MOTORISTS' PREFERENCES IN ROUTE DIVERSION SIGNING

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A questionnaire survey was conducted in the Baltimore-Washington corridor to determine motorists' preferences in route diversion signing. The study site was located near the southern end of the corridor at the interchange of I-95 and I-495. The objectives of the questionnaire study were to determine 3 types of information concerning the motorist and the diversion-signing system. In addition to determining the characteristics of drivers that use a major intercity corridor, the study sought to identify the type of real-time information desired by the road user and determine the format for conveying this information. Two different questionnaires were developed and tested, and over 6 thousand were distributed to motorists during 3 interview periods. On the basis of the motorists' responses, the study found 3 sign messages worthy of further consideration for real-time route diversion. These signs contained the following information: (a) length of congestion, (b) cause of congestion and exit instructions, and (c) alternate route information. The first type was preferred because of its conciseness. The other 2 were preferred because they conveyed a sense of authority and presented the motorist with an alternative to travel delay.

•THE MAJORITY of highway facilities operate satisfactorily for most of the day, but during the morning and evening peak periods some facilities become extremely overloaded, and heavy congestion, bottleneck conditions, delays in travel, and increased travel times result. These conditions are further aggravated during both peak and off-peak periods when other incidents are introduced on the roadway, and even lower levels of service are then given by the highway system. If specific problem locations can be identified, means can be used to divert some of the traffic to other facilities and thus increase the quality of flow for all motorists on the surrounding highway system.

Some information exists in the literature concerning the development and implementation of procedures for the real-time diversion of traffic (2). Several studies have investigated both the hardware and software problems in determining when traffic should be rerouted and have recommended policies to be followed for such programs. Numerous parameters, including traffic speed, traffic density, occupancy, traffic volume, travel time and delay, rate of motion, acceleration noise, and conflict analysis, have been suggested and used to quantify the level of service for highway facilities. In a typical program of real-time route diversion, 1 or more of these parameters would be monitored on major routes and on suitable alternate routes to evaluate level of service. When the level of service on a route falls below or is in the range of a specified threshold value, traffic would be rerouted to other facilities to alleviate the problems caused by a particular incident or heavy traffic.

Local motorists traveling on a facility that is operating under a lower than normal level of service because of some incident may elect to divert to some other facility and avoid the congested area. In other words, drivers, as decision-makers, evaluate the situation and make individual determinations on the best alternative to select. Motorists generally will not have knowledge of or interest in the system parameters used by the engineer to evaluate an operation. From the point of view of real-time diversion, mo-

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torists on intercity journeys or not familiar with the area create a more complex problem. Some means must be developed to accurately convey the highway situation and explain in an understandable manner what should be done. This was one of the objectives of this study—to determine what information concerning degraded system operation and the availability of alternate routes should be conveyed to motorists on intercity travel.

Of the 4 component areas found in the literature concerning real-time route diversion (quality of operation, incident detection, diversion policy, and communication), communication—the manner in which information is conveyed to motorists—has received the least attention. It may involve messages describing the nature of the situation or advice on the need to change to another facility because of an incident. If the facility is operating at a level of service low enough that it is advisable to divert traffic to another route, it is essential to know how to convey this real-time information to the motorists. In general, a real-time route diversion program advises motorists of the existing roadway conditions so that they can make an informed choice concerning their route of travel. It is therefore necessary to provide for conveying proper information to the drivers. Several forms of communication are applicable for diversion of intercity traffic. These can be either audio or visual and can use either stationary or in-vehicle equipment.

According to the literature, the most promising method of communicating with motorists is variable message signs. The 5 prominent types of variable message signs are as follows:

1. Lamp matrix,
2. Drum sign,
3. Blank-out sign,
4. Roller screen, and
5. Flipping disk.

Each of these types of signs has been employed in system surveillance and control programs. Although the physical type of the sign is important, the sign message and arrangement are of greater importance. The real-time information from these formats is divided into 2 general categories.

1. Descriptive information, which indicates the general roadway condition, includes CONGESTION, ACCIDENT AHEAD, KEEP LEFT, and ICY CONDITION signs.
2. Quantitative information, which specifies numerical values for some traffic parameter that the driver is able to comprehend, includes variable speed limit signs and estimates of delay time such as 5 MIN TO GORMAN ROAD.

