



## King County

### Metro Transit Division

Transit Safety Unit

Department of Transportation

11911 East Marginal Way South, Bldg. A

Tukwila, WA 98168

206.684.2810 Fax 206.684.2832

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<b>KCM ACCIDENT REPORT NO:</b>	2009LR0023
<b>ACCIDENT DATE/TIME:</b>	November 16, 2009, 14:51 Hours
<b>ACCIDENT LOCATION:</b>	YE
<b>DATE of REPORT:</b>	December 16, 2009
<b>REPORT TYPE:</b>	Final
<b>KCM RAIL OPERATOR:</b>	[REDACTED]
<b>RESPONDING SAFETY OFFICER:</b>	Vicki Smith-Jones, Rail System Safety Chief

### SYNOPSIS OF THE ACCIDENT

On November 16, 2009, at 14:59 hours Train 14 was involved in a non-injury derailment. Train 14 was comprised of a two LRV consist, lead LRV111 and LRV118, and was operated by Operator [REDACTED]. LRV 111 derailed when Operator [REDACTED] was performing a mainline reverse move operating from the cab of LRV 118. Contact was made between the LRV's 111/118 and fixed objects. There were no passengers in either LRV.

Train 14 was pulling out from the Operations and Maintenance Facility yard using track YA into revenue service. Operator [REDACTED] stopped at Signal YE8. The signal aspect showed a horizontal amber, which indicates "Stop". There is no evidence of a route request to enter the mainline. Operator [REDACTED] then proceeded through a "Stop" signal and entered the main track by trailing switch YE 5 with the B and C trucks of lead LRV111.

Operator [REDACTED], when notified by the LCC controller, stopped the train. The LCC controller directed Operator [REDACTED] to ensure that her switches were aligned correctly and then make a reverse move back to the yard. Operator [REDACTED] departed from the cab of lead LRV 111 to the coupled LRV 118 cab and activated LRV 118 as the lead LRV without checking the switches prior to making the reverse move. Operator [REDACTED] reversed over the misaligned switch causing LRV 111 trucks B and C to derail which resulted in a collision with the wing wall and guard rail.

- There were no injuries.
- The weather was rainy, sky was overcast, and there was daylight at the time of the accident.
- Estimated damage to equipment, track, and OCS was reported at \$195,000.
- Post Accident testing was conducted.

The probable cause of the accident and related damage was operating the train through a signal indicating "Stop". The error was then compounded by not continuing all the way through the switch, and checking switch alignment, prior to performing a reverse move over the switch.

### ENVIRONMENT

At the time of the derailment, trains use two auxiliary tracks, YA and YB, for egress between the Operations and Maintenance Facility yard and the mainline. The mainline is comprised of two tracks, northbound and southbound, that currently run between the Downtown Seattle Transit Tunnel and Tukwila station.

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Track YA is to the northwest of the Operations and Maintenance Facility. It is used for egress onto the mainline from the OMF yard. The YE8 signal is located just prior to the YA and YB tracks and governs traffic entering the mainline north or south bound.

*Weather* – Precipitation: Precipitation 0.91 in - Wind: Wind Speed 16 mph (SSE) Max Wind Speed 26 mph Max Gust Speed 37 mph Visibility 7 miles Events Rain

## **NARRATIVE**

### *Circumstances Prior to the Accident*

KCM employee [REDACTED] was qualified as a Rail Operator on October 23, 2009. Operator [REDACTED] held the Rail Operation's assignment on 11-16-09 as a report operator. She had the required time off period prior to reporting to duty and stated in her interview that she was well rested. She signed in for duty at 0700 hours which has been verified by the Operator Dispatch Sign-In Sheet.

KCM employee First Line Supervisor [REDACTED] completed his training as a Controller on December 14, 2007, and was certified as a Special Duty Rail Controller on August 22, 2008. On November 16, 2009, he worked his normal day shift.

KCM employee Chief [REDACTED] completed his training as a Controller on January 2, 2009. On November 16, 2009, he began his routine shift at the Operations and Maintenance Facility at 09:00 hours changing his work location and duties at approximately 14:00 hours to the LCC.

