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EVALUATION OF REFERENCE MARKERS
(Final Report)

by

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16. Abstract

The objective of this research evaluation was to evaluate the reference markers which were installed on sections of interstates and freeways in the Cincinnati-northern Kentucky area, the Lexington-Fayette Urban County area, the Louisville-southern Indiana area, and the Indianapolis area. The evaluation was conducted to determine if the use of reference markers at spacings of 0.1 or 0.2-mile intervals could improve the effectiveness of the emergency response and incident management processes. Also evaluated were color of the markers and the placement location within the right-of-way. Both "white on blue" and "white on green" markers were installed on various projects, with some installed on the median barrier wall and some on grass medians or shoulders. Included were condition surveys of the marker installations and opinion surveys of those involved in the incident or emergency management process.

Nearly unanimous endorsement of the reference markers was received from interviews and surveys of highway agency personnel and participants in the emergency management process.

Recommendations were made for spacing of the markers at 0.2-mile intervals, with exceptions in curved sections to allow for placement of the markers at 0.1-mile intervals. Based on what appears to slightly increased conspicuity of the "white on blue" marker as compared to the "white on green" marker, it was recommended that a standardized reference marker be developed and incorporated in the Manual on Uniform Traffic Control Devices with white letters on blue background. Because of reduced exposure to mowing operations and errant vehicles, it was recommended that reference markers be placed on median barrier walls where practical. Recommendations were also made for a standard sign size and message content consistent with the reference markers evaluated in the three states.

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EXECUTIVE SUMMARY

Reference markers have been installed on sections of interstates and freeways in the Cincinnati-northern Kentucky area, the Lexington-Fayette Urban County area, the Louisville-southern Indiana area, and in the Indianapolis area. An evaluation was conducted to determine if the use of reference markers at spacings of 0.1 or 0.2-mile intervals could improve the effectiveness of the emergency response and incident management processes. Also evaluated were color and placement of the markers.

The evaluation included a condition survey of the reference markers installed as part of the ARTIMIS project in the Cincinnati-northern Kentucky area and markers installed in the Louisville and Lexington areas. The condition of the markers was found to be very good and there appeared to be only minor maintenance problems in the time period since installation. The majority of the markers have been installed on median barrier walls and therefore have less exposure to the routine problems related to mowing and errant vehicles which may impact the markers and posts. In addition, opinion surveys were obtained from individuals who had exposure to the marker projects and who understood the intent and usage of the markers. Interviews and surveys of participants in the emergency response process and others involved in traffic management systems indicate nearly unanimous endorsement of the reference markers. Dispatch personnel continue to indicate that drivers are using the markers for identification of locations where incidents occur, with the resultant effect of a more efficient process for responding to incidents and crashes. Tow operators have noted special benefits from the reference markers when calls for assistance were received directly from motorists.

Highway agency personnel and emergency response personnel have also expressed satisfaction with the markers, whether placed at 0.1 or 0.2-mile intervals. It is apparent that more frequently spaced markers offer additional benefits and increased safety in curved sections, and where there are missing markers due to maintenance or vandalism problems. Considering all factors, it appears that the reduced clutter and economy of markers at 0.2-mile intervals outweighs increased benefits from more frequently spaced markers.

The use of markers with blue background color as compared to green was evaluated and some increased benefit was found related to the distinguishable color of blue and the consistency with motorists service markers. Green reference markers also appear to adequately serve the purpose of providing increased reference points along the roadway to help motorists and emergency response personnel identify and respond to incidents. The green color symbolizes the standard guide sign and the color results in a marker similar to the standard milepost. There appears to be added benefit for use of blue markers when considering the distinguishable color compared to landscape backgrounds and the ability of those with color weakness to distinguish blue more easily than green.

1.0 BACKGROUND

Reference markers were installed to assist in locating incidents/crashes for prompt and effective response by emergency personnel in several cities since the original installations in the Cincinnati-northern Kentucky areas as part of the Advanced Regional Traffic Interactive Management and Information System (ARTIMIS) in 1995 and 1996. Partially as a result of the success of the reference markers in the Cincinnati area, the concept was endorsed and installations were made in the Louisville and Lexington-Fayette County areas. Further building on the success of the installations in Kentucky and Ohio, installations were also made in the Indianapolis area. This report will serve as an update of the earlier reports on the interim status of reference markers installations in Kentucky, Ohio and Indiana (1, 2).

A critical link in the emergency response process is the timeliness and accuracy of location information provided to responding personnel. The report of an incident or crash is typically initiated by the driving public and the responsiveness of emergency personnel is dependent upon the accuracy of location information. In addition, personnel in dispatch centers must make decisions about the location information and determine the appropriate emergency units to notify. In order to improve the emergency response process in Cincinnati and northern Kentucky , an experimental feature of the ARTIMIS project was "white-on-blue" reference markers at 0.1-mile intervals to supplement the existing milepost referencing system. The increased frequency of the location of the reference markers was intended to allow more accurate identification of an incident or crash on the freeway system.

Results from a preliminary evaluation of the reference markers installed as part of the ARTIMIS project were documented in Research Report KTC 95-11 titled "Preliminary Evaluation: ARTIMIS Reference Point Markers"(1). The types and patterns of placement of subsequent reference markers installations varied somewhat from the markers installed as part of the ARTIMIS project and were further documented in Research Report KTC-98-23 titled "Evaluation of Reference Markers (Interim Report)"(2). Reference markers installed in Louisville use white letters on blue background; however, the spacing interval for the markers is 0.2-mile rather than the 0.1-mile spacing used in ARTIMIS. For the installations in Lexington, the markers have also been spaced at 0.2-mile intervals; however, white letters on green background have been used instead of white letters on blue background. For the Indiana installations, the reference markers incorporated the color scheme of white letters on blue background, and were spaced at 0.2-mile intervals.

A separate evaluation was performed for the Tennessee Department of Transportation for reference markers installed in Chattanooga, Knoxville, Memphis, and Nashville. The reference markers were white letters on blue background and were spaced at 0.2-mile intervals. Results of this evaluation are documented in Research Report KTC-01-12 titled "Evaluation of Tennessee Reference Markers"(3).

2.0 OBJECTIVES

The objective of this evaluation was to determine if reference markers installed at intervals more frequent than the one-mile increments of standard mileposts could improve the ability of emergency personnel to respond to incidents or crashes on the freeway systems in the Cincinnati-northern Kentucky area, and in Louisville and Lexington-Fayette County. The evaluation included the following three phases.

Phase 1

The objective of Phase 1, which was completed and documented as Research Report KTC-95-11(1), was a short-term evaluation of an experimental section of both white on blue and white on green markers to determine their effectiveness in providing location information for emergency response.

Phase 2

The objective of Phase 2 was to conduct a longer-term evaluation to determine the effectiveness of a reference marker system installed as part of the ARTIMIS project in Cincinnati and northern Kentucky. In addition, this phase was to serve as a preliminary status report on the installations in the Louisville and Lexington-Fayette County areas. Results were documented in Research Report KTC-98-23 (2).

Phase 3

Phase 3 was a continuation of the long-term evaluation of reference markers installed as part of the ARTIMIS project and to evaluate the reference markers installed in Louisville and Lexington-Fayette County. Another subtask was to prepare a status report on reference markers in Indiana. In addition, Phase 3 addressed the issues of adopting the reference markers as a standard for inclusion in the "Manual on Uniform Traffic Control Devices" (4).

3.0 SCOPE OF ACTIVITIES BY PHASE

Phase 1

As previously noted, reference markers installed as part of the ARTIMIS project in the Cincinnati-northern Kentucky area were evaluated and documented in an interim report titled "Preliminary Evaluation: ARTIMIS Reference Point Markers" (1). Subjective evaluations were performed to determine if size, color, placement, and message content of one type of reference point marker was more effective. Interviews were conducted with participating and affected agencies to determine if the enhanced reference marker had benefited the emergency response process. Evaluation of the test section was completed and the interim report was prepared in June 1995 (1). The report documented results of the initial evaluation and a recommendation was made for white letters on blue markers for systemwide installation.

Phase 2

The focus of Phase 2 was an evaluation the reference markers installed on most of the interstate highways and other major connectors included in the ARTIMIS system. A subjective evaluation procedure similar to that used for the preliminary test section was employed to assess the effectiveness of reference markers. In addition, agency personnel responsible for highway sections included in the ARTIMIS project were solicited to obtain information and opinions on the frequency of use and benefit of reference markers. As part of the opinion survey, an attempt was made to determine if the frequently spaced reference markers had an adverse aesthetic impact and whether the spacing of the markers should be altered. An assessment of the marker durability and maintenance issues was addressed through review of highway department records and visual inspections. In addition, preliminary recommendations were made relative to the adoption of reference markers as a standard for inclusion in the Manual on Uniform Traffic Control Devices. Results and subjective opinions supported the use of "white on blue" markers spaced at 0.2-mile spacings.

A subtask to this phase was a preliminary evaluation of the reference markers installed in the Louisville and Lexington-Fayette County areas. Also included in this evaluation was a general summary of the installations of reference markers in the Indianapolis area.

Phase 3

This phase included a final evaluation of the reference marker installations with subtasks devoted to evaluation of reference markers in the Cincinnati-northern Kentucky (Phase 3A), Louisville-southern Indiana (Phase 3B), and Lexington-Fayette County (Phase 3C) areas. The systemwide evaluation focused on the potential use of reference markers as a national standard.

Supplemental information was included to document the installations of reference markers in the Indianapolis area and other parts of Indiana.

