



## ***Safety and Security Consulting Services, Inc.***

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***3257 Elcano Lane  
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June 1, 2010

Shelly Lomax  
Executive Director, Operations  
TriMet  
4012 SE 17<sup>th</sup> Avenue  
Portland, OR. 97203

Ms. Lomax:

As requested by TriMet, K & J Safety and Security Consulting Services, Inc. (K & J) was asked to review, analyze and provide a system safety review and evaluation of TriMet policies, procedures and training.

To perform this task, K & J surveyed numerous transit systems throughout the United States and reviewed extensive information developed by the Transit Cooperative Research Program (TCRP), Federal Highway Administration (FHWA), Federal Transit Administration (FTA), Federal Railroad Administration (FRA), Transportation Research Board (TRB), National Safety Council (NSC), Transportation Safety Institute (TSI) and the American Public Transportation Association (APTA).

In performing this analysis, K & J found that TriMet has numerous “better than industry standard” programs currently in place and that TriMet is fully committed and actively involved in the practice and disciplines which characterize a strong system safety program and process. This commitment is characterized by the following proactive actions taken by TriMet immediately after the April 24, 2010 incident:

1. Revised its SOP on courtesy stops to prohibit making a courtesy stop in the same block as a left turn, in areas without standard block lengths and when there is less than 100 feet per lane change necessary to make a turn. This modification is being applied system wide.
2. Closed a bus stop and rerouted a bus line in order to allow greater distance between the stop and the upcoming left-hand turn located at 4<sup>th</sup> and Hall.
3. Restriped a lane of traffic to allow buses to turn left at the signalized intersection into the far right lane rather than using a slip lane and shifting to the right over multiple lanes in order to serve a stop located on SE Grand.

4. Closed a stop on SE Martin Luther King, Jr. Blvd and SE Mill St. that was within 100 feet of a long-term construction closure that required multiple lane changes in a short distance.

5. Closed a bus stop on Line 72 at N Lagoon Ave and N Anchor Street that was within 100 feet of a left turn requiring multiple lane changes before the turn.

Though TriMet has a strong and viable system safety program, K & J has identified several areas that improvements can be realized, including comments on improving security terminology. These improvements are detailed in the attached report which is provided for your review.

Sincerely,

*James Tucci*

James Tucci, P.E., CSP, WSO-CSSD  
President/Chief Engineer  
K & J Safety and Security Consulting Services, Inc.

# **Tri-County Metropolitan Transportation District of Oregon (TriMet)**

## **Portland, Oregon**

### **Technical Memorandum**

### **System Safety Review and Evaluation of Policies, Procedures and Training**

**June 1, 2010**

**K & J Safety and Security Consulting Services, Inc.  
3257 Elcano Lane  
Cantonment, Florida 32533**

## **INTRODUCTION**

At the request of TriMet, K & J Safety and Security Consulting Services, Inc. (K & J) undertook to conduct a safety review of current TriMet documents and programs. This request was made in the wake of TriMet concerns over bus safety following a fatal accident at NW Broadway and NW Glisan St.

The documents reviewed for this project included:

- Rail Operating Rules
- Rail Standard Operating Procedures (SOPs)
- Rail Training Curriculum for Certification of Train Operators
- Bus Operator Standard Operating Procedures (SOPs)
- Bus Operator Training
- Bus Stops Guidelines

In addition, in order to assure that the documents referred to above were in conformance with TriMet's primary guidance document in safety, the System Safety Program Plan (SSPP), K & J also reviewed that document as part of this project.

Overall, the K & J team found that TriMet has many safe and secure operating practices and procedures. In addition, TriMet has made safety and security improvements in recent years that have enhanced its overall service quality and safety. K & J commends TriMet on its overall commitment to the safety, security and high service standards for both its bus and rail operations.

K & J found that, in some areas, there are opportunities for improvement in safety and security. These recommendations are focused on overall adherence to the principles of system safety and security as practiced and espoused by practitioners in the industry, the National Transportation Safety Board (NTSB), the Federal Transit Administration's (FTA) Transportation Safety Institute (TSI), the Federal Railroad Administration (FRA), the National Safety Council (NSC) and the Transportation Security Administration (TSA).

## **RAIL OPERATION RULE BOOK (RORB)**

The Rail Operation Rule Book (May 26, 2010) reviewed by K & J combines the TriMet rail operating rules with many of the procedures used to implement these rules. The RORB reflects many of the effective safety rules and practice in place currently at TriMet.

It is worthy of note that TriMet has developed the RORB to fit its operations. Like all documents, it grows and changes with the system. It differs from more traditional rule book and procedure documentation in that, especially for FRA-governed rail systems, rule books and procedures are separate documents. This is not to say the TriMet documentation is not safe, effective or efficient; it is simply not traditional.

Our findings for this document are as follows:

1. There is no indication as to how changes and updates to rule books are issued to employees. While TriMet has a process to do so, a written procedure should be in place in order to verify that all transportation employees who are required to have a rule book to acknowledge receipt of individually issued changes and updates to the rules and the procedures that affect the operations of the system.
2. The current organization of the RORB does not allow for easy grouping of some rules and procedures. Some headings are very similar, such as “General Rules” and General Train Operating Rules.” It is recommended that TriMet use more specific or descriptive headings to facilitate categorization of rules with similar or related topics so that employees may more easily find rules and procedures. Other examples are:
  - a. The discussion pertaining to train orders, verbal orders, and special instructions priority is confusing. TriMet should ensure that this is clarified.
  - b. Worker Protection on the Right of Way is located in two separate locations within the book.
  - c. Consolidate the designated employee/lookout/flagger/watchperson functions, and clarify the difference between ROW work and work on or near tracks, if there is a difference.
  - d. Add a section discussing the Overhead Catenary System (OCS) hazard.
  - e. There is no mention of Manual Block operation in the RORB other than a definition. There is an applicable SOP but it is not an item in the book.

## **RAIL STANDARD OPERATING PROCEDURES**

TriMet submitted twenty-five Standard Operating Procedures covering a range of topics. As indicated in other documents submitted and reviewed, the TriMet system is a combination of several operating rail systems that often overlap or operate parallel to each other, which increases the complexity of the total operating environment. The Standard Operating Procedures reviewed are a reflection of this complexity, addressing non-routine situations deserving special attention or additional instruction. TriMet has done a commendable job with regard to detail and situational awareness.

