

**Conducting
In-service Road Safety
Operational Reviews of
Temporary Traffic Control
in Work Zones**

Monte Johnston, EIT
Transportation Safety Engineer
Hamilton-Finn Road Safety Consultants

Dr. John Morrall, P.Eng.
President
Canadian Highways Institute Ltd.

Bruce Swanson, P.Eng.
Detour Engineer
Roads, Traffic Assessment Division
The City of Calgary

Paper Prepared for Presentation at the
Work Zone Safety
Session of the 2003 Annual Conference
of the
Transportation Association of Canada
St. John's, Newfoundland and Labrador

Abstract

Work zones present unique traffic operations challenges for everyone involved, the road user, the contractor, and the owner of the road. For example, drivers expectations can easily be misled by the complexity of a temporary traffic control (TTC) set-up in a work zone. This can result in an increase in the perception reaction time of drivers to as much as 4.5 to 5.0 seconds, a significant increase from the 2.5 second perception-reaction time used in road design. This is one of the reasons that work zones can be dangerous for motorists, pedestrians, and workers. Approximately 1100 fatalities occurred in 2001 in work zones in the United States. Alberta had two fatalities and 133 injuries in work zones in 2001. This paper reviews the need for, and discusses how to conduct, in-service road safety operational reviews of temporary traffic control in work zones.

Presently there are no Canadian guidelines for determining when and how to conduct in-service road safety operational reviews of TTC in work zones. The Transportation Association of Canada (TAC) has recently released the 100% draft for the "Canadian Guide to In-service Road Safety Operational Reviews", however, TTC was not included in the scope for the development of these guidelines. Many of the techniques and methods that are outlined in the TAC guidelines are not applicable to conducting an operational review of TTC. This arises mainly from the fact that TTC set-ups are usually only in place for short periods of time. In-service road safety reviews of TTC set-ups do not often have any background collision and operational data to analyze and the actual review must be conducted very quickly. The time required to conduct a safety review on an existing road is often measured in weeks if not months, the time to conduct a safety review of a TTC set-up should be measured in days.

This paper reviews the need for a formal procedure for conducting in-service road safety operational reviews of TTC set-ups and discusses the methodology of conducting such reviews. This includes network screening / project selection, data requirements, review procedures and drafting the final report. Some of this methodology is currently being given by the Alberta Construction Safety Association in the Alberta Temporary Traffic Control short course, which outlines best practices with respect to designing, installing, maintaining and inspecting TTC set-ups. The focus of this paper is to provide information on conducting safety reviews of TTC set-ups in work zones.

1.0 Introduction

Safety audits and in-service road safety operational reviews are becoming a fundamental aspect of engineering activities with respect to new road construction and the improvement of existing road networks. The objective of a safety audit or a safety review is to reduce the likelihood and severity of potential collisions and can be a preventative and proactive approach to road safety. Safety audits and reviews are independent and take into account all of the users of the road networks; pedestrians, cyclists, motorcyclists, trucks, buses, and automobiles.

Work zones produce unique traffic operations challenges due to a number of reasons. TTC attempts to move road users through unfamiliar road conditions in close proximity to workers and equipment. The TTC set-ups for the work zones are typically in place for a short duration of time and necessitate numerous changes and alterations as the construction work progresses. Each of these challenges creates the opportunity for something to be missed or overlooked and possibly create an unsafe environment. Implementing guidelines for operational reviews of TTC in work zones would reduce the potential for risk and liability, resulting in a safer environment for both the road users and the site workers.

Work zone road safety reviews are a reasonable approach to reducing risk and limiting legal liability for work zones. Implementing a review demonstrates that reasonable care went into the design and implementation of the traffic management plan and that due diligence was practiced.

The Transportation Association of Canada (TAC) released a national guideline for conducting audits, "The Canadian Road Safety Audit Guide"(1), and has recently released the 100% draft of the guidelines for conducting operational reviews, called the "Canadian Guide to In-service Road Safety Operational Reviews" (2). However, road safety reviews of TTC in work zones is one area that is not currently covered by either of these documents. Due to the challenges involved with providing a safe and efficient environment for all users, work zone traffic control is an area that can greatly benefit from a formal and independent evaluation procedure. The importance of traffic safety in work zones is illustrated in TABLE 1, which shows the severity of collisions that have taken place in areas of roadway construction or maintenance between 1997 and 2001 in Alberta.