Studies have found that motorists prefer messages that convey real-time information. Heathington, Worrall, and Hoff (4) found through a questionnaire study that freeway motorists in the Chicago metropolitan area preferred signing that presented speed information or descriptive terms over signing that presented quantitative travel-time or delay information when there was heavy, moderate, and no congestion. This seems to indicate that motorists consider and choose alternate routes not only on the basis of travel time and delay during all types of driving conditions but also on the basis of information to which they can clearly relate. Other studies have found that motorists prefer a message design that distinguishes real-time visual displays from other types of freeway signs and employs unique features such as color to distinguish unusual or abnormal traffic conditions (3). It has been suggested that a uniform and recognizable color-coded message would stand out from the static signs and would help the driver to quickly perceive freeway conditions. For example, green could mean that the traffic conditions ahead are favorable; flashing amber might suggest that the driver should use extra caution (6).

In designing a signing format to be used to encourage diversion from one facility to another, the attitudes and behavior of motorists on route diversion must be considered. A recent report outlines the results of a study in Chicago with regard to voluntary di-

version from a normal route to work to some other route (5). Generally, the respondents were more receptive to diversion to avoid delay or to save travel time on the trip from work to home. Furthermore, the respondents indicated that they would be more likely to divert to avoid a delay than they would be to save travel time. Even though these studies were concerned with trips from home to work and from work to home, we felt that some of the findings might be useful in this study concerning motorists' preferences for signing for intercity travel.

Although there have been notable exceptions (1, 8, 9), work reported previously on real-time route diversion has concentrated on urban corridors. And although comparatively little has been done with respect to intercity diversion, the elements of traffic-flow evaluation and incident detection are basically analogous for urban and intercity diversion. The policies associated with intercity diversion would be established initially through simulation techniques on the proposed corridor and then would be tested experimentally. However, special attention is warranted for the signing aspects of intercity diversion because of the differing needs of local and through motorists.

The problems related to the design of a message format are specific. It is generally agreed that motorists choose routes on the basis of travel time and cost, safety, comfort, and convenience. The signing for route diversion must indicate when one or more of these factors exist at a degraded level. However, it was unclear as to exactly what format and what traffic parameters should be used to convey this information.

STUDY DESIGN AND FIELD INVESTIGATION

The type of information to be determined was motorists' preferences with respect to the wording and presentation of a sign message. To accomplish this, it was decided that a questionnaire survey of the road users offered the best opportunity to collect the necessary information. The questionnaire had to satisfy 3 objectives. It had to determine

1. The characteristics of the driver, including information about the number of years driven, distance driven annually, and frequency of freeway use;
2. What type of real-time information the road user desires; and
3. In what manner the road user wanted the information presented.

Because of the amount of information required and the number of questions asked, it was necessary to use 2 questionnaires. Questionnaire A allowed for the selection of a best and a worst sign and asked the respondents to indicate their reasons for making their choices from among 3 available signs. Questionnaire B was designed so that motorists could choose pairs from a total of 5 different signs, which would allow making 10 choices. During the interview, motorists were given either questionnaire A or B, together with an explanatory letter and a postage-paid return envelope. Both questionnaires contained identical questions to determine driver characteristics and information about daily commuting to work. These questionnaires are described in detail in a separate report (7).

Because the focus of this study on route diversion was the Baltimore-Washington corridor, it was necessary to choose a field location where traffic is oriented toward corridor rather than local usage. It was also desirable to have a representative level of through traffic in the sample of drivers interviewed. A third important criterion in selecting the site was to have a location where traffic could be stopped safely to distribute the questionnaires.

In conjunction with the Maryland Highway Administration, the decision was made that the most logical location for the field survey was the southern terminus of I-95 in Maryland at its interchange with the Capital Beltway, I-495. This 8-lane facility was opened to traffic in the summer of 1971. It runs approximately parallel to the 3 other major, north-south facilities in the corridor:

1. US-29, a 4-lane highway located approximately 3 miles (4.8 km) west of I-95 that

connects I-495 and I-70N (west of Baltimore);

2. US-1, a 4-lane highway with numerous access points located approximately 2 miles (3.2 km) east of I-95 that connects I-495 to I-695 (the Baltimore Beltway); and
3. Baltimore-Washington Parkway, a 4-lane facility with access control located approximately 5 miles (8.0 km) east of I-95 that provides the most direct connection between the centers of Washington and Baltimore.