4.0 DOCUMENTATION OF REFERENCE MARKER INSTALLATIONS

4.1 Cincinnati - Northern Kentucky Area (ARTIMIS)

The reference markers were installed as part of the ARTIMIS contract, which included various other traffic control components for an Advanced Traffic Management System (ATMS) and Advanced Traveler Information System (ATIS). As noted previously, initial installations were made to attempt to determine if there were advantages to using "white on blue" rather than "white on green" as the color for reference markers. The results of this preliminary evaluation were reported and there was a general consensus that the "white on blue" markers were more distinguishable and could serve to supplement the standard milepost marker which has been designated in the "Manual on Uniform Traffic Control Devices" to be "vertical panels having a green background with 6-inch white numerals, border, and the legend MILE in 4-inch white letters"(4).

Installations to evaluate the use of "white on blue" versus "white on green" markers were completed in the fall of 1994 and the evaluation report was completed in the summer of 1995 (1). The reference markers were installed on the mainline and ramps for approximately three miles of I-275 (between Mosteller Road and US 42) east of I-75 in Cincinnati. The experimental mainline reference markers had white letters on blue background for westbound traffic on I-275; with the marker containing information related to direction of travel, interstate route number, milepost number, and a number representing the tenth of a mile segment between mileposts. The "white on blue" mainline reference marker was 14 by 48 inches and mounted in the median on the concrete barrier wall where practical. For eastbound traffic, the markers were white letters on green background, 12 inches by 48 inches in size and placement generally consistent with the standard milepost marker. The "white on green" reference markers had MILE in 4-inch letters at the top, with vertically stacked 8-inch numbers indicating the milepost and tenth of a mile segment. A schematic showing the mainline marker and message dimensions is presented in Figure 1. Ramp markers used in the test section were also white letters on blue background. The marker size was 30 by 30 inches, with the message RAMP at the top of the marker and the message indicating where the driver would be coming from and going to when using the ramp. A schematic showing the ramp marker used as part of ARTIMIS is shown in Figure 2.

The primary installation of reference markers began in the summer of 1995 and all markers were installed in Ohio by June 1996. All of the Kentucky installations were completed in July 1997. Where concrete median barriers existed on the routes, the markers were installed on the barrier wall using a short post. On sections without median barrier walls, the markers were installed in the left median area on 2-inch square posts, and mounted back-to-back to allow viewing the markers from both directions. Highways on which reference markers have be installed include I-71, I-74, I-75, I-275, I-471, the Ronald Reagan Highway (OH Route 126) and the Norwood Lateral (OH Route 562). A map showing the locations where markers were installed as part of the ARTIMIS project and other installations is presented in Figure 3. Examples are shown for the ARTIMIS mainline markers in Figure 4 and the ramp markers in Figure 5.

An updated inventory and survey of reference markers installed in the Cincinnati/northern Kentucky areas was conducted in the summer of 2000. Results from that inventory show a total of 2,214 reference markers. A summary of the results from this inventory/survey is presented in Table 1. Previous cost analysis indicated an average cost of $166 per marker for the Ohio contracts and $154 per marker for the Kentucky installations (2).

4.2 Lexington - Fayette County Area

The reference markers in Lexington-Fayette County were installed on I-64 and I-75, the only two interstates which traverse the county. Installation began in the summer of 1997 and was completed in October 1998. Installation of markers was delayed for sections of interstate under construction or scheduled for reconstruction. A total of 634 markers were documented from the survey/inventory of markers in the summer of 2000. Based on unit costs determined from initial

installations, the cost in Lexington-Fayette County was $145 per marker(2). A map showing locations of reference marker installations in Lexington-Fayette County is presented in Figure 6. A photograph showing an example of the mainline reference marker used in Fayette County is presented in Figure 7 and a ramp marker in Figure 8.

4.3 Louisville - Southern Indiana Area (TRIMARC)

The reference markers in Louisville and southern Indiana were installed on sections of I-64, I-65, I-71, I-264, and I-265. A map showing the reference marker installations in the TRIMARC area is presented in Figure 9. A total of 939 reference markers were documented as part of the survey/inventory conducted in the summer of 2000 (Table 3) All markers were installed on the median barrier wall where possible, and in the grass median otherwise. Based on unit costs determined from the initial contracts, the average cost for installations as part of the TRIMARC project was $137 per marker(2). This did not include the costs associated with maintenance of traffic which was a separate bid item. Specific costs for the initial installations included mainline markers at $77 per marker; ramp markers at $82 per marker; steel posts at $15.50 per meter; and 107 brackets at a cost of $131. A photograph showing an example of the TRIMARC mainline reference marker is shown in Figure 10 and the ramp marker is shown in Figure 11. As shown in Figure 11, ramp markers for the TRIMARC project provided additional information in the form of a number for each ramp to distinguish each of them from similar markers which could occur more than once when a route intersects another route at multiple points. An additional number was placed below the ramp marker to note the sequential progression when there was more than one marker on a ramp. This allowed drivers to distinguish which ramp marker was being identified along the length of the ramp.

4.4 Indianapolis Area

The reference marker installations in the Indianapolis area were completed in the summer of 1998. The markers were installed on 120 miles of interstates within the urban area, including I-65, I-69, I-70, I-74, and I-465. A map identifying routes where markers have been installed is shown in Figure 12. A numbering scheme similar to the TRIMARC project was used on ramp markers in the Indianapolis area to insure the uniqueness of routes which may intersect other routes at more than one point. A total of 1,510 markers which were installed in the Indianapolis area at an average cost of $153 per marker. This cost did not include the contract bid items related to maintenance of traffic, mobilization, construction engineering, and the project field office. Since the initial installations in 1998 in the Indianapolis area, there have been additional installations in several other areas of Indiana; resulting in coverage of 275 miles of mainline with 221 miles on the interstate system and 54 miles on non-interstate routes. A summary of Indiana installations is included as Table 4 (5).

5.0 EVALUATION RESULTS

5.1 Condition Survey of Reference Markers

Results from the survey/inventory of ARTIMIS reference marker installations in Cincinnati/northern Kentucky as conducted in the summer of 2000 are presented in Table 1. The total number of markers was observed to be 2,273; with 68 noted to be missing from locations where they were expected to have been installed. Additional installations by the Ohio Department of Transportation that were not part of the ARTIMIS contract, but included in Table 1, were approximately 300 reference markers on Ohio State Route 562 and the Ronald Reagan Highway. It was noted that missing markers were predominately on sections where they had been installed on the shoulders of I-71 and I-275. This was expected since there would be much more opportunity for markers to be impacted by mowing equipment or errant vehicles if they were located on grass shoulders or median sections rather than placed on median barrier walls.

As part of the survey/inventory conducted during the summer of 2000, a total of 634 markers were observed on I-64 and I-75 in Lexington-Fayette County. Only 21 of the markers were found to be missing at the time of the survey. All of the markers on I-75 were placed on the median barrier wall. There was a delay in the installation of reference markers on I-64 due to construction through the summer of 1998. Reference markers on I-64 were placed on right-side grass shoulders rather than the median. Results from the survey of reference marker installations in Lexington-Fayette County project are summarized in Table 2.

Reference markers for the TRIMARC project in Louisville and southern Indiana were surveyed/inventoried in the summer of 2000 and there were 929 observed. A total of 33 were noted to be missing. Only 214 of the 985 markers installed as part of the TRIMARC project were placed on median barrier walls. A high percentage of the markers for the project were installed on ramps (531 of the 985 markers). A summary of the results from the survey of reference markers for the TRIMARC project is presented in Table 3.

5.2 Opinion Survey of Reference Markers

Results from opinion surveys of reference markers in the ARTIMIS area were obtained the Hamilton County Communications staff and documented in the interim report (2). Overall response from the staff members who interact with the public routinely was that the reference markers were very beneficial to the emergency response process. Comments were offered which indicated that in addition to the driving public, others benefitting from the markers included highway department maintenance personnel, police, fire, EMS, and tow operators. Also reported in the interim report were results from a second survey conducted to assess opinions from professionals involved with or knowledgeable of the incident management process. Results from the survey indicated that over three-fourths of the respondents felt the markers were very beneficial. The focus of this second survey was to determine whether the spacing and color of the markers used as part of the ARTIMIS project were preferred as compared to the markers

installed on I-75 in Lexington-Fayette County. It was found that 15 of the 22 felt that the 0.1-mile spacing of the markers for the ARTIMIS project were appropriate and preferred as compared to the 0.2-mile spacing in Lexington-Fayette County. When asked to respond concerning a preference of the "white on blue" markers in the ARTIMIS area versus the "white on green" markers in Lexington-Fayette County, it was found that 17 of the 22 preferred the "white on blue" markers. In general, there was a very positive response to the markers from those responding to the survey with a clear preference for the color and spacing of markers similar to those used as part of the ARTIMIS project. Results from the survey are presented in Appendix B.

At a meeting of the Lexington-Fayette Incident Management Committee in December 2000, members were requested to respond to a survey similar to the surveys conducted for the ARTIMIS project. There were 15 respondents from representatives of traffic engineering, police, fire, tow operations, and others associated with the emergency response process. The responses were very supportive of the reference markers and the opinions were nearly unanimous that the markers should be placed at 0.2-mile spacings. There was also support for the "white on green" markers; however, the same number of respondents felt that the "white on blue" markers used for the ARTIMIS project were also appropriate. The most frequent comments from the respondents were that the public did not fully understand the signs and that all freeway-type roads should have the markers installed. Results from the survey are presented in Appendix B.

An opinion survey was also conducted at a meeting of the TRIMARC Freeway Incident Management Task Force in March 2001. Results were similar to those reported from the other areas concerning the beneficial effects of the markers. However, there was a higher number of respondents who indicated that the public was unknowledgeable about the purpose of the markers. There was greater support for the "white on blue" signs and spacing at 0.2-mile spacings than in other areas. As with others involved in the incident management process, there were suggestions for placement of reference markers on other highways in the area. There also comments and opinions in support of using double route symbols instead of the single route symbol where interstate routes run concurrently. Results from the survey are presented in Appendix B.

