

APPENDIX A

AGENDA

NATIONAL CONFERENCE

Renaissance Hotel • Washington, D.C.
December 5-7, 1994

Sponsors:

**American Road & Transportation
Builders Association
Federal Highway
Administration**

Cosponsors:

**American Association of State
Highway & Transportation Officials
American Traffic Safety Services
Association**



Moderator:

**Dr. Nicholas J. Garber
School of Engineering &
Applied Science
Department of
Civil Engineering
and Applied Mechanics
University of Virginia**

MONDAY, DECEMBER 5

8:30 – 11:45 a.m. — Morning General Session

Introductions:

Anthony R. Kane
Acting Executive Director
FHWA
Kenneth R. Rezendes
Chairman
ARTBA
Francis B. Francois
Executive Director
AASHTO
Robert M. Garrett
Executive Director
ATSSA

Work Zone Safety Findings: Statement of Problem

Dr. Nicholas J. Garber
University of Virginia

Advanced Technologies: Arrow Panel Visibility

Douglas J. Mace
Last Resource, Inc.

Part VI MUTCD Changes

Michael Robinson
FHWA

12:00 – 1:30 p.m. — Luncheon

Transportation Outlook in the New Congress

The Honorable Nick J. Rahall II (D-WV)

1:45 – 5:00 p.m. — Afternoon Workshops

Philosophy of Traffic Control

Dr. Russell M. Lewis
John B. Moran

Work Zone Safety Implementation

Jon V. Jackels
Victor H. Liebe

Contractors Construction Management

Robert W. Attaway
Joseph R. Julian

Interaction With Public and Highway Users

Maj. Thomas H. Milldebrandt
Jerry J. Graham

Advanced Technologies

Dr. Ray Benekohal
Dr. H. Gene Hawkins, Jr.

5:30 – 7:00 p.m. — Reception

TUESDAY, DECEMBER 6

8:30 – 11:45 a.m. — Morning General Session

National Work Zone Safety Program

Joseph J. Lasek
FHWA

Liability/Litigation Insurance

Douglas D. Wilson
Partner
Parvin, Wilson, Barnett and Guynn, P.C.

Managing Work Zone Safety in NYDOT's Capital Construction Program

James E. Bryden, P.E.
Construction Division
New York Department of Transportation

12:00 – 1:30 p.m. — Luncheon

1:45 – 5:00 p.m. — Afternoon Workshops

Philosophy of Traffic Control

Dr. Russell M. Lewis
John B. Moran

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Dr. Ray Benekohal
Dr. H. Gene Hawkins, Jr.

WEDNESDAY, DECEMBER 7

8:30 – 12:00 noon — Morning General Session

Recap of Workshops: Discussion of Problem, Possible Solutions and Recommendations

Philosophy of Traffic Control

Dr. Russell M. Lewis
John B. Moran

Work Zone Safety Implementation

Jon V. Jackels
Victor H. Liebe

Contractors Construction Management

Robert W. Attaway
Joseph R. Julian

Interaction With Public and Highway Users

Maj. Thomas H. Milldebrandt
Jerry J. Graham

Advanced Technologies

Dr. Ray Benekohal
Dr. H. Gene Hawkins, Jr.