### *Accident Timeline*

The LCC Channel One Radio recordings (wav files), LCC Communication Log, Link Train Pullout log, SCADA Device Events by Location Log Report, and the LRV event recorder data were used to establish the time lines of this accident and the events leading to the accident.

At 11:40 hours Operator [REDACTED] was assigned by the dispatcher to perform a pre-trip inspection on a consist in the yard. She reported back to the dispatch window at 12:10 hours. At 14:19 hours Operator [REDACTED] was assigned by the dispatcher to 599/64, Train 14, with a pullout time from the YA of 14:44 hours and due at SODO station at 14:48 hours. Operator [REDACTED] stated that she performed a pre-trip inspection of Train 14 (LRV 111 and 118). At 14:42:30 hours Operator [REDACTED] stated to the LCC that she had read and understood the train orders and special instructions, and requested an on-line time. The controller stated that Operator [REDACTED] was clear to proceed to the YE8 signal and select her on line time of 14:44 hours.

At the YE8 signal Operator [REDACTED] radioed the LCC and stated that she was proceeding as instructed. The Controller responded that she was now six minutes late. LRV 111 event recorder shows the operator began moving onto the mainline. The corresponding signal logs from VHLC #1 and VHLC #2 and the SCADA Device Events by Location Log Report do not show any indication of the operator calling for or receiving a signal to proceed onto the mainline.

Train 4 Operator [REDACTED] radioed the LCC stating that he saw Train 14 coming out of the yard and asked if the controller would like him to hold at the YE 14N. This signal indicated that Train 4 should

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proceed. The LCC confirmed with Operator [REDACTED] that the YE 14N signal indication showed a "Proceed" and that he should hold at that signal. The Controller also directed Operator [REDACTED] to stop.

The LCC Controller then questioned Operator [REDACTED] as to her exact location and what track she was on. Operator [REDACTED] was unable to confirm to the Controller that she was headed northbound on the southbound track or specify her exact location per her responses as heard on the LCC Channel One Radio recording.

The SCADA Device Events by Location Log Report for November 16, 2009, (using a 24 hour clock) shows that at:

- 14:34:35 Signal YE 2S is "Clear" and switch YE 5 is "Locked" for mainline southbound traffic and track circuit YE 50T shows "Route Established".
- 14:35:57 Signal YE 2S shows "No Signal Clear"
- 14:36:23 Switch YE 5 is "Unlocked" traffic and track circuit YE 50T shows "No Route Established".
- 14:36:29 Switch YE 9AB is "Unlocked".
- 14:38:54 Switch YE 9AB is "Not Normal".
- 14:39:00 Signal YE2S is still showing "No Signal Clear" and switch YE 5 is "locked".
- 14:39:00 switch YE 9AB is "Locked".
- 14:39:01 Signal YE 8 shows "Signal Clear". Train 13 departs through the switch southbound on track YB.
- 14:39:00 the YE 9AB switch then shows "Reverse".
- 14:39:08 the YE8 signal is in the "No Signal Clear" mode. (The report shows no other activity on the YE 8 signal after this point through 19:41:08 hours.)
- 14:40:02 YE 9AB switch shows it is back in the preferred "Unlocked" position and Switch YE 5 is in the "Unlocked" position.
- 14:44:38 Signal YE 2S shows "Signal Clear" and switch YE 5 "Locked" for southbound mainline traffic.
- 14:44:39 Track circuit 50ST shows "Route Established".
- 14:45:46 Signal YE 2S shows "No Signal Clear" and track circuit 50ST shows "No Route Established". (The report shows no other activity from this point for signal YE 2S through 14:53:52 hours.)
- 14:45:54 track circuit 50ST shows "Track indication" and then "No Track Indication".
- 14:46:12 track circuit 50ST shows "No South Route Lock",. Switch YE 5 shows "Locked", and track circuit 50ST shows "No Track Indication"
- 14:51:12 track circuit 50ST shows "Track Indication".
- 14:51:17 switch YE 5 is "Not Normal".

