Proceedings

National Conference on

WORK ZONE SAFETY

December 5-7, 1994

Sponsored by:

Federal Highway Administration
American Road & Transportation Builders Association

Cosponsors:

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

NATIONAL CONFERENCE ON WORK ZONE SAFETY

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PROCEEDINGS

Sponsored by the

FEDERAL HIGHWAY ADMINISTRATION

AND THE

AMERICAN ROAD & TRANSPORTATION BUILDERS ASSOCIATION

Cosponsored by the

AMERICAN ASSOCIATION OF STATE HIGHWAY & TRANSPORTATION OFFICIALS

AND THE

AMERICAN TRAFFIC SAFETY SERVICES ASSOCIATION

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EXECUTIVE SUMMARY

On December 5-7, 1994, the American Road and Transportation Builders Association (ARTBA) and the Federal Highway Administration (FHWA) hosted the National Conference on Work Zone Safety. Cosponsors of the event were the American Association of State Highway & Transportation Officials (AASHTO) and the American Traffic Safety Services Association (ATSSA). The Conference, held in Washington, D.C., was designed to explore ways in which the highway construction industry and Federal, State and local governments can reduce accidents and fatalities in work zones. In 1993, following a healthy two-year decline in work zone fatalities, deaths rose from 647 in 1992 to 762. This trend underscores the need to identify the causes of these accidents and develop means to counter them.

Attending the Conference were more than 200 people representing diverse safety areas, including educators, engineers, corporate and Government officials. The two-and-a-half-day agenda was designed to offer a broad perspective from several disciplines as to the contributing factors causing accidents in work zones and possible remedies. Dr. Nicholas J. Garber, Professor of Civil Engineering at the University of Virginia served as moderator for the Conference, which began with an official welcome and introductory remarks by officials of the sponsoring organizations: Anthony R. Kane, Acting Executive Director, FHWA; Kenneth R. Rezendes, Chairman, ARTBA; Francis B. Francois, Executive Director, AASHTO; and Robert M. Garrett, Executive Director, ATSSA.

To give participants a foundation for their discussions in their respective workshops, the first day of the Conference featured an address by Dr. Garber, who presented an overview of existing problems related to work zone safety.

Consultant Douglas J. Mace, President of Last Resource, Inc., then provided an overview of new arrow panel technology based on information obtained from an ongoing NCHRP study. Arrow panels are widely used in street and road construction zones to warn motorists of potential hazards and redirect traffic. Manufacturers have been working to resolve problems related to visibility, which has sometimes been adversely affected by the use of solar power and a lack of sufficient quality control in the manufacturing process. Recently, researchers have sought to identify optimum visibility standards (light intensity) and distances with specific goals in mind—e.g., to alert drivers or to provide recognition.

The final morning speaker, Michael Robinson, Highway Engineer, Office of Highway Safety at the Federal Highway Administration, described changes in the *Manual on Uniform Traffic Control Devices (MUTCD)*, specifically those which apply to Part VI, which deals with work zone issues. Part VI took effect in January 1994, with the States being allowed two years to implement the final rule. In addition to changes in nomenclature which appear in the revised Part VI (namely the use of "temporary traffic control zone" in place of "work zone" and "road work" to replace "road construction"), the MUTCD now contains provisions which did not appear previously. These apply to the following areas:

- Identification of the four components of a temporary traffic control zone (i.e., Advance Warning Area, Transition Area, Activity Area, and Termination Area).
- Specifications for sign placement, colors, and content to reduce risk to motorists, pedestrians, and workers in temporary traffic control zones.
- Requirements related to training, worker clothing, barriers, speed controls, enforcement personnel, lighting, special devices, public information, and road closure.
- Selection of proper traffic control devices and methods.

The luncheon address was presented by The Honorable Nick J. Rahall II (D-WV), former Chairman of the Surface Transportation Subcommittee of the House Transportation and Public Works Committee. Congressman Rahall offered his predictions of how the new Republican Majority in Congress will view special transportation projects that are often included in highway bills. Despite the possible shift in priorities and focus expected to emerge under the Republican leadership, the Congressman indicated that he expects "relatively smooth sailing" in the House for the National Highway System bill in 1995 and is hopeful that the Senate will follow suit.

During the afternoon, the participants separated into workshop groups that focused on five topics. The sessions were led by facilitators who guided the discussions. Each group spent the afternoon exploring specific issues related to work zone safety and concluded their session by listing their concerns and recommendations for enhancing the safety of those who drive through or work in temporary traffic control zones.

On the second day of the Conference, Joseph J. Lasek, Chief, Technical Development Branch Safety Office, FHWA, opened the morning session with a discussion of the National Work Zone Safety Program. Section 1051 of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) requires the Secretary of Transportation to develop and implement a work zone safety program that will improve work zone safety at construction sites. Mr. Lasek explained that the three-year high for work zone fatalities between 1988 and 1990 and the spike in 1993 was a clear indication that development of such a program is vital if the number of accidents and deaths are to be reduced. Ultimately, a draft National Work Zone Program was developed, and it addresses issues related to (1) standardization and uniformity; (2) ensuring compliance (3) evaluation (information/feedback/direction); and (4) implementation of innovative technologies.

Comments on the draft program reflected widespread support for the FHWA effort to improve work zone safety. However, it was evident that the States' ability to follow the recommendations set forth by FHWA would be limited by the available resources. This underscores the need for cooperation among the Federal, State and local agencies to strengthen safety programs.

Attorney Douglas D. Wilson, of the firm Parvin, Wilson, Barnett and Guynn, PC, then addressed the Conference, noting recent developments in work zone safety as they relate to liability, litigation, and insurance issues. His report focused on four types of regulations and laws that impose liability on employers for work zone hazards that either harm, or have a potential to harm, persons on the work site: (1) Occupational Safety and Health Act; (2) workers compensation laws; (3) common law negligence; and (4) State safety statutes. Mr. Wilson explained that employers are subject to numerous Federal and State laws regarding the safety of their workers on construction sites, and courts have continued to expand upon potential liability for employers in this area. This makes it more important than ever for employers to comply with existing statutes and regulations to avoid injury and liability for injuries and/or unintentional violation of paperwork rules.

The morning session concluded with a discussion of Work Zone Accident Data Collection by James E. Bryden, P.E., Construction Safety Coordinator, New York Department of Transportation. Mr. Bryden underscored the necessity of agency commitment to the health and safety of employees, contractors, and the public. New York's management of this area is centered around three integrated components: engineering, enforcement, and public awareness. By refining its data collection mechanisms and requiring accurate reporting, the State has achieved a better understanding of the causes of accidents and how they might be prevented. This has enabled State officials to implement more effective traffic control measures and enforcement activities, although improvements are still needed.

During the afternoon, participants again separated into different workshop groups which focused on the same five topics addressed in the first afternoon sessions. At the plenary session on day three of the Conference, the workshop facilitators had an opportunity to report on the discussions in their groups over the previous two days.

PHILOSOPHY OF TRAFFIC CONTROL

Dr. Russell M. Lewis, a consulting engineer, and John B. Moran, Director of Occupational Safety and Health, Laborers Health and Safety Fund of North America, reported that their groups had explored several issues related to this topic: (1) The proper application of traffic control devices to guide motorists through work zones; (2) creative and flexible use of traffic control devices to attract motorists' attention; (3) dissemination of highway information to the motoring public; and (4) appropriate use of enforcement personnel to achieve greater safety of both motorists and work zone personnel.

Dr. Lewis noted that in work zones, where normally available safety factors are reduced, it is essential to communicate effectively with most drivers. Many accidents tend to be predictable, given the characteristics of the highway and the limitations of drivers. Driver behavior can be adversely impacted if motorists are annoyed, late,

lost, or otherwise surprised or inconvenienced; impatience and anger can affect judgment and performance, and variable traffic patterns can cause congestion, distraction, and confusion.

Driver performance, therefore, may be enhanced to a degree by minimizing delays, distractions, and inconvenience. Among the temporary traffic control principles and recommendations which emerged from the discussions in Dr. Lewis's and Mr. Moran's groups were the following:

1. Traffic control procedures should be based on road users' needs and characteristics. Reduced speed zoning should be avoided as much as practical.

2. Roadway occupancy and work completion time should be minimized to reduce exposure to potential hazards.

3. The results of a systems failure should be analyzed. The justification for using higher types of traffic control increases with the greater potential for catastrophic incidents.

4. Traffic control devices are effective only to the degree that (1) they are consistent with people's desires; (2) they are believed to be unduly hazardous if ignored; or (3) there is fear of enforcement. Consistency is needed with respect to uniform traffic control devices and standard procedures.

5. While Part VI of the MUTCD is generally regarded as "good," the Manual is primarily focused on the protection of the public rather than workers in work zones. Changes that reduce risks to one group must not increase risks to the other.

6. There is a need to reassess construction methods and designs from a safety perspective. Designs should address methods to provide construction vehicle access on other than the traffic-disturbed roadway. Physical separation between traffic and the work zone should be employed where possible, and work vehicles and equipment should look like work vehicles.

7. A shift in attitudes (on the part of both the public and governments) is needed as to how resources are allocated to work zone safety. Too often, it is only when a fatal event occurs that appropriate resources are provided to enhance safety.

8. Also needed is an understanding of measures that have been successfully applied to improve safety and a means for disseminating this information. It is recommended that a national clearinghouse be established for this purpose.

9. Credibility is seen as a major problem in traffic control. Therefore, signs and warnings must accurately reflect the situation in the work zone if driver performance is to be managed effectively. Drivers are most likely to utilize traffic control information when it appears to be reasonable, useful, and consistent with their expectations and experience.

10. Systems of communicating with drivers must be improved. The news media can be engaged as partners in apprising motorists of work zone activities and potential delays. Innovative approaches to provide real time information to motorists is needed to minimize frustration and delays.

12. Adequate enforcement measures should be employed, including the allocation of police and highway patrol personnel as appropriate.

13. Double points imposed on a driver's record for violations may have more impact on motorist behavior than double fines.

14. Education is key to improving safety for motorists and workers. Almost no State driver handbooks contain any information related to safe travel through work zones. The appropriate time to begin training drivers is in elementary school, to instill a safety mindset from childhood.

15. Training of workers is essential in any safety improvement effort. Accidents and fatalities involving workers in work zones are very high during the first year of employment and drop dramatically for several years thereafter. Early training, properly administered, can significantly reduce the number of accidents among the most vulnerable group.

16. Contract provisions should be reexamined and modified and incentives / disincentives considered as means of enhancing the safety of workers and motorists.

17. Relative risks should be evaluated, including risks of daytime vs. nighttime work, particularly in light of the increasing trend toward night work.

WORK ZONE SAFETY IMPLEMENTATION

The purpose of these workshops, conducted by Jon V. Jackels, Work Zone Safety Coordinator of the State of Minnesota Department of Transportation, and ATSSA Director of Education and Training Victor H. Liebe, was to identify for public and private agencies good practices that ensure quality work zone traffic controls are applied in all work zones. Mr. Jackels and Mr. Liebe reported the following recommendations from their sessions:

1. Key elements of all work zone traffic control and safety programs include appropriate standards and guidelines; technical training; state-of-the-art work zone traffic controls; and quality control.

2. Successful implementation of work zone traffic controls involves both operations (Traffic Control Plans, public awareness) and monitoring (accident data collection, law enforcement) components.

3. Maintaining quality work zone traffic control devices requires the commitment of all levels of management; qualified field personnel; and up-to-date project manager tools.

4. Categories of good practices to improve the application of quality work zone traffic controls include surveillance by the owners, project personnel, workers and inspectors; quality tools and procedures; law enforcement personnel with traffic control and safety awareness training; positive and negative incentives; development of a safety culture among both workers and the motoring public; improved quality assurance procedures, to including training and certification as well as formalized procedures; and a traffic management scheme with some flexibility built in.

5. More joint participation should be encouraged among Government agencies and jurisdictions, contractors, and associations.

6. A central clearinghouse of information has great potential as a resource for agencies, contractors, and planners.

7. Pre-qualification of contractors should be encouraged.

8. More frequent inspections and better follow-up mechanisms could enhance work zone safety.

9. Future revisions of the MUTCD should be more user-friendly and more understandable, and cover areas not now included. More input from municipalities to supplement information provided by State and Federal agencies could make the Manual more balanced.

10. The MUCTD (or an organization such as AASHTO) should provide more guidance on how to develop a good Traffic Control Plan in an easily understood form. Current design handbooks are written for engineers and are not user-friendly for other principals involved in planning.

11. Greater public awareness of work zone safety issues can be achieved through education programs and media involvement.

CONTRACTORS CONSTRUCTION MANAGEMENT

The co-facilitators of this workshop were Robert Attaway, Highway Program Director, Institute for Transportation Research and Education, North Carolina State University, and Joseph R. Julian, President of James Julian, Inc. Their groups addressed the need for proper safety training of work zone personnel. Partnering was seen by both groups they led as the other key to achieving effective construction management. During the two sessions, the recommendations that emerged fell into four broad categories:

1. **Training.** The groups agreed that training should be a universal requirement for those who work in temporary traffic control zones. Moreover, training should be uniform from State to State, project to project (especially for flaggers) and readily available. It is less certain whether certification in particular areas (such as flaggers) is desirable, but it could be used to designate completion of training, rather than level of competence achieved.

2. **Partnering.** Partnering is a concept which, when approached properly, results in a level of flexibility necessary to make course adjustments during a project without violating the terms of the contract. In some States, the process has been quite successful; in others, it has had mixed reviews. However, most participants believe it has great potential for improving conditions in work zones that have an impact on the safety of both the motorist and the worker, and therefore should be encouraged.

3. **Lump Sum vs. Unit Pricing.** Each of these two methods for paying for traffic control items and personnel has proponents. The general consensus was that each is appropriate in certain circumstances. Innovation is called for in lump sum situations, particularly in the event of resequencing, where the lump sum would have to be renegotiated to reflect the resequencing. On the other hand, pre-set items, such as flaggers, can be very hard to plan and could exceed the anticipated quantity. In such cases, unit pricing could be the best option. The group recommended that planners take into account such issues, as well as the legal nuances in given jurisdictions, to achieve the appropriate balance between the two.

4. **Incentives and Disincentives.** The workshop groups concluded that there are too few incentives under the current system. One area in which they have proved effective is lane or interchange rentals, wherein the contractor is charged a specific amount for shutting down an interchange or lane if he exceeds the time allotted for completion of his project. Incentives can also be useful where it is important that a project be completed quickly or as a means of rewarding superior performance. It is suggested that criteria be developed for assigning value to superior performance on traffic zone safety, to be used as a measure to evaluate appropriate rewards.

INTERACTION WITH PUBLIC HIGHWAY USERS

These workshops, chaired by Maj. Thomas H. Milldebrandt, Criminal Justice/Traffic Law Enforcement Consultant, and Jerry E. Graham, P.E., President, Graham-Migletz Enterprises, Inc., addressed enforcement and speed control issues, and the need for public education programs to better inform motorists of the hazards of work zones. The recommendations that emerged from their discussions included the following:

1. The appropriate enforcement agencies should be involved in the formulation of the Traffic Control Plan rather than merely instructed in how they are expected to participate.

2. Police administrators must be sold on the importance of work zone traffic control and sufficient manpower to their total police mission.

3. Off-duty officers should be used where appropriate to provide a police presence and encourage motorists' compliance with work zone speed limits and controls. Funding through legislation should be considered for this purpose if necessary.

4. Enforcement personnel should be trained in the provisions of Chapter VI of the MUTCD in general and the current Traffic Control Plan in particular.

5. Law enforcement agencies should have the authority to cite those responsible for implementing and maintaining the Traffic Control Plan when they do not comply.

6. Public education programs should be developed and geared for various segments of society, including older drivers, children, contractors, construction workers, highway officials, police and others.

7. Driver awareness of work zone safety issues could be enhanced with greater exposure through driver handbooks and licensing tests.

8. The press and other media, including direct mail, should be used as tools to disseminate information and enhance public awareness of safety issues and concerns. Again, appropriate funding through legislation should be considered for this purpose.

The participants noted that enforcement is not, however, a panacea for poor traffic control practices. Rather, it should be planned for and accommodated under Traffic Control Plans.

ADVANCED TECHNOLOGIES

These workshops were conducted by Dr. Ray Benekohal, Associate Professor of Civil Engineering, University of Illlinois at Urbana-Champaign, and Dr. H. Gene Hawkins, Jr., who is an Associate Research Engineer and Program Manager with the Texas Transportation Institute of the Texas A&M University System. Their groups addressed means by which recent developments and emerging technologies can improve work zone safety for both motorists and workers. This subject is especially important at a time when night work is preferred for the convenience of motorists and to minimize workers' exposure to hazards posed by drivers. Recommendations from the discussions included the following:

1. Technological advances should be aimed at protecting both workers and drivers.
2. New products and technologies are needed to facilitate:
    - more accurate information to travelers (e.g., rerouting, etc.)
    - real-time information (e.g., travel times, delays)
    - credible messages
    - more active traffic control devices rather than the current passive TCDs
    - reduction of the duration of work zones.
3. Future traffic safety devices should enhance visibility and lighting, improve delineation of work space, and reduce distraction to drivers.
4. Guidelines for reflectance standards should be developed, and the development and evaluation of new retroreflective materials should be encouraged.
5. The development of computerized work zone data collection devices, including hardware and software that could track comprehensive accident data, should be encouraged. In addition, the procedures by which new technologies and devices are brought into practice should be streamlined.
6. A new category of funding for testing or development of new TCDs should be established. The ISTEA program should be revised to require a work zone safety management system.
7. Industry should develop and improve driver information technologies, using heads-up displays, radio, and changeable message signs.
8. There is a need for implementation procedures that can respond to advancing technologies, perhaps through specific user services (e.g., work alarms, vehicle positioning, driver information, and incident and congestion management).
9. Uniformity of systems is desirable, and may be achieved through the establishment of a national clearinghouse.
10. Automated vehicle control technologies for work zones have potential for ensuring speed compliance in work zones of the future. Such technologies could also be used to provide advance information of which the driver should be aware.
11. Economic incentives should be provided to encourage contractors to adopt technologies that can improve safety and to comply with existing standards.

CONCLUDING REMARKS

The Conference moderator, Dr. Nicholas J. Garber, noted that while numerous recommendations were developed in the workshops, they could be condensed into a few major themes:

1. **User characteristics.** Research in this area is needed to identify the characteristics of the people who are involved in problem areas, both drivers and pedestrians. Both groups must be educated as to the hazards of negotiating work zones and how to successfully get through these areas.

2. **Incentives.** Both positive and negative incentives can be useful tools in achieving the desired performance on the part of the contractor.

3. **Reducing exposure.** To the extent possible, the length of time motorists spend in work zones should be minimized.

4. **Speed management.** Rather than setting arbitrary speed limits that drivers often ignore, we should identify the correct speeds for work zones and the means of bringing the drivers to comply with reduced speed limits established in those zones.

5. **Partnering.** This concept has numerous applications, particularly in arriving at the appropriate means of paying for work zone traffic control and in reducing exposure by reducing the length of contractor activities.

6. **Separating traffic.** Current systems do not allow the separation of traffic in terms of speed and volume, but means of doing so should be explored.

7. **Advanced technologies.** Real time traffic control devices can offer motorists up-to-the-minute information and limit the frustration, delays, and unwelcome surprises that cause accidents. Advanced technologies also should be used to facilitate data collection in work zones.

8. **National clearinghouse.** Cooperative efforts among the Conference's sponsoring organizations and others are needed, particularly in the development of a national clearinghouse, whereby information can be disseminated more efficiently to interested jurisdictions and agencies.

9. **Regional conferences**, similar to this one, could be very useful in addressing these and other issues and in developing workable solutions.

SECTION I

INTRODUCTION

On December 5-7, 1994, the American Road and Transportation Builders Association, in cooperation with the Federal Highway Administration, conducted a National Conference on Work Zone Safety. Cosponsors of the event were the American Association of State Highway and Transportation Officials and the American Traffic Safety Services Association.

In attendance were over 200 work zone and highway safety professionals, including engineers, educators, researchers, enforcement officials, manufacturers, and highway construction officials and personnel, as well as representatives from private industry and Federal and State governments. Participants and speakers at the Conference addressed important current issues related to enhancing the safety of both workers and the motoring public in construction work zones. These discussions focused on the recent increase in work zone fatalities and how work zone-related deaths might be sharply reduced or eliminated.

The purpose of the Conference was to achieve a consensus on high-priority problems and issues facing the highway construction industry and means by which they should be addressed. Particular attention was paid to the following:

- Causes of fatalities and serious injuries in work zones.
- Protection of work zone personnel and the motoring public.
- Means of enhancing safety by achieving greater credibility and effectiveness of signs in work zones.
- How new technologies can be used to decrease incidents and improve traffic flow in work zones.

CONFERENCE STRUCTURE

First Day

Opening remarks were presented by Anthony R. Kane, Acting Executive Director of the Federal Highway Administration, ARTBA Chairman Kenneth R. Rezendes, AASHTO Executive Director Francis B. Francois, and ATSSA Executive Robert M. Garrett. Then, Dr. Nicholas J. Garber of the University of Virginia was introduced as the Conference moderator. Dr. Garber delivered an overview entitled, "Work Zone Safety Findings: Statement of the Problem."

Following Dr. Garber's presentation, Douglas J. Mace of Last Resource, Inc., discussed "Advanced Technologies: Arrow Panel Visibility" and FHWA's Michael Robinson identified "Part VI MUTCD Changes."

During the luncheon that followed the morning session, U.S. Congressman Nick J. Rahall (D-WV) offered his perspective on the transportation outlook in the new Congress, following the Republican Party's assumption of majority status in both Houses in January.

Conference participants then attended one of five workshops on topics of specific interest to them, with each session devoted to facets of the overall Work Zone Safety Conference theme. The workshops focused on the following areas:

- Philosophy of Traffic Control
- Work Zone Safety Implementation
- Contractors Construction Management
- Interaction with Public and Highway Users
- Advanced Technologies

In each of the workshops, the leaders offered a brief background on the topic to be explored, and facilitated the formulation of consensus on primary issues to be presented at the plenary session on the third day of the Conference. Each workshop was conducted according to the same structured format, and was limited to 35 participants. Except for the "Contractors Construction Management" workshop, which was jointly moderated by two facilitators, the other topics were explored in two workshops each on both days.

Second Day

Day two began with a general session at which FHWA's Joseph J. Lasek presented his views on the National Work Zone Safety Program. The second speaker, attorney Douglas D. Wilson of Parvin, Wilson, Barnett and Guynn, PC, addressed issues related to liability, litigation, and insurance. The final speaker was James E. Bryden, an engineer with the New York Department of Transportation, who discussed the way his State collects work zone accident data.

After lunch, participants retired to the workshops to which they had been assigned. All attended workshops different from the ones they attended the first day. This gave everyone an opportunity to participate in a broad range of discussions on topics of interest to them.

Third Day

It was anticipated that discussions and findings in the respective workshops would overlap, and this expectation was borne out in the plenary session on day three, when each of the workshop facilitators presented a recap of the discussions in their groups. Following these reports, the Conference moderator, Dr. Garber, offered concluding remarks and adjourned the meeting.

PROCEEDINGS STRUCTURE

This proceedings document summarizes the events of the Conference. It is divided into several sections as follows:

The E**xecutive Summary** contains an overview of the speakers' presentations and a summary of the workshops and the conclusions offered during the plenary session on day three.

Section I opens with this Introduction and includes the opening remarks of the Conference sponsors and cosponsors on day one, as well as transcripts of the presentations by guest speakers on days one and two.

Section II includes the facilitators' summaries of the two days of workshops, as presented to the plenary session on day three. This section also contains the concluding remarks by the Conference moderator, Dr. Nicholas Garber.

The **Appendices** contain the Conference agenda, tables and background materials, a listing of Conference participants, acronyms found throughout this volume, and a summary of legislative activities related to work zone safety programs.

SYMPOSIUM WELCOME

OPENING REMARKS

Anthony R. Kane

Acting Executive Director
Federal Highway Administration

On behalf of the Federal Highway Administration, I want to welcome you to this Conference. It's a real pleasure to be with you here today, and I think the audience participation at this event is meaningful, important, and absolutely required. We have representatives from the Federal Government, State governments, local governments, industry, academia, and law enforcement agencies, and that's what is really needed to move ahead and advance safety in work zones.

The partnership among the organizers and sponsors of this Conference will help us make work zone safety effective. Certainly FHWA's support and sponsorship of this event reflects our long-term concern for, and involvement in, improving traffic flow and safety in work zones.

Frankly, the numbers are startling when you take a look at the work zone fatalities we've had across the country, particularly in 1993, when there were over 760 fatalities in work zones with over 100 of them involving construction workers and other pedestrians. At the same time, let's remember our two customers in this process: the driving public and the workers.

Let's look back for a minute and see how we got to where we are. Within our own region, in the early 1970s there were a number of activities where work zone safety became very important. In Virginia, where we had several concurrent Capital Beltway widening projects, we moved ahead in terms of technology. At that time we were alerted to the consequences of using inadequate traffic control devices such as timber barricades in an inappropriate manner, adjacent to high-speed, high-volume lanes.

In the 1980s, we had a very similar project in Pennsylvania involving the Penn-Lincoln Parkway, I-376. For the first time, we realized as an agency that we must participate financially in far more than just the construction, by addressing traffic handling capability. The degree to which we can alternatively handle traffic through work zones really benefits both the highway user and the construction worker.

Also in the 1980s, we were involved in another local project involving the Woodrow Wilson Bridge. This was one of the first to use incentive/disincentive clauses to keep the traffic way open during the day. That, of course, involves nighttime construction, which comes with a number of other problems. At the same time, it really facilitated the main traffic flow through the work zone area. The key there was working closely with the construction industry. And this really is the core of our partnership with the States, Government, the contractors, and the manufacturers of the products used in work zones.

While the use of incentive and disincentive clauses might have been an innovation, now in about 26 States we apply A+B contracts that focus on the importance of user costs and getting the construction done in a timely fashion. This is important, because it enables us to work together to really address the problems, to interact not in an antagonistic way but in partnership. The quality assurance efforts on the part of the construction industry will move us even further ahead.

At FHWA, we're going to continue our efforts in safety research, and certainly to promote new programs, products and equipment, offer new training courses, and work on good demonstration projects, in an effort to determine where technology is effective.

We're not alone as a Federal agency. The NTSB has also placed great emphasis on work zone safety. Over the years they've made a number of recommendations that we've implemented. The U.S. Congress has also zeroed in on work zone safety. There are three sections of ISTEA relative to work zones. The Section 1090 study provided a strong focus on the importance of mitigating traffic congestion due to work zones.

We're currently working with NHTSA on the provisions of Section 2002(a), which focuses on the importance of getting accurate highway traffic safety data and accident information. I realize it's very tough to gather this type of data, particularly as it relates to work zones. But it will be important, as we look for solutions, to understand why we're experiencing the kind of accidents and fatalities we now have.

Finally, Section 1051 requires the development of a of national work zone safety. That will be discussed later in this Conference. We had issued a *Federal Register* notice soliciting comments on the draft program. Many comments were received in response to the notice.

In closing, let me just point out something that is clear to all of you. We still have a long way to go. I think the sharp rise in work zone accidents in 1993 tells us that. We must pursue our ongoing efforts in terms of work zone safety, and that's why this Conference is so important. We have to focus on measures we can take in partnership with the private sector, with State and local governments, and with the Federal Government.

Ken Rezendes

Chairman
American Road & Transportation Builders Association

Good morning—and welcome to the National Work Zone Safety Conference!

I'm Ken Rezendes, the 1994 Chairman of the American Road & Transportation Builders Association, and a highway contractor from Assonet, Massachusetts. It is a distinct honor and privilege to be asked to lead off this important Conference.

We at ARTBA are extremely proud to have had the opportunity to sponsor this event in partnership with the Federal Highway Administration. Our Association—like FHWA—sees work zone safety as a major problem for our industry and the Nation.

One death or injury in a road construction work zone is one too many. That's where we start. The 762 fatalities through 1993 that were recorded by the National Highway Traffic Safety Administration (NHTSA) are wholly unacceptable. Highway safety in general has been a priority for the United States Department of Transportation for many years.

The Department's published Strategic Plan makes the promotion of safe, secure transportation one of its major goals. In the plan, Transportation Secretary Federico Peña writes:

> We will implement a new strategy to bring an end to the deaths through significant public outreach, public education, and aggressive enforcement in collaboration with safety organizations, in cooperation with state and local governments to promote new safety technologies.

This Conference reflects that top-level commitment to improve highway safety in a very specific way. We commend Secretary Peña, Federal Highway Administrator Rodney Slater, and the FHWA Office of Highway Safety for initiating and providing financial support for this important event. They are demonstrating true leadership in this area.

ARTBA, which has members from all sectors of the construction industry, public and private, has also been very concerned about this problem for many years. This concern led our traffic safety industry contractors and transportation officials division to organize the first-ever conference on road work safety in 1986. That event was cosponsored by FHWA and the American Association of State Highway and Transportation Officials. The 1986 conference led to specific recommendations for action, particularly in response to the need for better data about the problem at the State and Federal levels and the need to develop more effective and widespread public awareness campaigns to focus increased attention on this hazard.

Over the past decade, a number of States have developed excellent public awareness campaigns, many of which I am sure we will hear about over the next several days. The "Give 'Em a Brake" campaign, which I believe was developed by the Department of Transportation, has been successfully implemented by several States and is an excellent example of what can be done. It's also an example of how the public and private sectors can work together creatively to solve a problem. The data suggest that public awareness programs, when aggressively pursued, do have an effect. After the peak year of 1989, roadwork fatalities had been decreasing until 1993, when the data show a 20 percent increase.

Those numbers serve as a wake-up call. It is clearly time to revisit this issue and to redouble our efforts in this area. It is time to look toward new ideas and the implementation of new technologies to meet this problem even more aggressively, because one thing is certain: Without aggressive action, this problem has the potential to get much, much worse.

The road construction market has changed dramatically over the past decade and will continue to do so.

The days of Interstate construction when we were building highways on vast, mostly unpopulated lands are largely over.

Although there will always be some new virgin construction in this country to accommodate demands rising from changes in demographics, rehabilitating and adding capacity to roads that have already been built is the real market today. That change of market has brought new safety problems to our work sites.

Now, our employees are increasingly working under traffic, literally seven feet from tractor trailers and cars that are often moving at over 60 miles an hour. To minimize disruption to motorists, we are also increasingly being asked to do our construction work late at night, when driver and worker visibility is often reduced and the chance of having a drunk driver coming through our work zones is dramatically increased. Just in terms of worker alertness, what is the effect on safety of having a labor force that works at night rather than during the day? I don't think we really know, but I believe it is part of the problem we need to address.

The Congress recognized the need to do something about improving work safety when it passed the Surface Transportation Act of 1991. It called on the Secretary of Transportation to develop a program to reduce the number of fatalities and accidents at road construction sites. This Conference, which draws together over 200 experts in this field from academia and the public and private sectors, is an important part of that mission.

We at ARTBA believe the time for new solutions is at hand. For example, literally billions of public dollars are now being directed toward the development of intelligent transportation systems (ITS) that will utilize computer, radar, satellite, and fiber-optic technologies. Surely ITS solutions to work zone safety problems should be a fundamental and serious priority for that program.

ARTBA has suggested to the Federal Highway Administration that a "Workers Present" initiative that utilizes real-time communications technologies can improve the credibility and utility of our workplace. Science may be part of the solution we are seeking.

In our search for quality in the highway construction industry, the need for real-time messages to inform our customers—American motorists—what we are doing or not doing on the roads should in my opinion be self-evident.