The locations of these routes within the corridor are shown in Figure 1. There are 7 completed interchanges on the 22-mile (35.4-km) section of I-95 between the 2 beltways. The major portion of traffic on I-95 is not local, and a sizable percentage of the truck traffic, which is excluded from the Baltimore-Washington Parkway, uses this facility.

Figure 2 shows the location of the study site and the 3 stations where the questionnaires were handed out to the motorists. The researchers cooperated with officials of the Maryland Highway Administration and the Maryland State Police in the design and implementation of the field study. Personnel from these organizations together with researchers from the University of Maryland directed the traffic into the appropriate interview lanes by means of traffic cones and flares.

The advance warning signs used to advise the motorists of the traffic survey are shown in Figure 3. The signs were mounted on portable barricades along the roadway shoulder and were turned to face approaching traffic just before the beginning of the interviews. Table 1 gives some information on the interviews that were conducted on 3 different days in 1973. The interview process was quite smooth at stations 1 and 3, and the queue length never exceeded 10 vehicles per lane. The failure of the motorists to exit the ramp and approach interview station 2 at a suitable rate coupled with the poor operating characteristics of trucks on the upgrade approaching this station produced an unstable operation. The queue became excessive almost immediately after the distribution of questionnaires was begun. Because of the potentially hazardous situation created by this backup, this survey was halted after 12 min. More detailed information concerning the procedures used for this study and other pertinent facts suitable for future studies of this type are documented in a separate report (7).

A total of 6,593 questionnaires was distributed at the 3 stations with a breakdown per station as follows:

Station	Questionnaires
1	3,136
2	212
3	3,245

Peak questionnaire distribution rates of 8 per minute per lane were observed for lanes having 1 interviewer, and 13 per minute per lane for lanes having 2 interviewers.

ANALYSIS OF RESPONSES

An equal number of A and B questionnaires was distributed, and, of these, 2,896, or nearly 44 percent, were returned. In response to the first question, approximately 72 percent of the respondents indicated that, in general, current signing on the highway system was adequate. However, there may be an inherent bias in this question because those who responded negatively were asked to elaborate on their answer. Of those who indicated that the signing was inadequate, the most frequently cited complaint involved the lack of sufficient advance warning to permit proper route choice at interchanges and intersections. Ambiguity of sign messages, especially for motorists unfamiliar with the area, was the second most frequently cited complaint. Numerous respondents indicated a desire for more real-time information, especially with respect to traffic

Figure 1. Washington-Baltimore corridor.