TABLE 1: Alberta, 1997-2001
Collisions Occurring in Areas of Roadway Construction/Maintenance*

Collision Severity	1997	1998	1999	2000	2001
Fatal	1	1	3	2	2
Injury	150	106	144	143	133
Property Damage	456	395	417	438	477
Total Collisions:	607	502	564	583	612

* Based only on cases where construction/maintenance indicated as a factor in the collision report form.

Source: Alberta Transportation, Driver Safety, Research and Traffic Safety Initiative, August 16, 2002

In the City of Calgary, a large number of work zones involve temporary traffic control set-ups each year, which are designed, installed and maintained by different organizations. The City of Calgary Traffic Assessment/Traffic Field Operations create a large number of TTC set-ups as shown in TABLE 2. A large number of TTC setups are also created by private contractors, construction companies and utility companies working under indemnity agreements or annual street use permits. For larger construction projects, where temporary traffic control is contracted out to non-City staff, the request for proposal (RFP) documents typically requires a traffic management plan. The selected design-builder would develop the traffic management plan and obtain approval from the City prior to its implementation. In the case of private contractors, construction companies, and utility companies, compliance with the City of Calgary TTC manual (7) is expected.

TABLE 2: City of Calgary, 1999-2002,
Temporary Traffic Control Set-ups

Year	Number of TTC Set-ups
1999	3800
2000	5100
2001	4600
2002	4700

The large number of TTC set-ups are being installed on an ever-expanding road network, the City has experienced a growth of 288 new lane km from 2001 to 2002. This results in an increasing demand upon City staff to monitor these traffic management plans and site set-ups. This also increases the potential for liability and demonstrates the need for a process or procedure to be in place to ensure everyone's safety and reduce the liability for the parties involved. One such process would be a formal operational review.

A literature review indicated that little has been developed in terms of guidelines for in-service reviews of temporary traffic control for work zones. The notable exceptions are New Zealand and Australia. In New Zealand a "Pilot Safety Audit of Traffic Control at Road Work Sites (3) has been conducted and 'Interim Procedures for the Safety Audit of Traffic Control at Roadwork Sites"(4). Austroads (12) in the Second Edition of the Road Safety guide noted *"road works sites typically involve a change of speed environment, additional conflicts, and confined road space, which can increase the potential for crashes. As traffic arrangements during road works can change several times and can bear no resemblance to permanent arrangements. Audits at the design stages can give little indication of the safety of temporary works."* The Austroads (12) Safety Audit guide contains a comprehensive checklist for the audit of roadwork traffic schemes. Other areas that are closely related to safety review procedures include a clear understanding of traffic flow in work zone (9) and incident management in work zones (10).

Montella and Cistola (9) developed a road safety audit procedure specifically suited for work zones. The procedure developed by Montella and Cistola is based on detailed checklists and upon risk assessment. New risk indicators that involve the prediction of the number and severity of potential collisions associated with each safety item are defined. These constitute (3) the Total Weight Score of the main safety aspects, which relates to the risk factors that may be improved by engineering measures, and the Global Safety Index, which allows for the ranking of the work zone in the road network. The proposed safety evaluation procedure is related to the safety consequences of the identified problems, rather than on non-compliance or deficiencies and may be somewhat labour intensive.