If we have a work zone set up and no one is working there, let's tell the motorists why they are not working—for example, when it is too cold or too wet to pour concrete or lay asphalt or when the work is being done in the middle of the night to minimize the safety risks and inconvenience to them. Let's build their trust in what our signs tell them. Let's build credibility in what we are doing.

Some of you know doubt read the article in a recent *Wall Street Journal* that was headlined, "Japanese Seek Quality Time on Road Trips." For those who didn't see it, let me read you a paragraph:

> Highways in Japan are easy to use, with signs mostly written in English as well as Japanese. Electronic sign boards estimate travel times to a given destination under current traffic conditions.

Why don't we have that? Why don't we use real-time signs and vehicle traffic communication devices that tell motorists that in a half-mile, there will be people working within 12 feet of their car, and then change that sign when the workers are gone, to say something like, "No Workers Present in the Work Zone," or "Heavy Equipment Remains—Proceed with Caution."

We can and must do better. FHWA, State transportation departments, local contractors—we all have to do a better job. Last winter, over on I-95 in Rhode Island, that highway was blocked off to one-lane traffic throughout the winter, with nobody working. This is definitely unacceptable to today's motorist.

I think we have to be sure we take care of the public. They are the ones who are going to vote for any gas tax increases in the future. I think we have to work a little harder to make sure people can get through the traffic and get to work on time without being delayed for hours at a time.

We are greatly indebted to the other nine national organizations who participated in the Conference Planning Committee. They are all mentioned in your program.

Special recognition should be given at the outset, however, to the American Association of State Highway and Transportation Officials and their Executive Director, Frank Francois. Thanks also go to the American Traffic Safety Services Association, led by its Executive Director, Bob Garrett. Both of these fine organizations not only had major input into the development of our program but are also cosponsors of this important event.

And I would certainly be remiss if I didn't acknowledge the real behind-the-scenes movers of this Conference, Clark Bennett, who most of you know retired just a few weeks ago after a long and distinguished career as director of FHWA's Office of Highway Safety; Joe Lasek, Chief, Technical Development Branch of FHWA's Safety Office; and ARTBA's John Chisholm, who is managing director of our Traffic Safety Industries Division and staff coordinator of this Conference. Thank you very much, John.

Ladies and gentlemen, in closing, again I want to welcome you to Washington and thank you for participating in this Conference. We have a very impressive roster of speakers and delegates. We have a lot of work ahead of us over the next two and a half days. I am confident, however, that with the knowledge and experience that are assembled here, we can come up with recommendations and solutions that can make a difference.

Francis B. Francois

Executive Director
American Association of State Highway and Transportation Officials

We at AASHTO think this is a very important Conference. We're very pleased to have had a part in planning and organizing it, and to have a part in taking the results and putting them into action.

Why has work zone safety become such a big issue? If you look at it from a historical perspective, it's easy to understand. Before about 1980, most of our highway construction was across open fields and in new areas without traffic. We were building new roads. Well, we're not doing that any more. Most of our work now is trying to reconstruct highways and roads that have already been built and doing so under traffic. That's why this issue has become so important. It's obvious, I think, that the accident problem is greater now than it used to be, for the reasons I just outlined.

To give you some feel for the problem, we've talked here about percentages and of accidents and deaths. But now let's talk about real people. The Fatal Accident Reporting System (FARS) maintained by NHTSA indicates that in 1982 there were 489 people killed in construction maintenance and utility work zones. By 1988, that 489 number had risen to 708. That's about what it's hovered around ever since. There was a little drop in 1991; then in 1992 the accident rate dropped way back to only 647. I say *only*—that's still far too many. But as we noted earlier, in 1993 it went back up again: 762 people lost their lives.

AASHTO has been very involved in work zone safety for many years. We've had several committees that have worked on it alone, and with other organizations, including those represented in this room. Our Standing Committee on Highway Traffic Safety has as one of its principal goals to try to improve work zone safety. Our Administrative Subcommittee on Public Affairs picked up some of the public relations programs that have been operated by States and tried to get them into broader use across the country, with some success. Our Subcommittees on Construction and Maintenance are always concerned about safety, and are deeply involved with it. So we have been working on work zone safety, and intend to keep working on it.

In recent years we've adopted a new practice at AASHTO that is directly related to this subject. For a long time now, a specific function at our annual meeting opening general session has been to read a memorial list of those persons working for our member departments of highways and transportation who have passed away in the past year. Two years ago we added a special list for those killed in the line of duty and that list is about as long as the other one. This is a very solemn moment, when we review the names of the men and women who were with us last year but aren't here this year because of a work zone accident. Those are only the people who work for the States. There are many, many more who work for contractors, and innocent other people who get caught up in all of this.

When we did the Strategic Highway Research Program a few years ago, we insisted that there be a safety component. We did get what we think are some very innovative safety devices out of that effort: new signing techniques, some new warning devices, and so on. Those are being applied around the country more and more now, but more can still be done.

Also within AASHTO, we recently established the NTPEP, the National Transportation Product Evaluation Program. One of its major purposes is to ensure quality in traffic marking and sign materials. We are putting up a national program, and have the cooperation of industry in this. Indeed, we have signed two interesting partnership agreements, the first that AASHTO has ever had—one with the American Traffic Safety Services Association, and one this morning, with the American Road & Transportation Builders Association, whereby those two organizations in their respective fields of interest will actually

have people serving on the governing body of NTPEP to help guide it. We think this is the way to go—partnerships—because this is a partnership problem that we're facing.

The bottom line is, we need to do better. In 1992, the National Transportation Safety Board examined the subject of work zone safety, and it sent two recommendations to AASHTO. First, develop, in cooperation with the Federal Highway Administration, a program to enhance compliance with existing guidelines regarding work zone safety features; and second, develop, in cooperation with the Federal Highway Administration, a National Work Zone Safety Program that integrates substantive enforcement, public information, and education efforts. We must enlist the support of those organizations and associations that can provide expertise in the areas of engineering, enforcement, and education.

The FHWA received a similar letter. One of the reasons we are here today is to help carry out what the National Transportation Safety Board has identified as a need for this nation.

We are pleased to be a part of this Conference, and it certainly is a good program addressing a lot of issues. The five workshops deserve your full attention. We need to look at what we're now doing, how we can do it better, and what we can do that's new, particularly using advanced technologies. I hope that you will focus on this a bit. As our chairman here this morning asked, what can we do with the new intelligent transportation system technologies that would improve work zone safety? I think there's quite a bit we can do. I just came back from a week in Europe at the First World Congress on applications of ITS technology. Some 31 nations were represented, with well over 2,000 people from government and industry there, talking about many of the new technologies that are becoming available to help us.

A comment was made here about Japan, but the Japanese were there, and they do not by any means have their problems solved. They have much worse congestion than we do, which is why they are more active so far in getting involved with ITS. They already have on the roadways about 300,000 vehicles with advanced traveler information systems in them. Of course, that still is only a fraction of their vehicle fleet.

We're just getting started. A new Oldsmobile just out this year is our first commercial vehicle that has anything related to advanced transportation systems in it. Of course in this country for years we've had the media, mainly radio and television stations, providing us with traffic reports. A problem with those, as you well know, is that they're very short and they're not in real time. They're 15 or 20 minutes, a half-hour, sometimes an hour late s getting on the air. But they're useful.

ITS can do much more than that if we want it to. One of the elements of ITS is the advance traveler information system, which is a comprehensive way of delivering to drivers real time traffic information. It uses several technologies to do this. The key to it is gathering real time information, and this is not easy. It requires installation of devices by the public sector, it requires putting up notice boards and staffing traffic control centers—all of which cost money, but all of which can save lives and time.

The information can get to the drivers via in-car devices of various kinds, or by radio, which is still a great medium if it's properly used. In Europe, they've found a way to bring radio together, into basically a European-wide system in a way we can't emulate over here yet because of the way we handle radio frequencies in this country. It's called DAK, and it works. It's been very effective, because a person who speaks English can stay with English as he moves throughout Europe. We don't have that particular problem in this country to any great extent, but it is a problem. Multi-language services are something we're going to have to furnish more of.

Roadside signs and changing message signs can certainly be used to provide more messages and more meaningful real time information than we're now providing, if we choose to use them. So there's a lot we can do better, and I commend all of you for being here. We look forward very much to the results of this Conference. We'll be taking those results into several of our committees, and to ITS America, the Intelligent Transportation Society of America, which is doing the planning for ITS in this country. Right now they have a piece on the role of ITS in safety. We need to take a look at that in the light of what comes out of this meeting and see what we can do to use more of these new technologies.

We owe this meeting to the 762 people who died in 1993, to their families and their children. We owe it to ourselves, as the responsible professionals in America's transportation system. We can do better—we must do better. And I'm thoroughly convinced that the results of this Conference will help make that happen.

Robert M. Garrett

Executive Director
American Traffic Safety Services Association (ATSSA)

It's a real privilege to be up here with this illustrious group. ATSSA is very proud to be a sponsor of this Conference, particularly in the work zone area. Although ATSSA has a much broader base now, our roots go back to that. ATSSA really started as an organization of companies involved exclusively in work zone traffic control.

Let me just take a couple of minutes to give you a bit of history about our industry. It really began in the early '50s, when contractors finally started doing something about traffic control, closing lanes and so on. Someone invented a flashing light using a circuit that came from a fence charger, which was used to keep cows in the field. They used that to make the light flash. Out of that really grew an industry of people who took these lights and barricades, which evolved from the sawhorse, and rented them to contractors and utility companies and others so they could use them to close lanes and to warn the public.

In about 1966, five of the people from across the country who were in this business got together in Chicago, and decided they would like to communicate better and form an organization. It was informal for a while, and then in 1970 actually became what is now ATSSA. This means 1995 will be our 25th anniversary, and we're very proud of that.

I started with ATSSA myself only two years after it was formed, in 1972. At that time we had 35 members, 30 of whom were barricade rental companies and five of whom were manufacturers. At that time, we were affiliated with what was then the American Road Builders Association. In 1980, we split off from ARTBA and became an independent organization. Since then we've added many more aspects to the Association—sign manufacturers, pavement marking companies, public officials, consulting firms, international members—and we now have about 1,100 members and 19 staff. Our headquarters is in Fredricksburg, Virginia.

We've done a lot of things related to work zones, and that continues to be a major emphasis in our Association.

The new MUTCD Part VI was approved by FHWA in January this year, and ATSSA has published it. In fact, it's probably been the best-selling thing we've ever had. We've printed 45,000 copies just since March, and as we speak additional copies are being produced.

Last year we developed something that we were very proud of, the *Quality Standards for Traffic Control Devices*. This standard provides people in the field a means to judge when devices are at a point where they should be replaced, meaning barricades and cones and lights and so forth. We continue to publish the *Flagging Handbook*.

One of the biggest goals of our Association is in the area of training. In 1977 we developed a training course and certification program for work site traffic supervisors, and since then we've trained over 15,000 people and certified over 5,000 people across the country.

Our annual convention will be held in February in San Antonio, and we're planning many special activities because of our 25th anniversary. I'd like to invite everyone here to attend. There will be a lot of workshops and functions related to work zone safety. It is the largest trade show in the country related to traffic control devices, and last year over 2,300 people attended. This year we expect more than 2,500.

This Conference we are attending now is very important not only because of what we will be discussing, but because of what we will take home from this feedback. I was involved with a number of other organizations in planning this event. We asked, Should we develop a Conference where we just tell the people how to handle proper traffic control? Or should we get in some experts, to try to identify the

problems and their possible solutions? We decided on the latter course. So the 200 or so people here were specifically invited to attend, and are considered experts in the field.

Last year, according to the FARS data, 762 people were killed in work zones. I think about 100 were workers. Of the 40,000 total fatalities on highways that's only 2 percent. That may seem small, but if you're one of the families or employers of those 762 people who died, it's very important. We have the opportunity to do something about it, and we will be exploring this over the next couple of days. This Conference will try to identify some of those areas where we can improve.

In looking at the FARS data, I've noted that three States constitute 38 percent, or 262 of those 762 deaths in work zones. I don't want to embarrass anybody, but I noticed in looking over the roster this morning that none of those three States has representatives here.

Recently the Federal Highway Administration published a proposed rule regarding a work zone safety program. That was as a result of ISTEA, and we, as well as a lot of other organizations, had commented on that. We feel it's a very big step forward and something that had not been done before.

One of the things we felt was lacking, and we felt this was extremely important, was a definition of how various segments of the industry could work together to solve this problem. I think it has to be a partnering effort, otherwise nothing is going to happen. Public agencies at all levels, contractors and subcontractors, suppliers, manufacturers, utilities, police, academia and the driving public—everybody has to be involved. And as I see from the roster, most of those segments are here. It's a little disappointing that there aren't more State DOT people or general contractors, but we do have a very good cross section of State DOT people, and that's why I think we will be able to accomplish quite a bit.

For the next two and a half days, we have the resources here to identify where the problems are, and to come up with some potential solutions. I'm sure we'll do that. After the Conference is over, however, I think the important thing is that we go back and use what we've learned. I know that our Association's committees will be using the information from these sessions to work on recommendations and solutions.

Once again, I'm very pleased to be a sponsor of this Conference, and look forward to a productive few days. Thank you.

WORK ZONE SAFETY FINDINGS: STATEMENT OF THE PROBLEM

Dr. Nicholas J. Garber

Professor of Civil Engineering
University of Virginia

Let me take this opportunity to express my thanks to the American Road & Transportation Builders Association and the FHWA for inviting me to preside and give this presentation at this Conference. I am also grateful to those members of my TRB committee A3C04, Traffic Safety in Maintenance and Construction Operations, who supplied me with some relevant information, especially Dr. Russell Lewis.

In recent decades the demand for highway transportation facilities has continued to grow, and this demand is expected to continue for the foreseeable future. In order to supply the system to cope with this demand, the Nation continues to spend significant amount of money. In 1993 for example, the total amount spent on highway transportation was $86 billion, which represented a 7 percent increase over that spent in 1992. It is quite likely that this level of expenditure will continue. Unfortunately, it is unlikely that this expenditure will be for any major national program to build new roads. The States are therefore using these funds to adopt measures that effectively manage their existing highway transportation systems so as to obtain maximum efficiency in the use of these systems.

These measures include the addition of lanes to existing roadways that can be used as HOV lanes and the improvement of existing alignments. In addition to these efforts to improve efficient use of existing highways, several of the Nation's highways and bridges are in need of extensive repair. These factors have resulted in an increasing number of work zones on our highways. There is all indication that this trend will continue for the foreseeable future, especially if the National Highway System comes into fruition.

It is also known that crash rates tend to be higher at work zones than at non-work zones, and unless specific actions are taken to mitigate the causes of crashes at work zones, it is likely that high numbers of severe crashes will continue to occur there. This Conference is therefore necessary and timely, as it gives all of us the opportunity to contribute toward the development of actions that will help to mitigate the causes of crashes in highway work zones.

The Conference objectives are to:

- identify the latest technology, procedures and programs applicable to improving the safety at work zones for both travelers and workers;
- provide input for changes to efforts to improve work zone safety, including any needed research;
- develop recommendations for future national efforts that will respond to the challenges created by the need to maintain a maturing surface transportation system and simultaneously allowing traffic to be unobstructed as far as possible.

As a background to this effort, I will give a brief historic overview of the efforts in the United States to improve work zone safety, based mainly on the development of the MUTCD over the years. Because of time constraints I will not be able to cover all aspects of the problem, but will concentrate on traffic control and research. I must emphasize here, however, that education and training are major components of the required effort and that I have no intention of downgrading their importance.

The necessity for the unification of the standards applicable to different types of roads was recognized long ago. To meet this need, a joint committee of the American Association of State Highway Transportation Officials (AASHTO) and the National Conference on Street and Highway Safety developed and published in 1935 the original edition of the *Manual of Uniform Traffic Control Devices* (MUTCD). That manual had been periodically revised over the years. One of the earlier editions of the MUTCD is the 1948 edition, which had four sections: Signs, Markings, Signals and Islands. It made no specific mention of work zones and included only two signs related to work zones. These were the "ROAD CLOSED" and "MEN WORKING" signs. "ROAD

CLOSED" was black on white, and the "MEN WORKING" sign was black on yellow. The "ROAD CLOSED" then had dimensions of 40 inches by 24 inches.

The 1954 edition of the MUTCD was similar to the 1948 version and also did not include anything specific on work zones. In the 1961 edition, however, for the first time the MUTCD contained a section dedicated to "Traffic Controls for Highway Construction and Maintenance Operations," which was designated as Part V of the manual. Part V established general principles to be observed in designing, installing, and maintaining traffic control devices in highway construction and maintenance work, and provided specific standards where possible. In that edition, standards were given for several signs, although some of them were in use before its publication. Part V also had sections on Signs, Barriers and Channelizing Devices, Lighting Devices, and Control of Traffic Through Work Areas. Some of the signs formally introduced were:

- ROAD CONSTRUCTION AHEAD
- LOCAL TRAFFIC ONLY
- ADVANCED ROAD CLOSED
- DETOUR AHEAD
- LENGTH OF CONSTRUCTION
- DETOUR (shown with arrow)

In addition, the size of the "ROAD CLOSED" sign was increased from 40 inches by 24 inches to 48 inches by 30 inches. Some of the barriers and channelizing devices formally introduced were barricades, cones and drums. It should be noted that all signs were black on yellow background.

In 1971 Part V of the 1961 MUTCD was revised and became Part VI. For the first time, all work zone warning signs became black legend on orange background. Part VI was also produced as a separate publication to meet the special demand for uniform standards for traffic control during construction and maintenance operations on streets and highways. As a result, several States became active in the use of these standards. As the usage increased many requests were made for changes or clarification. These requests were few in the early seventies but increased significantly by the mid to late seventies. This resulted in further revisions to the MUTCD in 1978 and a revised PART VI was again published separately as *Work Zone Traffic Control: Standards and Guidelines*.

A revised version of the MUTCD was again published in 1988, followed by a revision of Part VI in 1993. There is also current work to reformat the MUTCD.

Let me now illustrate some of the changes that took place between 1961, when Part V was first published, and what we have in the 1988 Part VI.

SIGNS

- ADVANCED DETOUR sign. In the current manual the distance is shown and the background is orange.

- TWO-WAY TRAFFIC sign. In 1961 this sign was rectangular with words, but this was changed in 1971 to include the symbol also, and in 1980 the writing was omitted. The size was increased to 48 inches by 48 inches and this was retained in the 1988 edition.

- LENGTH OF CONSTRUCTION sign. This sign did not exist in the 1961 Manual; it was first introduced in 1971 edition. In the 1980 edition the word "next" was added. This was retained in the 1988 edition.

- DIVIDED HIGHWAY sign. This sign was not in the 1961 Manual but was first formally introduced in the 1971 Manual. The sign in the 1971 Manual had the plaque, which was removed on the 1980 edition. The 1980 sign was retained in the 1988 edition.

CHANNELIZING DEVICES

- **Barricades.** In the 1961 edition the stripes on the barricades were black and white or black and yellow. In 1971, orange and white colors were introduced; the black and white stripes were still allowed, although it was stated that the orange and white and black and white markings shall not be intermixed in the same installation or area.

- **Drums.** In the 1961 Manual it was stated that drums should be conspicuously painted with at least two horizontal, circumferential white stripes, 4 inches to 6 inches wide. These drums were mainly metal. In 1971, metal drums were still used but were then painted orange and white. They were predominantly orange, but a minimum of two white stripes per drum were required. In 1980, only orange and white stripes were allowed. This was maintained in 1988. Since 1971, it has been recommended that during hours of darkness a flashing warning light should be placed on drums used singly and that

steady burn warning lights should be placed on drums used in a series for channeling traffic.

TRAFFIC CONTROL

Several significant changes were made between 1961 and 1988 in the typical applications of traffic control devices. For example, in the 1961 Manual, when a two-lane highway was closed and a bypass detour provided, the "ROAD CONSTRUCTION WARNING SIGN" could be placed only 1,500 feet from the detour, with no channelizing devices at the ends of the detour section. In the 1988 Manual, however, channelizing devices were placed at the ends of the detour sections, with an additional advisory speed sign.

In the case of a four-lane undivided highway where half of the roadway is closed, the main channelizing device specified in the 1961 Manual was the old class 2 barricade, while the 1988 Manual required :

- The complete separation of opposing traffic by channelizing device.

- Placement of the first "ROAD CONSTRUCTION AHEAD" sign at about one mile from the start of the taper, compared with 1,500 feet specified in the 1961 manual

- The use of the arrow panel. Although this is supposed to be optional, it is used in most cases.

In the case of a four-lane divided highway where one roadway is closed, the significant differences between the 1961 and 1988 Manuals include:

- a much longer distance between the first warning sign and the taper;

- more common use of improved channelizing devices such as concrete barriers at the transition and the TLTW;

- addition of the "LANE REDUCTION" sign; and

- use of arrow panels.

We can see from these few examples that we have made significant progress in our warning signs and their use in channelizing traffic through work zones. But are these improvements reflected in the number of accidents or crashes that occur in work zones? Unfortunately, available data suggest that although we have made significant strides in improving our warning signs and in the manner in which we channel traffic through work zones, we have not been successful in significantly reducing the number of fatal crashes in work zones. The data also strongly suggest that most work zone fatal crashes occur during construction activities at Interstate highways and principal arteries.

RESEARCH

Let us now take a brief look at our research activities during the past few years. A review of the literature shows that research in areas pertaining to safety in work zones was rather minimal prior to the mid seventies. During that time, emphasis was placed on determining the appropriate widths for the stripes on barricades, mainly because the main channelizing device during that time was the barricade.

Between the mid seventies and early eighties, the emphasis was on visibility requirements, and early performance standards were developed. In the eighties, research areas included accident analysis, and it was determined then that data on work zone crashes were not readily available. It was also determined that crash rates tended to be higher at work zones and that they occurred mainly in the taper and transition areas. The predominant causes of crashes were identified as failure to drive within a single lane, failure to reduce speed, failure to yield right of way, and failure to drive within the designated lane.

Research in the area of pedestrian safety was also initiated in the eighties, with results indicating that good practice for protecting pedestrians at work zones was sporadic. The need for Part VI of the MUTCD to include a section on pedestrian protection was emphasized.

A major research effort in the eighties centered on the development and testing of traffic control devices such as truck-mounted attenuators and changeable message signs, and the evaluation of reflective sheetings with respect to the different grades: Engineering, Super-Engineering and High-Intensity grades. For example, studies were carried out to evaluate the impact performance of plastic traffic control devices, such as plastic chevron signs, vertical panels, and flashing or steady burn lights mounted on plastic drums. It was generally found that these plastic traffic control devices performed well in most tests, presenting no hazard in terms of passenger compartment intrusion, interference with vehicle control, or threat to workers and other traffic from impact debris.

In the area of traffic control, studies were initiated in the selection of appropriate speeds in work zones and the effectiveness of different methods in reducing speeds in work zones. It was shown that the static speed signs were not as effective as dynamic signs, such as changeable message signs, or police enforcement in reducing speeds at work zones.

Although human factors research has not been extensively carried out in the area of work zone safety, some human factors research was initiated in the eighties, mainly related to driver understanding of work zone signs.

With the development of knowledge-based expert systems, work was also initiated in the eighties to develop such systems for the design of traffic control plans in work zones.

Considerable effort was also placed in the eighties and early nineties on the SHRP Project to develop new and effective protective devices. These include:

- snowplow and salt spreader truck-mounted attenuators;
- robots for mobile advance warning;
- mobile barriers and crash cushions;
- portable rumble mats; and
- remote control Stop/Slow signs.

This brief history of the developments in work zone safety clearly indicates to us that during the last decade or so, considerable effort has been directed at finding solutions to the problem of safety in the work zone; but unfortunately, we have not been able to reduce the number of crashes significantly. What, then, are the issues of concern for the future that will need to be tackled to achieve what should be our goal of very low number of crashes at every work zone?

In recognition of this problem, and in compliance with ISTEA's mandate, the Federal Highway Administration (FHWA), has unveiled a Work Zone Safety Program to enhance safety at highway construction, maintenance, and utility sites by improving the quality and effectiveness of traffic operations, safety appurtenances, traffic control devices and traffic maintenance bidding practices as mandated by the ISTEA. This Work Zone Safety Program will consist of four components: Standardization, Ensuring Compliance, Improving the Evaluation of Work Zones, and Innovation.

CONFERENCE WORKSHOPS

It seems to me that the five topic areas selected for the group workshops in this Conference are in general agreement with the components of the proposed FHWA program. These are:

- Philosophy of Traffic Control;
- Work Zone Safety Implementation;
- Contractors Construction Management;
- Interaction with Public and Highway Users; and
- Advanced Technologies

Let me identify specific issues of concern in each of these areas.

Philosophy of Traffic Control

I am of the opinion that the issue of human factors and behavior is of critical importance. In all of our past research and development, the question can be asked: Have we taken human factors sufficiently into consideration? My answer to that question is no. For example, most of our efforts in trying to reduce the speeds of drivers in work zones have not been very successful. This may be due to the fact that we know very little about the behavioral characteristics of those who like to speed, even when abnormal conditions exist. It is likely that a clear understanding of the speeding driver will help us in identifying those measures that should be taken to influence them to reduce their speeds in work zones. I am therefore of the opinion that in developing any philosophy of traffic control in work zones the predominant behavioral characteristics of those drivers that are involved in crashes in work zones should be identified. Fundamental research is therefore required in this area.

In addition to the lack of understanding of human factors, the lack of adequate accident data in work zones will seriously hinder any effort that will be made in developing an appropriate philosophy of traffic control in work zones. It is therefore essential that innovative ways of collecting and reporting accident data in work zones be a prerequisite for developing an appropriate philosophy for traffic control in those areas. This issue is recognized by the FHWA, for it is included as one of the items of importance in its proposed Work Zone Safety Program. It is proposed that FHWA, in cooperation with

NHTSA, develop guidelines for collecting and reporting data on deaths and injuries occurring in highway work zones. A significant contribution of this Conference will be for us to develop the basis for such guidelines, indicating, for example, what types of data should be collected, how detailed the data should be, and what format should be used in reporting the data.

Work Zone Safety Implementation

There is no doubt that we have made considerable progress in the development of effective vehicular traffic control devices. Research should, however, be continued in this area in order to develop innovative protective devices, and condition-responsive work zone traffic control systems, that can be used for longer-term construction areas.

It also seems to me that hardly any effort has been made to develop suitable pedestrian traffic control in work zones. With the possible increase in the rehabilitation and widening of our urban arterial highways, it will be necessary to put considerable effort into the development of work zone traffic control plans that take into consideration not only vehicular traffic but also pedestrian traffic. Unless something is done in this area, it is likely that crashes involving pedestrians will increase considerably. The bottom line, therefore, is to identify the means by which we shall continue to develop better and more effective quality vehicular traffic control devices, while at the same time developing effective pedestrian traffic control devices.

There is also need to develop retroreflectivity guidance for work zone signs and pavement markings, and to establish the crash-worthiness of work zone safety appurtenances.

Contractors Construction Management

Research has shown that the number of accidents at a work zone is directly related to the duration of the work. An important issue, therefore, is the duration of maintenance and construction projects. Are there innovative types of contracts that will influence the contractor to complete the work in the shortest possible time without the cost of the contract being prohibitive? Developing criteria on which such contracts should be based will be a very useful development. These criteria should take into consideration the advantages and disadvantages of nighttime operation vis-a-vis daytime operation, and stage construction.

Interaction with Public and Highway Users

A major concern in this area is the ability to influence drivers to adhere to warning signs and instructions at work zones. I am of the opinion that although it is important to consider human factors and characteristics in developing and placing these signs, there are some who will still violate these instructions unless they know that some punishment will be meted out to them if they do. Unfortunately, because of restricted areas, it is not always possible to pull out violators at these work zones even when a police officer is available; also, in most cases it is not feasible to have police officers at the work zone throughout the duration of the project. It should therefore be possible for violators to be ticketed even without the presence of a police officer. The technology for doing this is now available, but it is not widely used because of possible conflict with individual rights to privacy. It therefore should be asked whether the individual's privacy is more important than the safety of those working in the work zone, and whether special provisions should be made in the laws to allow the use of the available technologies to permit the ticketing of violators in work zones. Answers to these questions will aid in finding solutions to the problem of enforcement at work zones.

Advanced Technologies

The recent surge in research in Intelligent Transportation Systems has resulted in advanced technologies that can be used to collect real-time data which in turn can be used to reroute drivers from the work zone area. However, the major concern is whether advanced technologies can be used to considerably reduce the exposure of workers at the work zones, by automating some of the work now being done by the worker on the road. It is therefore necessary to identify those work zone operations that can be automated, possibly through the use of robots. Identification of existing appropriate advanced technologies that can be used to implement automation and the description of those technologies that do not now exist but will be needed for automation in the future are therefore important issues.

Let me state clearly that the issues I have identified are not the only important issues of concern, and I am sure that the different groups will identify additional ones. I have noted them to serve as a catalyst

in your effort to achieve the goals identified for this Conference.

In conclusion, I am convinced that with the varied knowledge of experts assembled here for this Conference, there is no doubt that we will be able to achieve the difficult objectives outlined earlier, so that hopefully we will see considerable reduction in work zone crashes in the years to come and be proud to have contributed to the effort.

ADVANCED TECHNOLOGIES: ARROW PANEL VISIBILITY

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Prior to the introduction of solar-powered arrow panels (APs) near the end of the 1980s, advance warning arrow panels were considered to be a clear example of a conspicuous traffic control device. These diesel-powered APs could produce displays seen at great distances and wide angles. They also would produce operational and maintenance headaches, creating environmental nuisances with fuel spills, fumes, noise, and glare. The lamps used in these diesel-powered units are typically automotive foglamps, easily purchased at an auto parts store but allow for little quality control for lens color, intensity, or filament orientation.

With the development of solar technology, solar-powered arrow panels were introduced as alternative traffic control devices for use in roadway work zone areas. Tapping into the energy of the sun, these units were quiet and environmentally friendly, requiring no fueling and little maintenance relative to their diesel unit cousins. However, as with most new technology, performance and quality were spotty across the breadth of the early solar AP manufacturers. Required to meet the same MUTCD visibility standards as the diesel-powered APs, issues of lamp intensity and lamp angularity emerged. Newer generations of solar arrow panels have increased lamp technology research to address these concerns of visibility, which in turn has produced higher levels of quality control in lamp design and engineering.

The criticisms levied against the solar-powered APs provided the impetus to study the visibility factors necessary for adequate arrow panel visibility, independent of technology or power source. To determine these visibility performance requirements, we conducted a comprehensive review of literature and current practices and have completed several studies of factors affecting arrow panel visibility. This report will focus on a general discussion of what the problems are with regard to AP brightness and alternative ways in which they might be addressed.

The placement of arrow panels is perhaps the most frequently studied area in the literature reviewed. There seems to be little agreement as to whether APs should be placed in the shoulder lane, or at the beginning vs. downstream positions. One study reported that sight distances to an AP influence driver behavior and when the effective sight distance is less than 1,500 feet, it becomes desirable to use an advance supplemental AP. However, if an AP is used *too* far in advance (e.g., 4,000 feet) then drivers tend to return to the vacated lane.

Some researchers propose optimum performance standards that are well in excess of Decision Sight Distance recommended recognition distances. Manufacturers and solar AP lamp engineers are concerned with the etiology of the one-mile MUTCD legibility distance requirement for Type C APs. Most believe that luminance requirements should be based on driver needs and not on the technology used to produce a certain luminance level.

Prior to our research, very little had been done to evaluate the light intensity necessary for the visibility of APs. Our research, sponsored by NCHRP, has focused upon determining the minimum brightness levels required for AP recognition during daylight (probably about 100 cd) and the maximum levels necessary to control glare at night (probably about 300 to 400 cd).

