NATIONAL CONFERENCE ON WORK ZONE SAFETY

December 5-7, 1994

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

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.