Safety audits and operational reviews differ in the stage at which they are implemented. Safety audits are implemented during various pre-operational stages of a roadway including planning, design, construction and pre-opening. In-service road safety operational reviews are conducted in a post construction environment where the roadway has been in use and there is operational data on which to base the review. In-service road safety operational reviews of TTC in work zones have similarities and differences with both safety audits and reviews. Many of the techniques and methods that are outlined in the TAC guidelines for operational reviews (2) are not applicable to reviews of TTC. This arises mainly from the fact that TTC set-ups are typically only in place for short periods of time. In-service safety reviews of TTC set-ups do not often have any background collision and operational data to analyze and the actual review must be conducted very quickly. The time required to conduct a safety review on an existing road is often measured in weeks if not months and the time required to conduct a safety audit is typically weeks. The time used to conduct a safety review for a TTC set-up should be measured in days. The TAC Audit and Operational Review guidelines do, however, provide a good basis for developing a procedure for operational safety reviews of TTC in work zones.

By conducting a number of operational reviews of temporary traffic control in work zones in the City of Calgary and by comparing current procedures for conducting safety audits and reviews, a prompt list and set of guidelines for conducting road safety operational reviews of TTC in work zones have been developed. These guidelines will fill a gap that is currently present in this area of road safety, provide a basis for further study and development in this area and can be refined, or used as is, by agencies to conduct operational reviews. This will enable them to minimize the frequency and severity of preventable collisions, maximize the safety of all road users and the construction workers, as well as limit their liability.

2.0 Methodology

An operational review of several work zones in Calgary, Alberta was undertaken to aid in the development of a set of procedures or guidelines for conducting operational road safety reviews of TTC in work zones as well as to aid in the creation of a prompt list. The sites that were chosen were sufficiently large and complex so as to warrant an audit.

The initial reviews were done in a three step process, the first step was a review of the office documentation, the second was a review of the actual field set-ups, and the final step was a review of any other pertinent information and literature related to the set-up. The gathered information was then used in conjunction with past literature and current guidelines including "The Canadian Road Safety Audit Guide"(1) and the "Canadian Guide to In-service Road Safety Operational Reviews", 100% Draft (2) to develop a set of procedures and guidelines for conducting reviews of TTC in work zones.

Once the prompt list was developed it was used to evaluate several additional TTC set-ups by an independent party. The prompt list was then re-evaluated and updated using the information that was gained in this second set of safety reviews.

3.0 Results

The procedures developed for conducting in-service road safety operational reviews of temporary traffic control in work zones has been broken down into six main areas:

- Network Screening / Project Selection;
- Data Requirements;
- The Safety Review Team;
- Conducting a Review;
- Prompt List for Temporary Traffic Control; and,
- Report Preparation and Response.

3.1 Network Screening / Project Selection

While all TTC set-ups in work zones should be under a constant informal review by the involved parties, not all TTC set-ups require a formal and independent safety review. Network screening or project selection is a process that can be used to identify TTC set-ups for an independent and formal review and provides a systematic method of identifying projects that may benefit the most. As there are always limited resources, selecting the locations that can benefit the most is important.

There are many methods that can be used to identify and evaluate potential locations. Due to the nature of the industry, detailed information about potential locations and TTC set-up requirements for projects are not typically known a long time in advance of a projects' implementation. Screening must therefore be done on an ongoing basis where projects above a certain threshold are either selected for review or are then evaluated on a comparative basis with other projects that are expected to take place in the same fiscal year. The types of criteria that can be used to set a threshold and to evaluate different projects include:

- Number of individual TTC Set-ups Involved;
- Duration of each TTC Set-up;
- Set-up Type and Complexity; and
- Roadway Environment.

Number of Individual TTC Set-ups Involved

Many of the larger construction projects that take place on the road network involve a number of different TTC set-ups during different phases of construction. There can also be a repeating set of several set-ups though out a single day or week. This may include separate set-ups for the peak hours and for times of inactivity. Many different set-ups may also be in-place simultaneously within a construction zone. The larger the number of set-ups that are to be used on a project, the higher the probability for problems. This is mainly because there are more opportunities for errors to take place but may also be due to drivers becoming accustomed to a certain TTC set-up only to have it changed.

Duration of each TTC Set-up

Various set-ups can be in place for periods of time ranging from hours to weeks or months, the longer overall time that a set-up is in place the more beneficial a review can be. TTC set-ups that are in place for short periods of time are harder to review as less time is available to conduct the review and implement improvements. Also, the review may have a less significant positive impact as there will be limited overall exposure to the set-up, before and after any improvements. It is preferable to review set-ups that are expected to be in place for a week or more, though the set-up does not necessarily have to be in-place for the entire time but can be one of a number of repeating set-ups that are active at different times.