Lamps used in diesel arrow panels are higher wattage than those used in solar APs, and therefore have a much greater luminous intensity. Diesel lamps can typically maintain visibility out to a horizontal angle of more than 20 degrees, +/-3 degrees vertical, while solar lamps generally maintain visibility in a more narrow range, perhaps +/- 13 degrees horizontal. The question which must be asked is whether or not the angularity of the diesel lamp is needed in all situations.

With regard to the control of disability and discomfort glare, we recommend that the lamp intensity in any direction be kept below 300 cd at any angle. The current specification of 50 percent reduction in full rated lamp voltage is inappropriate and may result in diesel panels being too bright and solar panels having less than optimal brightness.

With regard to minimum intensity requirements for visibility, two worst-case scenarios may be envisioned which are depicted in the figures on the next page. First, the AP may be put on a long gentle curve extending beyond the minimum required visibility distance (MRVD). If both the driver and AP are on the curve, the curve must be less than +1.7 degrees to keep the viewing angle under 13 degrees. The severity of this curve may be doubled by aiming the AP into the curve. The second situation occurs when the AP is placed along a straight section of road but the MRVD extends into a curve. The shorter the straight section before the AP and any degree curve, the larger the viewing angle and, therefore, there is a perceived reduction in lamp brightness. By aiming the AP upstream, recognition distance may be increased, but at the cost of reduced recognition at closer distances. This may be a reasonable tradeoff because at close distances the AP is itself a very large hazard and does not require recognition of the arrow. With a longer straight section upstream of the AP or with gentler curves, less extreme aiming is necessary to keep the brightest point further away and AP recognition will be maintained at even closer distances.

Given the reduced range in the angularity of some lamps, it is important that attention be given to the placement and aiming of these devices. Choices may have to be made among a number of alternatives. If the primary purpose of the AP is to alert drivers, the AP should be aimed at the vehicle location 1,500 feet away. If the primary purpose is to provide recognition, the AP should be aimed to provide for recognition throughout the range from 1,500 feet to about 300 feet upstream.

It is expected that the recommendations of this research will allow State DOTs to develop standards. These standards would allow for the classification of any lamp in terms of its maximum angularity for daytime visibility and the voltage requirement to control nighttime glare. Charts will be provided to users which will allow them to determine the range of visibility for a lamp of a specific angularity, and how this range of visibility will vary with any change in the aiming of the AP.

FIGURE 1. Maximum Curvature for AP Recognition on Curve

FIGURE 2. Angularity Requirements as a Function of Length of Straight Section

PART VI MUTCD CHANGES

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Before we start, I'd like to say that the Manual on Uniform Traffic Control Devices has just been revised. What we did was to place a notice in the *Federal Register*, and the final rule actually took effect January 10, 1993. The States have two years to implement this final rule, in other words, to make this Part VI a legal document.

Among the changes that stand out on Part VI are changes in terms. For example, the term "work zone" in the MUTCD is now "temporary traffic control zone." The term "road construction" is now "road work." Here are the other changes that appear in Part VI.

Old: Not in old MUTCD.

New: The four components that constitute a temporary traffic control zone are described in the order that drivers encounter them. They include the following:

a. **Advance Warning Area.** In the advance warning area, drivers are informed of what to expect.

b. **Transition Area.** When redirection of the driver's normal path is required, traffic must be channeled from the normal path to a new path. This redirection is intended to occur at the beginning of the transition area.

c. **Activity Area.** The activity area is an area of roadway where the work takes place. It is composed of the work space and the traffic space, and may contain one or more buffer spaces.

d. **Termination Area.** The termination area is used to return traffic to the normal traffic path. The termination area extends from the downstream end of the work area to the END ROAD WORK signs, if posted. (6C-2)

Old: Not in old MUTCD.

New: At detours, traffic is directed onto another roadway to bypass the temporary traffic control zone. Detours should be signed clearly over their entire length so that motorists can easily determine how to return to the original roadway.

At diversions, traffic is directed onto a temporary roadway or alignment placed in or next to the right-of-way (e.g., median crossovers or lane shifts). (6C-4)

Old: Not in old MUTCD.

New: A yield or stop sign may be installed on low-volume, two-lane roads where one side of the roadway is closed and the other side must serve both directions. The side that is closed should yield to or stop for oncoming traffic on the side that is open. The approach to the side that is not closed must be visible (for a distance equal to the safe-passing sight distance for that approach) to the driver who must yield or stop. (See section 3B-5, Warrants for No-Passing Zones at Curves.) (6C-5)

Old: To facilitate adequate advance project planning, the plans, specifications and estimates (PS&E) for each project should include provisions for a reasonably specific traffic control plan for moving traffic through or around the construction zone in a manner that is conducive to the safety of the traveling public, pedestrians and workers. (6C-3)

Construction and maintenance zones often encroach into sidewalks or crosswalks, necessitating provisions for alternate routing. Where it is not possible to close a path and divert the pedestrians to other walkways, barricades may be used to define the path. (6C-9)

The primary function of traffic control procedures is to move vehicles and pedestrians safely and expeditiously through or around work areas while protecting on-site workers and equipment. (6F-1)

New: The new provisions are as follows:

- Pedestrians should not be led into direct conflicts with work site vehicles, equipment, or operations.

- Pedestrians should not be led into direct conflicts with mainline traffic moving through or around the work site.

- Pedestrians should be provided with a safe, convenient travel path that replicates as nearly as possible the most desirable characteristics of sidewalks or footpaths. (6D-1)

Old: Same as above.

New: The new provisions are as follows:

- **Training:** All workers should be trained in how to work next to traffic in a way that minimizes their vulnerability. In addition, workers with specific traffic control responsibilities should be trained in traffic control techniques, device usage, and placement.

- **Worker clothing:** Workers exposed to traffic should be attired in bright, highly visible clothing similar to that of flaggers.

- **Barriers:** Barriers should be placed along the work space depending on such factors as lateral clearance of workers from adjacent traffic, speed of traffic, duration of operations, time of day, and volume of traffic.

- **Speed reduction:** In highly vulnerable situations, consideration should be given to reducing the speed of traffic through regulatory speed zoning, funneling, use of police, lane reduction, or flaggers.

- **Use of police:** In highly vulnerable work situations, particularly those of relatively short duration, stationing police units heightens the awareness of passing traffic and will likely cause a reduction in travel speed.

- **Lighting:** For nighttime work, lighting the work area and approaches may allow the driver better comprehension of the requirements being imposed. Care should be taken to ensure that the lighting does not cause blinding.

- **Special devices:** Judicious use of special warning and control devices may be helpful for certain difficult work area situations. These include rumble strips, changeable message signs, hazard identification beacons, flags, and warning lights. Flagger-activated audible warning devices may be used to alert workers to the approach of erratic vehicles. Misuse and overuse of special devices/techniques can greatly lessen their effectiveness.

- **Public information:** Improved driver performance may be realized through a well-prepared and complete public relations effort that covers the nature of the work, the time and duration of its execution, and its anticipated effects upon traffic and possible alternate routes and modes of travel. Such programs have been found to result in a significant drop in traffic; that reduces the possible number of conflicts and may allow a temporary lane closing for additional buffer area.

- **Road closure:** If alternate routes are available to handle detoured traffic, the road may be closed temporarily during times of greatest worker hazard which, in addition to offering maximum worker safety, may facilitate quicker project completion and thus further reduce worker vulnerability (6D-2).

Old: Not in old MUTCD.

New: Added qualification: Training in safe traffic control practices. (6E-2)

Old: The retroflective material shall be either orange, white (including silver-colored reflecting coatings or elements that reflect white light), yellow, fluorescent red-orange, or fluorescent yellow-orange. The design of the retroflective portions including stripe width, extent, design and type of material shall be determined by the contracting agency or purchaser of the vest. (6F-3)

New: The retroreflective material shall be orange, yellow, white, silver, strong yellow-green, or a fluorescent version of one of these colors and shall be visible at a minimum distance of 1,000 feet. The retroreflective clothing shall be designed to identify clearly the wearer as a person and be visible through the full range of body motions (6E-3)

Old: Not in old MUTCD.

New: Uniformed law enforcement officers may be used as flaggers in some locations, such as an urban intersection, where enforcement of traffic movements is important. Uniformed law enforcement

officers may also be used on freeways where traffic is channeled around work sites and it is necessary to assure that the advisory and regulatory speeds are being enforced. For nighttime work and in low-visibility situations, a retroreflective garment as described above should be worn. (6E-3)

Old: Not in old MUTCD.

New: To improve conspicuity, the STOP/SLOW paddles may be supplemented by one or two symmetrically positioned alternately flashing white high-intensity lamps on each side. (6E-4)

Old: Not in old MUTCD.

New: Flagger stations shall be located far enough ahead of the work space so that approaching traffic has sufficient distance to stop before entering the work space. Table VI-1, Guidelines for length of longitudinal buffer space, may be used for locating flagger stations in advance of the work space. This distance is related to approach speeds, friction factors, and pavement and tire conditions. These distances may be increased for downgrades. (6E-6)

Table VI-1. Guidelines for length of longitudinal buffer space

Speed* (mph)	Length (feet)
20	35
25	55
30	85
35	120
40	170
45	220
50	280
55	335
60	415
65	485

• Posted speed, off-peak 85th percentile speed prior to work starting, or the anticipated operating speed in mph. (6C-2)

Old: Standards for height and lateral clearance of roadside signs are shown in figure 6-1. Signs mounted on barricades, or temporary supports, may be at lower heights but the bottom of the sign shall not be less than 1 foot above the pavement elevation. Higher mounting heights are, however, desirable. (6B-3)

Figure 6-1 shows that a urban sign should be mounted a minimum of 7 feet from the bottom of the sign to the ground. The same figure shows that a rural sign should be mounted a minimum of 5 feet from the bottom of the sign to the near edge of the pavement. (6B-4)

New: Guidelines for height and lateral clearance of temporary post-mounted roadside signs are shown in figure VI-5. Signs erected at the side of the road should be mounted at a height of at least 7 feet, measured from the bottom of the sign to the near edge of the pavement. The height to the bottom of a secondary sign mounted below another sign may be 1 foot less than the appropriate height specified above. (6F-1)

Old: Not in old MUTCD.

New: Unprotected sign systems should be crashworthy (refer to the Roadside Design Guide, Chapter Nine, for additional guidance). (6F-1)

Old: Not in old MUTCD.

New: Signs mounted on Type III barricades should not cover more than 50 percent of the top two rails or 33 percent of the total of the three rails. (6F-1)

Old: Standard sign sizes and colors are shown in the illustrations of the individual signs rather than in detailed specifications in the text. Where the orange background is specified and reflectorization is not required, a fluorescent material may be used for increased daytime visibility. (6B-1)

New: Warning signs in temporary traffic control zones shall have a black legend on an orange background. Yellow warning signs within the traffic control zone which are still applicable may remain in place. . . .

Where the color orange is specified, fluorescent red-orange or fluorescent yellow-orange colors may be used. The fluorescent versions of orange provide higher conspicuity than standard orange, especially during twilight. (6F-1)

Old: Where open highway conditions prevail on the approach to the work site, advance warning signs should be placed approximately 1,500 feet in advance of the condition to which they are calling attention. Where a series of advance warning signs are used, the warning sign nearest the work site should be placed approximately 500 feet from the point of restriction with the additional signs at 500-1,000 foot intervals. On expressway and limited access facilities, the advance warning distance should be increased to one-half mile or more. On city streets, where more restrictive conditions generally prevail on the approach to the work area, signs in the immediate vicinity of the work may be placed at closer spacings. Typical sequences and spacings of advance warning signs are shown in figures 6-2 to 6-10. (6B-3)

New: Spacing of Warning Signs Covered in 6H-3 Typical Application Diagrams

Where highway conditions permit, warning signs should be placed at varying distances in advance of the work area, depending on the roadway type, condition, and speed. Where a series of two or more warning signs is used, the closest sign to the work area should be placed approximately 200 feet away for low-speed urban streets to 1,000 feet away or more for expressways and freeways.

The following table presents the suggested spacing of warning signs for four general roadway types for use in section 6H-3, Typical Application Diagrams.

Old: It carries the legend ROAD (STREET) CONSTRUCTION (1,500) FT or ROAD (STREET) CONSTRUCTION (1/2) MILE. (6B-15)

New: It carries the legend ROAD (STREET) WORK 1,500) FT or ROAD (STREET) WORK (1/2) MILE. (6F-1B(6))

Old: If the one-lane stretch is of such length as not to be visible throughout from either end, or if the traffic is of such volume that simultaneous arrivals at both ends occur frequently, provision must be made to permit traffic to move alternately under control (Secs. 6F-6 to 6F-10). (6B-18)

New: If the affected one-lane roadway is not visible from one end to the other, or if the traffic is such that simultaneous arrivals at both ends occur frequently, flagging procedures or signal control should be used to control alternate traffic flows. (6F-1B(9))

Old: TWO-WAY TRAFFIC sign should be used as needed at intervals to periodically remind drivers that they are on a two-way highway which contains opposing traffic. (6B-21)

New: When one roadway of a normally divided highway is closed, the TWO-WAY TRAFFIC sign should be used at the beginning of the closing and at intervals to remind drivers that they are on a two-way highway with opposing traffic. (6B-1B(12))

Table VI-2. Suggested advance warning sign spacing

Road type	Distance between signs		
	A	B	C
Urban (low speed*)	200	200	200
Urban (high speed*	350	350	350
Rural	500	500	500
Expressway/Freeway	1,000	1,600	2,600

• Speed category to be determined by State highway agency in cooperation with local jurisdictions. (6F-1b(3))

Old: The ROAD WORK sign is intended for use in advance of maintenance or minor reconstruction operations in the roadway (fig. 6-9, page 6B-11). (6B-26)

New: Now the ROAD (STREET) WORK sign (W20-1).

Old: TURN OFF 2-WAY RADIO 96B-31)

New: TURN OFF 2-WAY RADIOS AND CELLULAR TELEPHONES (6F-1B(18B))

Old: The SHOULDER DROP-OFF symbol sign was adopted after the printing of the MUTCD. It was confusing to the public.

New: The SHOULDER DROP-OFF sign should be used when a shoulder drop-off exceeds 3 inches in height and is not protected by a portable barrier. (6F-1B(19))

Old: The UNEVEN LANES symbol sign was adopted after the printing of the MUTCD. It was confusing to the public.

New: The UNEVEN LANES sign should be used during operations that create a difference in elevation between adjacent lanes. (6F-1b(20))

Old: Not in old MUTCD.

New: The NO CENTER STRIPE sign should be used when the work obliterates the center stripe. This sign should be placed at the beginning of the zone and repeated at 2-mile intervals in long zones to remind the motorist. It should also be used at major connections, traffic generators, and / or at appropriate intervals as determined by the engineer, to advise motorists entering within the zone. (6F-1B(21))

For those interim situations of 3 calendar days or less for a two- or three-lane road, no-passing zones may be identified by using signs rather than pavement markings. (See sections 3B-4, 3B-5, and 3B-6.) Also, signs may be used in lieu of pavement markings on low-volume roads for longer periods, when this practice is in keeping with the State's or highway agency's policy. These signs should be placed in accordance with sections 2B-21, 2B-22, and 2C-38. (6F-6b(2))

Old: Not in old MUTCD.

New: The DOUBLE REVERSE CURVE sign may be used instead of the REVERSE CURVE sign (W1-4a) when two lanes in the same direction are maintained. The sign pictured is the W1-4bR (48" by 48"). See Figure VI-8a, TA-31.

Old: Not in old MUTCD.

New: The TRIPLE REVERSE CURVE sign may be used instead of the REVERSE CURVE sign (W1-4a) when three lanes in the same direction are maintained. The sign pictured is the W1-4cR (48" x 48"). See Figure VI-8a, TA-36.

Old: Special lighting units, generally trailer-mounted for easy transport to a job site, have been developed to supplement conventional signs, pavement markings and lighting for maintenance activities. The flashing lights on the unit are operated from a self-contained power source mounted on the trailer, either batteries or on an electric generator. A variety of light configurations are used for traffic warning and guidance.

Most units are designed with racks, channels or other devices so that signs may be displayed with messages appropriate to the particular kind of work being performed. (6E-6)

New: Portable Changeable Message Signs (PCMS) are traffic control devices with the flexibility to display a variety of messages to fit the needs of road and street authorities. Each message consists of one or more displays. Portable Changeable Message Signs are used most frequently on high-density, urban freeways, but have applications on all types of highways where highway alignment, traffic routing problems or other pertinent conditions require advance warning and information.

(1) Components: The components of a PCMS should include message sign panel, control systems, power source, and mounting and transporting equipment.

(a) Message Sign Panel: PCMS cannot always conform to the exact sign shape, color, and dimensions specified in these standards. PCMS should subscribe to the principles (i.e., color, letter

size and shape, and borders) and applications prescribed herein. The message sign panel can vary in size and may consist of one, two, or three lines. High-density urban freeways typically use three lines of eight characters per line. Each character module shall use, as a minimum, a five wide-pixel by seven high-pixel matrix. The front face of the sign should be covered with a protective material. Element colors for warning message should be black on a yellow or orange background; for guide messages, white on a green background or black on an orange background; and for regulatory messages, black on a white background. Color reversals are also acceptable.

The signs should be visible from 1/2 mile under ideal day and night conditions. Each sign message should be legible from all lanes, from the sign up to a minimum of 650 feet. In the field, the PCMS should be sited and aligned to optimize driver performance. The message panel should have adjustable flash rates, so that the entire message can be read at least twice at the posted speed, the off-peak 85th percentile speed prior to work starting, or the anticipated operating speed. Under low light level conditions, the sign shall automatically adjust its light source so as to meet the legibility requirements and not impair the drivers' vision.

(b) Control System: The control system shall include the following features:

- A display screen upon which messages can be reviewed before display on the message sign.
- A capability to provide an automatic programmed default message if power failure occurs.
- A backup battery to maintain memory when power is unavailable.

(c) Power Source: The PCMS shall be equipped with a power source and a battery back-up to provide continuing operation when failure of the primary power source occurs.

(d) Mounting: The mounting of the PCMS shall be such that the bottom of the message sign panel shall be a minimum of 7 feet above the roadway when it is in the operating mode. (6F-2a)

Old: These special lighting units are used most frequently on high-density urban freeways and are placed just in advance of the worksite. The flashing lights, together with appropriate signs, have proven to be very effective warning devices while also providing some physical protection to the maintenance workers.

Although these special lighting units were developed to satisfy a need on urban freeways, they have many applications on all types of highways. Their mobility, together with the availability of flashing lights and/or a variety of sign messages, makes them useful for almost any situation where conditions require extraordinary advance warning of the maintenance activities. If the units are to be used at night, consideration should be given to providing a means whereby the intensity of the flashers may be reduced during darkness when the lower intensities are desirable (6E-6)

New: PCMS have a wide variety of applications in temporary traffic control zones, including roadway or ramp closures, accident or emergency incident management, width restriction information, advisories on roadwork scheduling, traffic management and diversion, warning of adverse conditions, and operation control. PCMS should be used with conventional signs, pavement markings, and lighting.

. . . PCMS messages should be readily understood by drivers and thus will allow them adequate time to react. Messages should be designed taking into account the following factors:

- No more than two displays should be used within any message cycle.
- Each display should convey a single thought.
- Messages should be as brief as possible.
- When abbreviations are used, they should be easily understood.
- The entire message cycle should be readable at least twice at the posted speed, the off-peak 85th percentile speed prior to work starting, or in the anticipated operating speed.
- Messages shall not scroll horizontally or vertically across the face of the sign. (6F-2a)

Old: Generally arrow panels should not be used for shoulder or roadside work activities, nor should they be used on two-lane highways because the panels can cause unnecessary lane changing. (6E-8)

New: A PCMS may be used to simulate an arrow display. An arrow display in the arrow or chevron mode may be used for stationary or moving lane closures. (6F-3a)

An arrow display in the caution mode shall be used only for shoulder work, blocking the shoulder, or roadside work near the shoulder.

An arrow display shall not be used on a two-lane, two-way roadway for temporary one-lane operation.

An arrow display shall not be used on a multilane roadway to laterally shift all lanes of traffic, because unnecessary lane changing may result. (6F-3b)

Old: They shall consist of a minimum of three flags with or without a Type B High Intensity Flashing Warning Light. (6C-11)

New: A high-level warning device shall consist of a minimum of two flags with or without a Type B, high-intensity, flashing warning light.

An appropriate warning sign may be mounted below the flags. (6F-4)

Old: Not in old MUTCD.

New: Spacing of channelizing devices should not exceed a distance in feet equal to the speed when used for the taper channelization, and a distance in feet of twice the speed when used for tangent channelization.

The name and telephone number of the agency, contractor, or supplier may be shown on the non-retroreflective surface of all channelizing devices. The letters and numbers shall be a non-retroreflective color and not over 2 inches in height.

Particular attention should be given to assuring that channelizing devices are maintained and kept clean, visible, and properly positioned at all times. Devices shall be replaced that are damaged and have lost a significant amount of their retroreflectivity and effectiveness. (6F-5)

Old: Not in old MUTCD.

New: Tubular markers shall be predominantly orange, not less than 18 inches high, minimum 2 inches wide when facing traffic, and made of a material that can be struck without damaging impacting vehicles.

Application: Tubular markers have less visible area than other devices and should be used only where space restrictions do not allow for the use of other more visible devices. They may be used effectively to divide opposing lanes of traffic, divide traffic lanes when two or more lanes are kept open in the same direction, and delineate edge of pavement dropoff where space limitations do not allow the use of larger devices.

Steps should be taken to assure that tubular markers will not be blown over or displaced by traffic by either affixing them to the pavement with anchor bolts or adhesive, using weighted bases or weights, or weights that can be dropped over the tubular markers and onto the base to provide added stability. Ballast, however, should not be allowed to present a hazard if the tubular markers are inadvertently struck. If a noncylindrical device is used, and it could be displayed with a width less than the minimum facing traffic, it shall be attached to the pavement to ensure that the width facing traffic meets the minimum requirements. (6F-5c)

Old: Not in old MUTCD.

New: Vertical panels used on expressways, freeways, and other high-speed roadways shall have a minimum of 270 square inches of retroreflective area facing traffic. (6F-5d)

Old: The markings on drums shall be horizontal, circumferential, orange and white reflectorized stripes 4 to 8 inches wide, using a material that has a smooth, sealed outer surface which will display the same approximate size, shape and color day and night. (6C-6)

New: Steel drums shall not be used. The markings on drums shall be horizontal, circumferential, alternating orange and white retroreflective shapes 4 to 6 inches wide. Each drum shall have a minimum of two orange and two white stripes. Any non-retroreflective spaces between the horizontal orange and white stripes shall not exceed 2 inches wide. Drums shall have closed tops that will not allow collection of roadwork or other debris.

Drums should not be weighted with sand, water, or any material to an extent that would make them hazardous to motorists, pedestrians, or workers. When they are used in regions susceptible to freezing, they should have drainage holes in the bottom so water will not accumulate and freeze, causing a hazard if struck by a motorist. Ballast shall not be placed on top of the drum. (6F-5e)

Old: On high-speed expressways or in other situations where barricades may be susceptible to overturning in the wind, sandbags should be used for ballasting. Sandbags may be placed on lower parts of the frame or stays to provide the required ballast but shall not be placed on top of any striped rail.

New: Where no turns are intended, the stripes should slope downward toward the center of the barricade or barricades.

On high-speed expressways or in other situations where barricades may be susceptible to overturning in the wind, sandbags should be used for ballasting. Sandbags may be placed on lower parts of the frame or stays to provide the required ballast but shall not be placed on top of any striped rail. Barricades shall not be ballasted by heavy objects such as rocks or chunks of concrete. (6F-5f)

Old: When serving the additional function of channelizing traffic, portable barriers should be of a light color for increased visibility. For nighttime use, barriers shall be supplemented by the use of standard delineation or channelization markings or devices (6C-10)

New: When serving the additional function of channelizing traffic, the barrier taper shall meet standard channelizing taper lengths. The channelizing barrier shall be supplemented by standard delineators, channelizing devices, or pavement markings. Channelizing barriers should not be used for a merging taper except in low-speed urban areas. (6F-5g)

Old: Not in old MUTCD.

New: The temporary raised island should be used only on roadways with speeds of 45 mph or less except when recommended by an engineering study.

Temporary raised islands, not to exceed 4 inches in height, may be used to supplement channelizing devices and pavement markings to separate traffic flows in two-lane, two-way operations (TLTWO). Pavement edge lines may be placed on the island itself. Islands may also have application in other than TLTWO where physical separation of traffic from the temporary traffic control zone is not required. (6F-5h)

Old: Not in old MUTCD.

New: Channelizing devices, other than those specified above, may be required for special situations based on an engineering study. Such devices should conform to the general size, color, stripe pattern, retroreflection, and placement characteristics established for standard devices. (6F-5i)

Old: Warning lights shall have a minimum mounting height of 36 inches to the bottom of the lens. (6E-5)

New: Warning lights shall have a minimum mounting height of 30 inches to the bottom of the lens. (6F-7e)

This change addresses the use of lights on concrete barriers.

Old: Not in old MUTCD.

New: Impact attenuators are systems that mitigate the effects of errant vehicles that strike hazards, either by smoothly decelerating the vehicle to a stop when hit head-on, or by redirecting the errant vehicle. Impact attenuators in temporary traffic control zones protect the motorists from the exposed ends of barriers, fixed objects, and other hazards. Two types of impact attenuators used in temporary traffic control zones are roadside attenuators and truck-mounted attenuators (TMAs). Specific information on the use of impact attenuators can be found in the AASHTO *Roadside Design Guide*, Chapter 9.

Roadside attenuators are used in the same manner as permanent highway installations to protect motorists from the exposed ends of barriers, fixed objects, and other hazards.

Trucks or trailers are often used as protective vehicles to protect workers or work equipment from errant vehicles. These protective vehicles are normally equipped with flashing arrows, changeable message signs, and/or flashers, and must be located properly in advance of the workers and/or equipment they are protecting. However, these protective vehicles may themselves cause injuries to occupants of the errant vehicles if they are not equipped with TMAs. (6F-8a)

Old: One-way traffic operation necessitates the use of an all-red interval of sufficient duration for the traffic to clear the zone at the speed posted through the work areas. (6F-10)

New: One-way traffic flow requires an all-red interval of sufficient duration for traffic to clear the portion of the temporary traffic control zone controlled by the traffic signals. To avoid the display of conflicting signals at each end of the temporary traffic control zone, traffic signals shall be either hard-wired or controlled by radio signals. (6F-8c)

Old: Not in old MUTCD.

New: Rumble strips are transverse strips of rough-textured surface used to supplement standard or conventional traffic control devices. Rumble strips may be used to alert drivers of unusual or unexpected traffic conditions or geometrics, or to bring the driver's attention to other warning devices. They provide a vibratory and audible warning that supplements visual stimuli.

A rumble strip may consist of raised strips or depressed grooves. The cross-section may be rectangular, domed, or trapezoidal in shape. The strips or grooves should be placed transverse to the direction of traffic. The intervals between rumble strip pads should be reduced as the distance to the hazard diminishes, to create a sensation of acceleration for motorists.

The first rumble strip pad should be placed before the advance warning devices. The last rumble strip pad should be placed a minimum of 250 feet in advance of the traffic condition, gore, work space, or stop position. Rumble strip pads should not be placed on short horizontal or vertical curves where loss of vehicle control may occur because of the action of the rumble strips on a vehicle's suspension system. Rumble strips may be portable devices.

A sign warning drivers of the presence of rumble strips may be placed in advance of the strips. (6F-8d)

Old: Not in old MUTCD.

New: Opposing traffic lane dividers are delineation devices used as center lane dividers to separate opposing traffic on a two-lane, two-way operation. The upright, orange-colored panel shall be approximately 12 inches wide by 18 inches high. The legend on the divider shall be two opposing arrows, similar to those in the legend on the TWO-WAY TRAFFIC sign (W6-3). The divider should be made of lightweight material. (6F-8f)

Old: Figures 6-2 through 6-10

New: Figures TA-1 through TA-44 (6H-3)

- **Work Duration:** Work duration is a major factor in determining the number and types of devices used in temporary traffic control zones.

- **Location of Work:** The choice of traffic control needed for a temporary traffic control zone depends upon where the work is located. As a general rule, the closer the work is to traffic, the more control devices are needed.

- **Roadway Type:** Roadway type is also a primary factor in the use of temporary traffic control zone traffic control devices.

- **Enhancing Traffic Control:** To improve safety, typical designs may be modified to a more elaborate treatment. . . . (6G-2)

Old: Not in old MUTCD.

New: Work duration is a major factor in determining the number and types of devices used in temporary traffic control zones. The five categories of work duration and their time at a location are as follows:

- Long-term stationary: Work that occupies a location more than 3 days.
- Intermediate-term stationary: Work that occupies a location from overnight to 3 days.
- Short-term stationary: Daytime work that occupies a location from 1 to 12 hours.
- Short, Duration: Work that occupies a location up to 1 hour.
- Mobile: Work that moves intermittently or continuously. (6G-2a)

Old: Not in old MUTCD.

New: The choice of traffic control needed for a temporary traffic control zone depends upon where the work is located. As a general rule, the closer the work is to traffic, the more control devices are needed. Work can take place in the following locations:

(1) **Outside of the shoulder edge.** Devices may not be needed if work is confined to an area 15 or more feet from the edge of the shoulder. Consideration should be given to roadway characteristics, roadway geometrics, and vehicle speed. A general warning sign like ROAD MACHINERY AHEAD should be used if workers and equipment must occasionally move closer to the highway.

(2) **On or near the shoulder edge.** The shoulder should be signed as if work were on the road itself, since it is part of the drivers' "recovery area." Advance warning signs are need. Channelizing devices are used to close the shoulder, direct traffic, and keep the work space visible to the motorist. Portable barriers may be needed to prevent encroachment of errant vehicles into the work space and to protect workers.

(3) **On the median of a divided highway.** Work in the median may require traffic control for both directions of traffic, through the use of advance warning signs and channelization devices. If the median is narrow, with a significant chance for vehicle intrusion into long-term work sites and/or crossover accidents, portable barriers should be used.

(4) **On the traveled way.** Work on the traveled way demands optimum protection for workers and maximum advance warning for drivers. Advance warning must provide a general message that work is taking place, information about specific hazards, and actions the driver must take to drive through the temporary traffic control zone. (6G-2b)

Old: Traffic conditions on streets are characterized by relatively low speeds, wide ranges of volumes, limited maneuvering space, frequent turns and cross movements, a significant pedestrian movement and other obstructions. Construction and maintenance operations are more numerous and varied, including such diverse activities as pavement cuts for utility work, pavement patching and surfacing, pavement marking renewal and encroachments by adjacent building construction. Work on arterial streets should be restricted to off-peak hours to minimize conflicts with traffic.

Rural highways are characterized by lower volumes, higher speeds, and less interference from pedestrians, turns, and encroachments.

Limited access highways present problems requiring a special effort by administrators, supervisors, and work forces, Both high speeds and high volumes may be anticipated, with peak flows restricting work to relatively short periods during daylight hours. (6A-3)

New: Roadway type is also a primary factor in the use of temporary traffic control zone traffic control devices. Typical application diagrams of the following categories of roadway type are included in section 6H:

(1) Rural Two-Lane Roadways,
(2) Urban Arterial Roads,
(3) Other Urban Streets,
(4) Rural or Urban Multilane Divided and Undivided Highways,
(5) Intersections, and
(6) Freeways.