Our findings for the Rail SOPs are:

1. TriMet should look for opportunities to consolidate instructions, precautions or tasks that are common throughout the system. There are a number of reasons why this practice is recommended, including clarity, improvements in understanding, ease of instruction and qualification, and efficiency of the review and update process, among others.

## **RAIL OPERATOR TRAINING/CERTIFICATION**

Overall, TriMet's training and certification program for rail operators is excellent and is considered an industry bench mark by the reviewer. The certification process was arranged in a logical and chronological progression, built on existing skill accomplishments and demonstrated knowledge of the student. Classroom instruction is reinforced with hands-on training and field observation.

The training instruction incorporates generally accepted practices in rail operations. Instructions were clear and concise and digital illustrations were pertinent, illustrative and high-quality.

TriMet also achieved training quality assurance in the program through the use of testing, quizzes and homework assignments. Tests and quizzes were straightforward, covered the material adequately and clearly and effectively measured students' understanding. The use of checklists and student signatures is a good practice as well.

## **BUS OPERATOR STANDARD OPERATING PROCEDURES**

TriMet's Bus Operator Standard Operating Procedures (May 10, 2010 version) combine the bus operating rules and procedures into one document. This practice is reasonable and provides a single-source document for operators to access. Like rail operators, bus operators should carry their rules and procedures with them while on duty, and a portable (smaller or pocket-size) version should be made available so that operators can carry it with them for reference.

Our findings in this area are:

Overall, there are a number of areas in which the term "train" is used, such as in the Vehicle Communications Handset (VCH) instruction. The use of this term should be clear in its reference to a "training" activity and distinguishable from any reference to a vehicle (train). This should be evaluated for all TriMet Bus SOP's.

1. In SOP B101, the SOP provides for notices, memos and announcements regarding permanent or temporary changes, but does not explain the procedures by which these changes are distributed to all operators nor how their receipt and understanding by operators are verified. This is a crucial step to assure that any rules or procedures not listed in the book or covered in training is properly implemented by all operators. For example, if a reroute is in place for safety reasons, it is prudent to ensure through a verification process that all operators on that route know of the reroute.
2. SOP B101: In the "Expectations of Every Operator" section, several changes are recommended for clarification:

- a. There should be an exception to refusing an assignment or order when the operator can provide reasonable cause that doing so is unsafe. An SOP to provide “each employee the absolute right to challenge in good faith” such as the procedure provided for in the FRA Roadway Worker Protections (RWP) is recommended.
  - b. The list of expectations contains a prohibition against committing theft while on duty. It is recommended that TriMet expect that no crime of any nature be committed while on duty.
  - c. The list also contains the following: “Be convicted of a criminal act while on duty, in TriMet uniform, or on District property.” While the intent of this phrase is understood to mean that an operator shall not commit a crime of which he or she is convicted while on duty, while in uniform, or while on District property, the meaning is not clear from the proscription. It is recommended that the proscription read, “Commit any criminal act while on duty, in TriMet uniform or on District property. If any employee is convicted of such a crime, disciplinary action will be taken,” or wording to this effect. See (b).
  - d. Another proscription reads, “Take friends, family members, or animals on board your bus during your run for any non-transportation-related purpose.” It is clear from the Bus Operator Training Course that service animals are indeed allowed aboard vehicles. It is recommended that this proscription read, “Take friends, family members, or any animals on board your bus while in revenue service for any non-transportation related purpose.
3. SOP B104: in #6, operators are required to report any conviction of DUI to the station management; however, there is no time frame for doing so. It is recommended that the notification take place within 24 hours. In #8, there is a requirement that operators who have not operated in service for 30 days or more for any reason other than vacation must complete refresher training. While this is very proactive, and we commend TriMet’s policy in this area, the rule should include operators off for vacation. 30 days is 30 days, no matter the reason for missing the 30 days, and refresher training is warranted after 30 days.
  4. SOP B106: The Uniform Exemption should stipulate that it will only be granted if the exemption does not interfere with safe operation of the vehicle.
  5. SOP B201 & 202: The operator inspections should also include security sweeps.
  6. SOP B204: It is recommended that security procedures should be added to yard operating procedures. These include being aware of persons entering and exiting, challenges, suspicious packages and objects, etc. In addition, it is recommended that TriMet require the use of a spotter or guide for all reverse operations. It is understood that sometimes there will be limited or no availability

of personnel to act as a spotter or guide, but reverse movements offer little to no visibility and a high risk of collision. There is little risk to requiring a spotter or guide but a very significant risk to allow operators to make reverse moves at their discretion without one.

7. SOP B301: Under “General Communications Expectations,” the operator is, under #3, required to “confirm the receipt of instructions and information from Dispatch.” The safest practice is not to simply confirm, but to repeat any special instruction or information from the dispatcher (readback) and have the dispatcher confirm the instruction (hearback). This is the required practice in aviation and railroad, and is considered a best practice for transit. It is recommended that TriMet put such a requirement in place to ensure safety and security of patrons and employees.
8. SOP B801: Indicates that no audio or video device of any kind shall be used or visible while an operator is in the driver’s seat. It is recommended that TriMet institute a prohibition on the open possession, use or attention to any personal electronic device while operating any District vehicle (including motor vehicles) or on the wayside or in the yards, to include cell phones, iPods or other mp3 players, GPS devices, radios, portable DVD players, televisions, Blackberries or PDAs. The devices may be turned off and stowed in personal belongings (backpack, bag or briefcase) while on duty, but may not be carried on one’s person. Exceptions include District-approved electronic equipment required for performance of official duties, including electronic gauges, communications devices (such as the BDS) and other equipment. However, it should be stressed that NO device should be used while operating a motor vehicle, whether approved for work use or not. As far as trains are concerned, it is as hazardous for rail operators in street running mode to engage in “distracted driving” practices as it is for those who operate motor vehicles. This has been borne out by studies conducted by NHTSA, and the NTSB and the transportation industry have adopted strict standards for distracted driving prohibitions for street running trolleys, including systems in Charlotte and Tampa.
9. SOP B803: indicates that operators should not drive through water deep enough to reach the bottom of the front stairwell. This is not a safe instruction. Without the ability to see through standing water covering the roadway, it would not be possible for the operator to determine its depth. Most water on the roadway is opaque due to oil, dirt and other contamination. Rather, it is never recommended to drive through standing water if it completely covers the roadway (no road surface is visible from shoulder to shoulder for any portion of the road). Besides the risk of driving into water deep enough to strand the bus and require evacuation of passengers, the risk of contamination of brakes and other components and subsequent failure renders such an action patently unsafe. In addition, if the water is rising, which cannot necessarily be determined while operating a vehicle due to limited sight distance and time, the bus can be inundated. It is recommended that operators never operate through standing water covering the roadway.