Set-up Type and Complexity

There are many different types, and levels of complexity, of TTC set-ups. Different kinds of set-ups involve different levels of risk for road users, pedestrians and workers. The more risk involved, and the more complex the set-up, the more beneficial the review.

Roadway Environment

The roadway environment should play a role in project selection. The environment refers to factors such as the traffic volumes, pedestrian volumes, speed environment, road type, adjacent land uses and the roadway geometry and alignment. Each of these factors plays a role in determining the expected levels of exposure and the severity of potential collisions. The larger the traffic and pedestrian volumes and the higher the speed environment the higher the risk associated with the set-up. The adjacent land uses are important as they can affect the type, and layout, of the TTC set-up. For example, work zones next to schools and senior care centres or in proximity to rail crossings may require different TTC set-ups than would typically be used.

3.2 Data Requirements

Some of the data requirements of an operational safety review of a TTC set-up differ from typical operational safety reviews. The main difference lies in the fact that there is no collision history to aid in identifying potential safety issues. There are, however, still a number of other data sources that can be drawn upon, depending upon the stage the project. TTC set-ups that have been in place for a while before the review starts have data that will not be available if the review is started prior to the TTC being set-up.

The data that a work zone safety review may use includes:

- TTC designs for periods of activity for each phase of construction;
- TTC designs for periods of inactivity for each phase of construction;
- Schedule or plan for the installation and removal of the different set-ups;
- Written description of set-up and take-down for the TTC;
- Documentation of TTC design revisions;
- TTC inspection sheet;
- Photos or video of TTC set-up;
- Written description of any special requirements placed on the TTC set-up or traffic management for the work zone;
- Routing plans (Transit, School Bus, Dangerous Goods Trucks, etc.); and,
- Expected traffic volumes.

While all of these items may not be available, an attempt to retrieve them all should be made. Also, the lack of availability of some documentation can also be useful, as it can locate potentially costly gaps in the record keeping process.

3.3 Safety Review Team

The team that is conducting the safety review should be made up of at least two people, and include the skill sets necessary to ensure that the relevant safety issues and countermeasures are identified. It is also desirable to have an independent review team. The ideal skill sets to have in the review team include a road safety specialist, a temporary traffic control design specialist and a traffic operations specialist. Additional skill sets that would add value to the review team include road design, human factors, enforcement and intelligent transportation systems (ITS) specialist skills to name a few. Also, at least one member of the review team should be experienced in conducting operational safety reviews and safety audits.

3.4 Conducting a Review

The safety review process, discussed below, covers:

- Analyzing TTC Data;
- Analyzing Field Set-ups;
- Countermeasure Selection; and,
- Summary of Common Sources of Safety Issues and Related Countermeasures.

3.4.1 TTC Safety Review Process

The process for conducting an in-service road safety operational review of TTC in a work zone is shown in FIGURE 1. The first task is to select a project or work zone to review. The scope of the review should also be defined at this point. Next is the start-up meeting and the stakeholder consultation. This meeting allows the review team to meet and discuss the safety review with all of the stakeholders and to gather their input. This is followed by the start of the analytical work, which can be an ongoing process depending on the review. For projects that involve many different TTC set-ups that are implemented on an ongoing basis the review team must go through the analysis and report creation process many times, presenting the stakeholders with the results on an ongoing basis. This is done so that improvements can be implemented as soon as possible. This process is shown on FIGURE 1 by the horizontal arrow. Once the review of each of the set-ups has been completed a final report is created for the stakeholders. This should be followed by an evaluation of the level of success of the review. It is also important that a formal response to each of the reports be written to that legal liability is minimized.