**Concluding Remarks: Our Role in the Process/
Future of Work Zone Safety**

Dr. Nicholas J. Garber

Adjournment

APPENDIX B

TABLES AND BACKGROUND MATERIALS

Fatalities

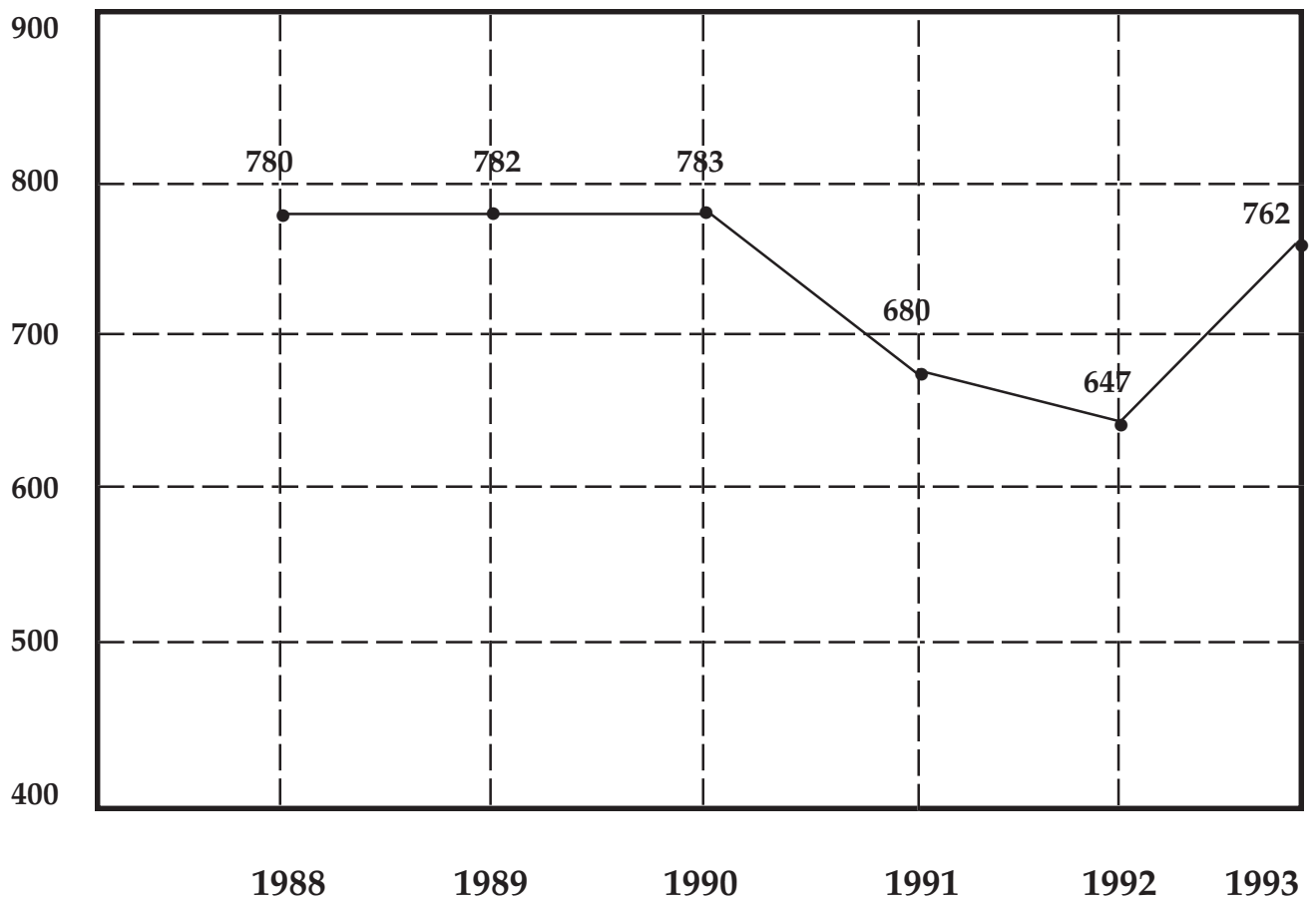


Table 1-A. Work Zone Fatalities

Percent
Of All
Deaths

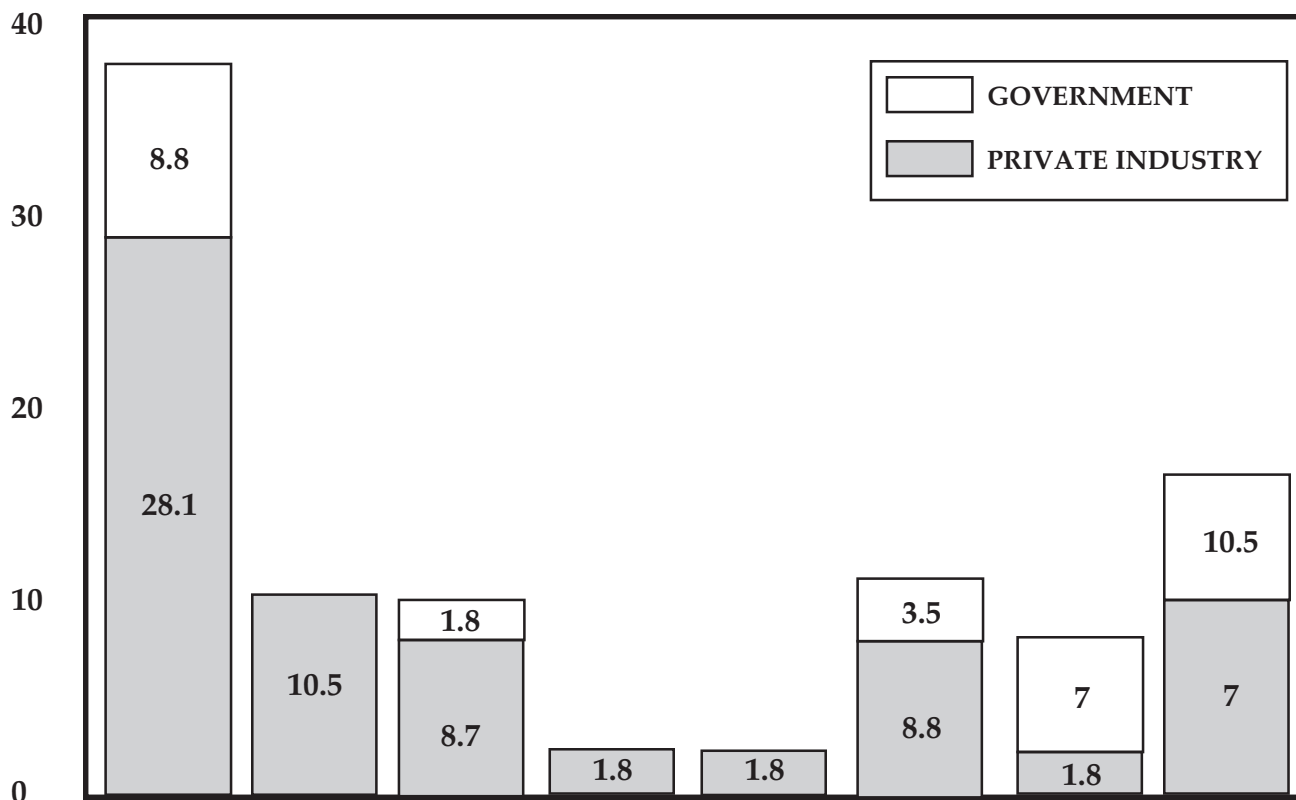


Table 2. Years With Employer

(Fatalities in SIC 161)

EXPERIENCES IN PARTNERING

by Joseph R. Julian, President
James Julian, Inc.

In three states in which I work, I have observed the application of partnership principles. Here are some examples.

1. I-495 Project, Old Baltimore Pike, Wilmington, DE

Extensive reworking of the original project MOT schemes was performed by James Julian, Inc., and DELDOT in order to make the project more builder-friendly, more traffic-friendly, and finally, more completion time-friendly. We were interested in the builder-friendly aspect of the reworks, DELDOT was interested in the earlier completion aspect of the reworks, and both parties were interested in the traffic safety aspect. Stages were eliminated at both projects, maximizing the length of the remaining stages.

Obviously, the earlier than anticipated completion of a project reduces the exposure of the traveling public to work zones, thus increasing the probability of safety. Moreover, a logically constructed staged project provides greater safety to the motoring public upon switching into the stages. Both projects will finish ahead of schedule, and accomplish the goals of the three impacted parties: the contractor, the owner, and the public.

2. Route 50/301 Project, Bowie, MD

Extensive reworking of the original project MOT schemes was again performed by James Julian, Inc., and MSHA in order to allow greater traffic safety, greater constructibility, and earlier project completion. Five traffic stages were eliminated, and that maximized the length of the remaining stages and resulted in a better quality project. Temporary detour roads that were designed for the project were eliminated, with traffic being detoured to alternate routes off the project. MSHA had to be convinced that the proposed detours would not clog those roads, so a traffic consultant report was prepared to detail traffic counts on the impacted roads. This