6.0 SUMMARY AND RECOMMENDATIONS

The use of reference markers has been shown to be a beneficial supplement to the emergency response process. Interviews and surveys of participants in the emergency response process and other representatives involved in traffic management systems have offered nearly unanimous endorsement of the reference markers. Dispatch personnel and tow operators have indicated that drivers are routinely using the markers for identification of the location where an incident has occurred. The resultant effect has been a more efficient process for responding to incidents and crashes.

Separate issues addressed as part of the evaluation were the comparative benefits of reference markers placed at 0.1-mile intervals versus 0.2-mile intervals and "white on blue" versus "white on green" markers. Based on a survey of members of the ARTIMIS Incident Management Task Force, results indicate they were clearly in favor of the markers being spaced at 0.1-mile intervals and that the "white on blue" markers were preferred. Representatives of the Lexington-Fayette County Incident Management Committee also strongly endorsed the reference markers as an addition to the emergency response process for more precise location of incidents. Respondents from Lexington-Fayette County appear to be satisfied with the use of markers at 0.2-mile spacing and favor the use of "white on green"; however, there was similar support for use of the "white on blue" sign colors. In the Louisville-southern Indiana area where the TRIMARC project is located, there was also very strong support for the reference markers. All of those offering an opinion noted that the use of "white on blue" markers were appropriate with much less favorable opinions for "white on green" markers. In general, it appears that the respondents offered opinions most favorable to the spacing and color of markers installed in their areas of travel. Overall support for the concept of reference markers was unanimous from those surveyed.

There have been over 2,300 reference markers installed in Ohio and northern Kentucky as part of the ARTIMIS project at a cost ranging from $154 to $166 per marker. The costs were generally in the same range for nearly 675 markers installed in Lexington-Fayette County at a cost of $145 per marker; and in the TRIMARC project where 985 markers were installed at a cost of $137 per marker. For the Indianapolis installations, the cost was $153 per marker for 1,510 markers. A summary of the number installed and cost per marker for each of the projects is presented in Table 5.

Based on information gathered form the Kentucky and Ohio projects, indications are that placement of markers at either 0.1 or 0.2-mile can benefit the emergency response process. Considering the minimal reduction in benefits that could be expected from the greater spacings, and the decreased cost, the 0.2-mile spacing of reference markers is recommended. Exceptions should be considered for locations where curvature of the roadway would not allow a driver to see a marker at every point on the road when installed at 0.2-mile spacings. Color of the reference markers is important from the perspective of standardization and the ability of motorist to distinguish the markers for emergency notification. The "white on green" marker symbolizes the standard guide sign and arguments could be made for use of a marker which is similar to the standard milepost marker. The "white on blue" marker is representative of motorist service signs, including police services and rest areas. Either color of marker could be used with supportive arguments from the Manual on Uniform Traffic Control Devices(4). Documentation was presented in the initial proposal for reference marker installation as part of the ARTIMIS project indicating that there are fewer drivers color deficient for blue than green (6). It was also noted that red/green is the most common color weakness and that blue/yellow is less common. Therefore, if the objective was to provide signing with the least potential for color weakness problems, then the "white on blue" markers would be more clearly distinguishable to a higher percentage of drivers. Based on the overall acceptability of both colors of markers and what

appears to be increased conspicuity of the color blue as compared to green, it is recommended that a standardized reference marker be developed with white letters on a blue background.

It should be noted that the Millennium Edition of the MUTCD within Section 2D.45 titled "Reference Posts" includes an option for an enhanced reference post numbering system (4). This section provides for use of reference posts spaced at one, two, or five tenths of a kilometer (mile). The standard application of reference posts presently requires vertical panels having a green background with 6-inch white numerals, border, and the legend (MILE) in 4-inch white letters.

All projects evaluated had reference markers installed on both median barriers and on either grass shoulders or grass medians. From the inventory of damaged and missing markers, it appears that there were considerably fewer problems on sections where the markers were placed on the median barrier wall. This result was expected because of less exposure of the reference markers to mowing operations and errant vehicles. Because of the reduced exposure and increased visibility when installed in close proximity to the driving lanes, it is recommended that markers be placed on median barrier walls where practical.

The size of the reference markers were significantly larger than the standard milepost marker because of the need to place more letters on the markers to distinguish the direction, route indicator, mile number, and tenth-of-a mile number. The largest milepost marker is 10 inches by 36 inches compared to the largest reference markers with dual interstate shields which are 18 inches by 48 inches. The difference in marker size did not appear to be an issue with any of those offering opinions; however, there was strong support for use of double route symbols where interstate routes run concurrently.

It is anticipated that the use of reference markers will be expanded in the Kentucky, Ohio, and Indiana areas, as well as in Tennessee. There has also been extensive use of reference markers in all of these areas and the positive effects have been documented (1,2,3). Based on the results of evaluations in these four states, it is recommended that a national standard be adopted and included in the "Manual on Uniform Traffic Control Devices" (4). Support for this recommendation is based on direct input from representatives of highway agencies and others involved in the incident management process, as well as objective evaluation results included in this report. The reference marker design and placement should be similar to the predominate type used in the areas being documented in this report. Specifically, the color of white letters and numerals on blue background at 0.2-mile spacing are recommended. The overall size and layout of the message should be similar to that presented in Figures 1 and 2 for mainline sections and ramps.

7.0 REFERENCES

1. Pigman, J.G.; "Preliminary Evaluation: ARTIMIS Reference Point Markers", Research Report KTC-95-11, Kentucky Transportation Center, University of Kentucky, June 1995.

2. Pigman, J.G.; "Evaluation of Reference Markers (Interim Report)", Research Report KTC-98-23, Kentucky Transportation Center, University of Kentucky, December 1998.

3. Pigman, J.G.; "Evaluation of Tennessee Reference Markers", Research Report KTC-01-12/TN1-00-1F, Kentucky Transportation Center, University of Kentucky, June 2001.

4. "Manual on Uniform Traffic Control Devices for Streets and Highways". U.S. Department of Transportation, Federal Highway Administration, 2000.

5. Correspondence from Gary Mroczka, Indiana Department of Transportation, Speciality Projects Group Section, June 2001.

6. Correspondence from the Kentucky Transportation Cabinet to the Kentucky Division Office of Federal Highway Administration transmitting proposal and supporting documents requesting funding for installation of reference markers as part of the ARTIMIS Project, January 1995.

TABLE 1. SUMMARY OF REFERENCE MARKER INSTALLATIONS
ARTIMIS PROJECT - NORTHERN KENTUCKY AND CINCINNATI- SUMMER 2000

ROUTE	COUNTY	MILEPOINT RANGE MAINLINE	MILEPOINT RANGE RAMPS	NO. of MARKERS	NO. MISSING/ CONDITION
I-75 NB	Hamilton	0.0-17.4		173	5-MISSING
I-75 SB	Hamilton	17.4-0.0		167	7-MISSING
I-75 NB	Hamilton		0.0-17.5	55	1-MISSING
I-75 SB	Hamilton		17.5-0.0	48	NONE
I-275 WB	Hamilton	40.0 -49.0		116	3-MISSING
I-275 EB	Hamilton	49.0 -40.0		96	5-MISSING
I-275 WB	Hamilton		40.0-49.0	37	NONE
I-275 EB	Hamilton		49.0-40.0	32	NONE
I-275 WB	Kenton	84.0-1.0		12	3-MISSING
I-275 EB	Kenton	1.0-84.0		18	3-MISSING
I-275 WB	Kenton		84.0-1.0	0	NONE
I-275 EB	Kenton		1.0-84.0	0	NONE
I-275 WB	Boone	Construction		0	
I-275 EB	Boone	Construction		0	
I-275 WB	Boone	Construction		0	
I-275 EB	Boone	Construction		0	
I-275 WB	Campbell	73.2-84.0		93	8-MISSING/2-LEANING
I-275 EB	Campbell	840.-73.2		92	4-MISSING

TABLE 1. (CONTINUED)

ROUTE	COUNTY	Mile Point Range MAINLINE	Mile Point Range RAMPS	NO. of MARKERS	NO. MISSING/ CONDITION
I-275 WB	Campbell		73.2-84.0	56	1-MISSING
I-275 EB	Campbell		84.0-73.2	63	1-MISSING
I-71 NB	Hamilton	2.7-16.9		147	1-MISSING
I-71 SB	Hamilton	16.9-2.7		142	1-MISSING
I-71 NB	Hamilton		9.1-18.10	13	NONE
I-71 SB	Hamilton		18.9-9.2	6	NONE
I-71/I-75 NB	Boone	179.0-183.0		25	1-MISSING
I-71/I-75 SB	Boone	183.0-179.0		30	1-MISSING
I-71/I-75 NB	Boone		179.0-183.0	25	1-BENT
I-71/I-75 SB	Boone		183.0-179.0	30	NONE
I-71/I-75 NB	Kenton	183.1-191.0		56	4-MISSING
I-71/I-75 SB	Kenton	191.0-183.1		59	4-MISSING
I-71/I-75 NB	Kenton		183.1-191.0	43	NONE
I-71/I-75 SB	Kenton		191.0-183.1	28	1-MISSING
I-74 WB	Hamilton	19.1-15.1		40	1-MISSING
I-74 EB	Hamilton	15.1-19.1		37	4-MISSING
I-74 WB	Hamilton		19.1-15.1	3	NONE
I-74 EB	Hamilton		15.1-19.1	5	NONE
S.R. 126 WB	Hamilton	16.5-13.1/11.9-1.0		102	2-MISSING
S.R. 126 EB	Hamilton	1.0-11.9/13.1-16.5		103	3-MISSING
S.R. 126 WB	Hamilton		16.5-13.1/11.9-1.0	14	2-MISSING
S.R. 126 EB	Hamilton		1.0-11.9/13.1-16.5	27	NONE
S.R. 562 WB	Hamilton	2.5-0.1		23	2-MISSING
S.R. 562 EB	Hamilton	0.1-2.5		23	2-MISSING

