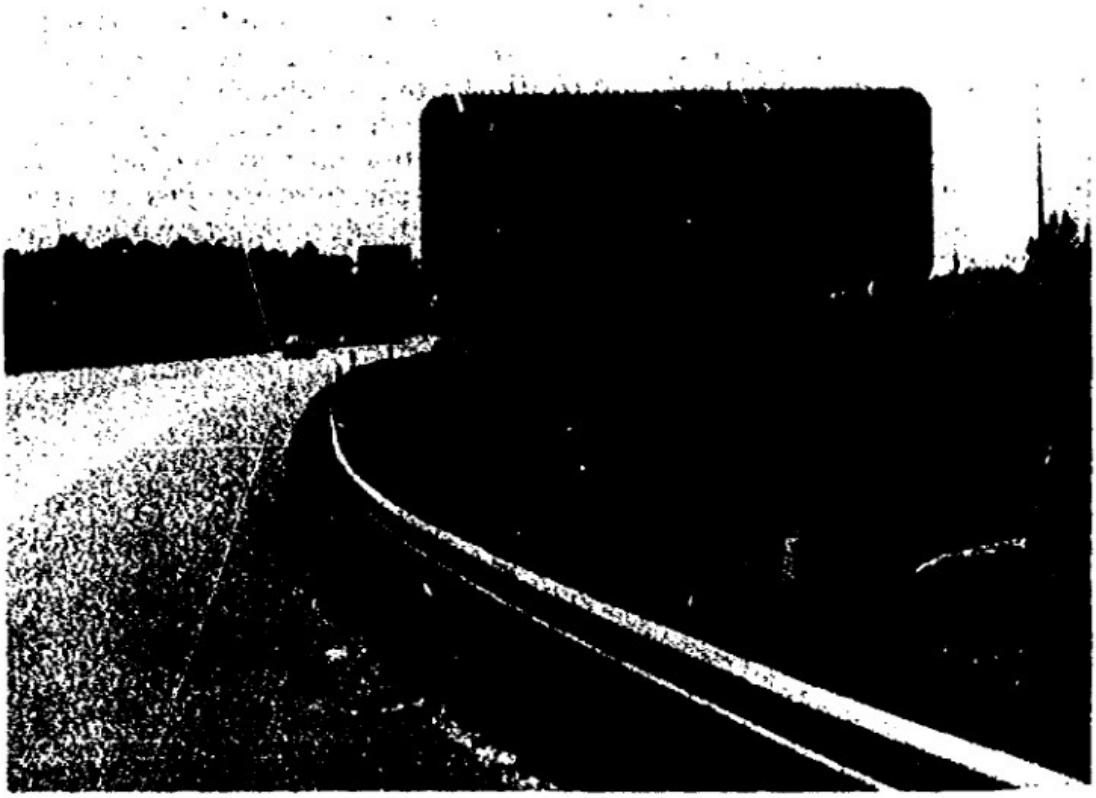
The actual gore signing is shown here. The overhead sign on the left to Route 123 North and the sign Route 495 Alexandria shown over the through lanes with a downward pointing arrow.

Now, the signing here which has been shown in these illustrations is that which is currently in place. For some time there were signs with different messages and these tend to illustrate the relationship between directional signing and accidents; a relationship which is not always easy to establish but one which it is reasonably easy to conclude, particularly when you watch traffic at some of the interchanges or when you see movies of the behavior of motorists at interchanges which does in fact exist.

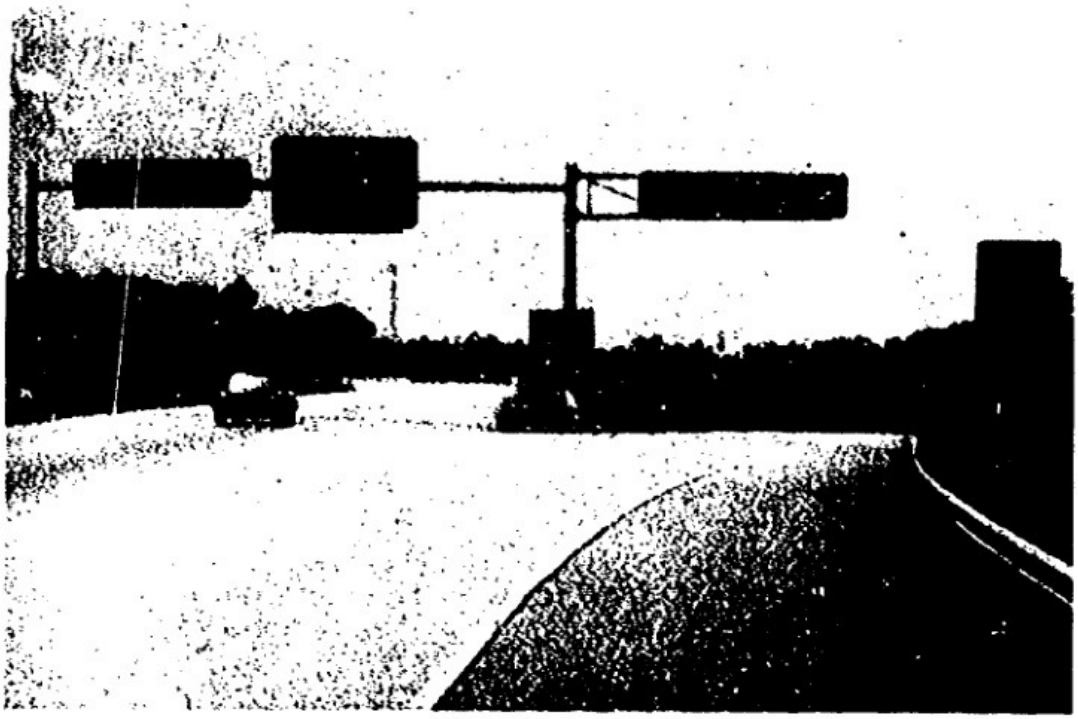
To illustrate this point there are illustrations of the signing which was in place at this interchange earlier and these are shown in the next series.



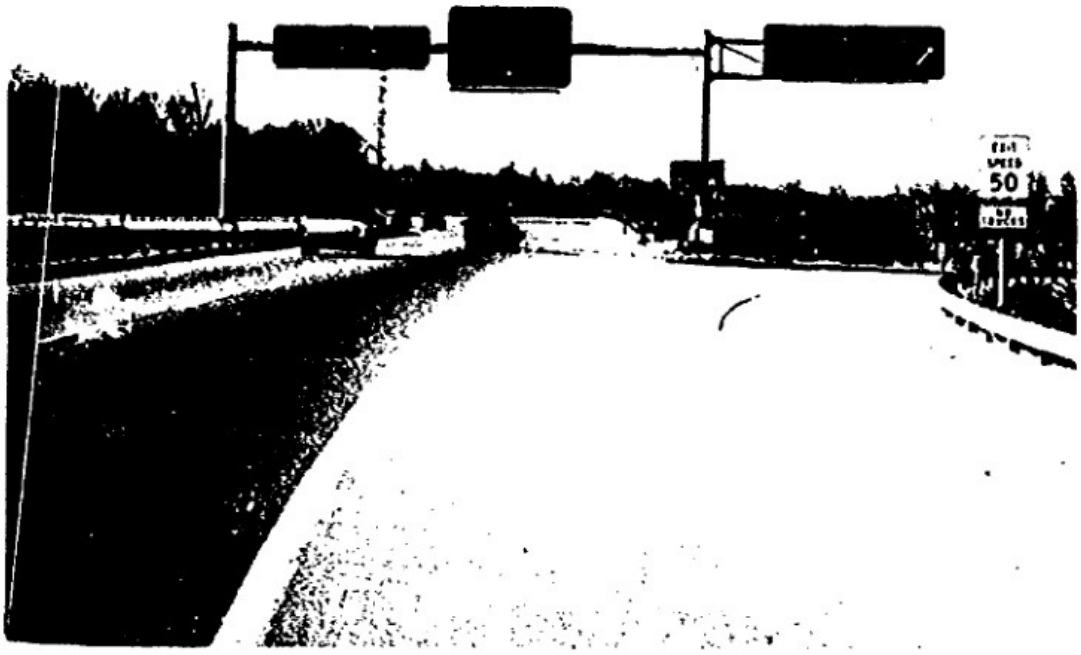
The earlier signing began 1 mile in advance of the interchange with a sign which said "Dulles Airport—Exit 1 mile."



A little farther on was an additional directional sign saying "Dulles Airport" with an upward sloping arrow to the right.



Then at the actual gore were the signs we saw previously overhead—"Dulles Airport, Alexandria," but the panel on the left was blank.



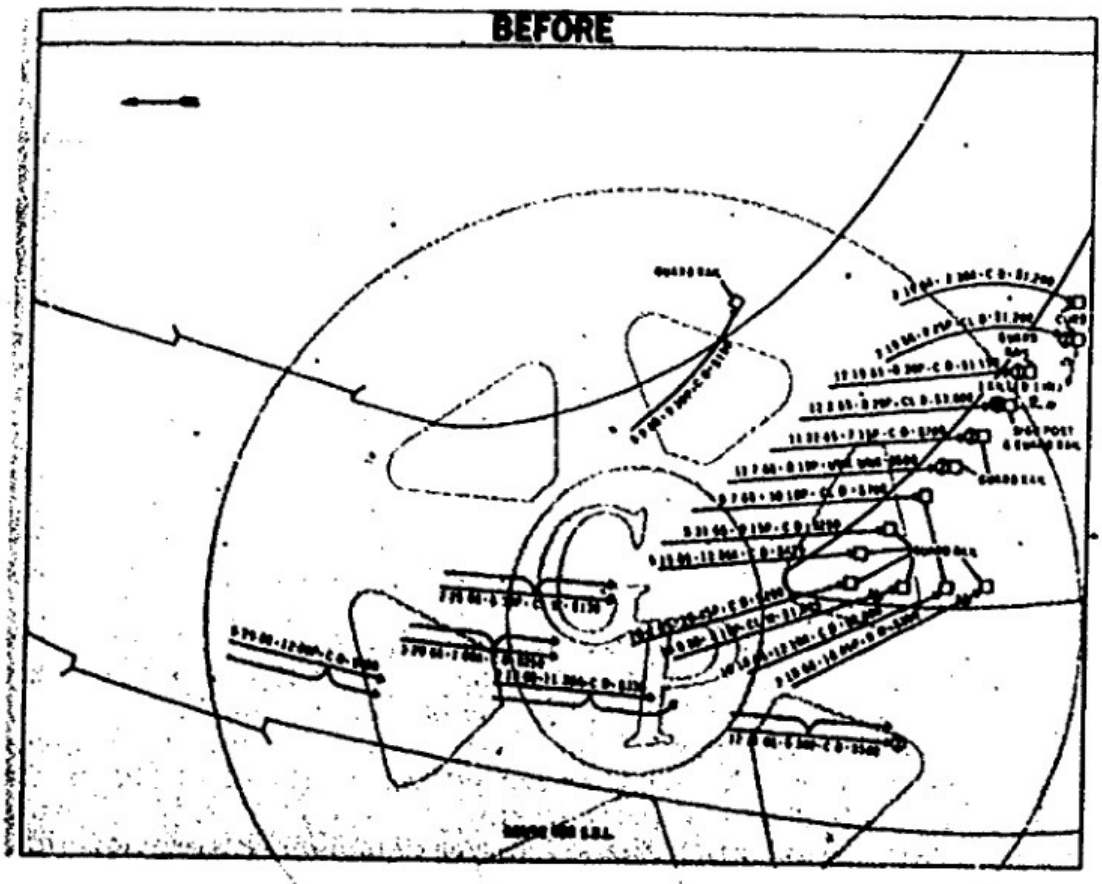
The one there now says, as shown in this illustration, reads, "To Route 123 North."



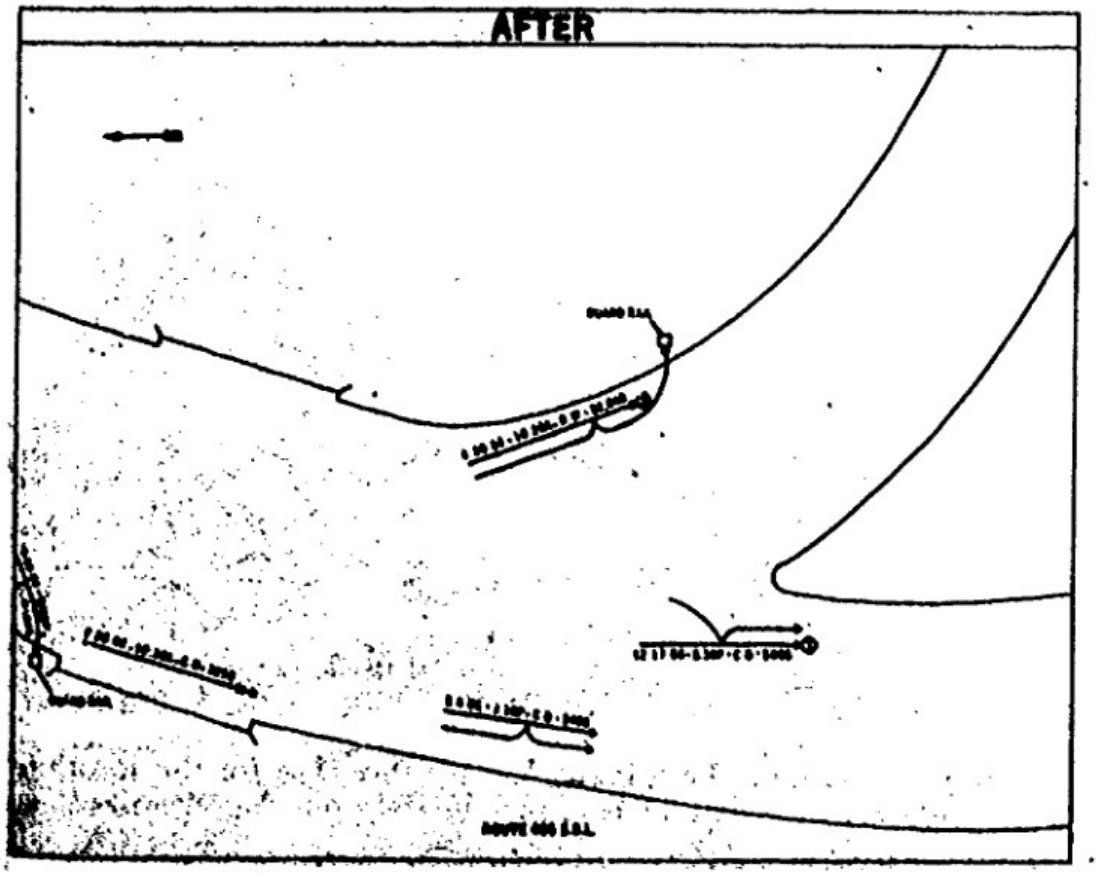
This picture shows that older set of signs a little more clearly—it's a closer shot. At that time no message at all on the panel over the exit ramp.

The staff of the subcommittee has obtained the accident records for this interchange. Before the signing was changed there were a number of collisions, primarily involving vehicles which struck the guardrail, the poles and curb, and so forth, along the gore.

These are illustrated in a collision diagram of the 1-year period prior to the changing of the signs.



For the same period after the signs were changed the accidents illustrated in this diagram occurred. As you can see there were far fewer of them. These are diagrams made up by the Virginia Highway Department on all the interstate interchanges.



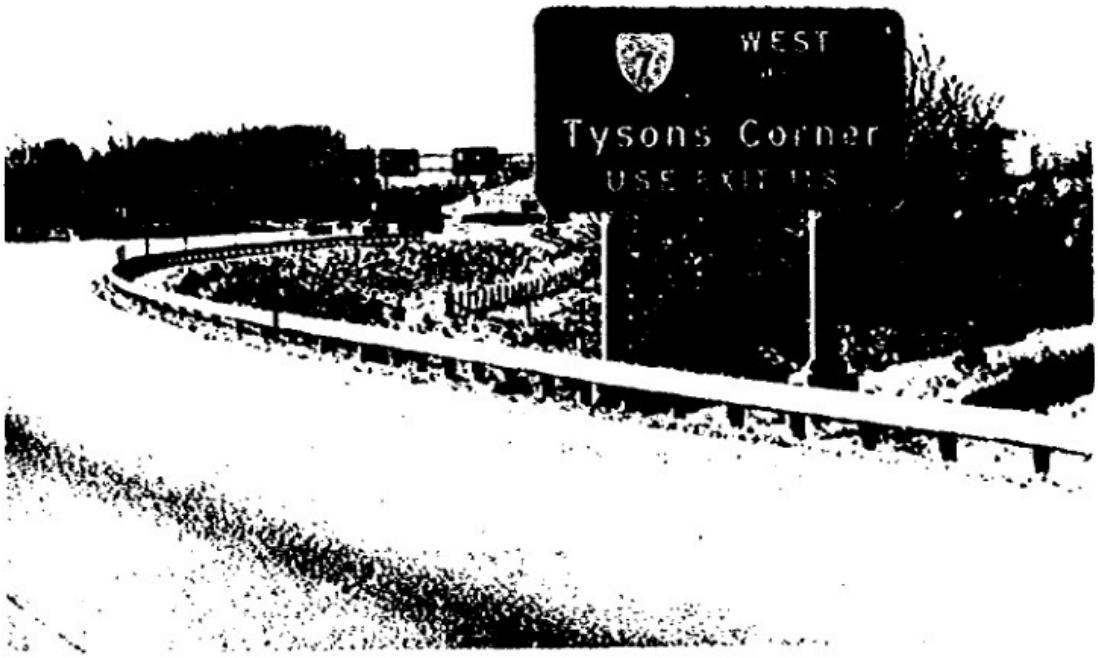
SUMMARY			
	BEFORE (Mar 65 to Mar 66)	AFTER (Mar 66 to Mar 67)	% CHANGE
TOTAL ACCIDENTS	19	5	- 73.7
FATAL ACCIDENTS	1	0	- 100.0
PERSONS KILLED	1	0	- 100.0
INJURY ACCIDENTS	5	2	- 60.0
PERSONS INJURED	10	3	- 70.0
PROPERTY DAMAGE ACCIDENTS	13	3	- 76.9

This information is summarized here. For the 1 year before the signs were changed there were 19 accidents. For the year after only five. There was one fatal accident in the before period and five injury accidents. In the after period there were no fatal accidents and only two injury accidents. The 1-year period before the changing of the signs then resulted in one person being killed and 10 injured, while in the 1-year period after the signs were changed there were three persons injured and none killed.

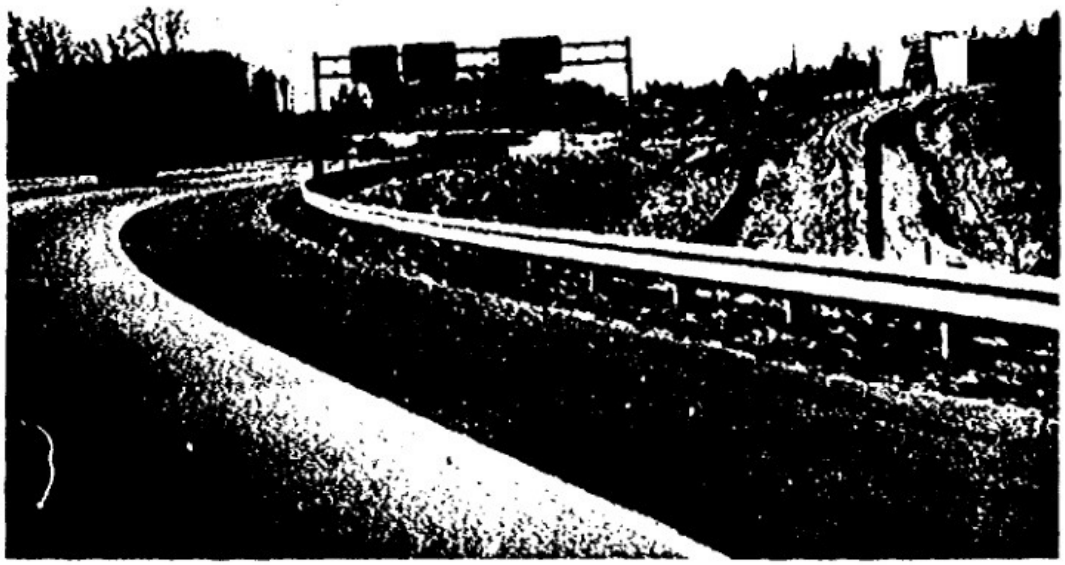


Moving on south on the beltway the advance sign for the Route 123 interchange which is exit 11 is approximately one-fourth mile in ad-

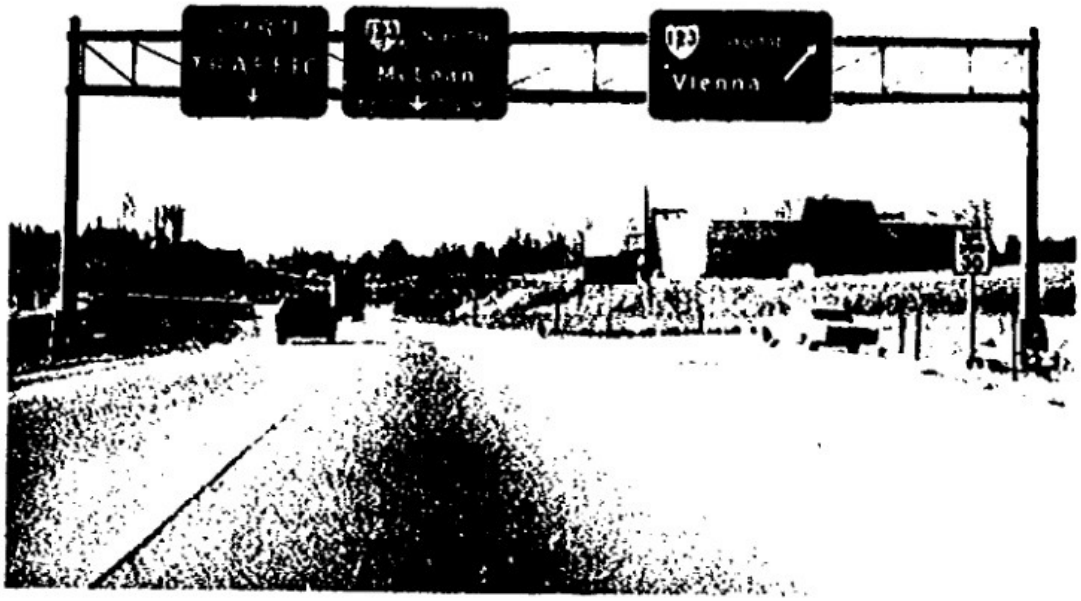
vance of the off ramp. This, as you recall, is due to the very close spacing between the three interchanges in this series.



The next sign a southbound motorist would see is shown here, "Route 7 West, Tysons Corner, Use Exit 11S." Now, you'll recall from the overhead plan that there is no off ramp from the beltway to Route 7 and therefore a motorist who is seeking Route 7 must see this sign and take action at Route 123, which is about three-fourths of a mile ahead of the point where he would normally find the ramp he is looking for.



At the interchange itself there is an overhead sign shown here. Again there is some curvature in the beltway and this sign is well off to the right of approaching traffic at this point.

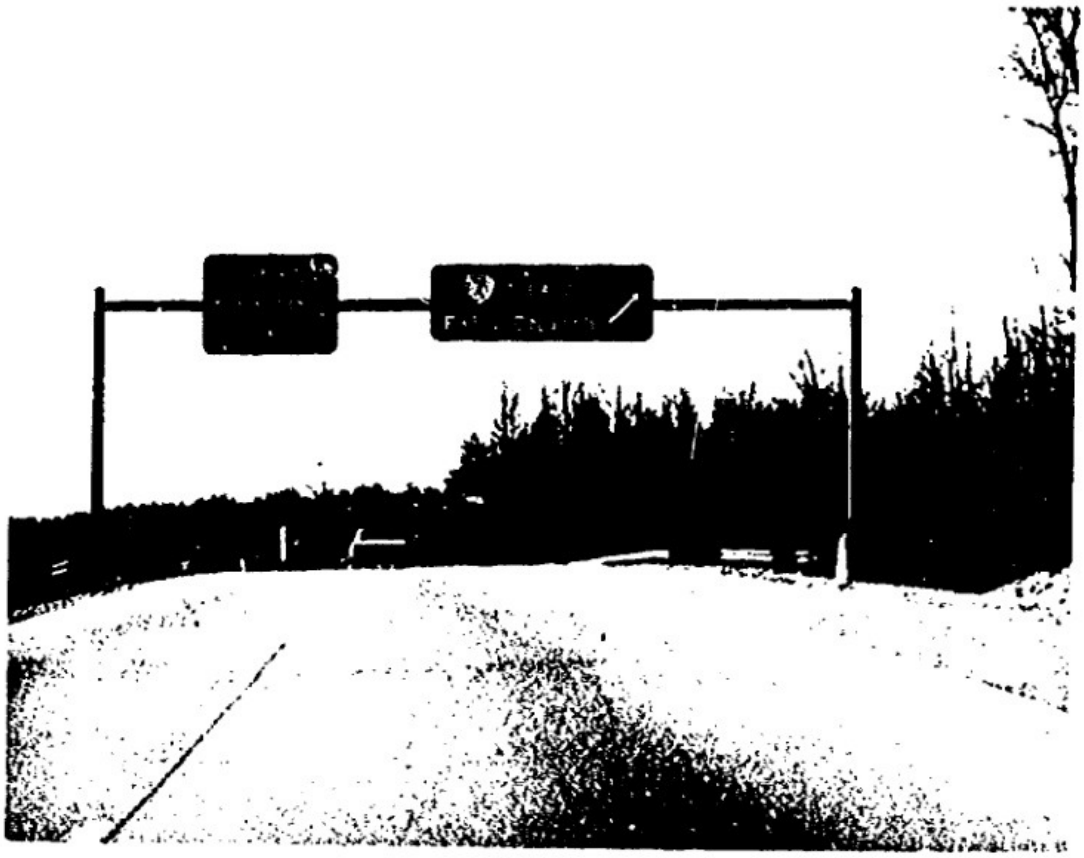


Here is a closer view of it. You can see the sign to "123 South Vienna" on the right over the off-ramp. On the right-hand lane north to McLean one-fourth mile and over the left-hand lane "Thru Traffic." The variety in signing of the kind represented by through traffic in this case is really surprising. We've seen signs to places like Baltimore

and Alexandria to Frederick. In other places along the beltway you'll see that they use very large route shields for Route 495 and in some places they use "Thru Traffic." There seems to be very little consistency in the message used to convey the idea to the motorist that the left lane is for traffic moving on beyond the interchange and the down arrow in this instance is somewhat questionable since the right lane continues on through for the full length of the freeway and it really isn't necessary for through traffic to be in the left lane.



The next sign is the loop off to the right for Route 123 north and McLean. This has an exit number—exit 11N.

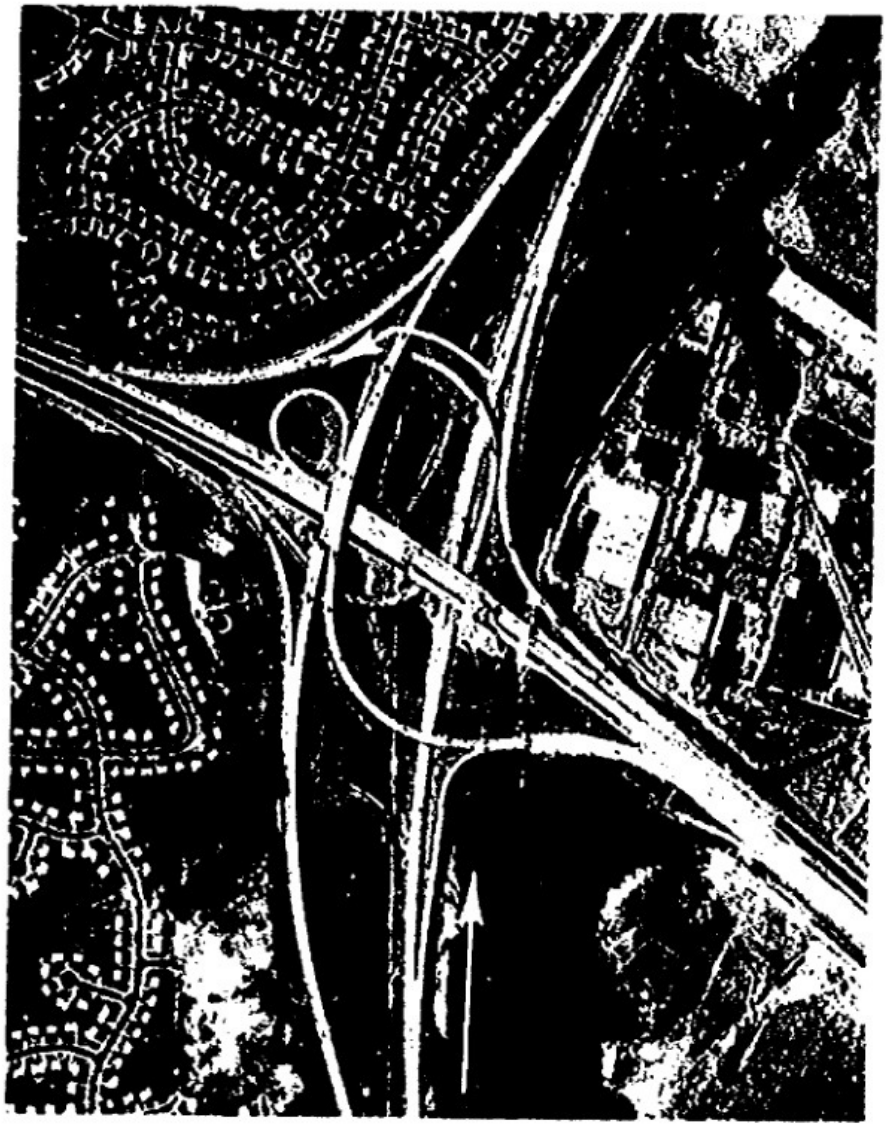


This is a picture of the sign bridge in advance of the exit to Route 7—Falls Church.



The last sign in the series is for exit 10E, Route 7, which goes to Falls Church. This particular exit is from a collector distributor road and there is no right turn into Route 7 westbound. As you recall, motorists who wish to do that had to do it at the previous interchange.

Mr. MAY. We will continue with the same witnesses we heard yesterday. We will begin by an analysis of interchange 4 on the beltway heading westbound, as we make the connection between the beltway and I–95 heading south to Richmond. Mr. Schoppert, perhaps you can lead us through these pictures.



Mr. SCHOPPERT. This is the intersection of I–95 and the beltway. I–95 in this area is also known as Shirley Highway. The beltway in this picture is the route running from top to bottom in the center, with I–95 crossing the picture. The particular movement Mr. May mentioned, westbound to south, would be coming up from the bottom and taking the second right and moving on around to the left into Shirley Highway.

Mr. MAY. Shall we drive through that?

(Movie.)

Mr. MAY. Is that the ramp for Washington, Mr. Schoppert, on the right?

Mr. SCHOPPERT. That is right, we are approaching the exit into the westbound to southbound ramp now.

Mr. MAY. You might watch that car in the front now. He seems to have a little difficulty. These films are to show the movement through the interchange.

Mr. SCHOPPERT. This is on the through lanes.

Mr. MAY. You will notice that the lane on the left is being dropped progressively.

Mr. SCHOPPERT. Those are the lanes coming in from the northbound Shirley Highway to the west and those on the right are those coming from southbound Shirley Highway to the west.

Mr. MAY. It ends up in two lanes. For a moment we had four lanes. Would you continue with that film, and we will show the activity on the part of the motorists as they approach the area that we just saw.

(Movie.)

The point here is that there is little question about the confusion caused to the motorists. The question remains: How frequently do these events take place? I think if we watch the film closely you will see that they take place quite frequently; as a matter of fact, one after another. In the same sequence, a number of motorists come into our view. It is a 65-mile-an-hour highway. (See p. 496.)

Maybe our panel of experts can analyze these pictures and suggest why some of these movements are taking place. After we finish the film, we will take you back and through slides, show you each sign progressively. There are a number of signs in advance. You will notice this car on the shoulder backing up.

There are two cars, one of them on the main travelway in a fast lane, both of them stopped. You see there is a trailer on the left that is evidently broken down. You will continue to see it through a number of those sequences which indicate they were taken at the same time.

Mr. O'Hara, when you took these films were you able to notice whether or not people were using their maps when they stopped?

Mr. O'HARA. Yes; we tried to use the telephoto lens and show it, but we were too far away. Quite a few stopped and took out maps and, as you will see later on, even got out and discussed it with another stopped driver.

Mr. MAY. We noticed the fact that a number of these cars were going through with apparently great confidence but were wrong because the staff went to the next interchange, Braddock Road, right up the road a bit, and talked with a number of motorists who pulled off at the next interchange, recognizing they were wrong.

Mr. DUNCAN. How far is it to the next interchange?

Mr. MAY. Two and eight-tenths miles. Notice the two vehicles parked on the shoulder. At least this fellow did not back up at this point. Here are two lost motorists discussing the matter with one another.

We are attempting to make the point during these hearings, Mr. Chairman, that these happenings occur frequently. They are happening in many locations, not only on the beltway but throughout other areas of the country.

We have had evidence now on several interchanges on the beltway and other places and will continue to make this point. Mr. Schoppert, perhaps we can now start to analyze that area to attempt to determine why some of the movements might be taking place.

Mr. CLAUSEN. Is the still photo now before us an aerial photograph of the same area that we have seen the movie on?

Mr. MAY. Yes, sir. (Previous slide is shown again.)

We are looking from bottom to top, heading westbound on the beltway. That interchange leads us into Route I-95. If you take the first right in the middle, that is the gore area we are looking at in the film.

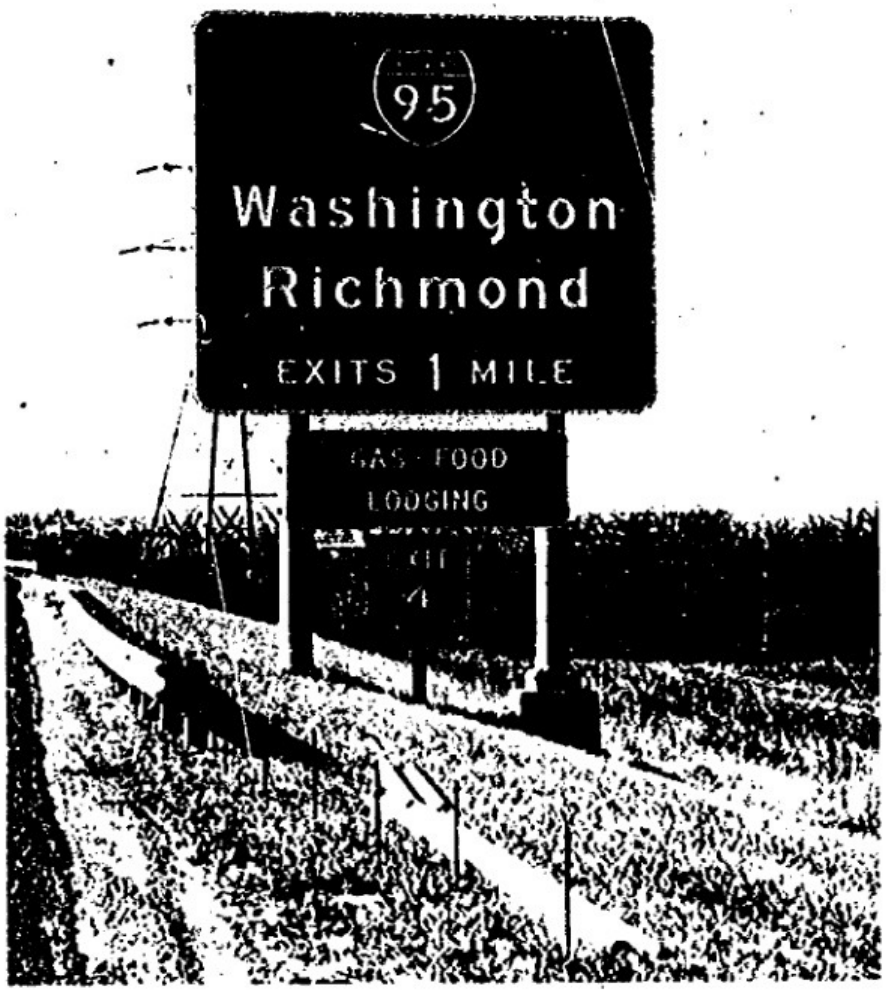
Mr. CLAUSEN. Could someone point that out?

Mr. SCHOPPERT. This is the point, right here. These movies were taken from the bridge at this point. Vehicles can proceed either up around toward the south or on through. This is westbound. If you recall from our discussion yesterday, this is a very critical point for a motorist making a long trip. For those, for example, who started out from Philadelphia, New Jersey, and New York and are going south, they would find this to be a very critical point in their itineraries because they are coming around the beltway now and they change from one freeway to another and proceed south. Now we will go back and look at the signing.



This sign is about 4 miles in advance of the interchange. It is not, strictly speaking, a part of the interchange signing, but it does show some of the advance notice which is given to motorists, 4 miles in advance of the interchange. It also calls out the next interchange which we saw yesterday, which is signed Franconia.





Here is the advance sign 1 mile from the interchange to Washington and Richmond.

The Washington exit would be the one to the right and the Richmond exit, the second right. It says, "Exits One Mile." Are there any comments on that?

Dr. HULBERT. I think this is a point of being perhaps overly cryptic where the signs might be improved by adding some of these connective tissue words in them.

The second point is that these are calling out a different piece of information added to the first sign. The first sign says Route 95. This now throws in two destinations. I am not at all sure that it appears to the motorist that these are all intending to give him the same piece of information that this is an interchange coming up. It doesn't say that there is an interchange coming up specifically. Many of us could conjecture on how to improve these signs but it will remain to be tested as to which configuration among all the many possible might actually do the better job.

Mr. MAY. Mr. Schoppert, we notice that this is a very major interchange.

Mr. SCHOPPERT. Yes.

Mr. MAY. Yet it seems as though this particular guide sign, 1 mile in advance of the interchange, is not unlike the other signs that we might see for Telegraph Road or Franconia or some lesser type destination. Does that make a difference?

Mr. SCHOPPERT. In my opinion, it does. I think there are different levels of importance of interchanges and I think this is one of the most important. As I pointed out, on the kind of trip the long-distance traveler is making, this is really a key control point. It is an interchange of two freeways. If he makes a mistake here, he has made a rather serious one.

I believe that interchanges of this kind should be marked much more prominently and much more explicity than, for example, the last interchange, the one to Franconia which is of interest primarily to people locally. I would be glad to hear any comments anyone would care to make.

Mr. MCGRATH. Mr. Chairman, yesterday we saw signs similar to this and commented that that word "Exits" was a bit subtle to inform people there were two opportunities to turn.

Mr. MAY. We can't hear you very well up here, Mr. McGrath.

Mr. MCGRATH. Yesterday it was noted that the word "Exits" was a little bit too subtle. I have seen this kind of signing on a development around Boston where the sign is broken into two different signs and one, for example, would read "Washington, Next Right" and the sign right below it would read "Richmond, Second Right" so that you had some information.

Also the Interstate shield would be on both signs and would read "North and South." So as I see the sign, the problem is that it doesn't give anywhere near as much information as it could.

Mr. SCHOPPERT. I think that is very true.

Dr. HULBERT. Also, I know what it is that was bothering me. Looking at this sign, I would think it is quite easy for the motorists to confuse this. It says "Route 95." Does this mean, "Onward on 95"? It might create momentary confusion which might not be too serious at this point, but building up if he doesn't get clarification at the next sign.

Also it says "Gas, food and lodging." Is it true that there are exit ramps to the nonfreeway system in this interchange that is coming up?

Mr. MAY. No, this is simply freeway to freeway.

Dr. HULBERT. If that is the case, what is the justification for the "Gas, food, and lodging" sign at this point?

Mr. MAY. How about that "Exit 4" down there at the bottom of the sign? It is kind of low. We had some comment in the prior hearings about truck blockage. It could well be, Mr. Schoppert, that exit 4 would be important to a motorist. He might have missed the sign saying that is exit 4. If he didn't see it, it isn't going to help him.

Mr. SCHOPPERT. I said several times yesterday that I think these exit numbers are extremely important to the people who live in the metropolitan area. They are a principal source of direction and I think they deserve a good deal more prominence on the signing than they sometimes receive.

I think there is a tremendous amount of information presented here in one gulp at 65 miles an hour for a lot of people, and I think some

of it is pretty subtle, as Mr. McGrath pointed out. An "S" meaning the difference between one exit and two exits seems to me like whispering to people rather than shouting.

The whole amount of information, some of it down below and some of it up high, does seem to me to be less than we could give them. Another thing that has been troubling me pretty much yesterday is that this photograph was taken from pretty close to that sign in clear weather by someone who apparently knows a good deal more than I do about how to operate a camera. It is pretty legible to us. At 65 miles an hour even in clear weather it is less so. In somewhat limited visibility it is even less than that.

We have had quite a long time to look at it now and think about what it says and doesn't say. You don't have very many seconds when you are out here driving, and you may not have enough time to catch all these small points.

Mr. CLAUSEN. Mr. May, I wonder if I could interject something?

Bob May, our counsel, was just pointing out to me that on some of these signs it says "4S," while this has "Exit 4" only, and they have other means of describing this. I think this brings out a very significant point.

Every one of us in this country has this basic failing. Somewhere along the line I believe that the individuals who actually do the drafting should have the average motorist in mind, or have a group of people make an evaluation of this recommendation before it is carried out. I think it is taken for granted that everyone understands what each one of us is doing, when in actuality the average person is certainly not informed.

Mr. LEISCH. Mr. Chairman, I think we are discussing here how this might be clarified. Again, I would like to say that if this were a single exit we would eliminate many of the problems. You wouldn't have to worry about whether it was exit or exits. You perhaps might not have to inform them in advance whether it is on the left or on the right. We wouldn't have to worry about whether it is exit 4–E or what have you. I think that would certainly make for simplification.

Then the point with regard to emphasis with regard to major interchange points, as between two interstate freeways. Perhaps we should always have an overhead sign in advance at a point like this, emphasized with oversized letters. These signs on the right, with heavy truck traffic in the right lane, can be pretty hard to catch or really to have the message go across. Having the sign or the legend simplified with nothing extraneous on it such as the "Gas, food, and lodging" and perhaps the exit number if it is used, to be a separate panel sort of superimposed on this overhead sign in a good spot and in a standard way, would be helpful. I think these things would work together toward improving quality.

Mr. MAY. Do you have some examples of what you just talked about, Mr. Leisch?

Mr. LEISCH. Yes; I have. I sketched up a few things last night. Actually, it might be better to show those when we get closer to the interchange and see what the problems are. I think the subsequent signs play a part in this and I would appreciate it if I could show them later on.

Mr. MAY. All right. Mr. Wilson, did you have a comment?

Mr. WILSON. Practically everything I was considering saying here has been covered by others except one point. I think for clarity the word "Junction" or "Jct" might be used in the upper part of the sign to indicate the junction with 95, which would indicate to me that I am coming to something fairly major. Actually, there is misleading information here as to whether or not that is a major exit.

The fact that that "Gas, food, and lodging" appears there bothers me considerably. I think it would mislead a motorist into thinking this is just like any other exit. This is not like any other exit. The exit numbers are only as good as the maps or other information that is available to guide the motorist. They don't appear on maps or on the material he used to plan his trip. They are not much good out here. It all has to be pulled in together.



Mr. SCHOPPERT. This slide shows the sign which was up for a period of time at this location as a test. You can see it is a temporary mounting. It has a different color from the standard signing we have been looking at. I understand this test was conducted by the Bureau of Public Roads and the Virginia Highway Department. Mr. Prisk, you might want to comment on this as to what the test was and what results you obtained.

Mr. PRISK. Yes, Mr. Schoppert; there has been quite a bit of consideration given to the uses of colors for highway signing and in connection with that some criticism of the green color for Interstate sign backgrounds based on the theory that a green background on an Interstate sign might very well fade into the foliage of trees and shrubs along the highway which present a green appearance at the roadside.

The thought is that with this alternate color shown at this location, of yellow, that would contrast rather sharply with the green foliage background and possibly even with the sky background that you see here. This was an installation made with the sign precisely the same size as the one you see in the background except that the colors are black on yellow instead of white on green. The letter size is also exactly the same. Both signs are reflectorized.

It does happen that the sign in the foreground with the yellow background is, of course, new, being made as an experimental sign, and the one in the background is an installation that has been there about 6 years. Relative legibility observations were made on the two signs, since there is a long tensioned approach to these locations and movies were made driving past the sign. These movies were observed by subjects who noted the relative legibility of the two signs.

Both day and night observations have led, very briefly, to the conclusion that the yellow sign is not particularly effective except as a target. As far as legibility is concerned, it suffers rather markedly under the nighttime conditions, which is most critical for Interstate signing.

There is a feeling, too, in support of the use of green, that it is perhaps preferable to reserve the use of yellow in highway signing to the caution series, the warning signs, which alert the motorist to a particular danger or hazard. The work has been concluded with this finding.

Dr. HULBERT. Mr. Chairman, if I may speak to that briefly; as you know, I have been on the color committee of the national joint committee of which Mr. Wilson is the current chairman. It has long been my contention that this problem of target value of any sign could be handled by allowing the engineer in the standards bureau to use a contrasting back shield.

In this particular case if a green sign were hard to see or to detect against a green foliage, a little color border, perhaps even a 12-inch-wide border around that sign, could be placed in that particular location. It might be yellow or white or anything that would give a good contrast with the dark green foilage.

This is currently not permitted in the standard signings. There is a little use of back shields on traffic signal heads, although not nearly enough in my opinion.

Again in an attempt to be standard, which is of great help to the motorist, of course, I think perhaps a little more leeway or a great deal more leeway should be given to the professional engineer in a standard way. He couldn't come up with a pink back shield, perhaps, but he could be allowed to use a yellow target to meet these visibility problems.

Mr. MAY. At least we have established that this is a very important location, 1 mile from this interchange at speeds of 65 miles an hour. The driver is going to get to the crucial point in less than a minute. This is a fine place to put him on the right track. How about the possibility of overhead signs at some of these crucial areas?

Mr. SCHOPPERT. I think Mr. Leisch has already suggested that it might be an excellent way to handle the situation. I would certainly agree to that.



This sign perhaps takes a little explanation. There is a community by the name of Springfield, located just south of the beltway. To reach that you must take the ramp to Richmond and then exit at the first exit available to you on Shirley Highway. This sign is intended to convey to those who are seeking Springfield that they should be sure to take that ramp. It is the ramp to Richmond which you saw. Does anyone care to comment on this?

Dr. HULBERT. This is an excellent example of a sign that is not cryptic. I would say that it probably is serving a useful purpose and was probably put up because of the requests by motorists looking for Springfield.

It is somewhat unusual in Interstate signing to see such a wordy and, you might say, a talkative sign, but this is a sample of the direction in which Interstate signing could very well go. It can be overdone, unquestionably.

Mr. SCHOPPERT. Does anyone else have any comment on that?

Mr. WILSON. I think I have to disagree with Dr. Hulbert as to where the request for the sign came from. I think in many cases requests for this kind of sign come from the local community. This is an attempt to fill their needs, as far as signing is concerned. In my experience with signing over a number of years, in more cases than not they will come from the local jurisdictions.

Mr. MAY. Mr. Wilson, I understood Dr. Hulbert's point was the nice sentence, "Springfield—Use Ramp to Richmond." This would be more easily understood by motorists than a somewhat more cryptic sign.

Mr. WILSON. Perhaps I misunderstood. I think as far as the message content is concerned, there is no problem there.

Mr. MAY. I think Dr. Hulbert's point in previous testimony was that sometimes in an attempt to put fewer words on the sign we get so cryptic that the motorist doesn't really understand. He would more easily understand it if it said, "You are going southbound." Is that right, Doctor?

Dr. HULBERT. Yes, sir.

Mr. LEISCH. I would like to comment on this particular sign. Frequently there is an additional piece of information that can be very helpful to the motorist, perhaps even someone who is not going to Springfield. If that piece of information becomes completely divorced from other signs where he is not harassed trying to read other messages, he can either absorb or completely disregard it. I think it can help to orient some drivers. Again, as it was said, it shouldn't be overdone, but I think there are some strategic places if there is a sufficient space between sign sequences where this sort of thing can be helpful.



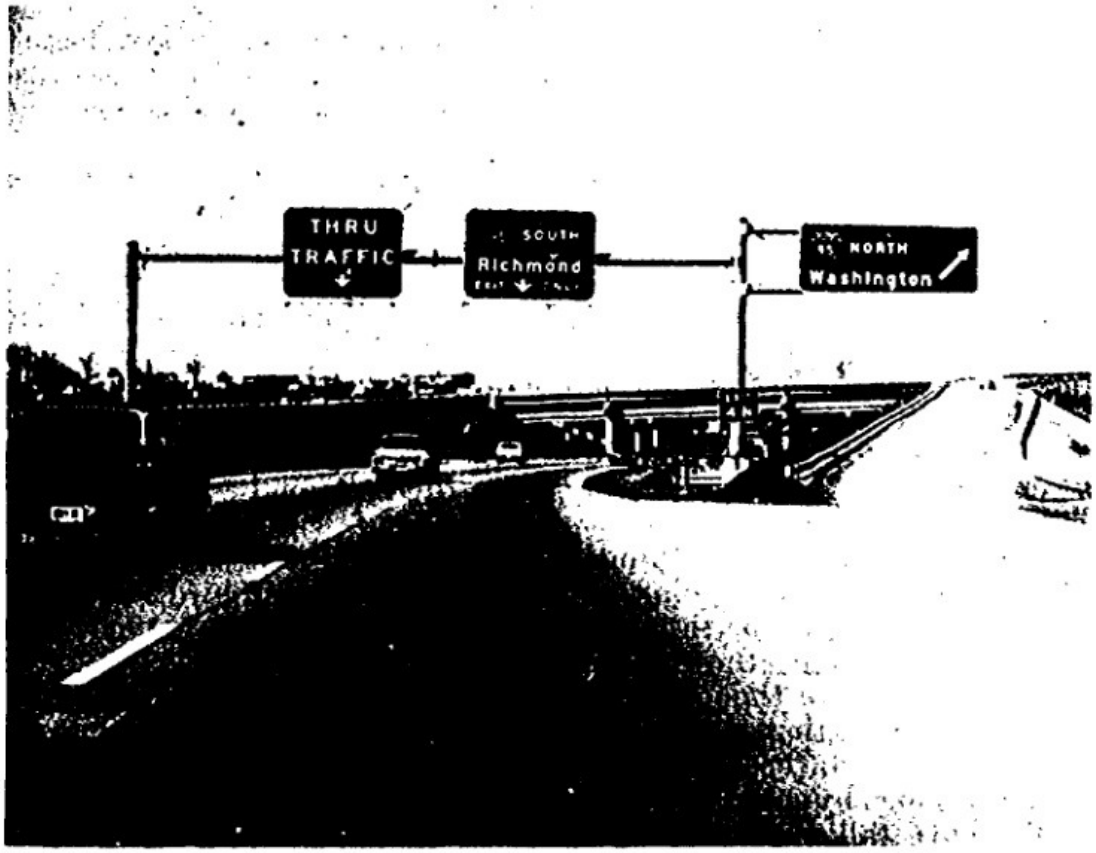
Mr. SCHOPPERT. This next slide is the ramp to northbound on Shirley Highway showing the exit to Washington. It is exit 4–N. Does anyone have any comment?

Mr. LEISCH. Yes; I would like to make a comment here. This sign is very clear and it is very concise and very much to the point. I am sure there are some drivers who are almost blindly following route markers like Interstate 95. I think it might worry them just a little bit because, of course, it is 95 and north is Washington but perhaps they didn't completely comprehend the advance sign and they are wondering how about 95 toward Richmond. It is a bit of worry.

I think the driver should be relaxed and he should have that information. In order to do that you would have to also indicate an additional sign here, which we would like to avoid. We would like to reduce the number of panels. Of course, this keeps bringing us back to this one exit design which I will continue to harp on, if I may.

Mr. MAY. When the motorist coming down from the north got on the Baltimore-Washington Parkway he began to see little signs saying "To 95." He swung around and finally got on 495, the beltway heading east, and then eventually was heading south and he kept seeing 495 signs. Finally he sees the one sign saying 95. I submit that some motorists think they are now on 95. Now they reach a point again where it says 95. This may add to their perplexity.

Mr. SCHOPPERT. I am inclined to agree with Mr. Leisch that for the fellow who is looking for Richmond and he really doesn't know which way he is going to turn, off to the right or off to the left, he probably just wonders what happens to Richmond and maybe they left it off for convenience or something and maybe this really is the way to Richmond. They were called out together the last time and only one is called out here. We might see what happens at the next point now.



This next slide is at the ramp. You see he does get the information as to where Richmond is now. Up to this point, there were three lanes in this direction on the beltway. There will only be two continuing through the interchange beyond the ramp to Richmond. Does anyone have any comment on this particular one?

Is this about the point where you wanted to talk a little bit about design? You said you wanted to show some slides when we get closer to the interchange.

Mr. LEISCH. I think we should hold those for the moment.

Mr. MAY. What is there about this sign that perplexes the motorist?

Mr. LEISCH. One of the problems here, at least following the beltway, 495, is that he might be worried if he wants to stay on the beltway and he might not be quite sure if this is 495 or not. I think that might be a source of worry. Of course, we discussed the other day what that might mean, that it could mean different things to different people, and that in itself could be confusing, depending upon how the particular motorist has himself oriented at the time.

Mr. MAY. Yes; it does say "thru traffic"; we have already discussed the fact that that is sometimes bothersome. Under ideal conditions a person with 20–20 vision could see it around 600 feet. If he has poorer vision or less visibility he sees it for a shorter distance than that. It is difficult for some motorists to distinguish between 495 and 95.

Mr. MCGRATH. Mr. May, you pointed out in the earlier signing that you saw the possibility that the sudden appearance of the Interstate 95 shield without the confirmation that you are on 495 might lead a driver to think he is actually now on 95. If that were so, then this sign up here would say to him that he is going south on Interstate 95 and if he stays in the right lane he is going to hit some exit that takes him to Richmond, and now he doesn't know where he is.

Of course, the through-traffic sign, as I commented yesterday, doesn't tell him anything. Again, his problem is that one highway has disappeared on him, I–495, and he doesn't know where it went and now he doesn't know what the other signs mean.

Dr. HULBERT. Mr. Chairman, as an approach, one that I like to take, is what is it that you would tell the motorist if you were sitting there in the car with him. What would you say? Just the same wordage that Mr. McGrath used is what you would say. You would say, "You are on 495. You are approaching an interchange with Route 95 and you can go either north or south. If you go to the north that will take you in the direction of Washington and if you go to the south it will take you in the direction of Richmond. If you are going to be in the right lane you are going to have to take that route to Richmond, so if you don't want to go to Richmond you had better get over."

There are all of these things that you would say to the motorist if you knew what was going on and if you had that bird's-eye view in mind. These are the things the sign is attempting to get across to him. You can't put all of that verbiage on the signs but you can go a long way, and we thought in the 1958 study that we had set forth some principles that would help to go in that direction. We haven't been referring to those various principles, but they have been alluded to in this panel by subject.

We have talked about the fact that the larger signs and larger messages and more overhead signs indicate more importance. That is one of the principles. We have talked about various others.

One we haven't mentioned is continuity where you suddenly provide different information than you had provided in the advance signs. That doesn't happen to be the case at this particular interchange, but it was discussed yesterday. At some time perhaps we might have a chance to relate these signing problems to those principles, if not in the hearing proper perhaps in some documentation later. Just such a

job has been done in the Voorhees study. I don't know if that is going to be introduced as testimony or not.

(Mr. Clausen assumed the chair.)

Mr. MAY. You bring up an excellent point, Doctor. Mr. Chairman, we would like permission for us to leave the record open after these witnesses have completed their testimony so that they would be allowed to submit in writing additional information and observations that they might have relative to the subject matter being discussed in these 2 days. May we do that?

Mr. CLAUSEN. Without objection, the request will be granted.

Mr. MAY. I noticed the words "Exit Only." Could we discuss that for just a moment?

Mr. LEISCH. Mr. Chairman, I think "Exit Only" is quite essential here, but I think we should also examine the situation geometrically in advance of this exit. If I am not mistaken, there are three lanes approaching this interchange. Is that correct?

Mr. MAY. Yes.

Mr. LEISCH. Also those three lanes are sort of the basic lanes that have been on the beltway for some distance? In other words, the "beltway" was a six-lane facility with three lanes in each direction preceding this point?

Mr. MAY. For some time; yes.

Mr. LEISCH. So the motorists were using the right lane as a through lane along the course of the freeway.

Here we find an exclusive lane, exit only, where actually we are dropping a through lane, which should never be done. I think this is part of the problem, of course.

Perhaps two things might be done here. They were not mentioned previously. One is the use that California makes of the lane that must go off by perhaps using a yellow panel in combination with the regular green and white sign to actually alert the driver. If the driver were educated to the fact that any yellow panel on any regular sign is an alerting element, perhaps he would be educated to the fact that is dropping off.

If the right hand land were an auxiliary lane, which it should have been—there should have been a fourth lane here, actually, and that is the only type of lane that is properly allowed to be dropped—then I would submit that it would be characterized somehow. Perhaps a new type of lane marking might be used to designate an auxiliary lane, so the driver would always know by that marking that sooner or later that lane is going to go off. If that marking were, for example, a 12-inch wide line, about three times as wide, or at least twice as wide as the normal lane marker, and of a different sequence such a stubby line, I think the combination here of a yellow panel and the lane marking, once the driver is educated, could do a great deal toward helping him.