report, along with the poor sight distances and grade deviations of the detour roads, enlightened MSHA and secured their approval of the changes.

All parties won as a result of the changes. The road was opened earlier, a better quality road was constructed, MSHA incurred lower costs as a result of the project opening earlier, and the motoring public was able to react to fewer stages for a longer period of time, thus improving their safety awareness. The motoring public also received the benefit of the better constructed and earlier completed project. Finally, no complaints were forwarded to our attention with regard to congestion on the alternate detour roads.

MSHA, through its recognition of work zone hazards to the workers of the contractors, has been in the forefront in promoting legislation to reduce speeds in the work zones and double the fines. MSHA has also specified the utilization and payment of state police to assist in the monitoring of work zones.

3. Amity Hall, 11/15, Pennsylvania

Numerous changes have been made to this 16-mile-long, heavily staged, and well-traveled project in order to make it more builder-friendly and, therefore, more work zone friendly. PENNDOT has been extremely proactive with regard to the changes, sometimes to the point of recommending the changes. Stages have been truncated in order to allow contractor access to construction areas earlier.

PAYMENT PRACTICES FOR MOT IN THE STATES

1. Delaware

DELDOT provides payment items for practically all MOT devices and operations. Message boards, permanent warning signs, temporary warning signs, arrow panels, drums, lights, flagmen, truck-mounted

attenuators, temporary markings (paint and tape), barricades, crash cushions, barriers, relocated barriers, furnished barriers and light plants are compensated by items. Some of the items, such as lights, arrow panels and drums, are compensated on an each-day scale; some, such as message boards and truck-mounted attenuators, are compensated on a lump sum basis, with maintenance and utilization costs incidental to the lump sum; while signs, flagmen, barriers and markings are compensated by the exact measurement.