TABLE 1. (CONTINUED)

ROUTE	COUNTY	MILEPOINT RANGE MAINLINE	MILEPOINT RANGE RAMPS	NO. of MARKERS	No. MISSING/ CONDITION
S.R. 562 WB	Hamilton		2.5-0.1	11	NONE
S.R. 562 EB	Hamilton		0.1-2.5	13	NONE
I-471 NB	Campbell	0.0-4.6		47	NONE
I-471 SB	Campbell	4.6-0.0		47	2-DAMAGED
I-471 NB	Campbell		0.0-4.6	34	NONE
I-471 SB	Campbell		4.6-0.0	23	1-MISSING
TOTALS FOR OHIO AND KENTUCKY				2,214	

Note: Reference markers on I-275 have been installed on the following three sections;
Milepoint Range 0.1 - 2.0
Milepoint Range 40.0 - 49.9
Milepoint Range 73.4 - 84.0

TABLE 2. SUMMARY OF REFERENCE MARKER INSTALLATIONS
FAYETTE COUNTY - SUMMER 2000

ROUTE	COUNTY	MAINLINE MILEPOST RANGE	RAMP MILEPOST RANGE	NUMBER OF MARKERS	NUMBER MISSING/ CONDITION
I-75 NB	Fayette	99-120.8		219	6- Missing
I-75 SB	Fayette	120.8-99		219	6-Missing
I-75 NB	Fayette		99-120	33	2-Damaged
I-75 SB	Fayette		120-99	30	Damaged/1-Missing
I-64 WB	Fayette	89.4-81.6 and 74.4-71		59	3-Missing
I-64 EB	Fayette	71-74.4 and 81.6-89.4		56	3-Missing
I-64 WB	Fayette		87-81	10	None
I-64 EB	Fayette		87-75	8	None
TOTALS				634	

TABLE 3. SUMMARY OF REFERENCE MARKERS INSTALLATIONS JEFFERSON COUNTY-SUMMER 2000

ROUTE	COUNTY	MAINLINE MILEPOST RANGE	RAMP MILEPOST RANGE	NUMBER OF MARKERS	NUMBER MISSING/ CONDITION
I-64 WB	Jefferson	9.0-0.0		43	3-Missing/1-Damaged
I-64 EB	Jefferson	0.0-9.0		44	2-Missing/2-Damaged
I-64 WB	Jefferson		8.0-1.0	27	None
I-64 EB	Jefferson		1.0-8.0	30	2-Missing
I-64 WB	Harrison(Ind.)	123.6-118		28	1-Missing/1-Damaged
I-64 EB	Harrison(Ind.)	118-123.6		28	1-Missing/1-Damaged
I-64 WB	Harrison(Ind.)		123.0-118.0	26	None
I-64 EB	Harrison(Ind.)		118.0-123.0	30	None
I-264 WB	Jefferson	15.0-9.0		32	None
I-264 EB	Jefferson	9.0-15.0		32	None
I-264 WB	Jefferson		15.0-9.0	49	None
I-264 EB	Jefferson		9.0-15.0	53	1-Missing
I-65 NB	Jefferson	128.0-137.0		46	None

TABLE 3. (CONTINUED)

ROUTE	COUNTY	MAINLINE MILEPOST RANGE	RAMP MILEPOST RANGE	NUMBER OF MARKERS	NUMBER MISSING/ CONDITION
I-65 SB	Jefferson	137.0-128.0		46	None
I-65 NB	Jefferson		128.0-137.0	25	1-Missing
I-65 SB	Jefferson		137.0-128.0	23	1-Missing
I-65 NB	Clark(Ind.)	0.0-16.0		56	8-Missing
I-65 SB	Clark(Ind.)	16.0-0.0		56	8-Missing
I-65 NB	Clark(Ind.)		0.0-6.0	14	None
I-65 SB	Clark(Ind.)		6.0-0.0	18	None
I-265 WB	Clark(Ind.)	10.0-0.4		47	1-Misplaced
I-265 EB	Clark(Ind.)	0.4-10.0		47	None
I-265 WB	Clark(Ind.)		10.0-0.4	47	1-Missing
I-265 EB	Clark(Ind.)		0.4-10.0	46	1-Missing
I-71 NB	Jefferson	0.0-3.0		15	1-Missing
I-71 SB	Jefferson	3.0-0.0		15	1-Missing
I-71 NB	Jefferson		1.0-2.0	8	None
I-71 SB	Jefferson		2.0-1.0	8	None
TOTALS				939	

TABLE 4. SUMMARY OF REFERENCE MARKER INSTALLMENTS IN INDIANA

ROUTE	AREA	MAINLINE MILES INSTALLED	MAINLINE MARKERS	RAMP MARKERS	TOTAL MARKERS
I-65/I-265	Louisville/ Falls City Area	18	90	96	186
I-65/I-69/I-70/I-74/I-465	Indianapolis Area	120	600	224	824
I-65/I-80/I-94	Northwest Indiana Area	34	265	101	366
US 31	Kokomo Area	11	55		55
I-64/I-164/US 41/SR 62/SR 66	Evansville Area	68	340		340
I-69	Fort Wayne Area	24	120		120

TABLE 5. COST SUMMARIES FOR REFERENCE MARKER INSTALLATION PROJECTS

PROJECT	MAINLINE MARKERS NUMBER	RAMP MARKERS NUMBER	TOTAL MARKERS NUMBER	TOTAL MARKERS COST/MARKER
ARTIMIS - Ohio	1,106	291	1,397	$166
ARTIMIS - Ky	598	321	919	$154
FAYETTE CO.	322	84	406	$145
TRIMARC	454	531	985	$137
INDIANAPOLIS	1,190	320	1,510	$153

Notes:

7) Separate contacts were awarded as part of the ARTIMIS contract for installation of markers in Ohio and Kentucky.

8) The cost for markers in the Lexington-Fayette County project did not include fabrication of the markers, which was performed in-house by Lexington-Fayette Urban County Traffic Engineering.

9) Traffic control and maintenance of traffic was not included in the cost of the markers used for the TRIMARC project.

10) Maintenance of traffic, mobilization, and construction engineering were not included in the price of markers for the Indianapolis project.

Figure 1. Schematic Showing Mainline Reference Marker Used in the ARTIMIS Project.

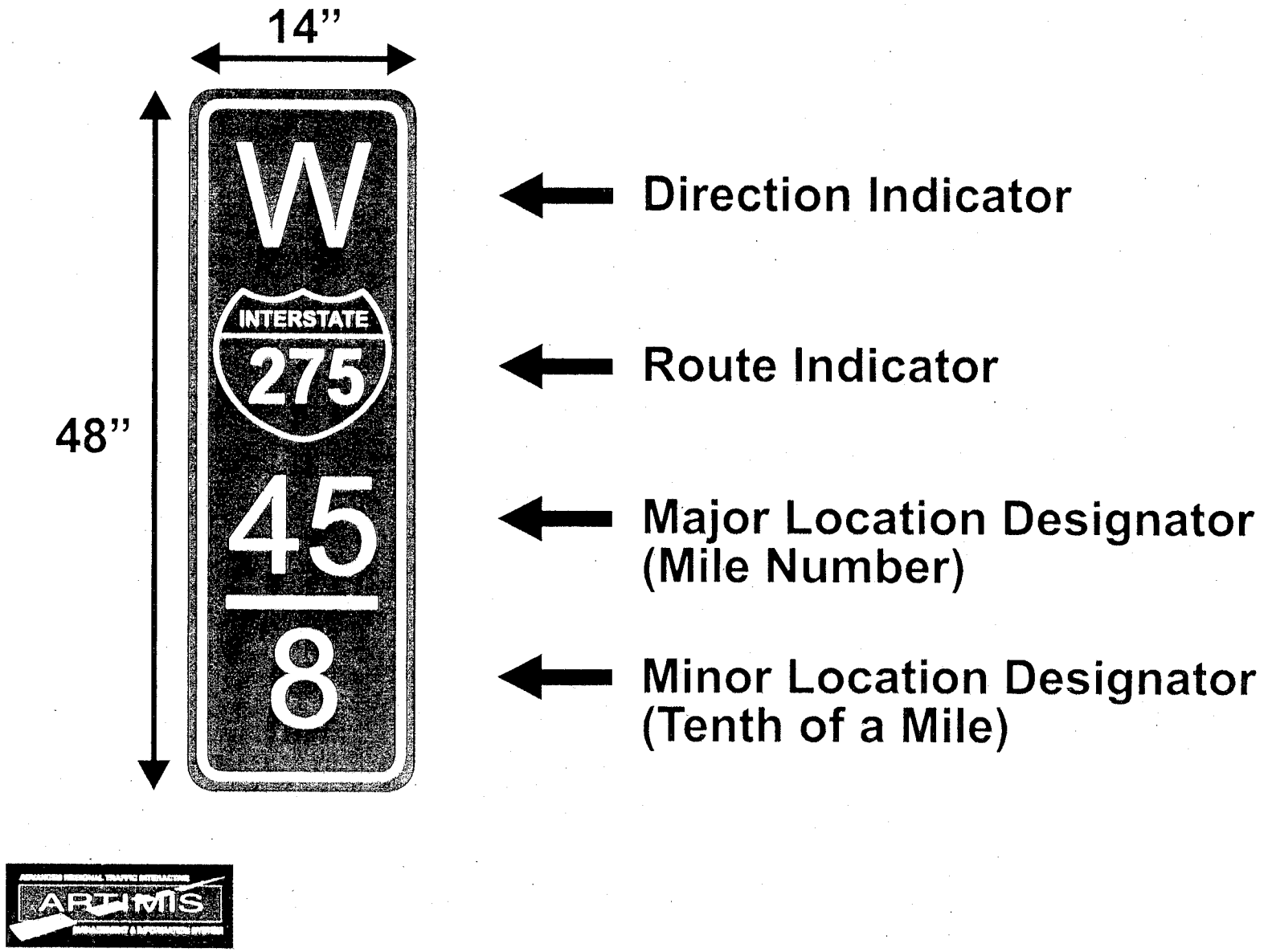


Figure 2. Schematic Showing Ramp Reference Marker Used in the ARTIMIS Project.