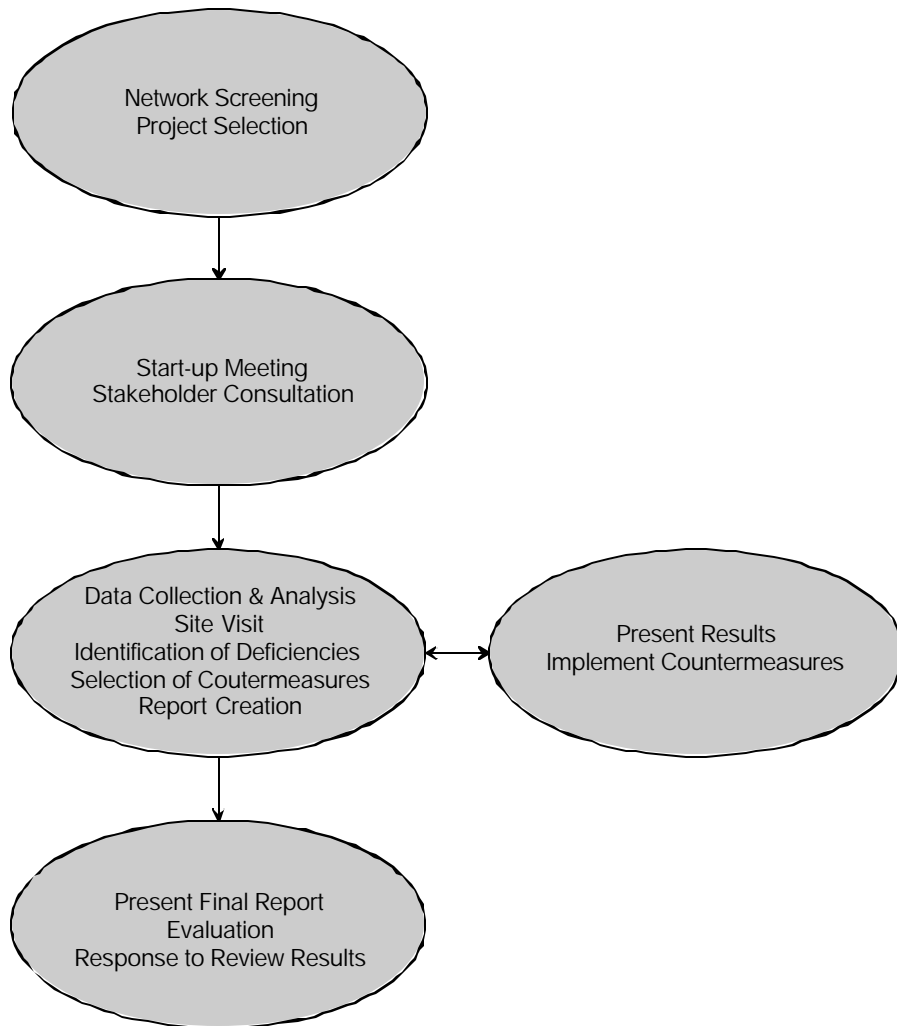


FIGURE 1 TEMPORARY TRAFFIC CONTROL SAFETY REVIEW PROCESS

3.4.2 Analyzing the TTC Data

All of the data that is provided should first be reviewed in detail to ensure that it is complete, up to date and accurate. This documentation should include the TTC set-up designs for each set-up, written documentation of any revisions made to the designs, a record of the inspections that have taken place including any video or photographs that were taken (if the set-up is in place), a written description of the set-up and takedown plans, traffic volumes, routing plans and any other information that is relevant to the set-up. Any missing documentation could create problems in the field and leave the road authority open to liability and so should be identified.

The designs should be examined to determine whether they have been prepared in accordance to the applicable guidelines or design standards and to determine whether there are any safety issues with the design of the set-ups. This should be done keeping all of the various road users, construction equipment and personnel and the road environment in mind.

A summary of what to look for when analyzing the TTC data is provided in the prompt list, located in Section 3.5.