Mr. MAY. Thank you. I wondered personally about the word "Exit" at this point. We are going from freeway to freeway.

Mr. MCGRATH. Mr. Chairman, I wanted to address myself to that, if I might. This may be just a personal hang-up of my own, but I have long thought that it was unquestionably the wrong word to use. I have a notion that people understand the word "Exit" very clearly to mean passing from one environment to another. We exit from

buildings and from lots of places. We always go into another environment.

I think the drivers know that a freeway is a different environment from that of the city streets or an ordinary highway. Also they could not care less. It is all one highway to them. All these numbers may help you to find your way around, but Interstate 95 and Interstate 495 are identical roads to the driver, I think, and they are freeways.

Now we tell them to exit. The driver is just afraid that that means he is going into another environment. I have had no opportunity to do research on it, but I just feel that if we tried to sign this interchange without the word "exit," we might do some of the things Mr. Leisch has suggested. We might find a new way to do it.

Mr. MAY. I wonder if other panel members would like to comment on the word "exit" at this point.

Mr. LEISCH. I think Mr. McGrath has a very good point. I think there may be no question about the word "exit" at the point where there is an ordinary street or road closing, if we wish to adopt the word "exit" as being completely comprehensible.

I like to think here that this is a transfer. Instead of exit you might use the word "transfer." You are transferring from one Interstate to another. I am not quite sure that that is right, but that is a thought in that general direction. With the use of a yellow panel, perhaps the combination could be quite indicative.

Mr. MAY. I noticed that previously we discussed a somewhat useful sign. It says "Springfield—Use ramp to Richmond." Even "ramp" might be better than "exit." Is that right?

Mr. LEISCH. I am not quite sure, because we think of a ramp, at least geometrically, as a facility that goes up or down and curves and so on. Frequently in a major interchange we refer to facilities that allow traffic to transfer from one roadway to another as the "turning roadways."

Mr. CLAUSEN. I realize we are dealing with a larger word, but would you try out for size the words "Richmond Turnoff?" I realize we are dealing with a larger word, but it would seem to me we would arrive at the same thing. It seems to me here is where you people should be playing with the kind of word that spells it out the most simply and understandably. What about the word "Turnoff" in a case like this?

Dr. HULBERT. This is an excellent example of what is needed, and that is a research facility. We could sit here and come up with words of course. I happen to like that particular one because this is a problem we have been dealing with in the Los Angeles area. The people out there are not particularly happy with the use of the word "exit" on the connecting ramps. As Mr. Wilson stated to me this morning, California has changed the advisory speed signs so that they now say "Ramp" instead of "Exit" and give the advisory speed. I have never been happy with the word "Ramp Only." It doesn't seem quite right, but that is only my opinion.

What we need is some way of exposing these alternatives to the naive motorists, preferably in some economical way, such as a laboratory setting, as realistically as feasible, before actually going out and putting them on the road. This type of trying out is being done, but only to a limited degree and this is being done in a kind of sporadic fashion with various research groups throughout the country, not on

every signing question, but on some and not on others. It needs a continuity. It needs support that is existent today.

Mr. SCHOPPERT. I would like to comment on that, too. I think your questions raise a very interesting point and that is—whose vocabulary is going to be used? Are you going to use an engineer's vocabulary for "ramp" and other things, meaning very specific things, or are you going to use vocabularies of the drivers? You are talking to the driver and it seems to me his vocabulary is the only appropriate one.

When we made this study in California we did a lot of interviews with people and we found they called ramps "cutoffs," much to our surprise. They may have changed their vocabulary in the intervening 10 years and, with more experience and added freeway mileage, they may have found a new word for it. At that time they called ramps, "cutoffs."

We tested a number of favorite words with drivers. Some of these engineering terms are not in the vocabulary of drivers. I think this question gets to the point pretty neatly—whose vocabulary do you use?

Mr. CLAUSEN. I was talking to counsel just a moment ago and it sort of follows what I had said here about the fact that the fellows who draw the plans are the only ones that really know what the sign means. I used to be in the insurance business, gentlemen, and there was one way in which we used to try to convey to our sales force a method of translating the message. We would give it the so-called "KISS" treatment, meaning, "Keep it simple, stupid." I think when you are dealing with people moving as rapidly as they are, with the various levels of education and that sort of thing, our signing has to be kept simple. Then you can add the rest of it if you like.

Mr. HULBERT. I might add to that, "Simple, but not cryptic." That is really why we have cryptic signs, I believe. There has been an attempt to keep them simple.

I just wanted to comment once more on this sign installation. That is the "Exit 4–N," the way it is mounted and all. It is just the way that the advance notice signs of exit 4 were mounted. It could mean that exit 4–N is the next turnoff, just as well as meaning what I think it means, that exit 4–N is this turnoff.

Mr. MAY. Up to this point nobody in anyway has mentioned 4–N. There it is for the first time.

Dr. HULBERT. That is a continuity principle that we are talking about. That is presenting new information at the choice point, which is generally not considered good as a result of our study. In addition to those points, I was referring just to the mounting of the sign.

Mr. CLAUSEN. I have traveled briefly in Europe. I am sure most of you have had similar experience in crossing the various borders where they don't have the same language and they apply symbols rather than just the spoken words, because again in the interest of standardization, they can use the same type of signing in all languages. I think this is rather significant.

It may be that we could take a page or two out of their book. Obviously, they have greater difficulty in communicating with all the people who are putting the highway to use than we have here in this country.

Mr. WILSON. Mr. Chairman, I would like to comment on that. There is in process now a new manual on Uniform Traffic Control devices

that we hope to publish very soon. We have taken the lesson from some of the symbols used in Europe and Canada and Mexico and some of our American States.

You will see, if the highway engineers and others can agree on the system proposed, that many more symbols will be appearing as a result of our studies. This is in the warning series, the regulatory series of signs.

There is one other comments, and you may have some photographs on this. This is a symbol-type directional sign not too far from this interchange we are now looking at which is on the highway right now and under some type of test. We are just around the corner, Mr. Congressman.

Mr. CLAUSEN. This is very welcome news. Dr. Hulbert?

Dr. HULBERT. I would like to comment on that. I couldn't understand for many years how some of the signs I saw in the European sign books could work because they were complicated. Then I got a chance to go over there in 1963 and drove rather extensively. I understand now how they work. Their roads by our standards are substandard roads. They have practically no shoulders. You can't go very fast anyway; so you can read the small complicated signs.

As they are upgrading their standards of highways to our standards, they are adopting our types of signing. It is kind of a trap we fall into as tourists, I think. We are so glad to see something that makes any sense at all, and we feel this is terrific. But it really isn't, in my opinion. I feel very strongly about this, as you perhaps can tell. I have been acting as an adviser to the sign committee and making my views known.

We do have a great many symbols already in use on our highways, perhaps more than most people realize. In many cases a symbol is not the answer and the European people are actually going away from it.

Mr. CLAUSEN. I am glad to have that comment, because this bears out something that we have in the committee have felt, that before we plunged ahead we had better study this thing very much in depth because if other countries are going to follow the standards and recommendations that come out of this committee, or the agency recommendations, we are certainly going to have to be right. I couldn't agree with you more, Dr. Hulbert.

It has been my experience in a number of the countries, during some of the international meetings, that one thing came through loud and clear, that everybody has their eyes on what the United States is doing. We must be right, not only for our own benefit, but for some of the other countries as well. I was at the 10th Annual Highway Conference in Montevideo and also the Pacific Regional Conference in Sydney, Australia. If that is a basis for my authority, I had the pleasure of representing my country in those meetings.

Mr. MATHIES. Mr. May, I would like to make one comment here. Everyone seems to have his preferred wording. We often use, not only in signing on the Interstates but also in signing on other roads, the term "this lane."

I believe from the configuration of this interchange, as we will see a bit later, the direction you will go to Richmond is to the left. I have never felt, as has already been expressed, that the use of "exits" when

you are transferring from freeway to freeway, of which this is essentially an example, is good usage. My personal suggestion would be to use "this lane" rather than "exit only." If the interchange number is to be used, I would have it mounted over the exit to Washington as figure "4 north" and over the lanes to Richmond as figure "4 south," because those are the directions you are going. I would certainly agree with the other panel members here that the "thru traffic" sign contributes nothing. In my opinion, there should be destinations up there.

Mr. CLAUSEN. What was your last comment, Mr. Mathes?

Mr. MATHES. At an important intersection like this, I think the route number for the beltway, together with at least one or not more than two destinations, should be over that lane.

Mr. CLAUSEN. There is a thought that occurred to me, and I think you gentlemen have responded very well to this probing on behalf of the committee. That is the question of the relationship between the driver's map and the signs themselves. This is something I wanted to present to you in the way of a challenge.

As the committee staff indicated earlier with their movies, if they had had a telephoto lens it would have revealed before this distinguished panel of experts that the driver himself was trying to refer to some pieces of information; namely, a map. I believe they should be tied together somehow and obviously this has to be coordinated with a number of people in the private sector that have as an advertising gimmick the distribution of maps. While we are thinking in terms of standards for signing, I just want to take this opportunity to express the point of view of one Member of Congress that somewhere along the line it is going to have to be tied in and coordinated with the people who distribute the maps, and I believe they themselves must have more of this type of information. You can't do one without the other.

Mr. SCHOPPERT. We think that is one of the principles of signing, that whatever you say up there has to relate to the kind of information the motorist has to begin with when he starts planning a trip. For the local people, those in the metropolitan area, probably the exit numbers are important. For the long-distance driver, obviously, names and route numbers and so on that he can get from a map are most important.

As I stated yesterday, I think the maps are really grossly inadequate for this purpose. They are all right for general orientation, but they are frequently inaccurate and out of date. With a rapidly expanding system they show roads which are under construction as completed and those which are completed as under construction. They don't show enough detail at this point, for example, to say that you are going to have to get off to the right or the left and things of that kind. Nor do they show in most cases enough detail to know that there is either a partial or a full interchange at that point. I think a good deal has to be done to improve the quality of the information this man can have before he begins his trip, so that he can cope with these situations.

Mr. CLAUSEN. But again the key, as far as the preparation of the map, must be the finest information in the way of signing, so that once this is transferred to the map you are dealing with something that is to give us the maximum in understanding and, hopefully, safety. I think this is the point Dr. Hulbert was making earlier. Is that correct, Doctor?

Dr. HULBERT. Yes. Of course, that is one of the six basic principles that were in the 1958 study. I also noted that in recent news releases there is some indication that the gasoline, the petroleum industry, are showing some reluctance to continue the free map service that we have grown accustomed to. They were citing examples in their testimony at a Boston hearing, as noted in the news, of difficulty in getting enough information. They were citing the great cost of updating a great many millions of these maps. So there is a problem on their part to which they have given voice. It looks as though it is going to need some attention in the future and not too far off.

Mr. CLAUSEN. How long do you believe it would take to complete the study we are now talking about and come up with the kind of recommendations that would give us the answers that we are really looking for as far as the signing is concerned? Would it take 6 months or a year?

Obviously this has to be coordinated between the various States and those people who are in the highway planning and engineering business. What would be a realistic figure? As you can see, gentlemen, I am very much concerned about what is happening here. We are considering safety legislation, and all of these things, and I happen to think this is one of these areas where we can really do something about helping the traveling public. How long would it take?

Mr. MATHES. Mr. Chairman, might I comment on that? I will also ask if Mr. Prisk and Mr. Wilson will say something about it. As was mentioned earlier, the standards in this respect are currently being revised, both for the Interstate and for all other types of highways. These other things I would like to request, if I may, that Mr. Prisk and Mr. Wilson use as the basis for comments. An attempt is being made to do the things which you have suggested. I believe they will provide some improvement over what we have had in the past. I believe getting them into use after they have been developed will be our main problem.

Mr. PRISK. I think it would be reasonable to put a fairly short time estimate on improvement of the standards as far as they are written into a national document is concerned. The American Association of State Highway Officials has a special committee at work now, on which I serve as secretary. It is in the process of revising the 1961 edition of the Manual for Signing the Interstate System, which has resulted in some of the installations that we are looking at here today. It incorporates a great many improvements above and beyond the things we are looking at here today.

For example, there would be no installation of this particular type sign at that location. It would be moved considerably in advance of the actual decision point. This is one other improvement that has not been mentioned under discussion.

The exit numbering which you see on the central post would be permanently displayed across the top of the sign so it would be the very first thing drivers saw. These kinds of improvements are being written or have been written, most of them, into the Interstate Sign Manual for a 1968 edition which should be available in the fall of this year.

I would say as far as accomplishing the installation, as Mr. Mathes mentions, in a particular State, this would depend on how rapidly an installation of that sort can be financed. All told, I expect that the

expenditure for signing on the Interstate System is on the order of a half billion dollars or more, so it is not a small expenditure that we are talking about making to replace the previous investment, but in those locations where signing deficiencies are critical, it is most important that replacements be made. I am sure that the Federal Highway Administration position on this will be to hurry these changes along in any case where there is a safety deficiency involved. That position has been flatly stated, both by the Director of Public Roads, and the Federal Highway Administrator, and is being followed.

With respect to the Manual on Uniform Traffic Control Devices, I think it would be best that Mr. Wilson, who is chairman of that committee, speak on the time schedule on that work, which is proceeding on a coordinate fashion with the changes for the Interstate System. I would say that we are extremely hopeful of having in print the Interstate Sign Manual within the next few months.

Mr. MAY. Mr. Wilson?

Mr. WILSON. Mr. Chairman, I have been associated with the National Joint Committee for a little over 4 years now. Some of the things that were brought to my attention during the early participation in these meetings have now borne fruit. To give you a rough idea as to the extent of time that some of these things may take, when I first joined the committee we were having a problem involving the driver driving down the highway in the wrong direction on a one-way highway. It took approximately 2 years to develop the research that was needed to find out just what we could do to help this problem. I think you are quite aware of what happened in California on this particular subject. There have been other studies that have been underway for a period of time. There has been some work done on changing the design of the yield sign. It is now a yellow background sign with black letters. The proposal has been made to make the yield sign a white background sign with a red border, which the National Joint Committee is going to propose. This has taken a number of years, to get all the things together.

One of the reasons for this is that there has been no real directed effort toward bringing all the research into a coordinated effort. The progress has been slow because of that. Another reason is that there hasn't been enough interest, you might say, in the particular areas of research. The effort has been small.

Even right now the Federal Highway Administration has a couple of projects underway and I am sure they are getting ready to work on others in the field of highway signs. There is one that has just been concluded by the Bureau of Public Roads on the development of symbols, the testing of symbols. There was a very modest project in the National Highway Safety Bureau to evaluate some of the new proposals that have been made by the National Joint Committee. This has just gone to contract and we expect to have some results from this somewhere around the first of next year, hopefully in time that we can have some influence on the publication of the Manual on Uniform Traffic Control Devices which we hope will be very early in 1970.

This research can go on simultaneously in a number of areas. For instance, the warning sign type of research can be carried on by one type of operation and the signing as we have discussed here can be

carried on by another unit, the guide sign series. I hope that out of these hearings we can get a more concerted effort to help the National Joint Committee in getting research done that will help them make the right decisions. They must be right because the figure that was just mentioned here of a half billion dollars to make a change in the guide signs series around the country is quite a stack of money, as we all know.

Mr. CLAUSEN. It will be pretty expensive for each State.

Mr. WILSON. That is right. As far as timing is concerned, it just depends upon the level of effort that is exerted on it. I think you could not expect any major work to be done in less than a year and it may take 3 to 5 years.

Another thing is, when you get that research done the needs of the driver may be changed by that time and you should continue such a program to find out what the needs are at that moment. It all depends on how much effort is directed toward it.

Mr. CLAUSEN. I think you have put your finger on what the key points are, which is there has not been any direct effort. This is the prime reason for the committee's holding hearings and I might say parenthetically I believe this is one of the great purposes that this committee and its staff can serve in the way of a function that serves the entire public interest.

In life, we tend to drift, and unless there is something that comes into our life that sucks us into a way of action, nothing happens. It is a question of priorities, and making a direct effort. I think there are other Members of Congress who are sitting on this committee who have grown almost to the point of impatience. Can you elaborate on the last date when the standards were established?

Mr. MAY. The current book for the Interstate signing is dated 1961. Is that right, Mr. Wilson?

Mr. WILSON. The National Manual on Uniform Traffic Control Devices, which covers all streets and highways except the Interstate—and it does cover the Interstates in many respects—was 1961.

Mr. MAY. And the Interstate Manual was also 1961?

Mr. WILSON. That is correct.

Mr. MCGRATH. Mr. Chairman, I would like to speak to this point. I agree wholeheartedly with what Mr. Wilson said. I might feel a little more strongly about it than he expressed. But are all the signs of all the streets and highways to be considered? The signs in the urban areas do not deal with 65-mile speeds, but we deal with very complex situations and we are using signs we do not know enough about. I am greatly disturbed by the way in which we are writing our standards. That book is loaded with page after page and word after word of standards and much of it, in my judgment, is purely judgment, with little research backing it up.

Dr. Hulbert mentioned sporadic research here and there and somewhere else. All of us who come together to work on this find we have little bits and pieces, but no one is directed to do it. I do not know whether a Federal agency should do it or some specially created nonprofit agency, but it seems to me absolutely essential that a continuing research into all kinds of signing—as well as other highway matters—be started.

On our timetable, as long as we continue to build new highways and develop them, we will have to keep researching and changing our approach to signing also. It is a developing process that in a sense is never ended.

Mr. MAY. Mr. McGrath, what research is the joint committee conducting?

Mr. MCGRATH. The joint committee doesn't do any research.

Mr. CLAUSEN. What was that again?

Mr. MCGRATH. It doesn't do any research. It has no wherewithal to do research. It receives research results from the Federal Highway Administration, from the highway research board, from the American Association of State Highway Officials, from the Institute of Traffic Engineers, and from anywhere else where it might be done. Its members, because of their position in other agencies, from time to time can cause research to happen that is needed, but the joint committee as a committee has no way to see to it that a piece of research that it needs and knows that it needs can get done.

Mr. MAY. Mr. Wilson, can you address yourself to that problem for a moment? What influence does the joint committee have on what research may or may not have to be done?

Mr. WILSON. Mr. McGrath is correct. The national joint committee has no facilities for research. The members have access to State highway department research results. In fact, when I was still working with the California Division of Highways, we were instrumental in conducting some research, but it was on a hit and miss basis. I had to sell the State highway engineer there on the needs for this particular research and in many cases permission to do it was granted.

Not all of the members on the national joint committee have access to this sort of thing. We have proposed, from time to time, requests for research through the highway research board committees, hoping to get some of the research conducted by the national cooperative highway research program, which is a combination of AASHO and the highway research board activity. We have gone that route. I might go one step further regarding membership on the committee. It is composed of many public officials and all from the private sector. It is a voluntary group. The members serve without compensation of any kind. In fact, many in the private sector pay their own way to the meetings that are held twice a year and occasionally oftener. These men are busy on other jobs. It is difficult for them to spend a lot of time on the effort that really is warranted. That is one of the problems, too. The committee just does not have resources along that line.

There are in the Federal Highway Administration two people who have been designated to serve on the staff in a secretarial capacity. Even these two people can only serve part time on it because they have other duties. The committee activity is somewhat limited, as you can see from this discussion.

Mr. MAY. Mr. Wilson, you mentioned that there is going to be a change in the yield sign. What is it going to look like?

Mr. WILSON. It will be the same shape. Let's put it this way: The national joint committee is recommending the new yield sign. It has not been approved by the current organization or given to the Federal Highway Administrator for compliance. The yield sign will be the

same shape. It will have a white background with a 5-inch red border around the outside of it.

Mr. MAY. What is the size of the letters?

Mr. WILSON. I am not sure there will be letters on it. Here is a symbol sign in the strictest sense. If there are letters, it would be a contrasting color with white. It could either be red or some other color.

Mr. MAY. Have we done enough study to conclude that the black on yellow yield sign is not working?

Mr. WILSON. A yield sign is a regulatory sign. It is a sign that the national joint committee feels should be in black and white combinations. The new color scheme that is being proposed by the national joint committee uses that in a restricted sense and we feel that the red has a greater application on this sign than the yellow.

The work that has been used to back up this recommendation was largely done by the State of New York. The people up there had tried this out. There is some research results that led us into this decision.

Mr. CLAUSEN. How many yield signs would you say you have in the country and what would it cost to replace them?

Mr. WILSON. That is a question I could not answer, Mr. Chairman. I know there are very few used in many States and many more used in others. The cost of an individual sign in all probability would be around $20, but as far as knowing what the overall cost would be to change them, I could not answer that.

You have to recognize that any change that is made is not going to happen overnight. Hopefully, we will be reasonable about this and face the economic facts of life. Changes of signs can be made during the normal maintenance. Signs generally have a life of 2 to 5 years and as they are worn out they can be replaced with the new signs. Hopefully it would not place any undue economic burden on local jurisdictions or State highways.

Mr. MCGRATH. Mr. Chairman, we should also consider the stop sign. We changed the stop sign some 12 years ago from yellow to red. You asked how many signs there are. There are probably, in a city, in the neighborhood of a hundred times as many stop signs as there are yield signs. We changed those, and other cities changed theirs, incidentally without any Federal aid. It was not burdensome. We had to do it, so we did it. It is costly, but it wasn't that costly. It was an improvement and we went ahead and did it, and I am sure we can do the same with the other signs if we have to.

Mr. CLAUSEN. From the standpoint of public acceptance, I am sure you wouldn't have any problem of convincing them of the need to make the change; would you?

Mr. MCGRATH. I think the public accepted the red stop sign as an improvement in a way. We found the yield sign simply didn't work in cities, although we have little research to back up that observation. People seem to think it is just a caution sign and don't use it properly.

Today we find ourselves using yield signs for two entirely different situations. Cities use them to control intersections and highway departments use them to designate right-of-way on entry ramps to freeways, which are not the same situation, and we probably should not use the same sign for it. City-oriented people think they should be changed to red like the stop sign.

I view the present design as a compromise. I don't think research should lead to compromise. I think it should be to achieve what is hopefully the right solution. I don't know whether the new yield sign is going to be good or not.

Mr. CLAUSEN. Dr. Hulbert?

Dr. HULBERT. I waited because I didn't want to be selling research, since that is my activity. I heartily endorse what has been said about it. I would only add that I have been advising on research matters to the national joint committee and would testify that I have never seen a bunch of harder working guys. They put in all kinds of hours and they are not supported, and neither am I, in my advice to them.

You can't solve all these questions by research in the classical sense. You can't turn these problems over to the aerospace industry because they have been doing a good job in another area of research. It is not that kind of information that is needed. Teamwork is needed here between the practicing people, the highway and traffic engineers.

Last year's hearing pointed to a communications gap between the design engineers and the traffic engineers. There are many other gaps here that need to be closed and they must be closed by some kind of a coordinated kind of teamwork approach.

A very good first step in that direction which was not pointed out, in answering the question, is the first meeting—and other meetings will follow—of the Task Force on Transportation Graphics and Communications. This was called by the Federal Highway Administrator and was an excellent meeting which I was fortunate to be able to attend. It brought in the graphics people, the architects, as well as communications experts from other spheres such as the Armed Forces and the telephone industry and the radio industry.

This sort of thing is just a step, but it is in the right direction. I would caution very seriously against the notion that you can just grant some money to either universities or to aerospace type research groups and they will solve your problem for you. They will not. This has to be a hard fought continuing research and trial. I would distinguish between research in the classic sense and the installation of signs, which in the last analysis, is the proof of the pudding. This is what the various traffic engineers, with the guidance of the Institute of Traffic Engineers, is continuously doing. It does need some centralization and coordination and some support.

Mr. CLAUSEN. Looking at the picture now being shown, there is one of the best examples of the gap between the design of the construction engineers. How many of you can see this sign saying "exit 4"? I sat here half an hour before I saw that. It blends in at this particular point with the construction. This brings me to probably a sensitive question, but I am pleased with the responses that I am getting from you gentlemen as a result of having challenged you a little bit. That is, some one person is responsible for this. How do we get to the person to make the proper kind of impression so that in the future that same mistake will not be made again?

I realize this is one of our great problems in trying to coordinate this with a number of agencies where there are a lot of people who are constantly shifting.

I think this is one of the great advantages of this particular committee. The way we handle this is to bring the people in who are ex-

perts. It is difficult for them to admit there was ever a mistake made, being particularly their own. I have taught a lot of people to fly in my lifetime. The one thing I constantly concentrated on was that they knew when they made a mistake so they wouldn't make it over again. Someone made that mistake. How can we resolve this? How can we get to this person so he will relay the message to other people not to make the same mistake? The best way to resolve these problems is not to make a mistake in the first place.

Mr. WILSON. Mr. Chairman, I would like to comment on that. At the conclusion of the hearings last year regarding safety, I will tell you how one department got to the right people. When I left these hearings, it was obvious that there was a communications problem between those who knew what to do and those who could do something about it. The fellow on the drafting board; the fellow who is resident engineer on the project who could still make the change was vital; the maintenance engineering man who is driving by here every day in the week and doing miscellaneous things that all lead to safety; all need coordination.

The highway department that I was associated with organized a training session and we trained 3,500 engineers of various kinds. They were the professional engineers, the key people in the construction department, the key people in the maintenance department. We had a day and a half seminar. It should have been 3 days or 5 days. It was done.

The results of that are almost immediate. The resident engineer that is shown what he can do, or what he needs to do, can go out immediately and make change orders in the contracts and see that it is done. The man on the drafting board can immediately institute changes which will appear on new highway construction, say 2 years from now, when it is underway.

Mr. CLAUSEN. You are referring, Mr. Wilson, specifically to the slides that were used in this hearing room, primarily brought about as a result of Mr. Joe Linko having focused some attention on this?

Mr. WILSON. That is right, and that was a year ago last June.

Mr. CLAUSEN. I am glad you responded as you did. As you know, I was one of those on the telephone with Gordon Luce and some of those others out there, bringing to their attention some of the information that was brought to our attention here in this hearing room. That is what I mean when I say that I believe this committee performed a very valuable function in bringing about these things, but the key is that you took it upon yourself to do something about it.

My question is, how do we get this done in every State in the Nation? Frank Turner is a man for whom I have the greatest respect. I think he is one of the finest men in the highway work in this country, but Frank can only be as good as the other links in the other States.

Mr. WILSON. I can make one more comment that I am sure you will be interested in. When it came right down to the wire as to how we were going to finance this program in the California Division of Highways, we looked to the Federal Highway Administration and the National Highway Safety Bureau for that help. They did finance 50 percent of the training given to these 3,500 engineers. When I transferred from the California Division of Highways to the Safety Bureau I was real happy to see that come about, as you well know.

As far as getting it into other highway departments, that is a problem that I have not overcome. We have endeavored to point out the benefits of such a training session by publications that have been put out by the National Highway Safety Bureau, but as yet we have not had a highway department respond and ask for this type of training.

If you want to think in terms of doing this same thing along the lines of signing and designing, I am sure that certain portions could be worked out and the same type of operation gone through. You see, the course we had was directly related to safety, directly related. This is, of course, safety oriented as well, but there are some other factors here that were not covered. We were primarily interested in the eight or 10 subjects that were discussed at the hearings last year—the median, the fixed object, the breakaway posts, and this sort of thing.

Mr. CLAUSEN. As you know, this committee also held some extensive hearings in one of the States that was having some very serious problems in the manner in which their inspectors out on certain highways were following through with the established guidelines. I do know that that particular operation of highways in that particular State is substantially improved because we brought a number of people before this committee and started asking them some questions. I think this is one of the great services that we can yield to you gentlemen who, I know, want to do that which is proper in providing the maximum in safety for our highways, as we move through this great transitional period in advancing the mobility of the country.

Mr. McGrath hit on a key point, which is the question of what is going to take place with the primary and secondary roads of this country. I can tell you as the author of the amendment that they are going to increase it. We have got to balance out the highway system in this country, and this is one of the things the Congress is going to have to face up to.

As far as I am concerned, I am going to do all I possibly can, because to me you tie economic growth with this and it will be self-sustaining, but we need to have a few more people focus attention on this. This is the sort of thing I think needs to have the kind of priority and consideration that has been long overdue. I am with you, Mr. McGrath.

Mr. MCGRATH. Mr. Chairman, a point on this training matter. Mr. Wilson pointed out a very successful program in California, because the California Highway Department saw the needs and initiated it. Then he finds in some other highway departments they are not so willing. What this suggests is that you cannot put all your training effort in a setup that relies on the other public agencies, local and State, to initiate training. You must also have a setup in which you can reach individuals. What individuals need is the opportunity to participate in a training program that has been established and is operating, and they can go to it and it doesn't make any difference what agency they happen to be working for at the moment. We all need a lot more trained people.

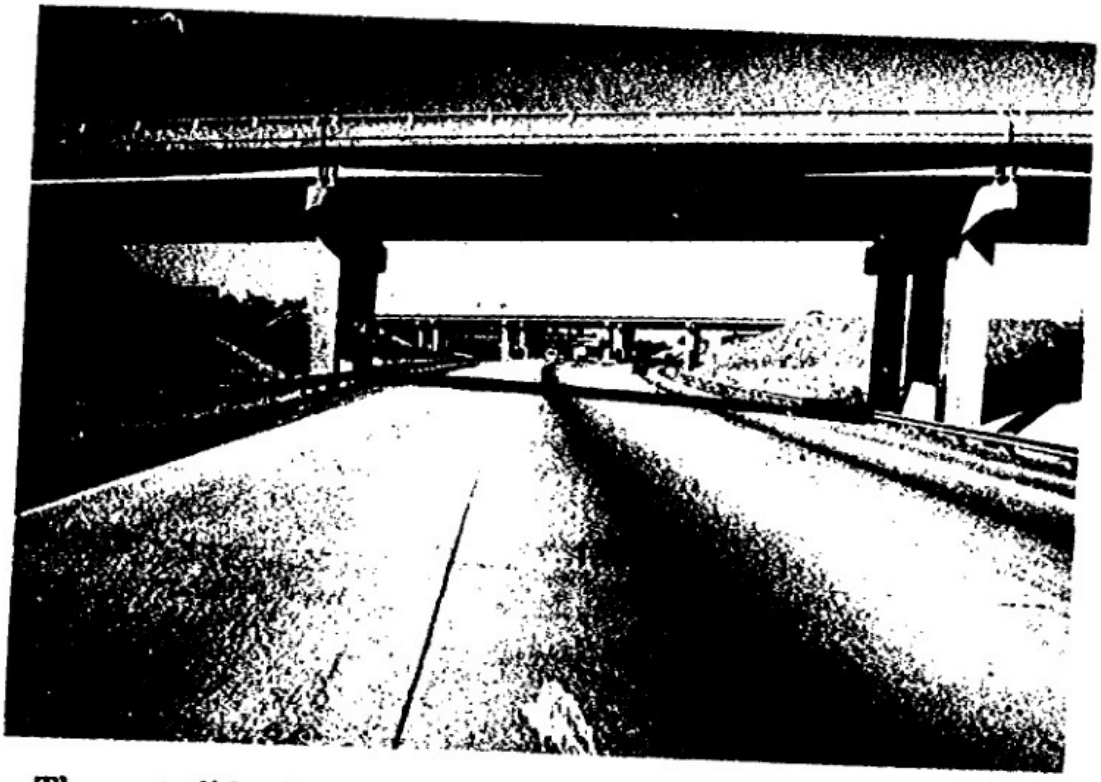
The situation today in the cities is such that we can virtually hire no one highway traffic experience. We are lucky to get a civil engineer with a bachelor's degree. We sometimes have to hire just anybody and train him on the job because there is just such a shortage of trained people for this work. If we relied on the agency, our city wouldn't be likely to initiate it, and yet our people would certainly like to see some of the employees trained if the facilities were available.

Mr. MATHIS. Mr. Chairman, I think I should speak here because I am a State highway engineer. Mr. Wilson has mentioned your training program in California. I don't propose to speak in defense of the States. I know that some of them may have better programs than others.

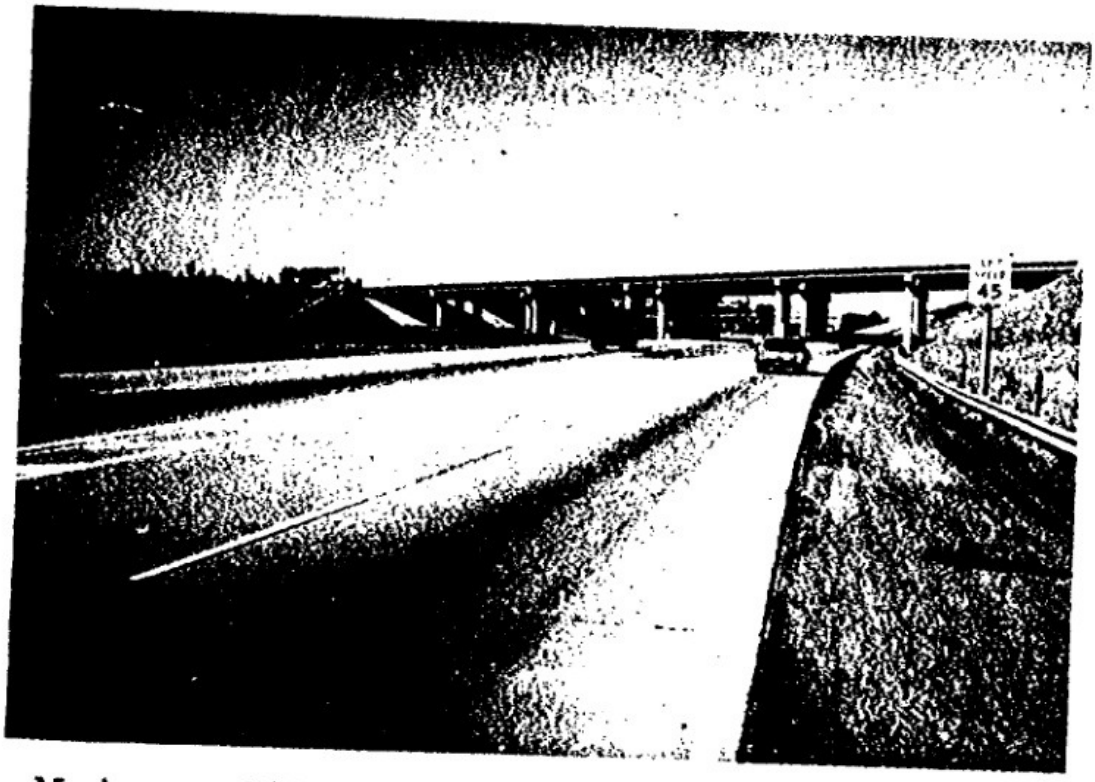
Speaking for my own State, we have a program of this type. It is what I would call a continous one. We have sessions such as this annually, where these matters are brought up. I would suspect that many of the other State highway departments do the same. I wouldn't say that we have always accomplished everything we would like to do, but I do believe that some of us—and I know my own State does, but I am not familiar with all States—have a program aimed at this area, particularly with reference to training and getting the information across to the workers in the field, the people who are out on the project doing the work. I wanted to mention this for that reason.



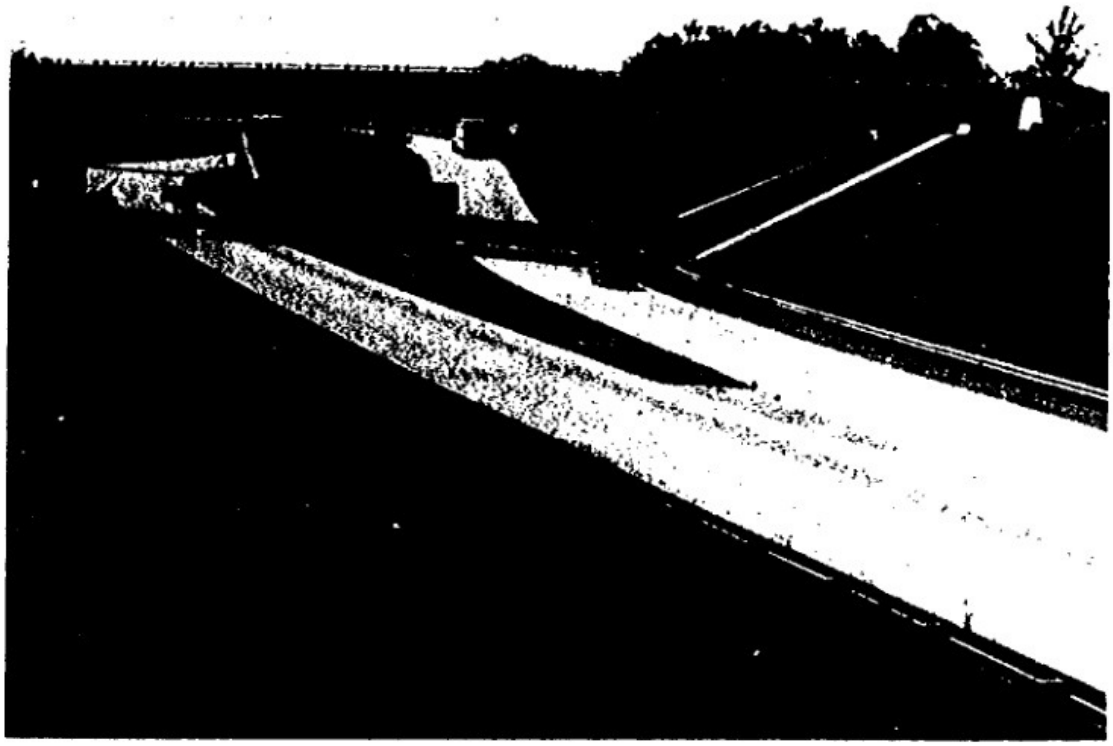
Mr. SCHOPPERT. The motorist continuing on the beltway beyond exit 4N would next see the sign shown here, showing Route 95 south to Richmond with an upward sloping arrow and under that exit 4S.



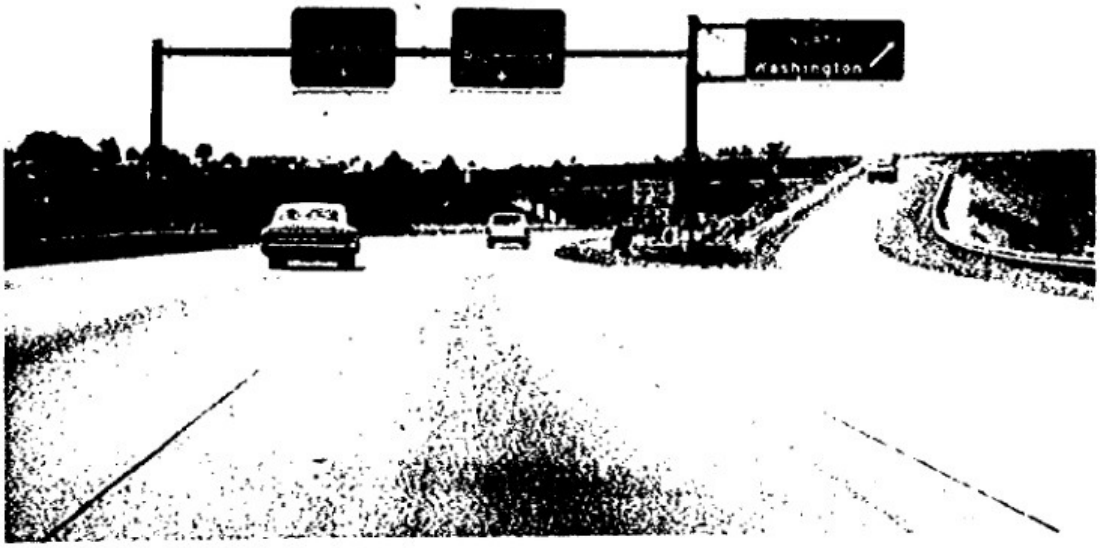
The next slide shows the continuation beyond that sign to exit 4S. You can see in this the off ramp to the right and the two lanes continuing on through.



Moving up a little closer to the actual point the off ramp becomes two lanes and the exit sign is a good distance beyond the point where the motorist has to make his decision.



The next slide is taken near the point of the gore and it shows the exit sign and the ramp to Richmond departing to the right from the main roadway on up and over for a left turn to go south onto Interstate Route 95. The signing at this interchange has been modified by the addition of a number of signs which say "This Lane Right Turn Only" and those signs were in place during the time the movies were taken showing the erratic behavior of motorists at exit 4S.



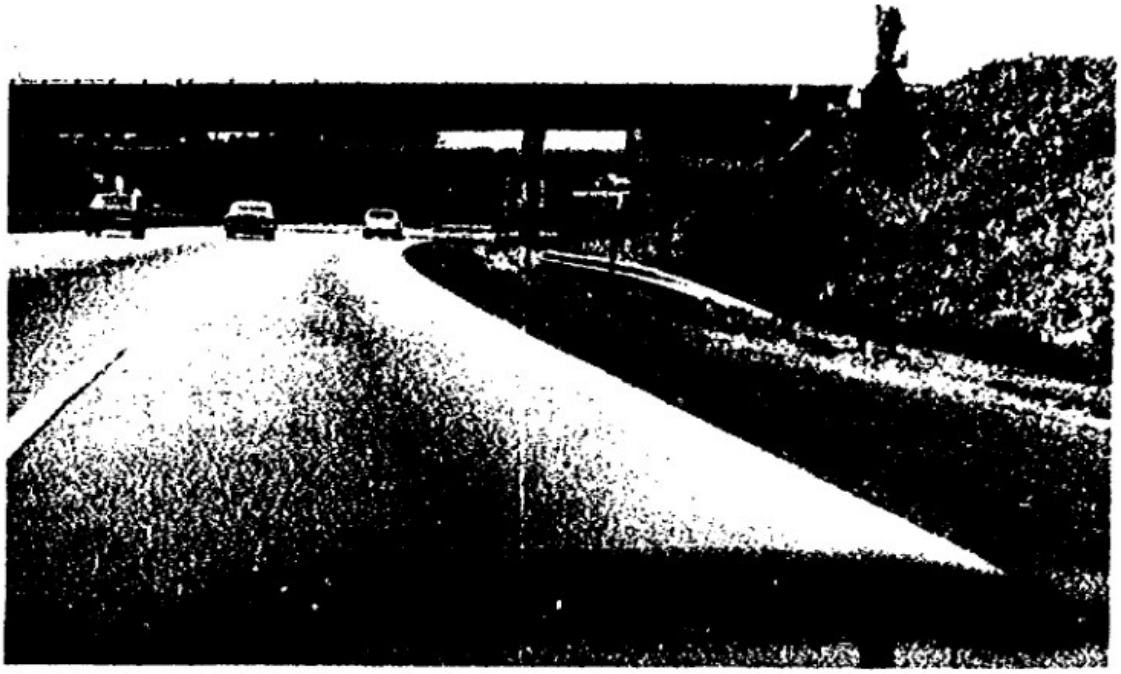
To illustrate how these new signs are positioned, we begin again at exit 4N where there are overhead signs, one saying "Route 95 North to Washington" on the right, then over the righthand lane on the beltway, a sign saying "Route 95 South to Richmond, Exit Only" with a downward arrow and over the left two lanes of the beltway through traffic.



Just beyond that sign is the first of the new signs which has the legend "This Lane Right Turn Only" with a small arrow sloping downward toward the pavement edge.



The second of the three signs is located just beyond the first and in fact is located so that it partially obscures the sign which was shown earlier. It has the same message as the first.



The last in the series of three signs is positioned just beyond the directional sign and is shown in two slides. Signs of this kind have been used at at least one other location on the beltway where a lane was dropped in an interchange and that's at exit 12 which is the Dulles access highway interchange with the Capital Beltway.

Judging from the erratic maneuvers of motorists which were shown in the motion pictures taken at this off ramp, the new signing has not been a complete success. I think there are definite limits to what signing can do to overcome flaws in the design of the highway and I would think a more permanent and lasting solution would be to eliminate the lane drop.

Mr. CLAUSEN. It is possible, gentlemen, that we may have to go over to the floor and there is another movie that I would like to see. I see Mr. Turner has come in and we would like to have him see this. Mr. Leisch, if you will make your comment, we will show this next movie.

Mr. LEISCH. I have been involved in training to some extent, and I have some obeservations on this. I think you can do a lot of training that does very little good. I think it is necessary to get to the top people in highway departments. It is absolutely necessary to get to them. I say this from experience. I teach regularly at Northwestern University Traffic Institute, where, as an example, we come together at least twice a year with about 40 men from all over the country who are with highway departments in cities. We present and discuss some of the things that are being discussed here. In questioning the man there, they say, "Well, this is all very good, but we can't get it across to our superiors, or we have certain standards we cannot overcome." This is a real difficulty.

In this connection, we tried something through Northwestern University in Illinois. At the particular time, we were presenting a seminar on highway capacity as a result of the new highway capacity manual. That brings forth tremendous improvements, or can bring them forth, in design or operation if it is applied properly. There is quite a bit of new material there.

This was presented to the working people, the engineers and technicians in the State of Illinois, in about three groups of 35 or 40. They were not quite sure if this was the way to put it across. We realized the problem and there was one additional seminar where the top people actually came and the course was condensed to about 3 days for them. In this particular course, the objective was primarily to develop the subject from the point of view of developing the proper attitude, a sense of responsibility, and the philosophy that is behind it. These men at the top could then accept what the men below have to offer as a result of their more intensive training. Unless we do it this way, I don't think a lot of this training does very much good. This is my experience over many years in dealing with this kind of problem.

Mr. CLAUSEN. I think Mr. Wilson's comments earlier got some results from the top people in California. You got some results, didn't you?

Mr. WILSON. Yes, we did. It was a good program and easy to sell.

Mr. CLAUSEN. I will not prolong it at this particular time, but if any of you gentlemen would like to amplify your remarks, possibly the committee could help in this regard. I would ask that the record be left open at this point in the event you would like to embellish any remarks you may have. You might like to indicate how you feel we can actually close this communication gap that Dr. Hulbert referred to earlier.

One other thought has occurred to me. When was the last time you had a questionnaire presented to the traveling public by any organiza-

tion, simply asking the question of what is on their minds, how can we improve safety, what are the problems they see? I assigned this to some young people who were traveling from California to Washington, D.C., to visit us. I talked to them on the telephone, and I said I would like to have them participate in this great experience we call democracy and outline to me some of the problems they encountered as they came across the country with respect to highways. The information was very revealing and very helpful to me. And I think again this question of involvement of the entire population needs to be considered.

I am going to ask permission to insert into the record a column from the Dodge News magazine of July 1968, which I have before me, and which asks questions of the traveling motorist. "What do you know?" Without objection, I will ask that it be inserted at this point in the record, because it tends to bear out some of the responses that are being offered by he traveling public.

(The article referred to is as follows:)

WHAT DO YOU KNOW?

This column recently called for ideas for improving our system of marking highways. One of our own ideas, giving each route its own distinctively colored road surface, has been applauded by many readers. On second thought, though, we aren't so sure about it. How would it work in winter when pavements are covered with snow, or in rain when the color of the surface might change?

A number of readers have come up with ideas of their own. Here's one from James M. Ambrose of Bergenfield, New Jersey.

". . . instead of pointed arrows being used on roadways and marker signs use rounded arrows. On the theory that the pointed arrows denote flight and speed whereas, the rounded arrows would indicate slowness and caution."

Mrs. Alice Lodesky of Plains, Pennsylvania, offers this for a new system of traffic signs: "Have a snake for a curve, a camel for a bump in the road, a turtle for slow, a reindeer with horns for a road divided, etc."

Mrs. Lodesky says this would be both easily understood and entertaining. And the possibilities for imaginative sign design are nearly unlimited. A one-hump camel for a small bump; a two-humper for a rougher one. And where there is a bridge or road charging a toll, we'd have a bell.

Mrs. Helen Hester of Stroudsburg, Pennsylvania, says:

"I am usually confused when trying to exit on the Turnpike. I know I must get off on the right exit or I'm in trouble. My suggestion is that if the exit is 46 and the town is Quakertown, why not have a small Quaker painted on the exit sign as well as on the road map.

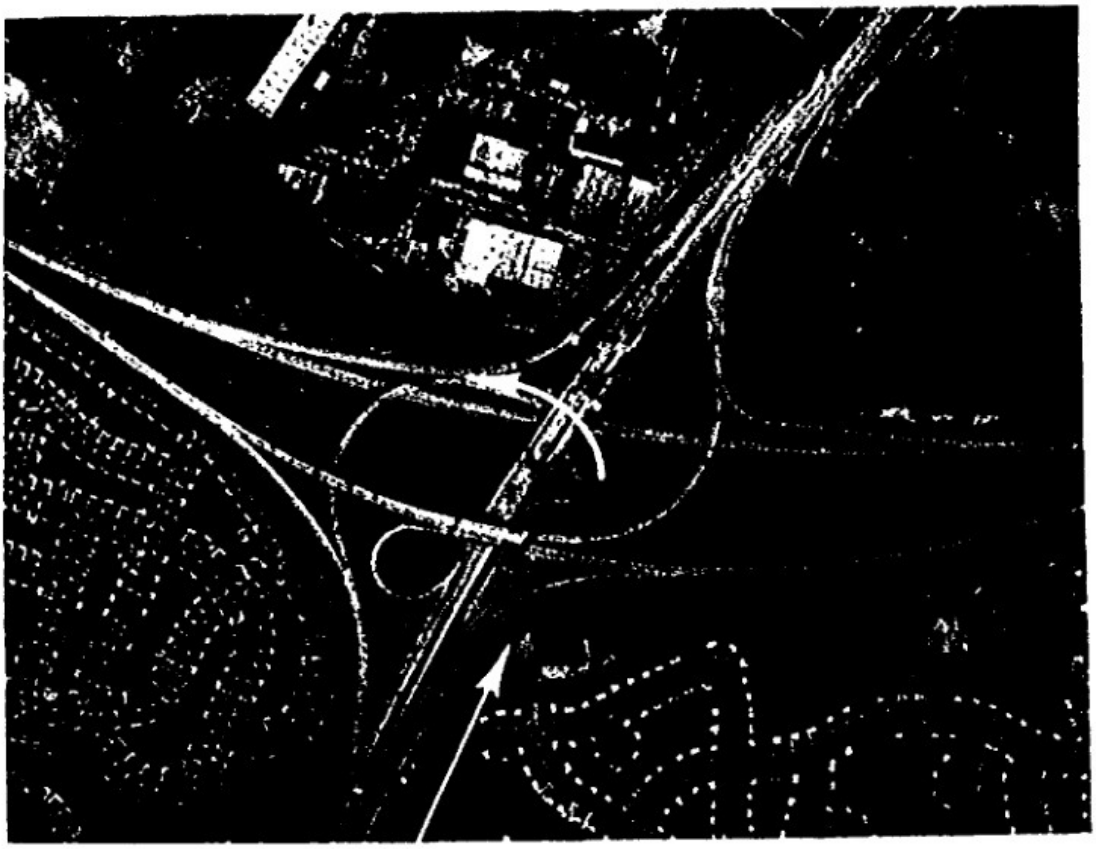
"If each city had its own symbol typical to that city, its landmark, industry, etc., I think directions would be much easier to follow."

Very good. Each city could have its own trade mark.

Interesting ideas, aren't they? Do you have any more? Send them to this column.

Mr. CLAUSEN. Some thought might be given to directing a questionnaire to a cross-section of the people asking them what problems they have as they travel around the country.

Unless someone has some further comments, I will suggest to Mr. May that we proceed with the film which you have prepared for us.



Mr. MAY. Mr. Schoppert, this is the aerial view again showing Route I–95 heading north and joining the beltway, I–495. We will see that the traffic has to lead to the right and then split again to go east and west on the beltway. Would you point that out on the screen?

Mr. SCHOPPERT. Here is the traffic from Route 95 northbound, all leads to the right and comes down here and then branches to go either west or east on the beltway.

Mr. MAY. I think the question might be asked: How far is it from that first gore area to the second? We think it is the area of some 500 feet. Would that be about right, Mr. Schoppert?

Mr. SCHOPPERT. I would expect that is about right.

Mr. MAY. Could we drive through that movement?

[Movie.]

Mr. MAY. At this point you swing right to go east on the beltway and left to go west. You will notice the sign "495 West, Fairfax." It is a 25-miles-an-hour ramp. We have had previous testimony that is a tight turn and gives trucks some trouble. You will notice if you keep looking toward the left how the lane begins to drop with no signing to the motorist that the lane will drop. It merges with the main lane from the right.

Right here it is four lanes and the left lane is tapering off. Now it is dropping and now we have three lanes, and two more lanes coming from the right. They will taper off also.

Now it is three lanes and now we are down to two lanes.

Now we will observe what happens in this area. We are looking at this first gore area. This is taken from another angle. That is the first gore area we are looking at.

Mr. CLAUSEN. It would be very interesting if we could have someone on the spot to talk to these stopped motorists, and ask each of them, "What is on your mind?"

Mr. MAY. The staff had talked to some of the people and found their comments very interesting. Watch that little black car. You will see he proceeded with confidence. Now here he comes back. You will notice that the motorists who stop will frequently pull back into traffic without regard to whether anybody happens to be around.

Here we will notice even the professional drivers have their problems. We now have a truck stopped.

We have great difficulty, Mr. Chairman, in getting across to many engineers how frequently these maneuvers take place. At no time, at any of these locations, did we have to wait very long to shoot film. These maneuvers take place generally within minutes. It depends on the traffic volume and how familiar the drivers are with the locations. Once you get strangers in here it happens more and more.

We have observed similar locations in many States in our work, and when we select a location sometimes you will get eight in a few minutes and sometimes you will get eight in a few seconds. If anybody picks any of these locations and watches them for just a little while, they will soon become convinced that they happen much too frequently. We have never been to any of these locations, even for a short time, without seeing these types of maneuvers.

Mr. CLAUSEN. Do you have any statistics on the possible number of accidents that might occur?

Mr. MAY. Yes. This is another very difficult area, Mr. Chairman, as to why the accident took place. It is very difficult to answer, particularly on this, from the way the reports are maintained. Mr. O'Hara, do you have that data?

Mr. O'HARA. There were 156 accidents.

Mr. MAY. Over what period of time did they take place?

Mr. O'HARA. That is over a 3-year period, 1965, 1966, and 1967.

Mr. MAY. This fellow must have backed down a quarter of a mile. Watch him. We have had so much testimony from research psychologists pointing out that what these people do is to balance what it means to them to take the chance of making this maneuver versus continuing on a road where they don't want to go.

Mr. Schoppert pointed out that sometimes you can't with confidence continue on to the next interchange, figuring you can turn around and come back, because sometimes you cannot.

The camera stops picking up this car, to pick up another person doing exactly the same thing.

Mr. CLAUSEN. Again, this is the ramp turning right off I-95 to go onto the beltway heading east. They didn't want to go there. They wanted to go north on I-95.

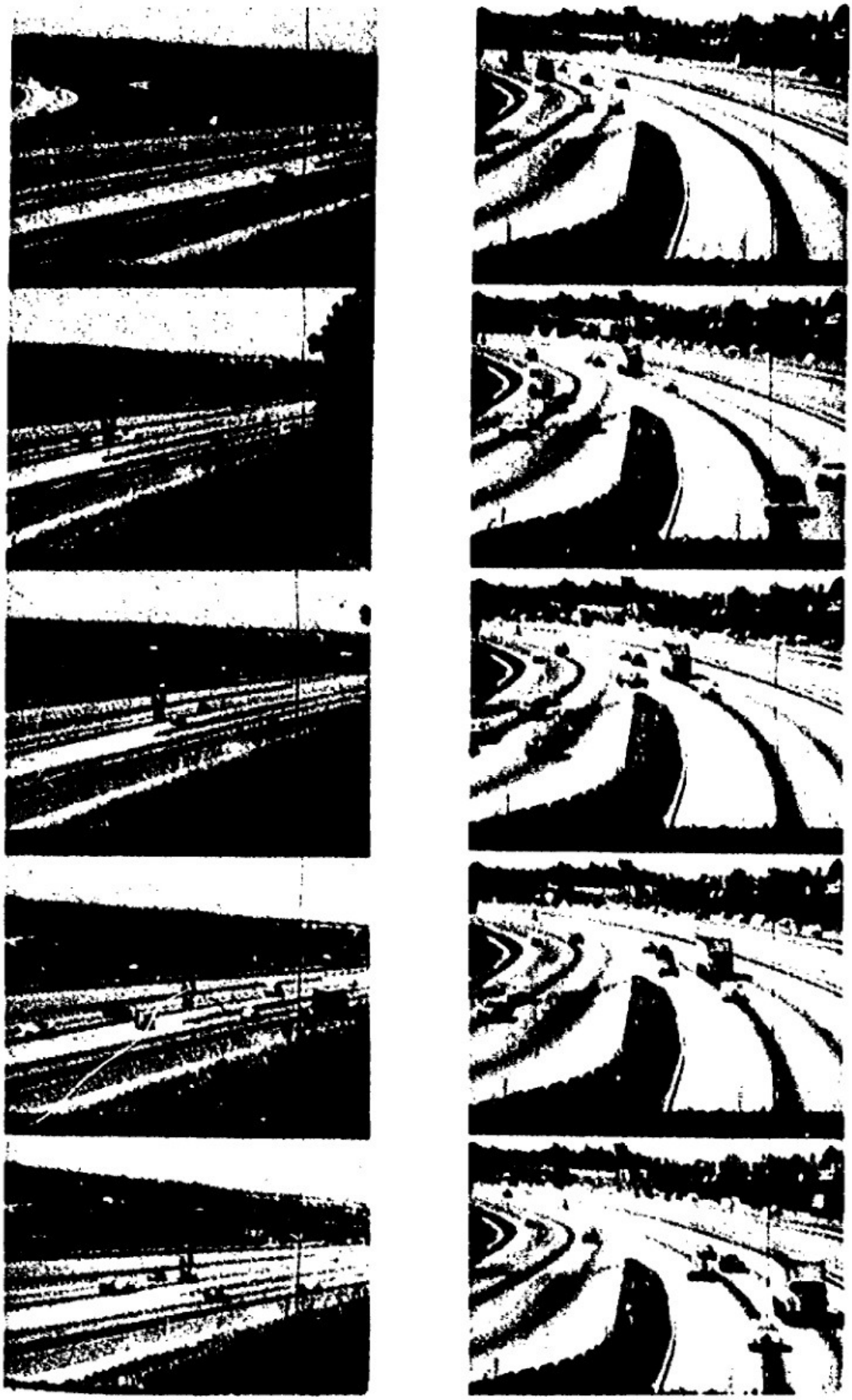
The gore route sign assembly was knocked down and you will see the maintenance man taking the sign away. I will say this for the highway department, that within a couple of days they replace them. Is that right, Mr. O'Hara?