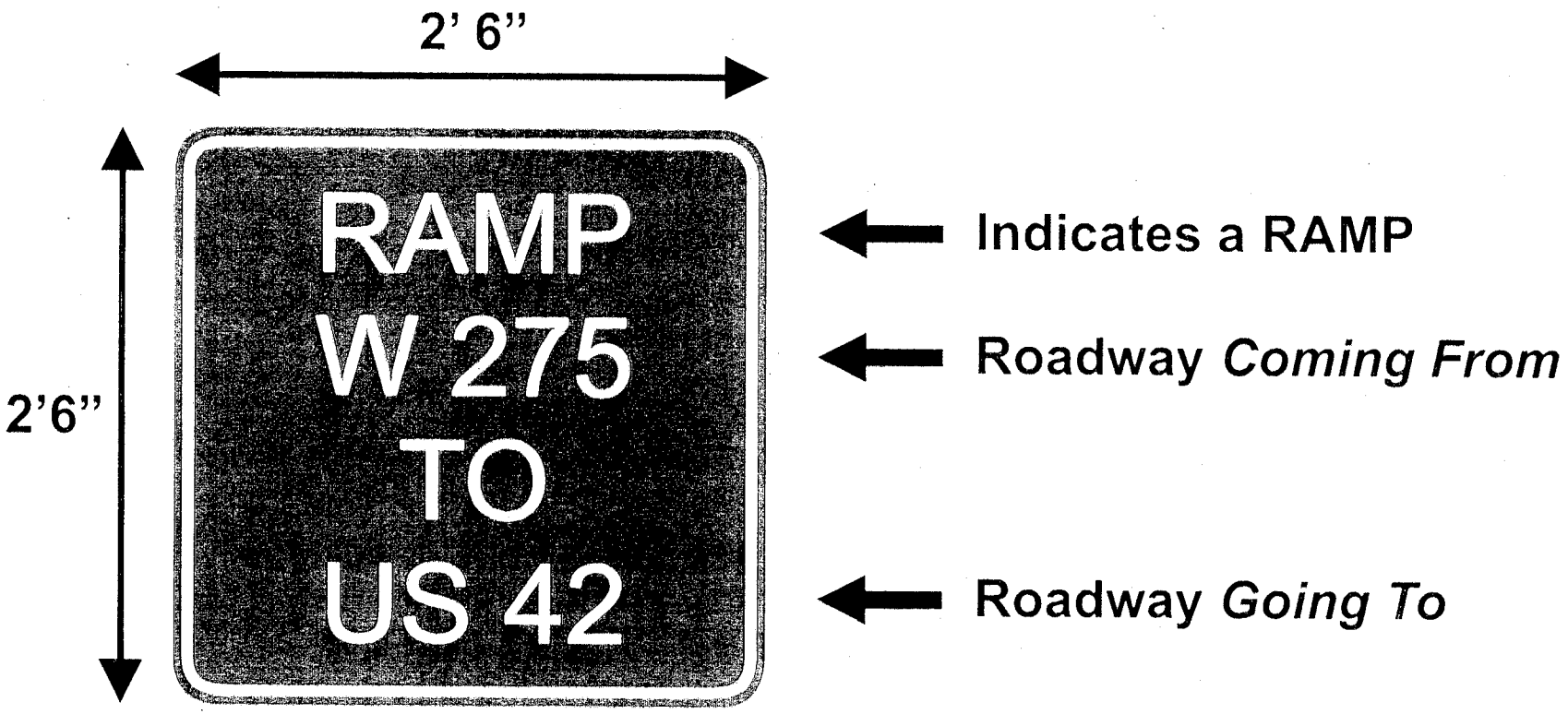
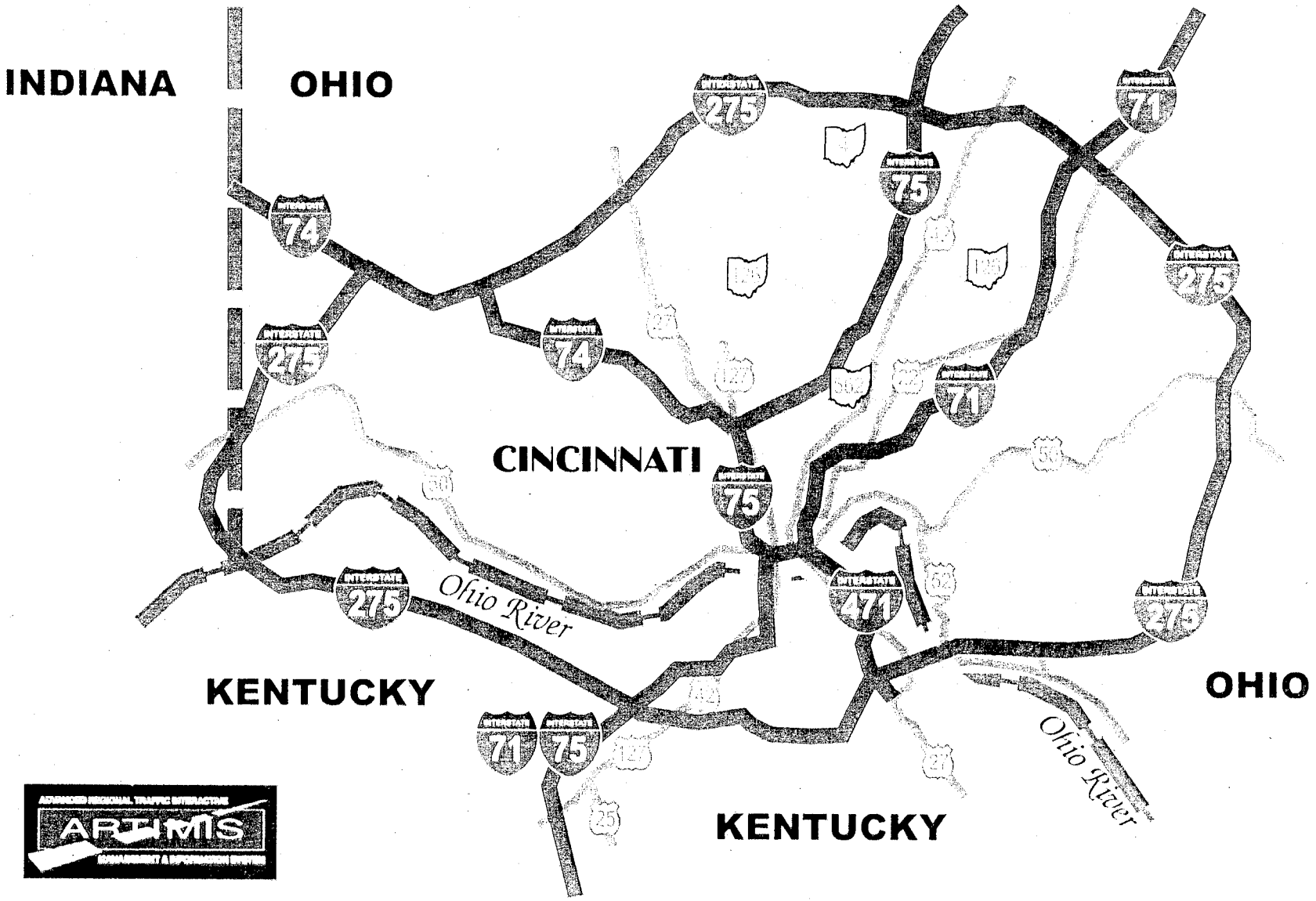


Figure 3. Map Showing Reference Marker Installations - ARTIMIS Project.



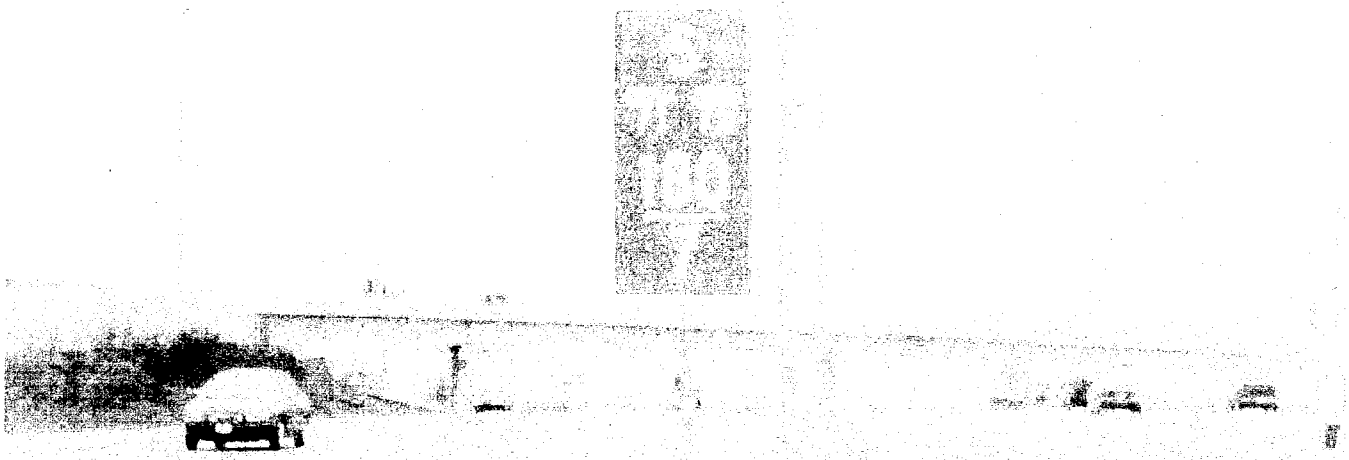


Figure 4. Photograph of Reference Marker Used in the ARTIMIS Project.