DELDOT's payment practices for MOT devices are modified every few years in order to rectify any payment or accounting problems with the items. DELDOT is very cognizant of traffic safety, and creates the traffic line items in order to allow the maximum utilization of the devices. The only items that DELDOT considers incidental to MOT are cone installation and pickup, traffic closing maintenance, and any other items specifically alluded to in the body of contract drawings or special provisions. DELDOT's approach to MOT compensation is probably the most advanced of the three states in which James Julian, Inc. presently works. DELDOT will also compensate for MOT lump sum extensions if a project is extended in time due to revisions or delays. DELDOT also provides compensation for utilization of state police as traffic officers.

2. Maryland

MSHA is slightly less enlightened than DELDOT with regard to MOT payments. Flagmen are compensated under the lump sum MOT item, while most of the other devices cited earlier are compensated by specific units. MSHA has recently allowed payment for traffic managers—employees who are educated at traffic seminars—to supervise traffic

maintenance at projects. MSHA also compensates for MOT for lump sum extensions when projects are extended.

MSHA also recognizes that increases in contract amounts also impact MOT costs and is willing to make adjustments which compensate the contractor for the extended MOT costs.

3. Pennsylvania

PENNDOT is the least enlightened of the three owners with regard to MOT device payment. Message boards, arrow panels, lights, extra warning signs and barriers are paid under specific items. However, a majority of the other items previously cited are incidental to the MOT item. Flagmen, drums, striping, and plan warning signage are not compensated specifically. The contractor, based on the maintenance of traffic design in the plans and contract specials, must estimate, as part of the MOT lump sum item, the quantity of these devices to be utilized and the number of utilizations for each device. PENNDOT, however, is receptive to change orders to the MOT lump sum when excessive direction of MOT utilization is provided.

In conclusion, payment for the MOT items should be similar to the DELDOT system of MOT compensation. The existence of numerous MOT payment items does not force the contractor to sacrifice the safety of motorists for project budgeting purposes. In addition, the contractor and the owner are not fighting about the necessity of utilizing safety devices if items are available for the devices. The DELDOT payment system allows MOT to be a given to the contractor. Although the estimation of the MOT specific item quantities prior to bid can be a substantial headache (i.e., Old Baltimore Pike), the items are necessary for a safe project.

APPENDIX C

SUMMARY OF KEY LEGISLATIVE AND ADMINISTRATIVE ASPECTS OF SELECTED TRAFFIC CONTROL AND WORK ZONE SAFETY PROGRAMS

SUMMARY OF KEY LEGISLATIVE AND ADMINISTRATIVE ASPECTS OF SELECTED TRAFFIC CONTROL AND WORK ZONE SAFETY PROGRAMS

This briefing document is intended to provide a summary of printed background material and other information pertaining to various aspects of traffic control and work zone safety issues.

Initially, this report features a discussion of the Federal legislative histories of provisions of law authorizing the establishment and funding of two key transportation safety programs: the Railway-Highway Crossings program and the Hazard Elimination Program. These programs are intended to support the design, construction, and relocation of physical improvements, as well as the installation and creation of signals, markings, signage and other “devices” needed to facilitate the control of vehicular and pedestrian traffic. The existence and operation of such devices and equipment/capital facilities, and the accomplishment of relocations, are intended to ensure the safety of vehicle operators, pedestrians and work site personnel.

The next section of this document provides a description and brief legislative history of the work zone safety program, followed by a discussion of the development of the *Manual on Uniform Traffic Control Devices (MUTCD)*. This Manual is a product of nearly six decades of research and other work which has been performed by academicians, practitioners and governmental officials operating in the various sectors of the traffic control engineering field.

This report provides an overview of the legislative and administrative aspects of traffic management and work zone safety programs which was used as background material to support the development of prepared remarks delivered at ARTBA’s National Work Zone Safety Conference.

Railway–Highway Crossings: Hazard Elimination Program— Legislative History and Tabulation of Recent Apportionment Data

During Congressional action on the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), the Senate Environment and Public Works Committee developed a “surface transportation program” (STP) provision which became §1007 of the new statute.¹ (§1007 is now codified as the new §133 of Title 23 of the U.S. Code. The STP funds the construction/rehabilitation of highways, bridges, mass transit facilities, interurban commuter rail systems, etc., in addition to environmental mitigation activities and other types of projects.)² The House Committee on Public Works and Transportation amended the Senate’s version of this provision by adding language requiring that 10 percent of STP funds (which are to be appropriated over the 6-year life of the ISTEA legislation) be applied to Railway–Highway Crossings (23 USC 130) and Hazard Elimination Program (23 USC 152) activities and projects.³