10. SOP B804: For safety reasons, it is important to emphasize in the SOP (as is done in the training program) that operators observe the passengers after they have boarded to ensure that they are safely seated and situated in such a manner that they are prepared for bus movement.
11. SOP B901 includes security procedures for operators. As recommended above, it is better to integrate the security procedures into the appropriate activities, rules and procedures rather than have them be separate. It should be second nature to ensure security as well as safety for all operators as they perform their regular duties. This is an industry best practice. There are many incidences where safety and security procedures have to be integrated for practical reasons as well as for safety and security reasons. For example, operator's uniforms provide functionality and protection in the arenas of operations (defining the person as an operator and providing practical equipment to complete the job), safety (ensuring that clothing does not interfere with operation of the vehicle) and security (ensuring that no one may impersonate an operator to inflict intentional harm).
12. SOP B903: It is recommended that TriMet clearly define accident and incident in this procedure. The industry standard for a bus is anytime there is a defect in the normal relationship of the tire to a paved or otherwise approved roadway or operating surface, including collisions with a fixed object, motor vehicle or person. This ensures that operators know and understand that, for example, an incident like the rubbing the sidewall of a tire on a curb is reportable. This type of incident causes a high-dollar loss to the agency as sidewall defects cannot be repaired as can tread defects; rather, the whole tire has to be replaced. Operators should not be operating with the sidewall in contact with anything, as it causes damage to the vehicle, as well as indicating unsafe, imprecise and careless handling of the vehicle. TriMet is advised to include as many examples in training classes like the sidewall example listed above as it feels illustrates the many ways that incidents resulting from poor operation of a vehicle are reportable, including right-hand mirror strikes, mirror scrapes and "readjustments" while in operation, tapping bumpers, maintenance test-drive incidents, etc.
13. SOP B903: On the top of page 2 of this procedure, the operator is instructed to notify dispatch when able to continue service; however, after an accident, the operator should not be making the determination as to whether he or she is ready for service. The procedure should include the process by which a supervisor, manager or other authority makes the determination that the operator may continue. This is also true of B904 (emergency response).
14. SOP B909: It is always better to define for operators what situations constitute an event severe enough to require evacuation rather than leaving it up to the discretion of the operator. Not every operator would consider, say, a knife fight between two patrons, as a situation where he or she should evacuate other patrons. Better to err on the side of over-explaining rather than take the chance that anyone is needlessly injured. It is also important to instruct the operators in

accountability; that is, insofar as they are able, when they evacuate a bus, they should try to ensure that all passengers who got off the bus move to an area of safety. They cannot control others, but should attempt to inform and guide passengers in the best way possible to ensure their safety and security.

## **BUS OPERATOR TRAINING**

K & J found the bus operator training program to be superior in many ways. It integrated an excellent classroom and road training program with good hands-on and situational-response training. The program provides for evaluation of students and trainers.

Our findings in this area are as follows:

1. Of concern is the fact that, while rail operators receive annual recertification, bus operators do not. Industry best practices dictate that bus operators be recertified in rules & procedures and emergency operations, if not annually, then at least biennially.

Though TriMet does not have a formal recertification program for bus operators, they do have an annual re-training program which is above standard industry practice.

2. The security training indicated in the Operator Training manual should be reviewed and updated. One example of training that needs to be revised is in the "Key Actions Guide for a Potential Explosive Device" of the Radio, Emergency and Accident Handling portion of the student program. Section 2.0 says, "Can you handle the situation yourself?" and the response is "Yes, if the situation can be resolved with customer service skills or polite directives." This is not a reasonable expectation for an operator to approach a person suspected of having a potential explosive device and should be changed. It is recommended that TriMet police assist with providing guidelines for operators to deal with potentially life-threatening security situations, and that all TriMet security training be evaluated and revised as appropriate.
3. There did not appear to be specific training on the use of the silent alarm; specific instructions on the type of situations where its use would be appropriate and indicated should be part of the emergency operations training.
4. The section on Over The Counter (OTC) drugs does not provide a list of available OTC drugs that may potentially cause impairment. It is recommended that TriMet provide such a list, so that operators may understand what preparations may be cause for concern. The list does not have to have every OTC medication on the market, but should list general items. The following is an example:

- Antihistamines (Benadryl, Chlor-Timetron, Tavist): These medications usually cause drowsiness. You must not use these preparations before or during work duty.
- Ibuprofen (Motrin, Advil): This is generally safe to use while operating vehicles. However, if you feel drowsy after using ibuprofen, do not use it on duty.

## **BUS STOPS GUIDELINES**

Overall, TriMet's Bus Stop Guidelines (2002) are well-considered, provide excellent guidance for the placement of safe and customer-oriented stops and maintenance of those stops, and indicate a high degree of interdepartmental and interagency coordination, which is crucial for ensuring that safety is an integral part of the planning process. Of particular interest to TriMet may be the TCRP Report 19, "Guidelines for the Location and Design of Bus Stops."

Our findings in this area are:

1. The guidelines manual we reviewed had a date of 2002. It is recommended that the guidelines be reviewed on a regular schedule of every two years. This review will ensure that any changes at TriMet, including stop, ridership and route data, local or state statutes or guidelines, changes in technology and other pertinent modifications are reflected in the guide. Even if no changes are made, the guide's date should be updated to reflect the most recent review.
2. The guidelines do not accurately reflect the strong concerns of patrons regarding security. It is not our belief that TriMet is unconcerned with passenger security; rather, the Bus Stop Guidelines do not make much mention of "security."