Figure 5. Photograph of Ramp Marker Used in the ARTIMIS Project.

Figure 6. Map Showing Reference Marker Installations -- Lexington-Fayette County.

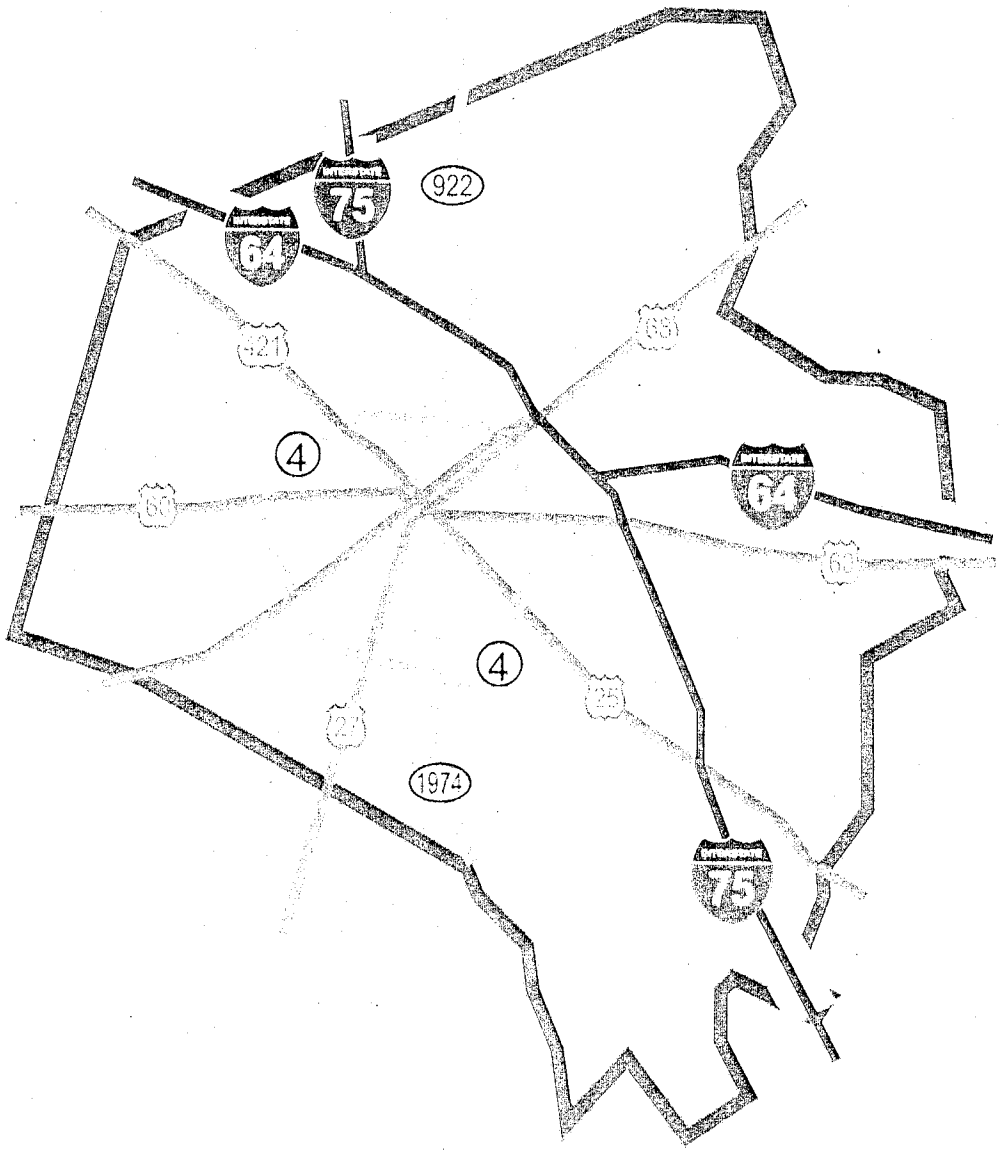


Figure 7. Photograph of Reference Marker Used in Lexington-Fayette County.

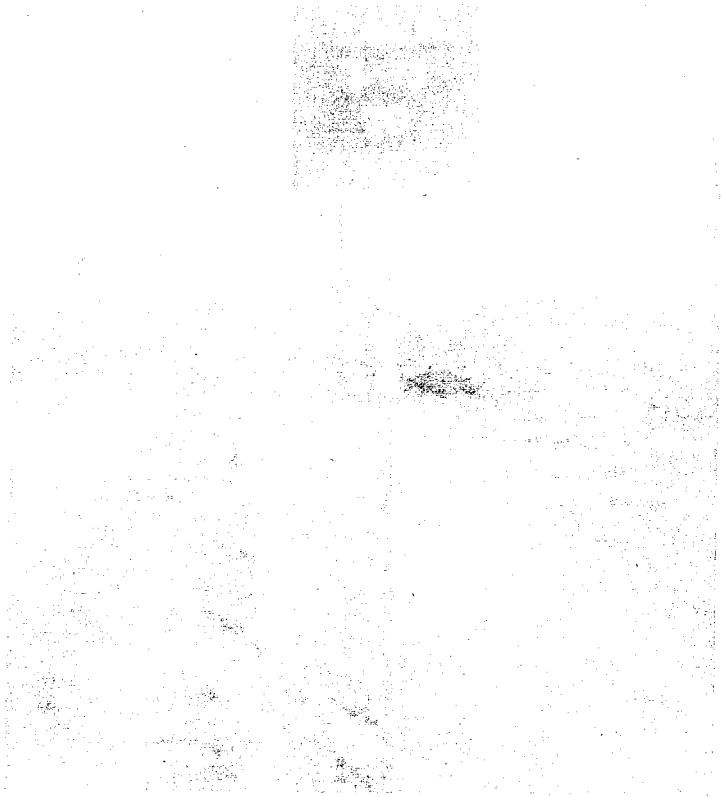
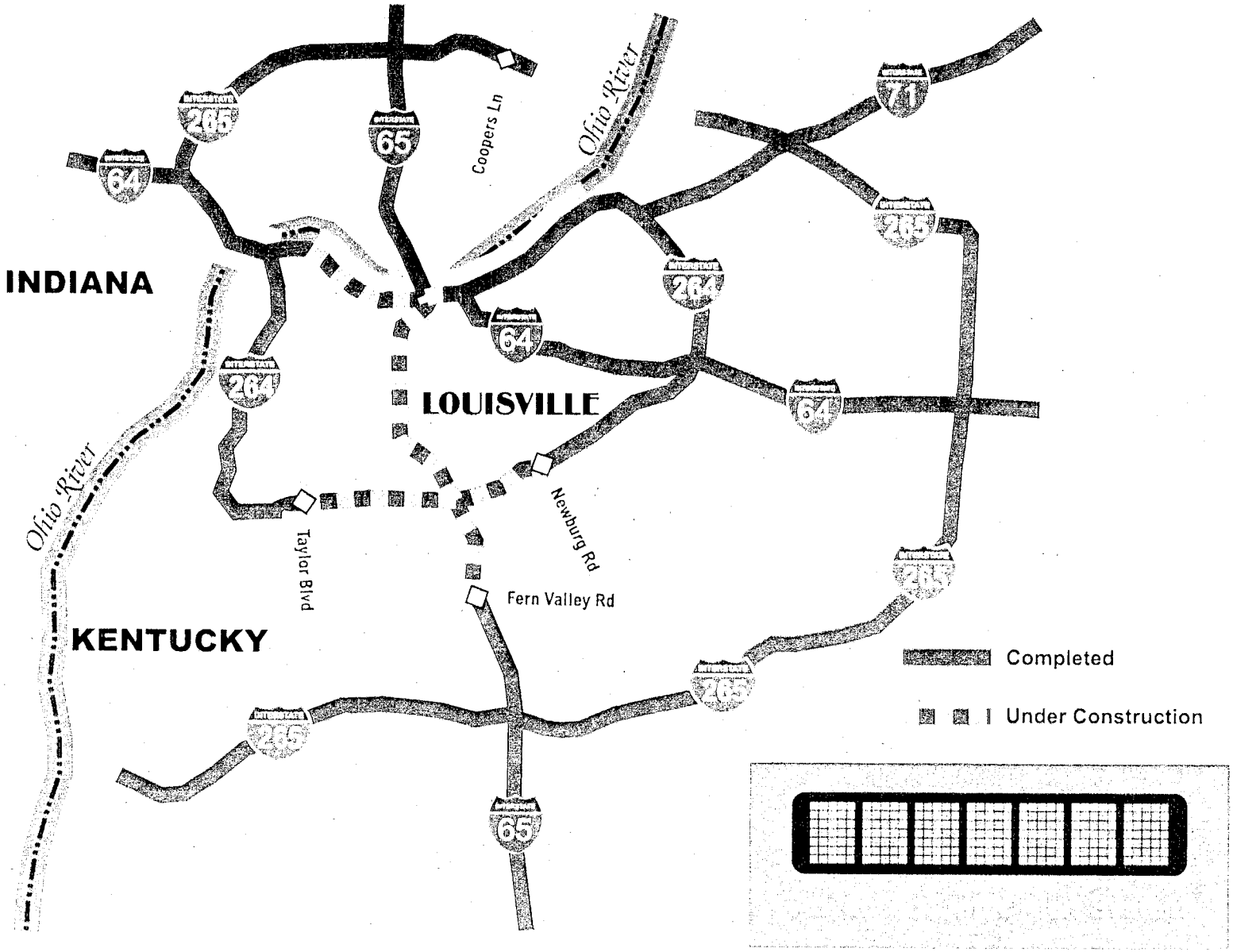


Figure 8. Photograph of Ramp Marker Used in Lexington-Fayette County.