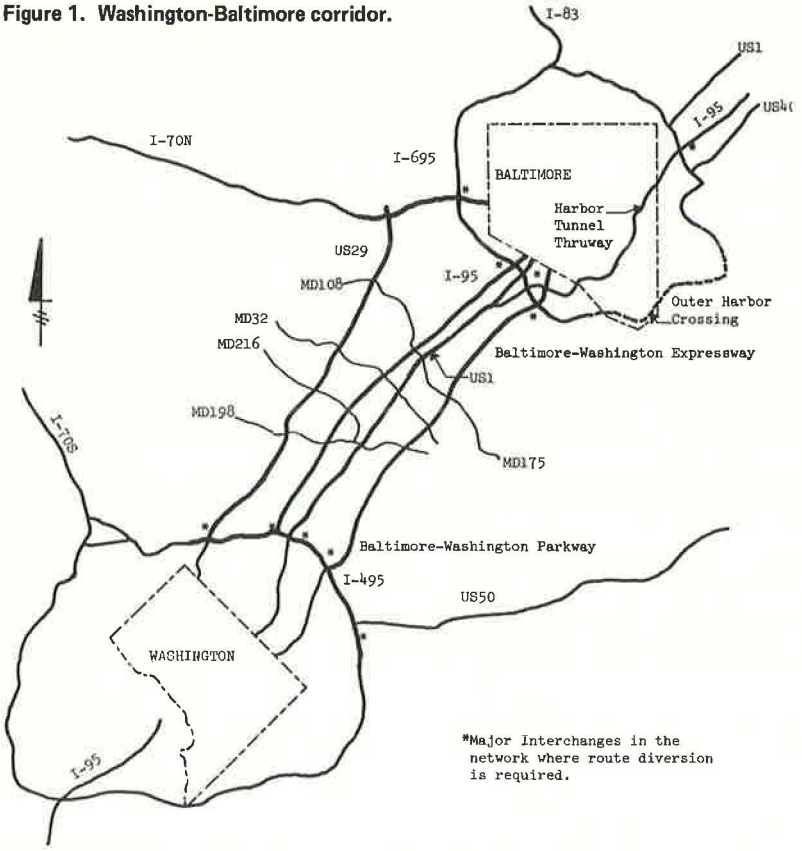


Figure 2. Operation of the I-95/I-495 interchange.

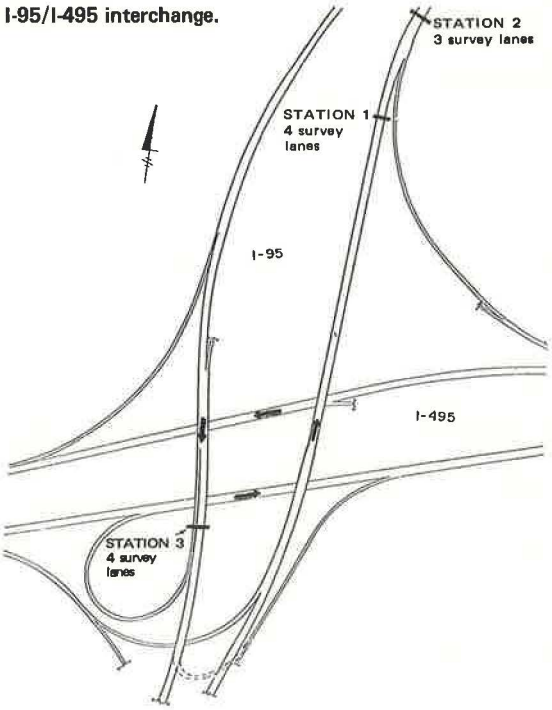


Figure 3. Signing for survey approach.

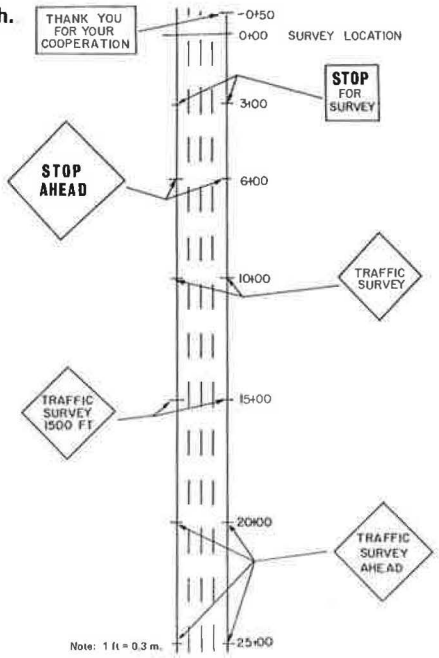
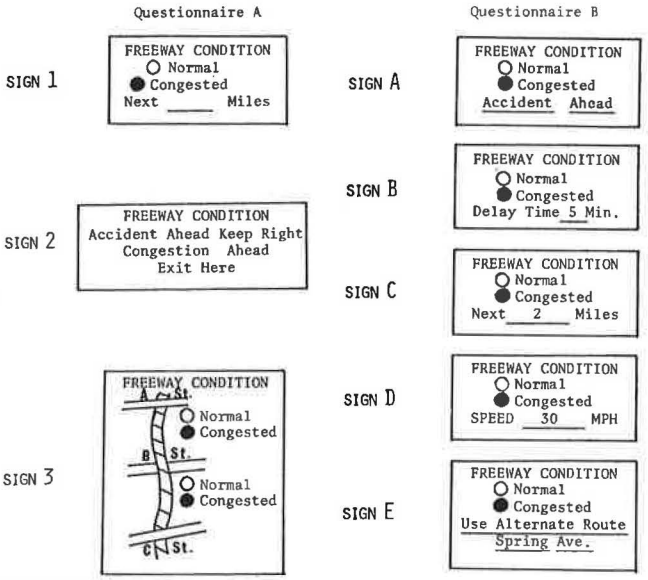


Table 1. Interview dates and locations.