Mr. O'HARA. Yes, sir; they replace them right away.

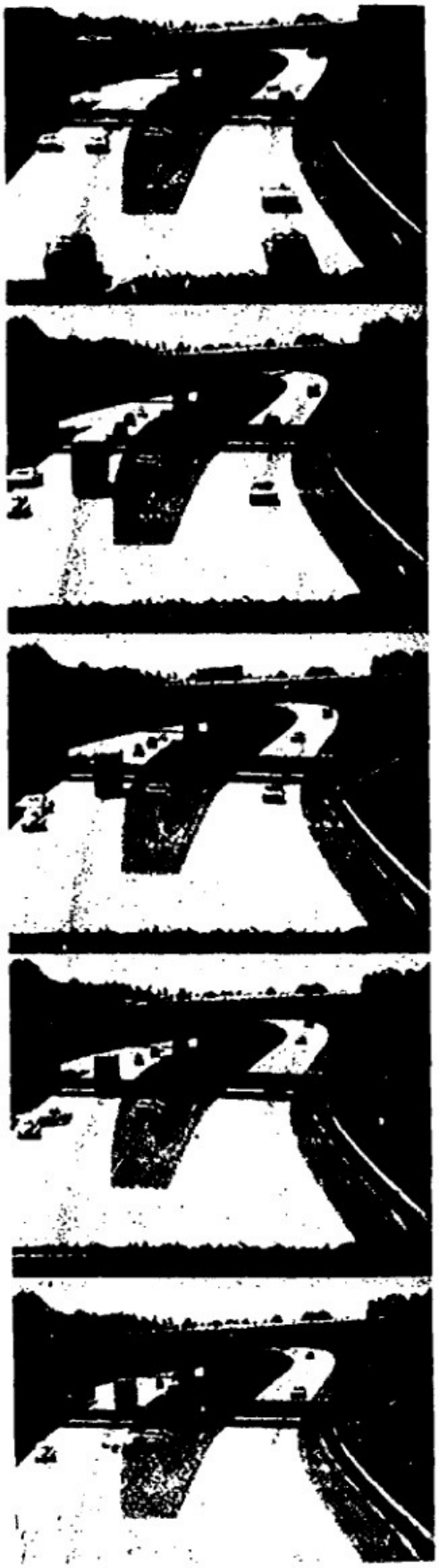
Mr. MAY. Now you will see him drive away with the sign and it doesn't operate much differently.

What we can appreciate, Mr. Chairman, is the skill on the part of some of the drivers. Here is a fellow who missed the first turnoff and drove right over the gore.

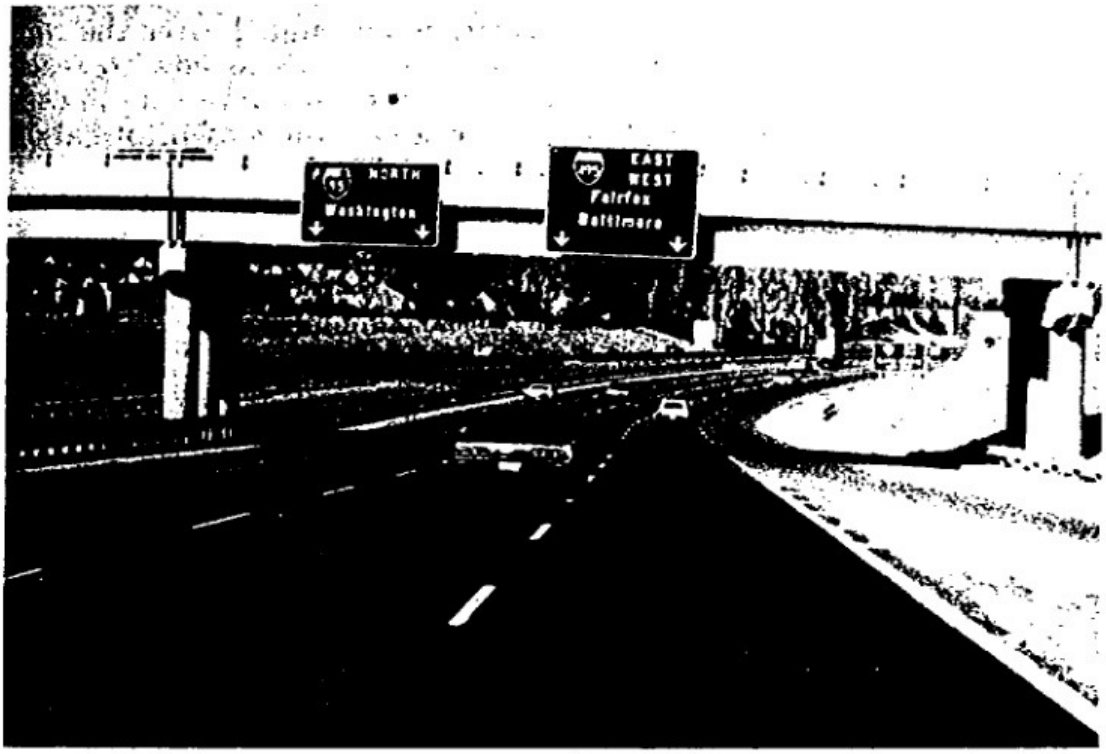
(Film slides pertaining to the matter above appear on pp. 500 and 501.)



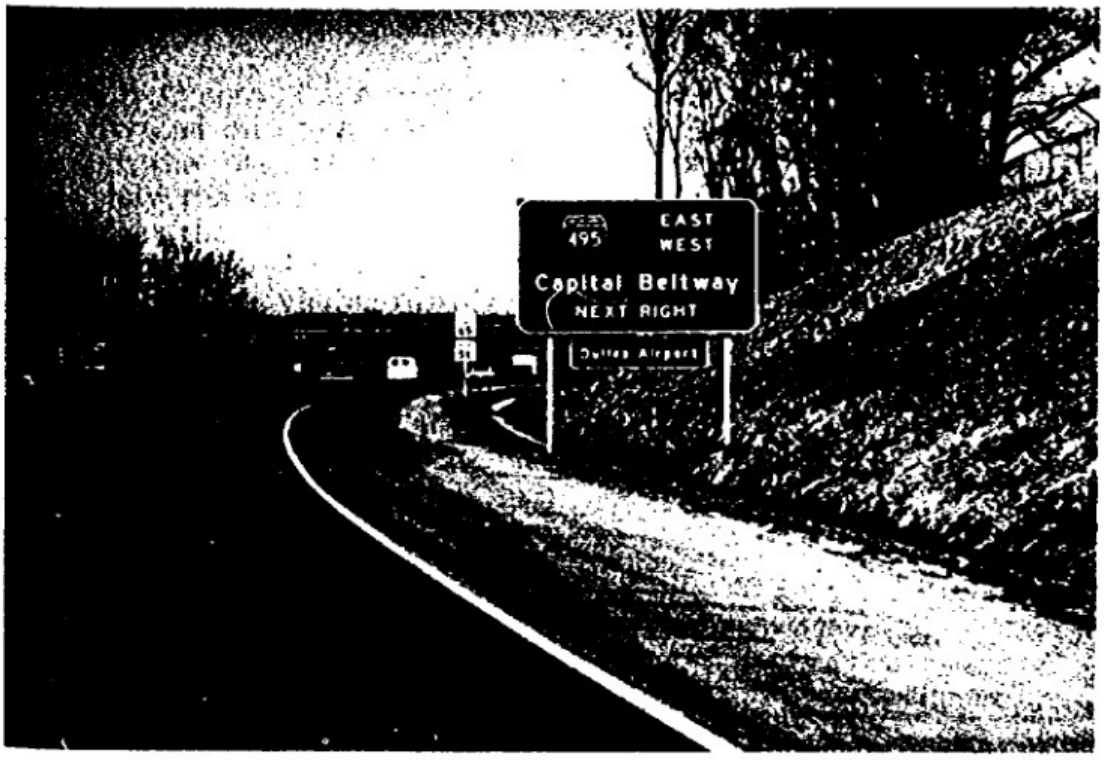




Mr. SCHOPPERT. This is the signing we just observed on Interstate 95 northbound at its interchange with the Capital Beltway.



This picture shows the signing for traffic northbound on Interstate Route 95 just south of the Capital Beltway. The two signs are mounted on the overpass for the Springfield interchange and they indicate that the two left lanes are for Route 95 North and Washington. The two right lanes are for Route 495 Fairfax and Baltimore.



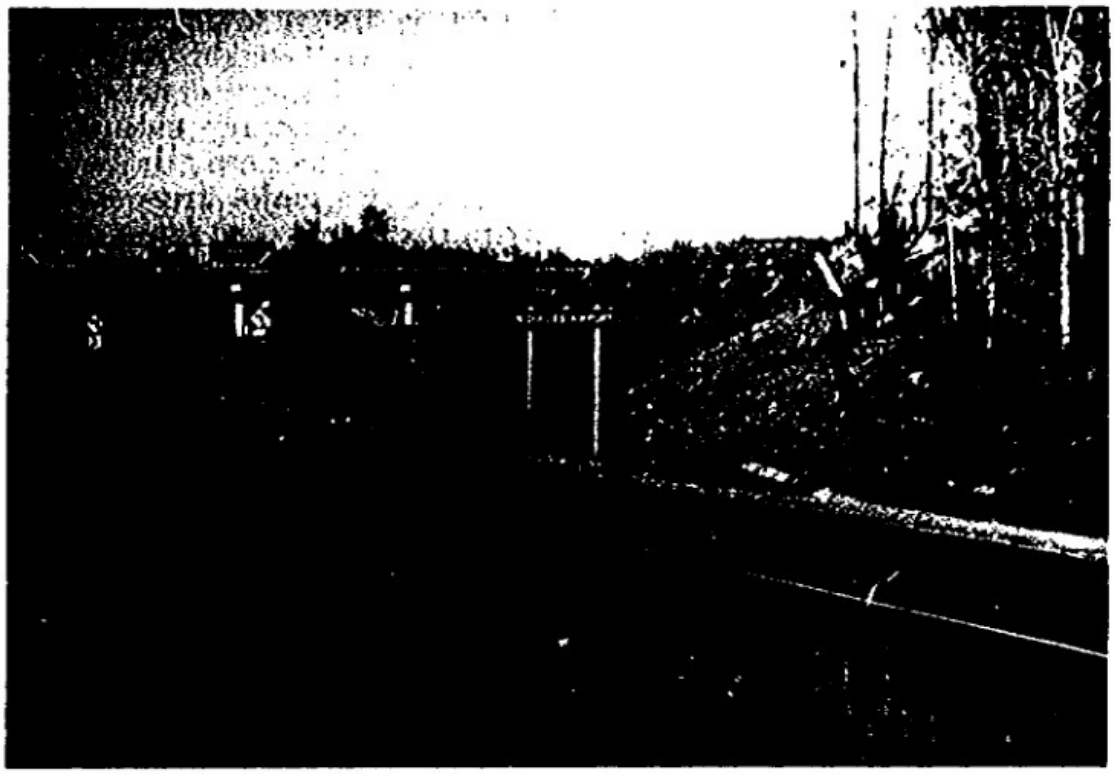
The next sign a motorist would see is mounted on the right side of the roadway and it carries the message "Interstate Route 495 East and West, Capital Beltway Next Right." Appended under that sign is the legend "Dulles Airport." This information was added after the sign was erected apparently in response to questions as to how to reach Dulles Airport from this general area. It's interesting to note in connection with this that Capital Beltway is a new piece of information not shown on the previous sign.



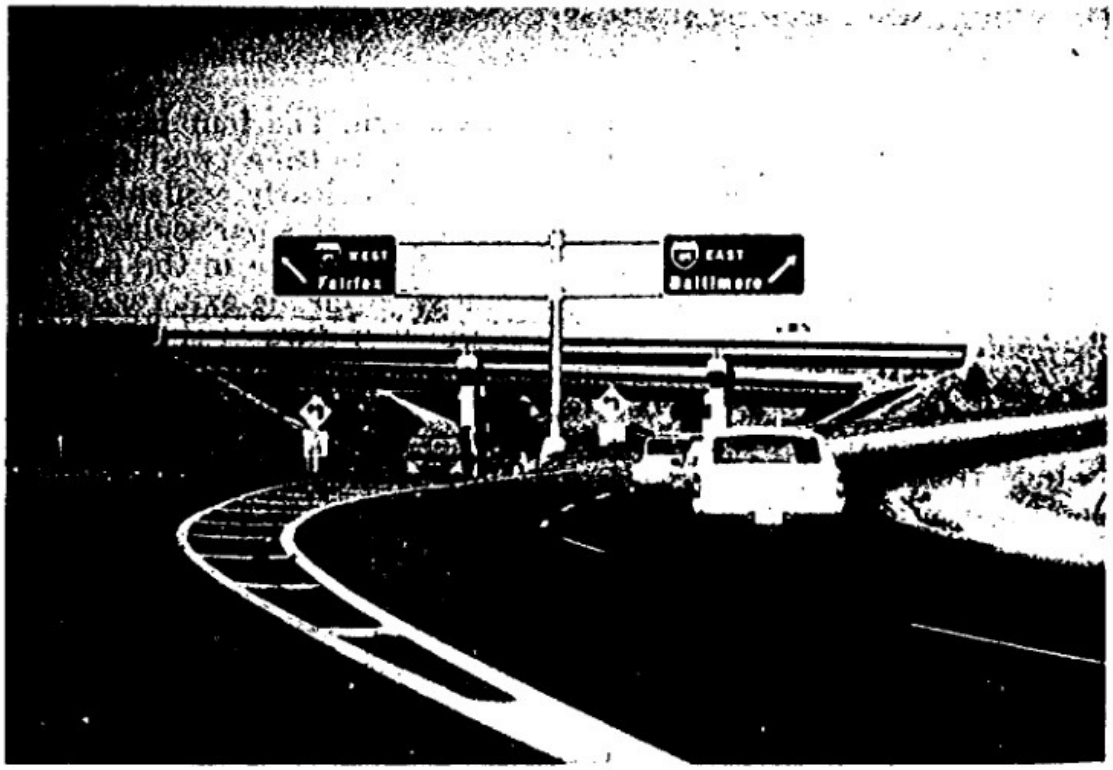
A little further on, again on the right, is a sign saying "Fairfax and Baltimore" with an upward sloping arrow to the right. Appended to this sign on the top is a route shield for 495 and a panel saying "East and West." The signing here is of a temporary nature and clearly considerably lower standard than would be normally be provided at the approach to an interchange of two major freeways. At this point the northbound traffic has approximately five lanes due to the acceleration lanes for the ramps from the Springfield interchange and this rather small sign mounted off to the right relatively low is not at all adequate for the volume of traffic using this particular roadway.



The next sign at the gore is typical exit sign. The four lanes have now divided into two sets of two which constitutes a two-lane drop through the interchange area. The skid marks clearly evident in the slide show the kind of activity which goes on at this particular point. It is clear that some of this skidding has taken place in the painted area between the two roadways and some of it on the exit roadways. Another feature visible in this slide is the curvature of the roadway to the right and in the distance you can see the signs at the gore beyond where traffic must divide—that wishing to go eastbound or westbound on the Capital Beltway. This is well off the line of travel and it tends to hide from motorists the fact that they are about to have to make another decision.



Inserted between the separation of the two roadways and the gore is another sign reading simply "Dulles Airport." This is a fairly recent addition to the signing and is apparently again in response to some demand for better signing to the airport from this area south of the beltway. The angle at which the picture was taken illustrates the point made earlier about the curvature and the angle at which drivers approaching the gore just beyond this point view the signs.



At the gore itself, which you can see takes place on a curve, there are signs above each roadway—one saying "East Baltimore"—the other "West to Fairfax" with the interstate route shield and upward sloping arrows.

Mr. MAY. I wonder if the panel members would care to comment again on what they have seen at this particular location? Dr. Hulbert, I understand you are not going to be with us tomorrow?

Dr. HULBERT. That is correct.

Mr. MAY. Would you have something to say now, besides goodbye?

Dr. HULBERT. My appreciation for the opportunity to have participated. Those pictures speak very loudly for themselves and the circumstances under which they were created. Apparently on almost any day you could go out and get similar pictures.

Again I would only relate to our six basic principles in the 1958 study, which, to the best of my knowledge, have not been incorporated and have not been disseminated and have not influenced current practice. I would be very brash to say that these six principles would solve all the problems, but we do think, since they were based on about 2 years of effort on the part of six researchers with a great deal of cooperation from the highway department in California, that they have some basis. That is the gist of my impression from having witnessed your very fine presentations and having heard the comments of the other members of the panel.

Mr. MAY. Thank you.

Mr. MATHES. Mr. May, this doesn't have to do with the discussions that we have had here this morning, but there is a comment I would like to make. Yesterday, during the testimony, there was a question concerning the size and weight bill currently before the Congress. Yesterday afternoon there was a newscast which apparently quoted me as saying that I was not necessarily in opposition to it but wasn't certain as to whether this would be good for my own particular State.

I would like to comment on this in a couple of ways. The question was not asked of me. I did not comment on it. I don't know how the newscast originated. I saw no record of it in the paper this morning.

I felt I should comment upon it here because my board and my State has not taken any position on this bill specifically, although we supported the things that are now contained in the Senate bill which I understand is now before the Congress. I felt that because of this situation I should comment on it here.

Mr. CLAUSEN. Mr. Mathes, would you like to add to your statement and would you like to have some more time so that you can carefully think out your comment and put it on the record so your statement will be recorded?

Mr. MATHES. I don't know that it would be necessary, Congressman. The source of my information is very reliable. It comes from one of the Members of the Congress who gave it to me. I don't know how it happened to get out. I am familiar with the bill and I am familiar with the House report on it. It represents the position that has been taken in our State and I think this is all I need to say. Thank you very much.

Mr. CLAUSEN. Has anyone else any comments? We are going to have to adjourn because there is a quorum call. Does anyone have additional comments they would like to make? If not, I want to say on behalf of the committee, that we are again deeply grateful to all of you gentlemen for taking the time to come down here and give us the benefit of your very sound advice and counsel. This is not an easy task. It seems we are all in the business of trying to do the best we can to improve the highway systems in the country. Many people are looking to America for leadership and I think your demonstration of ability and willingness to cooperate with us toward that end is deserving of commendation on the part of all Americans who will be affected. Thank you very much.

The Chair will announce that we will recess now until 10 o'clock tomorrow morning. We stand adjourned.

(Whereupon, at 12:30 p.m., the committee was adjourned, to reconvene at 10 a.m., Thursday, July 18, 1968.)

HIGHWAY SAFETY, DESIGN AND OPERATIONS

Freeway Signing and Related Geometrics

THURSDAY, JULY 18, 1968

HOUSE OF REPRESENTATIVES,
SPECIAL SUBCOMMITTEE ON THE
FEDERAL-AID HIGHWAY PROGRAM
OF THE COMMITTEE ON PUBLIC WORKS,
Washington, D.C.

The subcommittee met, pursuant to adjournment, at 10:15 a.m., in room 2253, Rayburn Building, Hon. Don H. Clausen presiding.

Present: Messrs. Clausen, Blatnik, and Cleveland.

Staff present: Same as previous day.

Mr. CLAUSEN. The meeting will please be in order. I am sorry we are late, but as you know, we have a simultaneous subcommittee meeting going on. We will proceed.

Mr. MAY. Mr. Chairman, we have the same panel of witnesses today that we had yesterday with the exception of Dr. Hulbert. May we swear in Mr. Charles H. Bottoms?

Mr. CLAUSEN. Mr. Bottoms, do you solemnly swear that the testimony you will give before this subcommittee will be the truth, the whole truth, and nothing but the truth, so help you God?

Mr. BOTTOMS. I do.

Mr. MAY. Mr. Bottoms, would you identify yourself, please?

Mr. BOTTOMS. I am Charles H. Bottoms, assistant location and design engineer for the Department of Highways, State of Virginia.

Mr. MAY. Mr. Bottoms has a few words to say relative to some of the features that we have analyzed in the past couple of days on the beltway in Virginia. First, we have just one item to handle.

Mr. Chairman, there was some discussion earlier in the hearings relative to recent legislation in the State of Vermont concerning business directional signs for motorists. I have here a statement on that from the president of the Outdoor Advertising Association of America and I ask, Mr. Chairman, that it be printed in the record at this point and I shall refer to it briefly.

Mr. CLAUSEN. Without objection, it is so ordered.

(The statement referred to is as follows:)

STATEMENT OF PHILLIP TOCKER, PRESIDENT, OUTDOOR ADVERTISING ASSOCIATION OF AMERICA

I am Phillip Tocker, President of the Outdoor Advertising Association of America, Inc. It is a privilege and a pleasure to appear before this distinguished Committee on behalf of the over 600 members of OAAA who make up the great majority of the standardized outdoor advertising industry in this country.

As the purpose of this hearing is to review the adequacy of official traffic signs and related matters as they pertain to the convenience and physical safety of motorists, it seems appropriate to bring to the attention of this Committee recent developments in the State of Vermont which will, we believe, needlessly jeopardize the safety of the motoring public who use the highways in that State. Specifically, I refer to a recently enacted Vermont law which will permit the widespread placement of commercial advertising signs *within* the rights-of-way of Interstate, national defense, and other highways in that State to compete with official traffic signs for the attention of motorists using these highways.

On March 23, 1968, the State of Vermont approved an outdoor advertising act for the ostensible purposes of promoting "the public health, safety and other aspects of the general welfare". This law authorizes the State Highway Department to erect and maintain "official business directional signs" within the rights-of-way of all highways in the State for the purpose of indicating to the traveling public the direction and distance to public accommodations, other commercial services and points of scenic, historic, cultural, educational and religious interest in the State. Included in the new law is a clause requiring a payment to the state of $50 for the first year for each sign and payments for successive years based on costs. The Vermont law also effectively bans all standardized off-premise outdoor advertising signs in areas adjacent to these highways.

According to the provisions of the legislation all "lawful businesses and points of interest and cultural, educational and religious facilities are eligible for official business directional signs . . .". It is further noted that although the Travel Information Council established by the Act is authorized to issue four "official business directional sign" permits for each applicant therefor, this limitation may be waived if the Council finds that it will result in "unnecessary hardship" for an applicant. Inasmuch as there are over 10,000 trade-name businesses registered with the Licensing and Registration Division of the Secretary of State in the State of Vermont, it would appear that in excess of 40,000 commercial advertising signs may eventually be placed within the rights-of-way of all public highways in the State, or in sign plazas.

We are naturally concerned that the Vermont legislation which, incidentally, has the stated approval of the Department of Transportation, (per Mr. Lowell Bridwell's letter to the Governor of Vermont) will foster the unchecked proliferation of commercial advertising signs within the public rights-of-way. We, of course, firmly believe that commercial outdoor advertising is more properly a function of private enterprise than a function of Government. As you know, in enacting the Highway Beautification Act of 1965, the Congress itself recognized the fact that outdoor advertising was a legitimate business. For instance, Section 131(d) of that statute clearly indicates that one of the purposes of the legislation was ". . . to *promote* the reasonable, orderly and effective display of outdoor advertising . . ." (underlinings supplied). In light of this, we believe that Mr. Bridwell's letter is misleading because the Vermont legislation is obviously inconsistent with the will of the Congress as expressed by this language in the Highway Beautification Act of 1965. But, of more significance to this Committee, we also object to the practice authorized in Vermont because we believe that the use of highway rights-of-way as a "dumping ground" for commercial advertising would tend to create confusion with official traffic signs in the minds of many motorists.

Attached is a newspaper picture that dramtically proves the confusion that will be created. As shown, there are four separate signs of substantial size advertising specific petroleum companies. These are affixed to official public signs on the public right-of-way and no fee whatever is charged for this exposure. Certainly, the companies dispensing food and the companies providing lodging will rightfully expect the same opportunity afforded the petroleum companies. This we submit as a perfect example of a course that will lead to the proliferation of commercial signing on the right-of-way, which is completely contrary with the intent of the Highway Beautification Act.

As the Chairman so aptly noted in his opening remarks, ". . . Hesitation or confusion, particularly on high-speed highways, can create chaos and contribute to traffic accidents . . .". Moreover, because of the proximity of these business directional signs to the traveled portions of highways, we can foresee greater danger of collisions between vehicles with these additional roadside obstacles. Accordingly, we seriously question whether the purposes of the Highway Safety Act of 1966 will be served by this drastic program adopted in Vermont.

We further suggest that the use of the rights-of-way of the Interstate, national defense and primary systems as envisaged by the Vermont law is in violation of both the Federal-aid Highway Act of 1958 and the Highway Beautification Act of 1965, inasmuch as the purpose of both of these Acts include the promotion of traffic safety (in addition to the promotion of enjoyment of public travel, the protection of the public investment in highways, the preservation of natural beauty, etc.). It should be emphasized that the word "safety" as contained in the policy statement of the Highway Beautification Act was interpreted in the accompanying House Report to strictly mean vehicular safety. Moreover, under both of these Acts, the first of which has since expired but lives on through agreements signed and ratified by 25 states (including Vermont), outdoor advertising signs are permitted only in areas *adjacent* to the Interstate and/or Primary Systems. With the limited exception of signs that give specific information to the traveling public, only directional and other official signs have been permitted by the Federal Government within the rights-of-way of the Interstate and/or Primary System. However, it should be noted that these "specific information signs" must conform to national standards promulgated by the Secretary of Transportation. To our knowledge no such national standards have yet been promulgated pursuant to the Highway Beautification Act of 1965. In any event, a review of the legislative history of the Highway Beautification Act of 1965 makes it clear that the use of "Specific Information" signs was never intended to supplant the legitimate private business of outdoor advertising.

Finally, to show that the true purpose behind the enactment of the Vermont legislation was a matter of economics, reference is made to a statement of policy by the chief sponsor of the Act, State Representative Theodore M. Riehle. In this statement, which is entitled, "Why Regulate Highway Signs?", Representative Riehle makes it crystal clear that the sole motivating factor behind this legislation was the creation of a publicity ploy which would hopefully focus nationwide attention on Vermont and her natural beauty in order to attract new tourists to the State. We do not believe that the Federal Government should become a party to a publicity program at the expense of the motoring public.

Let me just say in closing that unless the Federal Government promptly discourages this and similar schemes of using the public right-of-way of federally-financed highways for the purpose of commercial advertising, we can expect this threat to highway safety to increase rather than decrease in the years to come.

U.S. DEPARTMENT OF TRANSPORTATION,
FEDERAL HIGHWAY ADMINISTRATION,
Washington, D.C., February 12, 1968.

Hon. PHILIP H. HOFF,
Governor of Vermont,
Montpelier, Vt.

DEAR GOVERNOR HOFF: I want to acknowledge with thanks your letter of January 24, 1968, concerning H. 450, which is before the Vermont Legislature.

I note that the bill contains specific guidelines concerning conditions under which official business directional signs will be permitted within the right-of-way. Each business may be allowed only a limited number of signs, and highway safety considerations must be satisfied in each installation. Signs must be limited so as to avoid commercial advertising. Safeguards against proliferation are to be provided.

Specific regulations must, of course, be determined by the Tourist Information Council, in cooperation with the Vermont Department of Highways. Provided these regulations conform to the basic guidelines and goals of the bill itself, mentioned above, I can see no conflict with the spirit or letter of any Federal law or regulation. It is true that Federal law or regulations may, in the future, further limit sign proliferation, and the foregoing is, of course, subject to such further limitations as may be required.

We commend the Legislature of Vermont for considering this farsighted proposal. It is certainly consistent with the overall objectives of the Highway Beautification Act of 1965 and the highway beautification program. We look forward to observing its development and implementation.

Sincerely,

LOWELL K. BRIDWELL,
Federal Highway Administrator.

Mr. MAY. Two significant points seem to be that the Association contends that the Vermont law would permit widespread placement of commercial advertising signs within the rights-of-way of Interstate and other highways to compete with traffic signs for the attention of motorists and unsafe conditions could result.

Also, Federal law calls for such specific information signs to conform to national standards promulgated by the Secretary of Transportation, and no such national standards have yet been promulgated.

Mr. Prisk, do you have anything to say relative to this statement?

Mr. PRISK. I have examined that statement, Mr. May. I don't know that I have anything very substantive to say about it except that tentative standards have been released by the Department and have been in the public realm for some time now. Final standards have not been issued. I suspect that consideration of the Vermont legislation and of the tone of interest in identifying motorists' services for the driving public will be reflected in the final standards. There is no decision that I am aware of at this time.

Mr. MAY. Mr. Bottoms, I believe you have a few words to say to us.

TESTIMONY OF CHARLES H. BOTTOMS, ASSISTANT LOCATION AND DESIGN ENGINEER, DEPARTMENT OF HIGHWAYS, STATE OF VIRGINIA

Mr. BOTTOMS. The pictures and criticisms yesterday of the design of the beltway were very much the same as the Department had observed during the years. We did not take it as anything but constructive criticism. The Shirley Highway and the beltway were designed on the balanced lane concept based on traffic capacity, at the time that was required nationally.

I think we and a number of other States had mixed reactions to it. We went along with it on the basis that that was the concept at that particular time. It was required by the Bureau of Public Roads and certainly there were mixed reactions within the Bureau and within the State as to whether that was the very best concept at that particular time.

The capacity governed where a lot of vehicles were taken off at a place it was considered that the capacity was not needed. It was a good theory, but it didn't work out in practice.

The films yesterday showed some of the things we had observed on signing, and we had been in touch with the traffic engineers on the signing. I think the signing originally was put up according to the uniform manual of signs. Quite a few signs have been added that were supposedly to help out with some of the deficiencies of the manual. Some of them have been good and some of them have not worked out so well.

I think with that, we are looking ahead rather than back, to working on the beltway and coming up with a redesigned concept that will be as good or better than any other highways.

Mr. CLAUSEN. Will this be a traffic engineering or redesign concept?

Mr. BOTTOMS. It will be both. It will be traffic and redesign. We will add lanes and also look into the situation of correcting the lane drop situations and such. We have been working on such a plan for

several years now. It has not been brought forward and approved as yet, and I think after seeing what I saw yesterday, I believe we can do a little better than we had first thought we could.

Mr. CLAUSEN. What about the signing? That was one of the principal problems we saw yesterday, and I would be interested in your reaction and/or comments on what you saw on those films yesterday and what you think can be done to correct those problems.

Mr. BOTTOMS. I think a lot of the suggestions of the panel here are certainly well carried. I think they can be instituted, or some of them can be instituted. I think when I go back certainly the only thing I can report is that we need to do something about it along the lines we saw. I request that we have some way of getting copies of some of the pictures that we had yesterday so that it can be reiterated according to panel discussion.

Mr. CLAUSEN. Mr. Counsel, the thought has occurred to me that once you have taken corrective measures, I would frankly like to see another film with the new signing and have it brought back to the attention of this committee as a sort of before and after situation. I think this information would be exceptionally helpful, not only to this committee, but for other areas of the country, in letting them see what is the function of this committee.

It is our intent to look at these things objectively and hopefully come up with some constructive criticism. As I mentioned to the panel members yesterday, every one of us needs a needle every once in a while.

What we will come out of these hearings with cannot help but be beneficial to the traveling public. I think this can be in effect a sort of pilot project, and I would like to see a follow-up as far as this committee is concerned to see that this thing is followed through in cooperation with the Virginia people and then we will see a film afterward to see what the traffic pattern is at that time.

Mr. BOTTOMS. I had one little observation this morning coming up that I thought I would throw in here for the panel. I noticed that a majority of the signs, after seeing the pictures yesterday, are too low to the ground on roadside mounted signs. You can ride up the road and I can spot those service station signs way off from the interchange. I could see them before I could see the signs alongside the road. There was ground haze there, and also the background of the trees. If they will put them up higher and get a new minimum height, you will be able to see that sign a lot better, particularly if you are following a large vehicle.

Mr. MAY. You were coming up from Richmond this morning?

Mr. BOTTOMS. Coming up from Richmond this morning.

Mr. CLAUSEN. I would ask that the staff follow through on this to see that we do have this pilot project brought to fruition and then hopefully in the future we will have a similar showing of results.

Mr. CLEVELAND. Does counsel have a record of the time and dates that these pictures were taken?

Mr. MAY. Yes; we do.

Mr. CLEVELAND. It would be important that the timing was about the same time that the follow-up movies were taken.

Mr. MAY. Yes; we kept a log of every moment. We will do that, Mr. Chairman, and we will also make available to Mr. Bottoms of the Virginia Highway Department copies of these films. I think you men-

tioned, Mr. Bottoms, that you would like it for information and training purposes in the department.

Mr. BOTTOMS. Information and training purposes, yes.

Mr. MAY. We will do that. There is one thing that is somewhat bothersome. You mentioned that what we saw was designed and built under a certain concept that existed at that time. Has the concept been changed?

Mr. BOTTOMS. The concept has been changed in our design circles, but not in all cases has it been changed by the old road organizations.

Mr. MAY. No, and if we went out and took a look at a most recently opened Interstate project in Virginia, the chances are we would see some of the features that we saw in those films.

Mr. BOTTOMS. You would see some of them. I don't believe you would find a lane drop situation or anything of that nature.

Mr. MAY. Some of the other features we might see?

Mr. BOTTOMS. You might see them.

Mr. CLAUSEN. Could we ask you in the interim, sir, to submit a little bit more in depth report, first of all on your observations of the film and, second, what you will be recommending to your division of highway people for corrective action? I think this would be very helpful in the interim. I think it will also help you when you are trying to transmit a message to them that this information is necessary for the committee and it will help you in gaining that information, I believe. Could you submit that back to us?

Mr. BOTTOMS. I will be glad to do it.

Mr. CLAUSEN. Without objection, the record will be left open at this point so that Mr. Bottoms can again submit the response to my request.

(The information, submitted by Mr. Bottoms in a letter dated October 4, 1968, is as follows:)

After attending the hearings in Washington relative to the wrong-way maneuvers on the Capital Beltway (Interstate Route 495) and Route 95 at its intersection with Route I-495, we have considered many of the factors brought out at the hearings. In order to alleviate the wrong-way maneuver situation on I-95 between Springfield and Route 495, we made a revision in the lane striping. Observations by this office and the Traffic and Planning Division indicated that this was a considerable help to the traffic distribution through this area. However, there continues to be a great deal of wrong-way maneuvers.

We submitted to the Bureau of Public Roads a request to make some physical changes in the roadway and carry an additional lane through on Route I-95 north. As you know, the Route 95 work from south of Springfield north has only temporary signing at this time and we feel that this is inadequate. The plan for resigning has been completed and until the Federal money was withheld last month, we planned to let a contract for the permanent signing in December of this year. This may be delayed somewhat, however, we expect to let it at the earliest possible date after the Federal funds are released. In the meantime, representatives of the Baltimore Office of the Bureau of Public Roads requested that we consider temporary visual signs for the interchange to be placed between Springfield and Route 450. These would be similar to the symbol direction signs that were temporarily placed on the southbound lanes. We are considering this matter and we will have another meeting with the Washington Office and Baltimore Bureau representatives on October 17, 1968.

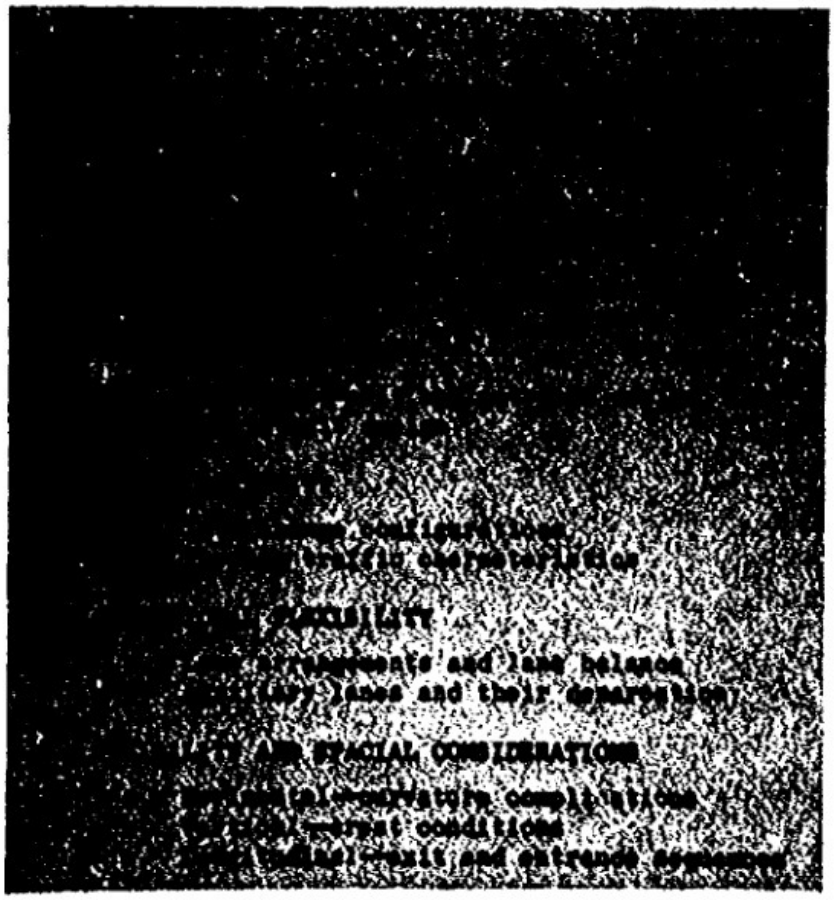
Our Traffic and Planning Division and our Research Council group at the University of Virginia in Charlottesville are making a study of all of the signing on Route 495 pursuant to letting a contract sometime in 1969, if approval is received. The placing of exit numbering signs will be included in this contract. Plans have been prepared for the elimination of the drop-lane situations along Route 495 and also the addition of lanes west of Route 95. While

we have no definite schedule for this work, it is hoped that a high priority will be given this work when new schedeules are made.

Mr. CLAUSEN. I mentioned this briefly earlier, but I do want the record to show that the full Committee on Public Works is meeting for the purpose of discussing water pollution legislation. That is one of the reasons that we do not have more Members of Congress present at this particular hearing. I think the panel members should be aware of this. It seems we have quite a logjam of legislative requests through our particular committee, so we must apologize to the distinguished panel for the absence of some of our members.

Mr. MAY. Mr. Chairman, we will try to move along quite rapidly. We go first to Mr. Jack Leisch. I think you have something to present and show to the subcommittee.

Mr. LEISCH. Yes, thank you, Mr. May. Mr. Chairman, last week on Thursday, July 11, I presented testimony dealing with coordination of highway geometrics and signing. And in doing so, I presented the five areas which could be identified which related to this subject. I dealt primarily with the physical aspects of the highway, the geometry of it, as related to signing. I had one additional topic listed in the outline which I presented, and that topic was reserved for a later airing, we might say.



6. EVALUATION OF PROBLEM AREAS IN SIGN DESIGN



This was a topic which dealt with, as we might entitle it, "Problem Areas in Sign Design." This deals directly with signing. We thought it was appropriate, perhaps, to air some of these points while the committee is present. What I would like to present has very much to do with what we saw on the film yesterday and what we saw on the slides. It fits right in.

This may answer some of the points raised yesterday, may have some explanation as to why some of the errors are being made, and some of the confusion created on behalf of the drivers. We attempted to do that in terms of geometry the other day, but this has to do more specifically with signs. In presenting this very briefly, I have a few transparencies on which I have scribbled a few things, and if I may just use the projector, I can do it that way.

In this connection, I would like to first expose to the panel some considerations with regard to sign layout and arrangements; this was touched on, and just what might be the problem with sign layout and arrangement.

The objective in the layout of signs is clarity and comprehension. This certainly is an effective objective, and I think sometimes this objective is lost: the way the sign actually comes out, what the sign specifically says, the words that are used, and more of how the various parts of the messages may be put together, arranged on a sign.



I would like to present a sign here. Here is a sign that says "Approaching Urban Area, Reduce Speed". This is very poor composition, no doubt, but there are many signs which give that impression. There are a number of words there. The driver is confronted with reading the entire message. It is pretty hard for him to sort out the things. If he is in a hurry, I would say he would have a problem comprehending that.

Why is that? There is too much sameness, for one thing. We have three lines. There is no variation in spacing and there is no variation of letter sizes and perhaps there is no variation in alphabet.





That can be improved if we do it this way. Look at the lower sign now and compare it with the upper sign. Two things have been done here. The message has been broken down into more logical units, even though there may be a longer line. Smaller sized letters are used at the top. Larger letters are used at the bottom for emphasis. "Reduce Speed" is the more important message here of the two. On top of it there is a deviation from what might be a standard in our signing manual today, but perhaps there could be some allowance for use of slant letters in special cases. I think this message reads more quickly.







Something else might be done. If there are certain allowances in the standards for emphasis to achieve clarity, this could be done. Look at the bottom sign now. That has even more impact. In this particular case the "Reduce Speed" portion may be an entirely separate panel tacked on. I don't mean it is just offset and painted within the same sign. Actually, there is a third dimension in there.

Perhaps it could have a yellow background on the "Reduce Speed" portion. That would really have an impact and the driver could read that and comprehend it very rapidly.

Compare that with the first line now and look at the last line, and you can certainly see the difference. I think this is the type of reasoning and attention that sign layout and arrangement deserve. I am not sure that it actually has received it. This is something that is not necessarily covered in the standards, although some mention should be made or some allowance should be made for these sort of things, but

this is individual design. This is tailormaking to the situation and it requires the understanding on the part of the designer as to just what the problem is.



Let's pursue this a little bit further. We will look at a more conventional sign. Here is one that says "Birchmont Avenue, Willsoner Street, Keep Right." Again, we are using upper and lower case and I think that helps in this particular case. Again, there is a great deal of sameness. But by grouping, like paragraphing in writing, it certainly helps comprehension.



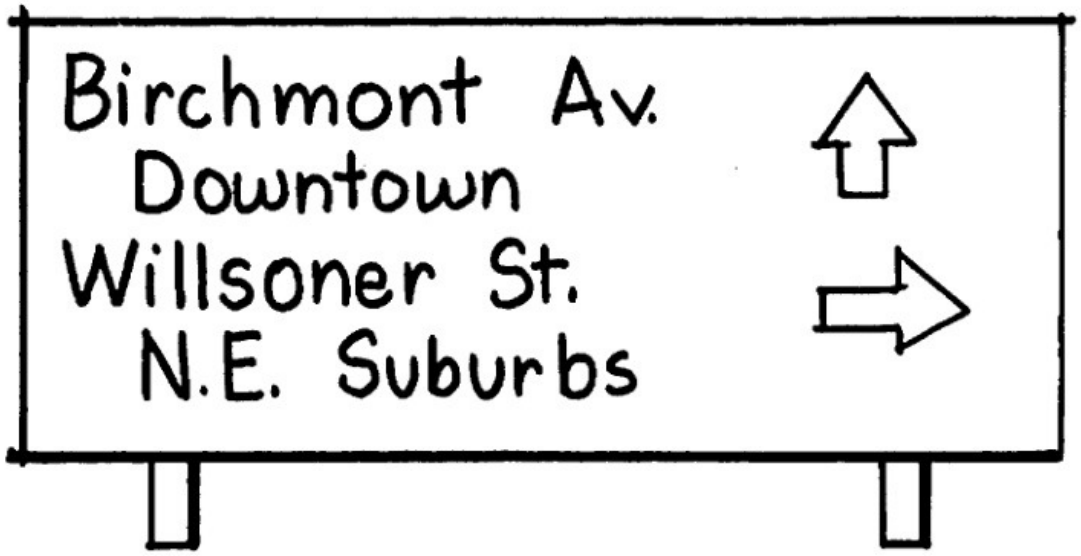


This lower sign reads a lot easier, doesn't it? Here Birchmont Avenue is a larger size. Perhaps this should be allowed. Why shouldn't this be allowed in the standards for emphasis? Even though the driver is being directed to two places, perhaps one place is more important. Or even if they are of equal importance, perhaps you can place emphasis on one of them more than on the other so that as a driver approaches, he first picks up Birchmont Avenue and then the other one comes into focus and it allows him to read them in some order.

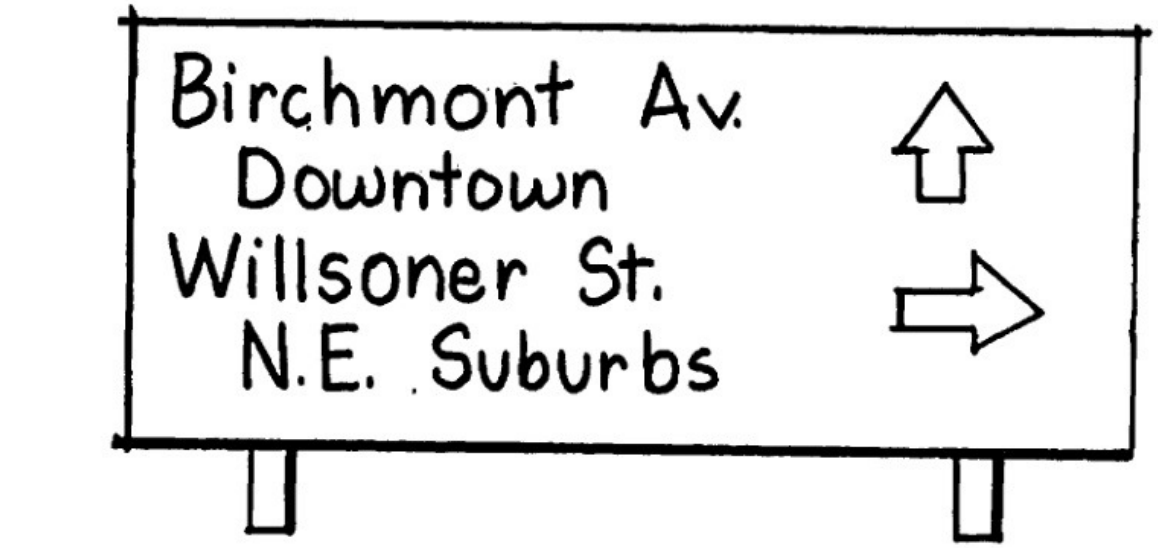
Then there is space below the second street name. The street names are grouped and the words "Keep Right" have a separate piece of information.

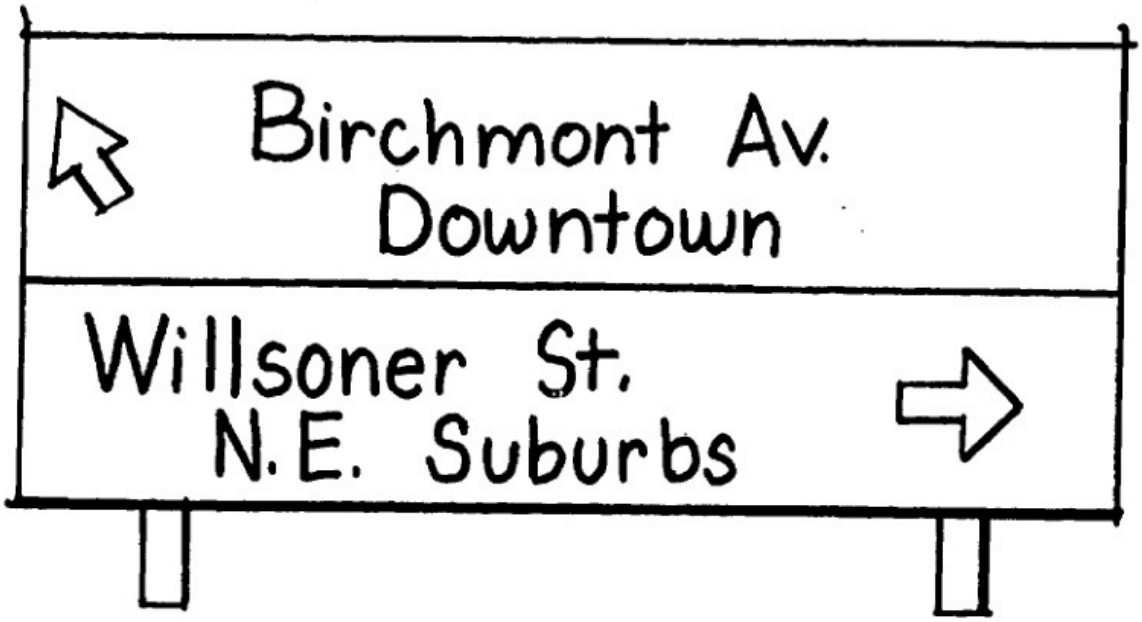
The lower sign is much more readable than the upper sign. Again, this is part of layout for the purpose of allowing the driver to comprehend more readily.

One of the problem areas we had is the secondary signs which are ground mounted, usually, and which occur at the second decision point. Let us say we have a single exit design and then when a driver leaves the freeway he approaches the crossroad and at that point he has to make a decision whether to go left or right or straight ahead or east or west or what have you. This is a very common type of sign that we find.

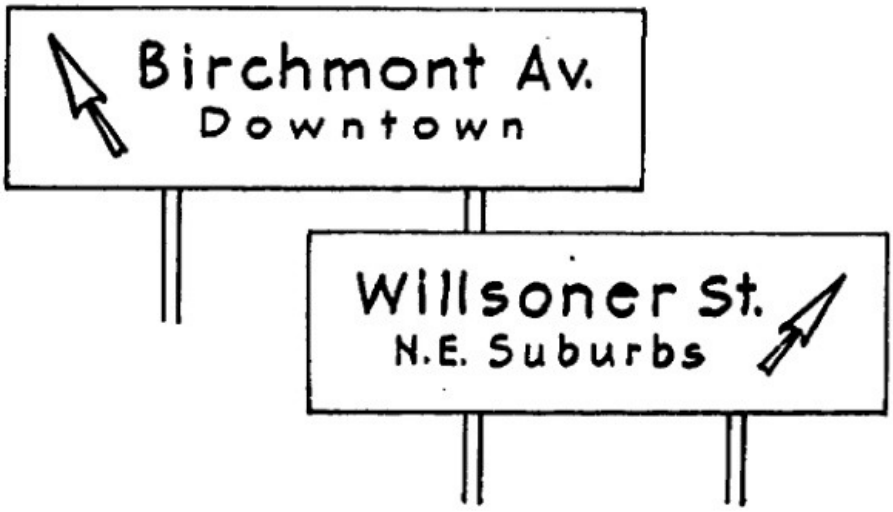


Here the driver is given two destinations basically, and a breakdown of two places to go with each one. Again, there is a lot on the sign and a lot of sameness.





This separation between the first and second part helps. The arrows don't have too much impact. This is done frequently by separating the two messages with a line between. Just that alone makes quite a difference. Still we could do better than that if it is important to really put the message across to the driver.



Suppose it were done this way, with two signs. Look how easy that is to comprehend; we are separating the two messages. Usually we try to keep the number of sign panels down, but in this particular case this is helpful. We have broken the message into two parts. We have graphically indicated direction by offsetting the two signs. It takes a little bit more work to do it, but look how much clearer this is. Now we will look at the previous one and as we look at the previous sign, you will certainly see the difference in the comprehension. Again,

this is layout arrangement in terms of helping the driver to comprehend.

Mr. CLAUSEN. Mr. Leisch, for the record, I am wondering if we will be able to have copies of these prints so they can be incorporated into the record. I think these examples that are presented certainly make an impression on me as a layman, and I am wondering if we could have them so that they could be made a part of the record.

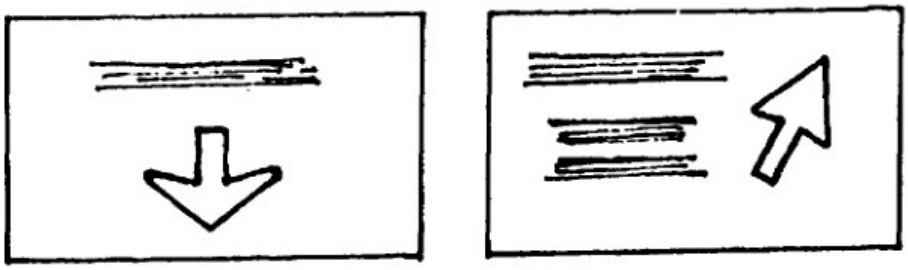
Mr. LEISCH. Yes; I can leave these here or I can dress them up as may be required.

Mr. CLAUSEN. Then we can consider this as part of your presentation and available to the committee?

Mr. LEISCH. Yes.

ARROWS

DOWN (LANE DESIGNATION) ARROW, AND
UP (EXIT DIRECTIONAL) ARROW
ARE TOO SIMILAR IN PRACTICE:

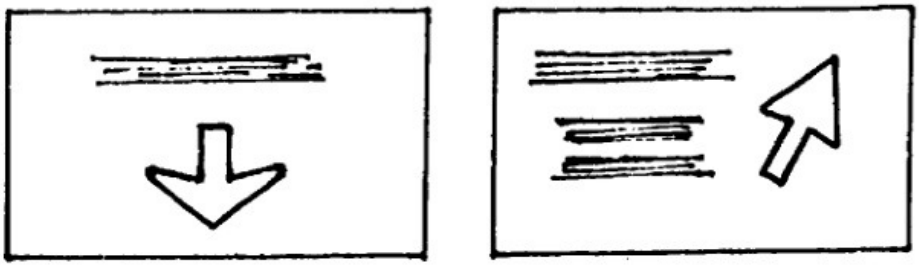


We have arrows to deal with, which are very important elements within signs. We deal with a down arrow as a lane-designation arrow and then an up arrow which is a general direction arrow. They both have their purpose. Both arrows are used side by side frequently. We find that one of the problems is that there is too much similarity between a down arrow and an up arrow, particularly where there is a choice in the length of stem, and very frequently we find that we use a very stubby stem because there is no space and we find two signs side by side looking something like what I am showing at this time.

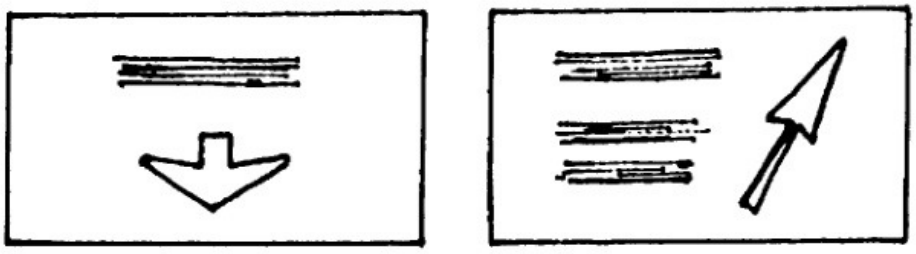
To the driver there is not that much distinction between the two arrows. I have very many samples of this where it is actually a little hard to distinguish between the two arrows under these circumstances. To me that is not quite right because you wonder what is up and what is down. I think it would help the driver to comprehend the intent. One is definitely pointing to the lane. It is a wide, stubby type of arrow. The other one is giving general direction. It should be quite distinctive.

ARROWS

DOWN (LANE DESIGNATION) ARROW, AND
UP (EXIT DIRECTIONAL) ARROW
ARE TOO SIMILAR IN PRACTICE:



SUGGESTED MODIFICATION
TO IMPROVE CLARITY:



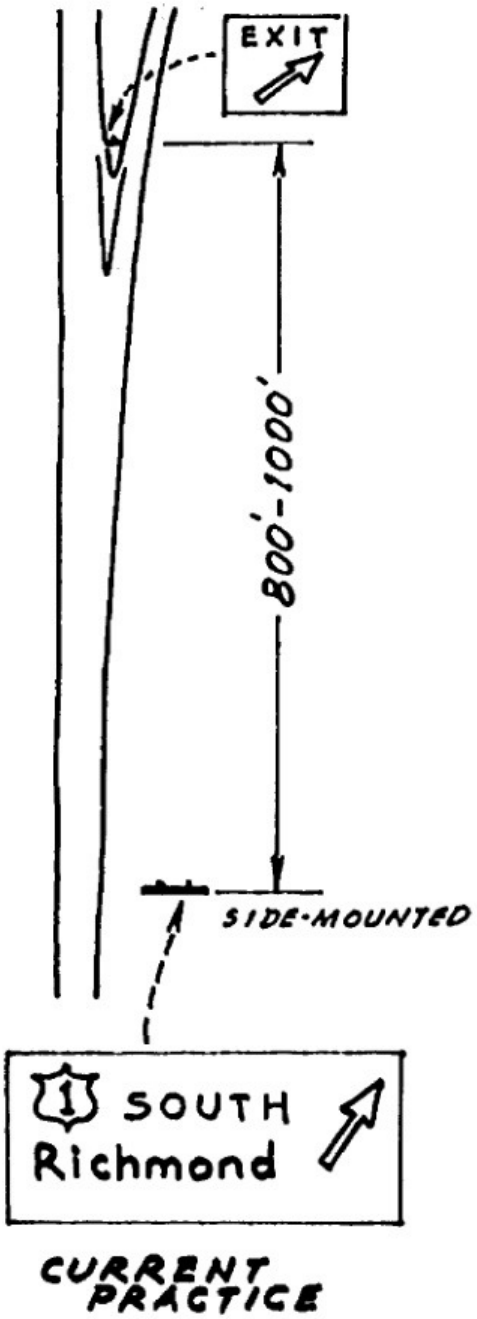
DISTINCTIVE DOWN AND UP ARROWS

Perhaps something of this order would be more effective. I find that the present arrow that we have is too much like a wide line. The head is not very distinctive. Perhaps the shaft is too wide. It is pretty hard to tell exactly what might be the problem. Sometimes with a short arrow, as we see in the upper right-hand diagram, because it is a short arrow, the head is made larger and you can distinguish it perhaps a little better, but then I think it is competing with a down arrow, which is very much the same. If it is a long stem, it appears that it looks more like just a wide line from a distance. The head itself is not too visible.