For example, on Page 6, the "What to Consider" list has Safety as its first item, and immediately provides the guidance "waiting, boarding and alighting must be safe." We recommend revising the first item to read "Safety and Security," and include appropriate references to security. The security measures should be integrated throughout the document using the term "security," such as when discussing shelters and amenities. TriMet police can provide excellent input in this area to support the bus stop planning process.

3. In the section on stop placement, it should be emphasized that mid-block placement is the least desirable of all placements, and should be avoided unless there is absolutely no other alternative. The only exception is when there is no access to pedestrians to cross the street mid-block. Mid-block stops are associated with high pedestrian/motor vehicle accidents, due to high-risk behavior on the part of passengers alighting and wanting to cross the street right away. It is a high risk to TriMet, also, as litigation may be filed against the agency for

establishing stops mid-block, which can be construed as encouraging mid-block crossings, or, at least, facilitating them. It is best to avoid this type of stop.

4. It is recommended that “Safety” be elevated to the primary position in considerations for customer information tools on page 15.

## **SYSTEM SAFETY PROGRAM PLAN (SSPP)**

Although the System Safety Program Plan (SSPP) was not part of the original request from TriMet for review by K & J, the reviewers felt that it was in the best interests of improving safety at TriMet to focus on the primary principle of system safety: that it is a system, and systematic improvements are the primary mode to improve safety overall at a transit agency.

The TriMet SSPP is a multi-modal document; this is not standard in transit but is an excellent practice and TriMet is to be commended for its consideration of all transit operations, regardless of mode and regardless of statute, to be under the umbrella of system safety. The SSPP has improved considerably since its first versions, and is a strong indicator of TriMet’s progressive approach to safety.

Our findings for this document are:

1. Overall, the most salient area needing improvement is clarity. There are a number of areas where tightening up language and providing more specific information will provide greater precision and remove ambiguity. A number of our recommendations below are related to this finding.
2. The primary safety-related finding is that, contrary to all system safety principles and the recommendations of the FTA and the NTSB, the Manager of System Safety is four levels down in the organization. According to the SSPP, the Manager of System Safety reports to the Director of Operations Support, who reports to the Executive Director of Operations, who then reports to the General Manager. In order for safety to take its proper place in the organization, this has to be reflected in the reporting structure. The importance of system safety directly reporting to the General Manger has been emphasized over and over in the safety field. One such example from a recent NTSB report (2006) notes that this structure is required to “ensure {the organization} effectively identifies and addresses safety issues.” After a recent fatal accident in June of 2009, the organization referred to here finally reinstated its safety officer to a direct report.
3. In section C.4, it is recommended that the matrix use titles rather than names to indicate responsibility. This avoids having to rewrite the document every time there is a personnel change. One primary task, Internal Audits, has no primary responsibility assigned. Operations Support, which includes oversight of Safety, is assigned “oversight” responsibilities for Safety Data Acquisition and Employee/Contractor Safety. These are primary safety activities usually assigned

to the Safety Department. In the interest of clarification, it may be more advantageous for TriMet to use the indications “P” (for Primary) and “S” (for Secondary) instead of X and O. Both the use of titles alone and classifications of P and S are practices endorsed by APTA, FRA and the FTA.

4. Section D.2 refers to the Transit Change Review Committee (TCRC) as having the primary responsibility for reviewing changes to the SSPP. However, this task is not listed as part of the responsibilities of the committee in the committee appendix.
5. Also in section D.2, it is indicated that line extensions, significant change to operations practice, changes to oversight regulation or other events may trigger a review of the SSPP. It is suggested that TriMet clarify what major system changes necessitate a review of the SSPP. The recommended language is:
  - a. When a significant change to the system occurs:
    - i. Line extensions
    - ii. New construction or installation, rehabilitation or overhaul of vehicles, facilities and system equipment (wayside, power, signals)
    - iii. Reorganization or reassignment of personnel affecting system safety responsibilities and processes
    - iv. Revision or creation of or changes to operating rules or procedures that require retraining of personnel
    - v. System changes deemed significant by the manager of system safety
6. Section E1.1 discusses New Extensions. The principles of system safety provide that the Safety and Security Certification process be the primary mode of hazard identification for new extensions, and the SSPP should note such in this section.
7. Section E.2.4 indicates that ad hoc reporting takes place, but only verbally. The SSPP should state the method used to ensure all safety hazards are properly documented and tracked to closure. TriMet should devise a method for ensuring that all ad hoc hazard reporting is captured in order to track hazards to closure.
8. Section E.3 refers to the MIL-STD 882D as the source of the guidelines for hazard severity and probability. 882D does not contain this information, and the latest update is 882E; however, system safety practitioners in the public transit arena use the guideline in 882C as it is most readily translatable to transit operations.

9. In section E.6, the hazard matrix indicates that third lowest level of hazard categorization is “Acceptable with review;” however, it does not say who is responsible for this review. Typically, this is the responsibility of the top system safety professional at the organization, as is the responsibility for ensuring all hazard assessment is done properly throughout the organization. TriMet should ensure that this information is reflected in the matrix.
10. Section F.3 should indicate that a post-accident hazard analysis will be performed by the safety department to ensure that no new hazards are introduced into the system by the circumstances of the accident and immediate corrective actions.
11. Section G.1 needs clarification of the role of the safety department, potential conflicts of interest and external audits. The safety department may not audit any area for which it has responsibility; ergo, it cannot perform the audit of the Internal Safety Audit or several of the other areas listed in this section. The list of areas is also not exhaustive; per the principles of system safety and security, other departments, including IT, security, environmental compliance, interdepartmental and interagency coordination and passenger and public information and safety programs would also have to be audited, among others. It is recommended that, for clarity, instead of a list of areas to be audited, the section simply state that the internal safety and security audits will encompass the SSPP and SSP, and that any area that cannot be audited by the safety department due to conflict of interest will be covered in an external audit (contractors, FTA or oversight) by agreement with ODOT.
12. Section I’s last paragraph states that independent assessments of maintenance and inspections programs are performed “on a risk basis.” This term is almost always applied solely to financial (stock) transactions; it is recommended that TriMet delete this phrase in the interest of clarity.
13. Section J.1 indicates that rules and procedures are reviewed, but it does not indicate an interval at which this occurs. Industry best practices are annual reviews.
14. Section K.7 indicates that rail operators receive “Observation Rides.” However, there is no indication that bus operators receive any evaluation of this type. It is recommended that TriMet institute a full program of training QA and efficiency/proficiency testing, to include one announced and one unannounced test per year, where bus and rail operators are formally evaluated for rule and procedure compliance and overall handling of their vehicles.
15. Section I.3 indicates that “periodic” emergency preparedness drills are held. TriMet should clarify what that period is, and ensure it is in line with industry recommendations, including TSA recommendations, of one field exercise per calendar year.