Figure 9. Map Showing Reference Marker Installations - TRIMARC Project.



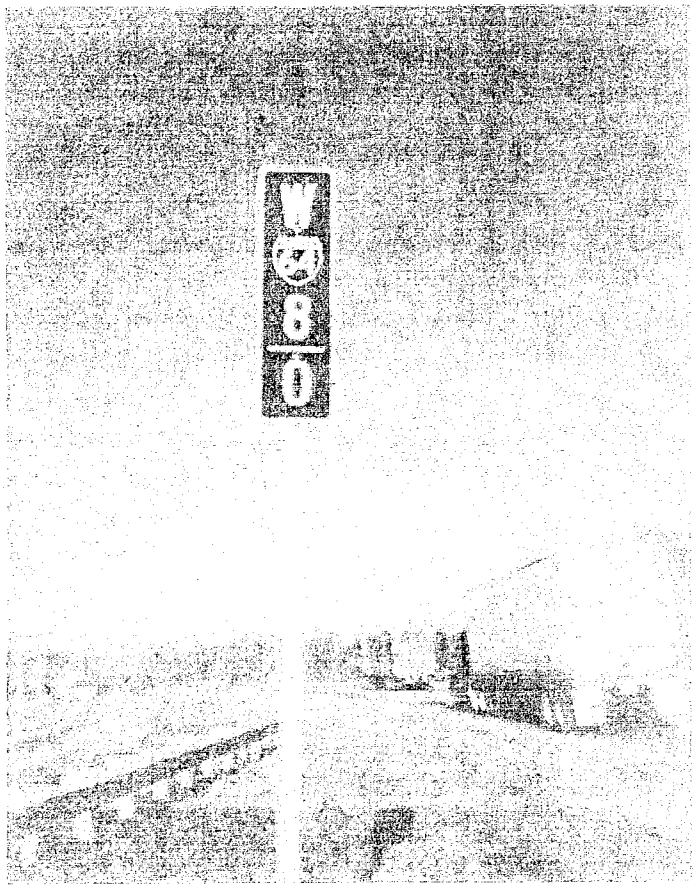


Figure 10. Photograph of Reference Marker Used in TRIMARC Project.

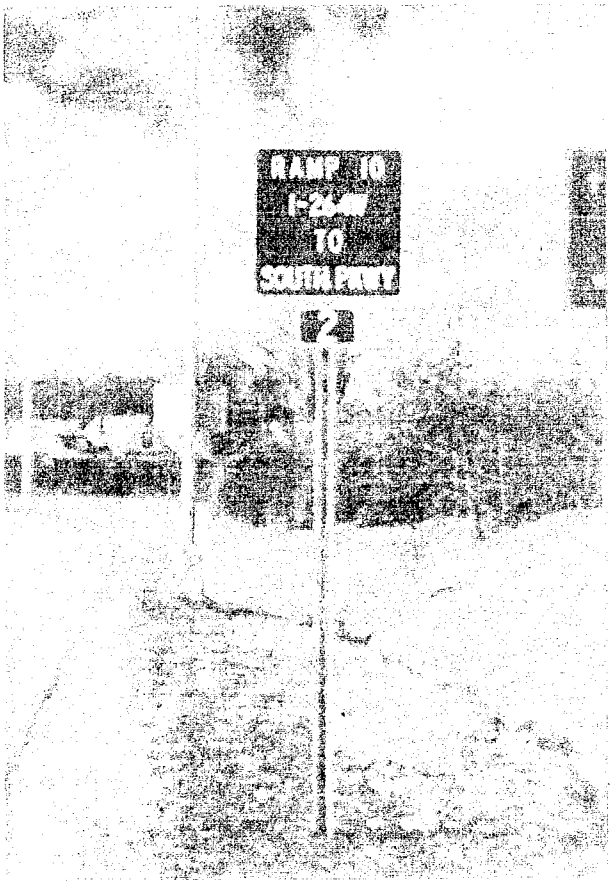
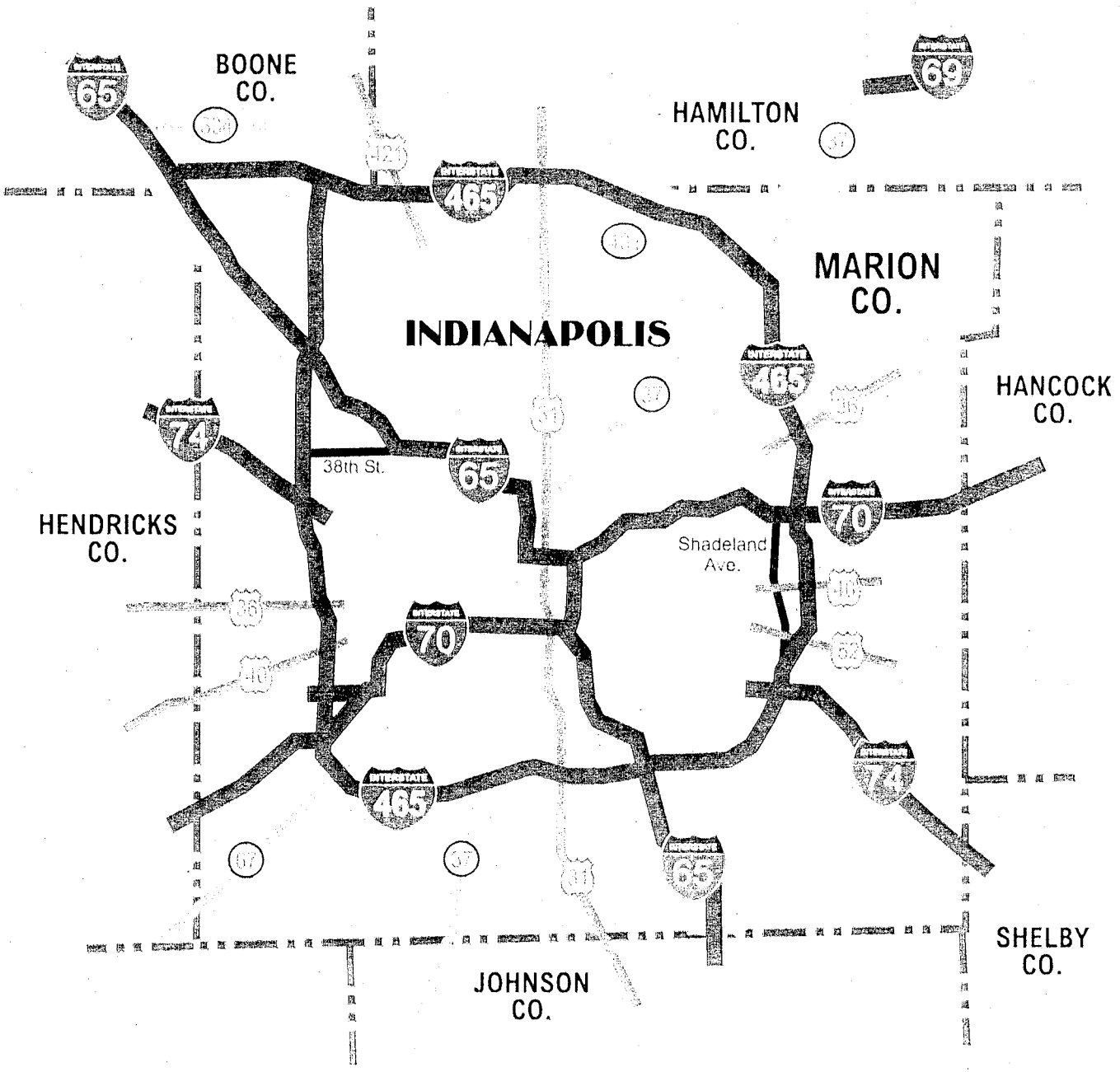


Figure 11. Photograph of Ramp Marker Used in TRIMARC Project.

Figure 12. Map Showing Reference Marker Installations - Indianapolis.



APPENDIX A

STATUS REPORT

REFERENCE MARKER INSTALLATIONS IN INDIANA

INDIANA DEPARTMENT OF TRANSPORTATION
100 North Senate Avenue
Room N755
Indianapolis, Indiana 46204-2249
(317) 232-5533 *FAX: (317) 232-0238*
An Equal Opportunity Employer ● *http://www.state.in.us/dot*

FRANK O'BANNON, Governor
CRISTINE M. KLIKA, Commissioner

Writer's Direct Line
(317) 232-5226
email: gmroczka@indot.state.in.us

June 27, 2001

Jerry Pigman, Research Engineer, P.E.
Traffic and Safety Section
University of Kentucky
Kentucky Transportation Center
176 Raymond Building
Lexington, KY 40506-0281

Dear Mr. Pigman,

This letter is a response to your phone inquiry concerning an update on the installation of 0.2 milepost reference markers in Indiana. INDOT currently has six urbanized areas where they have been installed. Here is the list;

Louisville / Falls City Area – On I-65, I-65 and I-265 → 18 miles installed through a KyDOT contract. Includes 96 ramp markers as well.

Indianapolis Area – On I-65, I-69, I-70, I-74 and I-465 → 120 miles were installed in 1998. Two more miles will be added in 2002. Includes 224 ramp and collector – distributor markers as well. In 2002, Greenfield District forces are resigning a 4.5 mile portion of I-465 to I-865, which presently have the 0.2 mileposts.

Northwest Indiana Area – On I-65 and I-80 / I-94 → 34 miles have been installed as of 2001. Along 19 miles of the I-80 / I-94 (Borman Expressway), the markers were installed every 0.1 mile rather than 0.2 mile due to large history of incident occurrence. Includes 101 ramp markers as well.

Kokomo Area – On U.S. 31 → 11 miles installed as of 2001 along a heavily developed urban arterial.