Rural two-lane roadways are characterized by relatively low volumes and high speeds. Urban arterial roads often have lower speeds, but they may require significant controls because of higher traffic volumes and closer spacing of such design features as intersections. Other urban streets with light traffic volumes will generally require fewer but more closely spaced devices. Major arterial roads and freeways need the highest type of traffic control, primarily because of high speeds and often high volumes of traffic. (6G-2c)

Old: Not in old MUTCD.

New: To improve safety, typical designs may be modified to a more elaborate treatment, as indicated by the following:

- Additional devices
  - Additional signs
  - Flashing arrow displays
  - More channelizing devices at closer spacing
  - Temporary raised pavement markers
  - High-level warning devices
  - Portable changeable message signs
  - Portable traffic signals
  - Portable barriers
  - Impact attenuators
  - Screens
  - Rumble strips
- Upgrading of devices
  - A full complement of standard pave ment markings in areas of high hazard
  - Brighter and/or wider pavement markings
  - Larger signs
  - Higher type channelizing devices
  - Barriers in place of channelizing devices
- Improved geometrics at detours or cross-overs, giving particular attention to the provisions set forth in section 6B
- Increased distances
  - Longer advance warning area
  - Longer tapers
- Lighting
  - Temporary roadway lighting
  - Steady-burn lights used with channelizing devices
  - Flashing lights for isolated hazards
  - Illuminated signs
  - Floodlights

When conditions are not as difficult as those depicted in the typical applications, fewer devices may suffice. However, uniformity of devices and their application is always extremely important.

TRANSPORTATION OUTLOOK IN THE NEW CONGRESS

The Honorable Nick J. Rahall II

U.S. House of Representatives (D-WV)

Thank you for giving me the opportunity to address this meeting of the transportation community.

While I am sure you have an interest in the overall Federal aid highway program, I noticed from the conference agenda that you are involved in a number of workshops and sessions aimed at addressing construction worker and motorist safety in highway work zones.

Your participation in this Conference is commendable. As any highway construction worker knows, the safety of work zones is of paramount concern, and heightening the awareness of motorists to the risks these areas pose to themselves and to the workers is certainly a worthy goal.

My purpose this afternoon, however, is not to address the particulars of ISTEA's work zone safety program. I will leave that to you, the professionals in this area.

Rather, at this juncture, I think it appropriate to survey the political landscape in the House of Representatives as we prepare for the 104th Congress, and what we might expect in the way of highway and transit legislation.

First, however, I would note that the Republican tidal wave that washed across much of the Nation last Election Day did not reach the mountains of West Virginia. And in fact, I now find myself in the position of being the dean of the largest all-Democratic delegation to the House of Representatives. There are three House Members from West Virginia—all Democrats.

The last election, of course, did something else besides placing the West Virginia House Delegation in this particular situation. When the 104th Congress convenes in January, the Republicans will be in the majority in the House for the first time in 40 years. Obviously, among other things, this means that all of the Committee and Subcommittee chairs will shift from Democrats to Republicans.

From the perspective of the transportation community, this upheaval occurs at the very time when the National Highway System must be designated by legislation in order to avoid a September 30, 1995, cutoff in the flow of all Interstate maintenance and NHS funds to the States.

Further, it comes at a time when consideration must begin on the reauthorization of the core Federal aid highway and transit programs—the post-ISTEA era, if you will.

What, then, do these changes within the House of Representatives mean to the transportation community? My initial observation is that among all of the committees, this change will have the least impact on the Committee on Public Works and Transportation, especially as it relates to highway and transit legislation.

These bills have always been fashioned with close consultation between Democrats and Republicans —long known for our bipartisanship. Chairman Norman Mineta will be handing the gavel over to Representative Bud Shuster of Pennsylvania. And I will be doing the same, it appears at this point, with Representative Tom Petri of Wisconsin, who has served these past two years as the Ranking Republican Member on the Surface Transportation Subcommittee.

It is a fact that Bud Shuster's breadth of experience and expertise in the area of transportation legislation is legendary. I can think of no other Republican Member who I would rather see lead the Public Works and Transportation Committee in our effort to designate the NHS next year. The same goes for Tom Petri. I fully believe that he will be a very able Subcommittee chairman as I move into the Ranking Democratic Member slot.

I think there are three tests the Committee will face early on as it relates to highway and transit legislation. The first—and these are not in any particular

order—relates to how the new Republican leadership in the House will view special transportation projects that are often included in our highway bills.

These projects, while not always viewed enthusiastically by the Federal Highway Administration and certain States, have become somewhat a fact of life in the House and serve to facilitate the passage of our authorizing bills.

Further, the new manner in which these projects were considered earlier this year by the Committee when fashioning the NHS bill, I believe served to dispel much of the criticism that was once lodged against them. Full public hearings, the support of the States and localities, and an emphasis on how a proposed project fits into the overall transportation needs of the Nation were all elements of how the projects were selected.

This, in addition to the fact that the Committee offset any new contract authority for a project with a rescission of existing contract authority—playing a zero sum game—allowed the NHS bill to pass the House by an overwhelming majority last May. There were only 12 votes against it.

However, a fair question to ask is whether those who subscribe to the Republican Contract With America, particularly Speaker-to-be Newt Gingrich, will recognize the importance of an NHS bill that might include special transportation projects.

In the event the Committee continues to authorize these types of projects, which I fully expect, how we fare on the House floor next year will be interesting to watch. I can only say this: While I cannot speak for the new House Republican freshmen, Newt Gingrich certainly had his fair share of highway project money in our NHS bill this last year, as did many other Republican Members.

The second test the Committee will face is how our relationship with the new leadership of the House Appropriations Committee shapes up. As many of us can remember, the NHS bill this last year allowed us to avoid the differences that occurred between the authorizing and appropriations committees in 1993 that held up action on the Transportation appropriations bill for months.

These differences were based on the Appropriations Committee insisting on including unauthorized projects in their bill, as well as various other matters that were properly within the jurisdiction of the Public Works and Transportation Committee.

Peace within the family this last year came about because a closer working relationship between the two committees was achieved, and because of our ability to propose authorizations as part of the NHS designating legislation.

The third test we will face involves a proposed area of new jurisdiction for the Committee. Legislation involving heavy rail and Amtrak has been with the Committee on Energy and Commerce. It is now being proposed that this jurisdiction be transferred to the Public Works and Transportation Committee, and this is expected to occur. In fact, there is some talk about creating a new Subcommittee to deal solely with rail matters.

Because of the jurisdictional wall that separated heavy rail and light rail in the past, the Public Works and Transportation Committee has always been careful when devising transit legislation not to allow the Highway Trust Fund to be tapped for non-commuter purposes, and certainly not for Amtrak.

With the jurisdictions under one roof, the camel, so to speak, may try to get its nose under the tent. I think this will give rise to a more serious consideration as to how the highway and transit programs benefit the railroads—the rail/highway grade program, for example—and the extent of their relevant contribution to the manner by which these programs are financed.

The Amtrak jurisdiction, of course, brings with it a whole array of headaches as the line's financial solvency continues to be a source of concern.

With this stated again, I want to impress upon you that many things remain unsettled as to Committee makeups and jurisdictions at this time. The Republican conference is meeting this week, and after that we should have a clear idea of what to expect.

Again, however, aside from the three areas that I mentioned as being items to watch out for in the new Congress, I do expect relatively smooth sailing in the House of Representatives for the NHS bill next year. Hopefully, the Senate will see fit to act on this most important legislation as well.

Then, with that aside, we can all begin to focus on what type of legislation will be necessary in the post-ISTEA era.

Thank you again for inviting me to be with you today.

NATIONAL WORK ZONE SAFETY PROGRAM

Joseph J. Lasek

Chief, Technical Development Branch Safety Office
Federal Highway Administration

Good morning. After a full, informative day highlighted by the luncheon with Congressman Rahall yesterday, we are starting right out today on a special subject that is one of the focal points of this Conference: The National Work Zone Safety Program. The Conference was planned so it would occur sometime after the Work Zone Safety Program was published in the *Federal Register* and after comments were received in order to receive further input at the Conference.

Section 1051 of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) requires that the Secretary of Transportation develop and implement a work zone safety program to improve safety at construction sites. My first thoughts at the time were, Why require a national program now? Hadn't the FHWA been emphasizing the safety of work zones for many years? Also, many of the State DOTs have mature programs and engage in continuing efforts to improve the safety of their work zones. The Congressional committee reports on the ISTEA hearings provided little insight as to Congress's intent.

To digress for a minute, when new highway legislation is passed, the various sections of the law are assigned to the appropriate FHWA program offices of implementation. The Office of Highway Safety was designated as the lead for Section 1051. The development of the work zone safety program was then assigned to my office, the Technical Development Branch. That is why I am presenting this subject here.

Focusing on why Congress may have believed a work zone safety program was necessary, we reviewed the fatal accident data for work zones up to that passage of the ISTEA. Currently we track the impact of work zones on highway safety through the Fatal Accident Reporting System (FARS). Based on the FARS data for the 1980 to 1990, the time period prior to the passage of the ISTEA, the number of fatalities that occurred in work zones was greatest for the last three years. This three-year average was 783, while the previous eight-year average was 642.

Obviously this 22 percent increase in fatalities for three consecutive years seemed to indicate an increased hazard in work zones. However, it may just be a case of an increased number of work zones on high-traffic facilities during this time period. Due to the lack of exposure data it is difficult to know for sure what is happening nationally in work zones. Maybe this apparent reduced safety of work zones contributed to the Congressional action to include Section 1051 in the ISTEA.

Since the FHWA was already constructively engaged in a number of activities to further work zone safety, we had some difficulty determining what further gains could be achieved by a work zone safety program. Upon further reflection, we realized our current program was informal, and development of a national program could provide both emphasis and structure for this specific safety activity.

To understand our basis for developing a work zone safety program some background information is necessary. At the time ISTEA was enacted, Government agencies were trying to reduce or minimize the number of Federal regulations being generated. Also, the new Administration temporarily froze development of any new regulations except for the most essential ones in order to reduce the burden of Federal requirements on local government, business and the general public.

Finally, in recognition of the FHWA's changing role entailing less oversight and the increased authority granted the States for designing and managing their highway systems, it was decided that any National Work Zone Safety Program should be structured around identified safety deficiencies and what the

FHWA could accomplish through our national roles of providing leadership, technical guidance and program oversight. The resulting program would be a blueprint for headquarters and our field offices to follow, as well as serve as a model for State highway agencies to use as it fit their needs.

This background is provided because of some of the responses we received in the Federal docket per our Notice on the draft program requesting public comment.

We received replies from 25 organizations including 13 State DOTs, four national associations, four from private industry, a utility company, a safety advocacy group, a consultant, and a national insurance organization. Almost universally, they supported the FHWA effort to emphasize and improve work zone safety. I want to thank all those who provided comments to the Federal docket and to commend them on their very complete and well-thought-out responses and recommendations.

However, depending on the commentator's perspective, there were philosophical differences as to how we should implement the national program. General recommendations were made to either strengthen and mandate the program requirements for applicability to the States, or to limit FHWA's role to providing information, technology, and assistance to the States and avoid setting requirements that would increase demands on their limited resources.

To those of you who urged a strong role by the Federal Government and recommended extensive implementing activities, I repeat what I said earlier: The FHWA intends to lead by example, with the States exercising their management authority to define their work zone program.

For those who preferred a completely hands-off role for the FHWA, I would also remind you that we have an obligation to the Congress and a long-time commitment to highway safety for the general public. I assure you, we continue to be deeply concerned for the safety of the traveling public and the workers who are at high risk in constructing and maintaining our highway system. We will vigorously pursue those activities which can contribute to improving work zone safety within the limits of our resources and legal/administrative responsibilities, and we will apply friendly persuasion where appropriate.

A couple of comments were also received concerning the lack of opportunity for input by all the various segments of the highway industry in the development of the draft work zone safety program. Since the National Work Zone Safety Program is an FHWA model program, we felt it was necessary to first identify what its platform should be and what was achievable and reasonable given the FHWA and state DOT resources.

Through the *Federal Register* notice process and information gained from the broad range of participants attending this Conference, we expect to have the necessary input to implement the program.

At this time, I would like to skim through the draft program and cover key components, as well as discuss related docket comments we received.

OBJECTIVE AND SCOPE

The objective of improving work zone safety is straightforward. However, there was some concern about the scope of the program, focusing on the National Highway System to the possible detriment of other roads and streets. Please note the Work Zone Safety Program *is applicable* to all public highways and streets, despite our emphasis on the National Highway System. Since the NHS, which includes the Interstate system, is to be the basic Federal highway system of the future, carrying the bulk of all vehicle travel, it is only natural for us to focus on it.

Certainly the standards and information contained in the MUTCD, Part VI, has universal application to all local roads and streets as stated in Title 23 U.S.C. Also, any training courses, public education and awareness campaigns, promotion of new technology such as the SHRP work zone safety devices, etc., all have universal application and would not be confined to the NHS.

Alternatively, we recognize there are some practical limits as to what is needed for low-volume or low-speed roads and streets compared to the measures that may be needed for work zones on high-volume and/or high-speed facilities.

CONTINUING PROGRAM WITH BIANNUAL REVIEWS AND UPDATING

There appears to be some confusion about this. Our intent is for the program to be a continuing effort, and not a one-shot effort. We plan to review the total program and its successes and failures on about a two-year cycle and make changes to it where warranted. How this is to be accomplished is open to ideas. Some of you have expressed an interest in being on any task force organized to implement any of the program activities, and this might be an area where a task force representing a number of separate interests could provide advice for making future program modifications.

WORK ZONE PROGRAM COMPONENTS

1. Standardization—Uniformity
2. Ensuring Compliance—Quality/Assurance
3. Evaluation—Information/Feedback/Direction
4. Innovative Technologies/Procedures—Adaptation/Education/Procedures

These four components provide the platform for the national program.

Standardization

Standardization and uniformity are essential to addressing traffic control requirements for implementing agencies, work zone supplier industries, and contractors to achieve a common understanding of design features, device application and contract pay items. Uniformity is also useful for helping educate the drivers through consistent application of traffic control layouts and for quicker recognition of traffic control guidance.

One of the first things the FHWA needs to do under this component is review our existing work zone safety regulations as contained in 23 CFR 630 Subpart J. These were promulgated in 1978, and underwent minor revisions in 1982 and 1987. If changes are warranted they will go through the rule-making process and everyone will have an opportunity to comment on them and influence their final structure.

This is the area where we walk the fine line between requiring procedures that actually contribute to the safety of work zones vs. possible excess Federal mandates requiring expenditures of scarce resources. As noted earlier, comments received have endorsed both more mandates and fewer mandates.

Develop retroreflectivity guidance for work zone signs and pavement markings. We all recognize the need for visibility at night, and for other reduced visibility conditions it is important to have traffic control devices that can be seen and are legible at sufficient distance to take the proper actions in a timely manner. We have not had minimum retroreflectance guidance before, and a great deal of effort is being expended to develop reasonable guidelines for all traffic control devices. Most comments received on this subject were supportive of this effort.

Establish the crash-worthiness of work zone safety and traffic control devices. Again there was good support for this activity, with some cautions expressed. According to NCHRP Report 350, any work zone devices have to be crash-worthy for use on Federal aid projects after July 1998. Therefore, we are planning for a research project to test and evaluate generic work zone devices as a pool-funded study with cooperating States. The involved States will be used as a panel to identify which generic devices need testing and their priority of testing.

Some preliminary work is necessary to consider the degree of crash testing/evaluation needed for some obviously safe devices. On the other hand, we need to consider the best way to protect drivers who may strike portable arrow panels or changeable message signs used adjacent to the travel lanes.

Ensuring Compliance

This is an area where we believe the most work site problems exist and where perhaps the greatest benefits can be realized. If we can assure ourselves of the quality of the product over the life of the construction project or maintenance activity, we will have gone a long way to achieving safer work zones.

Identify/promote the use of procedures and speci-

fications which help achieve and maintain an acceptable level of quality for the traffic control plans, traffic control devices, and safety appurtenances used in work zones. This may be a hard goal for us and others to achieve. A couple of examples of attempting to identify quality are as follows:

- The booklet developed by ATSSA describing the acceptable and unacceptable quality levels for work zone traffic control devices is an excellent effort to provide guidance on this.

- A National Highway Institute training course for work zone safety inspectors, which has been under development, focuses on assuring the quality of devices and appurtenances as supplied and maintained. An initial pilot course was recently held and a second one is scheduled. It should be available for regular presentations next year.

Promote development and implementation of public awareness and education programs. We have been keenly aware for some time that the traveling public doesn't fully understand many of our traffic control devices and that they have received very little training and information on driving in work zones and the meaning of related traffic control devices.

One of the *Federal Register* respondents identified the problem relative to lack of compliance with existing work zone traffic control layouts and devices. While he listed project managers and designers, construction supervisors, and contractors as problems he ended with: "The biggest problem is the driver. He ignores speed limits, warning signs, the traffic control devices, etc. This is an area where the largest benefit can be achieved in terms of real improvement in safety."

I believe his point is well made. Apparently many of the States agree at least to some extent with this issue, because many of them already have public work zone awareness programs, including excellent TV and radio public service announcements. This activity again received universal support in the docket comments. Although public awareness campaigns have been well received, I believe more needs to be done to *really educate* the drivers on understanding work zone traffic control devices and proper driving practices when passing through work zones.

Certification programs for flaggers and work site supervisors. We received a lot of comments on this item, varying from "mandate flagger certification" to "don't require certification." Also, we received recommendations relative to the need for establishing standards for training and certification programs.

There are several good programs already in existence, such as the American Traffic Safety Services Association's training courses leading to certification for flaggers and work zone site supervisors, the National Safety Council's flagger training, the International Municipal Signal Association's work zone safety certification program, and perhaps others I am not familiar with.

There are a number of issues to consider on this activity, and your thoughts as expressed in the workshop discussions will be of value.

Document "good practices" for use in safety management systems. We believe there has to be a connection of work zone safety efforts with aState or local government's overall safety management system. Again, comments on work zone safety and its role in safety management systems were numerous and varied. There seemed to be support for assuring that work zone safety is given full recognition in safety management systems. One commentator even suggested amending the interim final rule on safety management system requirements to include work zone safety management as part of a State's safety management system.

Improve Evaluation of Work Zones

As we have all learned from various management training courses and books on the subject, it is important to be able to accurately evaluate your program or function to quantify its relative success or lack of success and identify where changes are needed. Though this program component requires various information as a basis for evaluation, it can be invaluable in providing program direction for the future.

Develop guidelines for the collection and reporting of data on highway work site deaths and injuries. Anyone who has been involved for any length of time with work zone safety knows we suffer from a lack of complete, accurate information on accidents occurring in work zones. This is especially true for national data, except for certain fatality data, and also for many States, New York State, California and a few others being notable exceptions.

Because of the nature of work sites, with their ever-changing conditions, location, etc., it is even hard to define a work zone-related accident. We received comments strongly supporting a requirement for better accident data collection/reporting, and for standardization of the data to be collected. However, in a few cases this was tempered with the proviso, "as long as it didn't increase [their] burden."

Unfortunately, although desirable from an accident analysis basis, the collection of additional data elements on accident forms is often strongly resisted by State and local governments. Collecting added data elements increases the collection and processing costs, including time required of enforcement personnel. We have been seeking ways to make accident data collection more efficient and accurate through research and demonstration of various emerging technology.

FHWA review of sampling of projects. It should be noted that most States make annual reviews of a few selected projects to review their work zone operations. The FHWA division office usually has a standing invitation to accompany the State during these reviews. Due to our changing role of providing more technical assistance and fewer oversight reviews because of reduced resources, there has been a gradual reduction in FHWA participation in work zone reviews.

This program activity is designed to refocus on participating in more reviews by the FHWA divisions and including occasional region and headquarters staff participation. It is hoped that this will encourage those States that may not have been evaluating their work zone activities to increase their oversight efforts. Checking first on what is working or not working, identifying procedural lapses, etc., are valuable tools for learning firsthand what some of the common problems are and identifying possible solutions.

We need to consider various options on how to accomplish increased review participation, keeping in mind our limited resources and the oversight issues mentioned earlier. This is still to be resolved.

Implement Innovative Technologies and Procedures

This component embraces the concept of seeking and using new technology/procedures that have the potential for improving the traffic flow or safety of work zones. It also includes providing the necessary training for the decision makers, whether project managers, traffic control plan designers, safety inspectors, flaggers or contractors, to assist them in better understanding their role and doing a better job relative to work site safety.

Encourage the development and use of new technology for work zones. We all know how difficult it is to get new technology accepted. I have learned this firsthand in trying to implement the SHRP-developed work zone devices. The larger private companies usually have the resources to develop, test and market new products. However, the small entrepreneur often lacks the resources to fully develop a product, much less support the necessary testing and marketing of it in 50 States to gain acceptance.

The FHWA has several existing programs to accommodate and/or promote new, innovative technology such as the "High Tech" program being operated in cooperation with the American Society of Civil Engineers. It provides, for a fee, assistance in getting testing for products that do not fit existing standardized testing criteria.

Another example is the testing and evaluation of SHRP work zone safety products, which we have initially showcased and then funded performance evaluations conducted by interested States. We are also considering making available to our Regional Offices special limited funding (Section 6005 priority technology) for advancing the use of technology that is generally developed, but underutilized for lack of operational testing and marketing. Some of this funding may be applicable for advancing work zone safety features or devices. These are potential ways to help advance new technology.

This seems to be an area where everyone is looking for assistance or answers on how to achieve more

rapid deployment of technology.

Develop comprehensive work zone safety training programs for State and local government use. This program activity has strong support, based on the comments received. Historically this has been the case. It should be noted our oldest NHI basic work zone training course, "Design and Operation of Work Zone Traffic Control," has been the most popular of all the available NHI training courses based on the frequency with which it has been presented and the number of persons trained.

At the local level, work zone training courses offered through the LTAP centers are very popular. Additionally, the ATSSA-sponsored training courses are heavily subscribed. One comment we received that merits our consideration is that work zone safety equipment manufacturers' training material should be reviewed and incorporated into the NHI courses where applicable.

The FHWA will have two new work zone courses available for scheduling this coming year. One is "Inspection of Construction Zone Hardware," and the other is "Transportation Alternatives During Highway Reconstruction." Along with an updated version of the original basic work zone course, another recently updated course is "Work Zone Safety for Maintenance Operations on Rural Highways." One other available course, "Developing Traffic Control Plans and Strategies," did not need updating.

Work zone program implementation. The last item I will cover involves what comes next. Given that we finalize the work zone safety program, the FHWA needs to develop an implementation plan and marshal resources accordingly. We are already working on this. However, the results from this Conference's workshops will be valuable in helping us finalize the program and a plan of implementation.

One event that has already occurred in the Office of Highway Safety should increase our ability to focus on a wide scope of work zone activities. We have organized a work zone management team under a team leader. The team members include not only OHS staff but representatives from the Offices of Research and Engineering. Although this is not a full-time function for team members, the overall result will be a greater and broader-based emphasis of resources on work zone safety.

Our intent, unless we become convinced otherwise, is for our Divisions to work in partnership with their State highway agency and other appropriate agencies to develop and implement a statewide highway work zone safety program based on this national program. This will be an opportunity for each State to review its current situation and use the portions of the model program to initiate activities not currently in place or which need more emphasis.

Bob Garret mentioned yesterday that he felt the program did not identify how all the different organizations and agencies could work together to carry out a national program effort. That is true! Maybe some cooperative effort can be accomplished on a national basis, and perhaps other items can better be achieved on a per-state basis. We are open to suggestions.

In any case, implementing a work zone safety program should be a challenging task, but one that can improve safety and traffic flow in work zones. If all the different groups here today cooperate and join together in this effort, we can succeed.

LIABILITY / LITIGATION / INSURANCE

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This discussion focuses on recent events in four types of laws and regulations that impose liability on employers for work zone hazards which either harm, or have a potential to harm, persons on the work site. These areas are the Occupational Safety and Health Act, Workers' Compensation Laws, Common Law Negligence, and State Safety Statutes.

OCCUPATIONAL SAFETY AND HEALTH ACT (OSHACT)

The OSHAct requires employers to maintain work places that are free from recognized hazards to employee health and safety. It prescribes specific standards for the construction industry, as well as a "general duty clause" aimed at remedying hazardous working conditions for which a specific standard has not been set out. In addition to the workplace standards, there are interpretations of the Act that address the question of who bears liability in the typical construction setting in which employees of many entities are all present at the work site. A brief procedural overview provides an understanding of the citation and appeal process. Although States with approved occupational safety and health plans may take over enforcement of the OSHAct, in only a few approved States are the standards significantly different from those of the Federal act. The States with standards which frequently differ from the Federal act are Alaska, California, Hawaii, Michigan, Oregon, and Washington.

Conditions Resulting in Liability

1. Breach of specific construction industry standards. Areas covered by specific standards include:

- "Housekeeping." These rules require removal of combustible scrap and debris, removal of lumber with protruding nails from work areas, collection of refuse, coverings required on containers for flammable and other harmful substances.

- Medical care. Employers must ensure that medical personnel are available for consultation on occupational health matters and for prompt medical attention in case of injury. Equipment for prompt transportation must also be available, as well as a means for contacting an ambulance service.

- Drinking water, toilet and washing facilities.

- Controlling exposure to radiation, including laser use.

- Exposure to toxic gas, dust, and fumes.

- Lighting. Requirements apply to construction areas, ramps, runways, corridors, etc.

- Personal protective and life-saving equipment. Includes standards for head protection, hearing protection, eye and face and respiratory protection. Regulations pertain also to use of safety belts, lifelines and lanyards. These standards and other fall protection requirements must be reviewed in connection with specific steel erection standards.

- Fire protection and prevention. In addition to specifying fire prevention and extinguishing devices, these regulations also cover containers for flammable and combustible liquids and for storage and use of liquified petroleum gas.

- Warning signs and traffic control. These regulations prescribe background and lettering colors and sizes, the use of danger and caution signs, and sizes of flags. Flag personnel are required to wear red or orange warning garments, and those worn at night must be reflectorized.

- Materials handling, storage, and disposal. In addition to the rules for hazardous waste discussed below, the Act prescribes how materials may be stored so as to avoid sliding, falling, or collapse, as well as the use and inspection of rigging equipment such as ropes, chains, and u-bolts.

• Safety requirements for hand and power tools.

• Welding and cutting.

• Electrical requirements. These regulations pertain to general work site safety, not simply to electrical work per se. Electrical power circuits must be grounded or effectively insulated. Employees working with jackhammers or hand tools which may contact energized lines must wear insulated protective gloves. Warnings are required where employees may contact an electrical circuit either directly or through use of a tool or equipment. Pathways must be organized to avoid exposed electrical equipment.

• Stairways, ladders, and scaffolds. Comprehensive regulations cover these subjects, including the requirement of training and retraining programs for all employees using these items.

• Railings for floor and wall openings. Railings must include top rail, intermediate rail, toe board and posts, with the toe board designed to prevent falling material.

• Maintenance of heavy equipment. Separate standards are set out for preventive maintenance of cranes and derricks, and for other types of machinery.

• Excavation, trenching and shoring. Before excavating, employers must determine if underground utilities exist, by contacting utility companies. Cave-in precautions must be taken. Employees are prohibited from working above other employees on slopes unless the employees below are adequately protected from the possibility of falling materials or equipment. Daily inspection of trenching operations is required to avoid slides and cave-ins. Rebar extending vertically must be protected to avoid the possibility of impalement of those working above.

• Explosives.

• Hazardous materials. All employees who may be exposed to hazardous substances must be trained. In order to be a hazardous material, there need be only one scientific study showing significant evidence of acute or chronic health effects due to exposure. Therefore, ordinary materials such as gasoline are included. All containers of hazardous chemicals must be labeled or tagged, and accompanied by a materials safety data sheet (MSDS) identifying the health hazards, expiration limits, control measures, and precautions. Employers must develop a training program to communicate this information to their employees. They also must make available the written details of the training program, an inventory of hazardous materials on site, and the MSDS sheet. The training program must cover how to detect the presence or release of a material, physical and health hazards, protective measures the employee can take, and where and how to obtain the MSDS forms. Any time new hazardous materials are introduced to the site, additional training must occur. Additional requirements are applied to personnel who may become involved in responding to hazardous material emergencies.

2. General duty clause. This clause imposes a duty to provide each employee with a place of employment free from recognized hazards that may cause death or serious physical harm. To make out a violation of the general duty clause, OSHA must prove:

• the existence of the alleged condition or practice at the workplace;

• that the alleged condition or practice presents a risk of an event likely to cause death or serious harm;

• employer or industry knowledge that the condition or practice is hazardous and exists or potentially exists at the workplace; and

• the existence of a feasible method by which the employer could eliminate or materially reduce the alleged hazardous practice or condition. (Schal Associates (OSHRC) No. 85-0115, 10/10/86.)

The employer can be found to have violated the general duty clause even where it has a safety program in place, if OSHA can prove that additional feasible and effective steps could have been taken. The general duty clause generally does not provide a basis for liability where a specific standard applies. However, if the employer knows that a particular standard is inadequate, the general duty clause requires the employer to take additional protective measures.

Who Is Subject to Liability?

The construction industry standards apply "to every employment and places of employment of every employee engaged in construction work. Each employer shall protect the employment and places of employment of each of his employees engaged in construction work by complying with the appropriate standards. . . ." (29 CFR ß†1910.12(a))

1. Liability for hazards to the employer's own employees.

• Where the employees arguably are not involved in construction, or are not present at the work site. In *Reich v. Simpson, Gumpertz & Hegger, Inc.*, No. 92-2337 [16 BNA OSHC 1313] (1st Cir. August†20, 1993), the United States Court of Appeals for the First Circuit considered a case in which an owner had hired a general contractor and architect. The architect then hired the engineering firm, SGH. SGH reviewed the contractor's shop drawings for five floors of poured concrete over a base of steel and metal decking. One floor called for two pours of concrete with a layer of insulation between. After the first pour, the contractor observed some bending in the decking. He then called SGH. SGH's engineer informed him that the amount of bending was normal and said that he saw no problem with making the second pour that day. The weight of the two pours of wet concrete caused the decking to collapse, injuring five workers. The administrative law judge found as a matter of law that SGH was not involved in construction work, and therefore could not be subject to liability under OSHA. On appeal to the Circuit Court, the First Circuit Court of Appeals found that, because SGH had no employees at the work site, it could not be liable. SGH's employees were only occasionally at the job site, and none were on the site that day. The Court of Appeals failed to address the question whether SGH was involved in construction work. This case raises the question whether an architect/engineer whose employees visited the job site regularly could be liable under the OSHAct.

Secretary of Labor v. CH2M Hill Central Inc., OSHRC Docket No. 89-1712 (August 25, 1993), also addressed the question of the definition of "places of employment." In that case, the administrative law judge has defined the work site as a tunnel where a methane explosion occurred, rather than the entire job site. Since the engineering employees did not work in the tunnel, the engineering firm was held not to be liable.

According to the definition of the applicability of the construction standards, the OSHAct should be interpreted as requiring both that the employer have places of employment at the job site, and that its employees be engaged in construction work.

• Where a third party created the hazard. In *Anning-Johnson Co. v. OSHRC*, 516 F.2d 1081 [3 BNA OSHC 1166] (7th Cir. 1975), the subcontractor received an OSH citation because its employees worked on elevated floors lacking guardrails. The placement of guardrail was the responsibility of another contractor. The United States Court of Appeals for the Seventh Circuit reversed, holding that the subcontractor could not be liable for hazards it had not created.