16. Section M.1 indicates that the TCRC is responsible for review of changes to specific system documentation. In keeping with the principles of system safety, annual review of ALL major system safety and security documentation should be accomplished on an annual basis (SSPP, SSP, SEPP, etc.). These documents should also be covered by configuration management procedures in Section P.
17. Section O is titled “Interdepartmental and Interagency Coordination;” however, this section should be retitled “System Safety Responsibilities” to improve clarity. Per FTA requirements, a separate section in the SSPP should cover Interdepartmental and Interagency Coordination, and FTA guidelines dictate that it should include items such as ensuring that written SOPs cover communications between all departments at TriMet, list outside agencies that TriMet interacts with on a regular basis, and indicates that written SOPs cover those interactions.
18. In section P, the primary purpose for change control (see final paragraph) is hazard identification and assessment, which should be clarified in this section. Also, TriMet should have an agency-wide configuration management policy with supporting procedures so that all departments will be able to comply formally with CM requirements of the SSPP.
19. Overall, the number and type of committees at TriMet could be improved. There are a fairly large number of committees, and many of them perform similar functions in different areas. In addition, there seems to be little or no criteria for some committee memberships; it is very important to ensure that committee membership is not random, carries significance, does not provide opportunities for conflicts of interest and cannot be used for a personal agenda. Committee membership should carry qualifications, including length of service, exemplary discipline and safety records, and training and qualification requirements. It is recommended that TriMet undertake a review of its committees and make recommendations for streamlining committees and developing membership standards.

## **INDUSTRY BEST PRACTICES FOR TURNS AND AUDIBLE/VISUAL WARNING DEVICES**

Turning presents an exponential increase in the hazards of vehicle operations. The reasons are:

- Not only is the operator having to negotiate the hazards of one roadway, now he or she has to negotiate two, sometime more at multiple-street or poorly designed intersections. Once the operator takes his eyes off of one roadway, the hazards of that roadway are no longer foremost in his perception. One example of this type of incident is when a vehicle is queued to enter a roadway on a ramp. Often, operators take their eyes off of the vehicle in front of them to monitor approaching traffic on the roadway to be entered. This can result in striking the vehicle in front

if the operator sees an opening in traffic and accelerates, forgetting there is a car in front of him or her on the ramp.

- There are often pedestrians crossing at intersections, so in addition to avoiding other vehicles, the bus operator has to avoid hitting pedestrians.
- Sight lines are often diminished at intersections due to buildings obscuring oncoming traffic, and dusk and dawn present additional hazards with sun angles and adjusting to darkness.
- A longer vehicle presents the need to adjust for the shorter path of the rear wheels; if the operator does not properly set up the vehicle for a turn, he or she can cause additional hazards, such as crossing unsafely into the lanes of oncoming traffic, having to back the vehicle up to make the turn, or colliding with the curb and stationary objects. In addition, the overhang past the rear wheels can also cause a collision hazard.

Left turns present even more hazards. Additional hazards of left turns are:

- The operator is farther from the opposite roadway crosswalk, and if the streets cross at acute or oblique angles, it may be more difficult to see pedestrians in that crosswalk depending on the turn.
- Once the operator has committed to the turn by entering the lane of oncoming traffic, if there is someone in the crosswalk and he or she has to stop for them, a collision hazard with oncoming cars is introduced.

K & J investigated innovative approaches to turning issues, and we present those programs we determined to have merit:

### **General Programs to Improve Safety in Turns**

It should be first noted that there is no existing federal regulation that dictates the speed in which an operator should negotiate a left or right turn. Approach speed when negotiating left or right turns is more often based on any one or combination of factors such as the judgment of a professionally trained operator, road conditions, environmental conditions and any other hazards that may be present. However, the Transportation Safety Institute (TSI), the safety and security training arm of the Federal Transit Administration (FTA) generally teaches in its Bus Operator Training class that operating speeds through intersections in preparation and in making a right hand turn should be 0 to 5 miles per hour 4 feet from the curb. It is safe to assume that this speed could also be applied when making a left hand turn. Because this is a practice taught by an entity of the United States Department of Transportation (USDOT), Federal Transit Administration, this can be generally considered the industry standard.

TriMet training materials indicate that turns should be made at 5 miles per hour or less. This should be reinforced in a standard operating procedure.

In general the majority of the agencies we surveyed responded that their agency typically dealt with left or right hazards through the application of rules and operator training. Rarely was the application of engineering controls, relocating stops or re-cutting runs to remove or reduce the number of Left or right turns employed.

With that said, the following additional comments are provided. A thorough Hazard Analysis (HA) at specific locations should be performed prior to implementing any of these changes.

1. Buses carrying passengers should not make right or left turns **on red** even if it is legal for motor vehicles at that intersection.

This approach has been taken by various DOTs and school districts across the nation, including NY, California and North Carolina. This approach has been taken to avoid the hazards of turning right or left. In some states it also applies to hazardous materials transport. New York City has prohibited right turns on red for all intersections for all vehicles EXCEPT where a sign allows it. In Washington, DC, about 40% of intersections in the city prohibit right turn on red for all vehicles during the period from 7AM to 7PM. It should be noted, however, that a landmark study conducted by Fleck and Yee in 2002 for the ITE found that there is actually a lower incidence of collisions on right turns on red than right turns on green. Their findings are as follows:

If prohibiting right turns on red at all intersections would clearly improve pedestrian safety, we would support such a change. However, we do not believe that this is the case. Prohibiting right turn on red would require drivers to turn on green. This would most likely increase the number of collisions by right turning vehicles. It is also intuitive that accidents involving right turn on green are relatively more severe than right turn on red, as vehicles in the former case are moving nearly at full speed.