The Device Events By Location Log Report compilation above and the physical evidence (photographs, DVR LRV 111, SCADA and signal logs) show that Operator [REDACTED] violated the YE8 "Stop" signal indication and trailed through switch YE5.

Chief [REDACTED] stated during his interview that he looked up from his work station at the Overview screens at this time. It appeared to him that Operator [REDACTED] had made a wrong signal call (called "Left" instead of "Right"). He also stated that the Overview screen graphics do not clearly display the exact location of the train and therefore could not determine if the train was physically over a switch or

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not. (A photograph of the controller console screen that he observed is included in the appendix illustrating Train 14 occupancy of multiple track circuits) Because he assumed that a call had been made, he also assumed that the switches would be aligned for the move and therefore requested that Controller [REDACTED] have her reverse back into the yard.

Operator [REDACTED] was requested by Controller [REDACTED] to reverse back into the yard "if the switches were set for her move". The operator affirmed the instruction by a "Yes Sir" per the recorded LCC Channel One radio recording. Operator [REDACTED] then moved from the lead cab of LRV 111 to the lead cab of LRV 118. She was asked in the interview if she had physically looked at the switches. She stated that she did not look at the switches when moving between LRVs.

Train 4, which was stopped at signal YE 14N was requested to proceed which he did passing Train 14 without incident. On LCC Channel One Radio wav file 0000000536\_Channel \_\_12009-11-16\_15\_16\_34 Controller [REDACTED] can be heard asking Operator [REDACTED] if the switches are aligned for her move. In the next wav file Operator [REDACTED] is heard responding that "it seems that it is, but the train has stopped". She then is heard reading the messages she is viewing on the Train Operator Display (TOD). Per the DVRs, SCADA, Signal logs, and the event recorder the train had moved and derailed at this time. It appears from these wav files that the LCC controller was expecting an affirmation that the switches were aligned prior to the move and that Operator [REDACTED] was unaware that she had derailed.

#### *The Accident*

The accident occurred in two segments. In the first segment Operator [REDACTED] proceeded through a stop signal and then trailed through Switch YE5 with what appears from the physical evidence (sLRVring on the rails, bent switch rod, LRV 111 DVR, sLRVring on the wheel flanges) to be trucks B and C of lead LRV 111. Operator [REDACTED] then proceeds to operate Train 14 in a reverse move from lead LRV 118. LRV 118 trucks and the A truck on LRV 111 reverse with out incident on the track. However, due to the switch alignment, as the train proceeds back into the yard, LRV 111 trucks B and C continue southbound on the south bound track, derailling between points 14+27 and 166+38. The derailment blocked the southbound mainline and YA tracks. At the point of the derailment the operator was operating from the lead cab of LRV 118. Trailing LRV 111 swung to the north east striking the guard railing and wing wall. The pantograph on LRV 111 broke off and pulled down an OCS support rod. Loss of power to LRV 111 caused Train 14 to stop. Operator [REDACTED] radioed the LCC about loss of power. The operator was unaware (when calling the LCC about power loss) that the train had derailed.

The LCC requested that Vehicle Maintenance send a mechanic to her aid. The responding mechanic upon approach to the train saw that Train 14 had derailed and communicated that fact to the LCC.

King County Metro Rail Vehicle Maintenance, Track, Traction Power, Operations, and Safety personnel responded shortly after. Operator [REDACTED] was taken to the OMF facility for interviews and to await transportation for post accident testing.

#### *Post Accident*

Operator [REDACTED] radioed the LCC for assistance upon loss of power to the train. Vehicle Maintenance personnel gave instructions over the radio to power down and then power up the train.

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VM personnel also responded to the scene to assist the operator. Upon approach they saw that Train 14 had derailed and radioed the status to the LCC.

Vehicle Maintenance personnel under the supervision of Chief Robert Blackburn re-railed LRV 111 and towed it into the shop.

On November 17, 2009, Transit Safety Officer Darryl Russell and Transit System Safety Rail Chief Vicki Smith-Jones interviewed Operator [REDACTED]. Local 587 representative Randy Stevenson was present. The interview was recorded.