The Railway–Highway Crossings program, originally established under §203 of the Highway Safety Act of 1973, as amended, was codified (as 23 USC 130) through the enactment of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (STURAA).⁴ The Hazard Elimination Program was established under §152 of Title 23 through the adoption of the 1982 amendments to the Surface Transportation Assistance Act of 1978 (STAA).⁵ These two programs have been created for the purpose of eliminating or mitigating hazards at railway-highway intersections (particularly through the relocation of highway segments away from railroad trackage/rights-of-way) and making safety-oriented improvements to highway facilities, respectively.⁶ Neither of these programs provides funding for such projects on the Interstate highway system.⁷

Since its inception, the Railway-Highway Crossings program’s implementation has reduced the rate of fatal accidents by 89 percent, nonfatal injury accidents by 62 percent, and combined fatal-plus-nonfatal injury accidents by 66 percent.⁸ Reductions of 50 percent, 26 percent, and 26 percent in the incidence of the same types of accidents (in corresponding order) are attributable to the operation of the Hazard Elimination Program.⁹ (It

should be noted that the rate of fatal traffic accidents dropped almost 50 percent, from 3.1 to 1.6 per 100 million vehicle miles [MVM] between 1974 and 1992. [See Attachment 1.] However, the actual number of fatal traffic accidents that occur each year dropped only about 13 percent between 1974 and 1992. [See Attachment 2.]

The following chart depicts the funding amounts that have been apportioned under the Railway–Highway Crossings and Hazard Elimination programs, pursuant to the 10 percent funding requirement, in fiscal years 1993 and 1994. Apportionment figures are also shown for the optional safety program, whose funding is also covered by the 10 percent amount. However, data would have to be gathered on the State-by-State use of the optional safety monies in order to determine how close U.S. Department of Transportation (DOT) officials are to achieving the goal of dedicating 10 percent of STP funds to the two principal programs. (The STP section of Title 23 authorizes the apportionment of \$26 billion over a 6-year period. Therefore, in each year in which the full funding level is being met through the Federal appropriations process, approximately \$430 million will be provided to finance the programs enumerated below.)¹⁰

Fiscal Year	Program	Apportionment
1993	Railway Crossings	\$149.3 million
1993	Hazard Elimination	\$156.2 million
1993	Optional Safety	\$112.8 million
TOTAL		\$418.3 million

Fiscal Year	Program	Apportionment
1994	Railway Crossings	\$149.3 million
1994	Hazard Elimination	\$156.2 million
1994	Optional Safety	\$116.2 million
TOTAL		\$421.7 million¹¹

Work Zone Safety Program: Legislative History — Related Provisions of ISTEA: Other Congressional Action

The Work Zone Safety Program was created through the enactment of §1051 of ISTEA. House Committee staff drafted this provision and incorporated it into the House version of the ISTEA legislation, after having reviewed testimony from witnesses and other information indicating that work zone safety objectives were not being met.¹² In addition to promoting improvements in the operation of traffic control devices, this provision addresses the development of traffic control plans, as well as the enhancement of the process of bidding on traffic control-related contracts.¹³ Based on data gathered from the regional offices, Federal Highway Administration (FHWA) officials have determined that the most serious threats to work zone safety involve the acquisition of poor-quality equipment, improper or inappropriate placement of traffic control devices, and sporadic enforcement of vehicular speed limits within work zones.¹⁴ The assessment of double traffic fines and the training of individuals who have a role in the traffic control plan design process are also among the suggestions and recommendations gathered by FHWA officials who are studying this problem.¹⁵

The following provisions, which pertain to work zone safety, were adopted as part of the ISTEA legislation.

§1051 — Work Zone Safety

(Described above)

§1077 — Revision of Manual

This section directs the U.S. Secretary of Transportation to revise the *Manual on Uniform Traffic Control Devices (MUTCD)* and certain other regulations and contracts, in order to authorize the installation of “stop” or “yield” signs at railway-highway crossings. Such signs may be installed at sites that lack automatic traffic signals and are traversed by at least two trains per day.¹⁶

§1090 — Methods to Reduce Traffic Congestion During Construction

This section required the Secretary to perform a study of how to facilitate traffic flow and reduce congestion during the construction of Federal-aid highway projects. The study was transmitted to Congress in September 1992.¹⁷

§2002 — Highway Safety Programs

These provisions require the States to report to the Secretary once each year regarding the status of their efforts to reduce the incidence of deaths and injuries at highway construction sites.¹⁸

In early 1994, the Senate Labor and Human Resources Committee held hearings on the Occupational Safety and Health Act (OSHA) reform legislation. At the hearing on February 22, 1994, Eamonn McGeady, President of Martin G. Imbach, Inc., testified that OSHA inspectors should be authorized to be engaged in consultative discussions with employers rather than be limited to the functions of seeking out violations and writing citations. (Imbach does pile-driving, underwater construction and other high-risk work.) Mr. McGeady also stated that OSHA officials have admitted that their objective is to raise revenue (ostensibly by imposing fines) rather than acting to promote safety. Moreover, Mr. McGeady indicated that he is opposed to the mandatory establishment of safety committees when employers are capable of appointing and convening their own health and safety panels.¹⁹

Although this hearing was somewhat far removed from the process of crafting surface transportation legislation, Mr. McGeady’s statement and other similar testimony tend to support the premise that a great deal of effort must be made before some sectors of the construction community and Federal regulators can reconcile the interests of employers with the practices designed to ensure that standards for safety and industrial hygiene are being attained in work zone areas.