Evansville Area – On I-64, I-164, U.S. 41, S.R. 62 and S.R. 66 → 68 miles installed as of 2001. All markers were installed by Vincennes District forces. 43 miles were off interstate on heavy volume urban arterials.

Fort Wayne Area – On I-69 → 24 miles installed as of 2001.

In summary, INDOT has installed 275 miles of mainline 0.2 milepost reference markers including 221 miles on the interstate system and 54 miles on non-interstate.

If you need any additional information concerning this matter, please feel free to email or call me.

Sincerely,

Gary Mroczka, Manager
Specialty Projects Group Section
Design Division

gm

cc: File
D. Louie / D. Boruff
M. Newland

APPENDIX B

SURVEY FORMS AND SUMMARY OF RESULTS

ARTIMIS REGIONAL INCIDENT MANAGEMENT TASK FORCE

LEXINGTON-FAYETTE COUNTY INCIDENT MANAGEMENT COMMITTEE

TRIMARC FREEWAY INCIDENT MANAGEMENT TASK FORCE

REFERENCE MARKER SURVEY
ARTIMIS REGIONAL INCIDENT MANAGEMENT TASK FORCE

1. Are you familiar with the reference signs which have been installed as part of the ARTIMIS project?
   Yes ----___22____ No----_____

   If you are familiar with the signs, what is your personal impression of the effects or potential effects which the signs may have on the emergency response process?
   Very Beneficial--___17_____ Possibly Beneficial--____5____ Not Beneficial--_____

2. Have you received calls from motorists who have used the reference signs in their description of the Location where emergency response is needed?
   Yes----___16_____ No----____6_____

   If you have received calls where these signs have been mentioned, has there been any response from the public which would indicate a positive impression of the signs?
   Yes----__14_____ No----_____ Unknown----____6____ NA---__1___

3. Are you aware of incidents where the reference signs have had an effect on the response times for emergency personnel as a result of being provided better location information?
   Yes----___11_____ No----____3_____ Unknown----____6_____

4. Do you have an opinion whether the frequency of sign spacing is appropriate?

   Spacing of signs for ARTIMIS Project is 0.1 mile or approximately 500 feet.
   Appropriate--___15_____ Not Appropriate--__4_____ No Opinion--__2_____

   Spacing of signs for Lexington Project is 0.2 mile or approximately 1000 feet.
   Appropriate--___7_____ Not Appropriate--____6_____ No Opinion--___5____

   Signs could be placed a little farther apart;
   Perfect Spacing;

5. Which sign color do you feel is most appropriate or effective for emergency response use?

   The ARTIMIS signs are white numbers and letters on blue background.
   Appropriate--___17_____ Not Appropriate--_____2_____ No Opinion--__3____

   The Lexington signs are white numbers and letters on green background.
   Appropriate--___4_____ Not Appropriate--___8_____ No Opinion--___8____

   Blue;
   Blue or white;
   White on blue:

6. Do you have an opinion whether the reference signs should be placed on other sections of roads in order to assist with the emergency response process?
   Yes----___15_____ No----__2_____ No Opinion----___5_____

   Major arteries;

7. Please provide other comments related to the reference signs.

   Do we have potential for information overload?;
   Spacing, color, location all great!!;

Extremely valuable for precise location determination, and "easy to use" for the "below average" motorist (just ask them to "read" the sign to the dispatcher and location can easily be determined).;
Had occasion to talk to an out of state motorist who loved them, she felt like she always knew where she was even though it was unfamiliar territory.;
Signs are quite effective.;
More signs with different information could cause confusion at highway speeds, current plan is simple and easy.;
Place signs where addresses are not available.;
The signs are a great aid in getting more precise information from the public and relay and send the appropriate agency to a problem.;
Great idea!;
This project is overdue and should be expanded without delay!;

EVALUATION OF REFERENCE MARKERS
Lexington-Fayette County Incident Management Committee

1. Are you familiar with the reference markers which have been installed as part of the interstate signing projects in the Lexington/Fayette Co. area? _15_ Yes _0_ No

   If you are familiar with the markers, what is your personal impression of the effects or potential effects which the markers may have on the emergency response process?
   _13_ Very Beneficial _3_ Possibly Beneficial _0_ Not Beneficial

2. Have you received calls from motorists or are you aware of anyone who has used the reference markers in their description of the location where emergency response is needed?
   _9_ Yes _7_ No

   If you have received calls or are aware of incidents where these markers have been used to describe the location of an incident, was there a positive impression of the markers?
   _8_ Yes _0_ No _6_ Unknown

   Do you feel that the public generally understands the markers and knows their purpose?
   _9_ Yes _2_ No _4_ Unknown

3. Are you aware of incidents where the reference markers have had a positive effect on the response times as a result of emergency personnel being provided better information to locate the incident?
   _9_ Yes _2_ No _4_ Unknown

   Are there cases where the reference markers have had a negative effect on response times?
   _0_ Yes _5_ No _10_ Unknown

4. Please provide your opinion concerning the frequency of reference marker spacing:

   Spacing of markers for Lexington/Fayette Co. projects is 0.2 mile (approximately 1,000 feet).
   _11_ Appropriate _2_ Not Appropriate _1_ No Opinion

   Spacing of markers for Cincinnati/N. KY area is 0.1 mile (approximately 500 feet).
   _7_ Appropriate _5_ Not Appropriate _3_ No Opinion

   Are you aware of motorists being unable to observe a marker when using the 0.2-mile spacing of reference markers?
   _1_ Yes _11_ No _4_ Unknown

5. Please provide your opinion concerning color of the reference markers for effective emergency response use:

The Lexington/Fayette Co. markers are white numbers and letters on green background.
_10_ Appropriate _3_ Not Appropriate _2_ No Opinion

The Cincinnati/N. KY and Louisville markers are white numbers and letters on blue background.
_10_ Appropriate _2_ Not Appropriate _3_ No Opinion

6. Where interstate routes run concurrently, should only the dominant single route symbol or double route symbols should be used on the reference markers?
_3_ Single _11_ Double _1_ No Opinion

7. Do you feel that reference markers should be placed on other highways in your area to assist with the emergency response process?
_11_ Yes _5_ No _0_ No Opinion

8. Are you aware of any maintenance problems with the reference markers or posts?
_2_ Yes (If yes, explain below) _9_ No _4_ Unknown

9. Do you feel that changes should be made in the design or placement of the reference markers to make them more understandable and usable for the public?
_4_ Yes (If yes, explain below) _6_ No _4_ No Opinion

10. Please provide other comments related to the reference markers.
(maintenance issues, design or placement of the markers, expanded use ?)

- People seem to be confused about how to read the reference signs
- Opinion that 0.1 mile spacing would be ideal
- Change the signs to read 20.5, for example, instead of 20/5 for the mile markers
- All placement of signs should be dependent on how the road is laid out
- Opinion to have the markers only on the freeway because there are fewer landmarks

EVALUATION OF REFERENCE MARKERS
TRIMARC Freeway Incident Management Task Force

1. Are you familiar with the reference markers which have been installed as part of the interstate signing projects in the Louisville area? _20_ Yes _0_ No

   If you are familiar with the markers, what is your personal impression of the effects or potential effects which the markers may have on the emergency response process?
   _18_ Very Beneficial _2_ Possibly Beneficial _0_ Not Beneficial

2. Have you received calls from motorists or are you aware of anyone who has used the reference markers in their description of the location where emergency response is needed?
   _16_ Yes _2_ No

   If you have received calls or are aware of incidents where these markers have been used to describe the location of an incident, was there a positive impression of the markers?
   _5_ Yes _0_ No _15_ Unknown

   Do you feel that the public generally understands the markers and knows their purpose?
   _6_ Yes _11_ No _3_ Unknown

3. Are you aware of incidents where the reference markers have had a positive effect on the response times as a result of emergency personnel being provided better information to locate the incident?
   _10_ Yes _4_ No _6_ Unknown

   Are there cases where the reference markers have had a negative effect on response times?
   _5_ Yes _6_ No _9_ Unknown

4. Please provide your opinion concerning the frequency of reference marker spacing:

   Spacing of markers for Louisville projects is 0.2 mile (approximately 1,000 feet).
   _15_ Appropriate _1_ Not Appropriate _4_ No Opinion

   Spacing of markers for Cincinnati/N. KY area is 0.1 mile (approximately 500 feet).
   _5_ Appropriate _4_ Not Appropriate _10_ No Opinion

   Are you aware of motorists being unable to observe a marker when using the 0.2-mile spacing of reference markers?
   _3_ Yes _11_ No _6_ Unknown

5. Please provide your opinion concerning color of the reference markers for effective emergency response use:

The Louisville area markers are white numbers and letters on blue background.
_17_ Appropriate _0_ Not Appropriate _5_ No Opinion

The Lexington/Fayette Co. markers are white numbers and letters on green background.
_6_ Appropriate _5_ Not Appropriate _11_ No Opinion

Where interstate routes run concurrently, should only the dominant single route symbol or double route symbols should be used on the reference markers?
_6_ Single _12_ Double _2_ No Opinion

7. Do you feel that reference markers should be placed on other highways in your area to assist with the emergency response process?
_18_ Yes _2_ No _2_ No Opinion

8. Are you aware of any maintenance problems with the reference markers or posts?
_13_ Yes (If yes, explain below) _1_ No _8_ Unknown

9. Do you feel that changes should be made in the design or placement of the reference markers to make them more understandable and usable for the public?
_10_ Yes (If yes, explain below) _7_ No _5_ No Opinion

10. Please provide other comments related to the reference markers.
(maintenance issues, design or placement of the markers, expanded use ?)

- Replacement of damaged or missing signs is slow
- The reference markers are a great help in locating accidents
- The public needs to be made aware of the signs and their purpose
- Police need to know who to contact to fix damaged signs
- Take the geometry of the roadway into account when placing signs
- Lexington signs appear a little less cluttered