If some alterations were considered for the up arrow, such as we see here on the right, possibly elongating the head and reducing the width of the shaft at least as it is up against the point of the arrow, it might be quite effective. There are designs of this sort. I wonder whether some consideration might not be given to reexamining the up arrow.

Mr. MAY. This is something the staff has commented on in its travels. We have noticed so often that those kinds of arrows that you have on the top there from a distance look to us like a couple of blobs. You can't distinguish them until sometimes you are too close to them.

Mr. LEISCH. Another point I would like to cover was brought up yesterday. Let's take a look at this diagram first. In rural areas, and perhaps in suburban areas, I think this is a fairly standard setup.



CURRENT PRACTICE

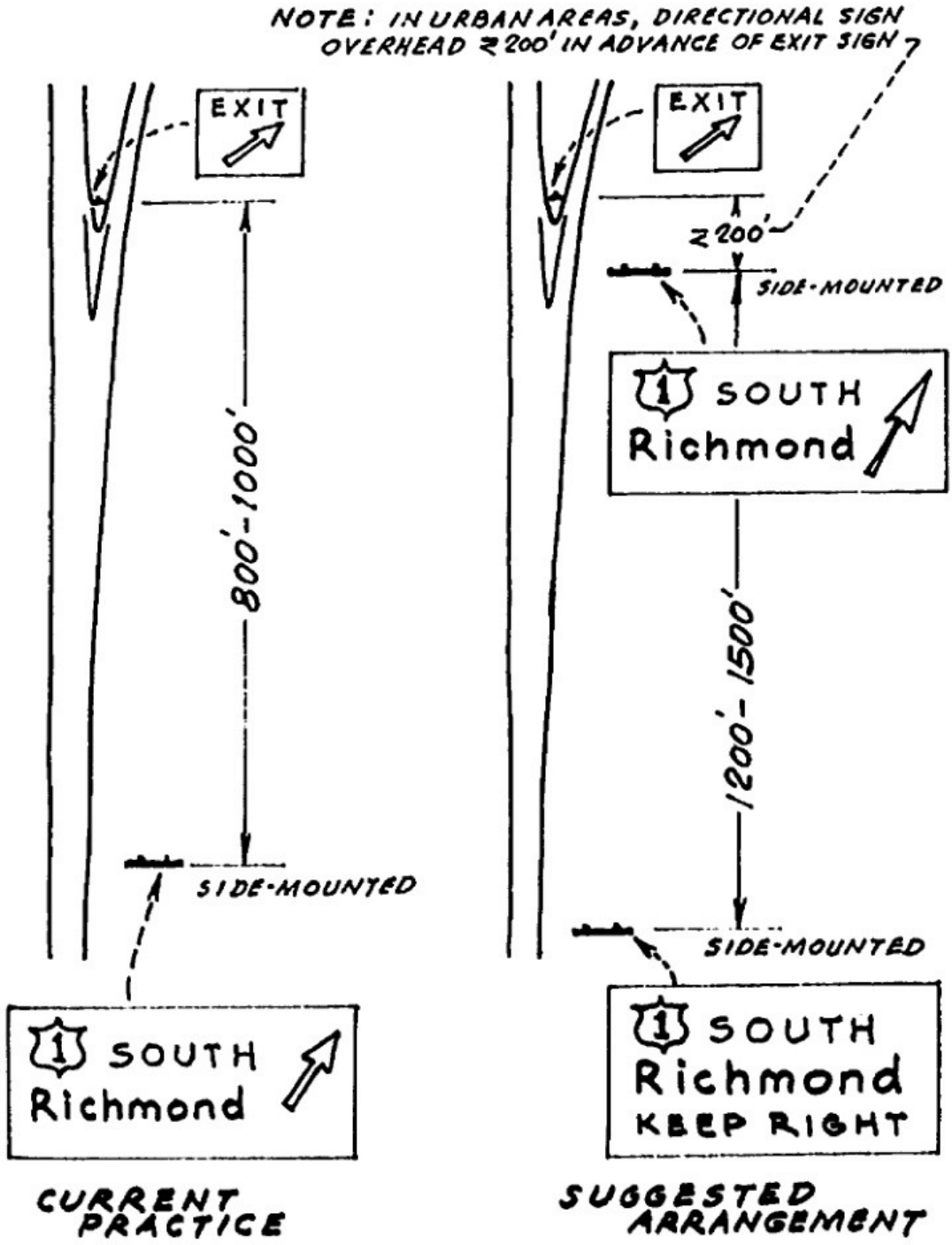
DIRECTIONAL SIGN POSTING—RURAL AREAS

I don't believe that distances are mentioned necessarily, but perhaps the sign is at the beginning of the separation or the speed-change lane which is mentioned. This usually comes out on the order of modern design in the order of 800 to a thousand feet and it could be a good bit more.

This morning coming in from Baltimore on the Baltimore-Washington Parkway, I measured on the speedometer some of the spacing of the directional signs in advance of the exits. One of them approached four-tenths of a mile. There were some at three-tenths and some at two-tenths of a mile. They were 1,200 feet and up to possibly, for some of them, 1,500 or 1,600 feet. I think it is a little disturbing in

heavy traffic when you pass a message and it almost flashes before you. Then you are just confronted with the plain word "Exit."

I am wondering whether the driver needs to have a confirmation and whether it is not helpful to the driver to physically see the layout of the actual exit and a confirming sign. He has had signs in advance which told him to keep right and probably an advance sign before that; so he is preparing himself. I think there is something logical about the last decision you make. You are actually leaving the highway now and it is an important decision. You see not only where you are going to go and how you are going to accomplish this maneuver, but at the same time you are reading the message and it is a confirmation and you say, "Oh, yes, this is the point," and you are happy and on your way. I am wondering whether this is not a consideration.



DIRECTIONAL SIGN POSTING—RURAL AREAS

This is what have at the top. To me that is disturbing. Perhaps we might want to look at the next diagram where we use the same setup, practically. We might increase the distance to 1,200 or 1,500 feet. On a high-speed road if there is very little traffic and you are out in a rural area, that is practically there. But under heavy traffic that 800 to a thousand feet is quite a long distance, with trucks and everything else. If the highway is jammed and you pass that sign, the only thing you can see thereafter is the word "Exit."

By introducing the sign a little further away and giving the message, in this particular case, "U.S. 1 South, Richmond, Keep Right," then when we come to the point of bifurcation and within 200 feet of the physical nose, we have an identical sign but this time we have an arrow.

One of the disturbing things that we discussed yesterday or the day before is that arrow can send you out in a field someplace. This has no arrow, but it prepares the driver. This one with the arrow confirms to the driver. He sees the physical exit and the sign and it is all put together for him and he makes his final decision. This may take a little bit more signing to accomplish, but I think it could be much more effective.

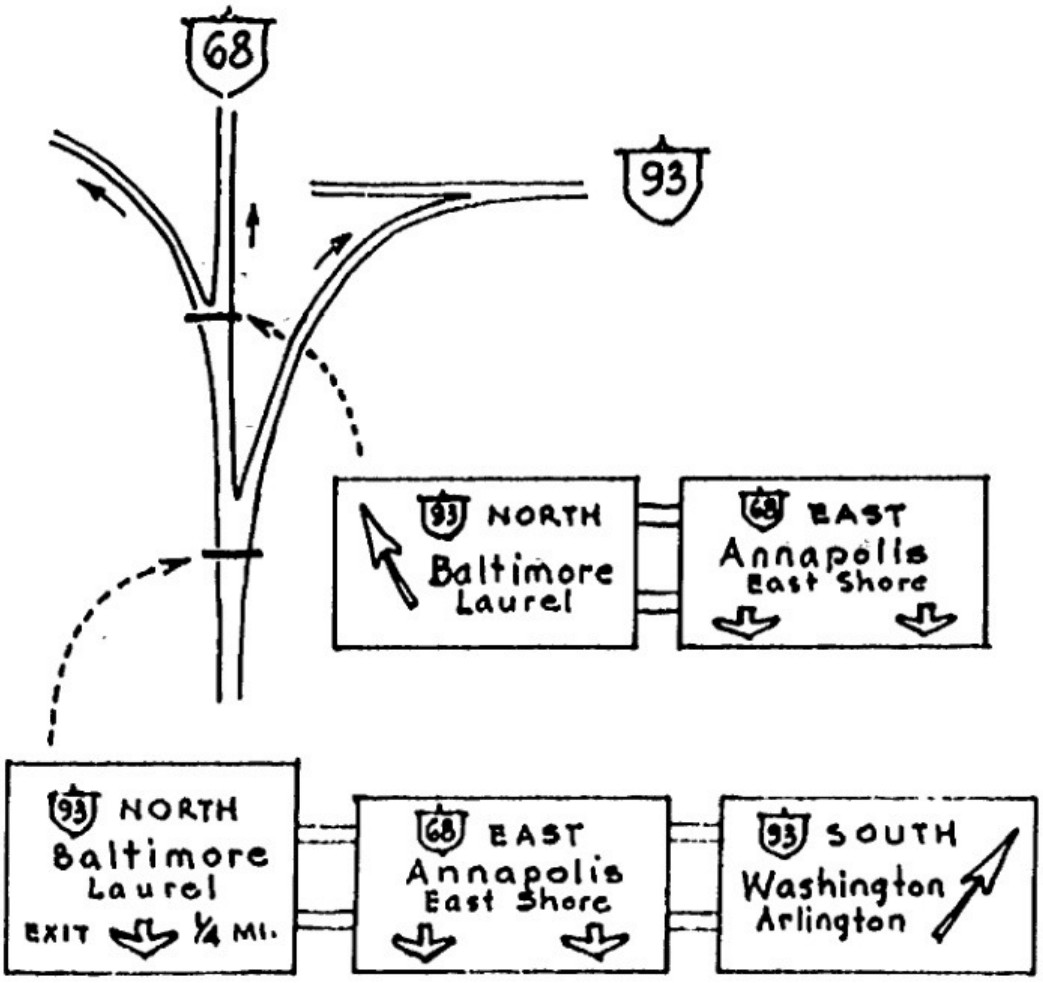
This would be true for rural and suburban areas, this type of signing. In urban areas frequently we have to go to overhead signs. I think this very much relates to what we saw in the pictures yesterday. Perhaps some of the errors or indecisions were because the overhead sign, which perhaps may have been readable from some distance and effective at the time the driver was looking at it, was some 1,000 feet or perhaps more in advance of the exit. When we get to the exit, there was nothing there but an exit sign or a couple of shields and the motorist wasn't sure.

I think in one picture we saw a driver walk back to look at the gore and he couldn't find anything more there, but he just wanted to see something to confirm his judgment, a final message. We saw drivers getting out of cars and talking to others to try to communicate and ask questions. I think there is a need for confirmation.

In urban areas where overhead signs are used, I don't have a sketch here, but I think there the overhead sign, which would appear across the gore, within 200 feet of the physical nose, would be very helpful. The exit sign could be framed just below as the driver approaches. With appropriate warnings in advance, I think it is more effective to have the actual message together with the facility for the driver to put it all together and perform accordingly.

There is another problem. We looked at the last two exits in the film that we had approaching the double exits yesterday. There were a number of signs involved. We did not see an approach that had one of the left-hand exits as well. I don't know whether that will be coming up or not.

Mr. SCHOPPERT. Yes.



5 SIGNS ON FREEWAY

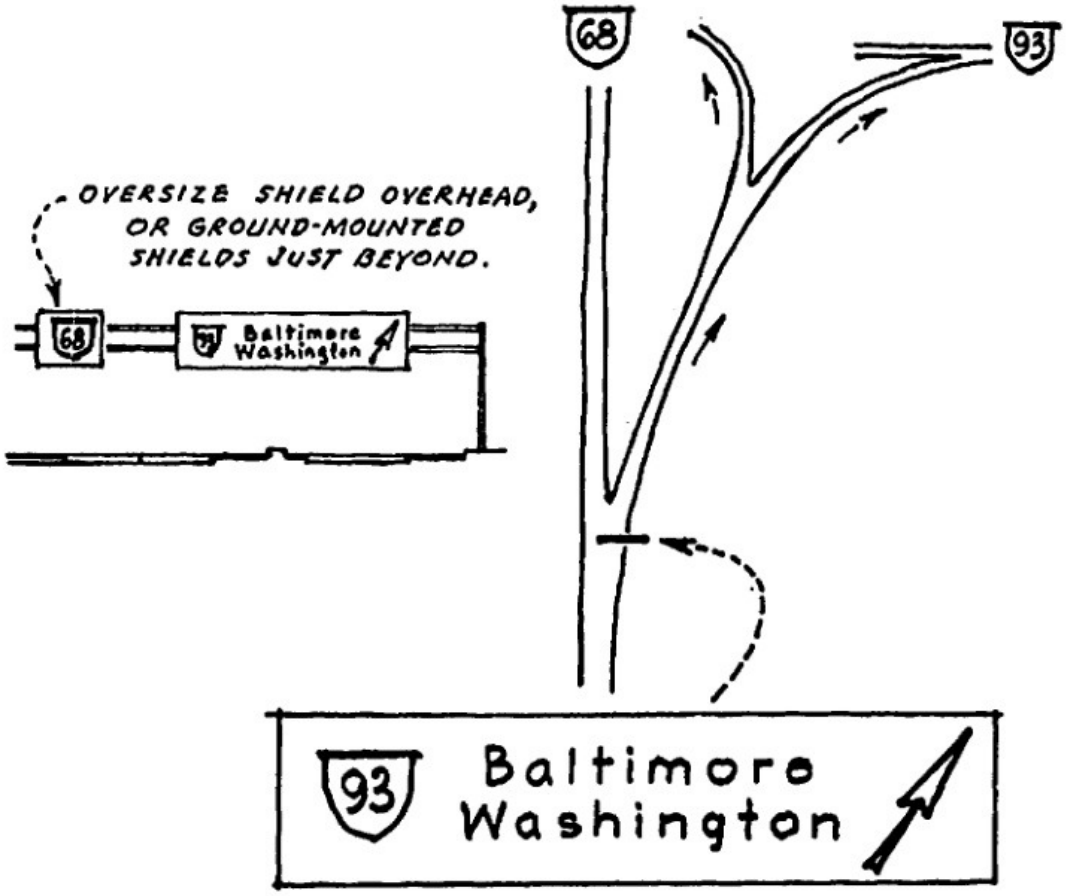
DIRECTIONAL INTERCHANGE
2-EXIT DESIGN

Mr. LEISON. I presume what we will see will be something of this order. Here is the design. This is a major interchange. In the last one we had, two of the approaches had this configuration. You were on the freeway here and if you make a right, it is at this point and you make a left at that point.

The key sign in approaching here, the three signs we see across the bottom, are absolutely essential. One sign tells you to proceed to the right at the first gore point. In this case it is Washington and Arlington. Then there is a sign giving instruction to go north, which is to Baltimore and Laurel. This one must be in the left lane. Then you

would have to tell the driver about proceeding through. So three panels are required on the freeway. If the driver is able to get by all this, then he comes to the second decision point and you have to use two signs which tell him to go to Baltimore and Laurel or if he proceeds through he will be on the beltway.

Here we have five signs. What we find here is not uncommon in terms of the number of units or components of the signs. There are five signs, and you can count the number of components and you will find it staggering. This is a two-exit design, a directional type of interchange, with five signs on the freeway with all these components on them.



1 SIGN ON FREEWAY

DIRECTIONAL INTERCHANGE
SINGLE-EXIT DESIGN

Coming back to the single-exit design, this is what we get—one sign. There is just one sign on the freeway. There will be additional signs off the freeway, but on the freeway there is one sign, compared with five, and look at how simple the message is. There is no comparison between the single-exit and the two-exit design for these directional interchanges.

I believe this is where many of our problems lie. I think many of the problems we saw in the films can be associated with this sort of thing. The sequence of signs, the way they appear, not having a confirming sign right at the gore itself, are a source of trouble. Having two exits rather than one exit is a tremendous source of trouble.

Perhaps another one is that of the sign makeup, the composition of the sign itself and not using some of these layout principles that are being used in advertising. There are certain graphics that can be combined with some of the features which produce, normally, certain clarity.

Mr. WILSON. Could I ask a question here? Would you care to comment on why you feel that a confirming through message is necessary in the former case and is not necessary in this case?

Mr. LEISCH. If we are on a radial-type freeway, not on a beltway, but a radial-type freeway, and if we were operating with single exits as a standard, and if this were an established fact, and the drivers have had time to become educated and were helped in being educated, it would not be necessary to confirm where you are except perhaps at a transfer interchange of two important highways.

At ordinary interchanges, I don't think it would be required to belabor the point that the driver is on a freeway. He has a characteristic type of the sign, and whenever a sign says "10th Street" or what have you, he knows that if he is on a freeway he also keeps to the left of the bifurcation point and it just says where it will lead to. It might be quite different at the major interchanges. Perhaps at that point, since this shield appears like this, it would be advantageous, as shown in the little sketch up here, to run a great oversized shield that will overpower the one in the main sign, and nothing more. That could become a standard.

At freeway-to-freeway interchanges, perhaps it would have a confirming point. We can save extra panels and extra signs that we don't need if we have single-exit designs and all they say are "10th Street," for example, at ordinary exits. Then I don't think there is any problem.

We might make a point of posting just beyond the gore on each side a very high post—it can be knocked down, of course—and a shield on each side that would be framed just behind it. That is the confirmation just in case.

Mr. WILSON. If the shield would be good enough in this situation, if you go back to the other case where there were five lines, you could use a shield of similar design between the other two; could you not?

Mr. LEISCH. Possibly you could, but the fact that there are so many messages and destinations as to where to go make me wonder whether you need not also tell the driver something in addition to that. That would be an improvement if it were to work out, if we used a very large shield right down the middle. That would make it clear. Maybe the arrows are all right, too, but we still have the panel. Maybe you don't

need the destination, but perhaps you do. In any event, I think there is no comparison between the two. It is realized that we have a mixed system and perhaps one-half of our interchanges are of a single-exit variety. The other half probably are not. I realize it would take time.

Perhaps we should look toward new designs that would be of a simpler form. If this is logical, perhaps the present signing could be gradually phased out. We see every day new interchanges popping up and some of them are very complex in terms of number of exits and so on.

Mr. WILSON. I think the confirming through message is necessary if the exit, which in this case could be two lanes, to the average motorist looked just as attractive. Then I think you need it.

Mr. LEISCH. I certainly would agree.

Mr. WILSON. I think the shield is sufficient here, and I think maybe this shield in the previous case is sufficient.

Mr. LEISCH. It might be, but the fact still remains that we do have a lot of signs. Also we have some of these interchanges that we have to live with for a while; so perhaps using the large oversized shield at these two places will tend to reduce the amount of information the driver is getting, which is just too much. I think that is a step in the right direction.

Mr. MAY. Mr. Mathes.

Mr. MATHES. I would like to comment here if I might, because I think the particular example that you are showing is one which is a matter primarily of design which affects signing. The two must go together. What you are talking about here is eliminating the second gore. If you eliminate the second gore, then you eliminate some signs. This is what you are actually doing.

As we discussed yesterday, I agree with Jim Wilson that some information for the motorist who is going on through is most important. I believe it needs to be up here. Any time you go to this type of design and eliminate the second gore, you simplify the type of maneuvers that have to be made and you simplify your signing. I think this point is well taken, but I wonder if it was made clear. This is what you were attempting to do. Instead of having that second gore, the traffic that would take off at this second gore is leaving.

Mr. SCHOPPERT. I think we ought to remember that the reason for eliminating the sign is that you are moving a decision point from one location to another and you are putting decisions in sequence rather than all at one point. You are making it easier for the driver to make decisions one at a time as he moves through, and you are providing space for him to make a second decision. It isn't just the signs. I am sure they both are very much aware of that. You are changing the whole decisionmaking process that the motorist has to follow.

Mr. MAY. And it is coming through very clearly that those other decisions that he must then make, he will make off the freeway.

Mr. LEISCH. A very good point. I think this confirmation is important. I certainly would go along with Mr. Mathes and Mr. Wilson on that. I would like to get an expression from the panel with regard to this matter at other than major interchanges. You know, these situations are repetitive. I would like to hear whether they feel it is necessary to have a confirming sign or whether just a plain shield in itself would do the job. You could put it overhead. You might use a truss

support that might not be so expensive or I wonder whether confirming shields, one on each side just beyond the gore point where the driver can still see them, might not do the job.

Mr. WILSON. Ten years ago it was felt in our State that you should have a confirming through message, but we dropped that practice at all major interchanges. It depends entirely upon the physical makeup at that point.

If the exit looks attractive and a motorist is attracted to it by size or by geometric configuration of the highway, where maybe the main highway veers off to the left and the exit ramp goes straight ahead, then you are going to have to do something about the confirming through message. Generally speaking, we dropped the idea of using confirming messages and merely used a shield on a low post about 75 to 100 feet beyond the gore area on the main line as a confirming message. This was actually put up on a light standard which usually occupied that area and did not take up any additional space and was very inexpensive.

Mr. MCGRATH. Mr. Chairman?

Mr. MAY. Mr. McGrath.

Mr. MCGRATH. It has been well pointed out that the simplified design simplifies the signing, by moving the decision point elsewhere, to the exit ramp. This would be a terrible mistake not to realize that those people also have a decision ahead and that they had better not be treated in a second-class fashion or they are in trouble. I think some of your films show that the second split is perhaps just as important as the first split and needs good signing as well.

Mr. MAY. You also will consider that the distance between that first gore area and the second gore area is very critical.

Mr. LEISCH. That is part of the geometry of getting sufficient distance to allow the driver not only to view that sign, which would be at this second split, but also to read the sign and to prepare for the appropriate lane. I presume half the drivers will be in the right lane and the other half may have to shift. Of course, the repeaters would be in the right lane to start with and the stranger is the one you are signing for. The distance is tremendously important and what you say on that other sign is tremendously important. We certainly saw that in the films, where there was a problem at the second decision point as well as the first.

Probably one of the reasons for the problem at the second decision point was that the first decision point didn't make things too clear. When the driver got to the second decision point he was still confused.

The combination of this sign and the two panels for the other point must be complimentary and must be so arranged and worded that all the elements are there for clarity and information for the driver.

Mr. SCHOPPERT. I think what you have said is very good. I think this question of whether or not you need a message over the through lanes for a continuing route hinges on two things. Mr. Wilson brought up the problem of the actual geometrics in the situation.

It may well be that even at minor interchanges you would need it there because it is not clear to the driver what is happening to the main route. Second, and perhaps more important, is how this fits into some system of signing which keeps him oriented as he comes

along the route. I would hope we could have some time to discuss that problem.

The sign has two purposes. One is to keep the driver oriented, and assured that he is on the right track, and second to provide him with information at decision points. If the two are done properly together, I think what you have suggested can be done in most cases.

Mr. McGrath. Mr. Chairman, another thought is that this says "Baltimore and Washington." I presume it has you leaving the beltway. I think in a beltway-radial freeway system there are bound to be a lot of points where the volume of traffic interchanging between the radial freeway and the beltway may very well be greater than the traffic passing through on the beltway by the nature of destinations.

If that is so, the design and the designing have to reflect that. There is the matter of freeway-to-freeway versus the freeway-to-local street systems which is involved here. If this appeared to be a ramp rather than a major freeway connection, signing or no signing, you might have a hard time convincing the driver that really is the way to Baltimore and Washington.

So the volume which is going to be anticipated, not just the matter of capacity, is important. The way the driver is going has to look to the driver like the way the major road goes.

Mr. May. I wonder about that.

Mr. Leisch. I would like to disagree with that. We had quite a discussion on this last week. This is route continuity. I realize this is very much an urban problem and we are faced with this all the time. I can sympathize with it and I approach it myself with mixed emotions. I know exactly what you mean, Bill.

I think we have to give weight to route continuity. In other words, if this is the designated highway here in the example and we are crossing, as in this case, Interstate 93, and the volume leaving at that point is larger than the through volume, it would still be configurated exactly the same way. The reason why it would be, even though the volume is greater but it is a major fork, is that it has all the capacity built into it. We don't have to worry about handling it even though it is a larger volume. We know how to do that now.

We are signing for the stranger. The stranger is following a route. You have to give that route continuity irrespective of the relative volumes at the points of bifurcation. I realize this is a bit of new philosophy, but I think it is essential and if we are to make a little bit of order of some of the chaos we have, I think it is essential to get this type of consistency in route continuity. Once you are on a designated route, you always do the same thing. All the traffic that transfers from that facility onto another one does so on the right and does so only at one point.

If we were ever to achieve that and the drivers became fully accustomed and educated to it and appraised of it, we would eliminate a tremendous number of problems. We would relax the driver, particularly going through urban areas. I know driving through some of the urban areas is relatively hair raising. You know you want to get off at a certain point. The map doesn't tell you whether it is going to be a left or right exit. You assume it is going to be a right and at the last minute it is a left and there are a million signs and exits and you have four or five lanes in one direction, and that is real stress.

We can eliminate all of that completely if the driver is fully educated and we are very consistent with our design and we can relax the driver. That is what makes for safety, if we can relax the driver and let him operate in a more normal and regular fashion.

Mr. MAY. Mr. Leisch, what would be done to the main line to assure route continuity?

Mr. LEISCH. We are signing for the stranger. The repeat user or the familiar driver, knows what he is doing anyway. It is the stranger who is confronted with the problem. By "stranger" I don't mean a fellow from out of town. A stranger can be a local fellow who is not experienced with this particular exit. He is also the unfamiliar driver. The familiar driver, the repeater, never reads the signs anyway, so we are not signing for him. We are signing for the unfamiliar driver.

Once we have a designated route, that route should follow through. All transfers from that designated route are then made on the right at a single point each time. Then that is route continuity. The through driver always keeps to the left of the points of bifurcation as he perceives on that particular facility.

Mr. MAY. So the main line would always look like the main line to the stranger?

Mr. LEISCH. Would always look like the main line to the stranger and would always be on the left side of the bifurcation point.

Mr. MAY. And at times it might have more lanes than the capacity might justify?

Mr. LEISCH. Yes; you have to make it look like a through road and you might have an extra lane in there. I can't imagine the amount of imbalance to the point where you have to stack lanes, but you might have an extra lane there anyway because if some breakdown occurs on that facility, the whole thing gets jammed up. If you have some extra capacity at these major points, at the same time you can make it look like the main road.

Mr. MAY. Thank you.

Mr. MCGRATH. I would like to ask a question to which there perhaps is no answer, but I am curious to find out what is going to happen. In Boston, Mass., the Interstate Highway design system of the inner belt consists of what will be seven radial freeways, in effect all intersecting with the inner belt. Half of it will be designated I–95 and the other half will be I–695. Where is the route continuity you are talking about and how will they sign that, do you suppose?

Mr. LEISCH. I think this is a special problem and I think you have got a real problem there. In terms of design and traffic distribution, I think we might agree that we now attempt to avoid a T situation. If one of those Interstate highways or freeways is intercepted by the beltway and there is no need to carry that route through as a route, you might have an escape, a through shot which goes to, we will say, the street system. It may pick up a whole series of one-way streets. This allows for distribution and eliminates a heavy buildup of traffic on the belt itself. I think this is the aim we are after under some of the circumstances.

That in itself changes the picture a little bit. Still, when you have many facilities which do key in—of course, some of them would not cross—you might have some special problem, and I think you have to examine these cases individually. We are talking here about the basic arrangement.

Mr. McGrath. I think what I am trying to suggest is that I believe the problem is substantially different when you are right in the very heart of the urban area than it is when you are as far out as the beltway.

Mr. May. Why?

Mr. McGrath. Because you do get involved in so many different movements, different localized destinations that you cannot sign such as Baltimore or Washington, because it is really sort of downtown or not downtown. Where does this exit go? It goes to the street. I am not suggesting I know the solution, because I do not; but I think the signing problem is even different than the signing problem here.

Mr. Leisch. Signing is relatively difficult in urban areas and in certain detail it might be different, but I think fundamentally it should be the same. I think this is what we should strive for if we are to gain this consistency. I believe it can be accomplished.

Mr. Clausen. Do you have a circumferential in Boston?

Mr. McGrath. It is not built, but it is in the plan.

Mr. Clausen. Will that relieve it?

Mr. McGrath. Oh, I am sorry. You mean an outer circumferential? That is Route 128. That is built and that functions in many ways like the Washington Beltway. What I am talking about is an inner belt which is only a total of about 4 miles in diameter, so you are only 2 miles from the center of town any place you go around it.

If you have seven radial freeways entering it, your interchanges are so close together you hardly have acceleration and deceleration lanes in between. All of these are essential T's, all but one, the Massachusetts Turnpike extension which does cross.

Mr. Leisch. I am not sure this inner route should be signed. I am going to produce a number of signs which we have tested for all sorts of routings. I don't think the inner belt lends itself too well, frequently, to a continuous signing, and I am not sure whether it is completely necessary. You might sign two routes around it somehow and then you would still follow the route continuity. You would observe the right and left points and so on.

I think it is a very difficult problem, as you say, but the basic principles can still be applied and there is still a lot of study to be done to really sort this out. It is presented here in a very simplified form. I certainly agree with you that the problem is very difficult, but I believe the basic principles can still be applied.

Mr. Clausen. Do any of the other panel members have a comment that they might feel they could add to this on the questions raised by Mr. McGrath?

Mr. Schoppert. I would like to say a couple of things very briefly. We have seen here this morning some very imaginative and exciting ideas for improved signing, but I am not aware of any way that these can be tested, applied, or worked out to see how they might fit.

Then we have heard about a problem which is coming at us very rapidly, I am sure much too rapidly for Mr. McGrath, for which we don't have a solution. I think we need a system, a place or maybe more than one place, to try these things out and find out what works, what people understand and what they don't understand; what can

you do about his route numbering problem and his loop problem, and how to make these things work before we get them built.

We may have some standards which are very appropriate out of town, but aren't worth much downtown. I feel very frustrated at times in ability to get from ideas to action and something that people can use. I think this was brought up yesterday. This is a classic example.

Mr. CLAUSEN. Is it possible to develop through a film, based upon what we have seen here, certain examples in certain areas of the country? I think the star of the show really has to be a stranger coming into the community. Isn't that true?

Mr. LEISCH. Yes.

Mr. CLAUSEN. Adding to what we already had here, it would seem that certainly you could try it on an experimental basis with some motorists going into the area and then checking reactions.

Mr. SCHOPPERT. I think the techniques for doing this are fairly well established or could be established rather quickly. The problem is more the procedure, the funding and the people who would do it. That is not as well established.

Mr. CLAUSEN. Who do you think would be the most logical group or groups to do this? Who would be the most qualified? I mean by that, having access to all of the facts so they would be fairly well balanced.

Mr. SCHOPPERT. I think there are a number of people who could do this. I think it must be done under the direction and supervision and general cognizance of the people who had the problem, the city and State highway and street officials.

Mr. CLAUSEN. Jim Wilson, would you like to make any comments on this?

Mr. WILSON. No; except that where highway departments or local jurisdictions want to do some experimentation, there are Federal funds available for it through the highway planning and research moneys. There is not enough of this sort of thing being done and perhaps there are too many other things being done with these funds.

There are systems available, as Dave Schoppert points out. Slade Hulbert's sign tester was developed to do just this sort of thing. It has been limping along with modest support from the State of California, and moneys from the Federal Government. It could have been developed faster. You just heard him say a couple of days ago that we are now in a position where we can use color on the signs, which is a major factor. I think it is a redirection of effort that would be necessary to get into this sort of thing. That has been neglected too long.

Mr. CLAUSEN. You say California hasn't done as much as it could or has not given Mr. Hulbert the necessary support. Is there any other State doing this?

Mr. WILSON. There are other methods of attacking this. I know that States can join together under the Bureau of Public Roads and do this sort of thing. They have done this down at Texas Transportation Institute in going into the breakaway sign problem. There is no reason in the world why a dozen States couldn't get together and do this.

Mr. CLAUSEN. Why don't we do it?

Mr. WILSON. It can be done. The initiative, perhaps, should come from the States who claim they have these problems.

Mr. CLAUSEN. Why haven't they done it?

Mr. WILSON. It has been very difficult over the last few years to direct research into this kind of effort. To be quite frank, we have been doing a lot of work in connection with safety, which is also necessary. We have been doing a lot of work in connection with pavement thicknesses. This is very necessary. I think the highway administrators would have to recognize this is a problem that affects every motorist and try to redirect some of the effort.

Mr. CLAUSEN. Where would you put this in line of priority?

Mr. WILSON. This sort of thing affects safety and affects every motorist on the road. At some time or other he is confronted with decisions to make. I think it should occupy the same importance as the pavement he is riding on, and it hasn't up until now.

Mr. CLAUSEN. Do I understand from your response that you would place it in top priority or second or third or what?

Mr. WILSON. Very high. I would say you must have a road to ride on first, but I think we have done a lot of work in connection with soundness of pavements and this sort of thing. Naturally, there are improvements in this other field, too. This is the sort of thing here that everybody who has a driver's license criticizes because he sees them every day. I think we ought to get at it.

Mr. CLAUSEN. Mr. Mathes, where would you put this in line of priority in light of your experience?

Mr. MATHES. Perhaps I am a little bit out of step. I think a lot can be done with what we have right now if we will apply uniformly the standards which we now have. This, I think, it not being done. I wouldn't say we should not continue with a research effort because I think this has to be done all the time, even if we come up with something better now.

I believe that perhaps this would be an area that could be set up as a NCHRP project and put up for that purpose. Perhaps no one has suggested it yet. There is quite a little funding available to this source, and it covers the areas that Jim mentioned. There is research being done and there is a tremendous amount of money being put into the research program through NCHRP. This is a pooling of funds by the States. I think this might be one way.

Then it would be assigned to someone to do. It could be the Texas Transportation Institute or it could be someone else.

Mr. CLAUSEN. I think you have hit on something we discussed yesterday, Jim. My feeling is that we need more coordinated initiatives among all the States. This applies not only to highways. I am convinced that some of the so-called lead States are sitting back and taking California's results because they don't have a budget for it themselves. This is great and California enjoys the position of prestige and leadership, but let's take another look at the entire country.

Is this the proper thing for us to do? I realize that everyone has problems with funds. Here again, if we are going to have a Federal system of highways, and we are going to minimize these problems, it seems that it will be of no value for one State to be way out in front with the others lagging substantially behind.

Let me ask this question: Wouldn't the Bureau of Public Roads be a good coordinating organization to pick up some of the ideas on how this can be best implemented? I believe your comment, Mr. Schoppert, was "How do you implement this?"

Jim, why couldn't the Bureau of Public Roads coordinate this and get a recommendation back to this committee?

Mr. WILSON. They could, and, in fact, they are coordinating the State effort that was carried on by 14 States. They were the agency that brought the group together and formulated the contract with TTI. Yes, they could do that.

Mr. CLAUSEN. I was aware of that and that is one of the reasons I made this comment.

Mr. WILSON. I think as long as they are involved in the design, they should take the leadership.

Mr. CLAUSEN. How long will it take?

Mr. WILSON. I am afraid I can't speak on that.

Mr. CLAUSEN. Mr. Prisk, how long would it take?

Mr. PRISK. There are some things that are rather encouraging, Mr. Congressman, that are not completed, but perhaps just starting today. I might say that in attending the Federal highway administrators staff meeting, we discussed the possibility of purchasing some of the type of equipment that Dr. Hulbert talked to us about the other day, placing this in the States to see whether or not this could be used and would stimulate the initiative there.

As to how long a given piece of investigation would take, I think it would depend pretty much on its scale. You could work on a specific class of locations and perhaps accomplish within a year's period a very considerable refinement in what we now know as our standards for signing. Certainly a great deal could be done within that period of time.

Mr. CLAUSEN. Do you think on the outside that through the coordination of the Bureau of Public Roads of the States that a year would be ample time to get us some definite recommendations on how to implement some of the content of the suggestions we have here?

I would like to have you embellish on this, Mr. Schoppert, because I think you hit on a key point. You can come up with ideas, but how do you implement them? Also, Mr. Leisch, if you have some comments on this, I would like to hear them. I am looking for action, as you can see.

Mr. SCHOPPERT. I think what we really are confronted with are two things. One is catch up and the other is keep ahead. I am sure your question about "how long" is with respect to catching up.

I tend to agree with Mr. Prisk that a year, or perhaps 2 years, would be sufficient. He says a year and I say perhaps 2 years to catch up. Then I think it will take us substantial effort to keep ahead. I think we have some demonstration here that we have fallen behind in the recent past.

I really believe that we could catch up in 2 years. I think it is a forever project that we are talking about, though. I think catching up would cost a considerable amount of money, although I don't think money is the answer, strictly speaking. I believe you can spend a great deal of money and get very little return for it under the conditions that prevail today. We are in business to provide services which are provided by people. One of our major efforts is recruitment. We know the problems of recruitment of qualified people, people with the background and the imagination and the education to do a good job. We know that the State highway departments are confronted essentially

with that same problem, although not uniformly across the country, and that the cities and counties or local governments are perhaps in the worst situation of all with respect to being able to recruit and retain the kind of people they need.

I see this as a problem of balancing the amount of money which might be spent against the amount of money which could be spent fruitfully. I think it turns out to be a relatively small amount of money when you put the "fruitfully" condition on it.

I think we need in addition to a catch-up-and-keep-ahead situation, what you call bridging the gap as we talked about yesterday, the communications gap, as part of the catching up and keeping ahead. I see this as pretty much a long-term problem over a fairly long period of time. I would think that the money to be expended in this direction might more fruitfully be spent on these last two things, bridging gaps and filling the staff positions that are required to do the job properly.

With that I would be happy to hear what others might have to say on it.

Mr. PRISK. I think I would like to say quickly, Mr. Congressman, that Mr. Schoppert interprets your question one way and I another. In thinking of the evaluation of the ideas that have been presented here, this is really what I mean when I think a very meaningful report on the worth of these could be turned in well documented within that period of time. If you get into some of the other ramifications that have not been discussed—and I am sure Mr. Leisch would be the first to admit that what he has presented is not the full spectrum of the problems—there are a great many other things. One not mentioned at all yet is the very simplification of our route-numbering systems themselves. A great deal can be done just by careful study of a map and full evaluation of what numbers are used on what routes. In Iowa a few years ago I think there were more than 200 miles of duplicate route numbering that were eliminated by a rather simple study. This, of course, has a tremendous impact on simplifying signing presentations.

So if you get into all of these other facets, such as some of the complications Mr. McGrath mentioned, Iwouldn't say you could do it in 2 years. I think it would be a long ways away. This is sort of an everlasting job which is going to rely pretty heavily for its rate of progress on the competence that can be turned into it. This competence is a little bit thin right now.

Mr. CLAUSEN. Does anyone else have any comment on this?

Mr. MATHES. I might comment just a little bit to Charlie's last statement there. This is going to take also a tremendous amount of understanding and cooperation from the public, because it is so difficult to ever eliminate a route marker once you have it. You may know it to be the best thing in the world to be done, from an operating standpoint, but getting the support of the public to do it comes awfully hard. This is one of the things that takes so much time.

Again, at the possible risk of seeming to be a little out of step, I think there are a lot of things that can be done soon if we apply and continue to apply and uniformly apply the standards we have right now. I think there are a lot of things that can be done now that won't cost a great deal of money.

Mr. CLAUSEN. That brings up a point Mr. Prisk raised that I jotted down. At this point in the record I would like to have each of you, if you could, give the committee what you consider to be the whole spectrum of the problem under discussion. It would be very interesting to have these papers as part of the record so that we can have our staff evaluate the full spectrum of the problem. Then, hopefully, we can come up with a possible recommendation for action.

Again, I am very much concerned over the comment that Mr. Wilson made and that is, when do they focus attention on this. To me yesterday was too late in light of what I have seen in these films. And also in light of what others have said that it is a changing problem with that consistency.

I can't predict what is going to happen in the next few years as far as establishing priority on highway constructions in this country is concerned. I am a firm believer that one of these days the highway construction program and, for that matter, the entire transportation construction program is going to be recognized for the value that it really has and can contribute in the way of overall growth. I don't think we have even touched on the potential justification under established criteria.

I am going to predict that in the next 10 years you are going to see some pretty exciting developments. I, for one, as you well know, gentlemen, have been of the point of view that the entire highways system in this country has to be balanced a little better, balanced between the national, the State and the local. The only way this is going to come about is through a balanced method of finance. We know this.

Again, I believe you are going to see substantially increasing pressures on the part of the Congress to work with the legislatures in bringing about a partial reversal of this trend.

We have permitted ourselves in this country to develop a migratory trend where 70 percent of the people now live on 1 percent of the land. I am of the opinion that this is a little bit ridiculous. I think there is going to have to be a new philosophy to somehow figure ways and means of retaining people in some of the smaller communities and also finding ways and means of getting some of the people out of the big cities. I think our security depends partially upon this. This obviously will be somewhat dependent upon who is in charge of the executive branch.

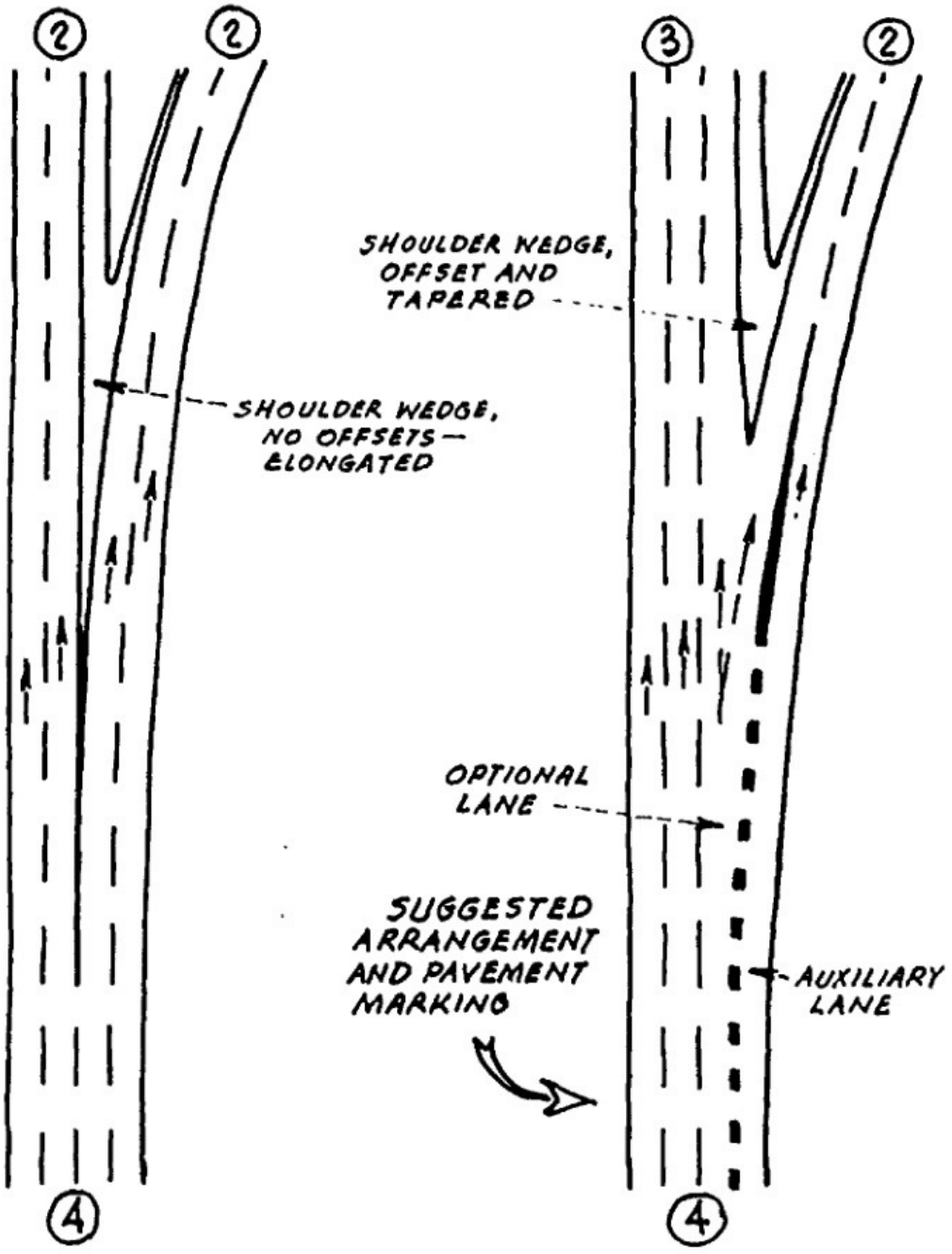
Again I will predict that this trend is going to take place. In my judgment it has to because you can only crowd so many people into a given area and this again will extend itself, I think, to a movement toward a balance of the entire transportation system. I believe that airports and highways are going to take on a new sense of direction if I see the situation correctly. Of course, I am the least expert of all the people who are here; so I probably should not speak too much. I genuinely believe that something like this will have to occur so that we can someday anticipate the whole potential of our economic growth.

This is all tied to highways and transportation and that sort of thing. I don't think you people have been adequately recognized enough for what you can yield. We have had too many priorities at all levels of government in our budget for items that I believe should be further

down the list, and this sort of thing should be at the top of the list.

Mr. MAY. Do you have additional material, Mr. Leisch?

Mr. LEISCH. Just one more point, if I may. Then I will be finished here. Mr. Prisk certainly made a good point of some of the things he said that are being discussed as only the beginning. There are many facets and elements in this that have to be looked into and all combined to improve the problem. These are only certain ones that are being touched on here. They were specifically selected on my part because I thought they related directly to the films and slides we have shown in the last few days.



AUXILIARY LANE DEMARCATION AND USE OF OPTIONAL LANE AT EXITS

The one last point I would like to discuss deals with lane marking, which must be associated with signing and, of course, with geometry. I think it is a tremendously important point. The problem we saw on the film and one of the gore points, I believe, was in part due to the manner in which the lanes were arranged and the way the lanes were demarcated. There was one particular exit point where there were four approach lanes to a point of bifurcation, which appeared something like this on the left. There were four lanes going away into two lanes each. That was the film indicating the problem where many people were backing up with people coming from Richmond.

Mr. CLAUSEN. Can we have the description for the record?

Mr. MAY. Yes; that is I–95 heading northbound at the junction of I–95 and the beltway, I–495, swinging both east and west. Traffic leaves the main line and then makes the turns.

Mr. LEISCH. We found one type of maneuver, you may recall, where drivers would approach at a pretty good speed and cross the gore area. We found them going in both directions. Of course, there was also a group of people who actually stopped and were confused. There were quite a few that were actually crossing the gore area.

The problem here is in having a very rigid design in terms of lane arrangement where everyone must position himself very accurately in advance in order to exit. That makes for a problem and can make for many lane changes. Of course, this particular problem is also activated by the fact that that road was on a curve. The ramp was at least a thousand feet beyond the overhead sign and the driver continued to go around the curve. He could not see what was there and he had no idea of precisely how he had to position himself where there was little time to position himself in these lanes, and he found this kind of action taking place.

It was necessary for certain lane changing to take place. We examined this the other day. I think this particular configuration as we have shown here potentially may require what we call six lane changes, whereas a configuration which allows for the use of an extra lane—and this certainly fits in with what was mentioned earlier, in that sometimes we have to provide the extra lane to give emphasis to a primary route whether it is needed in terms of the actual measurement of traffic or not.

But then it also has another value from an operational point of view. So if this were arranged, let us say, this way, as shown on the right, where we had the same four lanes on the approach, then we would find that we had what is called or what is the equivalent to an optional lane. That middle lane allows traffic to make its last minute choice in either direction. It has not been necessary for drivers to position themselves quite as accurately.

The number of potential lane changes here is two, compared with six. By adding this one extra lane in here as an auxilliary lane, we can eliminate many of the problems.

In this particular case we actually had two lane drops. Here we only have one lane drop and that cannot be avoided in a two-lane exit. However, this lane which is dropped should be an auxiliary lane. This lane should have been added somewhere and designated as an auxiliary lane. We mentioned that the other day.

I would like to submit this as a possibility for consideration, that auxiliary lanes as they are introduced—and they might be brought on from a previous exit or introduced a half mile or so in advance—should be definitely designated as an auxiliary lane. It might then be marked in some characteristic fashion, a lane marking which we do not have but has been used overseas for similar purposes where it would be quite characteristic. It might be a lane line that is 12 inches wide having a stubby short line and spaced a little differently so it is quite characteristic. This way this will just be a source of information for the driver that if he is to the right of a lane of that sort he is on an auxiliary lane that is going to drop off.

That can be a standard piece of information and it would be tremendously helpful. Those people who are leaving at this exit know that in advance and will naturally stay on the right. They will also know, if we always have one more lane going away, that means that even if you are in the second lane, you could still go off and it is an optional lane. You can go off smoothly without getting in anybody's way. But if you are in the right-hand lane, then you must exit or, if far enough in advance, you can transfer out of that lane.

Also in combination with that kind of lane marking there must be an overhead designation as was brought up yesterday. California uses the yellow panel in addition over that sign to really place emphasis on the fact that that lane is dropping off. I think this sort of thing is very important in association with signs. Also in this connection, we find that these very long gores and barrier lines have run for some distance. At least psychologically for the driver, they are very constricting and they channel the driver into certain paths and he is not completely prepared for that. It doesn't even give him too much flexibility. However, by the use of a lane marking at the point of the gore that has some offsets on this point so the actual gore point isn't necessarily that long, some of these get to be 300, 400, 500, or 600 feet long. If it were cut in half and at this point is somewhere in the order of 200 or 300 feet in length, it might be sufficient, and I think it is more indicative of the way the driver should operate and is not as restrictive, and I think it is a basic principle of channelization.

This is the way we used to mark them with offsets. Why we have gotten away from it, I really don't understand. I know part of the problem is that it is much easier for maintenance people in the field to actually place those by direct measurements of the edges and make them conform exactly to the width.

Mr. CLAUSEN. What do you mean by the basic principle of channelization?

Mr. LEISCH. The basic principle of channelization is that in terms of diverging traffic you give the driver some leeway, not only psychologically, but physically, to allow the driver to have some inaccuracies and also to make it appear like the opening that he is going to be entering is a little bit wider. If you don't have that and you realine it completely to the lane lines and let this come forward quite a bit, then in a way you are constricting the driver. Much of it is psychological. We do that with actual physical islands.

I think the lane markings should follow a similar pattern. We have completely gotten away from that in our recent marking, and I think

this is something perhaps we should give some thought to and see what the action is with the different types of marking, particularly in line with the use of an optional lane which can tremendously improve operation at these points of bifurcation.

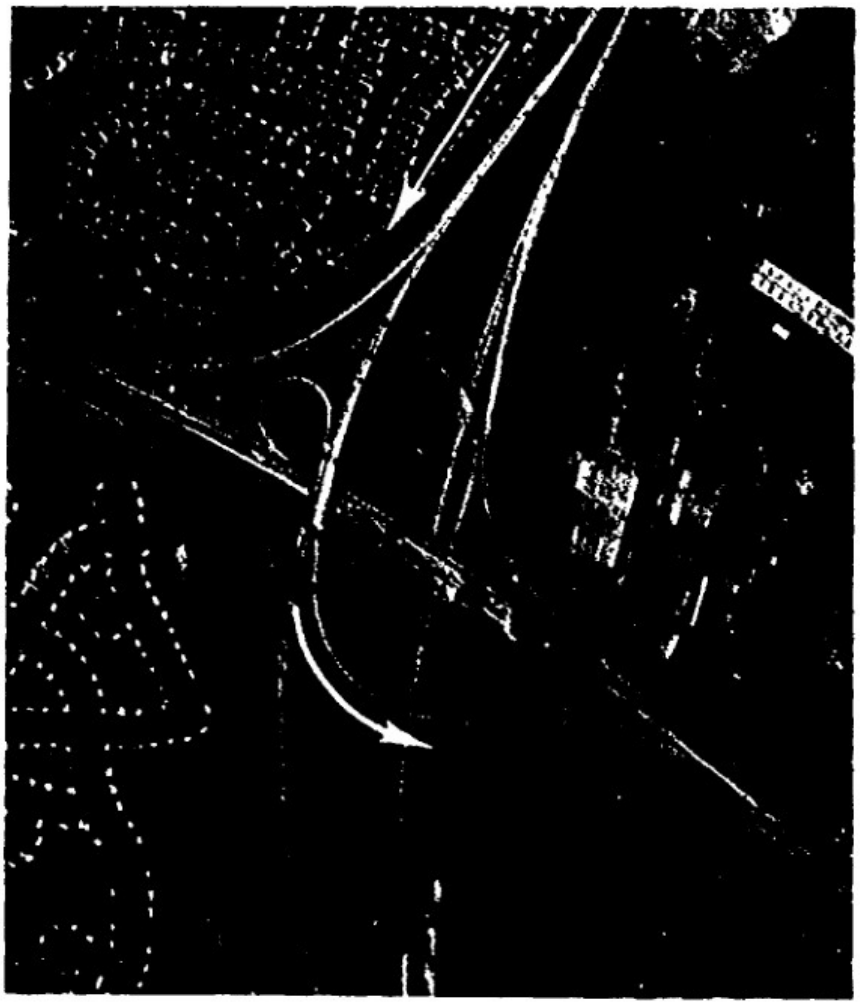
Mr. WILSON. You can do that by introducing a different color. Quite often you can change from concrete to asphalt and so on, and where you have them all concrete, you can put a dark coating on the concrete to designate it as an auxiliary lane. This is done quite extensively.

Mr. LEISCH. Yes, that is the way to do it. It has been a method which has been popular. I think we have gotten away from it somewhat. I presume the problem with that is because of the shoulders which have contrasting colors in themselves. Then you need three colors, which is a little difficult.

In an urban area they have so many auxiliary lanes coming on and off that it might become a little difficult. It might become a combination of both. I do think there is a need for a lane line which would be useful. This is all I have, Mr. Chairman.

Mr. CLAUSEN. We certainly appreciate your comments, Mr. Leisch. I believe we have had a frank and informative exchange based upon the thoughts that you have expressed and stimulated.

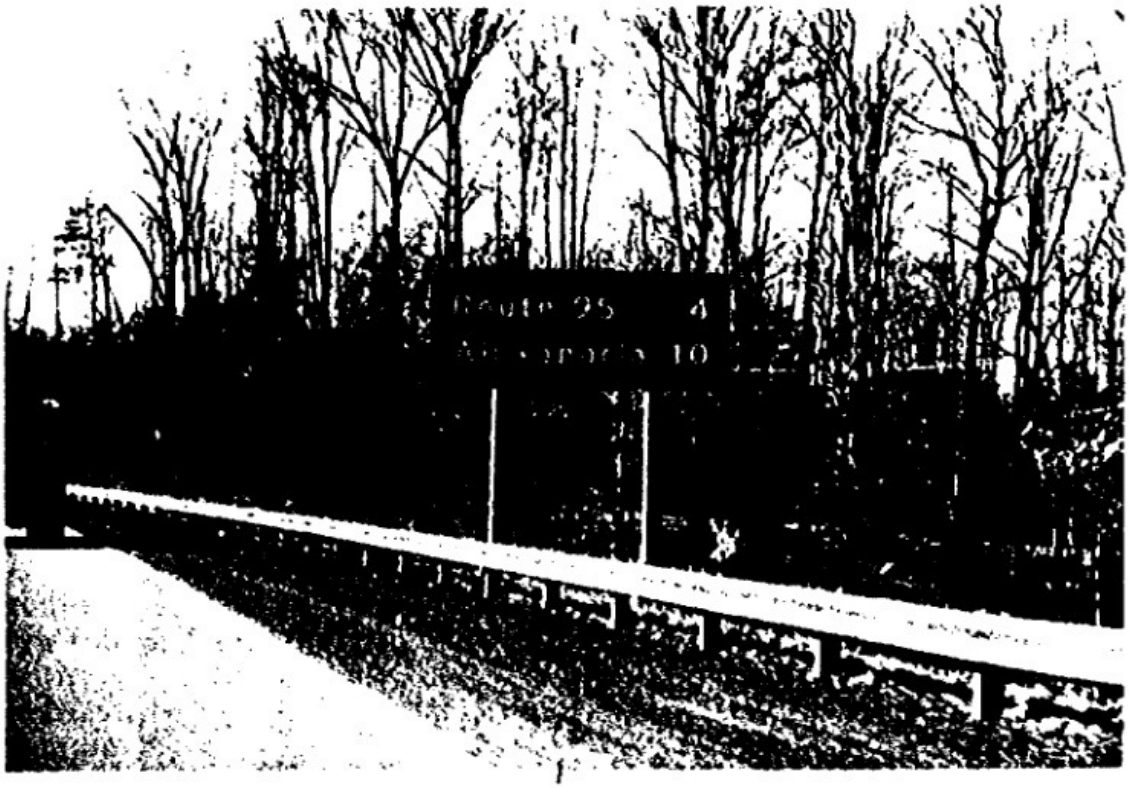
Mr. MAY. Mr. Schoppert, again moving as rapidly as we can, can we analyze the approach to Interchange 4 coming eastbound on the beltway, I–495? Would you do that for us?