The OSH review commission adopted this position in *Grossman Steel & Aluminum Corp.*, 4 BNA OSHC 1185, 1188 (1975). It imposed on subcontractors the additional duty, however, of taking some sort of affirmative action to eliminate hazards. Examples would be asking the general contractor or the responsible subcontractor to correct the problem, or (where feasible) directing employees to avoid the hazard. Otherwise, a subcontractor may be held liable despite the fact that it neither created the hazard nor had contractual responsibility for it. (See *DeTrae Enterprises, Inc. v. Secretary of Labor*, 645 F.2d 103 (2d Cir. 1981); *Zemon Concrete Corp. v. OSHRC*, 683 F.2d 176, 180-81 (7th Cir. 1982); *Dun-Par Engineered Form Co. v. Marshall*, 676 F.2d 1333, 1336 (10th Cir. 1982); *Secretary of Labor v. Western Waterproofing Co.*, 15 BNA OSHC 1491 (1992); *Secretary of Labor v. Law Engineering, Inc.*, 14 BNA OSHC 2224 (1991).)

2. Liability for hazards to others' employees.

The OSHAct refers only to the furnishing of the employer's own employees with a safe workplace. Accordingly, the United States Court of Appeals for the Fifth Circuit has refused to extend liability to firms that are not the employer of the endangered employees. (See *Horn v. C. L. Osborn Contracting Co.*, 591 F.2d 318, 321, rehearing denied, 595 F.2d 1221 (5th Cir. 1979).)

Elsewhere, however, special rules have evolved with respect to the construction industry. Unlike the usual workplace in which all persons working are employed by one employer, the construction site typically has employees of numerous contractors. Both employers having responsibilities for the overall condition of the work site or particular safety responsibilities, and employers who are responsible

for creating hazards, have been held liable for violations affecting other contractors' employees.

- Employers in a supervisory capacity can be liable for violations that affect only others' employees. This rule applies only to violations of which the supervisory employer is aware. Thus, for example, in *Knutson Construction Co.*, 4 BNA OSHC 1759 (1976), aff'd sub nom, *Marshall v. Knutson Construction Co.*, 566 F.2d 596 [6 BNA 0SHC 1077] (8th Cir. 1977), where the general contractor observed that the scaffolding on which subcontractor employees worked contained no toe hold or guardrail, it was responsible for those violations. It was not, however, responsible for detecting the small crack on the underside of the scaffold that led to the collapse of the scaffold and injured several subcontractor employees. Additional cases in which the prime contractor has been held responsible include *Gelco Builders, Inc.*, 6 BNA OSHC 1104 (1977); *Gil Haugan d/b/a Haugan Construction Co.*, 7 BNA OSHC 2004 (1979); *Red Lobster Inns of America, Inc.*, 8 BNA OSHC 1762 (1980).

In a 1992 case, however, the Occupational Safety & Health Review Commission further extended the general contractor's liability for hazards created by a subcontractor. In *Secretary of Labor v. Blount International Ltd.*, 15 BNA OSHC 1997 (1992), the contractor was held liable for a latent condition caused by a subcontractor. The general contractor had failed to ensure that its subcontractor performed properly. The subcontractor had not protected all outlets on electrical panel distribution boxes with ground fault circuit interrupters. The contractor did not perform its own testing, and did not ask the subcontractor whether it had tested the grounding. A dissenting opinion complained that the majority had now extended the contractor's liability from visible to invisible hazards.

In order to combat this case, the contractor would be well advised to demand safety checklists from its subcontractors, and to document evidence of any investigation of a subcontractor's good safety record, so that the general contractor may be held to have reasonably relied on the subcontractor in safety matters.

- Construction managers have also been held liable for hazardous conditions of the work site even where their own employees are not endangered. (*Kulka Construction Management Corp.*, 15 BNA OSHC 1870 (1992); *Secretary of Labor v. Frank J. Rooney, Inc.*, 14 BNA OSHC 1959 (1990).) The *Kulka* case was analyzed in terms of the decision in *Simpson, Gumpertz & Hegger, Inc.*, 15 BNA OSHC 251 (1992), in which the Review Commission held that those providing professional services, such as architects and engineers, will be subject to OSHA construction standards only if they substantially supervise construction activity. Although Kulka had no authority to order that hazardous conditions be corrected, since that authority remained with the owner, nonetheless because Kulka was engaged as a construction manager and was charged with instituting and reviewing safety programs, Kulka was liable. Construction managers are viewed as akin to general contractors despite the fact that construction managers do not perform the actual construction work.

However, administration of a project is not equivalent to supervision of the construction. See *Secretary of Labor v. CH2M Hill Central, Inc.*, OSHRC Docket No. 89-1712 (August 25, 1993). In that case, it was held that CH2M Hill was an engineer and not a construction manager, even though it had set up the project management office and had hired other engineering firms to help administer the project.

RECORDKEEPING REQUIREMENTS

OSHA requires that various kinds of records be kept concerning occupational accidents and illnesses. The records must be kept at each work site. Employers are required to report within 48 hours after the occurrence of an accident that is fatal to one or more employees or that results in hospitalization of five or more employees. These reports often prompt an inspection at the work site; therefore, employers should expect an inspection following any such reports, and prepare accordingly. In addition, an employer must keep a log of occupational illnesses and injuries with running totals and an annual summary. Occupational exposures which contribute to or aggravate preexisting conditions are also required to be noted. The logs must be readily available to employees. Supplemental reports on each individual illness or injury must also be kept. Medical records must be kept as to exposure to any toxic substance or harmful physical agent, and in some cases, ongoing blood monitoring is required. All employees must be given notice upon hiring and annually thereafter of the existence and availability of these medical records.

The importance of accurate, timely, and accessible recordkeeping has recently been emphasized by the recent citation of BE&K Construction Co. for over 600 recordkeeping violations, many of them willful, with proposed penalties totaling $560,000. BE&K denies that any violations were willful. While BE&K has indicated it will dispute the violations, the fact that they were issued is sufficient to act as a word to the wise. OSHA began investigating BE&K on a corporate-wide basis after it learned of one willful recordkeeping violation at a Maine paper mill. OSHA considers recordkeeping especially important in construction because of the role of accessible records in preventing hazards in the future.

PROCEDURAL OVERVIEW

1. Variances

Employers may apply for variances if they are unable to meet particular prescribed standards. Variances may be temporary or permanent. If temporary, the employer must show that it cannot comply with the standard by the effective date for compliance. The employer must also show that it is doing all that it can to protect its workers, that it has a plan for achieving compliance, and that it has notified its employees of the application for variance. In order to obtain a permanent variance, the employer must establish that its practices or procedures are as safe as the standard, although they do not correspond to it precisely.

2. Inspection, citation and review process

OSHA compliance officers are responsible for carrying out inspections. If the employer does not voluntarily agree to the inspection, the inspector must obtain a search warrant. Inspection ordinarily commences with an opening conference in which procedures for the inspection are discussed. Employer and employee representatives accompany the inspector. Workers are entitled to confidential discussions with the inspector. At the end of the inspection, the inspector informs the representatives as to practices and conditions that require modification.

The inspector reports to the OSHA area director. The director then determines whether to cite the employer. Any citation must be in writing describing the nature of the violation and the time in which the employer will be permitted to correct it. The employer must post the citation. The employer has 15 days in which to appeal the citation, the penalty, or the date by which the matter must be corrected. Notice of the appeal must also be posted.

If the employer appeals, the Labor Department files a complaint describing the claimed violations. The employer then has 15 days in which to respond. A hearing is held before an OSHA administrative law judge. The burden is on OSHA to prove the violations. The administrative law judge's decision is subject to review by the Occupational Safety & Health Review Commission at the request of either party. The OSHRC may or may not accept the appeal. If the appeal is not accepted, a party can appeal to the Federal Court of Appeals.

3. Penalties

- De minimis violations. OSHA can issue notices rather than citations. A de minimis violation does not become part of employer's history of prior violations. A de minimis violation is one which has no direct or immediate relationship to employee health or safety.

- Nonserious violation—up to $7000. Penalty is permissive, not mandatory. 29 U.S.C. ß 666(c)

- Serious violation—where there is a substantial probability of death or serious physical harm. There can be no finding of serious violation if the employer did not and could not, with exercise of reasonable diligence, know of the violation.

Trenching and fall and falling object protection violations are almost always deemed serious violations. The penalty is the same as for a nonserious violation, but is mandatory for a serious violation.

- Willful or repeated violations—up to $70,000. 29 U.S.C. ß†666(a).

- Criminal penalty—up to six months in jail, and up to $70,000. Requires indictment just as any other criminal proceeding. Can be doubled for second conviction. 29†U.S.C.†ß†666(e).

WORKERS COMPENSATION LAWS

Workers compensation laws are State laws under which employees are compensated for on-the-job injuries. Under these laws, employees are not free to sue their employers for negligence. The statutory remedy is the only remedy available to the employee. These laws typically provide for the payment of lifetime medical benefits for the particular injury, as well as the payment of wage compensation for a limited period of time. Contributory negligence is not a defense to a workers compensation case. Where the employee intentionally or willfully disregards safety precautions, however, which if followed would have prevented the injury, the employer may avoid some or all of the workers' compensation obligations.

Employers should document their safety training by having employees sign acknowledgements that they have been trained and instructed in the particular safety procedures.

Intoxication and illegal drug use can also be defenses to the employer's workers compensation obligations. Employers are advised to require employees to consent in advance to drug testing and to go to specified facilities for treatment for any occupational injuries, so that the employer can, by agreement with the facility, be assured that appropriate drug and alcohol testing is performed when any injury occurs.

COMMON LAW NEGLIGENCE

Workers compensation laws preempt suits for negligence by an employer's own employees.

Independent contractor rule and its exceptions: At common law, one who contracts with an independent contractor ordinarily is not liable for injury to the independent contractor's employees.

- "Inherently dangerous activity" exception. When the activity undertaken by the independent contractor is inherently dangerous, the one hiring the independent contractor can be liable to the contractor's employees or to third parties for injuries that are the result of the contractor's negligence.

This is a form of vicarious liability, in which the employer of the independent contractor can be liable even if the employer is not at fault. Since the passage of workers compensation laws throughout the States, however, courts have generally held that employees of the independent contractor cannot recover from the contractor's employer. Certain States, however, appear to continue to hold the employer responsible for injury to the independent contractor's employees, even where the employees receive workers compensation. (See *Lindler v. District of Columbia*, 502 F.2d 495 (D.C. Cir. 1974); *Giarrantano v. Weitz Co.*, 259 Iowa 1292, 147 N.W.2d 824 (1967); *Thon v. Saginaw Paint and Mfg. Co.*, 120 Mich. App. 745, 327 N.W.2d 551 (1982); *Peterson v. City of Golden Valley*, 308 N.W.2d 550 (N.D. 1981); *Colloi v. Philadelphia Elec. Co.*, 332 Pa. Super. 284, 481 A.2d 616 (1984); *Hagverg v. City of Sioux Falls*, 281 F. Supp. 460 (D. S.D. 1968); *International Harvester Co. v. Sartain*, 32 Tenn. App. 425, 222 S.W.2d 854 (1948) (but see *Richardson v. U.S.*, 251 F. Supp. 107, 113 [W.D. Tenn. 1966]).)

- "Retained control exception" to independent contractor rule. In addition to workers compensation coverage, another means of avoiding the independent contractor rule, so as to hold the employer of the general contractor liable for injury to the independent contractor's employees, is the "retained control exception." Under this exception, an employer who has retained control over the conditions of employment is held to have retained the liability associated with those conditions. In *Plummer v. Bechtel Construction Co.*, 440 Mich. 646, 489 N.W.2d 66 (1992), the Michigan Supreme Court held that where the owner had a full-time safety inspector on the job and the power to fire subcontractors, it had retained sufficient control over the independent contractor that it could be held responsible for hazardous workplace conditions even where the employee came to work drunk. Because the unprotected scaffold from which the employee fell was an obvious safety hazard, the jury was free to conclude that the owner, through its safety inspector, was responsible for safety on the job.

STATE SAFETY STATUTES

OSHA does not preempt workers compensation laws or most State safety statutes, because of its "savings" clause:

Nothing in [OSHA] shall be construed to supersede or in any manner affect any workman's compensation law or to enlarge or diminish or affect in any other manner the common law or statutory rights, duties, or liabilities of employers and employees under any law with respect to injuries, diseases, or death of employees arising out of, or in the course of employment . . . . [29 U.S.C. ß†653(b)(4)]

Courts have almost universally held that, by virtue of this language, OSHA does not preempt any such State statutes. Some examples of State statutes include health or building codes, scaffolding laws, the Illinois structural Work Act, the New York Safe Workplace Act, and right-to-know laws. Right-to-know laws in 25 States require that employers provide disclosures to employees concerning the presence of hazardous substances in materials used in the workplace.

CONCLUSION

It is clear that employers are subject to numerous Federal and State laws regarding the safety of their workers on construction sites. It is equally clear that the courts have continued to expand upon potential liability for employers in this area. While it is possible that the recent elections may preclude additional statutes, the efforts of the courts and the governmental bureaucracies in expanding employee rights by court ruling or regulation need to continue to be dealt with. It has become and continues to be of the utmost importance for employers to heed the written requirements of the statutes and regulations to avoid injury and liability for those injuries and/or unintentional violations of paperwork rules.

MANAGING WORK ZONE SAFETY IN NYSDOT'S CAPITAL CONSTRUCTION PROGRAM

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This paper discusses a number of approaches used by the New York State Department of Transportation to manage work zone safety in its capital construction program. One of the necessary enabling conditions to successfully address work zone safety is a strong commitment by agency management. That commitment is summarized in NYSDOT's safety policy, which States that *all* Department activities must be carried out in a manner that provides full consideration for the health and safety of our employees, the employees of our contractors and consultants, and the public that is impacted by our projects. In short, health and safety is given the highest priority in all areas of transportation operations.

New York's management of work zone safety is based on three integrated components:

• *Engineering* efforts are directed to ensuring that plans, specifications, and contracting procedures ensure a uniformly high level of excellence in the work zone traffic controls utilized on our projects.

• However, we recognize that a credible level of traffic *enforcement* is essential to ensure that drivers respect work zone guidance and regulations.

• Equally important, drivers need to be kept *aware* of the need for interruptions to their normal driving patterns, and they need to know how they are expected to respond to work zones.

New York's contract construction program has been steadily increasing in size over the past several years. During fiscal year 1993-94, 535 projects were let to contract, worth about $1.1B. At the peak of the 1994 construction season, over 800 projects were underway, worth about $3.3B.

ENGINEERING PROGRAM ELEMENTS

- **Accident Reporting and Analysis**
- **Accident Investigation**
- **Annual Quality Inspection**
- **Staff Training**
- **Standards and Specifications**
- **Contractor Outreach and Compliance**

Figure 1. Engineering Program Elements

Figure 1 lists some of the elements in New York's work zone engineering program.

• In order to improve work zones, we need to know what our problems are. Therefore, the routine reporting and analysis of work zone accidents, combined with in-depth investigation of serious accidents, is essential to direct efforts to the areas with the most payoff potential. Some of these statistics are examined later in this paper.

• Annual review of work zone program results is equally important to help measure program effectiveness and to identify points that need greater efforts. Over the past 8 years, we have gradually developed our annual inspection program to the point that it returns valuable feedback not only to Department management in terms of program effectiveness, it also serves to identify issues that need

attention. Equally important, it serves as a communication effort between program staff in the Central Office and our 11 Regional Offices.

Each year, our review team visits about 20 percent of our active projects, using a uniform procedure to provide consistency from project to project, Region to Region, and year to year. Over the past 5 years, the percentage of projects needing only fine-tuning or minor adjustments increased from 62 percent to 81 percent, while those with major shortcomings decreased from 11 percent to 4 percent.

• Staff training, improved standards and specifications, and contractor outreach and compliance are other important elements of our engineering program, but for the sake of brevity, they are not addressed further in this paper.

In 1989, New York implemented a program requiring direct reporting of accidents on construction projects by project staff. The program includes specific written procedures and accident reporting forms, and training was provided to Regional staff to foster full understanding of the program requirements and procedures. Basically, the procedure requires project staff to report all accidents, both traffic accidents and construction accidents, within a specific time frame, whenever specific criteria are exceeded.

These criteria include:

• *Any* traffic accident directly involving an active work site, a contractor's operation, or work site traffic control.

• Any injury accident in the area of work zone activities or temporary traffic controls.

• Any accident involving Department personnel or vehicles.

• Fatal accidents occurring anywhere within project limits are also reported as a control measure, but are not included as part of the work zone data base unless project work is actually involved.

Figure 2 summarizes traffic accidents involving construction project activities over 5 years. After some start up concerns the first year, fatal and hospital accidents have remained essentially stable. Although total accidents have tended upward slightly, this is attributed primarily to improved reporting. During this same period, program size has increased about 25 percent, and traffic volumes have also gone up. While we would be happier if serious accidents were declining in absolute terms, we believe the apparent decline on a program-relative basis is a positive trend.

PROJECT-RELATED TRAFFIC ACCIDENTS

Year	Fatal	Hospital	Total
1993	9	74	333
1992	7	66	286
1991	10	89	297
1990	7	74	231
1989	13	35	98
TOTAL	46	338	1,248

Figure 2. Project-Related Traffic Accidents

TRAFFIC ACCIDENT FACTORS (1993)

	Fatal	Hospital	Total	%
Lane Closure	3	23	98	29
Flagger	–	7	45	13
Intrusion	1	7	33	10
Detour	2	6	30	9
Constr. Ops.	–	2	25	7
Worker	1	2	11	3
Pedestrian	–	1	8	2
Other	2	26	83	25
TOTAL	9	74	333	

Figure 3. Traffic Accident Factors (1993)

Figure 3 examines 1993 traffic accidents by major categories. As has been the case for the past several years, lane closures are the leading location of work zone accidents, representing nearly 1/3 of all reported accidents, and about the same proportion of fatal and serious injury accidents. Other areas of concern include flagging operations and intrusions into work areas or other restricted areas.

WORKERS IN TRAFFIC ACCIDENTS			
	Fatal	Hospital	Total
Workers Involved	1	7	63
Total Accidents	9	74	333

Figure 4. Workers In Traffic Accidents (1993)

CONSTRUCTION ACCIDENTS			
Year	Fatal	Hospital	Total
1993	1	58	194
1992	2	58	129
1991	2	47	120
1990	2	38	142
1989	3	23	50
TOTAL	10	224	635

Figure 5. Construction Accidents

In addition to categorizing the general types of work zone situations involved in these accidents, a number of other parameters can also be examined from information included in the data base. These include various driver, roadway, and project characteristics.

Figure 4 examines worker involvement in traffic accidents in 1993. These numbers confirm that construction workers (including DOT and consultant employees as well) are involved in work zone accidents, including a number of very serious accidents resulting in serious injuries. Figure 5 examines non-traffic accidents involving workers over the past 5 years. A comparison of Figures 4 and 6 shows that traffic accidents are only a small part of the total problem for workers. General categories of construction accidents are examined in Figure 6. Several types of construction accidents, such as falls, moving and falling loads, tools, and large equipment, all represent major concerns for worker safety.

CONSTRUCTION ACCIDENT FACTORS (1993)				
	Fatal	Hospital	Total	%
Fall/Elevated	–	12	25	13
Fall/Trip	–	5	30	15
Moving/ Falling Load	–	13	32	16
Tool/Material	–	15	39	20
Large Equipt.	–	9	22	11
Demolition	1	–	2	1
Other	–	4	44	23
TOTAL	1	58	194	

Figure 6. Construction Accident Factors (1993)

Both the annual project inspection program and the accident data base are utilized to identify areas needing more attention and improvement. There are eight specific points where increased emphasis is now directed to improve the quality of work zone traffic control. These points are emphasized through Department training activities, as well as in improved standards and specifications.

1. The **condition of signs** on construction projects has been a continuing concern, because signs in poor condition detract from the effectiveness of work zone traffic controls.

2. **Unneeded signs** must be covered or removed to maintain driver credibility with controls that do apply. We recognize that we can't expect drivers to respect our signs if they are not directly relevant to what the driver encounters.

3. Signs must be mounted at the **proper height** to be visible, and to guard against adverse results if impacted.

4. Advance **countdown signs** must provide consistent, reliable messages, and adjacent sign series must not present conflicting information.

5. **Flagger warning signs** must be used only when flaggers are actually present to maintain credibility.

6. Signs must be **located** where they are visible and not hidden by other roadside features, or so close to other devices that drivers are not provided adequate time to respond and react.

7. **Channelizing devices** need to be in good condition and properly located.

8. **Lane closures** must be laid out according to MUTCD requirements and located to provide adequate sight distance and driver response times.

To address these and other concerns, we have undertaken a number of engineering initiatives aimed at improving procedures and specifications over the past several years. These initiatives have included:

- Full-scale crash-test programs developed temporary traffic barriers and improved traffic control devices to enhance work zone safety.

- Measures to ensure safe access to worksites on high volume roadways and other difficult sites, both for workers and construction traffic.

- Procedures to ensure consistent, effective use of arrow panels.

- Procedures to establish work zone speed limits.

- Procedures to improve flagging operations.

- Adoption of the ATTSA Guidelines for traffic control device condition.

- Specifications to protect pavement edge dropoffs.

Work zone enforcement practices involve an ongoing cooperative effort with our Division of State Police and a number of local police agencies. Unlike some other States, NYSDOT does not house a police or DMV operation. By agreement at the executive level, our Division of State Police provide a high priority to enforcement efforts on DOT projects, whether capital projects or maintenance activities

- Most enforcement is provided on a cooperative basis, where routine police patrols include our projects on a regular basis, and special patrols are provided to address specific needs or problems.

- When higher levels of enforcement are needed, dedicated enforcement can be arranged on critical projects whereby full-time police patrols are provided, with costs reimbursed by DOT directly to the police agency.

- First reliance is on the Division of State Police, with local police agencies our second choice if the Division of State Police are unable to handle the demand.

- To manage these efforts, DOT and DSP schedule annual program review meetings both at the executive management level in the central office, as well as each of the 11 Regional offices.

The dedicated enforcement program provides full-time police personnel on critical projects when needed. This program is governed by a formal agreement between DOT and DSP, with direct cost reimbursement from DOT to DSP. Over the past two years, dedicated enforcement has been included on 20 projects at a programmed cost of about $1.8 million. Full-time enforcement has proven to be highly effective, even essential, on critical projects, and its use is expected to expand somewhat. However, considering its cost, which comes out of the capital program budget, and the limited availability of police resources, reliance on this program will continue to be only for critical projects.

Figure 7 lists the nine elements of New York's driver awareness program. A DOT task force, with additional input from industry groups, has used funding from a highway safety grant to focus driver attention on work zone safety concerns. Notable successes have included roadside billboards with safety messages, Public Service announcements on radio and TV, and inclusion of work zone safety tips in DMV license/registration mailings. In addition, New York's Thruway Authority has distributed similar safety tips at toll booths. Other efforts have included a speaker's bureau to address work zone topics at meetings of community and civic groups, and displays at various events such as the State Fair and professional meetings.

New York's approach to improving work zone safety through Engineering, Enforcement and Awareness is having positive impacts, and the emphasis points and engineering initiatives developed using information from the accident data base and annual inspection surveys is focusing efforts where the greatest gains can be achieved. A key ingredient in achieving safety objectives is the successful execution of what is already known and recognized as important. However, this doesn't assume that we already know how to solve all of our problems. Therefore, this paper concludes with a short shopping list of improvements that are suggested to solve some of these outstanding problems.

DRIVER AWARENESS

- **DOT Task Force**
- **Industry Input**
- **Highway Safety Grant Funding**
- **Billboard Campaign**
- **Radio/TV Public Service Announcements**
- **DMV Mailings**
- **Thruway Handouts**
- **Speakers Bureau**
- **Seminars/Public Functions**

Figure 7. Elements of NYSDOT Driver Awareness Program

• First, our biggest accident problem continues to be at lane closures. In spite of signs, arrow boards, channelizing devices, and other tools, drivers persist in remaining in the lane being closed until the last minute to gain one or two positions in line. Some means to encourage drivers to vacate closed lanes sooner, such as truly portable, effective rumble strips that can be quickly deployed and removed, has the potential to reduce accidents significantly.

• Second, a *simple, effective* means is needed to effect speed reductions where they are actually warranted. Short of saturation enforcement, we have no effective, reliable means that can achieve more than a few miles-per-hour in speed reduction.

• Third, a device is needed to provide *positive* separation between traffic and workers that can be deployed and removed within a few minutes. We currently have a number of very effective work zone barriers, some of which can be quickly relocated. However, none of them can be deployed within a few minutes to protect isolated work areas from even moderate impacts. Considering the substantial numbers of intrusions we continue to experience, the potential payoff is very significant.

• Finally, we need better hand signaling procedures to control traffic in work zones. Accidents involving flagging operations continues to be a significant problem, especially for older drivers that fail to understand or respond to flaggers. Regardless of the device used and the skill and motivation of the flag person, there is still room here for a great deal of improvement.

SECTION II

INTRODUCTION

Section II contains workshop reports for each of the five topic areas. Each describes the countermeasures selected by workshop participants as holding the most promise for short-term improvements in work zone safety.

Following each report, where applicable, are additional noteworthy points raised by the participants in the workshop discussions but not included in the facilitator's final report.

Also included in the workshop reports are action plans devised for implementing countermeasures. Constraints and obstacles that may be encountered during implementation were also discussed at the workshops, and they too are addressed.

The final item in Section II is a recapitulation of the Conference activities presented by the Moderator, Dr. Nicholas J. Garber. His remarks summarize the primary recommendations derived from the workshops.

PHILOSOPHY OF TRAFFIC CONTROL

Dr. Russell M. Lewis
Consulting Engineer

PURPOSE AND SCOPE

This workshop on the Philosophy of Work Zone Traffic Control examined two closely interrelated subjects: fundamental principles of work zone traffic control and human factors/behavior in work zones. This paper, written before the conference, contains an introduction to the subject with the objective of providing a background for the workshop participants and to guide and elicit their participation. Various concepts and common terminology are established to facilitate communication. Only selected examples taken from the paper were presented as part of the introduction and charge to participants. The remaining material was made available selectively, as appropriate, during the workshop to provoke discussion or recapitulate the group's findings.

The term "we" as used in this paper refers to the highway profession, people who exercise authority over roads and streets, and those who work on roads and streets—personnel of public agencies, utility companies, contractors, and incident management teams.

THE SYSTEM

The highway/motor vehicle system comprises three components which must perform in consonance, namely the roadway, vehicle, and driver. There are limits and differences, however, as to how much control we can exercise over each of these components. Highway agencies have a high level of control over the roads under their jurisdiction. There is a wide range of facility types from local roads and streets to freeways. Nevertheless, within each functional classification, roads throughout the country have similar design characteristics.

Likewise, there is good control over the vehicle, although this control is exercised by others: the National Highway Traffic Safety Administration (NHTSA), Interstate Commerce Commission (ICC), State Departments of Motor Vehicles (DMV), etc. Manufacturers contribute to homogeneity by providing vehicles with a relatively short life; the fleet largely turns over every decade. Again, there are vast operational differences among functional types —between motorcycles and tractor-semitrailers, for example. Yet, within each classification, the differences are relatively minor.

The motor vehicle operator is by far the most variable and difficult to control. Drivers are basically licensed for life. A half century later the change in technology is mind-boggling. The only physical characteristic that is checked, and only occasionally at that, is visual acuity. Variations among drivers are enormous. Moreover, each person's characteristics vary with time and environment. Some changes are gradual, such as the decay politely called aging. Other changes can occur minute by minute due to emotion, distraction, fatigue, etc.

Highway agencies have little opportunity to manage drivers. Such matters as driver licensing, driver education, and license suspension fall under the jurisdiction of other agencies—DMV, education, law enforcement, etc. While highway agencies should be working with these agencies in areas of common interest, their ability to effect change is very limited indeed. Other organizations working on highways, such as contractors and utility companies, have no control over drivers.

Given this broad range in driver characteristics, how can we define the critical level that we need to accommodate? Clearly we cannot utilize average values, as this would exclude half the driver population. Statisticians use a 95 to 99 percent confidence

level for the determination of statistical significance. Traffic engineers have used the 85th percentile for the establishment of speed zones. This does not mean that the other 15 percent are not afforded safeguards. In work zones, however, where normally available safety factors are reduced, it is essential to effectively communicate with *most* drivers.

System Failures

Many traffic accidents are not accidental. By definition, an accident is an event occurring by chance or arising from unknown causes. Many of these so-called accidents are predestined. Given the characteristics of the highway and the limitations of drivers, certain types of failures are predictable. The event can be anticipated; only the timing and the participant's identity are unknown. Therefore, the term "crashes" has come to be preferred within the highway safety community.

In the broader context, many of us prefer the term "systems failure," which connotes a breakdown in the roadway-vehicle-driver system. The hierarchy of system failures is shown below. Note that crashes are but a subset of these failures.

Non-catastrophic:

- Annoyed
- Delayed
- Lost
- Stranded
- Erratic maneuver
- Near miss

Catastrophic (crash):

- Property damage only
- Injury
- Fatality

The first ones in the list, while not catastrophic, may adversely alter driver characteristics. Impatience may breed anger, which can affect judgment and performance. This may result in excessive speed after an imposed delay, reckless passing, or targeting flaggers, for example.

Erratic maneuvers and near misses can provide valuable insight as to the adequacy of the traffic control system. They are indicators that crashes may be imminent—the proverbial "accident waiting to happen." Clues to such deficiencies include evasive action, excessive deceleration (brake lights), skid marks, and displaced traffic control devices.

Statisticians like to look at an accumulation of events so that they may evaluate statistically significance (i.e., show that the events are not merely random). When we evaluate and inspect traffic control zones, however, if at all possible, we do not want to wait until after catastrophic failures occur to recognize a correctable deficiency.

Special Problems in Work Zones

Drivers negotiating highways must continually address a variety of situations. When they encounter work zones, they must contend with the following additional conditions and potential hazards:

- Surprise (negative expectancy, rare event)
- Changed and unusual travel patterns
- Conflicting information and confusion
- Distractions (work activity)
- Temporary devices (closer to traveled way and relatively unstable)
- Additional hazards (fixed hazards, excavations, drop-offs)
- Workers, material and equipment in and/or adjacent to roadway
- Dirt and debris (decreased device conspicuity and increased braking distance)
- Capacity restrictions and congestion.

RELEVANT ROAD USER CHARACTERISTICS

During the past several years, many extra words have been added to Part VI of the MUTCD to expand its coverage. In many places where the word "drivers" appeared, the words "pedestrians and workers" have been added. Not only is this verbose, it still improperly excludes all parties of interest. I prefer the all inclusive terms "road users." Included in this

term are motor vehicle drivers, equipment operators, cyclists, workers, pedestrians, bystanders and any other parties in or adjacent to the right-of-way that may be of concern.

A critical attribute of temporary traffic control systems is the effectiveness with which vital information is provided to road users. Therefore, the following information taken from the human factors field is presented relative to how people acquire and utilize traffic-related information.

Acquiring Information

Before people can modify their behavior to accommodate roadway needs they must first acquire relevant information. The means available are the five human senses listed below along with their associated sensory organs.

- Sight — eyes
- Touch — skin
- Hear — ears
- Smell — nose
- Taste — tongue

Vision

Sight is the primary means of communicating with road users. Touch may occasionally supply information through changes in road texture, rumble strips, etc. There are a few audible warning devices, such as those used at railroad grade crossings and on drawbridges. Motorists, however, can often be isolated by enclosed vehicles, in-car radios, etc. Hearing is more useful for workers, where the squeal of brakes or the impact with channelizing devices can provide information that a vehicle is encroaching upon the work space. Smell has little application, except perhaps that a clutch is slipping or brakes are dragging, and we have yet to find a way to utilize taste.