To the extent that RTOR collisions do exist, they are a problem. It is important to note that failure to stop is a violation of RTOR, and should be cited as such. Also, failure to yield to pedestrians is a violation of RTOR, and should be cited. With California's strict red light running fines (\$271), we feel that strong enforcement is a viable deterrent to such violations. Overall, we feel that education and enforcement are the best ways to improve driver compliance with the need to stop and yield before turning right-on-red. Design changes such as reducing the curb radius can also help discourage RTOR violations.

As noted, No-Turn-on-Red restrictions are desirable where high volumes of pedestrian and conflicting vehicular traffic exist. We recommend that such

restrictions continue to be implemented on a case-by-case basis, as provided under California law. (Fleck, Yee 2002, p. 8-9)

It should be noted that the elimination of left or right turns on red should be made on a case by case basis based on the application of a thorough Hazard Analysis (HA) of the route.

2. Limit buses to restrictive left turns only. No permissive left turns in the system, or in the city, depending on executive decisions (this would require significant collaboration the DOT/city to modify signal phases to include restrictive left turns, and/or rerouting/ redesigning routes to avoid permissive intersections).

This approach has also been taken by some DOTs, but no transit agencies surveyed have implemented such a change. FHWA and TRB have also commissioned extensive research on permissive and restrictive left turn safety, with restrictive left turn (turn on left green arrow only) being the most effective at reducing collisions. This strategy has also been cited as a mitigating strategy in the TCRP study of bus collisions (TCRP report 125). In addition, working with the DOT/city to restrict pedestrian "walk" signals so that they do not coincide with the left-turn arrow is a highly effective way of limiting opportunities for pedestrian collisions. In combination with the strategies below, pedestrian hazards at intersections can be reduced significantly.

3. Working with the local DOT/city, use embedded lights in pedestrian crossing (flashing) to indicate when it is OK for pedestrians to cross and to alert operators that pedestrians are in the crosswalk.

In a number of cities and urbanized areas, improvements to pedestrian warnings and crosswalks, and grade separation of pedestrian crossings, have helped reduce collisions with pedestrians. Some strategies include installing the flashing lights in the crosswalk (the lightguard system) and using audible pedestrian signals to indicate lawful pedestrian access to the crosswalk.

4. Working with the DOT/city, have particular intersections with lots of pedestrian traffic operate with a pedestrian-only cycle at peak pedestrian times. This is called a pedestrian scramble, 'X' crossing (UK), diagonal crossing (US), scramble intersection (Canada) and more poetically Barnes Dance. This type of exclusive pedestrian crossing system stops all vehicular traffic and allows (for 15 to 20 seconds) pedestrians to cross an intersection in every direction, including diagonally, at the same time. The most famous implementation of this kind of intersection is in Shibuya, Tokyo. and has been implemented successfully in Denver, Hartford (CT), NYC, San Francisco, New York City's Union Square (see picture below) and Washington, DC).



Photo courtesy of the [Wikis Take Manhattan](#) project, used with permission under a Creative Commons Attribution-Share Alike 3.0 Unported license.

### [The FHWA reports:](#)

An exclusive pedestrian phase dedicates an additional phase for the exclusive use of all pedestrians. This additional phase is configured such that no vehicular movements are served concurrently with pedestrian traffic. During this phase, pedestrians can cross any of the intersection legs and may even be allowed to cross the intersection in a diagonal path. This type of phasing has an advantage of reducing conflicts between...turning vehicles and pedestrians, but it comes at a penalty of reduced vehicular capacity and longer cycle lengths (which increases delay to all users). The exclusive pedestrian phase is not frequently used but can be found in the central business districts of several cities, including Denver and San Francisco.

<http://www.washingtonpost.com/wp-dyn/content/article/2010/05/08/AR2010050803153.html>

## **Left Turns**

### GCRTA Left Turn Program:

In 2006, the Greater Cleveland Regional Transit embarked on a program to reduce its left hand turn bus-pedestrian collisions. Upper management was involved and supported the initiatives to ensure that the program was successful. Although a bus-pedestrian collision mitigation program already was underway, the GCRTA experienced two pedestrian fatalities while Operators were making left hand turns: one in September 2008 and the other in March 2009.

The GCRTA modified its strategy from training and communications to other systems such as warning devices and covert ride checks to assist in reducing these collisions.

In January of 2009, GCRTA installed warning devices with audible beeping for left and right turns. Buses were retrofitted with the external beeping sound activated with the turn signal to alert pedestrians that a bus is turning. Strobe lights are also being installed above the left and right turn signals.

In addition, in 2009, GCRTA also took the following steps in coordination with the new devices:

- Safety stand-down occurred with RTA Management during the week of March 23, 2009.
- Revised Turning Procedures were developed to include blowing the horn before making the left hand turn.
- Revised "Safety Turning Procedures" distributed to all bus districts and mailed to each operator household (see procedure below).
- Decals for rear of the bus are in production to warn motorists of frequent stops at intersections.
- Distributed Passenger Safety Tips and the new passenger alarm information on April 7, 2009.
- Left hand Turn Observation Program (covert rides).
- Continued a Strict prohibition on cell phone and electronic device use.
- Retrained all operators on revised left hand turn training program.

In addition, GCRTA determined that Job Safety Briefings need to be conducted with Operators on a quarterly basis. Initially, the emphasis was on the new technique for

making turns. Handouts were provided. Safety and Claims were also on hand to discuss recent collisions and claims.

An Operator outreach safety program was also put in place. This program included:

- Install decals on buses to remind Operators about reading or counting pedestrians at the corners and watching their movements.
- Issue generic collision bulletin when collisions occur.
- Issue flyers and Posters about the "Counting of Pedestrians at corners and watching them.
- Post the top 10 most dangerous local intersections and provide information on which routes go through those intersections.
- Radio broadcast of safety messages to bus operators.

Early evidence demonstrates that the beeping and voice-alert warning devices, coupled with greater focus in training, can reduce left hand turn collisions. Currently, only a few properties are testing the new engineering based technologies. Due to the limited number of properties utilizing this technology and based on the fact that our industry is early in the evolution of this technology, more data will be needed to determine whether there is viability in any of these options.

As far as K & J can determine, the voice alert or talking bus is the first of its kind in North America. GCRTA's innovative beeping buses have now been implemented in other cities such as Ann Arbor, Michigan. Other transit agencies have expressed interest in the talking bus, including Los Angeles, California and Ontario, Canada.