Mr. SCHOPPERT. This is the aerial view. Traffic is approaching from the top of the picture going eastbound and has a left exit off the beltway if destined to Washington.



Here is the first notice, which is some 5 miles up the beltway, that Route I–95 is five miles ahead and Annapolis is 54 miles.



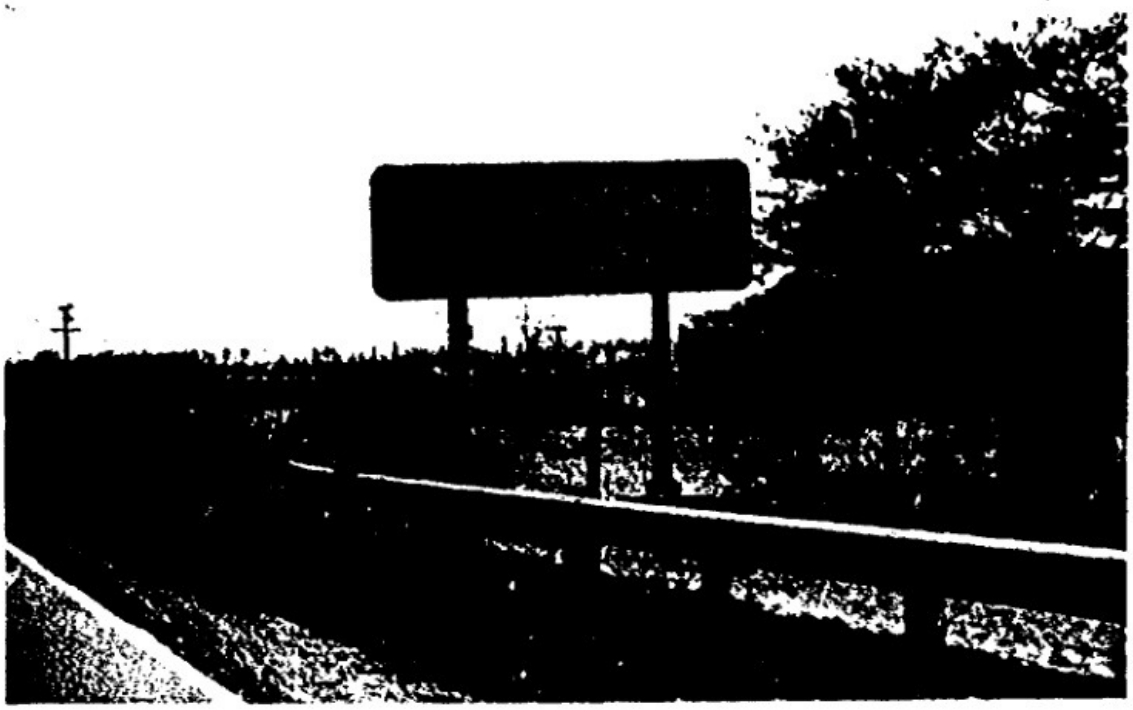
There is another sign at 4 miles ahead.



And there is an advanced sign to Interstate Route 95, "Richmond, Washington Exits 2 Miles."



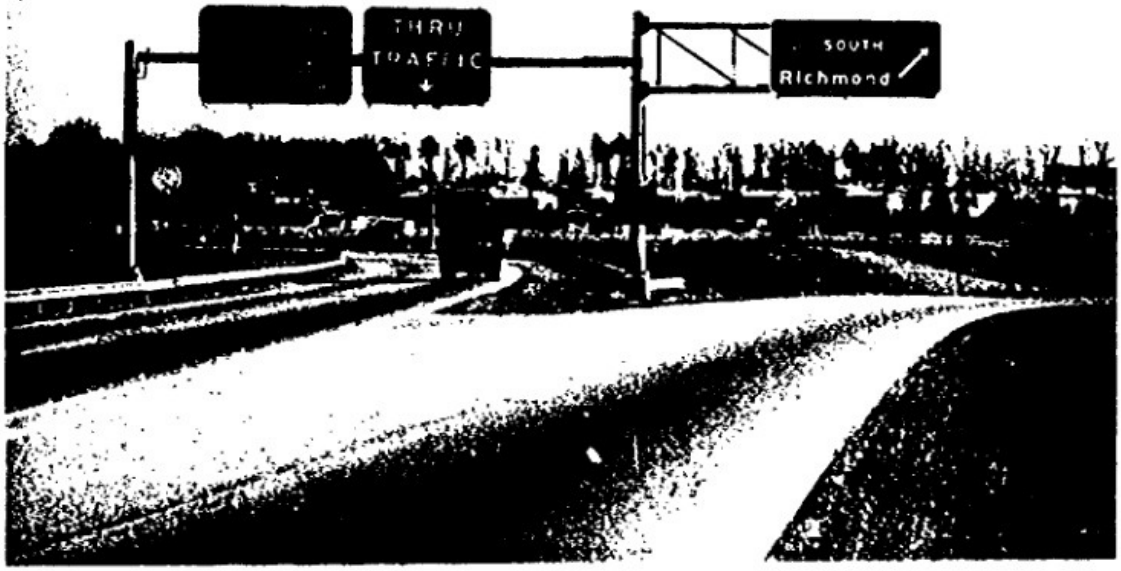
There is another one at 1 mile in advance showing the exit number.



There is a sign to Springfield. We had something similar to this approaching from the opposite direction yesterday, if you will recall.



Then there is a sign just in advance, with an arrow pointing to the right and saying "South, Richmond."



Then at the point where the ramp to Richmond leaves, we have this sign. Washington, as you can see, is a left exit and there is now a sign off the left lane saying that it is one-fifth of a mile.

If anyone wishes to interrupt at any point, please feel free to do so.

Mr. CLAUSEN. That is interesting. That exit 4–S sign. Which direction would they take for exit 4–S?

Mr. SCHOPPERT. They would go to the right.

Mr. MAY. We have seen in some States—I think Connecticut is one—some of the turnpikes where a sign like that might be differently shaped and kind of pointing to the right. Do you understand what I mean, Mr. Schoppert?

Mr. SCHOPPERT. Yes; I have seen them.

Mr. MAY. How would you react to something like that? That in itself might help the driver to recognize that 4–S is to the right. Otherwise he might have to debate whether it is straight ahead or to the right. We are not talking now about where it should be placed.

Mr. SCHOPPERT. I think there is a good deal that can be done with the shape and the composition of the sign to distinguish those which are at the point of action from those which are in advance of the point of action. We can stick pretty much with the rectangular shapes which I think limits us in some respects.

Mr. MAY. I was thinking more of a normal exit sign.

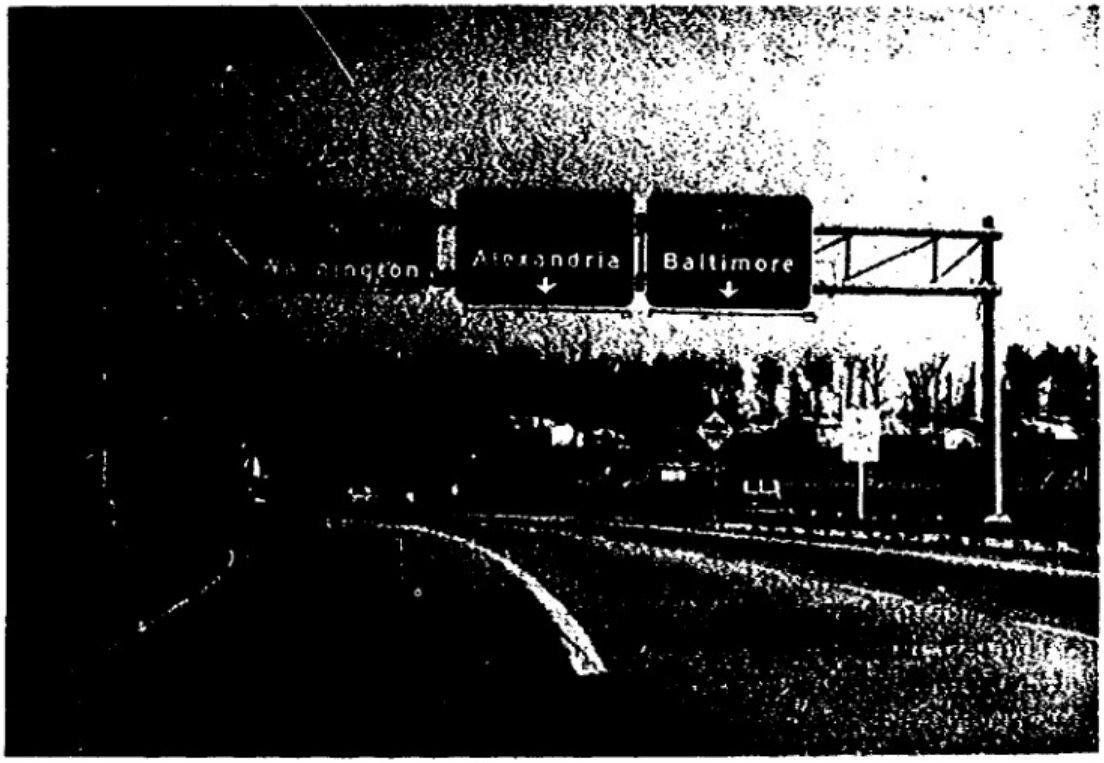
Mr. WILSON. The State of Michigan tried that when they first installed direction signs. They were in a shape of that nature.

Mr. MAY. Whatever happened?

Mr. WILSON. I don't know. They may still be doing it.

Mr. LEISCH. This is being used in Ontario and I think it is quite effective. That bevel angle there is quite indicative of an exit on the right. I think it helps. Also the actual exit sign, the word "exit" and the arrow, the standard sign that we have, which is rectangular, in Ontario, is used with a slight bevel on the right-hand side and it also fits the arrow better. It is a more compact sign. It is quite indicative. It is characteristic. Just the shape of it is immediately associated with an exit.

Mr. MAY. Sorry to interrupt, Mr. Schoppert. Go ahead.



Mr. SCHOPERT. This is the point where traffic would leave to go left and north on Route I-95, Shirley Highway.

Mr. MAY. I have to call attention to the small numbers in the I-495 shield.

Mr. SCHOPPERT. They are a good deal smaller than the 95.

Mr. WILSON. You are 50 or 60 miles from Baltimore. Do you have to make the decision at this point to get into the right lane? Is there a need for those down arrows?

Mr. CLAUSEN. A very good question.

Mr. WILSON. The format of the sign has probably been altered quite a bit, maybe only using one route shield with two messages, one above the other, divorcing itself completely from the left sign by leaving a little more space.

Mr. MAY. It is unnecessary to be in the right lane to go to Baltimore or the center lane to go to Alexandria. When you get to Alexandria the exit is going to be on your right.

Mr. SCHOPPERT. And you will get there before you get to Baltimore.

Mr. WILSON. Here again maybe a route shield about twice the size of Baltimore saying 495 might be all you need.

Mr. MAY. Up in Toronto, Mr. Leisch, we were commenting that down in the States we have 12-inch numbers on our overhead signs on the route shields, and up in Toronto we noticed pretty large numbers. The highway people said they were 24 inches.

Mr. CLAUSEN. Do we have this particular point identified for the record so that Mr. Wilson's comments would be tied in with it?

Mr. MAY. We are going to print all of these slides.

Mr. CLAUSEN. So you can tie this point in together with the suggestions that Mr. Wilson made?

Mr. MAY. Yes. Have we commented about the exit 4–N sign?

Mr. SCHOPPERT. It is in a somewhat different location than those which we had seen in the past. In the past they have been up ahead in the actual gore area. In this case it is over to the left.

Mr. CLAUSEN. Mr. May was demonstrating to me what might be done with shapes a moment ago. In a case like this, if I understood you correctly, instead of having a square you would come out here with something like this?

Mr. MAY. Yes, Mr. Congressman; and I think that shape should be considered more for the simple exit signs that we have seen instead of this particular sign. Personally, I don't think there is any question about that location for the exit 4–N sign; it is just plain wrong. The person is going to look up here at the overhead sign. I submit a good many are never going to see that where it is located, even if you made it a different shape.

So in this particular case I think the exit number is very important. As Mr. Schoppert pointed out, if you read the newspapers today, all the commercial people, the real estate people and the store and shopping centers will say to take the beltway and get off at exit 4. The exit number becomes very important to the people traveling.

Mr. CLAUSEN. Does the panel want to make any comment on this? Is this a realistic approach that should be considered, to change the shape?

Mr. LEISCH. I think the exit sign should have a characteristic form, definitely, so that the driver knows when he sees a symbol, either a U.S. or Interstate symbol, what that is. We ought to have some characteristic form for it. Whether it might be just a bevel, I am not sure, because we might want to reserve the bevel idea for the actual exit sign.

But perhaps the exit sign, first being of a different color, might have some characteristic shape like an hourglass or a trapezoid or something. Also I think it ought to be a separate panel tacked on for the number. For example, in this particular case it would be tacked onto the upper part of that Washington sign, somewhere above the arrow, and also sticking out halfway or two-thirds, but actually a panel that is physically three dimensional and always looking the same and always in the same place. Then I think we would be in the right track.

Mr. MAY. Yes; we have talked to a number of people in the field of traffic and the commercial people and although they are not highway people, they suggested to us that highway people should give very good consideration to changing our normal standard white on green rectangular exit signs. This is a very important sign and maybe it should be a different color or a different shape.

Mr. CLAUSEN. At this point I think it might be well to permit Mr. Mathes and Mr. Wilson and Mr. McGrath to comment on this if they have something they would like to add as it relates to their own areas of responsibility. Mr. Mathes?

Mr. MATHES. Yes, sir. I commented yesterday that in my opinion the exit should be located over the top of the destination sign, the destination that takes the exit. I think this can be done. In fact, I believe that the provisions in the current standards say that this should be done.

Mr. MAY. We are talking about the exit number?

Mr. MATHES. The exit number sign. When it is there and with the proper configuration on the sign, I am not convinced that you would need a different shape for it. I think it would be clearly understood. There might be some advantage, I think where you have the exit only, and a simple gore, with no information other than the exit number, perhaps in having a separate and distinctive shape for it.

There have been several shapes mentioned this morning. I do believe that where you have more than one exit the sign should be over the destination sign.

Mr. WILSON. I think maybe Mr. Prisk could comment on the fact that the special AASHO committee has discussed the format of the exit sign, which would include a change from the present sign in the manual to merely an exit with an arrow or using the exit and the number and an arrow. I don't recall having seen any of them in place yet, but this has been discussed.

Mr. PRISK. This is a modification of what we know as the standard exit sign to introduce the number in the exit sign that is mounted on the ground in the nose of the takeoff point. When you have an overhead sign like this the provisions that are presently going into the new edition of the manual will provide for a strip across the top of that 95 north and Washington sign an "Exit 4–N" sign and there will be an inset from the outer edges of that sign so that this will be a projecting rectangular piece on top of it. It will be on top of the main part of the sign, therefore standing out and calling attention to the exit number.

Mr. CLAUSEN. Mr. McGrath?

Mr. MCGRATH. Of this one, I don't recall ever having seen, until I saw this series of slides, an exit sign that didn't have an arrow with it. Maybe I have and didn't notice. As Mr. May suggested, this sign is just absolutely wrong and I agree. Mr. Mathes suggested that it be up on the other panel and be near the arrow, which would help. The New Jersey Turnpike has a special shape of exit sign which appears to be quite effective.

I think probably most important, regardless of what shape or what location, would be to have them absolutely standardized so they will always be the same shape and in the same location in respect to the gore; so the minute you see it you know what it means with respect to the gore—that this is the exit. I think that is what is missing here. Certainly the previous slide showing "Exit 4–S" didn't give us the slightest idea of which way that went. This looks like an afterthought. It just doesn't have any meaning.

Mr. CLAUSEN. Do you have any additional comments, Mr. Wilson?

Mr. WILSON. No, sir.

Mr. CLAUSEN. Are there any other comments from the panel?

Mr. PRISK. I think it might be said that at the time these exit panels were put up—perhaps Mr. Bottoms would want to comment on this since it is in his jurisdiction—the American Association of State Highway Officials standards applying to this type of display simply indicated that the use of exit numbers was desirable in many cases. The manner in which they were to be used was not specified in any detail. The new manual draft which is now coming toward completion will specify in detail how the exit numbers will be used and how on an overhead sign the exit will be at the top. On a ground-mounted sign, in the gore the exit number will be incorporated as a part of that design. I think it will add a great deal of clarity as compared with this situation.

Mr. CLAUSEN. Mr. Bottoms, in light of what the panel has said, could we have your comments on what they have said?

Mr. BOTTOMS. The exit signs and numbers were put on after the other signing was designed. Obviously, from what is being said, it should be put as an extra panel at the top, instead of placed here, but this was somebody's concept of just adding that exit 4–N sign after the other signing had been designed.

Mr. MAY. He did this with very little guidance. He had to make up his mind where to put it. He had no standards to go by, and I think the comment was made yesterday that we ought to get these ideas to the man on the design board. I think it is very appropriate. Whoever put these exit signs up was not informed as to what a standard sign of that type should be.

Mr. CLAUSEN. Is there anyone who can tell me who that person or that department is that would have the responsibility for establishing these standards or making some recommendations on it? Who is that person?

Mr. BOTTOMS. The person in our case is one of our traffic planning assistants who has supposedly made studies of this and has put this sign here on the beltway. As I said, it was a thing that was added with very little guidance.

Mr. CLAUSEN. You are talking about the State of Virginia and your highway department?

Mr. PRISK. Yes.

Mr. CLAUSEN. Who at the Federal level would be the person or what department would be responsible for this?

Mr. BOTTOMS. I think I would have to refer that question to someone else.

Mr. PRISK. This would be a responsibility of our division engineer at Richmond. If, in fact, these were put up separately, it is entirely possible that these may have come directly out of the State highway department's sign shop and gone directly to their position on that post that you see, without any formal action being taken at all. I am not aware of the situation.

Mr. MAY. Mr. Prisk, the party that determines whether there may be or not be a standard on a given matter would be the Federal Highway Administration, would it not?

Mr. PRISK. Yes. The Federal Highway Administration.

Mr. MAY. Mr. Mathes, you could help us here.

Mr. MATHES. I think in response to the Congressman's question and what has already been said by Charlie Prisk, the standard is the important thing and it will be in the manual. All States would then use it. It must be concurred in by the States and it must be concurred in by the Federal Highway Administrator. Then it would be a standard.

At the present time, it was indicated, this came about after the initial sign installations were in. There hasn't been anything definitely specified; so you got a variety. This will be standardized. The changes should be made. As Charlie indicated yesterday, this should be shortly. I think he indicated within a few months.

Mr. MAY. I think the chairman is looking in a very brief way for the procedure. How does the standard come about?

Mr. MATHES. When the manual is completed——

Mr. MAY. Who does that?

Mr. MATHES. It will go to the States.

Mr. MAY. Who draws up the manual?

Mr. MATHES. That is being done by the Federal Highway Administration right now. Charlie, you were doing all the work on it; weren't you?

Mr. PRISK. In the Federal Highway Administration work is being done; yes. At Public Roads there is staff work, but the responsibility is that of a special committee to the American Association of State Highway Officials, on which I serve as secretary.

Mr. CLAUSEN. Then would you suggest that we concentrate on the Bureau of Public Roads, the Federal Highway Administrator, or the American Association of State Highway Officials, to get the specific language incorporated as part of the standard into the manual?

Mr. PRISK. Fundamentally, this is an AASHO standard later concurred in by the Federal Highway Administrator. AASHO is the point of departure.

Mr. CLAUSEN. Will the staff make a note to check with Mr. Johnson on that? I think the entire panel agrees that something like this should be done. Is there anyone here that has objection to what is suggested here? I think it might be well to see that our findings here are immediately transmitted to the American Association of State Highway Officials if they are the ones who can get behind this and I would be happy to spend the time to talk to them myself.

Mr. MAY. Mr. Mathes, is it your committee that puts out the manual?

Mr. MATHES. No; not this manual. The one we are talking about now with respect to interstate. The interstate manual and signing for the Interstate System is a separate committee of which Charlie Prisk is secretary. The existing manual is in the process of being revised. What we are discussing here is being incorporated in it. This is what we pointed out. I am sure that what you would see there is what you have been talking about this morning. It will be in the manual. The physical work is in the process. The text and the exhibits are in the process of being prepared. And that goes to the States so that they ratify it, so to speak.

Mr. MAY. By two-thirds vote?

Mr. MATHES. It takes a two-thirds vote to adopt it by all States. Then it would go to the Federal Highway Administrator for concurrence in the standard. He has to agree as well, because Federal aid

funds are used in this work. This is the process. It is sometimes slow, but it is a democratic process and I have no reason to believe that it won't move rapidly once the manual is out. I think, Charlie, you have indicated several months. I hope that the actual physical work that is involved in order to get the manual put together can be done in that time.

Mr. CLAUSEN. So we then can take from your comments that this recommendation is underway? Is that correct, Mr. Prisk?

Mr. PRISK. Yes, sir.

Mr. CLAUSEN. In your judgment, how long will it take to get that into the manual itself?

Mr. PRISK. It is in effect in the manual. Many of the things that have been said about the exit signs are on paper today awaiting completion of other sections of the manual. As this total package is completed, which will take several months, it will be available this fall to all of the State highway departments in printed form, setting out precisely the ideas that are stated here.

Mr. MAY. Mr. Schoppert, would you continue?

Mr. MATHES. Could I make one more comment, Mr. May? The reason this takes so long, as I am sure you recognize, is that the American Association of State Highway Officials is an association of States. One State can't speak for another; so it has to go to them.

Mr. MAY. I understand.

Mr. BOTTOMS. There is one thing I might add. This doesn't have to wait for a manual to be changed.

Mr. MAY. You could do that this afternoon?

Mr. BOTTOMS. I won't do it this afternoon, but we will take the message back to our traffic division and certainly they will act on these recommendations.

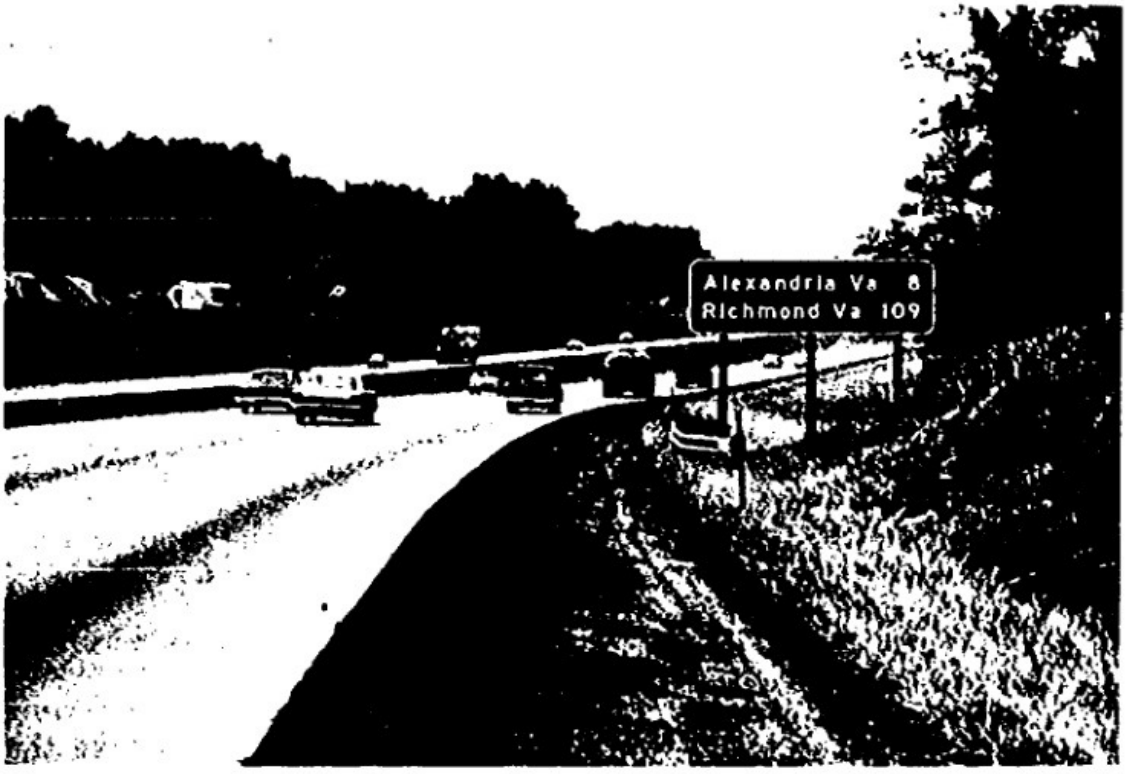
Mr. MAY. Tomorrow, I hope.

Mr. SCHOPPERT. One of the things we haven't touched on at all is the signing which is in addition to that at the points of decision. I am going to back up and show the slides just shown in advance of I-95 going eastbound on I-495.

Here for the through traveler it says Alexandria and Baltimore. Back here it says through traffic. Back here are those advance signs. This one says Alexandria is 10 miles. This one says Annapolis is 54 miles.

In fact, if you were going to Annapolis, you would have to leave the beltway, but not at that particular point. It does seem to us from the study that we made that it really is very desirable to have the signing done in a systematic way so you can provide this information at a point where no action is required but you follow it at points

where action is required with exactly the same information. We have some slides which show some means of providing this kind of what we call orientation signing on the beltway and on some routes in California.



Here is a typical sign of this kind. This says Alexandria, Va., is a distance of 8 miles and Richmond is 109. This is to give long distance orientation to motorists as they are proceeding.

Mr. MAY. These are in Maryland as we are heading westbound?

Mr. SCHOPPERT. These are in Maryland as you are heading generally westward toward Virginia.

Mr. CLAUSEN. This is Alexandria, "Va.," which is Alexandria, Va. From the standpoint of the panelists, is that an item which is really necessary?

Mr. MATHES. I don't think it would be necessary unless there would be an Alexandria, Md., as well

Mr. CLAUSEN. Does anyone know if there is an Alexandria, Md.?

Mr. MAY. No; we don't know of any.

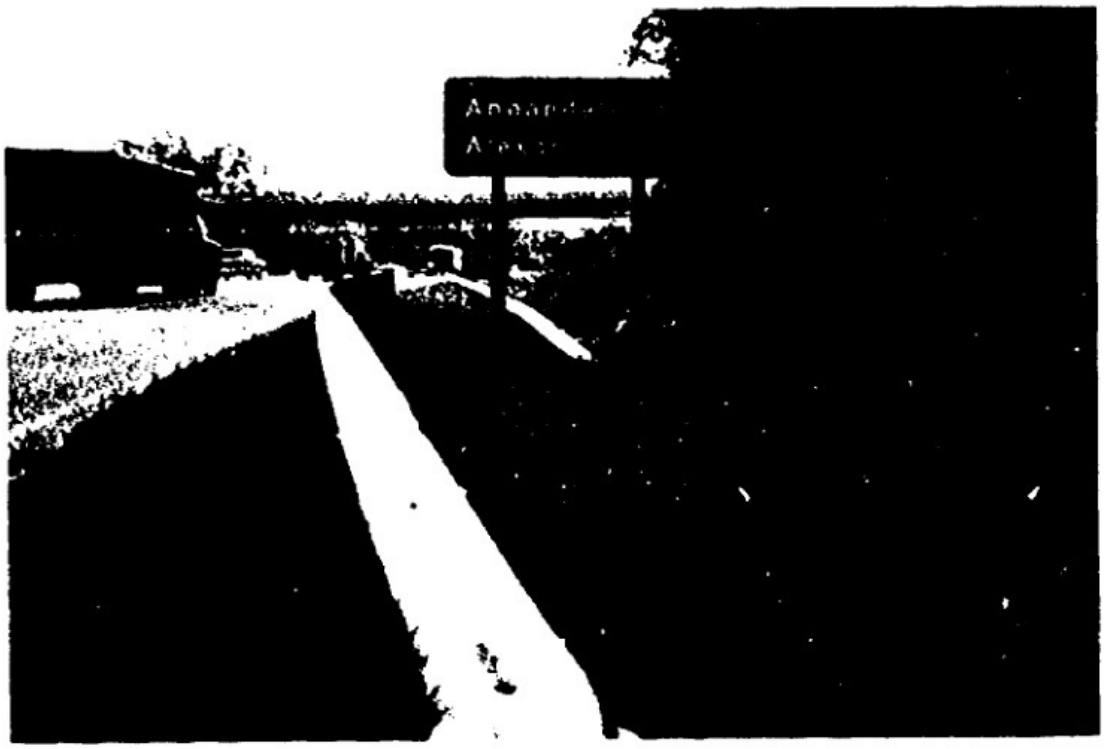


Mr. SCHOPPERT. This is one which I think we saw earlier, saying "Franconia, 2 miles" and "Route 95, 4 miles." In this case the information is tied directly to one of the routes. The other is just general places.



Here is one that includes two pieces of information. It shows us Arlington Boulevard and Maryland. This is just south of Route 50, which is Arlington Boulevard. The signing at the interchange 2 miles ahead where you might go to Arlington Boulevard never mentions Arlington Boulevard, but mentions Route 50 and some other places. It doesn't really say anything about Arlington Boulevard.

This is an example of the need to be conscious of what you are saying here with respect to what the motorist is going to read farther on. You really won't find any other information on the beltway about Arlington Boulevard.



Here is one saying "Annandale 5, Alexandria 16." This is well up north on the beltway.

Mr. MAY. Mr. Bottoms, what do you think of that guardrail installation?

Mr. BOTTOMS. I wish you wouldn't ask me that question.

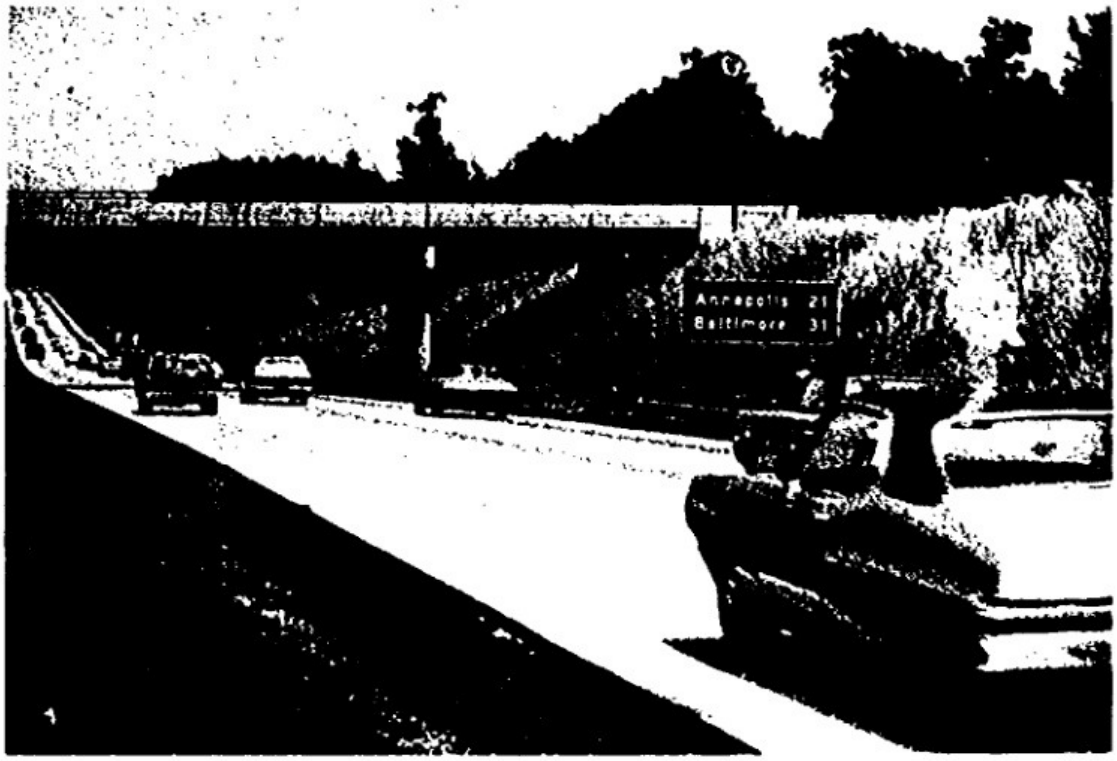
Mr. MAY. I understand it is being changed now.

Mr. BOTTOMS. Yes; it is being changed.





Mr. SCHOPPERT. This sign shows Route 95 and Annapolis. These are the ones we saw before.



Now here is an interesting thing that can happen. This sign says Annapolis is 21 miles; and if you will notice the next sign says it is three-fourths of a mile to the Annapolis exit. It is an advance sign; I think it is three-fourths of a mile in advance of the highway which takes you to Annapolis. So in the space of a relatively short distance you can read 21 miles to Annapolis or three-quarters of a mile to Annapolis. This again is an example of the kind of relationship that exists between this information which is intended to keep the motorist comfortable and informed, and oriented on his path, and the signing which he sees where he has to make a decision.

Mr. CLAUSEN. Would you suggest that an arrow be there?

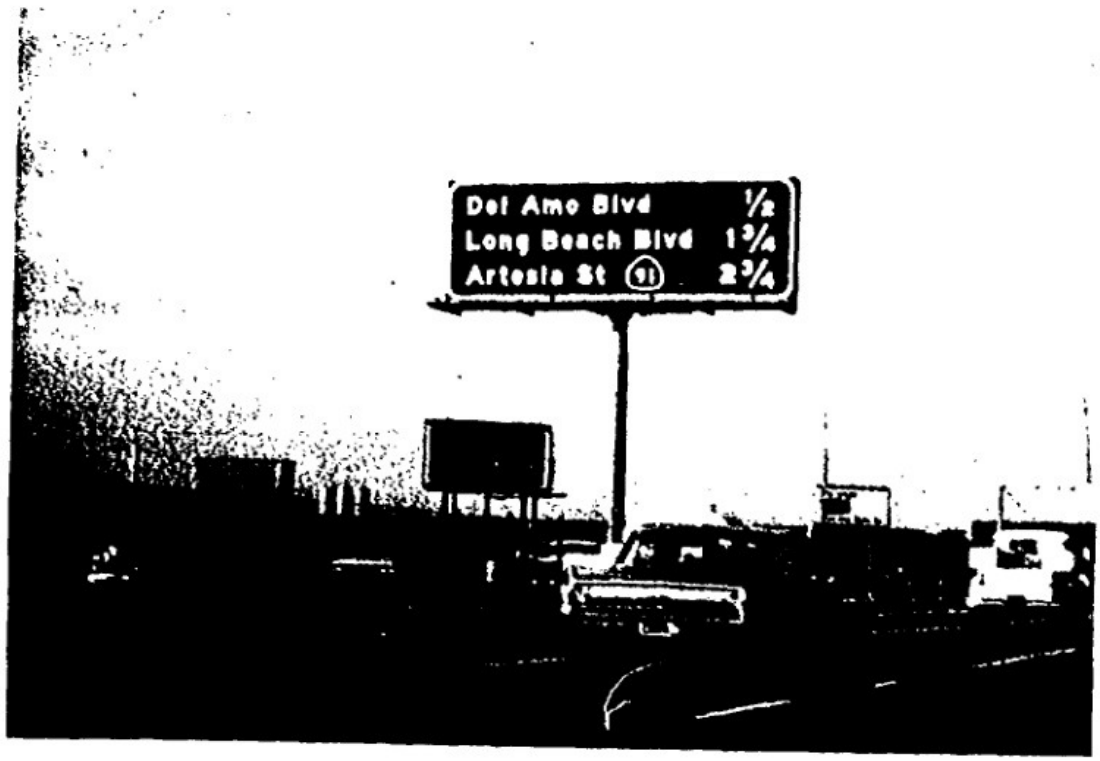
Mr. SCHOPPERT. We have seen several examples. One would say that so many miles to the route which goes to Annapolis, such as the example on Route 95 instead of Richmond. I am just suggesting that a good deal more attention has to be given here to what you are trying to convey to the motorist and not confuse him.

Mr. MAY. Mr. O'Hara has pointed this out time and time again to us. That sign says "Annapolis 21 miles." People get over here on the left in the high-speed lane. Some people figure they have got 21 miles to go to Annapolis. What that sign doesn't tell them is that they are about to come to the Annapolis exit. You can see it down the line.

Mr. LEISCH. I think there is another problem here. I am wondering whether you should ever put general information sometimes like that anywhere near the more specific signs about which the driver has to make decisions. I think these kind of signs will have to be very strategically placed and in such a way that they would in no way be confusing or detracting.

Mr. MAY. Put it somewhere else on the highway where the driver doesn't have anything else to do.

Mr. SCHOPPERT. You are competing for the driver's attention unnecessarily. You surely wanted him to see that one that says three-

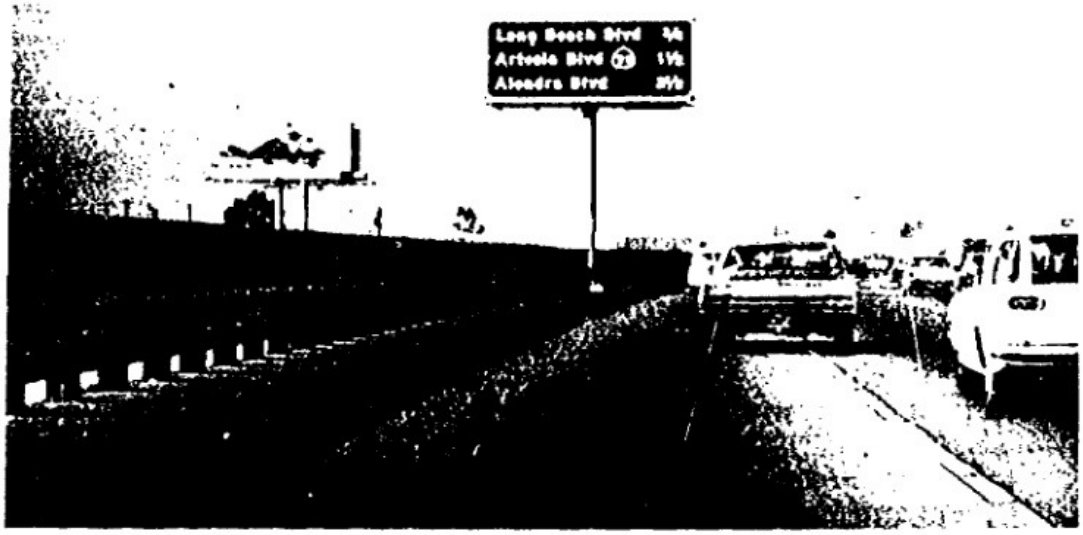


fourths of a mile. If he is in the left lane he has two lane changes to make within three-fourths of a mile.

Here is a sign which is used rather widely in California in urban areas. This is not an interstate route. It gives the distance to the next

three interchanges. We have a series of these. This one says Del Amo Boulevard one-half mile.





We then come to Del Amo Boulevard.

Then we pick up Long Beach Boulevard.

Mr. CLAUSEN. Mr. McGrath, does that type of signing begin to approach a partial answer to the problem you expressed?

Mr. McGRATH. Yes; I think this is excellent, particularly if they carry this on and the new third exit keeps appearing on the bottom and moving up. I can see a lot of potential for good orientation from that.

Mr. CLAUSEN. Then your trip here has been worthwhile, having seen these pictures?

Mr. McGRATH. I have learned something.

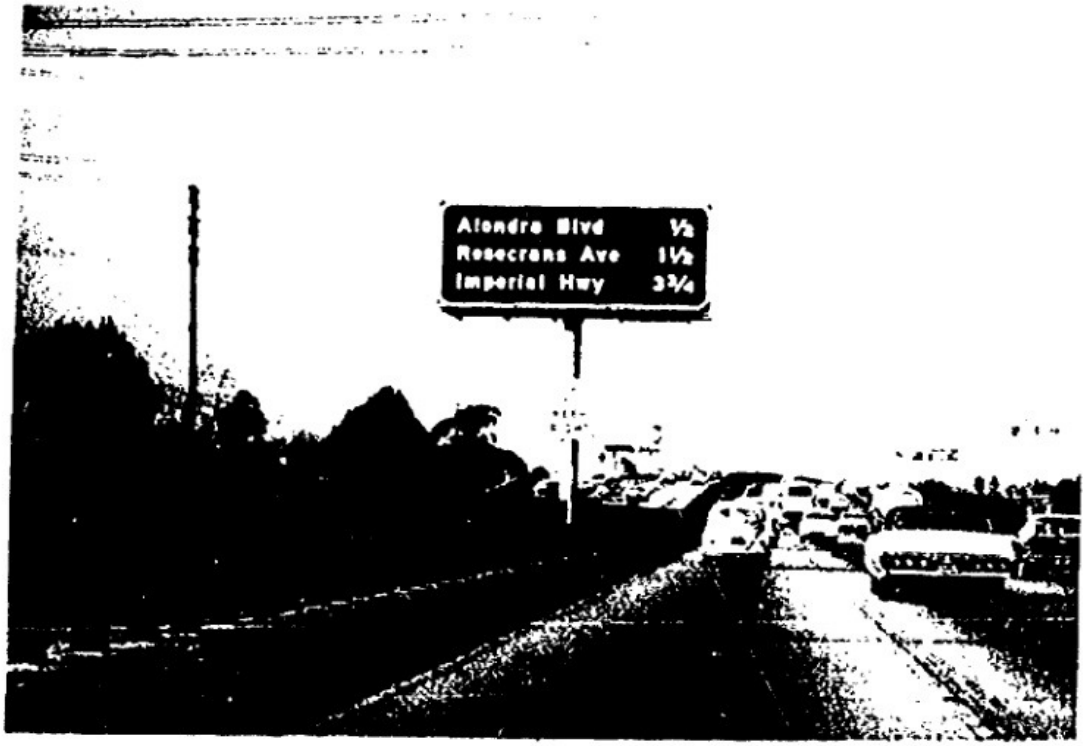
Mr. SCHOPPERT. When you interview motorists about the difficulties they have, you almost invariably hear that they don't get enough advance notice. The one on the bottom gives notice of an interchange 2½ miles in advance, which is a good deal farther than you can normally provide in an urban area with close interchange spacing.



Here is a sign on the left which says to get in the right lane for Long Beach Boulevard. We have not seen many of those.



This time Artesia Boulevard is worked up to the top and another one is added at the bottom, Rosecrans. We selected these slides to bring out some discussion about the need to provide this kind of orientation information which is keyed directly in the same terms and the same words to the indication which is used at the decision points.



Mr. CLAUSEN. Mr. Bottoms, would that be helpful in resolving the problem we have witnessed here in the pictures? Would this type of signing lend itself to the problem?

Mr. BOTTOMS. I think it is possible. It depends upon the placing of it. If you have lots of space between interchanges and can give a message there of that kind, then I think it would be helpful. I think this one being on the left of traffic, though, and saying "Slower traffic keep right," may not be so good. It may be in a position it wouldn't be seen by the driver.

Mr. CLAUSEN. Jim Wilson, would you have any comment on what Mr. Bottoms said?

Mr. WILSON. The "keep right" sign is a regulatory sign which is put there for an entirely different purpose, and it is only hung on the bottom there for convenience. It is not a decision point. We feel that the fellow who is traveling in the left lane would see it. It was really hung for convenience in that location.

I would like to point out that this kind of destination distance sign is provided for in the 1961 manual. It is spelled out and can be used in urban areas or where interchange space is close. It is a different system than your primary exit signs, your 1 mile, half mile, right lane, and action signs occurring in a different system. This is an entirely different setup that we chose to put in the median on divided highways.

In a great many cases you can pick up advance notice as in this case, 3¾ miles away. No decision needs to be made here, but if you were looking for Imperial Highway, it will creep from the bottom line up to the top line and before it reaches the top line you will start picking up the primary destination signing on the right-hand side or overhead, which will also start zeroing you in on Imperial Highway. These are particularly good where you have more than two lanes in one direction. Most of these are used on three and four lanes in one direction.

Mr. MAY. Do I understand that on the other side of this panel would be messages for the traffic flowing in our direction?

Mr. WILSON. That is right. Generally speaking, you will find messages on both sides of it. It is a matter of economy.

Mr. MAY. We could place these in the median of the beltway without too much difficulty, Mr. Bottoms?

Mr. BOTTOMS. They could be placed in there. I am not sure they would be too effective with the interchange spacing and so forth. I think that has a lot to do with whether or not you use this type of advance message.

Mr. MAY. Could these be placed on breakaway supports?

Mr. BOTTOMS. Oh, they could be. This might not be the place for a breakaway sign, but I am sure we could find some other means of using it.

Mr. WILSON. It would be difficult, under conditions we know of today, and perhaps impossible, to put an overhead sign like that on breakaway posts, where you have a median this wide, particularly.

Mr. MAY. So you might face a problem?

Mr. WILSON. But it is not a matter of concern at this location because you already have a median which is nontraversible because of a barrier that we had placed there to keep traffic from hitting each other headon. So it is not a problem in this case.

Mr. MAY. But we are talking about a system here, Mr. Schoppert; is that right?

Mr. SCHOPPERT. That is correct. That is the point we were trying to make. It is necessary to provide as much advance notice as possible, to provide it under the least stress conditions, where it isn't necessary to be reading other signs or maneuvering. This also relieves the motorist in the left lane of the necessity to read every sign on his right, which is not an easy thing to do.

But if we were looking for imperial highway, by now we would know that we are getting somewhere near it, so the driver is going to have to read every sign as he goes down the road. If he misses one, he may be in serious trouble.

Mr. MAY. I think Mr. Mathes has a comment to make.

Mr. MATHES. It was in line with your comment, Mr. May. I think the development of the standard method which you mentioned is the thing that is being pinpointed out here. You couldn't mount it in the center. If you were out in a rural area, for example, on two or more lanes, it could be mounted on the right or it can be mounted on overhead truss, but it is important information and the geometrics of the situation do not restrict the use of this type of information.

Mr. MAY. That is very good. Thank you.

Mr. WILSON. I support that. And in some suburban areas we have used them on the right, on the ground, and in those cases they could be mounted on breakaway posts. I have also seen them on the Baltimore Beltway. They are mounted overhead on panels.



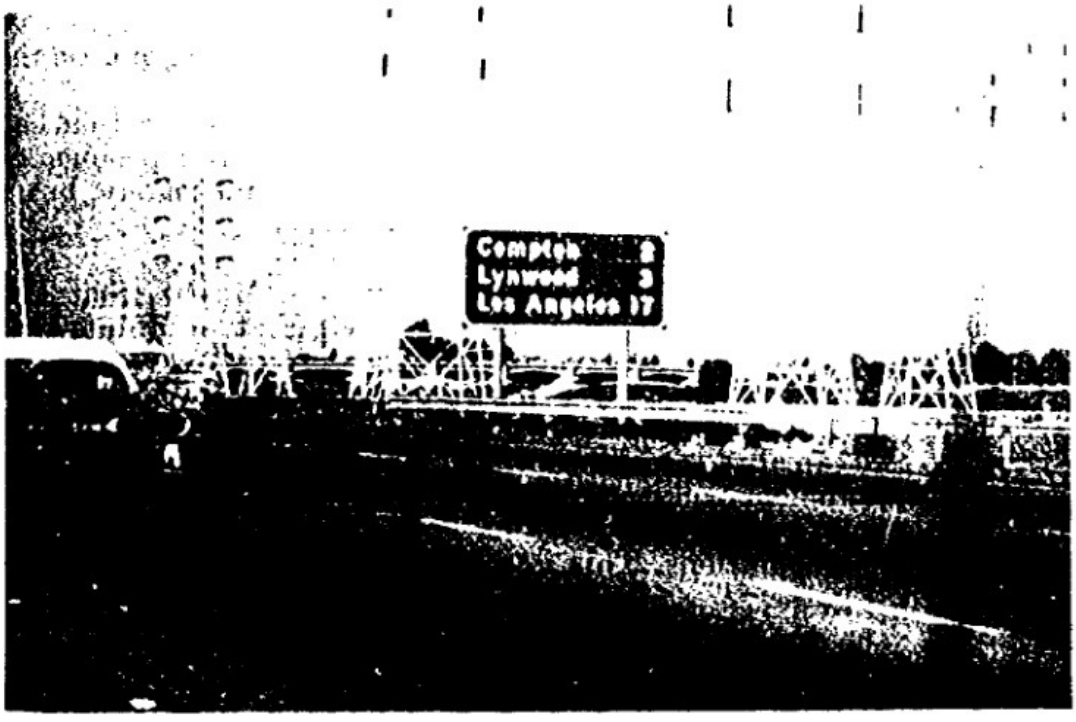
Mr. SCHOPPERT. Here is a view with a sign mounted on an intermediate structure, a bridge.

This sign takes us back to the first day of hearings. We talked about the need to guide the driver on a collector-distributor road, with the

idea that he can proceed on through and proceed to the freeway. This is a sign that illustrates how that is done in some cases. This is at the last departure from the collector-distributor road and it does indicate that the freeway is on ahead.



Mr. MAY. I think Dr. Hulbert mentioned that when we were discussing the Route 1 interchange. If somebody did get off on a collector-distributor road, maybe a sign like this might help him get back to the freeway. I think that was the point.



Mr. SCHOPPERT. Here is the signing which more clearly resembles the signing we saw on the beltway, showing places along the way. In this case, there are three of them. This is a different system, supplementary to the one in the median that we have just seen.



This is one of the exit only panels which I think we saw earlier.

Mr. MAY. Again we can notice here that other times we have seen the through traffic signs with an arrow or two. Here we see a shield, 405, with the name San Diego. Mr. Wilson, why the difference?

Mr. WILSON. In our experience out there we use very few, if any, of "Thru Traffic" signs.

Mr. MAY. I get the impression that the "Thru Traffic" sign is on the way out.

Mr. WILSON. Yes; I would say so. There is a problem here that has been touched on in the last couple of days and that is this problem of the lane leading to Long Beach. I don't know this intimately, but I suspect that is an optional lane.

Mr. MAY. It is.

Mr. WILSON. It is one of the solved problems. Maybe what Mr. Leisch proposed earlier this morning might help that situation. That is one of the problems that still remains with us.

Mr. MAY. We have come to get this impression after listening to the testimony, that we should see more and more optional lanes. As a matter of fact, we can always see the optional lane in places like this. Then we have the problem of how to identify to the motorist that that is an optional lane. We heard this morning from Mr. Leisch when he was making some suggestions. This is something that must seriously be considered, I gather.

Mr. WILSON. The reason we tried to put them in the proper lane is that probably a thousand feet beyond the major exit from the freeway you will find that there is some other split—one leading to Long Beach and the other leading to Pasadena. We tried to get the traffic oriented out here.

Mr. MAY. When we come to the next spot, the chances are that Pasadena will swing to the right and Long Beach will go to the left?

Mr. WILSON. I wouldn't bank on that. Do you have the next picture?

Mr. MAY. No. John Constandy says that is the way it happens. I would have been fortunate in that case.

Mr. WILSON. There is now information introduced here that we haven't talked about before, and that is the naming of the freeway.

Mr. MAY. Earlier in the hearings we had considerable testimony relative to this problem.

Mr. MCGRATH. Mr. Chairman, up around Hartford the Connecticut Highway Department in some of the complex interchanges tried to solve this with not only the arrow but by also using the term "This Lane." Where they use it, it turns out it is not an optional lane. It disappears in the direction you are going. You may or may not be able to get in that same direction from some other lane. "This Lane" means that is the only way it goes. I don't know whether it is effective or not, but it is a different approach.

Mr. SCHOPPERT. That is the end of that group.

Mr. MAY. Could we analyze the interchange of the Baltimore-Washington Parkway heading south as it joins the beltway, both heading west and east on the beltway?



Mr. SCHOPPERT. This is an aerial view of the interchange. This is the beltway running across the picture and the Baltimore-Washington Parkway running vertically. There is a local connection just north of this interchange which you can see up here. However, the advance signing for this interchange does overlap at a local road interchange just to the north of the beltway. You will have to remember that in order to understand what you are seeing.

Mr. MAY. Before we continue, do I understand that the Park Service operates the Baltimore-Washington Parkway, Mr. Prisk?

Mr. PRISK. Yes; the National Park Service.

Mr. MAY. They sign it?

Mr. PRISK. Yes.

Mr. MAY. When an interchange like this joining up with a Federal interstate route is being designed and constructed and signed, does the State highway department—in this case Maryland—work with the Park Service to iron out problems?

Mr. PRISK. Yes, they negotiate with them.

Mr. MAY. Is it then subject to the approval of the Bureau of Public Roads?

Mr. PRISK. Yes, as far as the Interstate participation is concerned, the things that are paid for from interstate funds.

Mr. MAY. How about the type of sign leading up to the interchange? Would that be approved by the Bureau of Public Roads?

Mr. PRISK. Not necessarily.

Mr. MAY. I think the key word is "negotiated."

Mr. PRISK. That is true. There are indefinite limits.

Mr. MAY. When anyone negotiates, it generally turns out to be compromise; doesn't it?

Mr. PRISK. I would say this happens.

Mr. MAY. Could we proceed, Mr. Schoppert? [Movies.]

Mr. SCHOPPERT. This is proceeding south on the parkway, starting out at a point north from that local road interchange. This is on the Baltimore-Washington Parkway. You can't see the signs too well.

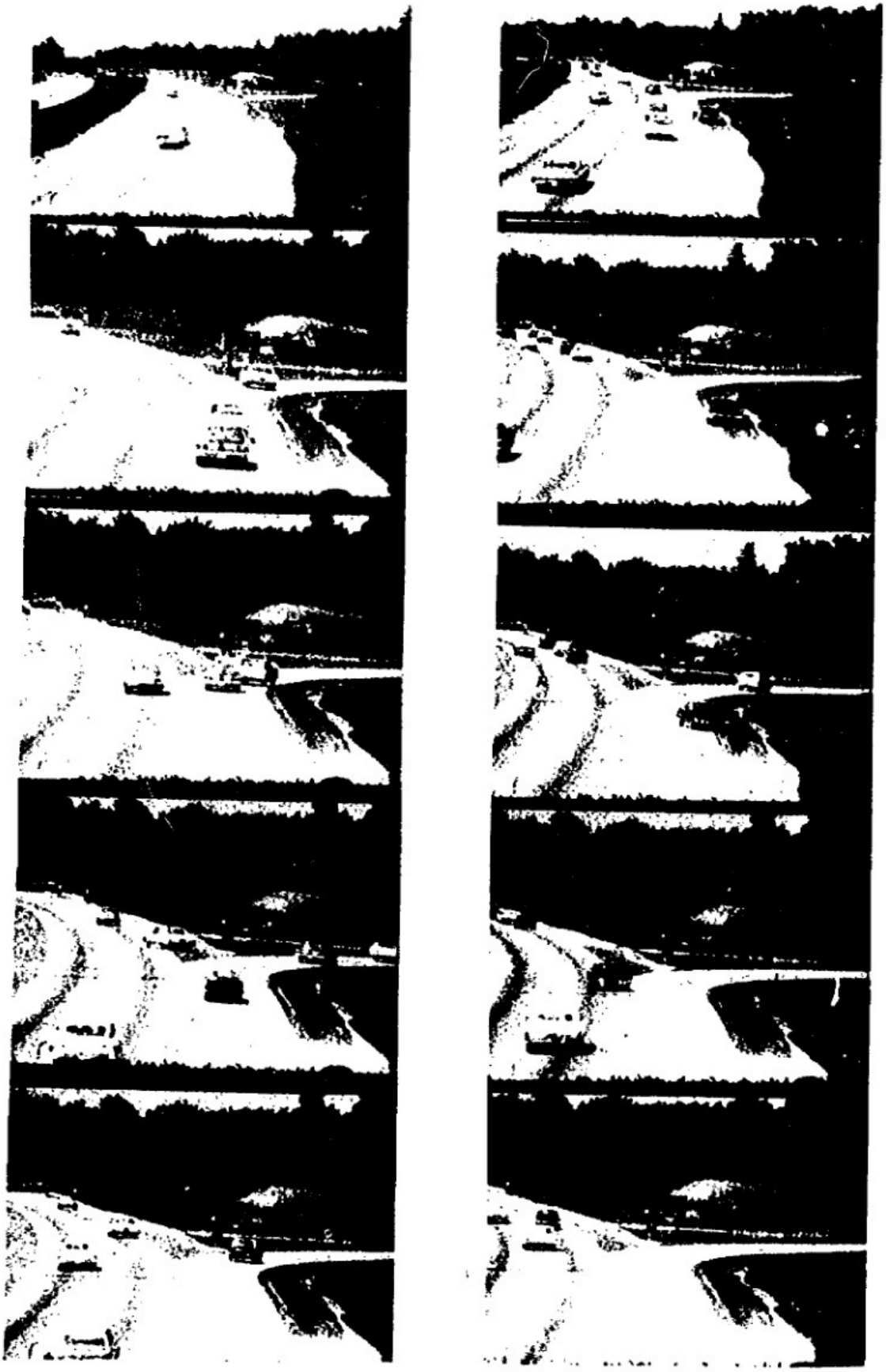
Mr. MAY. We will get a better look at those later when we use the slides. I think you will find the signs are kind of discreet. What is this point?