Relevant attributes related to sight are the following:

- Acuity
- Color discernment
- Night vision
- Glare recovery
- Depth perception
- Reading process

Conspicuity

It may not be sufficient that a traffic sign can be seen and read. Most signs are placed peripheral to the travel path. They often must compete with other information sources present in a visually noisy background. Therefore, we are concerned with device conspicuity; that is, the extent to which something is obvious or attracts attention. This property is also referred to as target value. Conspicuity can be enhanced by:

- color,
- contrast with background, and
- motion.

Driver Behavior

The ability of drivers to effectively utilize information and perform the driving task depends upon the following human characteristics:

- Intelligence
- Knowledge
- Ability
- Emotion
- Memory

Design Driver

For decades traffic engineers have used "design vehicles" to represent the critical dimensions of the range of vehicle types and sizes that need to be accommodated on highway facilities. More recently, the concept of a "design driver" has been advocated. The design driver is not intended to represent any particular person or groups of people. It is a hypothetical aggregation of all critical characteristics, some of which could not coexist in any one individual. For example, the design driver may be so short that the forward visibility is limited by the hood and so tall that it is limited by the top of the windshield.

The objective is to meet the needs of the vast majority of all users. This does not necessarily mean that the remainder are ignored. In many instances persons who fall outside the design range use special features or techniques to achieve safe operations.

Useful characteristics for describing such a design driver follow. Consensus as to the individual traits and their quantifying values remains to be achieved.

- Limited intelligence (IQ of ?)
- Impaired condition (blood alcohol of ?; increased perception-reaction time of ?)
- Colorblind
- No depth perception (only one good eye)
- Visual acuity (20/40 ?)
- Limited night vision (?)
- Long glare-recovery time (? seconds)

Critical Driver

For normal traffic control situations, the unfamiliar motorist is the critical one, and the design is predicated upon the characteristics of this type of driver. In work areas, however, the familiar motorist is often the critical one. Commuters and other drivers accustomed to the road are least likely to be looking for traffic information on their route. Take, for example, the situation where a temporary runaround has been constructed in order to reconstruct a bridge. The unfamiliar driver will most likely use the temporary roadway with the least amount of conflict. In fact, if the runaround is well designed, he or she may not even realize that it is a temporary roadway. The familiar motorist, on the other hand, is the one most likely (due to habit and inattention) to drive onto the closed bridge.

Positive Guidance

Positive guidance is a concept which combines highway engineering and human factors technologies to produce a driver information system matched to the facility characteristics and attributes of drivers. It is based upon the premise that drivers can be given sufficient information where they need it and in the form that they can best use to avoid hazardous driving situations. The application of positive guidance procedures requires an understanding of the drivers' tasks and their use of information. Decision-making failures attributable to information system deficiencies are identified as factors leading to inefficient traffic operations and crashes. The function of positive guidance is to increase safe driver performance by providing appropriate information to reduce driver-caused failures in the highway system.

Driver Performance

Driver performance consists of three levels, each having a different function. These levels are defined below, and the sources of information used in the performance of these tasks are described.

- At the *control level,* the driver exercises lateral and longitudinal positioning by means of the vehicle's controls. Information comes primarily from the vehicle itself through the driver's sensory mechanism.

- At the *guidance level,* the driver's task is the selection of speed and path along the highway. Examples include car following and passing. Information is obtained from the road, environment, other traffic and traffic control devices.

- At the *navigation level,* tasks include planning and executing a trip from its origin to its destination. Information sources include road maps, guide signs and landmarks.

Primacy

The above three levels of information are not of equal importance to the motorists. A distinct processing order exists. At the top of the primacy hierarchy is information utilized to maintain position on the roadway. Second in priority is situational or

guidance information. At the bottom of the hierarchy is navigational information. The primacy concept thus suggests that positional or control information must be processed completely before processing can begin at the situational or guidance level. Further, this level must be satisfied before navigational information can be processed. Whereas driver performance failures at the navigation level tend to result in low-severity systems failures, those at the control and guidance levels tend to be of high severity.

Worker Behavior

Many of the human characteristics described above are also applicable to those persons working on the highway. It should be recognized that a highway is one of the most hazardous workplaces that exist. By comparison, factory workers enjoy such safety benefits as controlled access to the workplace, protection from weather, controlled light, heating and air conditioning. Through constant exposure to highway conditions, however, workers may become conditioned and forget just how hazardous their workplace is.

Pedestrian Behavior

While all motorists are also pedestrians, the reverse is not true. Those pedestrians who do not drive may have little knowledge of the complexities of the driving task, thus overestimating their inability to be perceived and avoided. Similarly, stopping distances may be underestimated by non-drivers. Of particular concern are the very young and very old, because their physical and judgment capabilities may be diminished.

The fundamental differences between drivers and pedestrians is that drivers generally recognize that they are involved with a task that requires a certain amount of attention and skill. Pedestrians, on the other hand, frequently are:

- thinking about something other than their walking task,
- unaware of their local environment,
- willing to take chances, and
- very "shortest-path" oriented.

Therefore, pedestrians are less likely to notice signs. Also, they are more difficult to detour than motorists, as there is more resistance to added distance.

TEMPORARY TRAFFIC CONTROL CONCEPTS

Concept Hierarchy

In discussing the fundamental concepts of highway traffic control, it is useful to recognize a hierarchy between concepts and define a set of terms. The following set is proposed and is utilized in the discussion below:

- Laws, natural
- Principles
- Rules, imposed
- Standards
- Warrants
- Guidelines

Being an engineer, I prefer to reserve the term "law" for natural laws or laws of nature. As such, they are inherent and not subject to change. Various laws of physics apply to vehicular dynamics and traffic flow, and other laws relate to human nature and behavior.

Principles include maxims, axioms, precepts, and admonitions. As used here, principles are basic doctrines from which more detailed and specific standards and guidelines are derived. Rules are imposed and are sometimes arbitrary, such as driving on the right side of the road. Rules are generally established by statutes, ordinances, codes or regulations. Standards, warrants and guidelines, such as those set forth in the MUTCD, are engineering tools which are used to assure a consistent degree of quality and safety for road users. There is, of course, much overlap between these terms. Some States, such as Maryland, have adopted the MUTCD as part of codified law. The focus of this paper is the first two concepts listed above: natural laws and principles.

Example Laws

Several natural laws relevant to highway traffic control are presented below in boldface. These are merely examples. The list is not intended to be exhaustive, and the sequence is arbitrary.

#1. **Eventually a system failure will occur** — the essence of Murphy's First Law. The likelihood increases with exposure — time and traffic volume.

#2. **Devices are expendable and replaceable; people are not.**

#3. **Basic human behavior cannot be changed.** People must be accepted as they are. The human species has evolved over many hundred thousand years, and it is only within that time frame that basic characteristics are altered.

#4. **Human beings have free will; they can do whatever they want to do.**

#5. **People make mistakes.**

#6. **People can look at and focus on only one item at a time.**

#7. **People can process only a limited amount of information within any time interval.**

#8. **Perception-reaction time is a variable.** It can vary from a fraction of a second for a simple anticipated task to an eternity (as when the driver died before making the appropriate reaction). From a practical standpoint it varies from a few to many seconds. Note that in traditional highway design procedures, reaction time is treated as a constant (e.g., stopping site distance). Increased perception-reaction time is needed when drivers are faced with:

- unfamiliar and uncommon situations,
- multiple choices,
- distractions (such as the operation of construction equipment), and
- complex problems.

#9. **Short-term memory span is about one minute.** Motorists have a short-term memory bank in which information is constantly being updated and replaced. Information stored as short-term memory consists of items such as localized road conditions, traffic controls, and positions and speeds of other vehicles in the traffic stream.

#10. **Drivers develop expectancies that affect their responses to events or situations,** primarily as a result of experience. When expectancies are met and reinforced, they aid the driving task and performance tends to be error-free. When expectancies are violated, drivers need more time to respond, performance is poorer, and they are likely to commit errors.

#11. **Conditioned responses dictate to a large extent how people behave.** Such habits are developed as people repeatedly encounter the same situation and make the same response.

Concept Linkage

Each law may give rise to several principles. While some principles are stated in the MUTCD, others are merely implied, at best. A principle, in turn, may be implemented in several applications as standards or guidelines. For example, take Law #6, "People can look at and focus on only one item at a time." A related principle follows.

a. *Require only one action at one location.*

An implementation of this principle is specified in a typical application diagram [Figure TA-37]. It shows a double-lane closure on a multilane highway with two separate merging tapers separated by a transition distance of "2L", where "L" is the minimum length of the merging taper.

Other principles may be derived from the same law, such as the following:

b. *When channelizing devices are needed on both sides of a traffic lane, introduce them first on only one side.*

This principle is neither explained nor specifically prescribed in the MUTCD, but an example of its application can be found [Figure TA-40].

Example Principles

Provided below in italics are several temporary traffic control principles. These are merely examples intended to generate interest and discussion. Where the principle is directly derived from one of the laws previously listed, the source is so indicated.

1. *Traffic control procedures should be based on road users' needs and characteristics* (from Law #3). This is the basic principle which ties together the two subjects addressed in this workshop.

2. "*Roadway occupancy and work completion time should be minimized to reduce exposure to potential hazards*'" [§6B-2d] (from Law #1). Note that this principle and numbers 3 and 4 that follow are quoted from the MUTCD. A full explanation is provided in the next section of this paper.

3. "*Reduced speed zoning should be avoided as much as practical*" [§6B-2a] (from Law #4).

4. "*Flagging should be employed only when all other methods of traffic control are inadequate to warn and direct drivers*" [§6B-3c] (from Law #2).

5. *Analyze the results of a systems failure.* As stated previously, failure probability is a function of time and volume along with traffic control quality. The types of failures that can be anticipated must also be evaluated. The justification for higher types of traffic control goes up with greater potential for catastrophes. For example, a vehicle crossing the center line into opposing traffic may be of greater concern than a single vehicle off-road crash to the right.

6. *Traffic control devices do not "control" traffic.* By themselves they do not force compliance. Barriers are a device that can control traffic, but they are not by themselves considered to be a traffic control device. It should be noted that they are designed to interact with the vehicle, not the driver. A speed limit, for example, does not control speed. A speed limit is only effective to the degree that: (1) it is consistent with people's desires, (2) it is believed to be unduly hazardous if ignored, or (3) there is fear of enforcement (from Law #4).

7. *Drivers are most likely to utilize traffic control information when it appears to be reasonable, useful and consistent with their expectations and experience.* Traffic control zones should be designed so that drivers following their natural tendencies will perform in a manner that is reasonable and safe. Effective guidance and control can be achieved when the following driver characteristics are recognized (from Law #4):

- Drivers make their own decisions.

- Decisions are based upon the information at hand and on past experiences.

- Traffic control procedures should be designed so that drivers recognize the desired response and consider it to be reasonable given the circumstances.

- Merely stating that a certain action is required may not by itself be sufficient.

8. *Utilize consistency with respect to uniform traffic control devices and standard procedures.* Devices should be selected that are appropriate to the degree of hazard involved (from Law #8).

9. *Novelty is counterproductive.* It works against uniformity (from Law #8).

10. *Simplicity is desirable.* Avoid choices and nonessential information. Avoid surprises by using driver expectancy in a constructive manner (from Law #7).

11. *Minimize choices.* The best number of choices is zero; just instruct the driver as to what is required. Where choices must be given, make them binary choices. When multiple choices are necessary, separate them longitudinally along the roadway (from Laws #6 and #8).

12. *Clearly shut off closed facilities and movements so that they are not viewed as available options* (from Laws #7 and #8).

13. *Employ redundancy where appropriate.* There are many reasons why a motorist may miss a single information source. For example, a driver performing a driving maneuver may not be scanning the roadside for signs. Similarly, it is problematic whether a motorist operating in an interior lane will see ground-mounted signs placed beyond the roadway edges. One means of overcoming such information deficiencies is to utilize redundancy, as appropriate, to improve the opportunity for all motorists in the traffic stream to obtain important information and to enable the system to continue functioning even though a component is lost. For example, if a lane reduction sign is unseen or missing, channelizing devices may delineate the lane closure. If the channelizing devices along the taper are displaced, temporary pavement marking may still delineate the required merging location (from Law #6).

14. *To the extent feasible, temporary traffic control zones should incorporate self-correcting features.* Since people frequently make mistakes, traffic control zones should be designed to be forgiving and self-correcting insofar as possible. Drivers should be given information that enables them to detect that an error has been made and then have sufficient time and/or space to correct that error (from Law #5).

15. *Equivalency can be utilized when difficulties arise.* Equivalency means that if all individual requirements cannot be met, at least an equivalent level of safety should be provided. Sometimes, when adapting to field conditions, adjustments must be made that deviate from those specified. In such cases compensate by providing more than the minimum in another manner.

16. *Work vehicles and equipment should look like work vehicles.* They are units that may be stationary or mobile, in or adjacent to the traveled way. To enhance rapid recognition they need to be both conspicuous and identifiable. This can be achieved by color, color pattern, reflective elements and lighting devices.

17. *Spread highway information.* Information should be distributed such that items of low primacy are moved from areas of concentrated activity (information reception and/or required maneuvers) (from Law #6).

18. *Warnings should be repeated periodically*. Signs used in a series are generally placed at a maximum spacing of one mile for the initial warning signs, such as those warning of construction ahead, and at no more than a half-mile spacing for more definitive signs, such as those closing a specific lane. Signs warning of a continuing condition, such as those advising of a low shoulder, should be repeated every mile (from Law #9).

Evolution of Fundamental Principles In the MUTCD

It is useful to examine concepts provided in the Federal *Manual on Uniform Traffic Control Devices (MUTCD).* A new section entitled "Fundamental Principles" first appeared in the 1978 MUTCD as §6A-5. This section comprising 2-1/2 pages is herein summarized under the following phrases. The numbers refer to numbered paragraphs, each of which has several subparagraphs denoted by lower-case letters. The underline refers to the introduction section.

_. All traffic control devices shall conform to the MUTCD.

1. Traffic safety should be a high priority element.

2. Traffic movement should be inhibited as little as practical.

3. Motorists should be guided in a clear positive manner.

4. Inspection and monitoring should be performed.

5. Maintenance of roadside safety requires constant attention.

In 1983, words were added to the introduction of Part VI to clearly include pedestrians as part of the traveling public [Rev. 2, 12/83]. The Fundamental Principles section was again changed by Revision 5, which was first published as the 1988 MUTCD. This revision expanded the scope of this section to encompass utility operations and incident management.

A major expansion to the Fundamental Principles section, now §6B, was made in the complete revision to Part VI published 1993. The new wording emphasizes worker and pedestrian safety as well as motorist safety. Also, principles were added in the following areas:

_. coordination with other agencies;

_. oversized vehicles and hazardous cargo;

6. training (previously was §6A-8);

7. legislative needs; and

8. public relations.

A close examination of the Fundamental Principles section of Part VI using the criteria set forth earlier shows that it contains a combination of rules, objectives, principles, standards and guidelines. For those concepts listed as principles in this paper that also appear in this section, the source is cited in square brackets.

Additional points raised in workshop discussions:

Eventually, the highway system will fail. Devices are expendable; people are not. Basic human behavior cannot change. People have free will, but they can process only limited information. Perception and reaction times are variable, with short-term memory being one minute. Work zones must be designed to be self-correcting.

Governing principles suggested by the participants include the following:

1. Traffic controls should be based on road users' needs and characteristics; traffic control devices (TCDs) do not control traffic.

2. There must be consistency in devices; novelty is generally unproductive, so redundancy should be employed.

3. TCDs must be simple, limit choice, and incorporate self-correcting features.

4. Work vehicles and equipment should look like equipment.

5. Highway information should be disseminated in a systematic way, with periodic warnings.

One participant observed that if one were to design the best driver, the ideal characteristics would be low I.Q., knowledge, ability, emotion and memory. Changes in basic human behavior, however, would take hundreds of years to effect. Another disagreed, noting: "I used to feel that way about drunk drivers, that all the research and funds were going down a rat hole. But I've been proven wrong. Crashes due to alcohol are way down. The drunk driver's conduct is becoming less tolerable in today's society. The campaign against drunk driving, together with enforcement of penalties, has worked."

Other opinions and observations raised by the participants included the following:

- Impaired condition cannot be quantified. There are many kinds of abilities and disabilities, and there are functional limitations.

- There are other forces the driver must yield to; for example, the pressure of the drivers behind him, particularly when there is a significant lowering of the speed limit with little other information.

- Modern signage should be designed for higher speed. Speed variation is a big problem.

- Are drivers sometimes told more than they really need to know? Accelerating the pace of the work is safer because the workers are in the zone for a shorter period, but it is more costly. Roadways should be designed to be maintenance-free for 20 to 30 years, thereby eliminating the need for work crews to be out there at risk. At the same time the roadway is shut down, all possible work needed for the next 5-plus years should be done.

- We have the technology to identify impaired drivers, but we cannot violate privacy.

- Perhaps our goal should be to get accidents down to an acceptable range, such as 2 percent, much like an universally accepted rate of unemployment, since some hazards and damage will always be a fact of life.

- We need more restraints against impaired drivers. Barriers are the best traffic control devices, and we must increase the number of uniform traffic control devices.

- Temporary work zones are inherently unsafe. Enhancing the safety of all concerned entails cooperation among and with other agencies.

- We don't have unlimited resources to focus on safety. However, costs for rigorous enforcement are not necessarily prohibitive.

- Some research is very old, dating back to 1932. In addition, it is risky to rely too heavily on research results because there are too many variables.

Recommendations

- Consider traffic control devices not for their own sake, but in terms of how they can improve work zone safety

- Standard procedures should be developed for testing drivers. California has the best visual tests. We need to standardize definitions of what vision range is acceptable. However, tests must be realistic.

- After long-term exposure to them, people stop paying attention to traffic control devices. Work periods must be shortened, even if this is more costly. Flaggers must be trained and certified.

- Maintenance and utility operations are performed by low-level people who can't press for change. They need management feedback and support. Writers and researchers should go into the field; too many of them draw their conclusions without worker input.

- Consider closing down areas to shorten work time. However, if big trucks cannot be diverted, interstate coordination will be necessary.

- By reducing exposure, we can also reduce risk. One way to accomplish this might be to increase incentives to contractors. We need more creative contracting and to educate the public as to why the money is being spent.

- More research is needed on the effectiveness of variable message signage.

- There must be more and better training at the local level.

- The Uniform Vehicle Code should be standardized.

- The States should have a safety person at all pre-construction conferences.

- There should be material on all driver's examinations dealing with work zone safety, such as Illinois now has.

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About 40 Conference participants attended and contributed to the two "Philosophy of Traffic Control" workshops. Discussion and dialogue among the participants was extensive and broad-ranging. As a consequence, the participants felt that three specific recommendations had merit quite beyond the context of the workshop theme subject and subtopics. Those were:

1. There is a need to establish a National Clearinghouse. State and local jurisdictions are taking the work zone safety matter very seriously and are approaching resolutions through a number of innovative and dynamic practices and procedures. This information, with particular regard to details of what appears to have merit and what does not, needs to assimilated on a national basis so that it can be made available to others.

2. There is a genuine need to continue to hold conferences such as this. Such provide the only truly effective means for information exchange and networking among key players on a national basis.

3. The workshop approach used during this Conference provides a most useful approach to enhance dialogue and networking and should be continued as the framework for future such conferences.

Our two workshops addressing the "Philosophy of Traffic Control" addressed the following primary subtopics and other subtopics:

- Fundamental Principles
- Human Factors/Behavior
- Speed Management
- Training
- Positive Guidance.

The discussion which follows presents a summary of the work groups' recommendations for each of the subtopics.

FUNDAMENTAL PRINCIPLES

1. Chapter VI in the Uniform Manual regarding "principles" is generally viewed as "good."

2. The Uniform Manual is almost entirely focused on the protection of the public. As changes occur to mitigate the work zone fatality problem, we must be vigilant in assuring that such do not increase risks to workers in the work zones. Conversely, changes that reduce risks to workers must not increase risks to the motoring public.

3. Physical separation between traffic and the work zone is highly desirable and should be employed where possible.

4. There is a need to evaluate the relative risks, including the difference in risks between daytime and nighttime road work. There is an increasing trend, especially in high traffic density areas, to conduct work during low traffic density time periods.

5. There is a need to reassess construction methods and designs from a safety perspective. Disturbance of traffic flow equals high risk. Further disturbance by construction vehicles, for example, exacerbates this problem. Designs should address methods to provide construction vehicle access on other than the traffic disturbed roadway.

6. There is a need to facilitate a change in attitudes about how resources are allocated to work zone safety. Waiting until a fatal event occurs before appropriate and adequate resources are provided is not an acceptable approach.

7. There is a genuine need to gain a perspective on the true social costs associated with work zone safety incidents. Such information would aid decision makers in understanding the true value of the commitment of resources to reduce such incidents.

8. There is a need to better understand the dimensions of what is really happening "now" with regard to highway work zone safety and the measures being applied to improve safety. There is a lot going on now, as is evident in the workshop discussions during this Conference. What is working? What is not? What other problems are being created? What's "right"? Are all appropriate questions at this time.

9. Partnering, public awareness, and enforcement are viewed as key fundamental principles.

HUMAN FACTORS/BEHAVIOR

1. Credibility with the motoring public is a (if not *the*) major problem in traffic control. We need to focus our attention on this issue and attempt to recapture our credibility. Honest communication is viewed as a central theme to achieving improved credibility with the public.

2. There is need for a fresh look at what we believe characterizes human behavior. There was a general view that our understanding of human behavior based upon studies of over 20 years ago is simply no longer valid in today's world.

3. We need to focus increased attention on the training and education of drivers if we expect to "change their behavior," recognizing of course that changing driver behavior will be a very difficult process.

4. Public awareness of the hazards, to motorists and workers, of highway work zones needs additional attention. There is a need to engage the news media and others in assisting in this process.

5. Modifying driver behavior in the area of work zones is not simple. We must continue to evaluate innovative approaches such as "real time" information systems.

6. Contractor behavior needs to be addressed. SIC 161 has the highest lost time injury rate and fatality rate of any sector in the construction industry. Three issues require attention with regard to the contractor community: work zone safety compliance, standards of contractor performance, and contractor safety and health programs. With regard to the latter, it is noteworthy that several jurisdictions require contractors to have and submit safety and health programs, that ARTBA has a model contractor safety and health program, and that OSHA has recently initiated a "Focused Inspection Program" that targets inspection to only the four leading causes of fatalities in the construction sector where a contractor has an effective safety and health program (USDL: 94-484 Press Release).

7. There needs to be a commitment from top management to work zone safety. This applies to both owners and contractors.

8. There is a potential need to change some licensing requirements, especially for older drivers. One example was vision testing, which in many states is required only at the time of procurement of the initial driver's license.

9. Some concern was expressed that current "uniform" signage has resulted in a certain degree of "desensitization" on the part of the motoring public. There is a need to consider innovative approaches such as those used in parts of Florida involving unique exit ramp signage from within the work zone.

10. We need better work zone incident data. Our current data lack the necessary detail upon which to effectively target intervention efforts to high hazard occurrences.

SPEED MANAGEMENT

1. There was general concurrence that "speed control" was not the appropriate title for this subtopical area. At best, speed in work zones can be managed, to varying degrees.

2. Speed management in work zones is of critical importance, yet achieving it is very complex, difficult, and challenging. The following were discussed as among the approaches which merit consideration:

- Enforcement is a very important feature but it needs to have several dimensions. Some states have had a measure of success with "double fines" in work zones. It was suggested that "double points" might be an even more effective measure.

- Police presence clearly contributes to effective enforcement, but it has limits and is expensive.

• Drone radar with a timing device has evidenced some degree of success in selected work zones.

• "Real time" message boards have proved effective; however, the messages need to be near real time and accurate or the positive effects on speed management are quickly lost.

• Measures to improve credibility with the motoring public are viewed as beneficial for speed management.

• Physical speed management approaches, such as those utilizing barriers and weaves, have been applied successfully in some circumstances.

• It is appropriate to focus on project specific speed management approaches and methods.

TRAINING

1. There is need to focus on worker training. This is evidenced by the high fatality and serious injury rates among workers with the least experience.

2. Contractors require training as noted earlier. That training should focus on work zone management and safety and health program implementation and management. In addition, participants believed that the contractor should be required to have a "work zone safety management supervisor" on the job at all active times, and this person should have minimum defined experience and training. Certification of such individuals was suggested, although several felt this would not be viable in many jurisdictions.

Contractor and contractor employee training requirements should be part of the contract between the owner and the contractor.

3. Education and training of drivers was viewed as an important matter requiring attention. This might be accomplished through including work zone safety elements in the following:

• Driver education programs.

• State driver's license manuals.

• State driver's license examinations.

• Trucker's license tests.

• MVD mailing stuffers (with registration renewals, etc.).

POSITIVE GUIDANCE

Positive guidance is an important traffic control process which merits increased attention. Providing the driver relevant, site-specific, timely information that assists the driver in work zone decision making has substantial benefit. "Real-time" message boards, for example, are showing promise and should be pursued.

Additional points raised in workshop discussions:

Speed Management / Enforcement Issues

• Cracking down on violators can control accidents. Pennsylvania has found double fines effective, but they must use off-duty highway patrol officers to enforce the law.

• Violators comprise about 15 percent of motorists; the other 85 percent will be handled nicely through traditional traffic control methods.

• There is no guidance in Part VI of the MUCTD as to how to regulate speed. It states only that "Normal speed should be undisturbed as much as possible." Many states set forth work zone speed limits in state law. However, the arbitrariness of such laws makes it difficult to enforce because credibility is lost.

• If a speed limit is set, it is observed for a few days and then ultimately ignored. The proper speed limit must be established in the first place. Drivers will go as fast as they think is safe anyway, but they still have a lot of accidents, so they must be told *why* they need to slow down.

- In the quest for uniformity, do we desensitize the driver to construction zones? In Pennsylvania, troopers interviewed numerous violators—speeders—in work zones and found they didn't know the fines were doubled, and they didn't even know they were in a work zone, despite all the signage. Is desensitization to standardized worker zone signs a factor in motorists' behavior?

Technology /Communications Issues

- Real-time technology is available, and it is getting cheaper. Radio messages are effective if there are people keeping it up to date.

- In Mississippi, officials send out faxes to 75 media and law enforcement organizations every day regarding what is going on in the work zone. Good communication is the most effective tool available.

- In Cincinnati and New York, traffic control reports are aired on radio, including daily updates on construction zones. Many people listen just to get construction reports.

Training Issues

Research shows that six out of every 100 workers are injured. But there are lots of companies experiencing no accidents. This kind of track record requires commitment on the part of contractors.

Planning and Contractor Issues

- Conscientious planning on the part of contractors and transportation officials is essential. If construction zones are designed properly, speed will take care of itself.

- It was suggested that incentives for traffic control be considered. It takes time to write good contracts constructed with input from engineering, but this process is worthwhile. Unit pricing also appeals to contractors. If the contractor doesn't comply, he will then have the State on his back.

- In Florida, the contract specifies that the contractor cannot do the work until he is in compliance, and, the inspector has enforcement authority. However, this approach is successful only where there is proper participation at all levels, including levels of government.

- Once the job is started, achieving effective traffic control depends on money available for the project. A certain percentage of cost should be allocated for *managing* and for continuous reevaluation.

- Participant observation: "It pays to listen to the people who are actually out in the field. At one time, we had lots of accidents at ramps. Finally, our maintenance employees told us that people were confused about where the ramp was. They suggested putting up new, clearer signs and barrels. So these changes weren't designed initially, during planning, but were brought in as a result of their experience. We now work this factor into contract negotiations. This experience takes account of human behavior and enables us to deal with what people are doing rather than what they are supposed to do. We need flexibility and resources to make changes when something doesn't work."

- People in upper management get out on the roadway and see what the conditions really are.

- The increasing amount of night work going on may have an adverse impact on accident and fatality trends. Studies have shown that just as many accidents occur at Xmph *under* the speed limit as the same mph *over* speed limit.

- There are instances where it makes sense to close the road: 1) it's safer, and 2) it takes much less time, which could confer a long-term benefit that could sell the temporary inconvenience.

- Construction vehicles trying to get into the zone cause crashes. Therefore, perhaps we should consider separating construction traffic and the highway traffic as well as workers and public traffic.

- Problems can stem from complacency due to long periods with no accidents or fatalities. This can lead to failure to ensure proper safety training. Is the bidding process within the State a factor in accidents among short-term project workers? Companies are forced to be competitive in the bidding process and encouraged to cut corners, so in some States they are hiring lower-skilled workers, thus contributing to accidents and deaths.

- Contracts of this nature often involve entry-level, well-paying jobs for young people who do not have prior training or work experience. The demographics of work groups do not favor construction workers over 60 years old. Most are younger.

- The more money going into work zone control, the less there is available for patching, overlay work, etc., on the project. It's hard to change attitudes on funding that have built up over 50 years, but attitudes must be changed on how money is to be allocated.

Liability Issues

- Unfortunately, too often contractors/owners eventually discover the hard way that they should have put more money into the safety (especially after accidents, lawsuits). Good training, adequate signs, etc., will go far to head off liability costs.

Human Factors

- Human factors play a role. The basic problem is not with desensitization of drivers, but a familiarization on the part of the repeat drivers. Strangers do use the information. It's the regulars who don't see flaggers, devices, barrels—the drivers have become so routine in driving, thinking of other things, that they lose sight of driving tasks and don't pay attention, especially truck drivers, who are so tired they are driving in a daze. Even drivers who are otherwise alert will stop paying attention.

- Pennsylvania is concentrating on not on slowing people down—which is considered a lost cause. Accidents usually occur where there is a disruption in the traffic flow. We should look at the construction methods we are using and target those disruptions to the traffic flow.

- To achieve speed control, it has been found that the tunnel effect will slow people down because it makes them *perceive* the lane is narrower.

- Another successful method is to leave both lanes open to the taper and put up a sign: "Merge: Take Your Turn." The value of this sort of system may not be in actual throughput, but in the fact that there is a *justice* value. This can reduce frustration that could create later problems.

- Much of the existing problem has to do with the duration of the work. People get used to it and stop thinking of it as a work zone.

- The bottom line is that people want traffic maintained without interfering with their own convenience.

- Public attitudes about spending habits can be changed through education programs, public service announcements, etc., but the problem is how to get attention for *this* cause as opposed to other worthy causes. People must be made to understand that providing the investment for safety makes the project cheaper in the long run.

WORK ZONE
SAFETY IMPLEMENTATION

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WORKSHOP FORMAT

The workshop consisted of introductory remarks by the facilitator to "set the stage" for the topics included in the workshop. The mission statement was reviewed and agreed on by a majority of the participants so discussion could be effectively limited to those areas intended.

The remainder of the workshop consisted of open discussion identifying topics and practices to ensure proper work zone traffic control and safety implementation. These practices were refined and agreed on by most participants.

The workshop concluded with the development of an outline presented at the closeout session. This outline may be used, by any agency, to develop practices (policies, procedures, etc.) to ensure quality traffic controls are used.

WORKSHOP MISSION

The mission of this workshop was to identify good practices, for public and private agencies, that ensure quality work zone traffic controls are applied in all construction, maintenance, utility, and incident management work zones. This includes, but was not limited to:

- aspects of the agency's management system
- goals of the agency at all levels, from the CEO to the field personnel
- identification of important elements of work zone traffic controls
- training of all personnel involved with work zone traffic controls
- selection of proper work zone traffic control devices
- methods to ensure all devices are of adequate quality.

The need for a comprehensive work zone traffic control and safety plan was stressed during the discussion of the mission statement.