## GCRTA SAFE TURNING PROCEDURES

In addition to your normal safe operating procedures, when making turns,

YOU MUST:

### BEFORE THE TURN

- SCAN the intersection upon approach.
- Activate your turn signal 150 feet before the turn.
- WAIT TWO SECONDS before proceeding into your turn, and do not move early in anticipation of a green light.
- SCAN the complete crosswalk FROM CURB TO CURB.
- BLOW YOUR HORN during the turn.
- Look Both Ways along the crosswalk and use the ROCK AND ROLL [scanning both mirrors] technique to eliminate blind spots.
- Square off your turns (90').
- Turn at a speed that is 5 MPH OR LESS.
- SCAN the area, and your mirrors, to make sure that it is clear behind you or beside you.
- Once the bus is straight you can cancel your turn signal.

NOTE: PEDESTRIANS HAVE THE RIGHT OF WAY AT ALL TIMES!!!

### Des Moines Area Regional Transit Authority (DART)

DART experienced seven bus-pedestrian collisions in Des Moines between 2007 and 2009; in each, the bus was turning left. As a result, DART has instituted a policy of blowing the horn in turns. The General Manager, Brad Miller, also banned left turns across much of downtown Des Moines temporarily while considering more permanent modifications to routes to minimize the hazards. One of these modifications is that operators must follow a new procedure in left turns: they must make a stop before proceeding when making all left hand turns.

It should be noted that a thorough Hazard Analysis (HA) should be performed on this option prior to implementing such a drastic change to standard operating practices. The

impact on bus operators, motor vehicle operators and pedestrians needs to be adequately analyzed to identify any and all latent or active hazards.

### San Francisco Metropolitan Transit Authority (SFMTA)

SFMTA experienced numerous bus-pedestrian collisions from 2006 to 2009; in each case, the bus was turning left or right. As a result, SFMTA has instituted an engineering change tying external enunciators to the left and right turn signal activation. When the turn signals are activated, a 70 decibel warning alarm is activated to draw attention from pedestrian's attention to the bus movement.

### **Transit Change Review Committee (TCRC) Urgent Review Process**

The key elements of the National Safety Council's (NSC) Guide to Determine Motor Vehicle Accident Preventability are the following:

1. Using Preventability and Defensive Driving as the Basis for Accident Review
2. Setting up the Accident Review Committee
3. Setting a Standard for Safe Driving Performance
4. Outlining Committee Procedures
5. Using National Safety Council Guidelines for Determining Accident Preventability

Based on the utilization of the standards listed above, the review of the TCRC Urgent Review Process is as follows:

- The TCRC methodically and thoroughly reviews the key areas of accident investigation. These areas include possible causal factors involving:
  - Operations
  - Training / Operator History
  - Vehicle
  - Maintenance
  - Signals
  - Historical Data / Mitigations
- The TCRC does a commendable job reviewing any and all field data available to it.
- The TCRC review process is performed by members of the TriMet staff from all key departments within the organization.
- The TCRC routinely addresses the key potential causal factors as well as conducts lengthy discussions on preventability and mitigation which is a critical area for compliance to National Safety Council Standards on accident preventability practices.

- The committee openly discusses all aspects of the incident to include a review of any previous accidents that may have occurred within a geographical location to the current incident as well as a thorough review of the involved operators training and performance record.
- The TriMet TCRC process is compliant to the agencies System Safety Program Plan (SSPP), System Security Plan (SSP), State Safety Program Standard (SSPS) and is well documented in several agency Standard Operating Procedures. Additionally, I feel that the TCRC process also meets and exceeds the minimum requirements established in 49 CFR Part 659.19 for accident investigation for rail transit accidents and is in keeping with sound system safety practice.
- The committee focuses on preventability of further incidents by spending time discussing mitigations involving possible engineering, operations and training techniques.

The following comments/recommendations are provided based on review of TriMet SOP #576, #001 and #217.

SOP #576 – Accident / Incident Investigation:

1. General - It would be very helpful if a numbering system were used to reference the various sections instead of bullets.
2. General - Consider creating an accident investigation kit, if one is not being used, or at least a list of equipment that would aid the field investigation.
3. General - Consider identifying a checklist of activities that need to be performed in the field.
4. General - The sections relating to Notification of an Accident/Incident should be consolidated into a specific section for notification and should reference other related SOPs
5. General - Activities that are not specifically related to Accident Investigation should be moved to more appropriate SOPs. The SOP is weakened by covering too many areas other than accident investigation and being too lengthy. This SOP probably should not exceed 4 to 5 pages.
6. General - Consider the use of a flow chart or matrix to show the activities for the field part of the investigation process.
7. General - Consider utilizing the Rail Supervisor as the lead investigator for minor accidents/incidents and designating the Safety Office Representative as the lead investigator for major accidents/incidents.

8. General - Consider having an authorizing signature on the SOP.
9. Page 1, under "Purpose" - Consider adding "49 CFR Part 659" as a reference.
10. Page 1, "Statement of Principles" should include – "to preclude reoccurrence" as an objective.
11. Page 2, this section is defining what major and minor accident/incidents are and should be separated from "Statement of Principles".
12. Page 3, second bullet: this conflicts with the responsibilities of the Safety Representative who is to coordinate with ODOT.
13. Page 4, fourth bullet, All of the procedures from "Duties and Responsibilities" to this point (starting The Safety Office Representative) are related to emergency response and not to accident/incident investigation. They should exist in other SOPs.
14. Page 4, last bullet, this paragraph should be used to identify the team and the last sentence should be eliminated. The Safety Office Rep will activate the team as previously described.
15. Page 5, third to last bullet, the Safety Office Rep is to receive all reports. If the Controller is collecting these online, the SOP should reflect that.
16. Page 6, all procedures under "Object in Trackway Struck by Train" are related to emergency response and not accident/incident investigation
17. Page 8, first bullet, a "Rail Investigating Supervisor" is listed under "Rail Supervisor's role. This individual's duties and responsibilities have not previously been provided. This person should not be the "Rail Supervisor" who is Incident Commander.
18. Page 8, second bullet, not just be alert to safety hazards, but take steps to protect personnel from the safety hazards.
19. Page 8, sixth bullet, once the Supervisor begins to provide first aid, he becomes committed to that task. Sounds good but is not practical.
20. Page 8, the extensive tasks listed for the Rail Investigating Supervisor are probably not going to be accomplished by one individual considering the urgency to restore revenue service. Also, in question is the broad background this individual must possess to perform the specialized tasks being required. This individual probably should be supervising others who are performing the tasks.