Mr. SCHOPPERT. This is the ramp off to a local road. Here is another sign here on the beltway. Then immediately under the structure is the deceleration lane to go west on the beltway. We are coming generally in a southerly direction and then you make a loop around to the right onto the beltway to go down to Alexandria and onto Route I–95. This is for long-distance travelers, as we mentioned previously. Here are some of the maneuvers that take place.

Mr. MAY. Again, the films themselves suggest how frequently these maneuvers took place.

Mr. LEISCH. It seems to me one of the problems here is that the driver gets information about the beltway, where he wants to go, and it only tells him that he can go west. He has no idea about going east. He is wondering whether he should turn here to get on the beltway or whether he should pay attention to the word "west."

Mr. MAY. In a moment we will see a mowing machine to our right and we might observe the number of strange maneuvers that take place just while the fellow is mowing the grass. You will notice beyond the gore area the dirt road beyond the gore made by motorists that we find so common.



Mr. SCHOPPERT. When we did the study of signing the beltway, we had observers counting the unusual maneuvers. We finally had to ask them to stay out of the office. They came back with such hair-raising stories that it disrupted the work. We also had to hide them, because, as you can see here, if the motorists could find them, they would stop and ask directions. Sometimes we hid them in some very unusual places.

Mr. MAY. I think you found that one observer couldn't keep up with the unusual maneuvers; did you not?

Mr. SCHOPPERT. That is right. Initially we were concerned that there wouldn't be enough for an observer to do. We were disabused of that in a hurry. We finally found we had to have two because there was too much for one at some of these interchanges.

Mr. MAY. You will notice the brake lights on the cars in this picture.

Mr. SCHOPPERT. You can see the road the motorists have built for themselves over behind the sign.

Mr. MAY. Yes. I noticed the short steel posts that had been put up to try to prevent the motorists from making that turn.

This is the next ramp. Traffic is now coming at us and heading south and this is the ramp where they swing around to go east on the beltway. Again we have the ever-present dirt road made by the traffic beyond the gore area. Here you will notice that these ramps have no shoulders and that adds to the problem. There are not very large shoulders on the main route.

(Mr. Blatnik assumed the chair.)

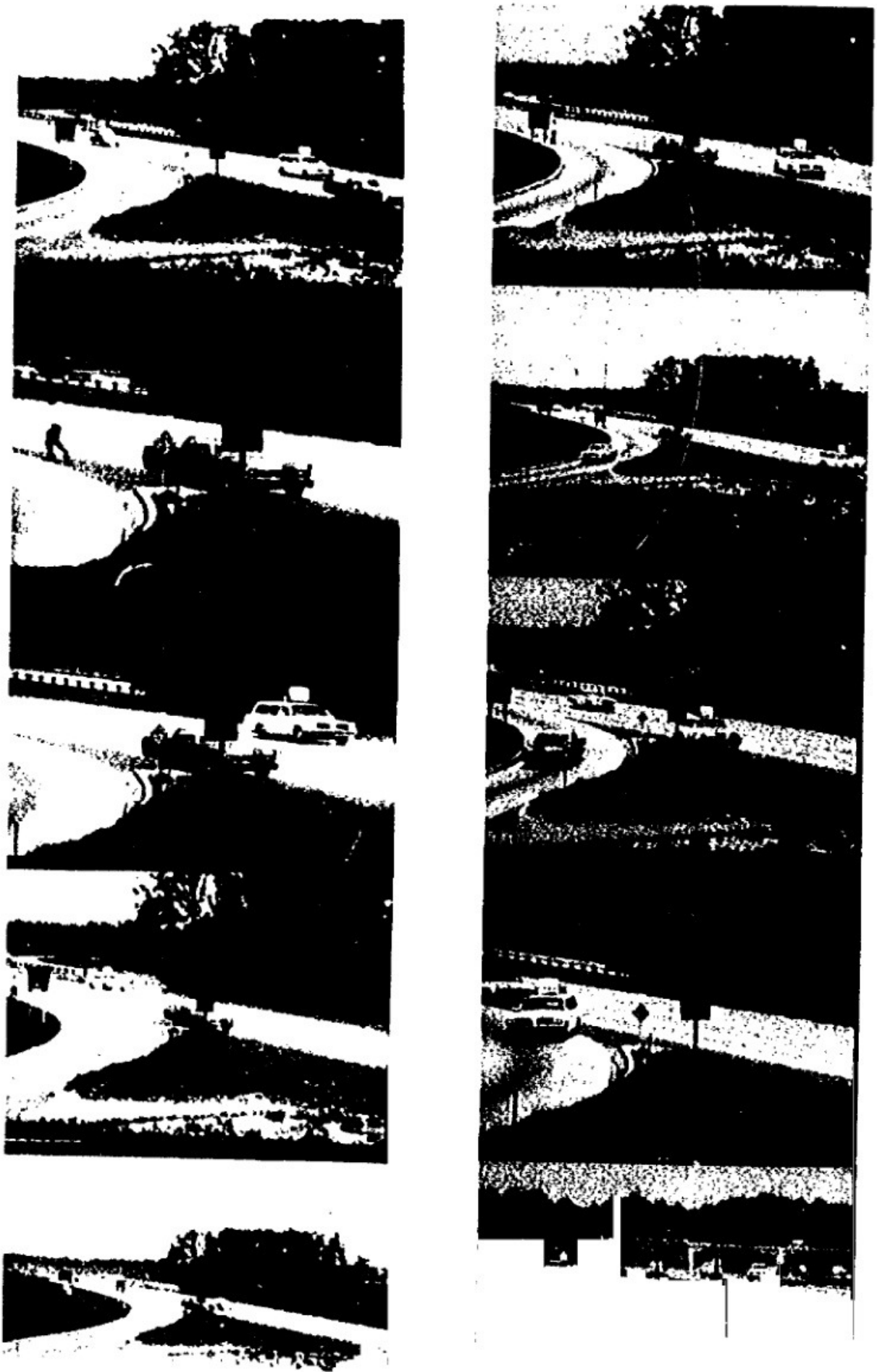
Mr. MAY. In a few moments, just briefly, you will see a white station wagon with luggage on the roof slip through our picture to the right and I would like to call your attention to him if I can catch him.

These people are out of their car looking at the sign, but it says only "Exit."

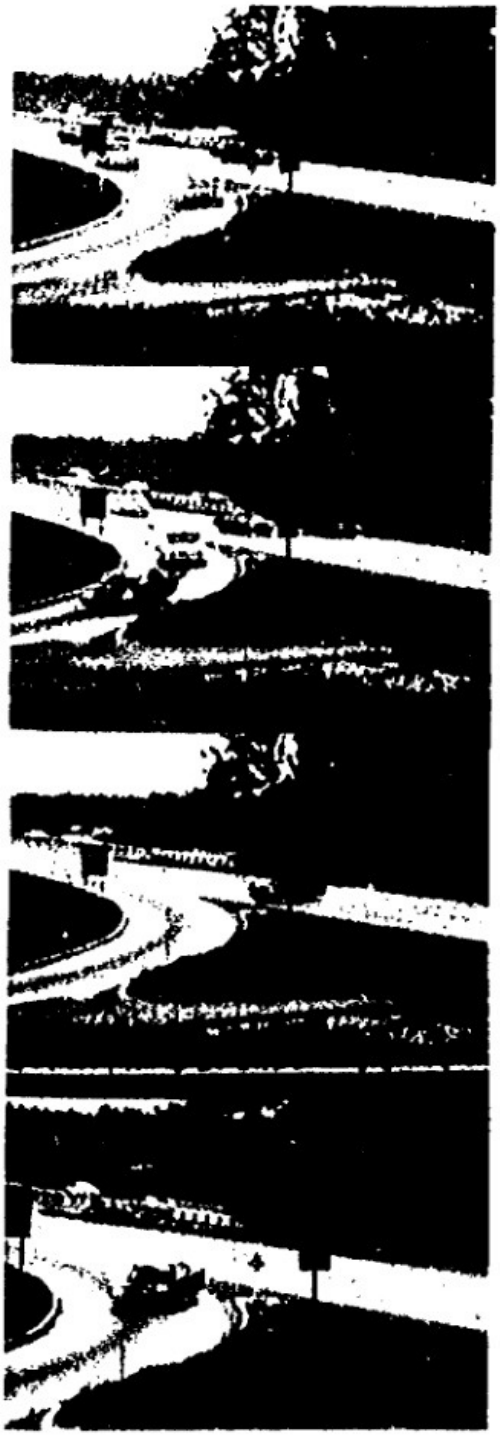
This man wasn't satisfied with our exit sign.

Here comes our station wagon back. This will be his second shot at this ramp. He won't make it. Here is his third shot at it. But keep him in mind. Here he comes again. I will explain what he did in just a moment. This is his fourth shot at this ramp. We will show you how he got back.

Mr. Constandy, will you help us explain what the man did?







Mr. CONSTANDY. The first time he passed the ramp he stopped in the fast lane and he backed up and came down on this loop to 495 eastbound and backed up this loop, back up to go north on the Baltimore-Washington Parkway, off the parkway again at the next ramp to head west on the beltway then up the ramp to the parkway going southbound where he began and for the second time went down that loop to go east on the beltway.

Mr. MAY. We might mention what is on that right lower sign leg. Isn't there a little shield that says 95?

Mr. CONSTANDY. Yes. Here on the parkway southbound where you go to 495 east there is a shield that says simply "95." It doesn't say "to" 95, or the direction. It simply says "95." The signing prior to that on the parkway reads "to" and then the shield for I–95.

Mr. O'Hara has made an analysis of the accident history in all of these locations. I want you, Mr. O'Hara, to just give us an idea of the type of accidents that happen in this case.

Mr. O'HARA. Do you want the number of accidents also for the 3-year period?

Mr. MAY. I am more interested in the type of accident that takes place. We are not saying that all accidents take place in this fashion, but in great numbers. These come directly from the accident reports?

Mr. O'HARA. These are from the accident reports. It is the part where you are supposed to describe what happened, and in this case it is the police officer talking:

> The vehicle missed a turn to go eastbound on 495 and stopped in the travel lane, was hit in the rear.
>
> He stopped to avoid a vehicle which had stopped in the travel lane by the exit ramp to 495 and he was hit in the rear.

Then another one, "Vehicle backing up the ramp caused him to slow down and he was hit in the rear by a third vehicle."

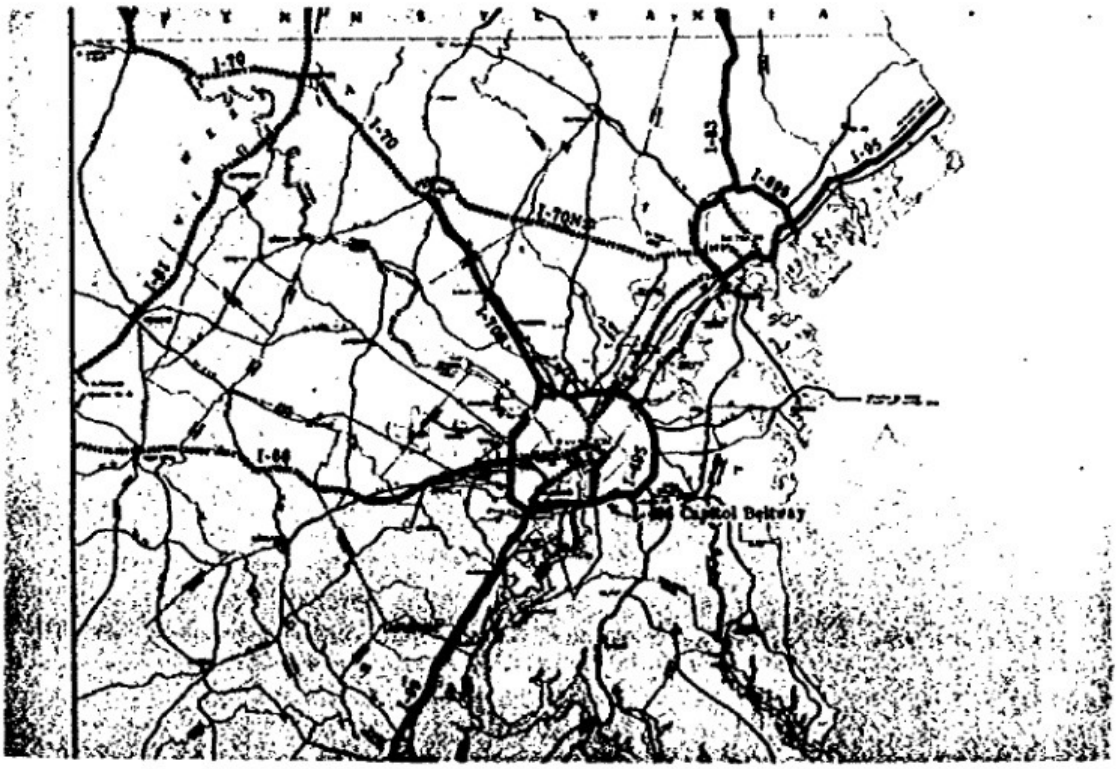
Another, "vehicle backed up trying to get on the ramp to eastbound 495, and he backed into another vehicle."

Another, "driver said he was slowing down to read the signs and he was hit in the rear."

Another one hit a vehicle which had stopped in the gore because he was lost and he didn't know where he was going.

Most of these are property damage accidents. Here is one where the vehicle slowed down to check the road signs at the ramp and was hit in the rear and this resulted in six injuries in one car.

Mr. MAY. Very quickly, Mr. Schoppert, could we proceed through the signing of this interchange? Then we will probably have to conclude.



Mr. SCHOPPERT. This is a map of the beltway. For those of you who may still be a little puzzled about where we are, the Baltimore-Washington Parkway comes down here. Since this link of the system isn't completed, it is the route used by long-distance travelers, and the interchange we are looking at is right there on the beltway.



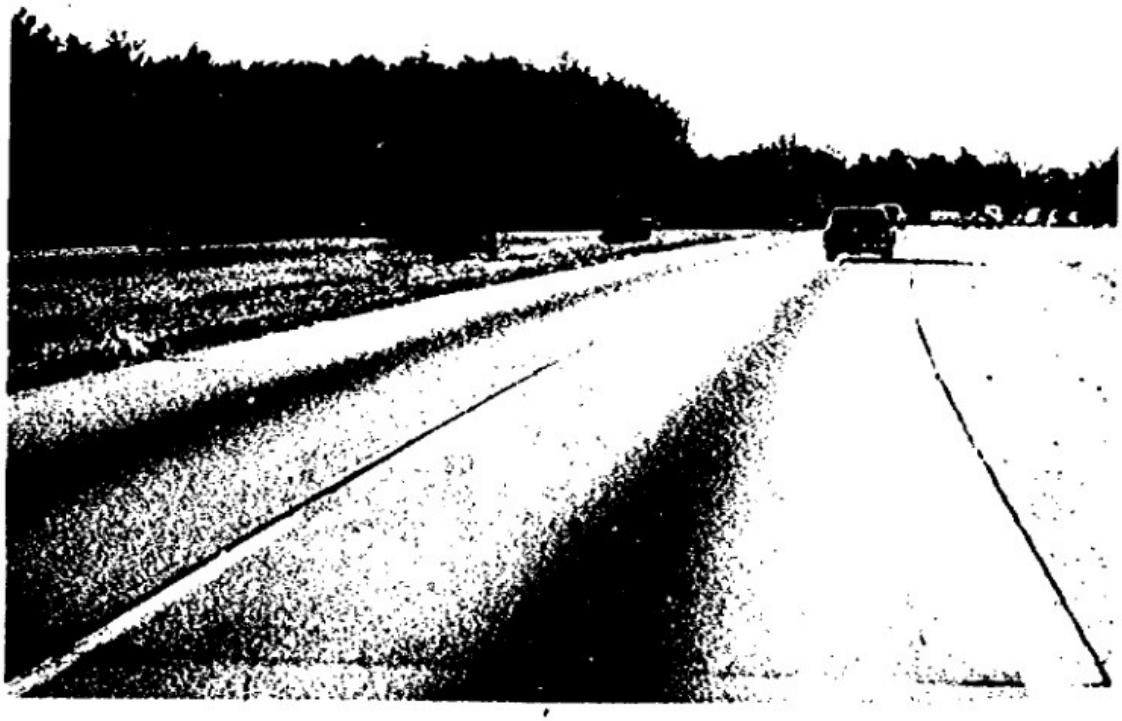
This shows the advance signing. You can see it on down by that vehicle. On the right is a sign that says "No Stopping on Pavement, Emergency Use Only."



Here is the advance sign. It says "495 Beltway Exits 1 Mile."

Mr. MAY. You must be guessing at that 495 beltway.

Mr. SCHOPPERT. I must be. I really cannot read it from here. Here is a closer view. You still have a hard time reading it.



Mr. MAY. These signs seem almost ashamed of 495.

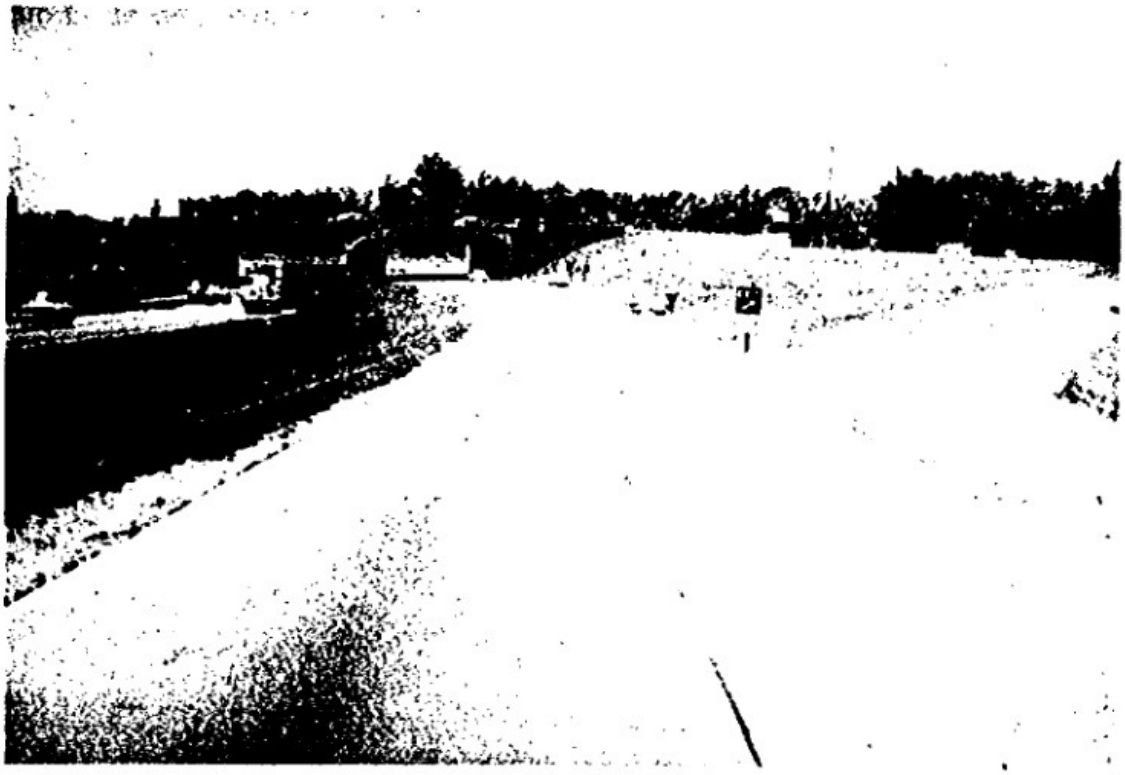


Mr. SCHOPPERT. Then intervening is this other local road, the Greenbelt Park being located off to the right. Then there is Maryland 193, with College Park, Greenbelt, and the Goddard Space Center. You



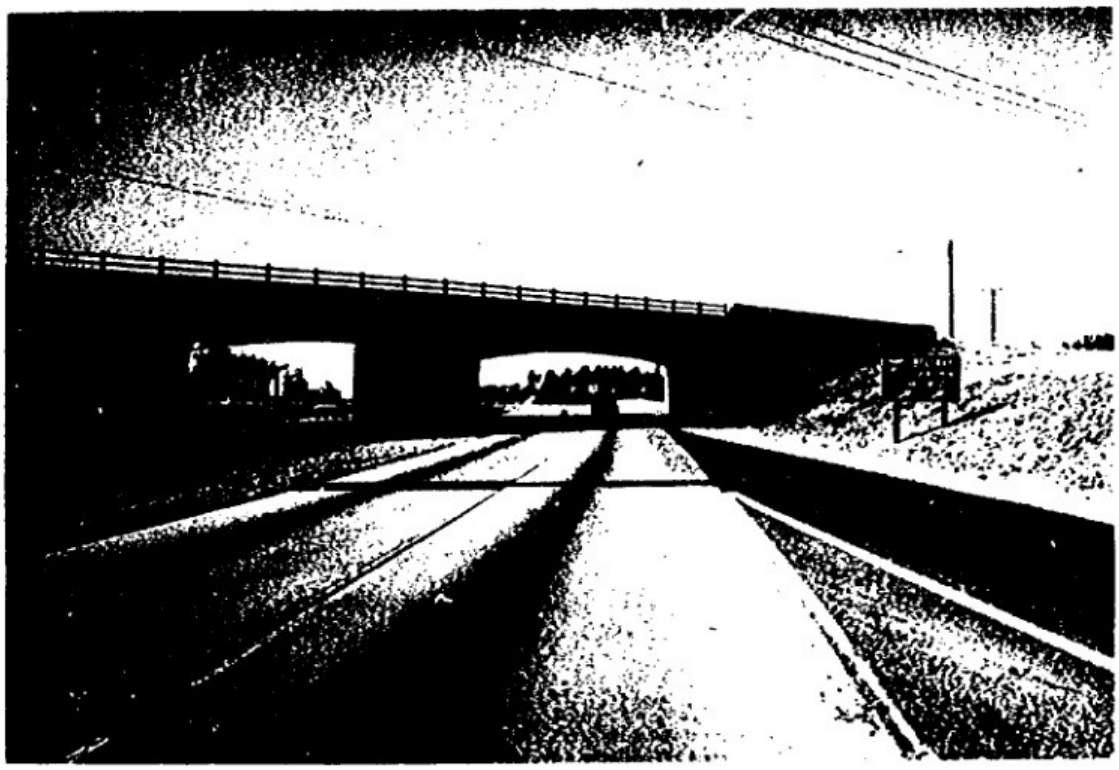


keep right for the University of Maryland. Here are two other signs for Maryland 193.



Then here is the point where the exit from the ramp, with a sign immediately opposite saying beltway and Silver Spring and west, to take the next right. Apparently, motorists believe that applies to this

ramp. They frequently get off there and they have to get back on. They realize they are not on a road which will take them where they are going.



Here at the onramp from Greenbelt Road is another sign.

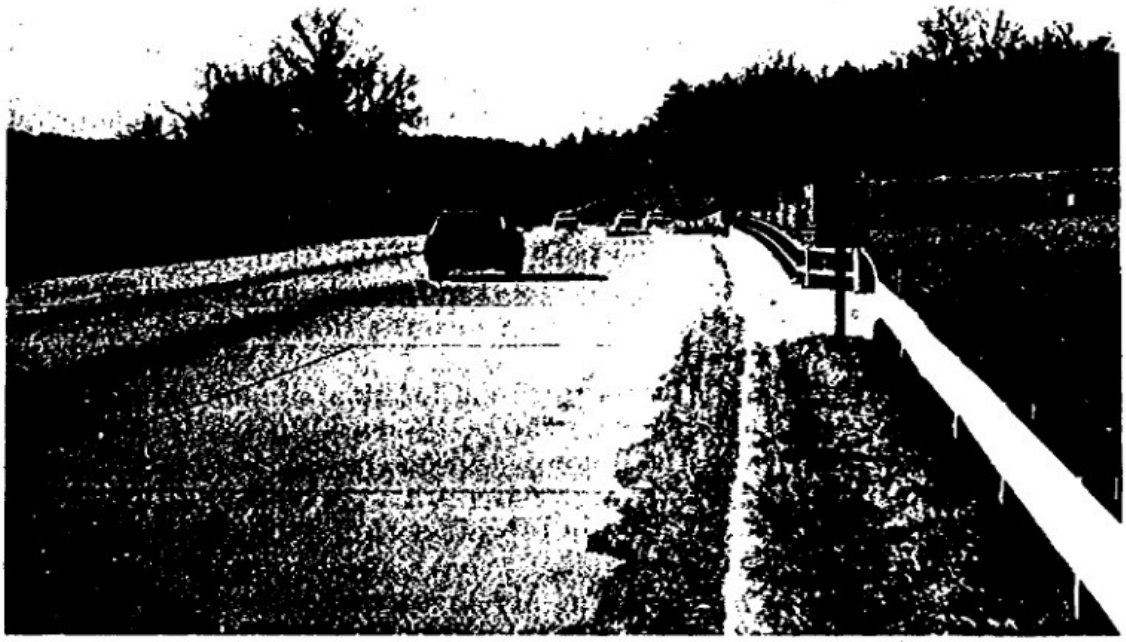


Then as you go under the structure, under the structure there is a deceleration lane with another sign to the left.



This one on the left says "Alexandria and South" and on the opposite side "Silver Spring and West."





Here is a trailblazer to Route 95.
Mr. MAY. This is what that man with the station wagon saw.



Mr. SCHOPPERT. Then there is a sign just in advance of the exit saying "Alexandria and South." Then, you can see, there is a route shield for Route 95 added to the post supporting that sign.

Mr. MAY. Anyone heading down south, say to Richmond and south, would be looking for 95. If they saw this what do you think they would figure it meant? Mr. Leisch, what do you think?

Mr. LEISCH. I guess I am as confused as other drivers.

Mr. SCHOPPERT. I am afraid I wouldn't know what to make of it immediately. Some of these drivers are pretty alert.

Mr. MAY. I am simply suggesting that some of them might consider that 95 is straight ahead.

Mr. SCHOPPERT. I think there are any number of conclusions you might come to.

Mr. MAY. I notice that in the past several days we have been critical of some of the signing on the Federal-aid roads and the Interstate System and the freeways. What do you have to say about parkway signing, Mr. Schoppert?

Mr. SCHOPPERT. I think we can draw a number of conclusions from what we have seen here. For one thing, the signing really isn't very large or legible and is not well composed or spaced. It does have this complication of a local road interchange in it, which is unfortunate. I think this also might call to mind the fact that we haven't looked at all at signing "to" Interstate routes.

Mr. MAY. With your permission, Mr. Chairman, we will insert what we were not able to include this morning in the record, for record purposes.

Mr. BLATNIK. Without objection, it so ordered.

(The above material appears as appendix A, see p. —.)

Mr. SCHOPPERT. This is done by another jurisdiction directly, or at least part of it is. This has the one characteristic that it is temporarily—I don't know how to define temporarily in this case, but it may be several years—serving as a major link in the Interstate System.

Mr. MAY. I think our time has expired; so we will have to conclude. Mr. Chairman, just one more comment from the staff. It is difficult for us to express how much we appreciate the time and effort of such people as those represented on this panel. There have also been Mr. Bridwell of the Federal Highway Administration and the people from Public Roads. Everyone has cooperated with the staff. We need all the help we can get. We are so much indebted to Mr. Frank Pugh, who is Chief of the Publication and Visual Aid Branch of the Federal Highway Administration. We are extremely indebted also to Mr. Charles Harrell who is a visual information specialist. It was through their aid that we were able to make the slides and movies and the visual aids we used at these hearings.

I think we owe a debt to our staff members, Mr. John P. O'Hara and Mr. Sherman Willse, who took the movies we have seen through the hearings. They did it some days when it was 97 degrees and better in the hot sun. As you can see, Mr. Willse has held up very well.

Mr. BLATNIK. Thank you, Mr. Counsel. The Chair expresses for himself and all the members of both sides of the aisle not only our appreciation but our gratitude and our indebtedness to this panel of outstanding experts in different fields who have combined to make available this record which will be available to so many people vitally interested and concerned with this problem. In my own opinion it will be very significant in making alterations and modifications which may result in improvement in the areas of signing and road design.

We thank you collectively and individually. If more of us have not been able to have been present right along, as we would have liked to do, we have had simultaneously about four operations going on between heavy floor work, two separate conference sessions with the Senate and House committees, and a final marking up of the executive session of the full committee. Between these four areas, we were truly under terrific pressure for time.

Do be assured that this in no way minimizes the impact of your testimony and any contribution that you have made, which will be reviewed and scrutinized with thoughtful care in a penetrating matter. When we come to an evaluation which will lead to some final judgments, I am confident that yours will be a most helpful and a very necessary contribution for the national interest insofar as this program is concerned.

Before we conclude today and adjourn these hearings, there are a few observations I feel need to be made in view of the testimony we have heard on the subject of highway signing and related design features.

Our impressive and knowledgeable witnesses at these sessions have contributed to a growing record that is beginning to shed more and more light upon those weaknesses in safe highway design that have become increasingly evident since the start of our hearings more than a year ago. I will discuss in a moment the pattern of causation that has emerged from this entire series of hearings, but first I wish to make a rather basic point.

To me it seems incongruous to spend several million dollars in the design and construction of a modern-type freeway and then to have its operation impaired because of a sign that is ambiguous or too small, or poorly placed or for some other reason ineffective.

If the sign exists in that fashion because it cost less money, then I submit it is a costly way to save money. If it exists in that fashion because a better way was not known or appreciated, then I submit we have a lot of work to do. What we have learned during these hearings, however, indicates that the fault does not lie entirely with either of these causes, but rather with a tragic weakness that has been described by witnesses throughout this whole series of hearings.

A witness at one of our previous hearings made the observations that research has little inventory value and knowledge gained from even the most successful research must be put to practical use—otherwise things remain as though the research had never been conducted.

That particular witness was talking about research that had been done in connection with roadside hazards that line the country's roads. However, again during these hearings we have heard testimony through which has run the same theme: Failure to apply knowledge gained through research and experience. Frankly, the Chair feels a growing impatience on the part of members of this committee at perpetuation of this phenomenon.

And it is evident that our problem is more than one of signing. It seems to me, based on what we have learned here, that there must be a reevaluation of our approach in certain areas of highway design. Perhaps my feelings are best captured by the following quotation which appeared in a highway publication:

As highway administrators accept responsibility for part of the accident toll and as suitable traffic engineering studies and analyses are made, valuable find-

> ings result, showing that to an unrealized extent safety can be built into highways. There is an all too little realization of the advantage of built-in highway safety features. Built-in safety features are once-and-for-all-time corrections. In contrast, accident reductions produced by police patrolling, and other enforcement measures, and those accomplished by education are temporary and require continuing effort year after year and generation after generation.
>
> On a highway with hazards built-in—narrow pavements, poor shoulders, inadequate sight distances, sharp unbanked curves, etc.—there are only two alternatives so long as physical corrections are not made: We must (1) suffer year after year the agony of human losses and high costs of numerous accidents; or (2) pay year after year the high costs of extra policing, arrests, court actions, warning devices, and intensive education to induce persons to use an unsatisfactory highway environment so carefully as to cut the tolls. In either case, the human losses and costs capitalized would generally pay, or more than pay for the needed built-in features. Especially should it be obvious that new roads should embody design features which studies of driver and pedestrian behavior and of accidents have proved to be essential for a high degree of safety.
>
> It is not intended to imply that built-in safety features can eliminate the need for such lines of attack as proper laws and regulations, effective driver training and licensing, control devices, and education. But they will reduce the problem in those other remedial areas * * *.

Interestingly, this statement did not appear in 1968, nor even back in 1958; the year was 1948, some 20 years ago. It was true then, and is equally true today. I hope the engineers will consider it deeply the next time they are about to design a left-hand exit or other accident-inducing features.

Gentlemen, we have reached a crossroad in this highway program. We have a choice to make. We can elect to plunge straight ahead and continue to do things pretty much the same, in which case our citizens must continue to endure certain features of our highways. Or we can turn right and do things quite differently, in which case we really will have performed our task in full.

Although these hearings must now recess, subject to further call by the Chair, the interest of this subcommittee in the subject matter before us will continue. The work will continue with the same thoroughness and deep sense of responsibility which has characterized it in the past.

This concludes this phase of the hearings and also concludes the session for this morning. Again, with our deepest gratitude to each and every one of you panelists, and to all staff people and technical assistants who made possible a very successful presentation and a permanent record for the Congress, we thank you all.

With that, the hearing and this session are adjourned.

(Whereupon, the hearing in the above-entitled matter was adjourned at 1:20 p.m.)

APPENDIX

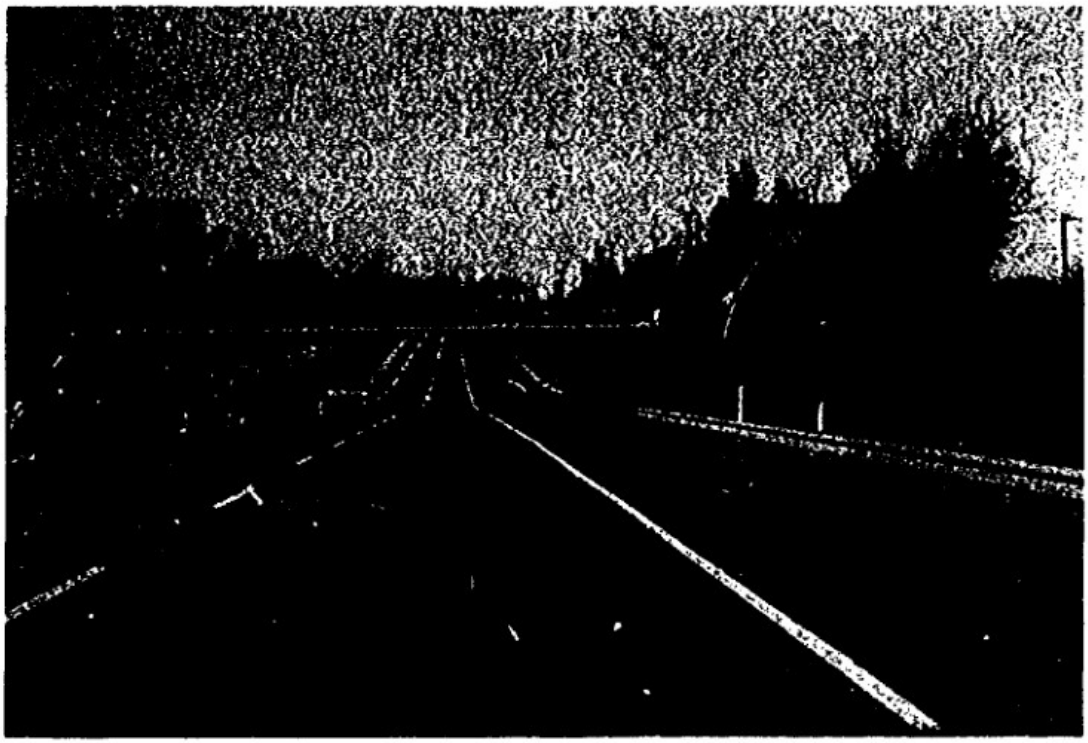
Appendix A

Material supplemental to testimony by David W. Schoppert on the Washington Capital Beltway.

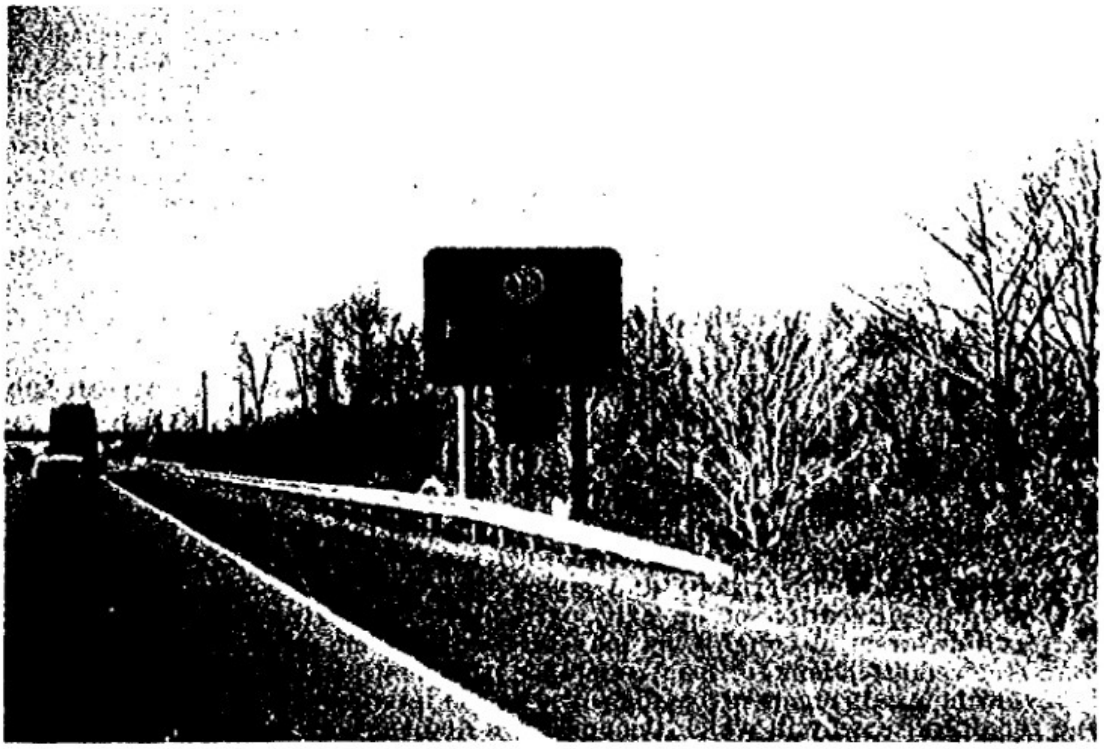
EXIT NUMBERING

Mr. Schoppert. Previously in discussion of the signing at various interchanges we've talked about exit numbers. We also mentioned that exit numbers are frequently used in advertising and giving directions. They are an important method of identification of an exit, particularly for drivers who live in the metropolitan area, although they may be used to some extent by drivers who have received directions for longer distance trips as well. It's of interest, I think, to review how exit numbers are displayed at the interchanges along the Beltway and the different way in which their position and some of the techniques which have been used to distinguish between two off-ramps or exits at the same interchange.

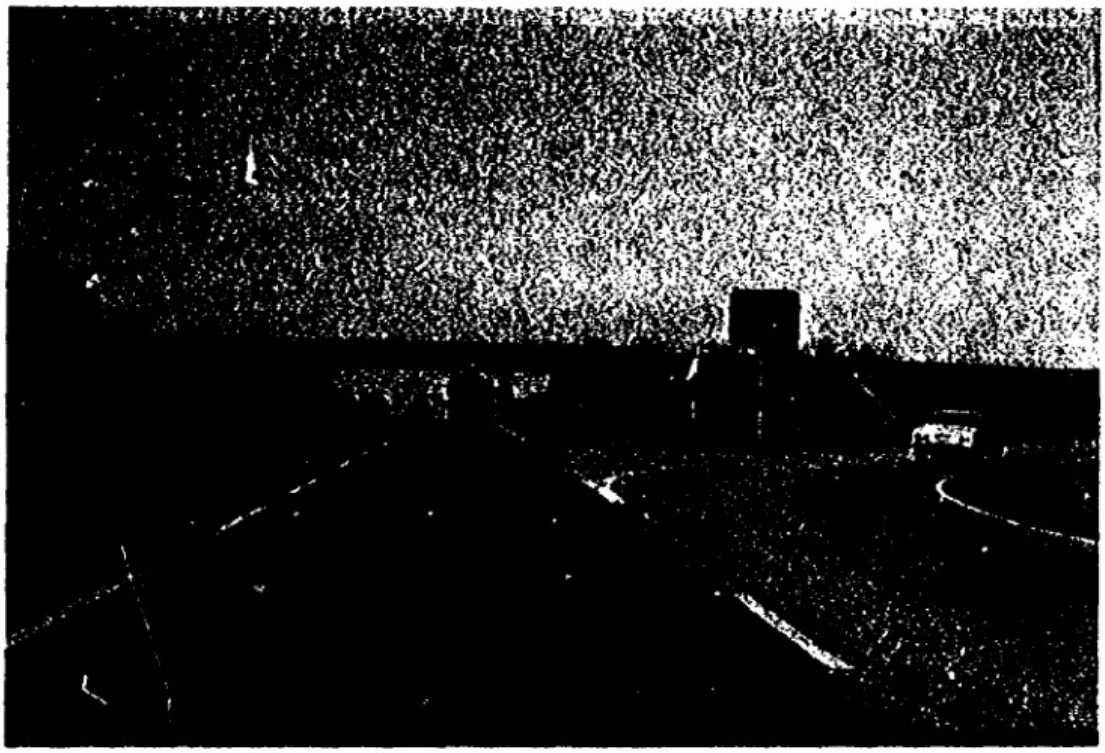
We might begin by looking at the method used in Virginia and then take a look at the method which is in use in Maryland.



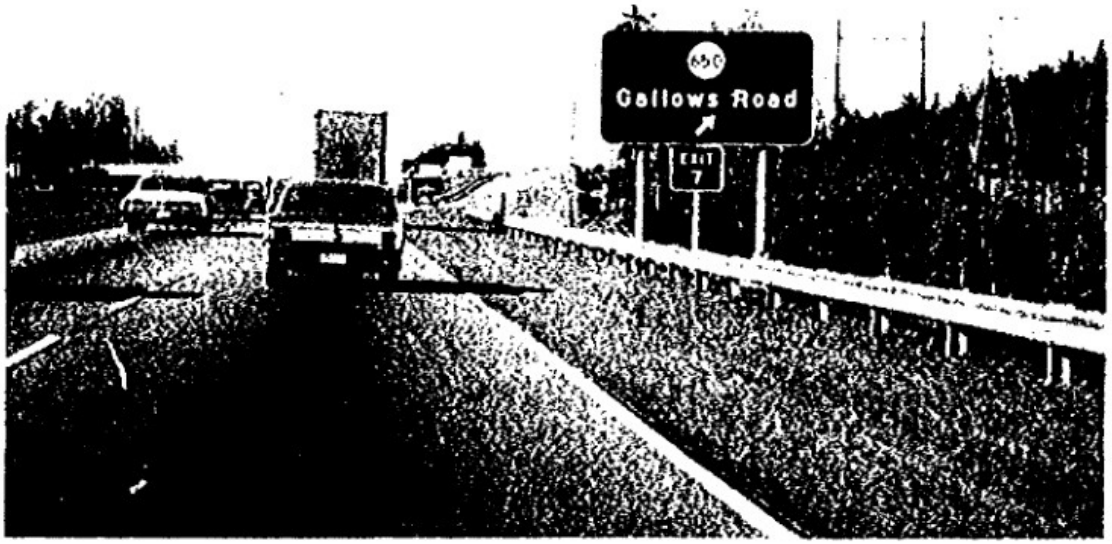
Slide #1 is the advance sign for the interchange for Virginia State Route 613, which is also signed to Franconia. This is the sign one mile in advance of that interchange.



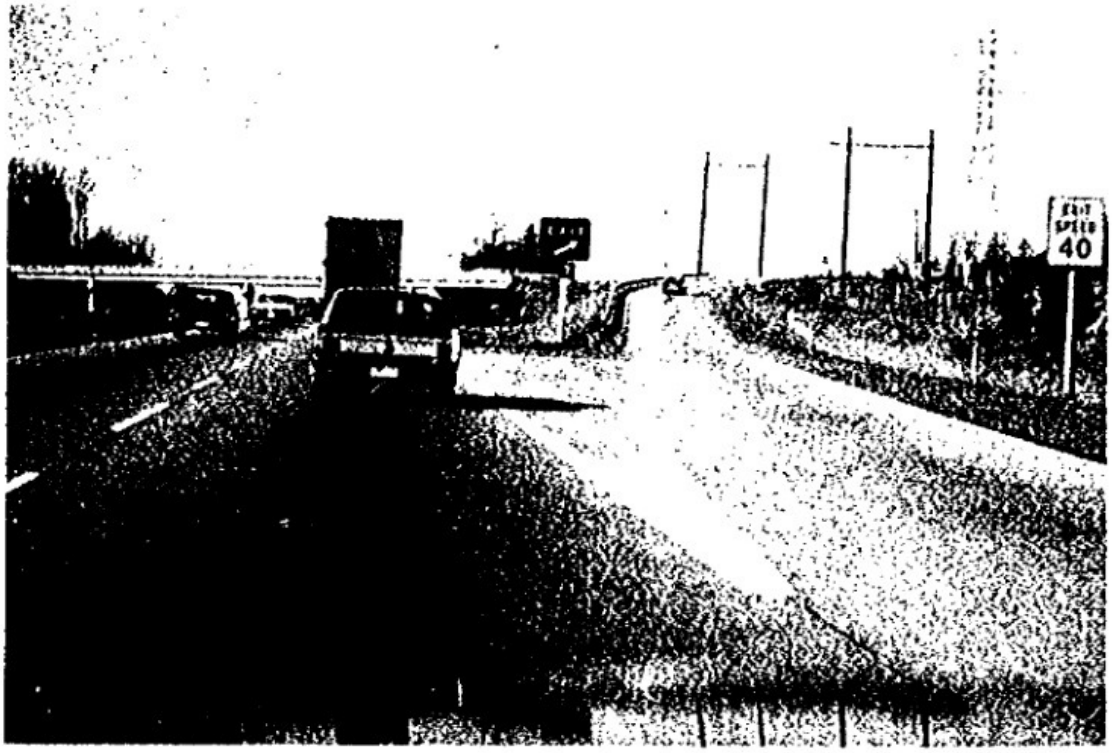
Slide #2 is the sign just in advance of the deceleration lane and you see mounted under it and between the supports a sign saying Exit 3.



At the gore there is a sign saying Exit but the number 3 does not appear at that point.



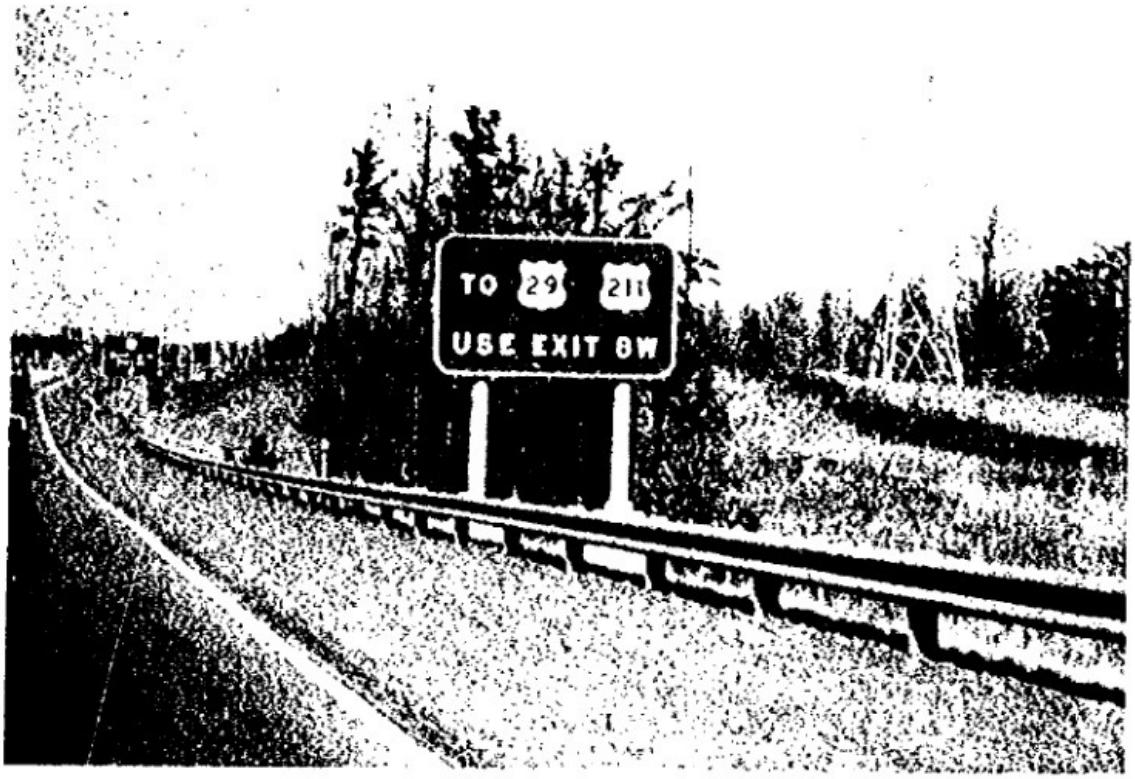
Just a few miles up the road there is a similar interchange—this for State Route 650 Gallows Road and mounted under it and between the supports is a sign saying Exit.



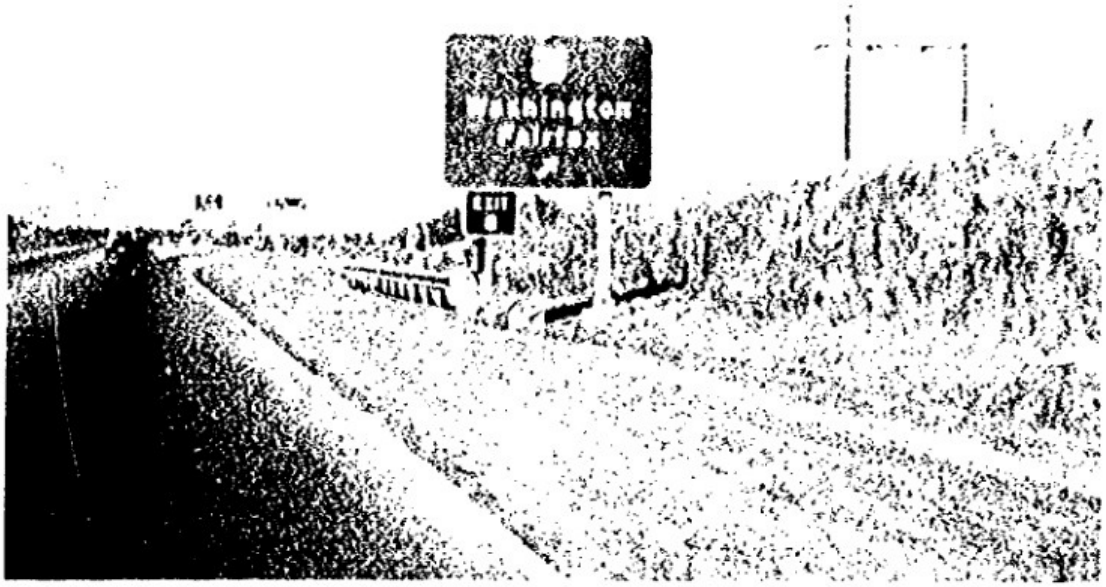
And at the gore an exit sign and under it a small 7.



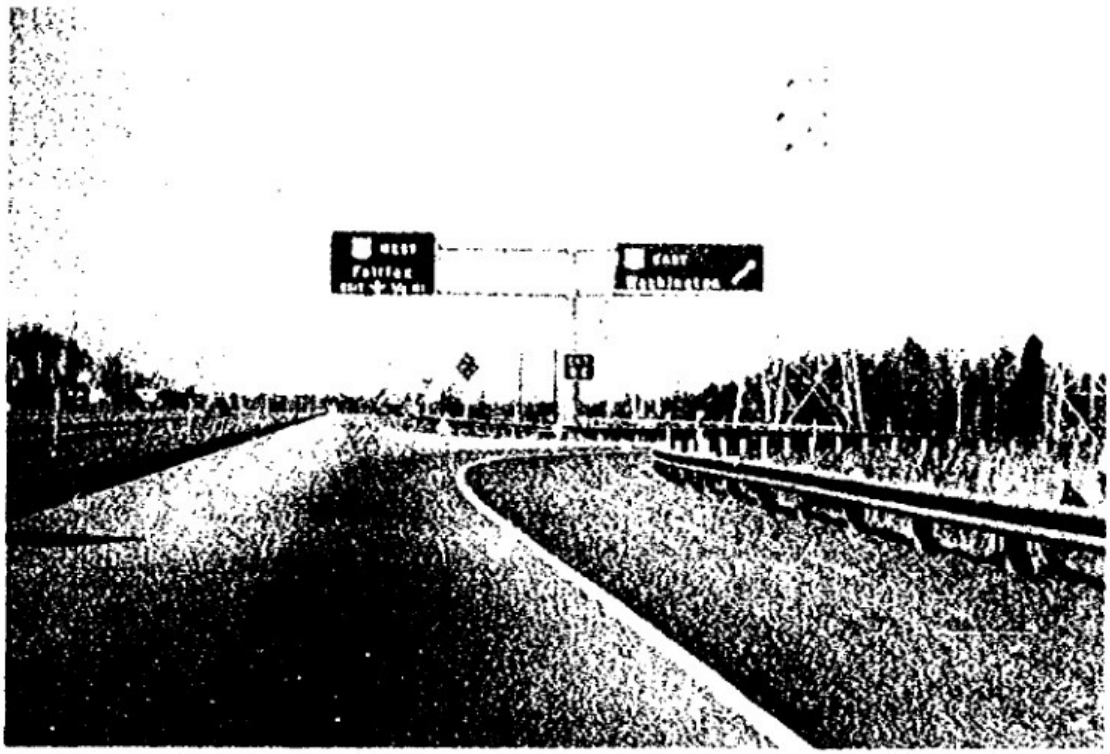
At the next interchange on the Beltway just beyond Exit 7 we come to advance signing for U.S. Route 50. This sign is ½ mile in advance of the exit.



The next sign advises motorists that to U.S. 29 and U.S. 211, which are actually the same road, use Exit 8W. It's interesting that this is really the only information about U.S. 29 and U.S. 211 that a motorist will see as he traverses the Beltway, but let's move on up to the next sign just beyond this which you can see in the background.



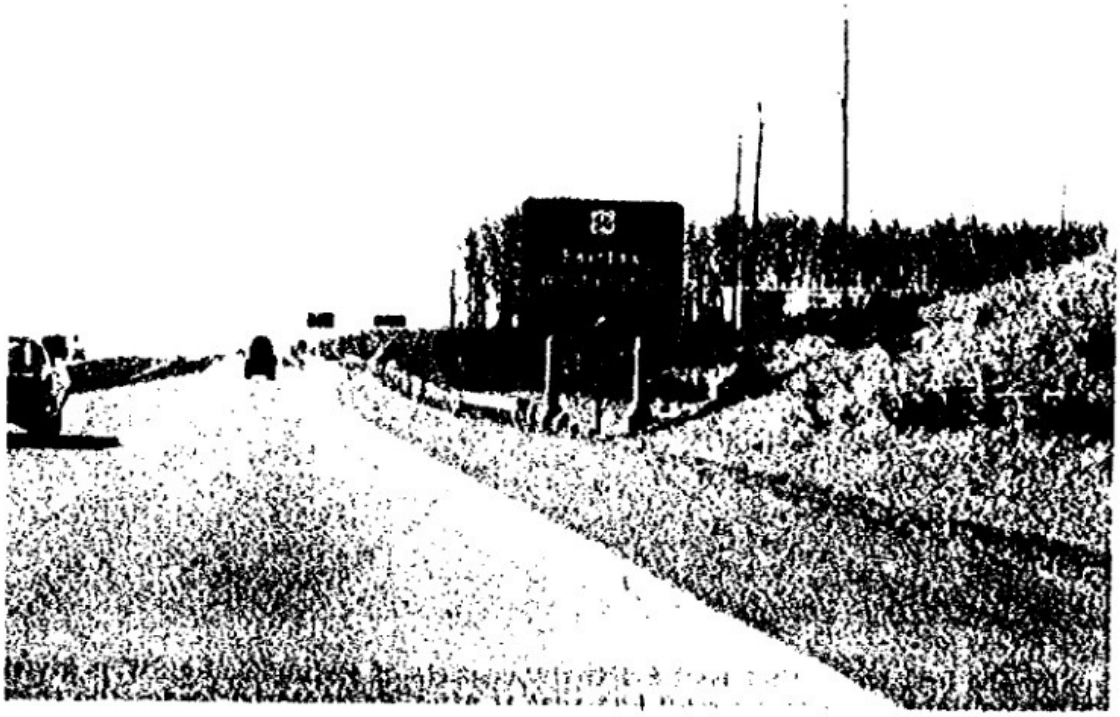
It says U.S. 50 Washington and Fairfax and mounted under it on one of the supports Exit 8, not 8W but 8.



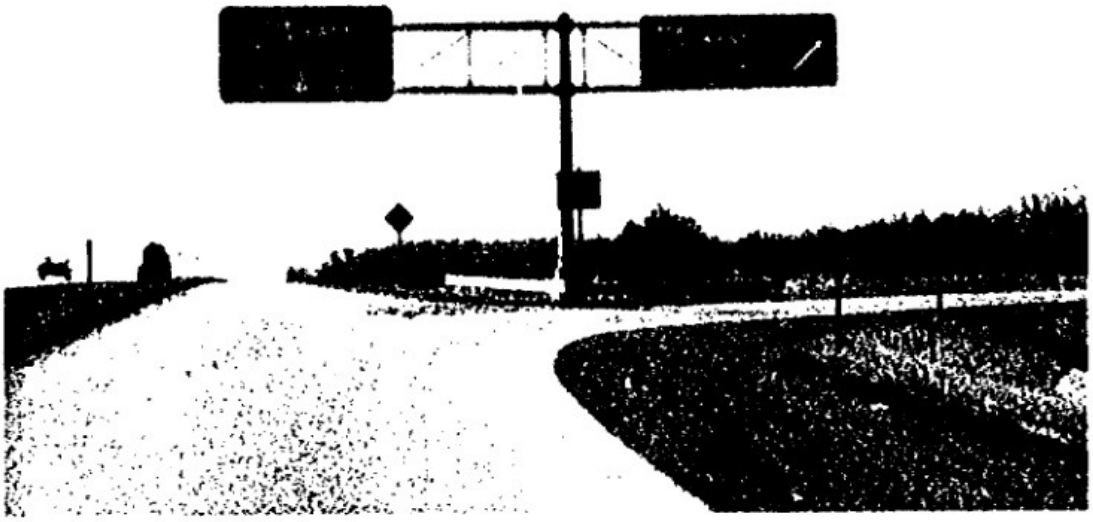
Now the first notice that Exit 8 actually consists of Exits 8E and 8W is given *on* the collector distributor road and that is after the motorist leaves the thru lanes and gets onto the collector distributor road and sees the sign in this slide East to Washington on U.S. 50 and under it Exit 8E. The sign over the collector distributor road to the next exit doesn't carry an exit number.