3.4.3 Analyzing the TTC Field Set-ups

A field inspection should be conducted for each of the TTC set-ups during any different lighting and traffic conditions that it may be exposed to throughout the day. It is also important to keep the users of the TTC set-up in mind while conducting the review, these users may include workers, pedestrians, cyclists as well as various types of vehicles and equipment. Also, TTC plans do not always contain all the necessary information on roadside obstacles and vertical alignment, which can cause problems with the set-up.

The field TTC set-ups should be examined in detail to determine if the plans had been followed. The geometric design, traffic control signs, channelization devices, pavement markings, human factors, and environmental factors should also all be checked. The detour geometric design, design speeds, signal timing, lane designation, taper lengths, and lateral shy distances should be analyzed and recorded on sketches where necessary. The set-up should also be checked to determine whether any signs and other devices were left up from previous set-ups, are stored in view of motorists, or are confusing to the driver in any other way.

Pavement markings are checked to see if the old markings had been properly obliterated and that the new markings were readily visible, in good condition, and that they followed accepted guidelines. Human factors aspects should also be reviewed including driver expectancy, driver workload, and positive guidance through the work zone. Environmental factors may impact the TTC set-up's ability to function as so should be checked during different lighting conditions (night and day), adverse weather conditions, headlight glare, and worksite illumination.

Analysis of the field set-ups provides a good overall picture of the level of safety provided by the TTC set-up. A summary of what to look for in when analyzing the TTC set-up is provided in the prompt list, located in Section 3.5.

3.4.4 Developing Countermeasures

Possible improvements or countermeasures should be recommended for each of the safety issues that are identified for each of the TTC set-ups. The majority of the time these countermeasures can be broken down into two main groups:

- Immediate or Short-Term Improvements; and,
- Long-Term Improvements Strategies.

Immediate or Short-Term Improvements

The vast majority of the improvements typically identified by an operational safety review of TTC in work zones are immediate or short-term improvements. These improvements may be due to small errors or oversights in the design, implementation or maintenance of the TTC set-up or the result of specific operational characteristics. This type of improvement can typically be implemented very quickly and may involve small changes to the set-up such as adding or removing signs and channelization devices or additional enforcement activities. The additional enforcement activities are typically focused on an identified issue or specific location within the TTC set-up. The changes to the TTC set-up are typically small and do not impose significant costs as they can usually be carried out during typical TTC maintenance activities.

Long-Term Improvements Strategies

Some of the improvements that are identified in an operational safety review may fall into the long-term improvements strategies category. These improvements can include items that will effect future TTC set-ups as well as the reviewed set-up, however, they are often more costly to implement. Examples of long-term improvement strategies include: upgrades to documentation procedures and information sign sequencing, changes in equipment types and usage, educational programs for both drivers and workers and enforcement and advertisement strategies.

3.4.5 Common Sources of Safety Issues and Related Countermeasures

Many common sources of safety issues were identified in the operational safety reviews that were conducted on TTC set-ups in the City of Calgary. These common sources of safety issues are listed in TABLE 3 along with possible countermeasures.

TABLE 3 COMMON SOURCES OF SAFETY ISSUES AND RELATED COUNTERMEASURES

Common Sources of Safety Issues	Countermeasures
Non-Compliance to Plans	Ensure Compliance to Plans
Poorly Documented Records	Ensure Good Record Keeping
Plan Revisions not Documented	Ensure all Plan Revisions are Signed-off
Lack of Pedestrian/Bike Control	Provide Good Pedestrian/Bike Control
Poor Guidance Through TTC	Provide Positive Guidance Through TTC
Construction Zone Limits Not Marked	Clearly Mark the Limits for the Construction Zone
Work Site Not Secure During Operation	Secure the Work Site During Periods Operation
Work Site Not Secure During Periods of Inactivity	Secure the Work Site During Periods of Inactivity
Improper, Unclear, or Lack of Pavement Markings	Provide Clear and Proper Pavement Markings
Poor Barricade End Treatment	Provide Good Barricade End Treatment
Poor Visibility of TTC and Work Zone at Night	Ensure TTC is Visible at Night
Speed not Gazetted	Gazette Speed
Information Signs Contain Too Much Information	Sequence Information Signs so they are Readable
Non-standard Signs Used	Use Standard Signs
Poor Worker Visibility & Proper PPE*	Ensure Good Worker Visibility & Proper use of PPE*
Unmarked Hazards or Obstructions	Ensure that all Hazards or Obstructions are Marked
Poor Treatment of Excavations	Provide Good Treatment of Excavations
Improper Speed Reduction	Provide Proper Speed Reductions
Missing or Knocked Down TTC Devices	More Frequent Site Inspections
Conflicting Traffic Signal Operations	Ensure Compliance between Signal and TTC Set-up

* Personal Protective Equipment.