Station	Movement	Date	Time
1	I-495 eastbound to I-95 northbound	Oct. 23	4:00 to 6:00 p.m.
2	I-495 westbound to I-95 northbound	Oct. 24	4:00 to 4:12 p.m.
3	I-95 southbound to I-495 eastbound	Oct. 31	7:00 to 9:00 a.m.

Figure 4. Signs in questionnaires.



Note: 1 mile = 1.6 km.

operations and weather conditions.

With few exceptions, complaints regarding current signing centered on guide signs rather than on regulatory or warning signs. This was expected because guide signs predominate on most highway systems. Also the degree of standardization that is inherent in the design, use, and placement of regulatory and warning signs tends to make them more commonly understood. On the other hand, the uniqueness of guide signs, coupled with only generalized criteria on their design and use, is conducive to motorists' misunderstanding and confusion.

Proper signing techniques are essential for a real-time program of intercity route diversion. The message must be presented at the proper location, be clearly and quickly understood by motorists, and be credible. That a small but significant percentage of drivers feel that current signing, which is primarily static, is inadequate suggests that special attention would be warranted in the development of variable message signs.

Information on the general characteristics of the motorists using I-95 was obtained through a set of 10 questions; this information was used primarily to examine possible relationships between these characteristics and sign preferences. The characteristics served to create a profile of the typical peak-period motorist on this facility. The typical driver on this facility had been driving for 19 years and had covered an annual driving distance of 21,000 miles (33 800 km). The mean number of vehicles in the family was 2, and the freeway was used approximately 10 times per week. The only average characteristic that seemed unusual was the reported 21,000 miles (33 800 km) of travel per year. This may be explained by the fact that drivers tend to overestimate their annual travel and because there was a rather high percentage of commercial drivers in the sample [17 percent of the drivers reported more than 30,000 miles (48 300 km)].

As mentioned previously the 2 questionnaires that were distributed provided different methods for the respondents to indicate their preference for various types of diversion signing. Questionnaire A presented 3 signs, and asked the drivers to choose the best, the worst, and to select from a list the reason for their choices. Questionnaire B presented 5 signs and asked the respondents to indicate their preference when the signs were compared in pairs. The signs are shown in Figure 4. A summary of the responses from the 2 questionnaires is presented in an appendix.[1]

Questionnaire A

Sign 1 on questionnaire A had color indications for normal or congested flow together with information concerning the length of the congested section. Sign 2 employed a word message advising of travel conditions. This message would be changeable in response to conditions but would not use color or picture indicators. Sign 3 combined a pictorial representation of the area with color indications of normal and congested flow.

The sign most frequently chosen as best was sign 2. Approximately 46 percent of the time it was chosen as the best sign; 41 percent of the time sign 1 was selected. The distribution is comparatively small and does not suggest a real difference between a simple, colored-coded sign containing minimal information and a word-message sign giving more detailed messages. The sign most frequently identified as worst was the pictorial, color-coded sign. This sign was chosen as worst 74 percent of the time. About 15 percent of the time sign 2 was chosen as the worst sign. The conciseness of sign 1 was most frequently cited as its major advantage. The authoritative nature of sign 2 (EXIT HERE) was appreciated by many motorists who were concerned about what action to take. The major problem noted for sign 3 was that it took too long to find the desired information on the sign.

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[1] The original manuscript of this paper included an appendix, Traffic Survey Summary. The appendix is available in Xerox form at cost of reproduction and handling from the Transportation Research Board. When ordering, refer to XS-54, Transportation Research Record 531.

Analysis of the responses to questions that solicited drivers' opinions showed that drivers desired that sign messages, in order of importance, (a) be brief and concise, (b) indicate the nature of the situation, (c) suggest appropriate driver response, and (c) provide supplementary information. When the respondents were asked to supplement their reasons for selecting a sign, few did so. The only substantial comments were related to the use of the words normal and congested. Several motorists noted that the terms were ambiguous. It was not clear to some drivers whether normal meant free flow, average flow, or typical conditions for the specific time of day when the message was displayed. Although the color code itself was comparatively straightforward, the interpretation of the message must be clarified if this method of presenting information is to be useful.