History of the Development of the Manual on Uniform Traffic Control Devices

In 1935, the *Manual on Uniform Traffic Control Devices (MUTCD)* was created by the Joint Committee on Uniform Traffic Control Devices (JC). The JC consisted of the American Association of State Highway Officials (AASHTO) and the National Conference on Street and Highway Safety (NCSHS).²⁰ This document has been used for nearly 60 years to advance the state of the art of creating and utilizing signals, signs, markings and other roadway equipment and features to control the flow of vehicular and pedestrian traffic on the Nation’s secondary roads and highways.²¹ The text of the original Manual was deemed extremely useful in that it emphasized the significance of the shapes of signs, the use of symbols rather than words, and the critical need to illuminate signs instructing motorists to stop, slow down or watch out for an approaching train at a railway-highway crossing.²² In 1939, the JC adopted revisions to the initial draft which addressed other important features such as signal warrants, no-passing zones, pavement markings, and pedestrian signals.²³

Although a wartime edition of the MUTCD was developed in 1942, the revisions contained in this version of the document primarily reflected a need to meet special demands created by the national security crisis. Therefore, this edition did not contain any real changes in signage or equipment design or traffic control standards.²⁴

The next series of important revisions were made in 1948 and included increases in the dimensions of certain signs, required illumination or reflectorization of “regulatory” (i.e., speed, stop, parking, etc.) and warning signs, and the use of solid and broken lines to indicate that the changing of lanes would be prohibited or permitted, respectively.²⁵ The 1948 revision process also entailed consideration of the use of traffic actuated and fixed-interval signalization equipment and a modification providing for the use of signals on direction-reversible lanes.²⁶ In 1954, the JC made changes in the Manual to establish that stop signs would feature white letters on a red background, and include no other messages in addition to the word “stop.”²⁷ During that same year, the Committee altered the shape of the “yield” sign, in order to conform to international standards, and established that roadway hazard warning signs should be placed 250 feet in advance of the hazard site in urban areas, and 750 feet ahead in rural areas.²⁸

The years 1960 and 1961 featured important changes in both the structure and composition of the Committee, as well as the content of the MUTCD. The JC’s membership was expanded in 1960 to include the two preeminent organizations representing local governments: the American Municipal Association (now the National League of Cities) and the National Association of County Officials.²⁹ The panel also established that eligibility for receiving Federal aid highway funds would be contingent upon attainment of the standards prescribed in the MUTCD.³⁰ Also, in this iteration of the Manual, the phrase “right-of-way” was dropped from yield signs, and “wait” indications for pedestrians were changed to “don’t walk.”³¹ Moreover, the Committee (then named the “National Joint Committee”) added two new parts to the document, one of which, Part VI, covered traffic control signalization, signage, and operations during roadway construction and maintenance activity.³²

The year 1971 also brought about dramatic changes in the MUTCD revision process in that the FHWA took over the management of the Manual’s development.³³ At that point in the MUTCD’s history, the Committee became an advisory panel with no official standing with the FHWA.³⁴ At that stage, the FHWA also began to make revisions to the MUTCD by invoking the formal Federal rulemaking process.³⁵ Substantive changes in the Manual’s content, such as the inclusion of instructions to paint yellow lines separating parallel and countercurrent traffic and to use orange barricades to protect work zone areas, were also made that year.³⁶

Although the MUTCD’s 1978 edition largely represented the mere incorporation of post-1971 modifications into a single document, in 1978 a few changes were made that are worth noting.³⁷ Pedestrian indications were made more symbolic and less verbal; a new chapter was created to develop traffic control standards for railway-highway intersections; and, most important, traffic control plans were identified as necessary to promote the enhancement of roadway work zone safety.³⁸ (Due to the Carter Administration’s efforts to phase out a number of Federal advisory panels, the Committee became fully independent from the Government in 1979, and was then renamed the National Committee on Uniform Traffic Control Devices [NCUTCD].)³⁹