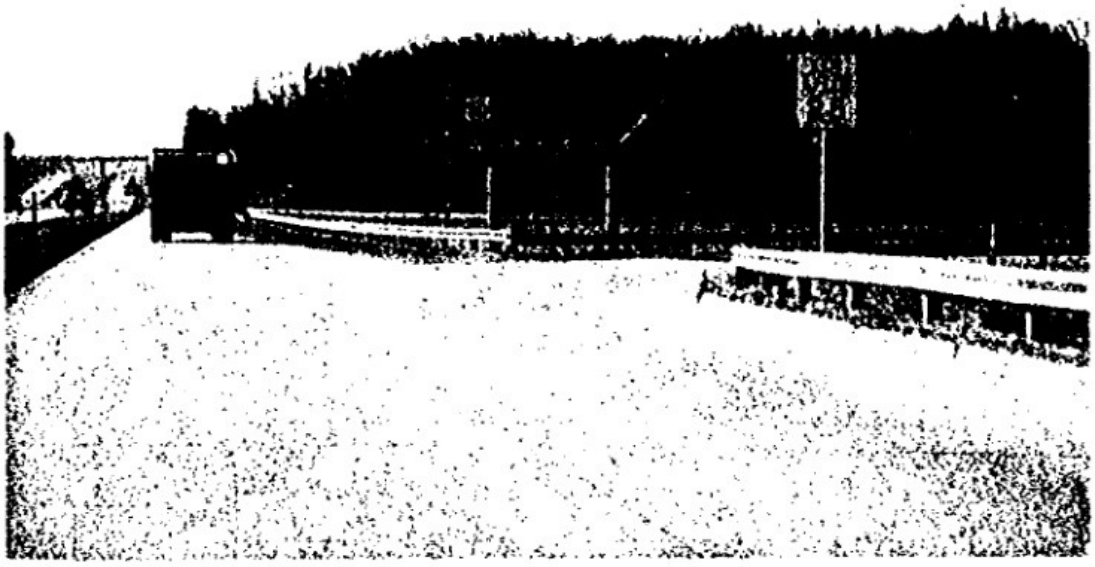
But the next slide is at the gore and it says U.S. 50 Westbound, Fairfax, Exit 8W. Now, this is where the motorist, advised sometime back how to get to U.S. 20, 211 would actually turn. He would have had to turn off the main road some distance back on the collector distributor road to find this particular piece of information.



As a point of interest for motorists traveling south on the Beltway through this same interchange you would see the sign in this next slide, Route 50 Fairfax and Washington, and mounted under and between the supports a small sign saying Exit 8. To reach either 8E or 8W you would have to take the collector road which is visible just beyond the sign.



You will see in the next slides he would then find Exit 8W U.S. 50 West to Fairfax and on down the distributor road a little farther U.S. 50 East to Washington, Exit 8E.



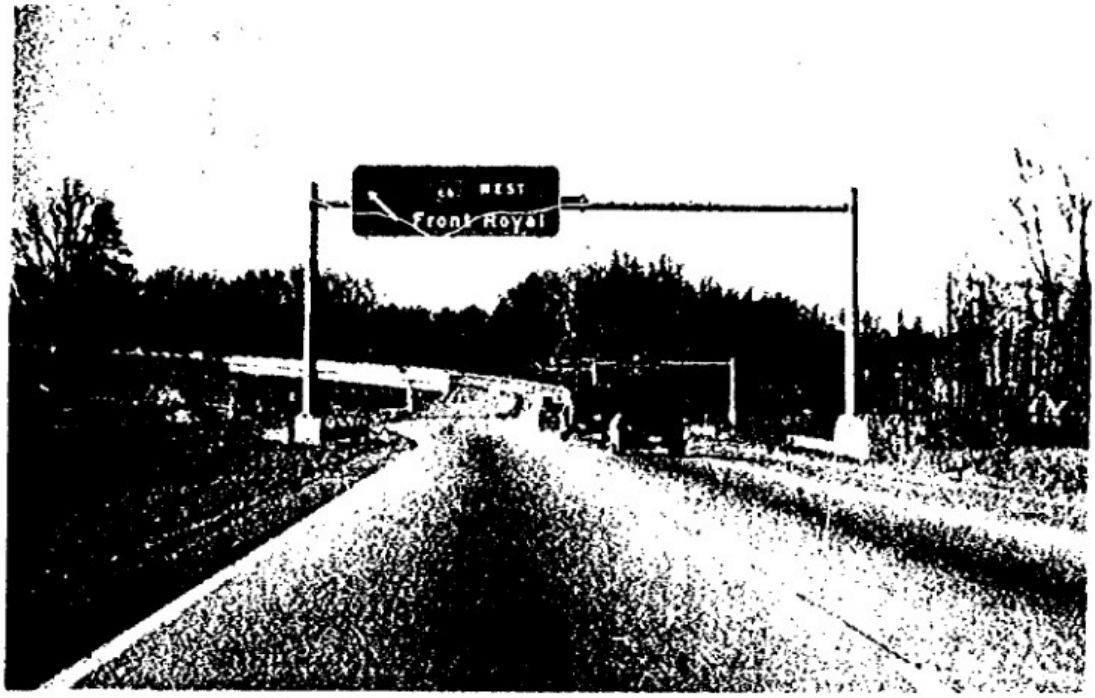
Now, we mentioned earlier that many motorists do in fact seek exit numbers—that they are used in advertising and giving of directions—they are also used as we've seen earlier and as we see in this next slide in the primary signing along the highway.



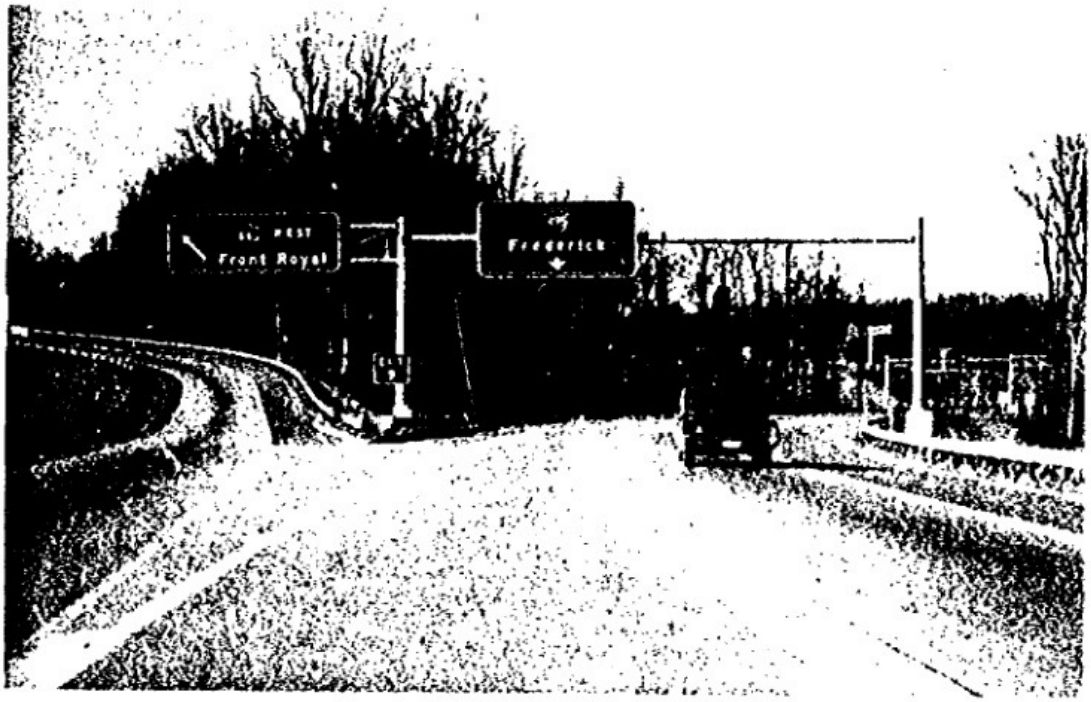
Here's another example of that usage where it says Vienna Use Exit 9. This is a left exit. We've discussed this interchange earlier in the testimony and under this sign now has been mounted an additional panel which says that it will be a left exit.



The next sign in the series is Interstate Route 66 West, Front Royal, Left Exit ½ Mile. It does not, however, give any indication of the exit number.



And just at the point of the beginning of the deceleration ramp there is an additional sign shown here in the next slide, Interstate Route 66 West to Front Royal with an arrow to the left.



And in the gore, mounted on the support which carries the two overhead signs, down low, is the exit number, Exit 9.

In view of the importance of these numbers to a very large segment of the motoring public and in view of their use in other signing to identify a particular point, it does seem that there could be a great deal more consistency given to their location, their mounting, their relationship to other primary signs and to more frequent display of these numbers on the advance signs.

Now we used as an example at Exit 8 the use of E and W off a main roadway. If in fact this was the only way in which the Ws, Es, Ns, and Ss which go with exit numbers were displayed there might be less confusion in the minds of the motorists.

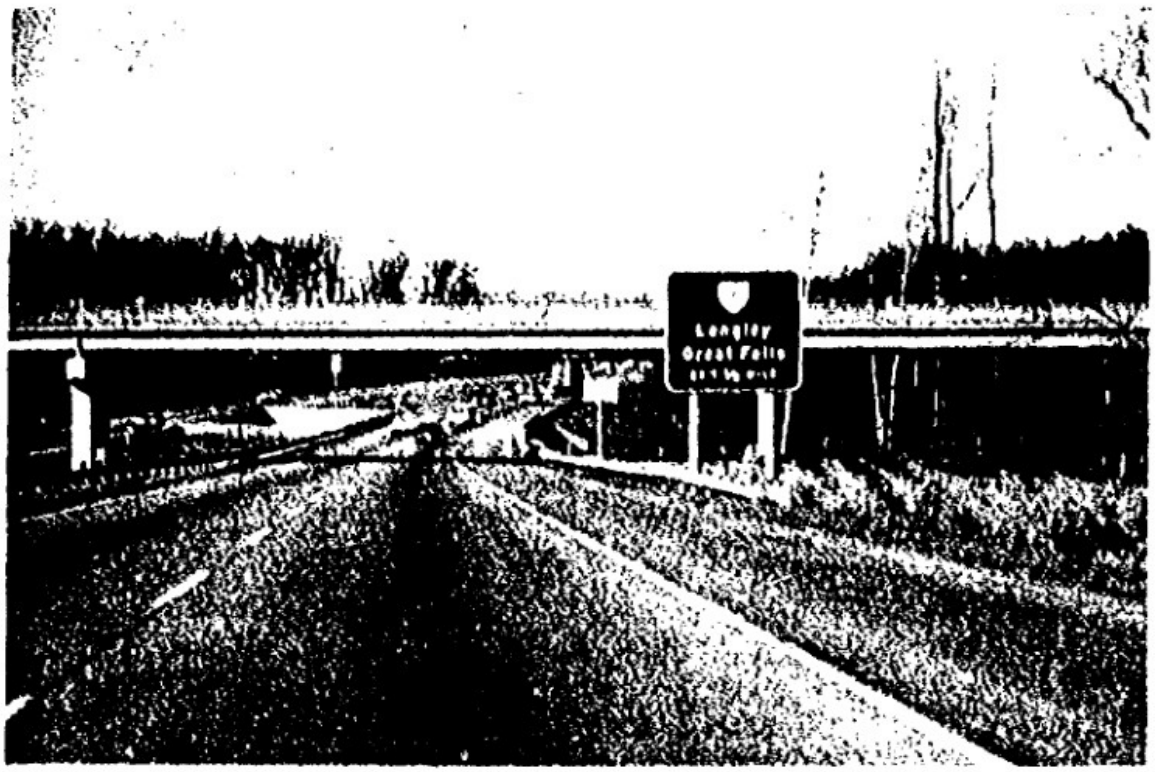


However, on this slide which is in advance of interchange #10 and which we've seen earlier, the sign says Route 7 East Falls Church and under it is mounted Exit 10E. Now, this is on the main roadway—the Beltway—in advance of a major interchange and so it is not unusual for motorists driving along the main route to find an exit number with an E, W, N or S appended to it. It's only in those cases where there are collector distributor roads that these letters are not used on the main line and this leads to some confusion on the part of motorists who are seeking a specific number with a specific direction letter with it.



The next slide which is at the off-ramp just beyond the previous one, again carries an exit number with a W—in this case on the main line visible to main line traffic.

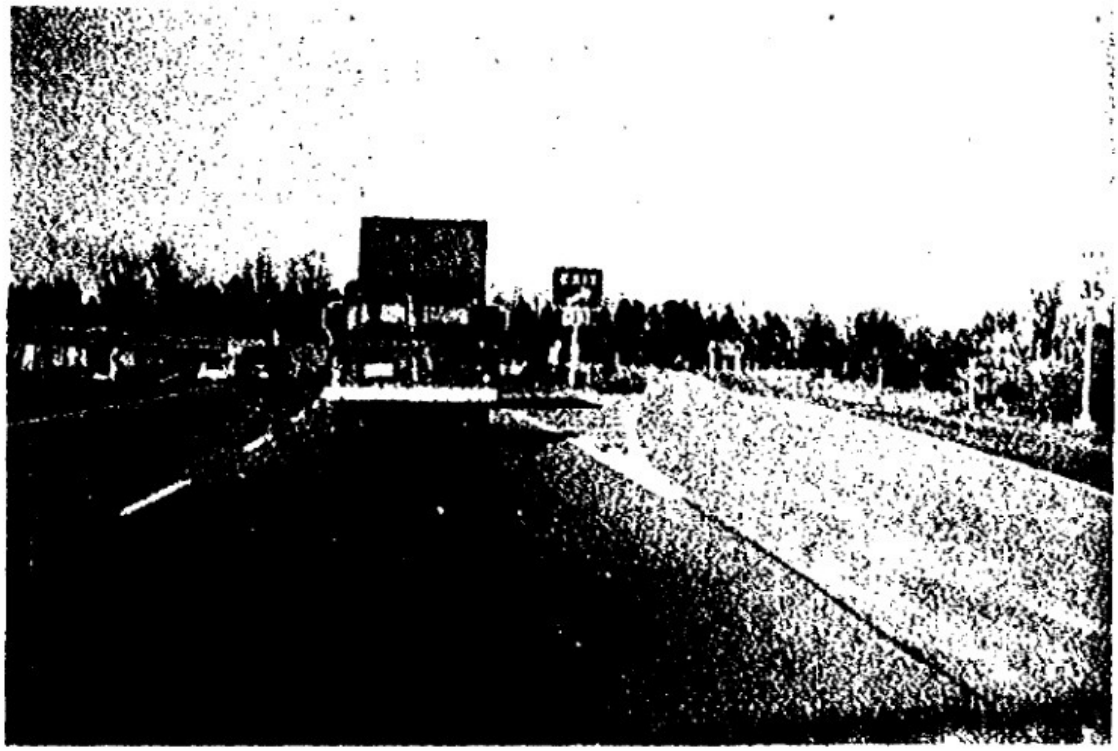
From the previous illustrations we brought out that the use of these numbers is not consistent at different interchanges, that is at one interchange the number was shown with the exit sign; at another interchange it was shown without the number. Here's an interchange which shows, by three illustrations, the lack of consistency at the same identical point.



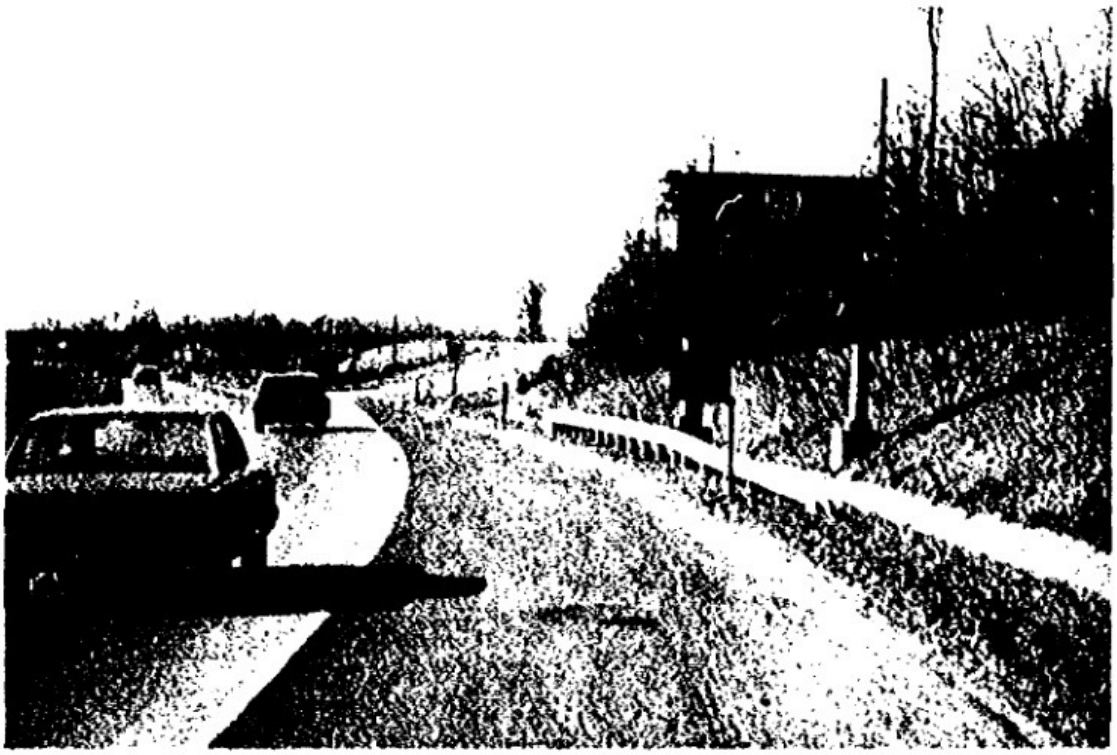
In this case the first slide is taken northbound on the Beltway ½ mile before Exit 13.



Next is the advance sign, for Langley and Great Falls and under it mounted between the supports the sign saying Exit 13.



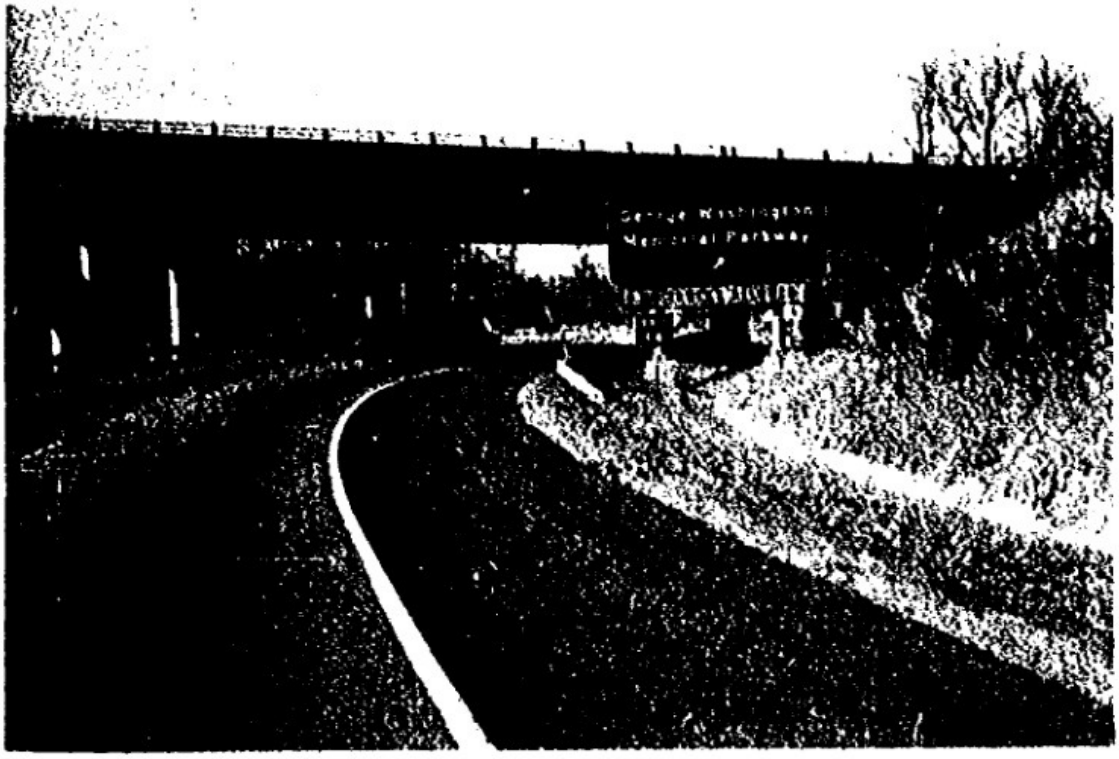
The next illustration shows the exit sign with the 13 mounted immediately below it.



For traffic going the other way at this same interchange the advance sign carries the same information—the route number and two destinations—and mounted on the left support or just in front of the left support is the sign Exit 13. In the background you can see the exit sign down at the gore and there is no Exit 13 number immediately below that, as you can clearly see.



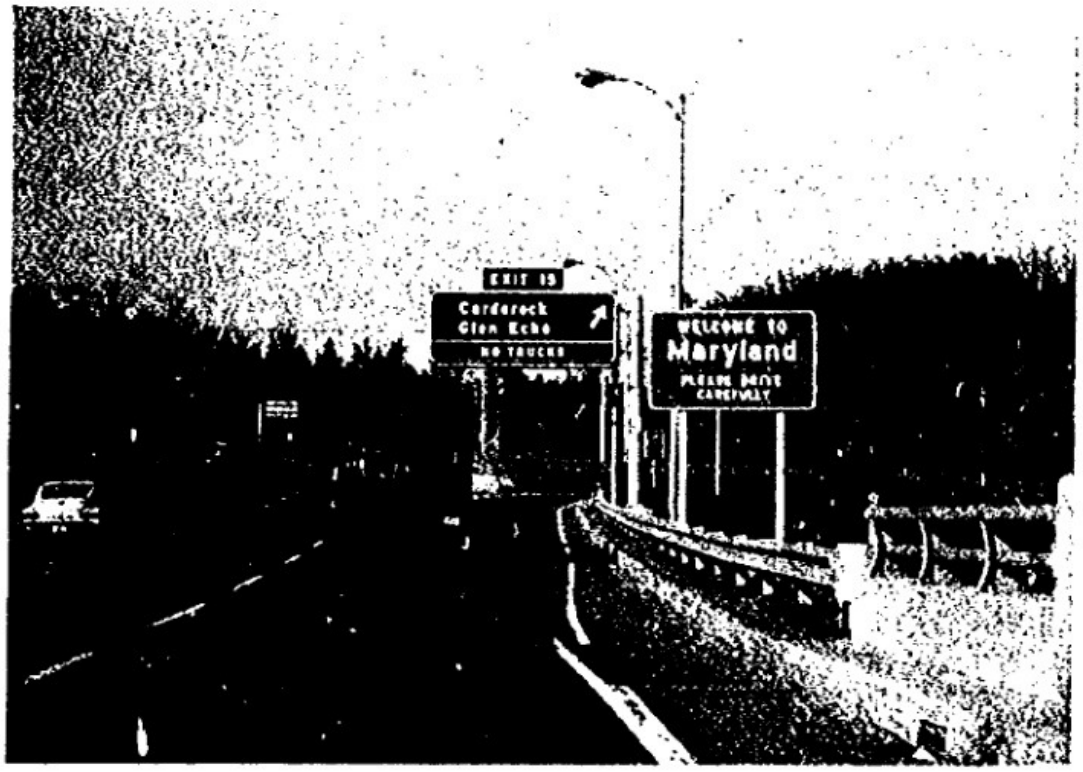
By contrast, at the next interchange, Exit 14 which is the George Washington Memorial Parkway, the advance sign has Exit 14 mounted below it and between the supports.



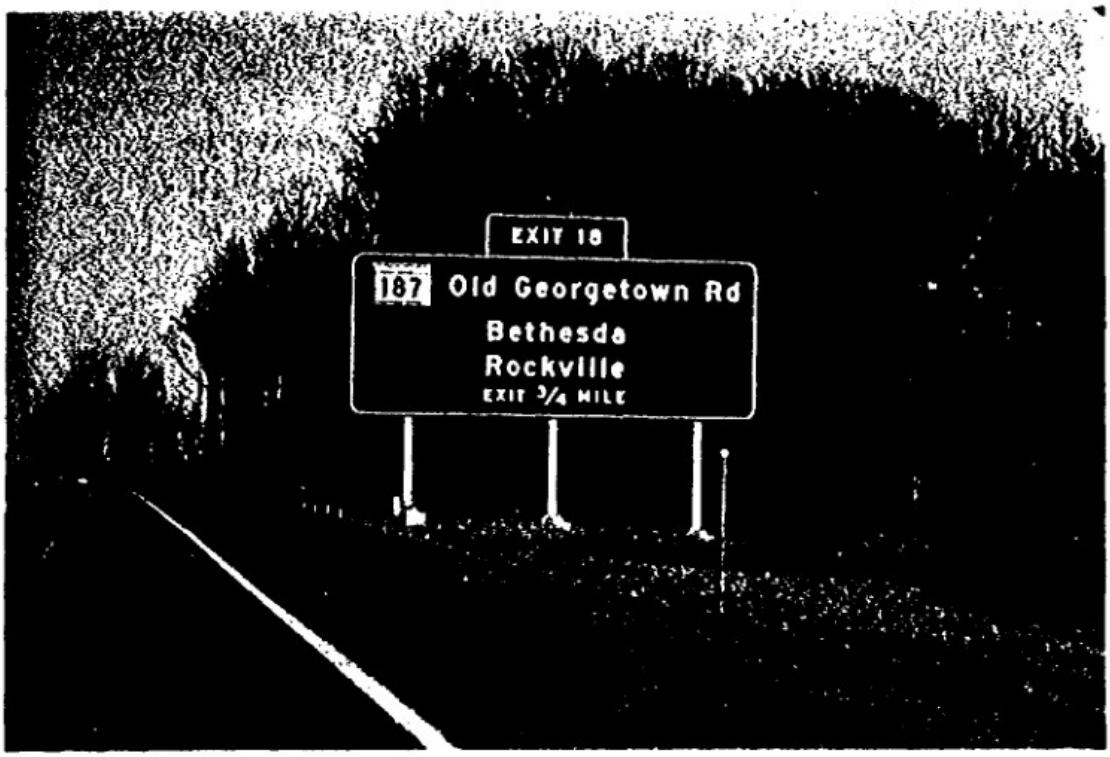
The next advance sign has Exit 14 mounted in this case in a slightly different position.



The exit sign carries number 14. So in this case it's shown three times in one series.



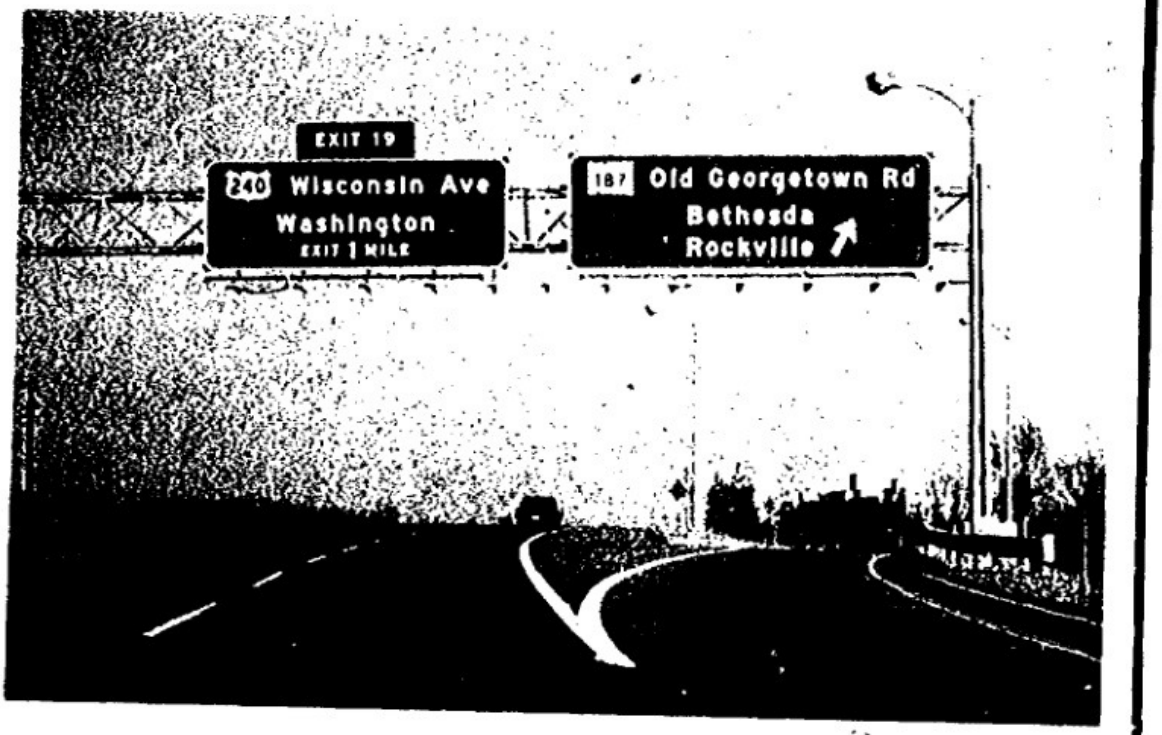
By contrast, in Maryland the exit number is shown above the destination signs. In this next sign you see Exit 15 just across the Potomac River in Maryland and there the exit number is positioned above and about the center of the sign just at the gore.



The next slide in this series shows a more conventional use of the sign in Maryland. In this case this is an advance sign three-quarters of a mile ahead of the exit to Old Georgetown Road and the exit number is mounted above that sign, in the same color, and centered.

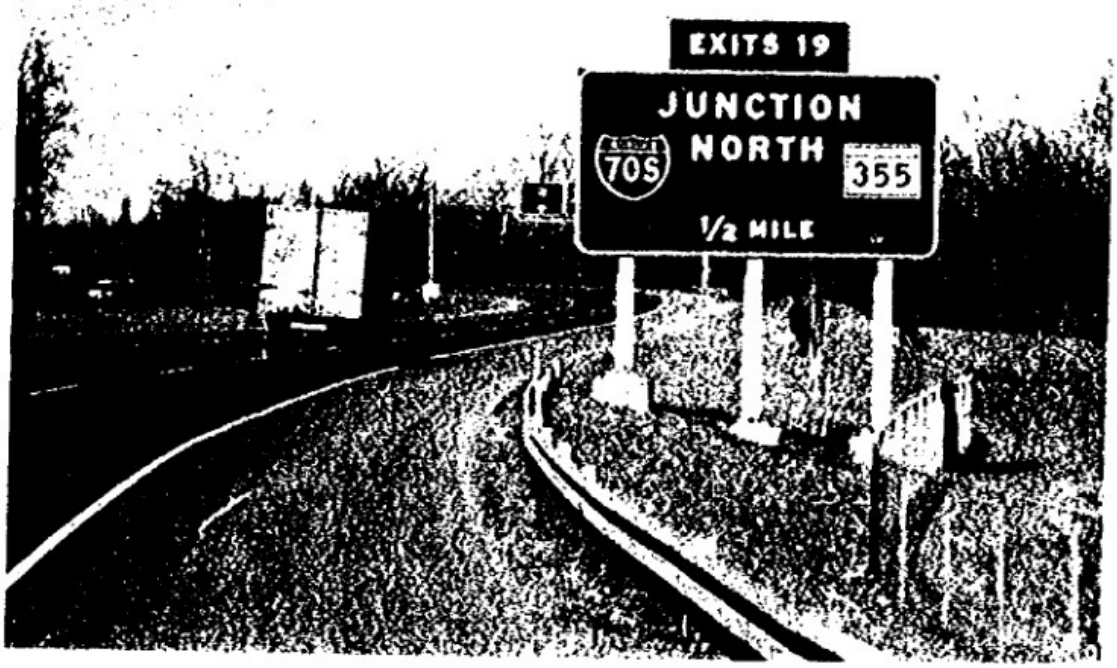


The next slide shows the right lane advance sign to Old Georgetown Road and in this case the exit number is not shown.

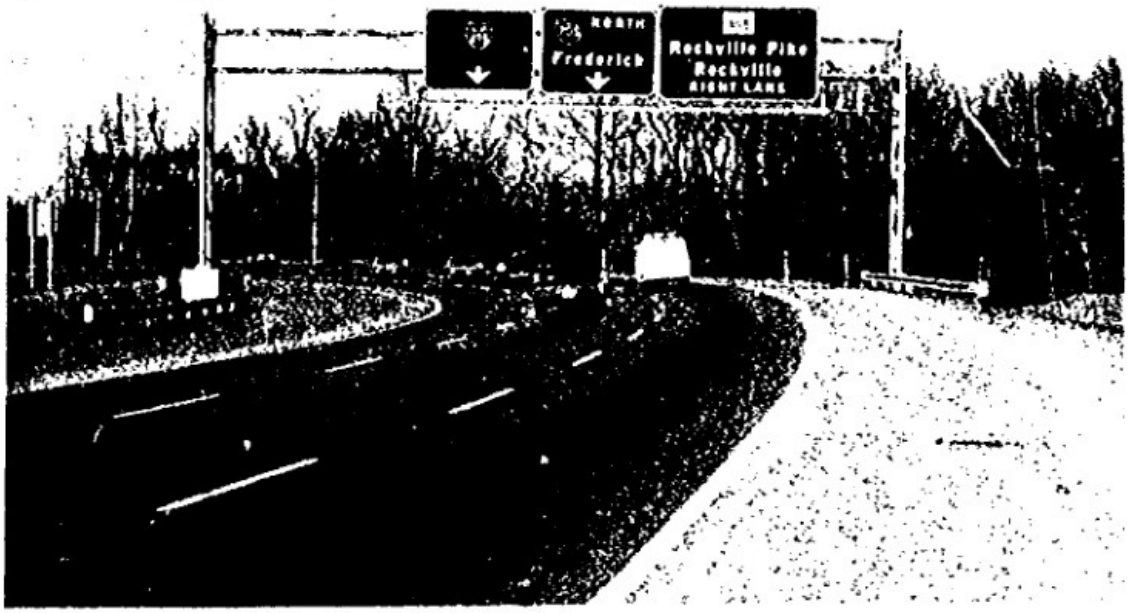


The next sign is at the exit number for Old Georgetown Road and the exit number is not shown with that sign. However, in this case the advance sign for the next interchange, Wisconsin Avenue, is shown at this point and, it being the first in the series, carries the exit number. This is the conventional practice on the Maryland portion of the Beltway to show the exit number only in connection with the first advance sign for an interchange.

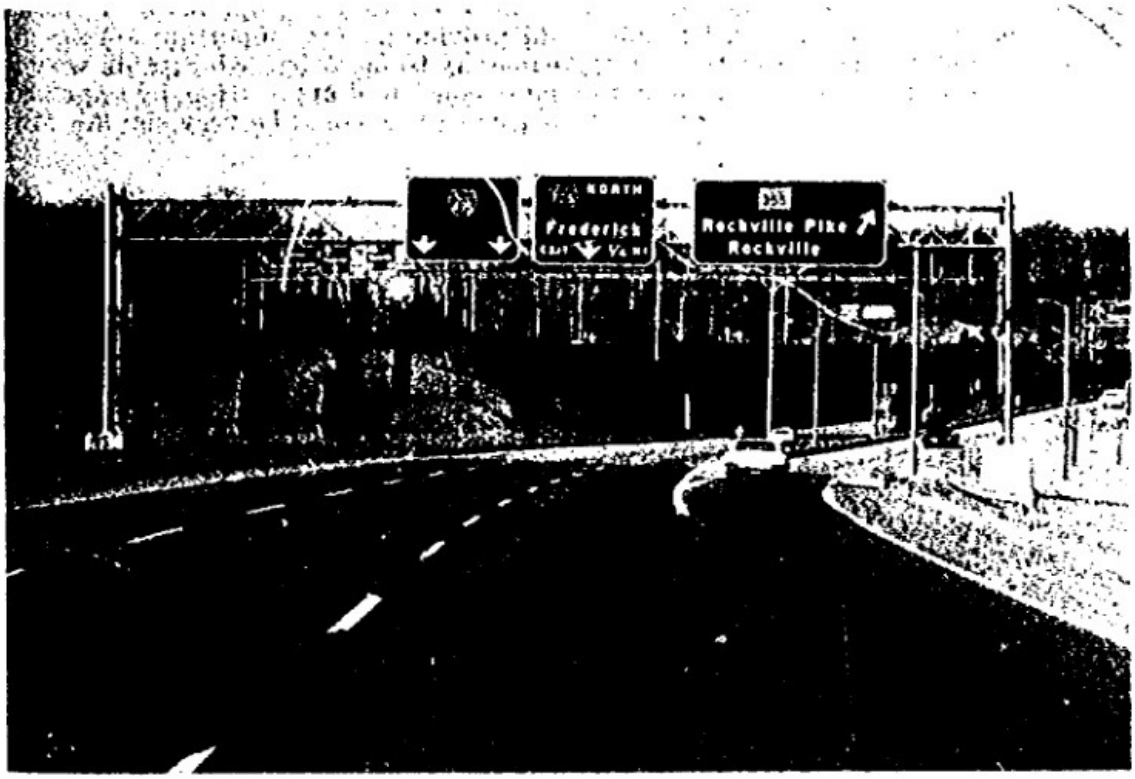
The next series of slides deals with Exit 10 in Maryland and this is westbound and on the Beltway as you approach Route 355. Now, the interchange just ahead has two ramps; one to Route 70S and one to Route 355 which is also named Rockville Pike.



And you'll notice that in this case the exit number sign above the panel says Exits 19. These are really to two distinctly different roadways. They're not the conventional pair of ramps—one going to one direction or the crossroad to the opposite direction, but nonetheless they carry the same number and to illustrate this we might show the remaining signs in the series.



The next slide shows an overhead set of signs, one saying Rockville Pike Rockville Right Lane—that's for Route 355, and the other over the center lane Interstate Route 70S North to Frederick. Now those are the two roadways for which Exits 19 apply.



The next slide was taken at the point where the off-ramp to Route 355 Rockville Pike leaves the main line and the overhead signs there essentially repeat the information which was provided on the previous set.



And the last slide in the series shows the off-ramp to Interstate Route 70S. So those two ramps or exits were grouped under Exits 19, although they do in fact go to distinctly different places and to quite different roadways—one being an Interstate route and the other being a local major road.

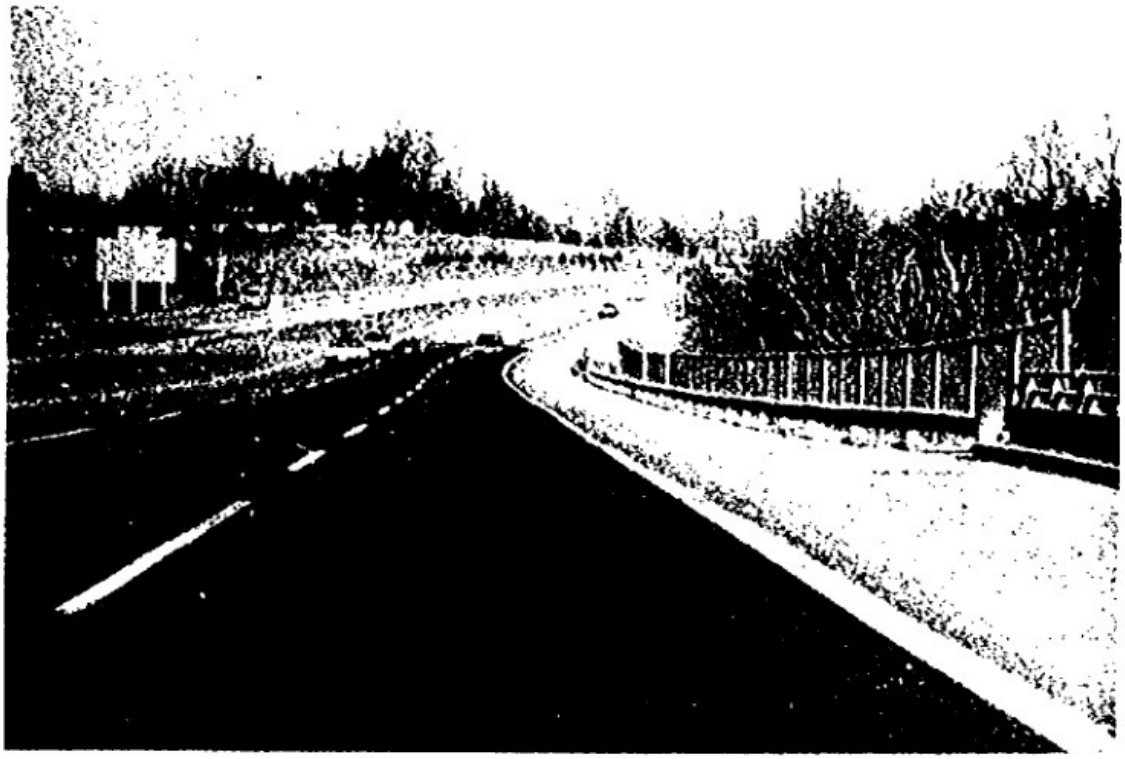
That concludes the series of signs on exit numbers. I think that these slides illustrate a lack of uniformity in the treatment of exit numbers and the manner in which they are displayed, in the manner in which they are applied to different situations. I believe that exit numbers do provide a very important service to motorists and as I stated at the outset, primarily to motorists who reside within the metropolitan region. I believe that by more consistent application, by improved positioning and clarity and legibility, that this service could be very significantly improved.

MARYLAND INTERCHANGES 23 AND 24



Mr. SCHOPPERT. This is another example similar to interchanges No. 10 and 11 in Virginia. It is the view of interchanges No. 23 and 24, which are the intersections of Colesville Road and University Boulevard with the Beltway in Maryland. The two intersecting roadways come together just north of the Beltway and as in the case of interchanges 10 and 11, which we discussed earlier, several of the ramps at the interchanges with the Beltway have been left out or have not been provided with the expectation that motorists would arrive at a common destination at the intersection of the two routes or would select the proper route to get to the Beltway.

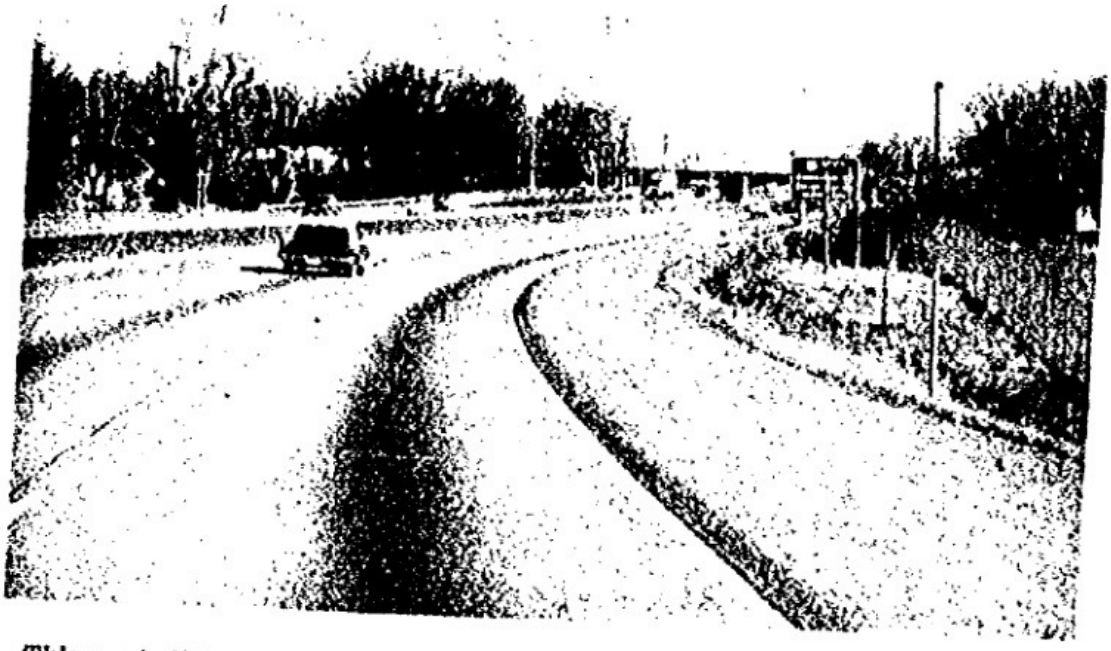
In our study of signing we received a number of comments from people we interviewed with respect to this set of interchanges and again their difficulties at this point dealt both with problems of getting from the Beltway to the route they wished to follow and from these local roads onto the Beltway.



This is a view taken on the Beltway eastbound as you approach the first sign to interchanges. You will note that because the Beltway at this particular point is curving off to your right that the sign is only barely visible behind the trees bordering the road.



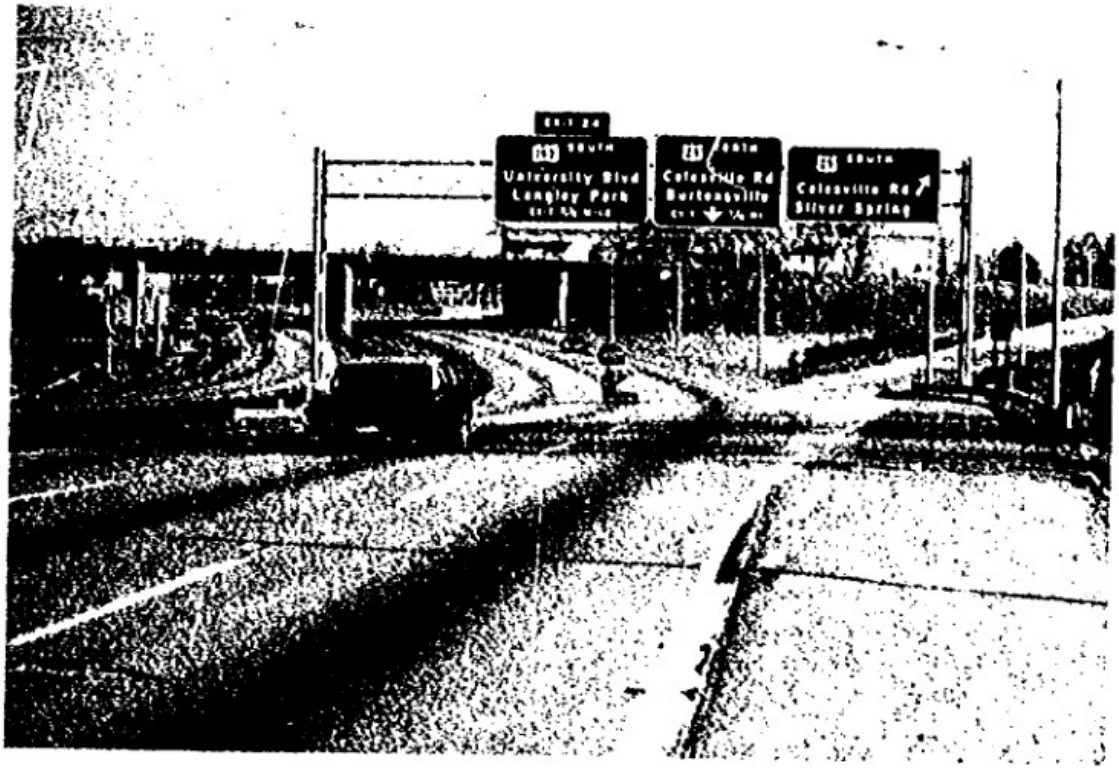
The next slide is a closeup view of the first sign which gives the information Route 20, Colesville Road, Silver Spring, Burtonsville, Exits ¾ of a mile. You'll note the panel mounted above this sign which says, "EXITS 23." You should remember Burtonsville. I want to talk about this later as we're looking at the signs for westbound traffic on the Beltway.



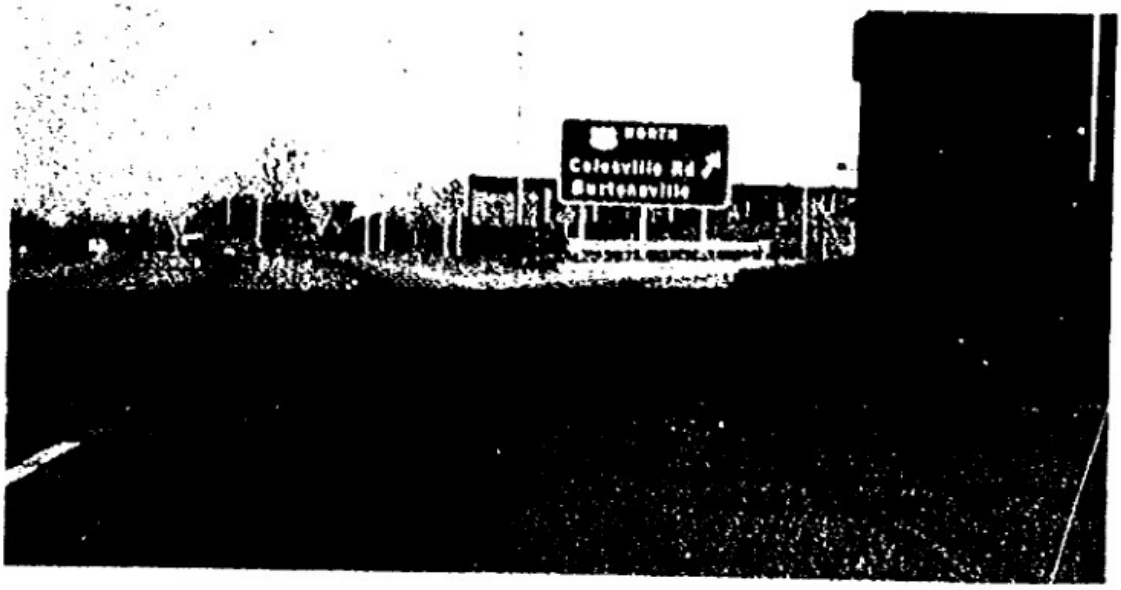
This next slide shows the next advance sign again the roadway curving to the right. You can see a number of new trees have been planted as part of a highway beautification project. When they reach maturity the sign will be even more difficult to locate.



Off to the right and behind a good deal of foliage this is a closer shot of the sign saying Colesville Road, Silver Spring Right Lane Route 20 South.



The next sign shows the sign bridge near the beginning of the off-ramp which has Colesville Road, Silver Spring on the right panel over the exit ramp, and Colesville Road, Burtonsville over the right lane with a down arrow and the legend "Exit ¼ Mile" to indicate the proper lane to make the loop beyond the bridge for the northbound on Route 29. Over the two center lanes of the Beltway is an advance notice for Exit 24. This is partly because of the very close spacing of these two interchanges. You can see that advance sign indicates University Boulevard Langley Park Exit ¾ of a mile, so there is slightly less than ¾ of a mile, actually only about half a mile between these two interchanges.



The next slide is taken under the overpass structure showing the sign at the loop which goes to Route 29 northbound indicating Colesville Road and Burtonsville.



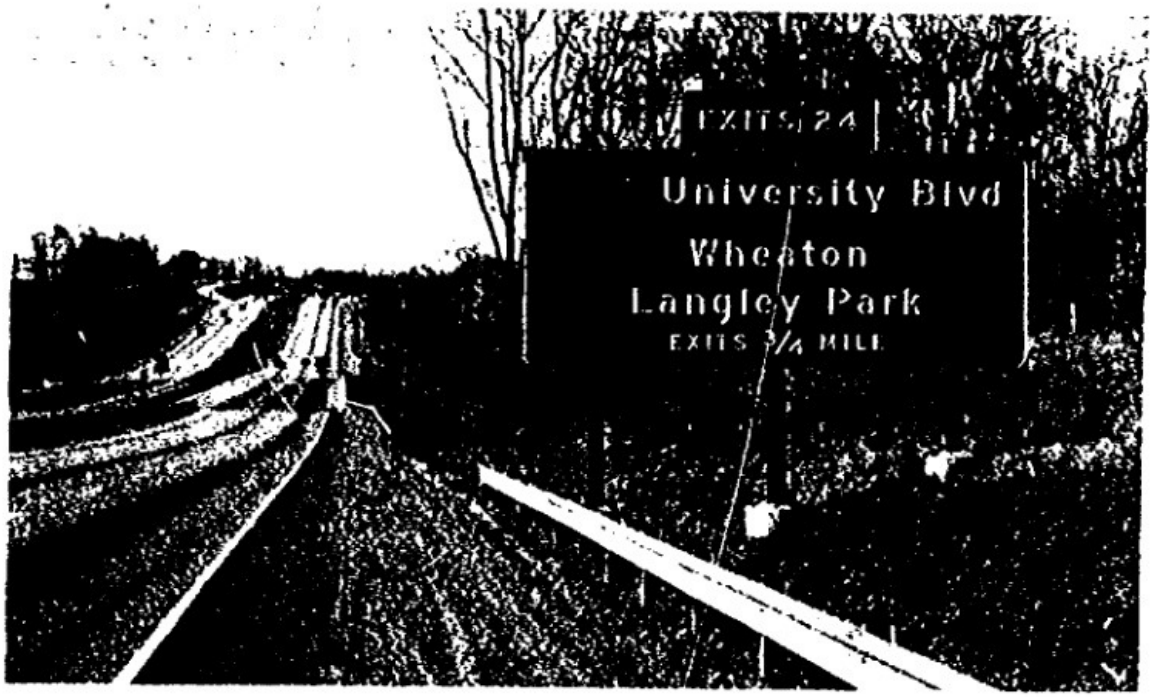
Moving on down the Beltway the next sign indicates Exit 24 on the panel above the sign, "(Route) 193 SOUTH, University Boulevard-Langley Park, RIGHT LANE." Now, the point here is that if you wanted to go north on University Boulevard, you would have had to leave the Beltway at the last off-ramp which would, in addition to Route 29 North, also make it possible for you at the next intersection north of the Beltway, to go north on University Boulevard. There was, however, no information to that effect, as you recall, on any of the signs preceding the interchange.



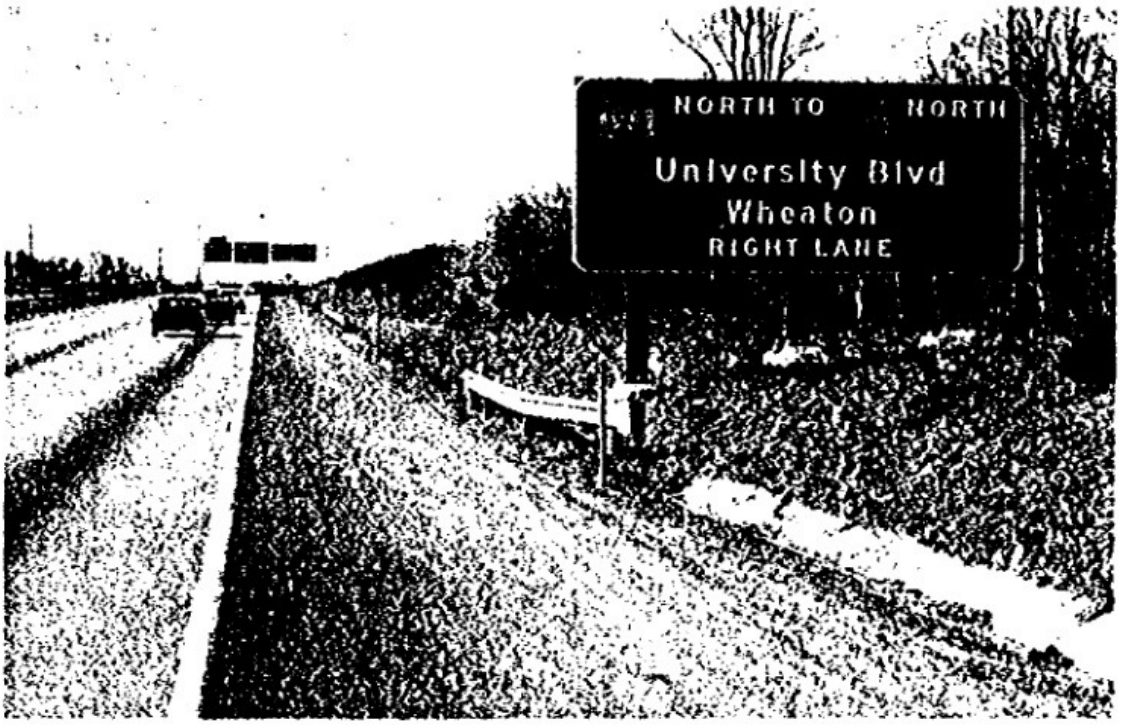
This slide is a long view of the sign at the ramp indicating University Boulevard and Langley Park. You'll notice unlike most of the other signs that we've seen up to this point, it's positioned off to the right and in advance of the actual gore at this off-ramp.