Further analysis of the signs on questionnaire A indicated that sign 2, the most popular sign, was increasingly more popular among those motorists who drove great annual distances. On the other hand, those that indicated lower annual driving distances tended to prefer the graphic representation given on sign 3. Using an analysis of variance test to compare the sign selected as best versus the annual distance driven, we found (at the 5 percent level) that these 2 factors were interrelated.

The hypothesis that the number of years of driving experience was unrelated to the choice of the best sign was tested in a similar manner. Preliminary analysis suggested that preference for sign 2 increased with an increase in driving experience. Sign 1 was clearly most popular with those who had less than 8 years of driving experience. Enthusiasm for sign 3 tended to decrease among drivers who had more experience. These apparent trends were confirmed by statistical testing, which concluded that sign preference was related to years of driving experience.

Questionnaire B

Five different signs were presented on questionnaire B, and the respondents were asked to indicate their preference among signs that were compared 2 at a time. Each sign included a color-coded indication for normal or congested conditions along with 1 of the following types of variable message:

Sign	Message
A	Cause of congestion
B	Expected delay time
C	Length of congestion
D	Variable speed limit
E	Alternate route information

Sign C, which indicated length of congestion, was the most popular. It compared favorably with each of the other 4 signs. The runner-up was sign E, which suggested an alternate route of travel to avoid the congestion. In response to the question comparing signs C and E, sign C was selected 54 percent of the time. Sign B ranked third, and was followed by sign A. In comparison with each of the other signs, D was always judged to be the worst.

Rather consistent patterns were found when sign choice was related to annual distance driven. Sign C was identified as best in all of the distance-driven groupings. Those traveling less than 12,000 miles (19 200 km) per year selected sign B as their second choice; those reporting higher levels of annual travel selected sign E as their second choice.

Analysis of sign preference as a function of years of driving experience produced somewhat mixed results. Those citing experience in the 3 middle ranges (4-45 years) selected sign C as the best sign although the comparatively small sample of respondents (4 percent of the total) with less than 4 years or more than 45 years of experience pre-

ferred sign E. The variable speed limit message on sign D was judged worst by those with less than 20 years of driving experience although the remaining drivers assigned the cause-of-congestion message on sign A to this category.

SUMMARY

On the basis of this analysis, there are 3 types of signs that are worthy of consideration for real-time route diversion. These are

1. Congestion length (questionnaire A, sign 1; questionnaire B, sign C),
2. Congestion cause and exit instruction (questionnaire A, sign 2), and
3. Alternate route information (questionnaire B, sign E).

The congestion-length message is preferred because of its conciseness. It provides motorists with information they should be able to evaluate and translate into effective action. The latter 2 signs by nature are not concise, but they do convey a sense of authority. In addition, they give motorists an alternative to being unnecessarily delayed on the planned travel route.

The comparatively close ranking of these 3 signs precludes a judgment at this time on which sign is truly the best. Based on this sample of intercity freeway drivers, it is not possible to recommend signs employing schematic representations or those indicating speed or length of delay. The former seem to require too much time to locate the intended message, and the latter apparently do not satisfy drivers' needs for meaningful information.

Although the signs tested in this study are representative of those that others have suggested (and have used in urban corridors), there is no assurance that the optimal sign message and design is included among the signs presented on the questionnaires. This, in fact, is an inherent problem in trying to select an optimal alternative. However, judicious field testing and evaluation of the recommended signs may suggest ways in which they can be modified to achieve the most suitable design.

The generally recognized need for uniformity and consistency tends to support the concept that 1 type of route diversion sign should be used. It is easy to appreciate, however, that the sign should be suited to the circumstance, and that this may require 2 or more types of signing along a route. The placement of signs advising the motorist to exit or to use a specified alternate route requires that the diversion network include a proper route for diverting at least moderate volumes of traffic at that location. When the only available alternate at a particular interchange is a local road, the more subtle advice given by the congestion-length message might be more appropriate. It would be more likely to prompt the early exit from the freeway of a few local motorists who had originally planned to exit within a short distance. On the other hand, the diversion of through motorists at major diversion points is probably enhanced by signs advising of alternate routes.

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