Since 1978, the FHWA and the NCUTCD have added a requirement under which temporary pavement markings would be made in construction work zones, in addition to language providing for the use of “yield” and “stop” signs at railway-highway (at-grade) crossings.⁴⁰ These latter provisions were, of course, adopted pursuant to § 1077 (Revision of Manual) of ISTEA.⁴¹ Finally, it should be noted that the FHWA and the Committee have recently generated a new Part VI on construction and maintenance-related traffic control devices and operations. The provisions of this most current version of Part VI were codified (under the Code of Federal Regulations [CFR]) in a January 1994 FHWA rulemaking. Each State must adopt either the new Part VI or a more stringent traffic control regime by January 10, 1996.⁴²

Conclusion

These programs and initiatives are essential parts of a long-term Federal effort to accomplish the integration of architectural and structural safety-oriented improvements, and traffic engineering/work zone safety applications, with the ongoing development of the Nation's surface transportation infrastructure. The apportionment of 10 percent of STP funds to transportation safety activities has been combined with other program elements (such as the 90 percent Federal match provided under the Hazard Elimination Program) to "leverage" the construction of barriers and other safety facilities, the installation of traffic control devices, the relocation of highway improvements away from railway corridors, and other projects. Efforts to provide State and local agencies with greater flexibility to make transportation safety decisions, such as in those cases where "yield" and "stop" signs may be installed at certain railway-highway intersections, also contribute to the integration process.

At the same time, the MUTCD, whose revision has been subject to the Federal rulemaking process for the last 23 years, constitutes a mechanism through which important traffic control and safety standards can be promulgated and enforced. Moreover, the Manual's development has been influenced by the expansion of the Nation's economy, the increasing mobility of individuals, the advancement of technology and other socioeconomic, demographic and transportation-related factors. This evolutionary process has been reflected by certain architectural modifications and policy shifts such as changes in the shape and dimensions of signs, the widening use of symbols rather than words, and the increasing emphasis placed upon traffic control planning for roadway construction work zones. Eventually, efforts made by States and their political subdivisions to implement the MUTCD's prescribed measures may be reinforced by private sector-initiated safety standard compliance activities mandated under the OSHA reform legislation.

Overall, the combination of Federal funding, State and local government action in response to FHWA rulemaking, and employer efforts to meet Federal construction contracting and safety standards could serve to ensure the "national priority" status of traffic control and work zone safety.

Background paper prepared by Leon A. Mariano, Legislative Representative, ARTBA, for the National Conference on Work Zone Safety.

ENDNOTES

¹ Jean Lauer (professional staff member, U.S. Senate Committee on Environment and Public Works), telephone discussion, November 1994.

² *Title 23, U.S. Code, Sec. 133.*

³ Jean Lauer (professional staff member, U.S. Senate Committee on Environment and Public Works), telephone discussion, November 1994.

⁴ Department of Transportation, Federal Highway Administration, *The 1993 Annual Report on Highway Safety Improvement Programs* ([Washington, D.C.]: U.S. Department of Transportation, Federal Highway Administration, 1993), I-2.

⁵ *Ibid.*

⁶ *Title 23, U.S. Code, Sec. 130.*

⁷ Department of Transportation, Federal Highway Administration, *The 1993 Annual Report on Highway Safety Improvement Programs* ([Washington, D.C.]: U.S. Department of Transportation, Federal Highway Administration, 1993), I-2.

- 8 _____. *The 1993 Annual Report on Highway Safety Improvement Programs* ([Washington, D.C.]: U.S. Department of Transportation, Federal Highway Administration, 1994), S-2.
- 9 Ibid.
- 10 Kenneth Epstein (highway engineer, Department of Transportation, Federal Highway Administration), telephone discussion, November 1994.
- 11 Ibid.
- 12 Caryll F. Rinehart (professional staff member, U.S. House of Representatives, Committee on Public Works and Transportation, Subcommittee on Surface Transportation), telephone discussion, November 1994.
- 13 *Intermodal Surface Transportation Efficiency Act of 1991, Statutes at Large*, 105, § 1051, 2001 (1991).
- 14 Department of Transportation, Federal Highway Administration, *FY 1992 Annual Work Zone Traffic Safety Summary Report* ([Washington, D.C.]: U.S. Department of Transportation, Federal Highway Administration, 1992), 4.
- 15 Ibid.
- 16 *Intermodal Surface Transportation Efficiency Act of 1991, Statutes at Large*, 105, § 1077, 2015 (1991).
- 17 Department of Transportation, Federal Highway Administration, *FY 1992 Annual Work Zone Traffic Safety Summary Report* ([Washington, D.C.]: U.S. Department of Transportation, Federal Highway Administration, 1992), 5.
- 18 Ibid.
- 19 Congress, Senate, Committee on Labor and Human Resources, *Comprehensive OSHA Reform Act, S. 575: Hearing before the Committee on Labor and Human Resources*, 103rd Cong., 2nd sess., 22 February 1994.
- 20 H. Gene Hawkins, Jr., P.E., "Evolution of the MUTCD: Early Editions of the MUTCD," *Institute of Transportation Engineers Journal* 62, number 8 (August 1992): 17.
- 21 Ibid., 17-23.
- 22 Ibid., 18.
- 23 Ibid., 20.
- 24 Ibid., 23.
- 25 H. Gene Hawkins, Jr., P.E., "Evolution of the MUTCD: The MUTCD Since World War II," *Institute of Transportation Engineers Journal* 62, number 11 (November 1992): 17.
- 26 Ibid., 18
- 27 Ibid., 18.
- 28 Ibid., 18.
- 29 H. Gene Hawkins, Jr., P.E., "Evolution of the MUTCD: Early Editions of the MUTCD," *Institute of Transportation Engineers Journal* 62, number 8 (August 1992): 19.