MINNESOTA'S WORK ZONE SAFETY ORGANIZATION

The three main components of Minnesota's work zone safety organization are:

- Work Zone Safety Coordinators;
- Work Zone Safety Committee; and
- Work Zone Safety Advisory Committee.

Work Zone Safety Coordinators

It is essential that the responsibility for work zone traffic controls be assigned to specific individuals. The axiom "Safety is Everyone's Job" is true; however, specific duties must be assigned to individuals or the job never gets done. It is key that the authority to make decisions be delegated to the lowest level possible to ensure that changes are made in a timely and efficient manner.

To accomplish this, Minnesota established a full-time Statewide Work Zone Safety Coordinator position in 1989. This position exists to coordinate all work zone traffic control and safety efforts in Minnesota.

In addition, each of MN/DOT's eight construction districts has a District Work Zone Safety Coordinator. The duties of the district coordinator are to provide technical expertise for the district and ensure that proper traffic controls are used in all work zones.

To provide project-level work zone traffic control and safety each project has a Project Work Zone Safety Inspector. This inspector has the responsibility and authority to ensure all traffic controls meet project requirements.

Work Zone Safety Committee

The role of the committee is to act as the focal point for work zone traffic control and safety efforts in Minnesota. Committee members include FHWA; Associated General Contractors; the Northland Chapter of the American Traffic Safety Services Association; counties; cities; law enforcement; and functional groups of MN/DOT (traffic engineering, construction, maintenance, state aid, and safety).

The major activities of the committee include:

- presentation of annual work zone safety awards for construction, and county efforts;
- review and application of new technologies in work zone traffic control;
- development and delivery of public education and awareness programs;
- research and development of new techniques and improved work zone traffic controls;
- providing designated law enforcement in work zones; and
- implementing work zone traffic control and safety policies in Minnesota.

Work Zone Safety Advisory Committee

This committee consists of representatives of construction contractors and labor unions that meet monthly with the commissioner of transportation to discuss work zone traffic control and safety issues. The committee's primary role is to keep communications open among labor, industry and government. This group is also active in promoting the efforts of the Work Zone Safety Committee on a statewide basis.

Members of this committee are active in promoting legislative initiatives concerning work zone traffic controls and safety as well as public education and awareness programs.

ELEMENTS OF A TRAFFIC CONTROL AND SAFETY PROGRAM

It is essential that all work zone traffic control and safety programs include:

- work zone traffic control standards and guidelines;
- technical training;
- investigation of state-of-the-art work zone traffic controls; and
- quality control.

Work Zone Traffic Control Standards and Guidelines

It is essential that all agencies adopt and use work zone traffic control standards and guidelines, which must be drawn in accordance with Federal, State, and local regulations.

Technical Training

To ensure that proper traffic controls are installed in work zones, it is important that all workers receive training that is consistent with their job responsibilities and authority. This training varies from traffic engineering courses to work site traffic control supervision to flagging and basic traffic awareness training.

Investigation of State-of-the-Art Work Zone Traffic Controls

It is MN/DOT's philosophy that the best technologies and techniques need to be applied in work zones to provide safety for the worker and traveler. To accomplish this, there is a Work Zone New Products Subcommittee that reviews new technology in work zones. This review includes a research summary and covers traffic control device performance, and traffic control techniques.

Quality Control

Work zone traffic controls must earn the respect of the driver. To accomplish this it is necessary to use properly installed, high-quality traffic control devices. It is believed that if the workers cannot show enough respect for the devices and the drivers to provide high-quality traffic controls, the drivers will not respect those devices.

ELEMENTS OF WORK ZONE TRAFFIC CONTROL IMPLEMENTATION

It is essential that all agencies develop a traffic management plan for handling traffic near work zones. This traffic management plan has many key elements. The two major elements concerning the implementation of work zone traffic controls are:

- work zone traffic control operations; and
- work zone traffic control monitoring.

Work Zone Traffic Control Operations

Work zone traffic control operations are those items provided in the planning and design process to aid in providing traffic safety in work zones. The key components are traffic control plans, pay items and to project specific public awareness.

Work Zone Traffic Control Monitoring

The most critical element of the traffic management plan is the monitoring of work zone traffic controls during field operations. To ensure that proper monitoring is accomplished, it is necessary to assign the responsibility and authority to a specific individual on the project. This individual ensures that proper monitoring of devices is conducted and any corrective actions are taken promptly. The primary duty of this person is to enforce the work zone traffic control standards and guidelines that apply to this specific project.

Other critical components of monitoring include enforcement of traffic laws and collecting and analyzing work zone accident data. It is important to provide the proper level of law enforcement on projects to ensure the safety of the worker and the motorist. It is also important to review accident data on a project, state, and national level to identify areas that need improvement.

ENSURING USE OF QUALITY WORK ZONE TRAFFIC CONTROL DEVICES

The mission of this workshop is to identify good practices that ensure quality work zone traffic controls are used. To accomplish this, it is essential that all agencies have:

- management commitment;
- qualified field personnel; and
- project manager tools.

Management Commitment

All agencies, public and private, who affect the normal flow of traffic must be committed to work zone traffic safety, from top management to field personnel. This is essential for proper allocation of time, money, and personnel resources to work zone traffic control and safety.

It is important that all workers and travelers be aware of this commitment to traffic control and safety in work zones. This is communicated to the worker through training programs and delegation of authority to field personnel. This commitment is communicated to the driver by the attention given to work zone traffic controls and law enforcement on all projects.

Qualified Field Personnel

Field personnel are the key to quality work zone traffic controls and the success of any work zone traffic safety program. Therefore, it is necessary to provide training for these workers so they are qualified to ensure proper traffic controls are installed and maintained for the life of a project. This training must be consistent with job responsibilities that may range from traffic awareness for all workers to formal certification programs for work site traffic control supervisors.

Project Manager Tools

The goal of any work zone traffic safety plan should be to provide project managers with the proper tools to provide work zone traffic controls. These tools include:

- ATSSA quality standards;
- regular surveillance of traffic controls;

- penalties for non-compliance to Traffic Control Plan and standards;
- regular work zone safety meetings; and
- input to work zone traffic control standards and guidelines.

Like any other tools, these must be available for use by field personnel and must be kept up to date to ensure their application provides quality work zone traffic controls and safety.

It must be remembered that any successful work zone safety implementation plan must focus on the needs of field personnel and the traveling public. All other elements of the plan are important. However, if the worker is not given the necessary tools, this plan will not aid in providing quality work zone traffic controls.

MISSION OF WORKSHOP

This Conference was an excellent opportunity to discuss and share experiences in providing work zone traffic controls for all activities on streets and highways. The workshop format facilitated formal participation by all Conference delegates. This participation provided a way to capture the experiences of work zone traffic control and safety experts from across the country.

The workshop, Work Zone Safety Implementation, could include all aspects of work zone traffic controls. However, the following mission statement was adopted to direct group discussions:

> *Identify good practices, for public and private agencies, that ensure quality work zone traffic controls are applied in all work zones.*

Throughout the workshop discussions, it was stressed that everyone must be committed to work zone traffic control and safety. Also, field personnel are the key to ensuring proper application of quality work zone controls. Therefore, they must be given the tools that allow and facilitate these applications.

The planning committee for this conference asked that we address the quality of work zone traffic control devices and improved quality assurance during our discussions. During these workshops we identified many tools that can be used to improve the quality of the devices and traffic safety.

It is important to note that it was difficult for the groups to get out of the contract administration mode and concentrate on all work zone activities. Some discussion focused on how to use administrative techniques for permit type and maintenance operations—for example, the use of penalties and incentives along with regular surveillance on these topes of operations.

It was stressed by both groups that these good practices should be used by all agencies to improve the proper application of quality work zone traffic controls.

The categories of good practices developed during these workshops were:

- surveillance of work zone traffic controls;
- quality of work zone traffic controls;
- law enforcement;
- positive and negative incentives;
- development of a safety culture;
- improved work zone traffic control assurance;
- traffic management scheme; and
- issues that need additional attention.

The good practices are listed under each of these categories. Many of them could be developed into an entire section for this report. However, time did not allow this during the workshops, and it is hoped these practices will be developed and included in the National Work Zone Safety Program.

Surveillance of Work Zone Traffic Controls

- There should be regular surveillance by the owners (DOT, local road authority, etc.) project personnel.
- Regular surveillance by the contractor should be formalized by the use of a daily traffic control checklist that must be provided to project inspectors.
- Establish a 1-800 telephone number so problems can be reported by the traveling public.

Quality of Work Zone Traffic Controls

- Use the *ATSSA Quality Standards for Work Zone Traffic Control Devices* in all work zones.
- Develop procedures that ensure the crashworthiness of all work zone traffic control devices.
- Develop procedures to ensure the quality of the traffic control scheme and layout of traffic controls. This includes communication between field and design personnel.
- Improve the visibility and recognizability of all workers.

Law Enforcement

- Make law enforcement officers an integral part of the project team by including them in planning and design efforts, field safety meetings, surveillance of traffic controls, and enforcement of traffic laws.
- Provide work zone traffic control and safety awareness training for all law enforcement personnel.
- Use dedicated officers for traffic law enforcement.

Positive and Negative Incentives

Worker and agency

- Use penalties for non-compliance to work zone traffic control standards, guidelines, and plans. This varies from hourly penalties to shutting down the project.
- Develop and implement a work zone safety awards program to recognize extraordinary efforts in providing work zone traffic controls and safety.
- Implement a bonus program that provides incentive to perform beyond minimum requirements.

Facility owner (road authority)

- Realize that application of proper work zone traffic controls makes it possible to deliver a project on time, within budget, safely, and with reduced exposure to liability.

Public

- Enforce traffic laws in work zones to demonstrate the importance of driving safely in them.
- Use double fines in work zones to show the extra importance of driving safely in work zones.

Development of a Safety Culture

Workers

- Communicate management commitment and support to all workers.
- Make work zone traffic control and safety an integral part of all work activities. Too often traffic control and safety are considered add-on items that are neglected when time is short.

Public

- Develop and deliver work zone traffic safety public education and awareness campaigns on national, regional, statewide, local, and project levels.

Improved Work Zone Traffic Control Quality Assurance

- Provide improved technical training for all workers that is consistent with their job duties and responsibilities.
- Develop certification programs to ensure those responsible persons are qualified to apply work zone traffic controls.
- Develop a work zone traffic control field manual for work zone traffic control that facilitates application of standards and guidelines.
- Formalize agency policies concerning work zone traffic control and safety so all workers are aware of their duties.
- Provide flagger certification to ensure that all flaggers are capable of controlling traffic through a work zone.
- Assign responsibility and authority for work zone traffic controls to field personnel.
- Listen to field personnel to improve work zone traffic control and safety standards, guidelines and policies.

Traffic Management Scheme

- TCPs should be developed for all long-term projects. TCPs should include guidance on solving common problems encountered in the field. Examples include providing extra traffic control devices, how to handle changes to the plan, how to provide traffic controls for unexpected drop-offs, etc.
- Provide for regular work zone traffic control and safety meetings at all levels. These levels include project, local, statewide, regional and national.
- Provide timely responses to all deficiencies in work zone traffic controls.

Other Issues Requiring Attention

Following is a list of items that the groups decided need additional development:

- work zone traffic accident analysis system to identify traffic safety problems;
- a national work zone traffic safety public education and awareness program;
- work zone traffic control training and awareness for upper management;
- use of lane rental and A+B bidding concepts to improve traffic safety by reducing exposure;
- implementation of new technologies and techniques to reduce hazards and improve safety; and
- inclusion of specific guidance for pedestrian traffic controls in the *Federal Manual on Uniform Traffic Control Devices* including fences, detours, and walkways.

CONCLUSION

This Conference and workshop have shown that most work zone traffic control and safety issues and concerns were shared by all delegates. It is obvious that these types of forums facilitate development of common solutions to these concerns. Therefore, the groups both recommend that this national work zone traffic control and safety conference become an annual meeting. This would allow attendance at the meeting by public officials, as well as provide solutions to common problems in work zone traffic control and safety.

Additional points raised in workshop discussions:

To counter the problem of motorists attacking workers on site, it was suggested that input from troopers during the planning stages could be valuable. At the site, however, flagger training is often more important than relying on the use of troopers to prevent violations. Workshop participants also believed that some voluntary flagger training for troopers could be useful.

In some States, troopers at work zones serve more to enhance safety rather than to enforce the law. In California, some troopers serve a joint role; some offers on bikes are assigned solely to enforce safety in work zones. Also in that State, safety measures are enforced via fines and penalties imposed against work zone contractors.

Quality Control Issues

- Participants recommended that Traffic Control Devices (TCDs) be subjected to regular and spontaneous inspections, and that they comply with existing standards and specifications of design and performance.
- Information for motorists should be user-friendly; encourage alternative transportation where possible; advise them of the duration of the project; and notify them of applicable fines and penalties. Symbols and signs should be easily understood whatever the driver's native language. In addition, work zone safety should also be addressed in State driver's handbooks and incorporated into the driver's tests.
- Public awareness programs should be implemented through national campaigns, driver's education programs, the public schools (including elementary schools), and partnerships with motor carriers through penalties/incentive efforts, insurance companies, and commercial driver's license activities.

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Everyone who participated in my two workshops worked very hard to produce some really meaningful recommendations.

The first key to effecting work zone safety is to understand why problems exist, and why there are no uniform practices in designing work zones.

Although those in a State agency conduct projects of a similar nature as those in a municipality, and perhaps a utility contractor has a similar project, all three are treated differently from the standpoint of traffic control. Thus there is a problem in maintaining uniformity. It differs from job to job, and from area to area.

We sought to identify the basic problems, and found that one of the major items was lack of enforcement. Perhaps even more important are monitoring and inspection: Who's in charge? Who is checking to see that the system is the way it's supposed to be, whether it is of a quality design, whether it is maintained at a high quality? In other words, does the system work?

Enforcement is a logical follow-up: What compels a contractor or even an agency work force to change the system to make it work? Perhaps it has something to do with pay practices on the part of the contractor. There was much discussion of contractor payment for traffic control work—lump sum vs. item-per-day basis. There were no States represented that paid on an item-per-day basis, so we couldn't really define that part of it. The States that were represented all paid on the basis of a lump sum; however, it was a modified system that allowed for maintenance, improvements, changes, modifications and so on. So in effect you have a value per day basis. This was not a real issue, but it does boil down to contractors getting paid for the work they do, and if payment is not made justly, then the quality of work suffers.

RECOMMENDATIONS

We came up with some solutions to maintaining a good plan:

- It was recommended that there be more joint participation. What we're really talking about is this partnering concept, albeit from a somewhat different approach. It was the consensus of both groups that there should be more joint participation by State agencies, counties, municipalities and other jurisdictions, contractors, and associations. We talked about the chaptering organization that ATSSA has as a mechanism to get people to cooperate.

- It was also suggested that we need some type of central clearinghouse where people can inquire about common practices, a source of information that is easily accessible. We talked about a number of possibilities there, and I think this has good potential for development on a national basis.

- Pre-qualification of contractors: I'm sure this is not a practice of all State agencies, but the recommendation was to encourage that.

- More frequent inspections: Better follow-up must be encouraged by some means or mechanism, but we're not sure what that mechanism should be. Constant, continuous inspection, knowing the current situation, is very lacking right now, and there needs to be significant improvement in this area.

- The issue of the Manual was discussed, about what it really is and what the group thought it should be. Some thought there is not specific enough information in the Manual. There was some desire to see the Manual separated into more specific areas, perhaps into three parts covering the general categories of a high-speed, high-volume expressway type of operation. Many of you who have participated in

activities related to the Manual know it assumes high-speed, high-volume situations. All other designs, all other roadways, are patterned after that because the concept of handling traffic control is the same; it's just done in a slightly different way. This is not presented clearly, but if the Manual were segmented into parts showing peculiarities, a variety of lane closures, handling perhaps intermediate speed, intermediate-volume type situations, and the low-speed, low-volume type of activities, this could be useful. We didn't spend a lot of time thinking about exactly just how each type of category should be derived, but merely recommend this as food for thought. We're not suggesting complete reorganization of the Manual; it's a good document, but how can we make it better, more usable, more understandable?

- One problem we noted, which is evidenced here, is a lack of representation by some major municipalities. We have some city, some county, some State representation but virtually no major municipality. We don't have significant representation by municipalities, and I think their input is as valuable as anyone else's. The emphasis seems to be on agencies and State departments of transportation, and I think we need to get the cities more involved. That was a recommendation of our group.

- It was also recommended that some design manuals be developed, and that there be more in the MUCTD on how to develop a good Traffic Control Plan. It was the group's consensus that there be guidelines, but that there be enough flexibility to leave leeway for judgment and discretion. However, there is still a lack of a single document, a single source that describes how to put all of the elements together that are needed to design a good Traffic Control Plan. It's more than just a "cookbook" situation, putting in amendments. You have to look at volumes, speeds, quality traffic, congestion, capacity. My personal view is that we must include the people who are involved: traffic engineers, engineering technicians, people with that education. This may sound like a simple answer. We have those people in the world today, but maybe we don't have enough of them in certain areas. Again, it was recommended that some kind of source be developed, similar to the clearinghouse mentioned earlier, possibly a design manual, perhaps done by AASHTO as the appropriate source, just like the AASHTO Design Guide. It is recommended that this at least be considered. We do have a handbook that is a good document, but only engineers can understand it.

- The last item that we focused on was the education of the driver: getting the public involved, making them want to buy into a program, making them understand that they are a part of the problem as well as a part of the solution. Everything we do is for the sake of the driver, as well as for the workers. Some time ago, FHWA made a couple of pilot public service announcements, and we were wondering what happened to those. Perhaps PSAs could make only a small dent in a major problem, but something needs to be done to raise the public's awareness. In other words, we need a greater emphasis on public education.

Additional points raised in workshop discussions:

Contract Issues

- Participants agreed that there is often a gap between contract specifications and job site realities. Enforcement of standards imposed must be a goal. Compliance often becomes problematic when it comes to subcontractors: How can their compliance be assured? One answer is to define the applicable criteria related to their bid from the beginning of the contract process. However, sometimes the problem lies in the fact that one entity will bid while others actually do the work, and there is no communication between the two separate disciplines.

- Meeting standards set for traffic control devices can be achieved through assessment of penalties applied for every day the contractor is not in compliance.

- Sometimes problems arise not with actually providing the materials but with ensuring proper maintenance. In some States with heavy traffic in well-populated urban areas, people are assigned whose job is solely to maintain equipment.

New York has a centralized statewide team to evaluate work zone issues and prepare a report on these annually. Pennsylvania has prepared a detailed work zone manual addressing each potential situation which may be of concern. Inspectors have no leeway to tolerate lapses. Participants suggested that such a manual is a good idea, but it should responsive to the public and to practical needs. Consistency of standards and enforcement provisions is essential.

Liability Issues

Although liability may arise even if one lives by all the rules, tort liability is a lightening rod.

- One participant cited the need for more detailed specifications or standards, but if these are too specific, they become a resource for lawyers to use in litigation. General guidelines, he said, are preferable to specifications. Another participant disagreed, citing a need for explicit guidance and incentive to use the latest technology.

- Contractors often will ignore guidance; thus, documentation as to why a specific practice was instituted is needed.

Retroreflectance Standards

- ATSSA will demonstrate a mobile reflectometer which will collect data for safety management systems on reflectance performance. It will work by having a vehicle go down the roadway and use a strobe light to measure feedback from devices. Data will be collected using an onboard computer. These vehicles will cost about $125,000 each, but FHWA is trying to bring down the price.

Problem Solving

- Most work zone problems can be resolved through good execution. The real needs are training and motivation, throughout all levels of an organization, as well as quality testing of implemented plans.

- The moderator advocated improved quality assurance along the entire chain of command of a traffic program (TCP), using experienced and trained personnel. A poorly designed TCP costs time and money to defend in court, with the weak link often being the TCP implementation.

Training Issues

Regarding flagger certification and traffic control planning training, in states such as Nevada financing training can be an issue. The State wants to be able to use apprentices and then develop qualifications. However, less training often means higher accident probability. Retention levels among trainees are a concern. Minnesota's experience is that shorter sessions over time increase retention.

Enforcement and Inspection

- Enforcement can be viewed as a follow-up to inspection, which ideally should occur early in the process to discourage implementation of undesirable traffic control plans. In New York, following clearly defined inspection procedures is the responsibility of professionals hired by the State DOT. Contractors are expected to implement quality plans, although inspection is important and New York does conduct spot checks.

- Some believed a job should not start without the approval of a certified inspector/engineer. In Illinois, a specific date is established for a project to implement the TCP and a contractor gets 25 percent of a lump sum after the implementation is approved by a traffic control supervisor. A contractor must set up a lane closure correctly to get paid.

- A State's liability is raised if enforcement of contractors is inadequate. One participant's observation: "You can't expect what you don't inspect."

The Federal Role

The moderator suggested that Federal approval of devices at some point in the future is unlikely. FHWA basically does not approve devices, but it does set standards. However, even if a product meets a standard, that does not imply approval.

CONTRACTORS CONSTRUCTION MANAGEMENT

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It is appropriate that one of the topics discussed in our workshops was partnering, since we actually "partnered" to conduct it. We will try to summarize some of the highlights of our discussions on construction management and how it is working in the States.

Actually, we thought this was going to be a pretty mundane topic, but when we started our sessions it turned out to be very interesting, so we're going to cover it in some detail.

PARTNERING

In the first area, partnering, we discovered that there is a lot of it going on and, for the most part, people felt pretty good about it, and that it was successful and working well. We had extremes from some States with no partnering to other States where it's used on every project.

A couple of things I'd like to point out: Most of the problems we talked about resulted from one or more parties not being honest. Not getting everyone to buy in up front is a problem that needs to be addressed for effective partnering. Making a commitment to get the decision making down to the lowest level—that was something we also felt is important if the partnering process is going to work. If that's done, a lot of the problems that arise will be resolved quickly and painlessly.

We discussed some agencies that allow changes to be made up to $50,000. These could be made by the project engineer. That's the type of thing this partnering process allows. In addition, partnering permits us to change the way we may have done business in the past. Some of the participants were joking that if they discussed five years ago the same issues they are discussing today, they'd all be in jail.

Another issue raised was sharing the risk, not only from the State side but from the contractor's perspective.

Partnering is an evolutionary process. There have been States where it has been a resounding success and other States where it has had mixed success. But in terms of traffic sequencing and putting the issues out on the table in a candid manner where everybody knows all the facts, we think partnering has great potential for improving the entire construction process as well as safety on the project.

TRAINING

This was one of the emphasis areas in our discussion. One of the things we addressed was the need for uniformity in training, the need to make it available, and the need for incentives. Our unanimous consensus was that training is needed and that everyone who's out there working should be trained. There's no question about that.

The second recommendation is that training be uniform, particularly for flagging; one procedure needs to be established so that from project to project and State to State, flagging will be uniform. Training should also be uniform for traffic control. There was some discussion about what direction traffic control training should take and what existing training courses offer and how they may be improved.

The certification issue was something we discussed a lot in both sessions. There was not a strong consensus about whether or not certification is the way to go. There was a consensus, however, that training should be accomplished, with perhaps certification as to training having been completed but not as to a certain level of competence.

LUMP SUM VS. UNIT PRICING

The next subject that we talked about—particularly in the second session, in a rather spirited manner—was lump sum vs. unit cost as a means for paying for traffic control items and traffic control people. Problem number one was that lump sum may not be the best way to pay for traffic control items such as flaggers, variable message boards, arrow panels, and other safety items. Among the participants at both our sessions, there was a wide range of experience related to different States and how they handle this issue. I think one of the solutions we discussed was that pre-set items, like flaggers—which are very hard to plan and could run way above planned quantity—might be the way to go. We do that in Delaware and it works well. There's very little controversy about it and it's periodically adjusted for inflation.

Presumably if a new traffic control device comes on the market, particularly with a unit price structure, there's a possibility for a quick response and it's something we can use in our applications. The other side of that issue is that unit prices can be an administrative nightmare. Counting the number of barrels on a 10-mile area on I-95 and counting them every day, is without question an administrative nightmare. So we concluded that it might be better to use lump sums for some items, while using unit prices on others.

There was some opinion that if you're doing it on a unit price basis perhaps the contractor's interest is not as great as it would be if it were a lump sum or if he had an incentive to make sure it's right and economical. It was also argued that lump sum jobs may provide better traffic control. I'm trying to be as objective about this as I can, because I'm a contractor and I agree with that. The bottom line is that there's got to be a balance. Lump sum payments may be the way to go in some instances, where unit prices for variables such as flagging might be appropriate if there is control set up to start with.

We need to be as innovative as possible with changes in lump sum prices that may have an impact on traffic control. One of the problems with lump sums is that if there is a resequencing of the traffic lanes, for whatever reason, then all of a sudden there have to be major negotiations as to how the lump sum is adjusted to reflect this resequencing. This could chill the whole process, and the time spent in renegotiating the entire operation might impede the opportunity. That's why we concluded there should be a balance.

INCENTIVES AND DISINCENTIVES

First, there are not enough incentives. The solution that some States are using involves lane rentals and interchange rentals. In Oklahoma, interchanges rentals are actually coming up, wherein the contractor has a specific amount chargeable for shutting down an interchange or lanes, and if he exceeds the allotted time, then he's charged for that specific amount. One contractor we discussed even splits his incentives with his subcontractors and suppliers.

Second, can work zone traffic control be included in incentives and disincentives? I think we're all familiar with A+B contracts, but somebody talked about A+B+C, with C being quality performance issues. It would be a wonderful thing if we could devise a method of assigning value to superior performance on traffic zone safety. I don't know how to do that, but it might mean giving the contractor an incentive for achieving not only the specified performance but a superior performance.

Our philosophy has always been that if you can get the job done sooner, obviously the exposure is decreased, not only to the traveling public but to the workers. So there's been a strong emphasis on being as innovative as possible in changing and improving sequences of lane closures, etc. We talked about how long it takes to get change orders processed. This is an issue we'll probably have as long as we have construction. But it relates to a traffic issue that needs to be dealt with as soon as possible.

It was pretty much agreed that incentives may not be workable in all jobs. But if a matrix could be developed regarding incentives for superior performance, everybody would win in that situation.

Additional points raised in workshop discussions:

Use of Intermediaries

• One effective tool can be the designation of a facilitator to act as a third party who sets procedures for settling disputes up front.

• Florida has been using a system which involve scheduling a three-day session to put all issues on the table with everyone involved to ensure all parties understand what is expectated of them. This process is now incorporated as a part of Florida contracts involving work zones. It offers professionals a way to solve problems without the situation becoming adversarial.

The process starts at the time the contractor is selected; meetings are held before construction planning sessions take place.

At the first meeting the parties discuss:

– expectations—on-time, in-budget, no claims, etc.

– dispute resolution—how issues are decided and by whom.

A document is signed to confirm what has been agreed and this serves as a resource in the event disputes later arise. It specifies deadlines for action (i.e., a time line for resolutions, etc). This helps speed the process because all understand their roles in advance.

BENEFITS OF PARTNERING

• Exchange of ideas: Florida and Minnesota use retired contractors to review plans and give their valuable perspective.

• The biggest advantage is in the decision making process—things move more efficiently.

• Issues can be negotiated onsite.

Speed Enforcement in Work Zones

• Contractors' biggest concern in work zones is speed and the closeness of trucks. For example, in Maryland there were once advisory speeds of 10-15 miles below posted speed, but these were not normally enforced until something tragic happened.

• There is a real need to educate the public about why speed controls are necessary. In addition, speed limits must be credible. It was suggested that speed limits be set based on the degree of exposur. In addition, the level of traffic control and enforcement would depend on the real need for the lower speed.

Public Awareness

• Dedicated funds are needed to improve public awareness of work zone safety issues; money for this purpose is available for NHTSA.

• In South Carolina, the public was surveyed on their response to work zones. To motorists, this seems to be a non-issue, because work zones don't affect them except to cause delays.

• Public programs that take a personal approach, such as those depicting families left behind when people are killed, can be effective.

• North Carolina developed a sign and two mascots (Buddy Barrel and Connie Cone). Materials were developed for distribution in meetings, at the state fair, etc. Truckers can also be allies in this effort.

• Though many States have developed public awareness programs, the USDOT has not produced anything outside NHTSA. DOT could be a catalyst for a national campaign.

• In South Carolina, public service campaigns aired through commercials and news broadcasts have made a difference with motorists.

Recommendations

- Coordination among agencies about detour and alternative routes.
- Establish driver call number to report violations (as in HOV lanes).
- Driver education on safety.
- Upgrade driver's license requirements to include safety awareness.
- Produce videos on work zone safety, PSAs, etc.
- Consider closing roads when necessary.
- Do more night work.
- Find alternative routes or detours (using traffic impact analyses to demonstrate needs).

Incentives

- In high-volume areas such as Virginia, traffic volume has outpaced our ability to work in a window (e.g., between 9 a.m. and 3 p.m.); so night work is about the only option left, but it requires a lot of preparation. Daytime windows don't work because construction trucks can't get to the site and still back up traffic. In addition, during holiday travel weekends, hunting season, Memorial Day, etc., there are problems because of heavier traffic volumes.
- Jobs with high liquidated damages force contractors to plan well. A downside of incentives is that a contractor may push to get the work done quickly but the work may be less than the best quality.
- Worker safety is an issue of concern: every hour and day the job is done sooner means less exposure by workers to risks.

Training

- Training is addressed in ISTEA's section on the national program. DOT oversees training and certifications procedures.
- ATSSA offers a course and certificate in a three-day program.
- Rhode Island has union problems with certification because different groups are in different unions; some subcontractors attend the courses; the problem is getting flagger certification. FHWA helps with the classroom programs, which are growing but not yet well organized.
- Maryland requires certification of traffic managers. Delaware uses a national certification program; it is not required for flaggers. Some States use retired personnel on call and say this works well.
- Twenty States require certification of flaggers; however, there is a lack of consistency with setup, and flagging procedures sometimes cause problems for motorists.
- Virginia has developed its own certification program, and as a result professionalism has improved.

Cost Factors

- In North Carolina, if changes are safety related, authorization on the job is unlimited. There are advantages to reducing or eliminating bureaucracy.
- Accident reports should be required under contracts. A safety person should be on staff; if the contractor's personnel perform this function, no one from the State should be needed in that role.

INTERACTION WITH PUBLIC AND HIGHWAY USERS

Maj. Thomas H. Milldebrandt

Criminal Justice/Traffic Law Enforcement Consultant

Two identical panels were held, with a total of 27 participants contributing during the discussions. The participants represented such diverse disciplines as law enforcement, State and local highway administration, organized labor, public utilities, public relations, Federal highways, equipment manufacturers, and transportation associations.

The panel discussions and recommendations are grouped in six principal areas:

- Problem Identification
- Funding
- Education
- Driver Licensing
- Credibility
- Open Communication

PROBLEM IDENTIFICATION

It was unanimously agreed that to make any public information drive successful we must identify the areas that pose the most problems to drivers in work zones. This process begins with compiling far more extensive and accurate crash statistics, including total, property damage, injury, and fatalities data. Although a single fatal crash is extremely significant to those directly involved, using the published national figure of 700 fatalities in work zones fails to signify a significant national concern.

Meaningful data could be collected using statistically recognized sampling techniques. When collected, this information should be disseminated nationwide to all concerned agencies, including national and local media outlets.

Although this problem identification effort is desperately needed, while the statistics are being gathered and disseminated, the highway and law enforcement agencies should make maximum use of the shock value of local tragic work zone crashes.

More research into human factors needs to be conducted in order to firmly identify the driver's needs in work zones.

FUNDING

It was the consensus of the panel that if we really are as serious about work zone safety as ISTEA suggests, legislatures must then provide the funding necessary to fully educate the public, provide more police presence on the highways, and train the parties involved. Every possible approach to increasing safety in work zones starts with Congress and State legislatures appropriating the funds necessary to implement new ideas.