3.5 Prompt List for Temporary Traffic Control

In keeping with the philosophy of the Canadian Road Safety Audit Guide (1), a prompt list and not a detailed checklist has been developed. The prompt list is based on the premise that the safety audit team must consist of experienced individuals who are experts in their field, and who are trained and experienced in conducting audits. As noted in the Canadian Road Safety Audit Guide (1) experienced auditors find voluminous checklists to be redundant and there is a danger that a detailed checklist may be delegated to junior staff who may simply “*check-off the multitude of items on the checklist without a proper assessment of safety risks that can only come with experience.*” As noted previously, the audit process should be undertaken by an audit team consisting of a minimum of two experienced people.

1. Review of Office Documentation

- a. TTC plan prepared according to required Provincial, Municipal or Federal Guidelines (including TAC MUTCD Section D-Temporary)
- b. Written description of set-up and take-down
- c. TTC revisions on paper and signed-off
- d. TTC inspection sheet
- e. TTC record keeping
- f. Photos or video of TTC set-up

2. Geometric Design

- a. Review of all detour geometric elements
- b. Design speed consistent with upstream driver expectations
- c. Taper lengths according to design speed
- d. Lateral buffer zone between travel lane and work zone

3. Traffic Control Signs

- a. Sign type / Set-up type
- b. Sign location/spacing consistent with driver expectations and according to
 - Advance warning area
 - Approach area
 - Transition area
 - Activity area (buffer space and work space)
 - Termination area
- c. Sign conditions
- d. Retro-reflective properties
- e. Existing signs covered and signal timing revised (if needed)
- f. Proper ballasting

4. Channelization-Devices (or delineation devices)

Condition, placement, type and size of the following devices

- Cones
- Drums
- Barricades
- Flashers
- Candlesticks/tubes

5. Other Devices

- a. Traffic Signals
- b. Arrow Boards
- c. Variable message boards
- d. Impact attenuators

6. Compare Plan with Field In-Place Set-Up

- a. Similar
- b. If not- were changes acceptable, documented and signed-off?

7. Work Site Secured

During operation

- a. Separation of pedestrians/bicycles from vehicles and work areas
- b. All zones set up according to plan
 - Advance warning area
 - Approach area
 - Transition area
 - Buffer space (empty or truck with TMA)
 - Work space
 - Termination area
- c. Excavations properly protected

During Periods of Inactivity

- a. Signs covered as required
- b. Excavations properly protected
- c. Provisions for night

During Transition between TTC Signage and Permanent Signage

- a. TTC signs covered/removed as required during period of transition to avoid having conflicting messages.
- b. All other TTC devices to be removed in a timely fashion
- c. Redundant pavement markings obliterated

8. Pavement Markings

- a. Obliteration of old markings
- b. Condition of TTC markings
- c. Positive guidance provided

9. Flagging

- a. Flaggers trained
- b. Properly attired
- c. Proper equipment
- d. Following accepted procedures

10. Human Factors

- a. Driver expectancy (violated?)
- b. Driver workload (too many signs?)
- c. Positive guidance through TTC set-up

11. Environmental Factors

- a. TTC functions day and night and in inclement weather conditions
- b. Headlight glare. Check detour sections with narrow median. Is there a need for glare screens
- c. Work site illumination. Does it dazzle the driver
- d. Visibility during sunset and sunrise periods

3.6 Report Preparation and Response

There are two types of reports that should be utilized by the review team when conducting safety reviews of TTC set-ups:

- Individual TTC Set-up Reports; and,
- Final Safety Review Report.