- 30 H. Gene Hawkins, Jr., P.E., "Evolution of the MUTCD: The MUTCD Since World War II," *Institute of Transportation Engineers Journal* 62, number 11 (November 1992): 19.
- 31 Ibid.
- 32 Ibid.
- 33 H. Gene Hawkins, Jr., P.E., "Evolution of the MUTCD: Early Editions of the MUTCD," *Institute of Transportation Engineers Journal* 62, number 8 (August 1992): 19.
- 34 Ibid.
- 35 Ibid.
- 36 H. Gene Hawkins, Jr., P.E., "Evolution of the MUTCD: The MUTCD Since World War II," *Institute of Transportation Engineers Journal* 62, number 11 (November 1992): 20.
- 37 Ibid., 21.
- 38 Ibid., 21.
- 39 H. Gene Hawkins, Jr., P.E., "Evolution of the MUTCD: Early Editions of the MUTCD," *Institute of Transportation Engineers Journal* 62, number 8 (August 1992): 19.
- 40 H. Gene Hawkins, Jr., P.E., "New Developments with the MUTCD," *Institute of Transportation Engineers Journal* 64, number 2 (February 1994): 17.
- 41 Ibid.
- 42 Michael E. Robinson (highway engineer, Department of Transportation, Federal Highway Administration), telephone discussion, November 1994.

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- _____. "Evolution of the MUTCD: The MUTCD Since World War II." *Institute of Transportation Engineers Journal* 62 (November 1992): 17-23.
- _____. "New Developments with the MUTCD." *Institute of Transportation Engineers Journal* 64 (February 1994): 16-21.
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Rinehart, Caryll F. (professional staff member, U.S. House of Representatives, Committee on Public Works and Transportation, Subcommittee on Surface Transportation). 1994. Telephone discussion.

Robinson, Michael E. (highway engineer, U.S. Department of Transportation, Federal Highway Administration). 1994. Telephone discussion.

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_____. *The 1993 Annual Report on Highway Safety Improvement Programs*. [Washington, D.C.]: U.S. Department of Transportation, Federal Highway Administration, 1993.

_____. *The 1994 Annual Report on Highway Safety Improvement Programs*. [Washington, D.C.]: U.S. Department of Transportation, Federal Highway Administration, 1994.

Intermodal Surface Transportation Efficiency Act of 1991, Statutes at Large, Vol. 105 (1991).

Title 23. U.S. Code.

APPENDIX C

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APPENDIX D

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ACRONYMS

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AP	Arrow Panel
ARTBA	American Road & Transportation Builders Association
ATSSA	American Traffic Safety Services Association
cd	candela
CDL	Commercial Driver's License
DMV	Department of Motor Vehicles
DOT	Department of Transportation
FARS	Federal Accident Reporting System
FHWA	Federal Highway Administration
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITS	Intelligent Transportation Systems
IVHS	Intelligent Vehicle Highway Systems
JC	Joint Committee on Uniform Traffic Control Devices (now known as the NCUTCD)
MRVD	Minimum Required Visibility Distance
MSDS	materials safety data sheet
MUTCD	Manual on Uniform Traffic Control Devices
NCHRP	National Cooperative Highway Research Program
NCUTCD	National Committee on Uniform Traffic Control Devices
NHI	National Highway Institute
NHS	National Highway System
NHTSA	National Highway Traffic Safety Administration
NTPEP	National Transportation Product Evaluation Program
NTSB	National Transportation Safety Board
OSHA	Occupational Safety and Health Act (Administration)
PCMS	Portable Changeable Message Sign
PSA	Public Service Announcement
SHRP	Strategic Highway Research Program
STAA	Surface Transportation Assistance Act of 1978
STP	Surface Transportation Program
STURAA	Surface Transportation and Uniform Relocation Assistance Act of 1987
TCD	Traffic Control Device
TCP	Traffic Control Plan
TLTW	Two Lane/Two Way

NOTES