These activities include producing and disseminating public information through safety videos, television and radio commercials, mailers and driver education material. Funding is also critical to provide for essential police enforcement and direction within work zones.

EDUCATION

We must better educate all parties involved in work zone safety, including contractors, workers, law enforcement personnel and the motoring public. The panel viewed a traffic safety video entitled, "Getting Past the Orange Barrels," produced by the AAA Foundation for Traffic Safety. This is an excellent example of an educational tool that is already available. More use should be made of this video, and additional materials are urgently needed.

Work zone safety needs to be emphasized at all educational levels, beginning in elementary schools and continuing through driver training and driver's license testing.

DRIVER LICENSING

The panel recognized an alarming deterioration nationwide in the level and quality of training and testing of new and experienced drivers.

Driver licensing procedures seem to have become focused on revenue generation rather than education and testing to put qualified operators behind the wheel. This is having a deleterious effect on motor vehicle operation in general and work zone safety in particular. Of great concern to the panel was the lack of regular reexamination of all drivers and inadequate vision testing of elderly drivers.

CREDIBILITY

Transportation agencies in their traffic control plans, contractors in their implementation of these plans, and enforcement agencies in requiring compliance must be consistent in their efforts. Otherwise, the motoring public becomes desensitized and disgusted with work zone areas.

Currently speed zoning in work zones is often decided arbitrarily, in some cases by statute. In order to gain credibility with the motoring public such limits should be set based only on practical and proven engineering standards. Mississippi's attempt to set such limits, "A Methodology for Establishing Speed Limits in Work Zones," was discussed and seemed to hold promise.

OPEN COMMUNICATIONS

There must be open communications among officials, contractors, laborers, transportation agencies, Federal officials, State legislatures and Congress. All parties involved in work zone safety must work together to exchange ideas so that everyone shares the same information and understands each other's problems. Conferences like this one are a good start, but we need to expand them to include Federal and State legislators.

We need a national program, a unified front, so that individual jurisdictions do not have to create and recreate workable solutions to the same problems.

INNOVATIVE IDEAS

While much of the panel's attention was focused on problems and needs, several innovative ideas were presented that seemed to be headed in the right direction:

1. The New Jersey State Police has received funding for a Work Zone Safety Unit comprising 24 officers who are dedicated to full-time duty enforcing construction safety regulations. Six of these officers assigned to each geographic region enforce all regulations in work zones, with emphasis on speed enforcement and ensuring proper signing as required by the State's Traffic Control Plan (TCP).

2. In Oregon, the State Legislature provided for eight new officers. The State Police apportioned monies to existing officers statewide to provide dedicated "on duty" officers in work zones.

3. In Maryland, the State DOT regularly conducts "peer reviews" of work zones. They ask selected citizens, usually from civic organizations, to drive through a work zone. No pre-briefing is given and only two questions are asked after the drive-through: "Did you feel safe?" and "Did you know where you were going?" Answers to these questions give MDOT valuable information on which to base changes to the reviewed work zone and future TCPs.

4. The Rhode Island State Police assign four or five officers to work selected work zones at night. One unit is placed at the beginning of the work zone and the second at the beginning of the taper. The officers in the second unit are out of the vehicle, making their presence obvious. Funding for this type of assignment is written into construction contracts.

5. Minnesota DOT has funded a public education program in which second graders are introduced to work zone safety through activity books. This program is fully funded at about 30 cents per pupil.

6. In Arizona and Vermont, city newspapers carry regular daily announcements about where construction is going on so motorists can avoid it if possible.

7. In Nevada, organized labor is lobbying at all levels of Government for increased awareness of, publicity about, and enforcement in work zones.

In response to a questionnaire, panel members in general thought that "the jury was still out" as to whether or not current programs to double fines in construction zones were productive.

Additional points raised in workshop discussions:

Enforcement Agencies' Role

- The police should be involved in developing Traffic Control Plans. Too often, if involved at all, they are called in at the last minute simply to be instructed in their anticipated participation.

- Enforcement agencies are notoriously undermanned and are consequently reluctant to dedicate manpower to areas other than those of the highest priority. In order to garner support for work zone enforcement, police administrators must be sold on its importance to their total police mission.

- One of the most effective ways of assuring an active police presence in work zones is to make provisions in the construction contract for the employment of off-duty officers. This guarantees uniformed officers in marked patrol cars during construction activities. Often, however, this manpower is underutilized by the lack of clear-cut assignments, training and supervision of these officers.

- Besides providing for off-duty officers, increased police participation in work zone safety can be accomplished by training area supervisors and patrol officers in the provisions of Chapter VI of the MUTCD in general and the current Traffic Control Plan in particular.

- The police should have authority to cite those responsible for implementing and maintaining the Plan when they do not comply, as is the case in Arizona.

Educational Programs

- Public education programs are needed to better inform the public concerning the hazards of work zones. Efforts are needed to reach various segments of the public, including all motorists, older drivers, children, contractors, construction workers, police, and highway officials.

- Tools that are effective in reaching the public include radio, television, newspapers, outdoor signs, and direct mail.

Ideas That Seem to Work

- Vermont created a public relations campaign involving "Reggie Radio," a cartoon character who promoted work zone safety. This seemed to spark the public's interest and get them more involved.

- Persuade local news media to enter a work zone with a camera and reporter. This makes a great public interest story, alerts the public to work going on in the area, and reminds them that work zones are dangerous.

- Continuously run instructive videos in state driver licensing offices. That way they are viewed while the motorists stand in line for licenses.

- Make fines in work zones include demerit points as well as doubled fines. One could model the idea around the existing legislation regulating school zones.

- In New Jersey, when projects are bid, the hours of "traffic director" time are contracted and added to the contractor's bill. The officers are then assigned to a job. When the six officers are all busy, the State then uses off-duty officers to cover the remaining jobs. Thus, officers are trained as well. The program is partially funded through a combination of DOT and FHWA funds and receives a lot of support.

- New Jersey also has created Snow Emergency Rooms, where police with weather condition information can call back and alert the Room to where snow crews need to be dispatched.

Jerry L. Graham, P.E.

President, Co-Owner and Founder
Graham-Migletz Enterprises, Inc.

In my consulting practice I spend a great deal of time developing and presenting work zone training courses for engineers, technicians, and flaggers. These courses detail the standards and guidelines used in planning and setting up work zone traffic controls.

A question often asked by my students is, "Who is educating the driver about the meaning of work zone traffic controls?" How many of you feel that even 10 percent of drivers know the meaning of the stripes on barricades? A device as powerful as the arrow panel may have an intuitive meaning to many drivers, but who is telling the driver what is meant by the caution mode on an arrow panel?

There are some efforts underway to educate the public, but much more needs to be done. The State of Iowa has recently added a work zone question to their driver's test, and Minnesota has an educational program for elementary schools called, "What's Your Orange I.Q.?" For our discussions here, I reviewed a number of drivers' manuals to determine how much information they include about work zones.

One organization, the AAA Foundation for Traffic Safety, sponsored a video that was produced by Graham-Migletz Enterprises, Inc. This video is meant to educate drivers about the meaning of many of our common work zone safety devices. I believe that educational materials like this video should be required viewing when obtaining a driver's license. The unfortunate truth is that you can obtain a driver's license in most States with very little knowledge of work zone traffic controls. Is this situation fair to the people who must work on our streets and highways?

Another obvious way that we affect drivers is the way that we set work zone speed limits. Graham-Migletz Enterprises, Inc. has been studying the methods States use to set speed limits in work zones. Some States have a blanket speed limit that must be installed in every work zone. These limits are often mandated by well-meaning legislatures. However, the effects of the reduced limits on accident rates in work zones would probably surprise most of the politicians responsible for imposing these mandatory limits. Simply lowering the work zone speed limit can actually *increase* accident rates!

Our panels covered two primary topics: public information and use of enforcement techniques. The participants recommended that FHWA and NHTSA increase efforts to get information to drivers about work zones. Two videos were viewed that could be useful in accomplishing this. These should be available at offices where licenses are renewed.

Enforcement is not a panacea for poor traffic control practices, and should be planned and coordinated with enforcement agencies. Traffic control plans should be designed to accommodate enforcement efforts.

Additional points raised in workshop discussions:

The participants made the following observations about issues related to interaction with the public:

- Creative funding mechanisms for educational programs are needed. Suggested resources include grants, FHWA, and contractors. South Carolina has produced an effective video on speeding through work zones.

- Work zone safety education should begin in childhood. Pennsylvania has developed a successful program to educate children.

- Industry and agencies should work with the National Safety Council to integrate work zone safety into their programs.

- Citizen peer review also can be effective. In North Carolina, there is a work zone safety team comprising contractors, DOT and law enforcement representatives, and EMS personnel who meet to discuss current work zones in the State.

- Enforcement capabilities can be enhanced through better communication between the project manager and troopers, the placement of police cars in work zones, and proper accident reporting.

- The FHWA should develop a users guide to highway construction and work zones that States could distribute and use for their own educational programs.

- Work zone safety information should be disseminated through driver education programs and coordination with organizations, including the AARP.

- Every license renewal should include eye exams to test ability to comprehend shapes and colors.

- There should be greater focus on proper signage in work zones; it was recommended that penalties be imposed for improper signage.

- Highway advisory updates on the radio are desirable, but reports should be updated regularly to maintain credibility and drivers' confidence in the system.

- States should consider awards programs to recognize contractors with low accident rates in work zones.

ADVANCED TECHNOLOGIES

Dr. Ray Benekohal

Associate Professor of Civil Engineering
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A total of 35 people participated in two three-hour Advanced Technology sessions. They represented private companies, Federal, State, and county governments. The following five topics were discussed:

I. Future of the industry

II. New safety devices, technology and reflectance standards

III. Information gathering techniques and devices

IV. Institutional issues (barriers)

V. New traffic control devices (TDCs), novelty effects and uniformity issues

The issues identified and the recommendations are summarized here.

I. FUTURE OF THE INDUSTRY

The traveling public will be seeing more work zones in the future as the highway systems undergo rehabilitation and maintenance. Advanced technologies can be helpful in making work zones safer and more efficient. The following points were made in the sessions:

1. We must consider safety of workers and drivers as well as travel needs of drivers.

2. We will see more work zones in the future, and more nighttime work zones.

3. More active TCDs should be used as opposed to the current passive TCDs.

4. We need to do more public relations and educate everyone involved about work zone safety.

5. We need better definition and understanding of work zone problems to find more effective solutions.

6. Industry should use advanced technologies to promote and improve work zone safety. Advanced technologies are not just electronics, but includes new materials, procedures, and processes.

7. Using real-time work zone traffic control is a viable option and should be encouraged. However, there are issues related to cost, its utility on all roads, and getting approval of their use.

8. Increase cooperation among and involvement of all parties involved (e.g., trucking industry, law enforcement, and local government).

9. We have to deal with diverse groups of motorist in work zones and need to be aware of their capabilities and limitations (e.g., impaired-normal, older-younger, and truck-car drivers).

10. Enforcement of the existing laws is a challenge now. How will the future laws due to advanced technologies will be enforced.

11. It should be realized that the industry mainly responds to the needs and often times does not lead.

12. Different levels of protection may be needed depending on the type of road and volume of traffic. One work zone traffic control solution may not fit every condition.

13. Promote safer design of work zones for prevailing speed (realizing that speed reduction will not always work).

14. Provide re-routing traveler information on a real-time basis.

15. Do not overload drivers with messages, there are already a lot of signs in work zones.

16. Credibility of on-line messages must be high; otherwise, they will not be effective.

17. Cost of new traffic control devices is a concern.

II. NEW SAFETY DEVICES, TECHNOLOGY AND REFLECTANCE STANDARDS

New traffic safety devices and technology can help to improve work zone safety and provide real-time information to drivers. The definition of "work zone" was broken down into four areas and recommendations were made for each.

Before and thru advance warning area	Transition Area	Work Area	Termination Area
A	B	C	D

The recommendations for area A are:

1. Notify drivers (audio, visual) on condition and status of work zone on real-time.

2. Provide re-routing options.

3. Promote advance trip planning and work zone notification.

4. Develop seamless traffic management system for better congestion control on work zone, detours and alternate routes.

The recommendations for area B are:

1. Develop positive (visual not necessarily physical) guidance systems that are interactive.

2. Use advanced technologies to increase compliance on placement of TCD.

3. Intrusion alarm for drivers and workers but don't over do it.

4. Explore the feasibility of using new devices and paving materials to warn the out of control vehicles (there was some support for this).

5. Explore the feasibility of using interactive lighting, marking and visual aids (e.g., sequential lighting).

The recommendations for area C are:

1. Use warning devices that rely on more than audio aids.

2. Study how new materials and techniques can reduce duration of work zones.

3. Improve delineation of work space and reduce distraction to drivers.

4. Explore the use of more robotics devices for work or flagging.

5. Explore improving enforcement by electronically monitoring speed of individual vehicles (e.g. using ID tags).

6. Consider lighting roadways under construction.

The recommendations for area D are:

1. Study further delineation of termination area so vehicles would not race to get to the open lane.

2. Explore feasibility of sequencing vehicles out of work zone speed.

Additional recommendations were made to improve overall work zone safety:

1. Explore providing horizontal guidance (e.g. wet reflective pavement marker).

2. Promote evaluation and use of new devices and determine their benefits.

3. Provide additional dedicated flexible funds for developing and evaluation of new devices.

4. Maintaining uniformity was a concern.

5. Promote "partnering" and bring in a broad range of people.

6. On reflectance standards the following recommendations were made:

- Support setting retroreflectivity standards / guidelines.

- Continue studying ways of improving visibility of work zones (e.g., night vision or use of wider letters).

- Pursue development of low-cost-more-efficient retroreflectivity inspection or measuring devices.

- Encourage development and evaluation of new retroreflective materials.

III. INFORMATION GATHERING TECHNIQUES AND DEVICES

1. Develop more uniform and consistent criteria / procedure for accident reporting.

2. Use advanced technologies to gather more comprehensive and more useful accident data.

3. Develop computerized work zone data collection devices, including hardware and software.

4. Measure accident exposure rates for work zones.

5. Provide education and training to staff/operators on how to use the advanced technologies or new devices.

IV. INSTITUTIONAL ISSUES

1. Consider life-cycle cost concept (including accident cost) in assessing the benefits or costs of using advanced technologies or new devices.

2. Need to clarify what category of funding can be used for new traffic control devices (TCDs).

3. Need more flexibility on trying new work zone TCDs.

4. Study liability issues and effect tort reform.

5. Provide information clearinghouse on the use of new TCDs.

6. Establish new category of funding for testing or development of new TCDs.

V. APPROVAL OF NEW TCD, NOVELTY EFFECTS AND UNIFORMITY ISSUES

1. Utilize available channels for testing of new devices such as NTPEP and ASCE's Hi TEC.

2. Novelty effects of new devices is a concern.

3. Uniformity of devices/procedures is a concern because travelers expect that.

4. Enforce the existing laws/regulations to increase the effectiveness of TCD.

5. Enforce existing specifications in MUTCD on setting up traffic control plans.

6. Provide adequate funding to address work zone safety.

Dr. H. Gene Hawkins, Jr.

Associate Research Engineer and Program Manager
Texas Transportation Institute / Texas A&M University System

Many of the findings from our workshops have already been described by the previous speakers.

I presided over two very interesting, but different, workshops. The discussion in the first workshop tended to be more general and covered a wide range of topics. Not only did we talk about advanced technologies, but we also discussed some low-tech applications for safety devices and retroreflectivity. The second day's workshop, on the other hand, discussed far fewer topics, but went into much more detail on those subjects. The participants in both workshops often went off on tangents which were related to our subject matter, but were outside the scope of the workshops. However, when I reviewed my notes in preparing these summary comments, I found that the recommendations from both workshops were amazingly similar.

These are the major recommendations that resulted from one or both of the workshops on Advanced Technologies:

- At the beginning of each workshop, I asked the participants to describe what they thought work zones would be like 50 years from now, in the year 2044. Their thoughts were that most of the work zones would be physically separated from the traveled way, the MUTCD would be in an electronic format contained within the vehicle, traffic in work zones would be controlled with portable traffic management systems, lighting would be better, and many aspects of the vehicle/roadway system would be automated.

- Early in the discussion, we agreed that future emphasis should be on "work zone traffic management" instead of the more traditional "work zone traffic control." We will have to learn to do a better job of managing our traffic in work zones instead of just trying to control it while it is in the work zone.

- For drivers to respond properly to work zones, they have to have confidence in the information given to them. A recurring theme of the discussions in both groups is that advanced technologies should be used to improve the timeliness and accuracy of the work zone information being presented to drivers.

- Speed control was a popular topic in both workshops. One group felt that technology should be used to reduce speed differentials in work zones by slowing down vehicles traveling at excessive speeds.

- Obviously, any discussion about advanced technology applications in transportation must be considered within the framework of Intelligent Transportation Systems. However, ITS has not really considered work zone applications as a specific element of the overall system. Both of the workshops recommended that Work Zone Traffic Management become a component of ITS. We even developed some User Services for work zones. These include:
  - Intrusion alarms
  - Crash alarms
  - Automated vehicle positioning
  - In-vehicle work zone information
  - Pre-trip work zone information
  - Vision enhancement.

- The ISTEA program should be revised to require a work zone safety management system.

- A few of the specific applications for advanced technologies include:
  - Continuous lighting
  - Complete separation of vehicles and work areas
  - Wider use of automated traffic control
  - Use of advanced technologies to ensure that traffic control devices are in place and functioning
  - Vehicle speed control technologies to reduce the speed of vehicles traveling faster than the rest of the traffic stream
  - Use of camouflage to hide work zone activities from drivers
  - Electronic drivers' licenses could be used to identify the specific individuals who are violating traffic regulations.
- Implementation of new technologies into actual practice is a difficult undertaking in the best of circumstances. Both groups indicated a need to streamline the procedures by which new technologies and/or devices are brought into practice. One of the groups indicated the need for a national system or clearinghouse to ensure uniformity of systems. Also, economic incentives are needed to encourage contractors to implement new technologies and to be accepted by agencies. The use of national demonstration projects may be useful for gaining acceptance of advanced technology applications for work zones.
- One of the groups emphasized the need to improve nighttime and wet weather visibility in work zones. Some of the suggestions included:
  - Wider edge lines
  - More lighting, including temporary high mast lighting
  - Wider use of strobes
  - Greater use of RPMs.
- The two groups had completely opposing opinions on one subject: The first day's group felt that congestion pricing may have a role in work zone management. The second day's group completely opposed the idea.
- With respect to the proposed retroreflectivity standards, the first group had a few comments. For the standards to have any real meaning, they must be something that can be implemented and measured by field personnel. Some suggested that different standards may be needed for work zone applications.
- Both of the workshops also recognized that the effectiveness of advanced technologies will be limited by the capabilities of the field personnel who will have to implement them. Therefore, proper training of field personnel is a vital element of any effort to bring advanced technologies to work zones.

As a final note, I would like to thank ARTBA and FHWA for putting on this conference. I would also like to extend my appreciation to ATSSA, AASHTO, and the other contributing organizations for their support of this conference.

I really don't believe that the comments we have heard today are anything of an earth-shattering nature. We have heard most of them before, and I think that a group of three or four individuals could have developed the same recommendations if they had been locked in a room for two and a half days. However, the value of this morning comments is that they were developed through the efforts of some 200 highly knowledgeable individuals who represent the future of this industry. The collective contributions of these individuals give the results of this conference a legitimacy or authenticity that would not be present if the recommendations were developed by a single consultant or agency.

Additional points raised in workshop discussions:

Retroreflectivity Considerations

- Definitions of both too little and too much brightness.
- Use of larger signs and/or brighter signs to improve the conspicuity of signing.
- The application of different procedures in work zones for measuring and implementing retroreflectivity standards.

Miscellaneous Ideas

- In-vehicle technologies should be developed for automated vehicle guidance, to provide advance information to stimulate driver attention, and to warn drivers of impending crashes (e.g., alarms).
- Use advanced technologies to improve the acquisition of data used for work zone traffic management.
- Develop technologies that can vary the light output of devices according to the amount of light that is appropriate for a given situation (dark night, dawn, dusk, rain, fog, snow, etc.).
- To take full advantage of emerging technologies, it will be necessary to improve processes for implementing new developments. This may be accomplished through:
  - Economic incentives to encourage contractors to adopt technologies which can improve safety.
  - Economic incentives to encourage contractors to comply with existing standards.
  - Wider use of demonstration projects to gain governmental agency acceptance of advanced technologies and assist in the implementation in areas of identified need.

OUR ROLE IN THE PROCESS/ FUTURE OF WORK ZONE SAFETY

CONCLUDING REMARKS

Dr. Nicholas J. Garber

Professor of Civil Engineering
University of Virginia

ARTBA has asked me to offer a few closing remarks in summary of this Conference. This will prove difficult, but I believe there are at least a few points that I can make here.

One of the major themes we have discussed relates to the characteristics of the people who are using the road. We need some research in this area, and some data, so we can identify the characteristics of those users, including drivers and pedestrians. Both the workers and the drivers must be educated as to the problems of work zones and how they can cooperate in realizing some of the goals we need to achieve.

Another important topic that was established here is the need for positive and negative contractor incentives that are related to performance.

Most of the groups also recommended reducing exposure of motorists to work zones.

With respect to the implementation of work zone safety, several factors were identified: enforcement of standards, developing incentives to agencies and workers, law enforcement, development of a "safety culture," and improved quality assurance.

With respect to speed, a new term, "speed management" was suggested. While we do not want to increase the number of situations in which speed must be varied, at the same time we have to be able to identify the correct speeds for work zones and the means to bring drivers to comply with the reduced speeds in those zones.

Partnering is also considered a very effective method to achieve a greater measure of work zone safety. It has been suggested that with respect to exposure and construction, the best way of paying for work zone traffic control could be a combination of both unit cost and lump sum. We should also consider specific means by which we could reduce the duration of the contractor activities and thus decrease exposure.

Another important issue relates to means of segmenting traffic in terms of speed and volume (high speed/high volume, medium speed/medium volume, low speed/low volume). This is something that can't be done right now, but it is something we should keep in mind.

With respect to advanced technologies, one important factor which has been noted is the need for real time traffic control devices. The motorist entering a work zone wants to know what's happening now, not what was happening two hours ago. So developing means to get that information to the driver is essential. In addition, there should be an effort to make data collection in work zones easier and more detailed. How those data might be collected—whether by police officers or work zone employees—and identifying what type of data are needed also are important issues.

Also it has been suggested that additional funding for congestion management and work zone safety should be strongly considered.

Finally, it was recommended that cooperative efforts among ARTBA, ATA, FHWA, AASHTO, State Departments of Transportation, NHTSA, and other associations are needed. Unilateral efforts may not be as effective as a cooperative effort. The establishment of a national clearinghouse may be one step by which we can better disseminate the information that is generated through these efforts.

Where do we go from here? It is the individual responsibility of each of us as we leave here today not to forget what we have been discussing over the last three days, but in every little way, in every action that we take, whether in designing or in supervising construction or in supervising contracts or in manufacturing, we should make the effort to achieve and implement the constructive ideas we have heard here.

Having said that, I would suggest to ARTBA and FHWA that once these proceedings are published, it would be very useful to have more regional conferences where these issues can be discussed in detail, where additional issues may be raised, where additional ideas can be addressed.

Let me take this opportunity on behalf of ARTBA, FHWA, AASHTO and ASSTA to thank you for participating in this Conference. It is fantastic, the amount of work which has been accomplished here in the past three days. I also want to thank the cooperating organizations who sponsored and put together this program. It will go a long way toward bringing us all to a better understanding of work zone safety and how it can be enhanced.

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

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.

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

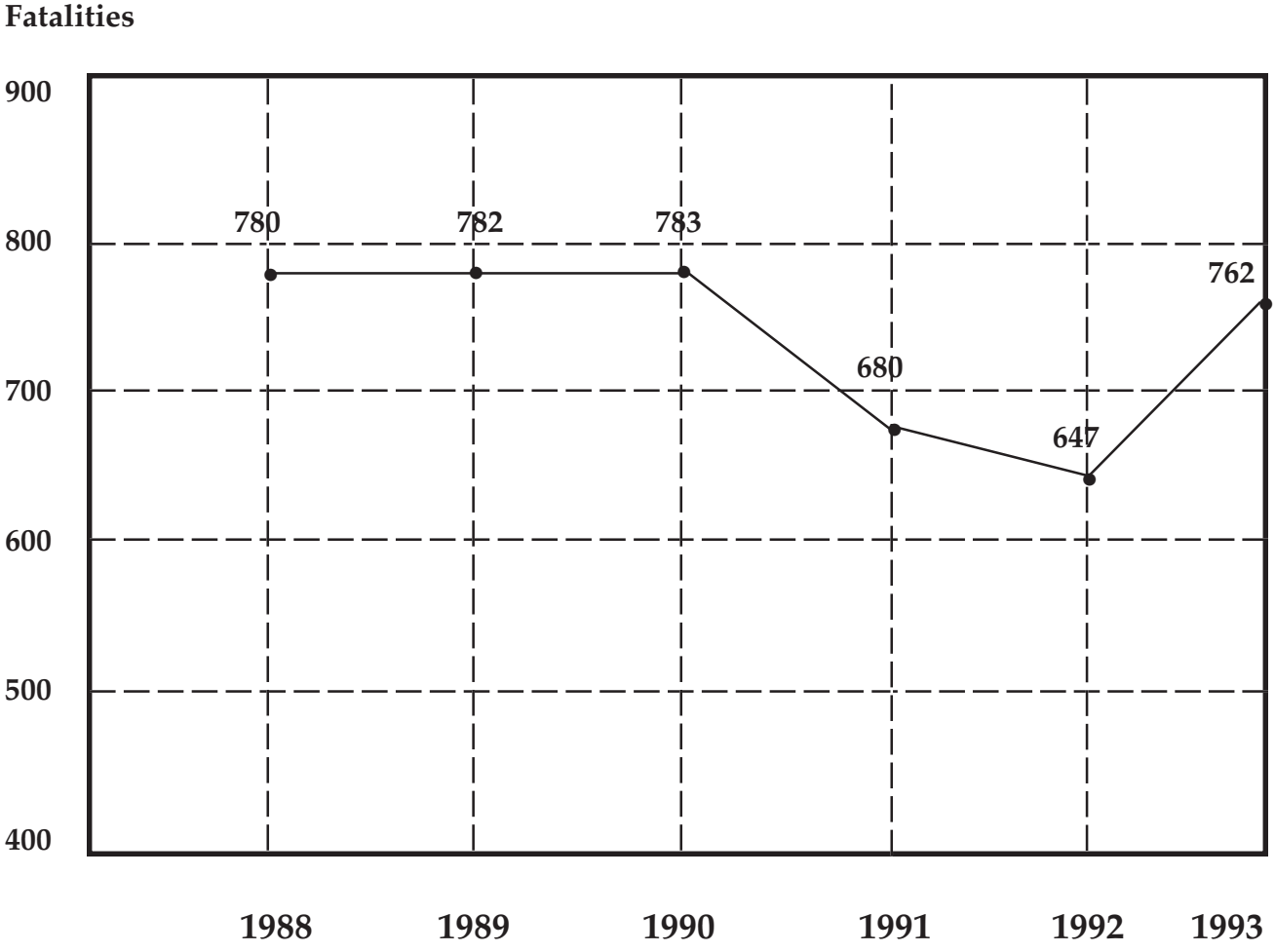

Table 1-A. Work Zone Fatalities

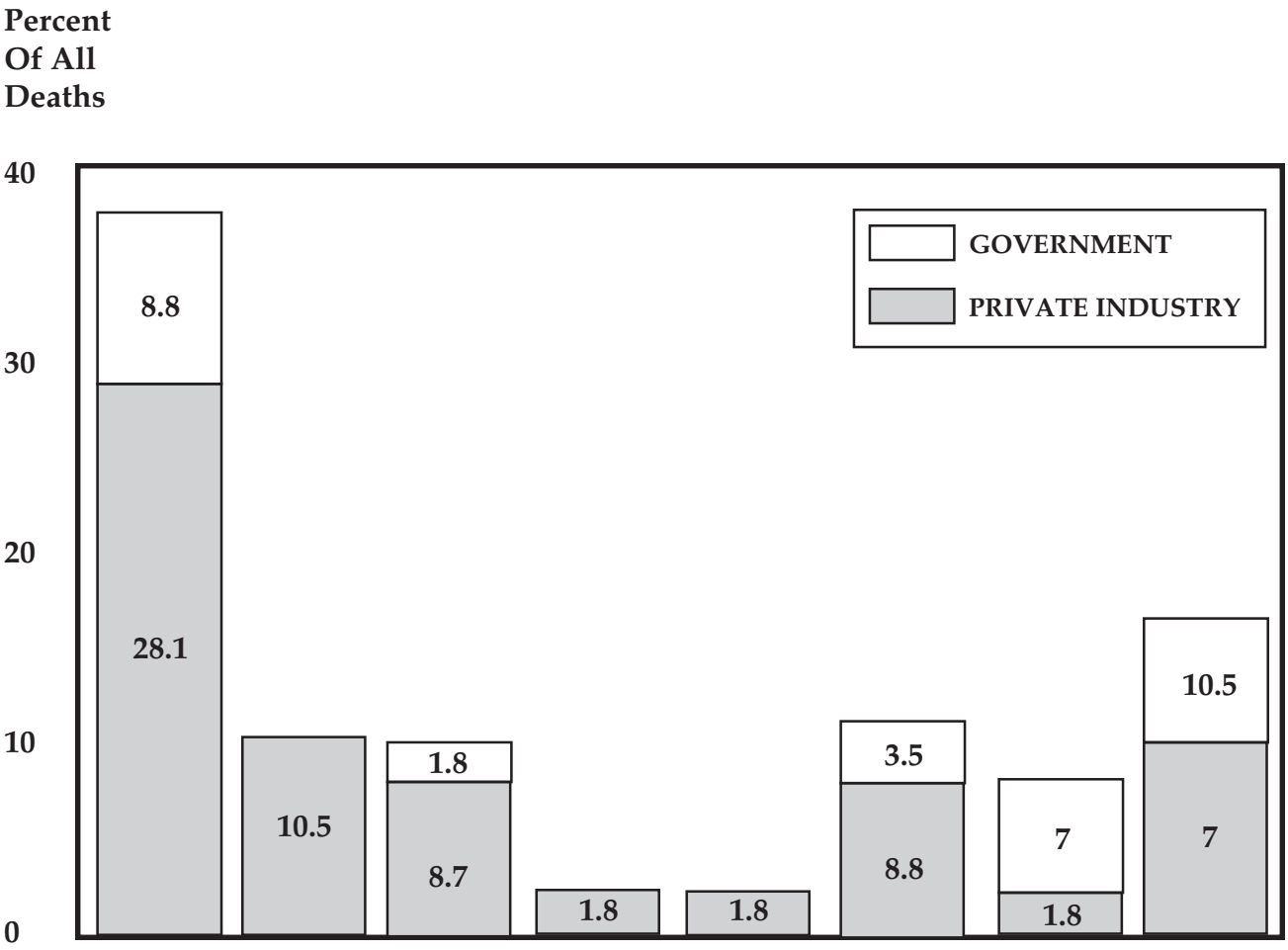

Table 2. Years With Employer

(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 safefy 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 mesage boards and truck-mounted attenuators, are compenated 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 million**[11]

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 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.

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ENDNOTES

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APPENDIX D

ACRONYMS

ACRONYMS

AASHTO	American Association of State Highway and Transportation Officials
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