The owner and the TTC contractor should draft a formal response to each of the submitted reports.

Individual TTC Set-up Reports

The individual TTC set-up reports should be provided on an ongoing basis as each of the individual TTC set-ups for a project are reviewed. The report should be in the form of a memo and briefly outline the safety issues for an individual, or sequence of TTC set-ups and outline the short-term improvements. This report should be given to the key stakeholders within days of the review of the individual TTC set-up. This will allow the improvements to be implemented in a timely fashion, increasing the potential benefits.

Final Safety Review Report

The second report is the final report that is given to the stakeholders when the reviews of all the individual TTC set-ups have been completed. This report summarizes the information provided in each of the individual TTC set-up reports and provides additional information on any long-term improvement strategies and education and enforcement improvement strategies. As the TTC set-ups have been completed prior the final report, it is not under the same tight time restrictions. Before the final report is provided to the key stakeholders, it is a good practice to provide them with a draft report to review and comment on.

Response Reports

The response report outlines the actions that will be taken in response to each safety concern that is identified by the review team. These reports are critical to minimize legal liability and should be prepared jointly by the project owner and the party responsible for the TTC design and set-up. The response report can be in the form of a letter or memo and should briefly identify how each safety concern in the report is to be addressed. It is not necessary that every safety concern be addressed in the manner suggested in the review team's report, only that a valid reason is provided for the action that was taken.

It is recommended that a brief response for each of the individual TTC set-up reports be prepared within days of receiving the report. A response to the final safety review report should also be drafted. The final response report should summarize the all the preceding response documents and address any additional safety concerns. It is desirable to have the final response completed within a few weeks of receiving the final report.

4.0 Conclusions and Recommendations

An in-service operational review procedure should significantly reduce the number of unsafe situations that are presently occurring in the work zones, as well as reduce the level of liability currently experienced by the involved parties. It does this by providing a formal means of evaluating the safety of the work zones. This brings attention to unsafe situations, and allows for these situations to be corrected in a timely manner. Liability would be reduced as the operational review would show due diligence and ensure that safety considerations were forefront. The importance of in-service road safety reviews of temporary traffic control in Alberta is underscored by the fact that it has been introduced to the Alberta Temporary Traffic Control course. This course (5) is provided by the Alberta Construction Safety Association and available to all public and private groups involved with road building and maintenance throughout Alberta.

Bibliography

- 1) Transportation Association of Canada. The Canadian Road Safety Audit Guide. 2001
- 2) Transportation Association of Canada (100% Draft). The Canadian Guide to In-service Road Safety Operational Reviews. April 2003.
- 3) Transfund New Zealand (1998). Pilot Safety Audit of Traffic Control at Road Work Sites: Summary Report. Retrieved March 28, 2002, from World Wide Web: <http://www.roadwaysafetyaudits.org/library/item67.html>
- 4) Transfund New Zealand. Interim Procedures for the Safety Audit of Traffic Control at Roadwork Sites. Report No. RA98/6895. 1999.
- 5) Alberta Construction Safety Association. Alberta Temporary Traffic Control. 2000.
- 6) Transportation Association of Canada. Manual of Uniform Traffic Control Devices for Canada, 4th Edition. 1998.
- 7) City of Calgary, Roads. Temporary Traffic Control Manual. 2003.
- 8) Alberta Construction Safety Association. Flagperson Training Workbook. 1996.
- 9) Montella, Alfonso and Civtola, Giacomo, "Road Safety Audit at Workzones" Transportation Research Board, Washington, D.C., 2002.
- 10) Pesili, G., Jensen, D.R., Byod, P.S., and McCoy, P.T. "Traffic Flow Characteristics of the Late Merge Work Zone Control Strategy" Transportation Research Board, Washington, D.C., 1999.
- 11) Charles, P. and Higgins, R. "Successful Incident Management on a Major Reconstruction Project" Transportation Research Board, Washington, D.C., 2002.
- 12) Austroads. Road Safety Audit, Second Edition. Sydney, Australia. 2002.