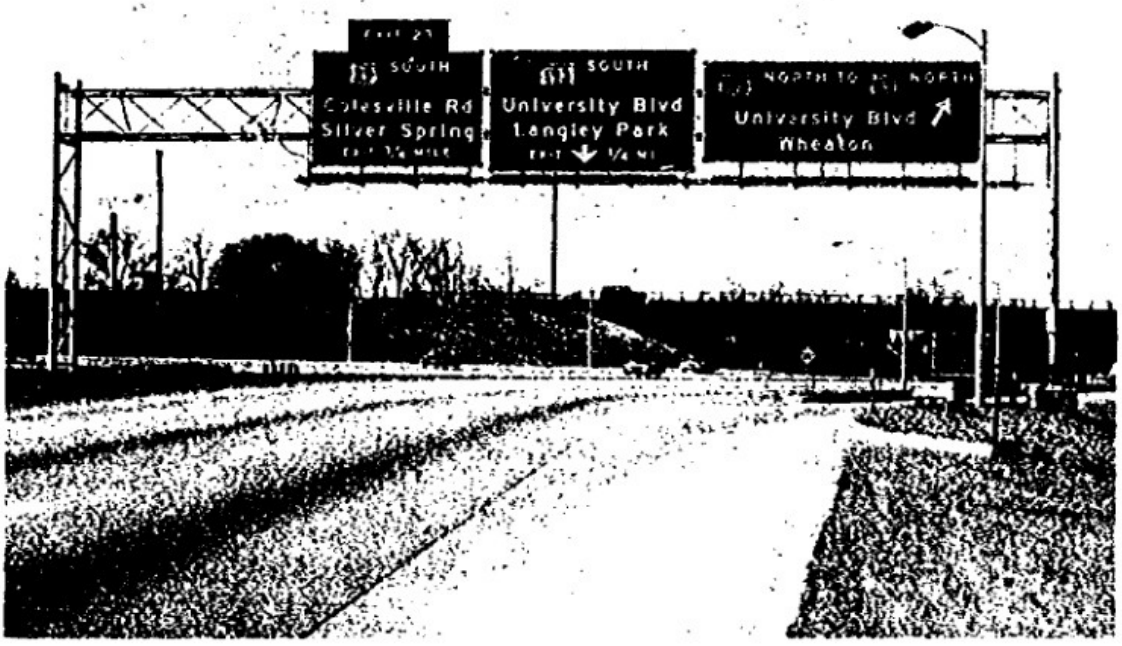
The next slide shows this more clearly. It's the same sign mounted directly above the off-ramp, but the position of the support being to the right of the off-ramp lane.



Now, westbound on the Beltway approaching these two interchanges, we come first to University Boulevard. Exits 24 in this case, and the message here is Wheaton and Langley Park. You will recall that for northbound traffic on Route 29 which we saw coming eastbound, the destination given was Burtonsville. This change in the name of the point on the northbound leg of the interchange is quite logical. Wheaton is reached by University Boulevard. Burtonsville is reached by Route 29. This could, however, pose some problems for a motorist who recalls that the last time he used this interchange coming from the other direction, he saw a sign which directed him to Burtonsville. Now he's approaching it from the other direction and Burtonsville is clearly not one of the choices he has here; at least that would be the conclusion he could reach from the information he has.



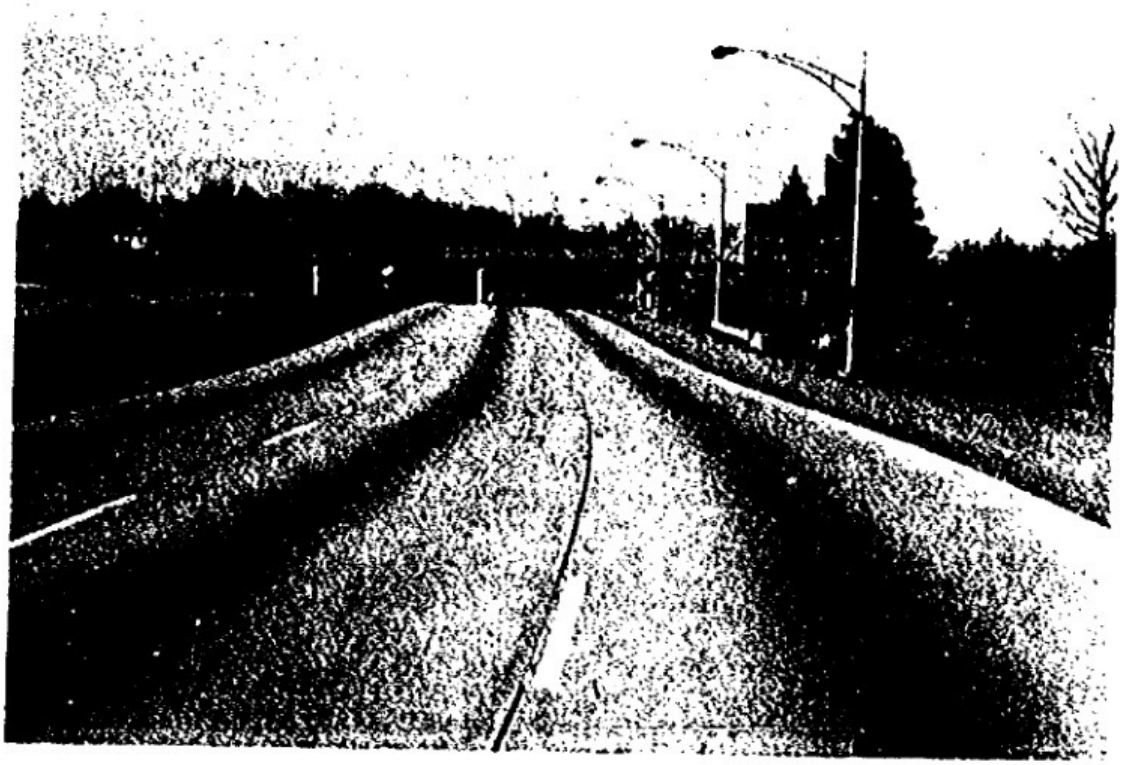
The next slide shows the sign just in advance of the off-ramp which says, "(Route) 103 NORTH to (Route) 20 North, University Boulevard-Wheaton, RIGHT LANE." This is a new piece of information to him since at the previous sign there was no mention made of Route 29. Let's move on up to the interchange now and see what the message is at the actual point where the ramp departs.



This sign is a bridge just in advance of the gore. On the right the sign repeats the message we just saw, "(Route) 103 NORTH to (U.S. Route) 20 NORTH, University Boulevard-Wheaton." Over the right lane, continuing, is (Route) "103 SOUTH, University Boulevard-Langley Park, EXIT ¼ MILE," and over the two center lanes, "EXIT 23, (U.S.) 20 SOUTH, Colesville Road-Silver Spring, EXIT ¾ MILE." This is very similar treatment to that which you saw for the traffic moving eastbound on the Beltway.



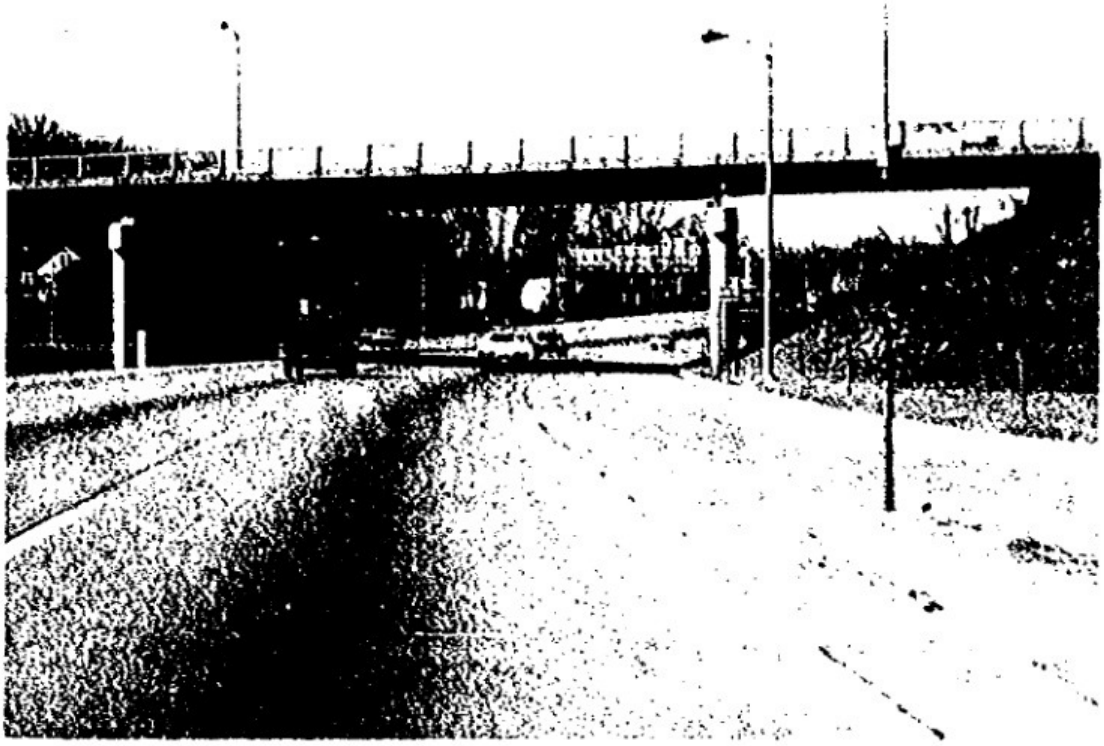
The next sign at the point where the ramp beyond the overcrossing leaves the Beltway repeats, "193 SOUTH, University Boulevard-Langley Park," and over the right lane, "(U.S.) 20 SOUTH NEXT EXIT."



Moving on down the Beltway, continuing in a westerly direction, the next sign advises "(U.S.) 20 SOUTH, Colesville Road-Silver Spring, RIGHT LANE."



The next slide shows this at a little closer view.



This next slide illustrates again the kinds of difficulties that you can encounter when the main road is curving through an interchange. The sign for the off-ramp just beyond that structure is slightly visible behind the structure and the slope and various signs and lighting poles and so on to your right.



Let's move on up and take a look at that a little closer. This slide shows the sign, now visible, advising "(U.S. Route) 20, Colesville Road-Silver Spring," to the right. This sign, incidentally, is mounted again slightly different in that it is actually in the gore and low. I'm sure in part to make it visible for traffic through the structure.



The last slide is a very close view giving the picture of the sign in full detail unobstructed by structures and lighting poles and other obstructions.

The important point illustrated however by this series is not so much the curvature and the placement of the signs and all that, as it is the problem of the design of these two interchanges. They are very close together. Some of the ramps were not provided; therefore, a motorist approaching this series of interchanges must be prepared to select the proper ramp to reach his destination. That ramp may, in fact, be at a road which bears another name and another route number from the one he is, in fact, trying to find. He has to make this decision before he arrives at the one he's seeking; after he arrives there it's too late for him to do anything about it. He has no way of correcting for his error. If he does take the ramp which goes in the wrong direction of the road he is seeking, he will then have to make a U-turn at some nearby point in order to get headed off in the proper direction.

Another point worth reiterating isthat the destination names are different for the two approaches to the interchange.

APPENDIX B

STATEMENT BY THE AUTOMOBILE CLUB OF SOUTHERN CALIFORNIA, BY JOHN W. MCDONALD, DIRECTOR, ENGINEERING AND TECHNICAL SERVICES, AND PAUL H. FOWLER, TRAFFIC ENGINEER

Mr. Chairman and Gentlemen:

We appreciate and welcome this opportunity to appear before you as spokesmen for the Automobile Club of Southern California, and in the interest of improving driving conditions for our members and the motoring public generally. We feel this is a privilege and a pleasure.

As Mr. Constandy has indicated, we have had a longtime interest in the subject of signing, and more recently in the field of freeway operations generally. We have observed with interest the activities of this Committee over the years, and share the feeling that operations is a vitally important area of concern in the highway field today.

Before getting into the subject matter, I would like to make the position of the Automobile Club of Southern California as clear as possible with respect to this hearing and with respect to our relationships with the responsible public agencies generally. A fundamental purpose of our organization is to support and strengthen these highway agencies and their programs. Thus, we make every effort to make any criticisms we may have constructive. We feel that there is a great deal yet to be accomplished in the fields you are exploring. However, we also feel that a great deal of positive effort on the part of public agencies and others has been, and is being, extended to meet these problems, particularly, perhaps, in our own State of California.

To illustrate this position with a specific example, I would like to read the short letter of transmittal included in our 1963 Progress Report on Freeway Signing:

"This report is intended primarily for those with responsibility for metropolitan freeway signing in California. Hopefully, it may be useful in other areas as well.

Along with federal, state and local officials, we at the Automobile Club of Southern California also have signing responsibilities. It is our responsibility to support and defend good signing principles and, as illustrated here, to convey to public officials and others our interpretation of motorists' needs in signing. When warranted, it is our responsibility to be constructively critical.

Our hope is to have the report received in the spirit in which it was composed—as an effort toward the evolution of better guidance for motorists—an effort to meet the responsibilities we share."

Paul Fowler will discuss the content of this report in a few moments.

In this case, as in others where we felt it necessary to be critical, we took our criticisms and suggestions directly to the people in the agencies responsible. We believe this to be the most effective procedure, and it is essential if we are to perpetuate the mutual trust and confidence which the Automobile Club now enjoys with agencies such as the California Division of Highways.

Paul Fowler and I know something of signing and highway operational problems from both sides of the fence. We are well acquainted with the public agencies. However, in our work with the Club, we have the additional advantages of being on the outside looking in, and of access to the very useful data source provided by over a million motoring members.

Today we will report to you on some recent and current studies in California and we will discuss some unresolved problems in the areas of highway signing and markings.

California is, and has been, involved in a large freeway building program which got underway immediately following World War II. Thus, our state has encountered in past years many of the problems which have only recently appeared in states whose first freeways were an outgrowth of the 1956 Interstate Highway Act.

In 1957, the Auto Club distributed questionnaires to its members, seeking their views on freeway signing problems and at that time, 11 years ago, the thousands of Club members who responded helped us to identify several of the basic problems—some of which, unfortunately, are still with us today.

In 1958, the California Division of Highways obtained the help of the Automotive Safety Foundation in making a study of "Driver Needs in Freeway Signing" and a report by that name was the result. The Institute of Transportation and Traffic Engineering of the University of California also contributed to the study and report.

In our judgment, that report was a milestone along the way toward better signing. Signing practice has changed considerably in the 10 years since that report was written, but the principles identified seem as valid today as they were then. These principles include:

1. The need to carefully phrase signing messages to avoid misinterpretation.
2. The need for continuity with respect to the context of signs read in sequence.
3. The vital need for advance notice and repetition.
4. The importance of relatability as between sign messages and other sources of driver information, such as maps.
5. Need for signs of proper size in relation to traffic volume and speed.
6. Need for special attention in signing where design requires unusual maneuvers. (Obviously the counterpart of this is extending every effort to minimize these problems through better design).

In subsequent studies of freeway signing, we have found that directional signing problems on today's freeways can generally be traced to a violation of one or more of those principles.

The Automotive Safety Foundation study also clearly identified the differing driver needs, which John de Lorenzi mentioned, as between drivers on long trips, short trips, or intermediate length trips within a large metropolitan area. It is essential that these differing needs be recognized in any intelligent effort to meet the problems of signing.

In 1961, another important publication was produced entitled, "Freeway Operations—New Information on Emerging Responsibilities." This publication stemmed from a series of seminars held throughout the country on the subject of freeway operations. These seminars were conducted by the Institute of Traffic Engineers with assistance from the American Association of State Highway Officials, the International Association of Chiefs of Police, and the Automotive Safety Foundation. The seminar program was organized, incidentally, during the term of Mr. Joseph E. Havenner as National President of the Institute. Mr. Havenner has been a member of the staff of the Automobile Club of Southern California for more than 25 years, and is currently our Executive Vice President.

Among the problems identified as urgent in the freeway operations report were:

Wrong-way movements;
Lack of consideration of signing in the design stage;
Surface street connections within freeway-to-freeway interchanges;
Left-hand off ramps; and
Too many ramps in a relatively short distance.

In 1962, we became particularly concerned about the directional information needs of the driver on intermediate length trips within a large urban area. In an effort to gain recognition of this need, we also adopted the phrase "local stranger." The basic need of this driver, which was not being met, was for identification of freeways *by name* on freeway signing. This problem was complicated, of course, by the fact that many of the freeway names in common usage did not lend themselves very well to signing. For example, a freeway named for a city at one end, such as San Diego, creates a contradictory message when an attempt is made to use that name as directional information for traffic bound *away* from San Diego.

Again, the staff of the Automobile Club became deeply involved in this problem. Through the cooperation of the Division of Highways and the State Chamber of Commerce, we were able to obtain a Senate Concurrent Resolution calling for a study. This study was carried out and a report written which contains guidelines with regard to both parts of the problem: First, providing an orderly procedure for selecting *good* names and assigning them; and, secondly, for incorporating these names in metropolitan freeway signing.

Unfortunately, those recommendations lay dormant for a period of time and just this year, again by legislative resolution, they have been brought back to life.

Now, Mr. Fowler and I will report on some recent developments in several general areas—namely, directional signing *on* metropolitan freeways, signing *to* freeways, street name signs, wrong way drivers, and delineation of the travelled way. We will be happy to try to answer questions in other areas as well, and to enlarge on these subjects as your interests dictate and time permits. Let's start with directional signing on metropolitan freeways.

Mr. FOWLER. Following World War II the early growth pattern of the Los Angeles metropolitan freeway system was concentrated on a few freeways radiating outward from the central area. Each of these freeways was individually named and the earlier freeway signing is illustrated in these first two slides. However, as the network expanded along many alternate routes to its present 400-mile system, directional signing became an increasingly serious problem. The task of providing necessary and meaningful information to the motorist at the time and place it was needed in his decision-making process became very complex. The 1963 Auto Club report to which Mr. McDonald referred clearly identified five specific problem areas in Metropolitan Freeway signing:

1. The lack of freeway names at the major points of choice.
2. Inadequate directional guidance involving cardinal directions.
3. Inadequate lane designation.
4. Confusing format.
5. Improper destination names.

The following series of five slides illustrate the first three of these problem areas, namely, lack of freeway names at major freeway-to-freeway interchanges, inadequate directional guidance and inadequate lane designation.

At this location on the Santa Monica Freeway approaching the Harbor Freeway interchange, the advance signing identified the Harbor Freeway both by name and by the U.S. Highway 6 route shield. The following sign, however, located at the point of choice, identified U.S. Route 6 west to San Pedro and U.S. Route 6 east downtown. The original problem consisted of the omission of the Harbor Freeway name at the point of divergence and secondly, an additional problem created in California by the fact that U.S. Route 6 (a transcontinental east-west highway) traverses its entire 300 mile length in the State of California in a north-south direction. Since all connections to Route 6 must be designated either east or west, this caused a directional guidance problem in the Los Angeles area that was exactly ninety degrees out of phase with the compass. This became even more of a problem since both freeways carried even number east-west directions. After this problem became apparent, steps were taken to correct the situation by removing the east-west directions on the U.S. 6 Route and by adding the Harbor Freeway name at the point of choice. This improved the situation considerably but still represented only a partial solution, until ultimately the U.S. Highway 6 designation was changed to a local State highway route in the odd-numbered north-south series. The present third stage signing shows HARBOR FREEWAY NEXT RIGHT together with the north-south Route No. 11 on the advance sign. At the point of choice this is followed by HARBOR FREEWAY ROUTE 11 directing to San Pedro and to Downtown.

As a further example of inadequate directional guidance and inadequate lane designation, the following six illustrations depict a confusing situation on the San Diego Freeway, Interstate 405, approaching the Harbor Freeway southbound. The initial signing installed with the opening of the Interstate route gave notice that the No. 4 (right-hand) lane would connect with U.S. 6 to San Pedro and Los Angeles ¾ of a mile ahead. A second advance sign indicated once again that the No. 4 lane would connect to San Pedro and Los Angeles via U.S. 6, ¼ mile ahead. At the point of choice where the two freeways diverged, the signing failed to indicate that the No. 3 lane was, in fact, an optional lane which would serve both destinations. As a result, many unnecessary lane changing maneuvers occurred. Drivers in the No. 4 lane knew they could reach the intersecting freeway to Los Angeles and San Pedro but they were given no indication that the No. 4 lane was a mandatory lane serving *only* the intersecting freeway. At the last minute many motorists deserted this "trap lane" by forcing a merge into lane 3. At the same time, motorists in the No. 3 lane received no indication that they might remain on Interstate 405 or exit on the connector serving U.S. 6. As a result, many crowded to their right into lane 4 only to find it was completely unnecessary since the optional lane would have served them

also. The solution to this problem involved adding a black-on-yellow auxiliary plate reading ONLY on the advance signs above the No. 4 lane and also regrouping the legend so as to provide two downward arrows above the No. 3 lane. This gave a definite indication that the No. 3 lane was an *optional* lane serving destinations on both freeway routes. The east-west directional problem was eliminated as we saw in the previous series through a renumbering of the Harbor Freeway to a north-south designation. A third change consisted of adding the Harbor Freeway name to the signs in place of the cardinal directions.

These two slides on the new Pomona Freeway provide another example of the method for designating optional lanes which serve more than one destination. At this approach to a major freeway-to-freeway interchange serving three separate freeway routes, five down arrows were placed on the overhead signs above a four-lane freeway, so located as to indicate that the No. 2 lane may be used to reach either Interstate 10, the SANTA MONICA FREEWAY, or U.S. 101, the HOLLYWOOD FREEWAY. Unnecessary lane changing is thereby avoided and the choice between those two freeways will be made at some point farther ahead in that No. 2 lane. The second slide shows the signing at the point of divergence with the No. 2 optional lane splitting to the Santa Monica Freeway and the Hollywood Freeway.

California is no longer constructing left-hand connections to and from the high speed lanes of the freeways because of the serious operational problems which they created. However, several older freeways still have an occasional left-hand entrance or exit, both in the urban and the rural areas. This series of four illustrations gives an indication of the lane changing problem at a rural location where the original signing proved inadequate, with no advance information that would enable a motorist to move safely into the lef-hand lane to enter the off ramp. Clear evidence of sudden, unexpected lane changing is furnished by this close-up view of the skid marks on the pavements in the left-hand high speed lane. This type of situation has been improved considerably at another similar location by adding an advance overhead directional sign indicating LEFT EXIT ½ MILE above the No. 1 (left-hand) lane. A closeup of the ramp entrance indicates very little skidding and a much reduced incidence of last minute lane changing.

An example of a confusing sign format is given by this slide on the Golden State Freeway, because the overhead primary sign shows INTERSTATE 5, U.S. 101 and SAN DIEGO as three separate destinations, each with a separate lane assignment. In reality, all three of these messages refer to the same roadway without any significance to individual lanes. The resultant lane scrambling stopped when the message was corrected by removing all three down arrows and showing the two route shields side by side on the upper line with the SAN DIEGO destination name directly beneath on a second line.

In some instances, primary overhead signing at the point where freeway connections diverge fails to accomplish its purpose because of improper location, inadequate message size and confusing format. Such a situation is illustrated by a slide showing multiple route destinations located beyond the point of choice where they are illegible to a motorist when he needs the information. The obvious solution to such a situation lies in provision of additional advance signing, together with relocation, enlargement and simplification of the sign at the point of choice.

In the early days of the Interstate program, considerable confusion resulted from multiple route numbers for the same highways. Perhaps the most extreme example is shown by two illustrations on the San Bernardino Freeway, Interstate 10, at its interchange with Interstate 15 and other routes. Both the advance sign and the units at the freeway connections indicated ten separate highway route shields, together with six cardinal direction designations and two destination names. It was physically impossible for many motorists driving at a legal rate of speed to identify and properly react to this mass of information. The situation attracted so much public attention that it led directly to legislative action in renumbering the entire State highway system. By order of the Legislaure, duplicate highway numbers on the same roadway were eliminated and a priority established whereby Interstate designations would be given primary importance, many former U.S. routes were eliminated and intersecting State highway routes would be signed only if Interstate or U.S. designations were inapplicable. The third picture illustrates a simplification which reduced the route shields from ten to four. In the three years since this change, not a single public complaint has been registered with the Division of Highways, the Highway Patrol, or the Automobile Club, all of whom maintain district offices in the immediate area.

Particularly difficult problems exist in adequately signing freeway-to-freeway interchanges when local street connections also must be accommodated in the immediate interchange area. As the freeway network has grown and additional links have been constructed between the initial routes, every effort has been made to eliminate local street connections within the major interchange area. Where such connections are necessary in order to provide adequate traffic service, all local street designations have been separated from the primary overhead freeway signing so as to confront the motorist with a single decision at a time. As an example, this series of eight illustrations shows the improvements that have largely corrected the original problem. The first slide carries a confusing message format indicating INTERSTATE 10, INTERSTATE 5, U.S. 99, and the destination BAKERSFIELD all on the same overhead sign with two local connections to SEVENTH STREET and SOTO STREET. The following slides show a series of consecutive signs installed to more clearly indicate the successive connections. The first advance sign at ½ mile shows the GOLDEN STATE FREEWAY, INTERSTATE 5, and SANTA MONCA FREEWAY, INTERSTATE 10. The two local street connections to SEVENTH and SOTO were segregated onto a ground mounted secondary sign indicating they might be reached by the SECOND RIGHT. The third sign at the point of divergency simply lists the two Interstate freeway routes, together with the appropriate freeway names and the two principal destinations with down arrows for specific lane assignments.

Following this was an additional ground mounted secondary sign reading SOTO STREET RIGHT LANE. At the point of this divergence, the left-hand lanes repeated the Interstate route number, freeway name and major destination while Soto Street exit was indicated by an up arrow to the right. Beyond this point the other local street connection was indicated on a "butterfly" sign above the left-hand lane reading SEVENTH STREET EXIT ¼ MILE, and at the point of divergence an overhead bridge repeated the Interstate route, freeway name and major destination of the main roadway while Seventh Street as a local connection was indicated by an up arrow over the left-hand off ramp.

In a metropolitan freeway network having more than fifty freeway-to-freeway interchanges and often involving frequent directional changes on the part of the motorist, it has been found to be extremely helpful to post a "reassurance" sign immediately beyond each major freeway-to-freeway interchange. This reassurance sign most frequently is ground mounted on the right shoulder simply giving the cardinal direction, the highway route number and the freeway name. In some instances, particularly on viaducts, the reassurance sign may be located on an overhead sign in the median. Motorist reaction to this policy has been extremely complimentary.

No consideration of freeway directional signing would be complete without considering the problems associated with signing to local street connections. The earliest method is shown in the next slide of the early days on the Harbor Freeway. You will note a small ground mounted reflection sign indicating 37th STREET which proved to be completely inadequate. This picture was taken during the course of construction of the second stage development which showed Freeway. You will note a small ground mounted reflective sign indicating 37th Street and Exposition Boulevard. A massive structure such as this in the gore of an off ramp has been recognized as a focal point of serious injury accidents with the result that present practice no longer permits installation of sign structures in a head-on position at the ramp entrance. As we have seen from other preceding pictures, in many instances an overhead bridge is located at the point of divergence, or a separate cantilever structure is placed in advance of the gore supported by a column in the right-hand shoulder area as depicted in the exit to FRIARS ROAD.

Where adequate spacing exists between interchange connections, present practice on urban freeways is illustrated by the following series of directional signs for the Vermont Avenue exit. The first indication is given on an advanced overhead "orientation" sign in the median listing VERMONT AVENUE at the bottom of a three-line sign indicating it is the third off ramp ahead at a distance of 1¾ miles. This is followed by a second orientation sign with VERMONT AVENUE on the second line at a distance of ¾ mile.

The third orientation sign displays VERMONT AVENUE on the top line indicating the next off ramp at a distance of ½ mile. This is followed by a ground mounted sign on the right shoulder listing VERMONT AVENUE—RIGHT LANE. The next sign is an overhead butterfly at the right shoulder reading VERMONT AVENUE—EXIT ¼ MILE with a down arrow indicating the right-

hand lane. At the point of divergence VERMONT AVENUE is carried on an overhead sign bridge with an up arrow for the right-hand exit. Since the Vermont Avenue ramp does not connect directly with Vermont Avenue but instead enters a parallel local street, near the end of the ramp, an additional ground mounted sign is installed indicating a left turn must be made to reach Vermont Avenue. Where a series of six or seven signs have been installed giving a motorist adequate advance notice and guiding him into the correct lane for a safe exit, there has been a notable reduction in accidents attributable to last minute lane changing. Comments from the motoring public have indicated widespread acceptance and preference for this helpful information.

Summary Comments Regarding Signing on Freeways and Introduction to Signing to Freeways

Mr. McDonald. Mr. Fowler has just covered the five problem areas in the report plus a closely related one. He has also shown you the solutions which evolved from several years of experimentation with each of the five problems. The most important recommendations in the report, however, were not so much involved with the actual solution to specific problems as with the entire process of developing new and better freeway signing.

Directional signing should not be considered a static thing, but rather a dynamic and constantly improving operational method. In line with this general feeling, the Club recommended that freeway directional signing be reviewed by persons outside the Division of Highways in at least two stages prior to use by traffic. As a consequence, Club engineers, along with traffic engineers from other public agencies, have participated in both design stage and construction stage reviews of directional signing on all recently constructed metropolitan freeways. The latter review, usually conducted about a week before freeway opening, includes not only the directional signing but a review of all of the highway hardware such as guard rail, median barriers, delineators and warning devices where needed.

Another recommendation related to the process rather than the practice, was that the Division of Highways should institute a directional signing surveillance process to continuously analyze the effectiveness of freeway signing. To the best of our knowledge, this is also being carried out today. I might add that an important element in this process is the institution of nighttime surveillance in addition to the traditional working-hour kind of surveillance prevalent in most traffic engineering offices.

Over one million dollars has been spent over the past three years in the Los Angeles metropolitan area updating freeway directional signing. Our State Traffic Engineer informs us that by January 1, 1969, all signs on the state highway system will substantially conform to current standards at a total expenditure of more than $7 million.

We are pleased with the changes and believe that current freeway signing in California could serve as a model for signing throughout the country.

If there are no further questions on the subject of directional signing on freeways, let's turn to the subject of signing *to* freeways, and call again on Mr. Fowler.

Mr. Fowler. As the freeway system has expanded and more and more of the total daily traffic is diverted from local streets to the freeways, the importance of adequate signing to the freeway connections increases significantly. There are several reasons why this is true. For one thing, adoption of a new travel pattern frequently disorients the commuter who then must rely more and more upon signing to and from the freeway. Secondly, once a motorist becomes accustomed to freeway driving with its higher quality high-speed directional signing, he invariably becomes more critical of the quality of existing directional signs on local streets and roads. Lastly, since freeway trips have neither an origin nor a destination on the freeway, as traffic volumes mount, reliance upon local street signing is considerably increased.

In the early years after World War II, when very short segments of one or two freeway routes comprised the entire freeway system available to motorists, directional signs on local streets were necessarily few in number and could simply refer to "freeway—north" or simply to "Harbor Freeway." In any particular area of town, the name "freeway" obviously referred to only one available freeway route. These early signs are shown in several slides of typical installations in the sidewalk area. Often times these early signs were too small to attract

attention and provide adequate service to the motorist. In many cases, the lettering on the signs could not be read at a distance that would accommodate proper maneuvering into the ramp entrance. As the problem became apparent, the City of Los Angeles adopted a policy of installing larger reflective directional signs on major arterial streets in advance of the point where motorists would be required to turn in order to reach the freeway entrance. This early sign directing to the Harbor Freeway made effective use of the white-on-green directional colors adopted with the inception of the Interstate Program. More recent improvements are shown in the following slides of overhead advance directional signs, which quite frequently were illuminated for nighttime visibility under urban conditions.

In 1965, the urgent need for improved signing to the freeway together with the rapidly growing number of installations involved and the expense of larger, more durable signs, resulted in action by the State Legislature to permit the expenditure of State Highway funds for such signs on urban arterial streets outside the limits of freeway rights-of-way. Typical examples of recent installations are shown on the Santa Ana and San Diego Freeway signs placed in the median of divided arterials.

The use of freeway names as well as numbers is extremely important in identifying closely spaced freeways in an urban network. Public comments have made very clear that numbers alone are not adequately meaningful to local people who invariably attach a name to each freeway route, either unofficially in the press or by official action of government bodies. Of course, strangers to the area who rely on maps and tour books, frequently are more familiar with route numbers and are guided accordingly.

STREET NAME SIGNS

Mr. McDONALD. Another problem too easily forgotten in this era of freeways and expressways occurs on conventional streets and highways—simply trying to find the name of an intersecting street. Incidentally, in our questionnaire to members which I mentioned before, we asked only about freeway signing, however, the "writeins" regarding street name signs turned out to be the No. 1 complaint!

This problem is widespread. It appears at neighborhood corners, particularly with regard to need for reflectorization, and it appears on the important arterials. With the wide streets typical of western cities, it is essential that the driver have this information several hundred feet before arriving at the intersection so he can be in the proper lane to make his turn.

The problem of street name signing is compounded, of course, by the fact that there are 400 cities and 58 counties in California, each with jurisdiction over streets within its borders. Here, you don't have the advantage of being able to go to one agency, such as the Division of Highways, with a general complaint.

At the national level, the National Joint Committee on Uniform Traffic Control Devices is just now in the process of changing over from a minimum three-inch standard street name sign to a four-inch standard. This, of course, is a standard suitable only for narrow local streets, and in no way can be considered an adequate street name sign size for broad arterial streets. Paul Fowler will show you some examples of good and bad street name signing in the Southern California area.

Mr. FOWLER. Almost hidden at the far side of this major signalized intersection of Doheny Drive is the standard corner-mounted street name sign. Although customarily the sign may be located on a traffic signal or light standard, it fails to command attention from a generally distracting background and even with four-inch letters is frequently illegible at normal street widths. Many local jurisdictions throughout Southern California are turning to the use of overhead street name signs on the traffic signal mast arms. Some of these large signs may be illuminated as in the case of the illustration on Doheny Drive, while others may be simple reflective signs as shown on Washington Boulevard, Euclid Street and the other examples. But in each instance, the contrast between the normal three- or four-inch street sign on the corner and the six- or eight-inch legend on the overhead mounting is readily apparent and frequently the cause of favorable comment from motorists. The public demand for an expansion of this program was immediate and enthusiastic.

On some boulevards, multiple turn lanes are necessary to accommodate traffic flow during the morning and evening rush periods. Often times, it has been found necessary to install overhead signs clearly designating these special turn regulations. In such instances, an advance street name sign was installed on the overhead mounting between the two regulatory signs as shown on the example for SANTA BARBARA AVENUE. A later, more simplified version is shown on the following slide for CHATAUQUA BOULEVARD where the name was combined with the regulatory symbols on the same sign.

Large ground mounted advance name signs are familiar in the median for major highways in rural areas, as is illustrated by the unit at PLUMMER STREET. Far less common is the situation depicted in the following slide of an advance notification of 8TH STREET at the mid-block point in downtown Los Angeles. Noteworthy is the fact that this sign is mounted above truck height, together with a one-way sign indicating the direction of traffic movement along 8th Street. In this way, motorists are able to select the proper lane for making the turn into the one-way street.

The following slides illustrate typical *advance street name signing* in highly urbanized commercial, residential, and suburban business districts.

The Auto Club believes that this is a major problem confronting many urban areas throughout the nation, perhaps contributing significantly to accidents and certainly to driver confusion. This subject is of concern also to the National Joint Committee on Uniform Traffic Control Devices. Larger street name signs coupled with advance street naming on major arterials should be adopted as a national standard in the public interest.

WRONG-WAY DRIVER

Mr. MoDONALD. Another problem which has received a lot of attention both in the news media and in our State Legislature is that of the wrong-way driver. The California Division of Highways has studied this problem in two parts. First, wrong-way drivers resulting from median crossings. This part of the problem has been largely solved by the installation of various types of median barriers. In a moment I'll ask Mr. Fowler to show you just a couple of examples of the kind of barriers in use in California, in case you haven't seen them.

More pertinent to the discussion today, however, is the second part of the problem, the wrong-way incident which results from a vehicle entering the freeway via an *exit* ramp. A very detailed study of this kind of problem has been made in California with some disturbing sidelights. The majority of these wrong-way incidents involve, of course, driver error most often coupled with varying quantities of alcohol. In some instances deliberate attempts at suicide have been discovered. In any case, a considerable segment of the problem seems to be beyond the ability of the highway engineer to correct.

Now, Mr. Fowler will show you examples of the median barriers and of the sign installations presently in use on all California freeways to minimize wrong-way driving incidents.

Mr. FOWLER. Perhaps the most serious single problem encountered by freeway drivers as the system expanded rapidly into the rural areas concerns the head-on accident potential from wrong-way driving. A measure of the problem can be obtained from the fact that 1200 wrong-way drivers were apprehended by police in an 18-month period in California alone. How many additional motorists went unnoticed remains a matter of conjecture, but an average of 35 persons have been killed annually in wrong-way crashes. During the past four years, more than 150 persons died in 90 separate spectacular head-on collisions. The problem has been attacked in several ways, with notably significant improvement.

Full-scale dynamic testing led to the adoption and installation of more than 400 miles of median barrier on heavily traveled urban freeways. These are of two principal types, as shown in the following three slides. For narrow medians, less than 22 feet in width, the double blocked-out steel barrier beam has proven most effective, while for wider medians a more flexible double cable-and-chain link fence type of barrier is preferable. Both types are equipped also with an expanded metal glare shield and "curiosity screen" to reduce the distraction and potential source of secondary collisions on the other side of the freeway at the scene of accidents, maintenance work and other disruptions.

Many of the wrong-way movements involved vehicles mistakenly entering the freeway via an off-ramp, especially where the design of these connections placed

them closely adjacent or directly into a frontage road. The next slide shows the standard signing and marking at the surface street end of the off ramp, including multiple pavement legends and arrows as well as DO NOT ENTER, ONE WAY and KEEP RIGHT signs. As a result of tests with a special device shown in the following illustration, additional signs have been adopted and installed on all existing entrance and exit ramps. At the test sites, wrong-way vehicles actuated the flashing red signal, turned on a siren, illuminated the red sign reading "GO BACK, YOU'RE GOING THE WRONG WAY," turned on a floodlight and started a movie camera to record driver response. As a result, the white-on-red WRONG WAY sign was installed in duplicate beneath the DO NOT ENTER signs at all off-ramps, while special white-on-green FREEWAY ENTRANCE signs were erected at all on-ramps for reassurance to entering motorists. Statistical sampling from these 5000 installations showed a 41% reduction in wrong-way movements during the year following their installation.

In outlying desert areas (where freeway construction necessarily proceeds in a piecemeal pattern) special oversize WRONG WAY signs are used, together with pavement arrows and special warning signs using both a two-arrow symbol and the word legend ONE WAY or TWO-WAY TRAFFIC, as appropriate for the section roadway. Noteworthy in this series also is the California practice of delineating the left hand or median edge of a divided highway with a double yellow barrier stripe, which further identifies a one-way roadway and the direction of travel.

In all new interchange designs, special care is taken to properly channelize the frontage road so as to discourage wrongway entry. The example shown represents an off-ramp entering a two-way frontage road which has been divided with a center island and curved into a right angle intersection, so that oncoming traffic on the frontage road would have to make a deliberate right turn against all the posted signs and markings if they were to mistakenly enter the off-ramp.

DELINEATION OF TRAVELED WAY

Mr. McDONALD. In addition to signing, an effective method of communicating with the driver is through the use of pavement markings and roadway delineation. And again, like signing, this form of guidance seems to be in a perpetual state of evolution. Mr. Fowler will now show illustrations of current problems and developments.

Mr. FOWLER. Our first slide of a newly completed freeway section gives a typical view of roadside hardware and reflectorized delineators along both the main roadway and the adjacent collector-distributor road. In daylight hours the demarcation of the traffic lanes is unmistakable, but under nighttime conditions as shown in the next slide of another freeway segment, the random placement of roadside reflectors on bridge rails, guardrails, sign posts, culverts and other obstructions results in a confusing hodge-podge of reflected lights.

The obvious solution to this dilemma is two-fold: first, eliminate wherever possible the roadside structures and hazards that require random reflectorization; and secondly, improve the continuous delineation of the traffic lanes themselves. During the current year, three million dollars have been earmarked for the "CURE" (Clean Up the Roadside Environment) program on California highways, principally to remove roadside hazards and clarify delineation.

In addition, long term testing has been completed and more than four million dollars invested in a program to install raised pavement markers on all existing freeways statewide. Illustrated in the next slide is a typical lane-line application using groups of ceramic non-reflective marker buttons to simulate the former painted stripe, with brilliant silver reflectors at 48-foot spacing for nightime delineation. The following picture shows the improvement in visibility under wet weather conditions in the north coastal area of the state.

Among the many advantages afforded by the markers are the reduction in roadway hazards from slow-moving paint striping equipment; reduction in lane changing as a result of the audible and tactile sensations imparted to motorists when crossing the raised markers; and vastly superior visibility under difficult conditions involving oncoming headlight glare on wet pavements. Experimentation is continuing on possible application of these markers above the 3000-foot level where snow removal operations present special problems.

The following series of three slides clearly demonstrates the spectacular improvement in nighttime roadway delineation.

The final two illustrations depict an extra benefit afforded by raised markers that was formerly unattainable from painted striping. I am referring to the bidirectional capabilities of the reflectors, which display a brilliant silver reflection in the normal direction of travel, but exhibit a brilliant red indication to any wrong-way driver. This continuous pavement indication further reinforces the WRONG WAY posting we have seen in the previous section.

We look forward to significant improvement in both highway safety and traffic operations from widespread application of these pavement markers wherever they can be used effectively.

Mr. McDonald. Gentlemen, that concludes our prepared testimony. We hope it has served the intended purposes of being constructively critical and offering some useful guidance toward problem solutions.

Appendix C

The Geometric Design of Highways and Truck Operations

(By Richard A. Lill)

It is a distinct pleasure for our industry to have the opportunity to present our views on geometric design to your technical session. We frankly hope that this can strengthen the relationship between our industry and your profession, so there will be open channels of communication for exchange of thought when there is mutual concern and interest.

It is with a considerable amount of trepidation that I undertake a discussion of the geometric design of highways before the foremost engineers in the field, even when the area of discussion is narrowed to that principally related to truck operations. The subject is so broad and inter-related, and so many judgment factors are to be considered that I could easily make the mistake of presenting a wide-ranging personal opinion comment, with little for your actual consideration.

At the outset, therefore, we assure you of our intent to be as specific as possible, and to stick to those items of particular interest to us, even though this distinct separation of interest does not generally apply to the composite traffic stream. By this I mean that high standards of geometric design are of benefit to all highway users. Beyond that, they are essential to the continued economic development of the country, and to meet the needs of national defense.

It is a great pleasure for me to compliment you sincerely on the success of your efforts in the geometric design of highways, and the advances you have made. The growth of the trucking industry, as well as that of other traffic and industry, has been molded and promoted by the foresight of your planning and design, and we recognize this fact. We further recognize that to a significant extent your look into the future directs and influences future developments in highway transportation.

Generally speaking, the truck operator is vitally interested in the economic efficiency of his operation, the safety of his operation, and the problems he sees facing him when it comes to his ability to maintain and possibly expand his business in the future.

The geometric design of the highways is important to him because it strongly influences the type of vehicle he will use, and the design of that vehicle. It is important because the history design can influence his schedules and routings, and his terminal locations. It is important because it influences his safety record and his economic well being. In short, it is an important factor in his entire operation.

In the background work for this paper, we found a wide area of the specifics of geometric design where we had no comments. It was apparent that many elements of design were either not directly related to truck operations or that the present criteria appeared adequate for the foreseeable future, all things considered. We include in this category such things as design speed, sight distance, alignment and widths of right-of-way, number and widths of traffic lanes, medians, etc.

The width of shoulders was considered as of significance to us, particularly in case of breakdown or other emergency, but it appeared that the provision of rest areas at intervals along the interstate and other routes was of equal or greater service. Hence, although a 12-foot wide shoulder along the pavement is obviously desirable, ten feet is an adequate minimum, particularly when coupled with periodic rest areas.

We found a much lesser grouping of specifics of geometric design in which we do feel that we have something to contribute for your consideration. The discussion of these points constitutes the bulk of this paper.

It is axiomatic that many elements of geometric design are inter-connected and can be major cost items. We would surmise that the minimum criteria of the present, as well as those of the past, have been dictated by these financial considerations.

Nevertheless, we also believe that, as design engineers, you have the goal of building above the minimum criteria whenever you have determined it to be a good investment.

History tells us that the improvement of the minimum criteria has been continuous with resultant improvement in the operation of the highway systems.

Operationally, therefore, the elements of design of most importance to us, and those which relate to possible problems, are vertical clearances, grades, interchanges and intersections and, to a lesser extent, signing and road information.

VERTICAL CLEARANCES

At first glance it may appear that the subject of vertical clearances is pretty well closed. The minimum clearance on the rural interstate system and on one routing in urban areas has been raised to 16 feet from the previous 14 feet, and about one half of the system is constructed. This is rather final.

The increased minimum standard resulted from considerations brought about by military need, as well as representations from the heavy-specialized carrier segment of the trucking industry. In each case it was developed that the 14-foot minimum criterion could be quite restrictive for specialized movements, even to the extent of prohibiting defense movements then quite common.

The selecton of the 16-foot minimum clearance on the interstate was a desirable and forward-thinking action, and probably all that could be justified for the system, although the feeling of our industry was that 17 feet was a more suitable figure. Nevertheless, it is certainly a fixture for some years, and adequate for the majority of the traffic.

But it is on the remainder of the highway system that trouble is developing. As you know, the vertical clearance criteria for other highways which pass under the interstate system are to be those of the lesser highway, namely a minimum of 14 feet.

In urban areas in particular, many segments of the city are almost being sealed off by interstate type construction. Highways and streets which have been adequate in the past for over-height permit operation may now be blocked to he movement of anything over 14 feet. As time goes on, the situation can very well get worse, as the proportion of highways built to controlled access characteristics will undoubtedly increase.

And there is another but slightly different aspect of the minimum clearance question which causes us concern, in this case with respect to regular operation. We are hearing of more and more instances of scalped trailers at underpasses where pavement resurfacing has reduced the vertical clearance to the critical point. We recognize that your criteria have recommended a few inches additional clearance to allow for resurfacing, but in the light of a 14-foot minimum, is it now an adequate allowance? And what steps are taken to insure, when a critical clearance exists, that it is not further reduced by resurfacing?

These problems bother us, and the solutions will clearly be a factor in our operation. We urge, therefore, your careful consideration of them in your vertical clearance determinations, to the end that the clearances we have will be maintained and the future accommodated.

You know better than we do the complexity of the problem we have touched upon, and the implications of change in the vertical clearance criteria. For our part, we recognize that virtually any reasonable minimum clearance could be too low for some particular shipment. But we also recognize that critical areas are developing or may develop for our so-called regular operation, and that the defense needs of the country and industrial demands are constantly pressing for the more specialized transportation.

It is not our intent to suggest any specific minimum clearance criteria for any highway system, although we believe it should not be as low as 14 feet. Such a basic minimum, we feel, must give careful consideration to the questions we have raised.

In the case of specialized movements, we offer the suggestion that their characteristics receive careful consideration early in the procedure of highway location and design, to the end that localized systems or routings may be established where there are no new overhead obstructions, or, at the very least, that interstate criteria are provided at reasonable intervals.

The decisions, of course, will be conditioned by the knowledge that there has been or will be a need. We feel that this approach will avoid the danger of building additional vertical constrictions in the highway plant and eventually

lead to lesser difficulties, both for the permit officers and the specialized carriers, as well as the military.

GRADES

A second area of interest to the motor carrier is that of the length and steepness of the grades on the highways he uses. Here again we acknowledge the advances of recent years and the problems and costs which may accompany higher standards. However, there are still, increasingly, operational gains to be made for all concerned, which we want to outline.

Much work has been done in the area of relating the power and weight of a motor truck to its ability, in terms of speed, to climb grades of varying steepness. You are all probably familiar with these general relationships and the potentials which exist when grades are reduced, and I need not discuss that to any extent.

There is, however, another factor directly related to the steepness of the grade which is of importance to the truck operator. This factor is the ultimate tractive capability of his vehicles—or, put another way, the minimum coefficient of friction between tire and pavement which will still permit the vehicle to climb a given incline.

Obviously, this is not a problem under normal road conditions, but when the pavement is slick it can become critical. Thus it may sometimes not be a question of how fast a given vehicle can go up a grade, but of whether it can climb it at all, regardless of the power which may be available.

A sample calculation will serve to show the effect of grade on each of these factors assuming the operation of a given vehicle. We have selected a 200 horsepower tractor with 32,000 # tandem drive, pulling 70,000 pounds up sustained grades of 3, 5 and 7%. The results are:

	Miles per hour	Minimum coefficient of friction
Percent grade:		
3	23.0	0.091
5	15.5	.134
7	12.0	.178

Thus, a decrease in grade from 7% to 5% provides an increased speed capability for this vehicle of about 3½ mph and a bettering of the critical minimum coefficient of friction of about 22%. A change in grade from 5% to 3% provides an increased speed capability of about 7½ mph and an approximate 32% improvement in the minimum tractive ability.

To be meaningful, the above coefficient of friction figures need to be related to some general criteria. For instance, the winter driving hazards tests of the National Safety Council indicate that glare ice has a coefficient of about 0.10. Other measurements indicate that the coefficient for the surface of a wet pavement will rarely go below 0.30, particularly at speeds below 30 mph.

The tractive capability of this particular vehicle, then, is adequate on all the selected grades, for normal operation, and has a pretty good reserve for the more severe type winter weather.

Trouble can develop, however, for the more extreme conditions of slippery pavements, or when one wheel of the drive axle or axles spin. In the case of a wheel spin, of course, one-half the traction ability is lost and the minimum critical coefficient of friction can be doubled. The benefits from the lesser grades are clear, then, in terms of the ultimate ability of this vehicle to surmount the grade.

In the over-all sense, we recognize that this discussion must be positioned with respect to the facts of life. Thus in mountainous areas of rugged terrain, substantially reduced grades may be out of the question. However, in these areas, where there is repeated severe winter weather, the truck driver is prepared for "chaining-up" when advised to do so by the highway department, and can generally continue his operation.

It is in areas of variable severe winter weather and also less rugged terrain that we believe the operational benefits from lesser grades can be substantial for user and highway department alike. For instance, it is likely that few of the

highway users will be properly prepared for sudden storms, so they face the problem of proceeding with normal equipment.

The highway departments, of course, can be seriously handicapped in their snow clearing activities if the roadway is clogged with stuck vehicles. All of which argues for keeping the traffic moving by design. Not to be minimized, either, are the benefits to be gained in better operation of specific snow clearing equipment, either in terms of more speed capability or more power available to move the snow, when the grades are low.

We do not attempt to state any specifics as to what we think the maximum grades should be, as that is obviously strongly influenced by all the elements of design. Nevertheless, we do urge you to consider the minimum grades that are at all feasible in a given situation. We believe it is a wise investment towards good operation of the highways.

INTERCHANGES AND INTERSECTIONS

From our vantage point, possibly no broad area of geometric design touches more aspects of truck operation in more ways than that of interchanges and intersections. It is related in one way or another to the bulk of the comments we receive from our operational and fleet safety people, and to the comments already offered.

For instance, the preceding discussion regarding tractive capability and the pavement coefficient of friction is directly applicable. In fact, it may be even more pertinent, as traction problems can be intensified if a vehicle is stopped on a ramp grade when the pavement is slick, and tries to get started again. If the grade is on a curve, we believe the difficulty to be worse, as there is then probably more tendency for the differential of the drive axle to function.

We do not have data which relates the degree of curve to the action of the differential, but our experience indicates that the loss of traction on one wheel is more likely to occur on the shorter radius curves. Logic and mathematics support this supposition, but do not supply any criteria as to what might or might not be a critical radius.

It is possible, however, to be more specific concerning other aspects of turning roadways or ramps, particularly those with short radii, which are of concern to the truck operator. As these aspects were pursued, we saw that continuity existed between them in terms of the design speed of the turning roadways. Thus the subject of grades, vehicle off-tracking and safety of operation all seemed to have a common determinant.

The literature deals adequately with grades and off-tracking, and we need not offer any comment on them. And, of course, safety of operation has always been the number one concern of highway design. In our industry's experience, however, there has evolved one aspect of turning roadways which we do want to discuss. It is the relationship which exists between the radius of curvature and the possibility of overturn on the ramp.

The factors which are most significant in this analysis are the degree of curvature of the turn, the amount of super-elevation of the roadway, and the speed, height of center of gravity and the track width of the vehicle.

It immediately became apparent in the investigation that there is no problem, even for a flat, minimum radius curve and a center of gravity as high as eight feet, as long as the vehicle negotiates the turn at the design speed. Normally loaded trucks can make the maneuver easily and safely.

It does develop, however, that the margin of safety *above* the design speed—that is, the margin which would permit a driver to make a mistake in the entering speed and still recover without overturn—is a function of the radius and super-elevation of the turn, as well as the vehicle characteristics.

For instance, for a 50-foot radius turn with an 0.00 super-elevation, permitted by the criteria, a vehicle with an 8-foot high center of gravity and an 8-foot wide track has a speed cushion of something less than five mph over the design speed of 15 mph.

Ramps of a more common design speed of 25 mph (150-foot radius) with the minimum super-elevation of 0.04, work out to have a speed margin of about 10 mph, and those with a design speed of 35 mph (300-foot radius) and a minimum super-elevation of 0.08 have a cushion of over 15 mph.

I want to emphasize that the assumptions which went into the above calculations are for uniform conditions. Each of the margins is reduced if a sudden maneuver, such as swerving or braking, is made, and probably by significant amounts.

Therefore, in order to provide for reasonable maneuver and/or error without overturn, even for the extreme assumptions of loading used in the examples, we conclude that it is desirable to have the foregoing safety margin on the order of 15 mph, corresponding to a ramp design speed of 35 mph.

We recognize that the conclusion could be influenced by a general practice of providing adequate length deceleration lanes before turning ramps. Nevertheless, we also note the compatibility of this conclusion to the AASHO guide values which relate *desirable* ramp design speed to through highway design speed, Table IX–2 of the Policy on Geometric Design. It is only for through highway design speeds of less than 40 mph that the desirable minimum ramp design speed is less than 35 mph.

However, the AASHO recommended absolute "minimum" ramp design speed never exceeds 30 mph, even when used in connection with through highway design speeds of as high as 70 mph. And we observe that such minimums are frequently used in interior loops of cloverleaf intersections, particularly in urban areas.

We believe that this is too low, and that the minimum ramp design speed should be 35 mph for through highway design speeds of 50 mph and above. Note that the resulting safety margin would thus include the bulk of the differences between ramp design speed and the highway design speed, and that there would be more speed compatibility between various ramps. Also, such a criterion has the effect of alleviating the problems of grades and off-tracking that the short radius loops may give us.

RAMP LOCATION

A final point which involves design has been brought to our attention regarding an operational problem at interchanges. This has to do with merging from the left into the traffic stream, particularly a heavy traffic flow.

Seated as he is, a truck driver rarely has as good visibility to the right-rear quadrant of his vehicle as he does to the left. Consequently, when he has to merge with traffic on the right, he may have difficulty in positioning his vehicle properly. The situation is the worst when the merging lanes come together at an angle and when there is a relatively short distance to accomplish the maneuver. The driver can see to the side and to the rear with his mirror, but there can be an area between the two which is out of his field of vision.

Our suggestion is twofold, therefore. First, if it is expected that there will be a significant flow of truck traffic merging at the interchange, we hope you will try in every way you can to have it merge from the right. However, if it is necessary that the trucks merge from the left, then we like to see adequate length, *parallel*, merging lanes. As said before, this does give the driver the opportunity to use his right-hand rear view mirror effectively, so he can safely accomplish the maneuver with a minimum of difficulty.

SIGNING

Finally, and we hesitate to mention it, there is one last comment concerning signing, particularly on the Interstate roads. We bring it up because it is important to good and safe highway operation, and because we have heard more criticism of signing, from the non-highway engineer, than of any other single feature of our new highways.

You know the importance of good signing, of course, and we know that you seek the highest and most informative standards for getting adequate information to the vehicle user. And it is probably true that most of the criticism is unjustified.

Nevertheless, a confused driver is not a safe driver and does not contribute to the good operation of any highway facility. All too often, for instance, we see a vehicle backing up on or beside an express lane at an exit. We suppose that this generally occurs because the driver did not see the sign in time or could not interpret it properly when he did. If there truly was a lack of adequate information available to this driver, then there has been a breakdown of signing.

We are aware of the very comprehensive Manual on Uniform Traffic Control Devices and the effort which has gone into it. We certainly urge you, therefore, to follow this manual, to modify it where necessary, and to continue and intensify your research efforts in this most important area of design. You must do your utmost to remove any cause for criticism which may exist in this area of direct contact with the highway user.

In summary, we are pleased to have had the opportunity of discussing geometric highway design and truck operation with you, and to present the thoughts that have come to us from the industry. We have dwelt on a few specifics of particular interest to us, have suggested some modification of the criteria, and have given the reasons for our suggestions. We believe that each can contribute to the achievement of the best possible operation of the highway systems, a goal that has been before you throughout the years and has led to the continuing advancement of the criteria for geometric design.

Appendix D

Publications of Drs. S. F. Hulbert and A. Burg

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