21. Page 10, the activities described under the bullet starting "All fatalities involving TriMet vehicles" are related to emergency response more than investigation. Fatalities are already listed under Major Accidents/Incidents on page 2.
22. Page 10, who has the responsibility to ensure that photographs are taken? The rest of the material is good photographic information for accidents.

SOP #001 "Transit Change Review Committee":

1. SOP #001 may benefit from a more quantified definition of a major accident or incident. Refer to the comment above in the section on Bus SOPs for the recommended definition for bus. For rail accidents, the definition is similar, but due to the infrastructure differences, would read, "Any defect in the normal wheel-rail interface, to include collisions..."
2. Reference the standard that is being used for an "unacceptable hazardous condition", such as Mil Standard 882 or other appropriate source.
3. If another SOP is being used for configuration control of in-service equipment, it should be referenced. If not, consider developing an SOP for configuration control.
4. SOP #001 is reactive to accidents/incidents that have occurred as a source of committee activity. If there is a hazard identification process and procedure or trend analysis using historical safety data, these could also be part of the committee activities as a proactive approach.
5. SOP #001 provides for one vote for each member but does not address if a simple majority is sufficient to approve a committee item or how the counting of votes is accomplished.
6. Consider adding to the open items log a date for scheduled completion of the item.

SOP #217 "Urgent Review of Major Safety or Security Incidents":

1. For standardization, insure the coordination of the definition of "major" incident with existing Accident/Incident Investigation Plans and Emergency Preparedness Plans, as appropriate.
2. The convening of the TCRC for urgent review of the incident gets somewhat confusing with the statement "The TCRC urgent review shall function as the preliminary review on behalf of the TCRC." The distinction between the urgent review function and the activities of the TCRC should be made clearer. This section of the SOP reads as if there are two different activities going on when it

may only be the convening of the TCRC to begin immediately reviewing the incident.

3. The list of determinations in #5 includes the restoration of “normal” service. Consideration should be given to including “restricted” or “restrictions to service” in this list of determinations.

The TriMet TCRC appears to be operating as intended in that it is a proactive open minded process focused on preventability and hazard elimination. The program is well managed, adequately documented, appropriately staffed and true to the core principals of system safety and the National Safety Council (NSC), which is accident preventability. TriMet has also apparently been successful in negating the commonly seen departmental finger pointing which can be devastating to the core mission of the TCRC.

In attempting to compare the TriMet TCRC Urgent Review Process to comparable post accident/incident review committees at other transit agencies, it was quickly evident that few properties we surveyed could compare to the TriMet TCRC process. Though most properties we contacted have accident/incident review committees, the make-up of these committees, evaluation process and mitigation analysis/recommendations were not as vigorously debated or analyzed at other transit properties as they are at TriMet.

GCRTA Cleveland has a Major Incident Executive Safety Review Committee made up of select senior leadership officials of the agency. Based on our review, this committee is most representative of the activities of the TriMet TCRC however it is not as well represented as the TriMet TCRC nor is there the same sense of urgency in the GCRTA committee as there is with the TriMet TCRC.

Charlotte (CATS), Orlando (LYNX), Jacksonville (JTA) and Tampa (Hart) all use extensions of their Collision Prevention Committee to review major incidents, but rarely address necessary mitigations or hazard controls in these reviews nor are they conducted as early post an incident as the TriMet TCRC meets.

Los Angeles (LACMTA) has a Collision Review committee but is only staffed by safety professionals and members of the accident investigation committee. This committee meets mainly in an attempt to deliver information to the executive staff on an as needed basis.

San Francisco (SFMTA) has an Accident Review Board (ARB) which is convened for the sole purpose of determining preventability as it relates to the operator involvement. At no time does this board meet to disseminate information to the agency or address possible mitigation options.

Oakland (BART) uses an arrangement of pre-qualified consultants to assist in the review and evaluation process as well as selected peer reviews on catastrophic cases. BART will disseminate this information to executive staff of their review and action. This may take several weeks or months depending on the political and media scrutiny.

Denver (RTD) employs an Executive Safety Committee to review “special reports” that are produced for cases meeting a catastrophic classification. The committee will review these reports for appropriate action and follow-up. The committee is made up of a select but limited number of executive staff.

Washington, DC (WMATA) will produce an incident report that is reviewed and signed off by the Chief Safety Officer (CSO) and Deputy General Manager (DGM) of Rail Operations but no apparent follow up or in-depth analysis is performed to ensure corrective actions are employed or enacted. There is no committee responsible for meeting and vetting available information associated with the incident.

Detroit (DDOT) has no accident/incident review committee of any type. Reports are produced by the safety department and provided to the State Safety Oversight (SSO) and agency General Manager (GM) for review.

Atlanta (MARTA) has no defined accident review board. Reports are produced by the safety department and provided to the State Safety Oversight (SSO) and agency General Manager (GM) for review.

Seattle (Sound Transit) employs a Safety Review Committee which meets monthly to review all accident/incident reports that are provided to it. The committee reviews the reports for thoroughness and recommendations for implementation.

New York City (MTA) utilizes a classification process of major and minor accidents which is based on dollar threshold of the incident. If a major incident occurs, the MTA may employ a Board of Inquiry. This board will more thoroughly analyze the incident report and evaluate the recommended corrective measures.

New Jersey (NJT) has an Executive Safety Committee comprised of a handful of agency executives who review accident/incident reports for committee action.

## **CONCLUSION**

Overall, TriMet’s safety programs are appropriate and are equal to or exceed the typical programs at other agencies of its size and service type. A number of safety related recommendations have been noted in this report to further enhance the exceptional programs TriMet currently has in place. It is our belief that TriMet embraces the goal of attaining the highest level of safety achievable for its organization and will continue to improve its programs with this goal in mind. This commitment is exemplified by TriMet undertaking this multi-phased system wide safety assessment.