#### *Training Record Review:*

During her training period, Operator [REDACTED]'s daily operating training evaluations demonstrate inconsistency in her ability to perform at a constant acceptable level. Operator [REDACTED] received additional practice performance exams prior to qualifying as an operator with passing scores.

LCC training records (syllabus, evaluations, quizzes, SCADA manual and tests) were reviewed. The training tools (syllabus, simulator, trainer manuals) and the number of employee evaluations, quizzes and exams were found to be minimal.

### **ROOT CAUSE**

Operator [REDACTED] proceeded through a signal where the aspect showed a horizontal amber bar which indicates "Stop" and trailed through a switch misaligned for the move.

### **CONTRIBUTING FACTORS**

Additional operator related factors and actions that contributed to this accident include:

- Failure to recognize that Switch YE5 was not aligned for her move.
- Failure to completely move the entire consist through Switch YE 5 before performing a reverse move.
- Operator did not appear to be cognizant of her surroundings as indicated by her responses when asked her location by the LCC and when requested to show location on a photograph in the post accident interview by Transit Safety officers.
- Operator was behind schedule and expressed feeling pressure and flustered.
- Training and performance evaluations indicated that that she is easily overwhelmed and lacking in confidence. When overwhelmed she tended to make operating errors.

Additional LCC related factors and actions that contributed to this accident include:

- The LCC controllers failed to hold the trains in place and to send assistance to the operator when the operator appeared flustered as evidenced by her inability to express recognition of her location
- The vendor provided insufficient Controller training. The Controllers have not been trained to recognize the SCADA screen switch information in the track diagram. At the time of the derailment, LCC Controllers were not trained to recognize a switch "out of correspondence" on the SCADA screens.
- Chief [REDACTED] made an assumption of the type of call made by the operator and did not affirm the call and conditions.

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- An LCC SOP or emergency checklist for Controller actions regarding train derailments was not available.

Additional related factors in system design that contributed to this accident include:

- SCADA screen graphics did not clearly show location of the train. The screen graphics show the train in multiple track circuits. Upon viewing this screen the Controller thought that the operator had made an improper call when moving onto the mainline and therefore could perform a reverse move.
- The GE Transportation Systems Global Signaling Central Operator Training Guide Page 26 track window diagram does not reflect actual SCADA screen illustrations. The indications appear to have been removed from the SCADA system and the software changes have not been communicated to the controllers.
- SCADA system does not have an audible alarm when switches are out of correspondence.
- SCADA manual refers to crosshatching when switches out of correspondence. That feature has been removed from the system.
- Two calls can be made to make the same diverging northbound move from the OMF YA track. To diverge to the northbound track an operator must enter a "32, R" or a "32, Call". The train will remain in street running mode until the system locks in the selected move. The train, once the route locks in, will switch from street running to ATP mode.
- The track circuit at the YE8 is not designed to prevent a train from moving past an amber stop signal onto the mainline ATP territory in street running mode.

## DAMAGE

LRV –Side body, pantograph and trucks B and C of LRV 111, *Estimated cost of repairs, \$30,000.*

*Fixed Objects - OCS support arm, personnel guard railing and wing wall, cement parapet; Estimated cost of repairs - Traction Power-\$25,000. Track-\$20,000. LRV 111- Section C side body, C and B trucks, Pantograph*

## ANALYSIS

The derailment was investigated by KCM Signal, Vehicle Maintenance, Traction Power, Track, Operations and Safety Section representatives. The LRV 111 event recorder download showed the times that the train was stopped on the YA, moved onto the mainline, operator switching cabs, and the reverse run into the yard. The event recorder shows the status of the Doors, Deadman, Control Station, Bell, Power, Brake, Safety Brake, Emergency Brake, Motor Controller Forward, Motor controller Reverse, Maximum Brake, Wheel Slip Indicator Sanding Control, Speed, Tractive Effort, Brake Cylinder Pressure, Propulsion Brake Effort and when the cab is keyed.

Signal Logs from VHCL#1 and VHCL#2 were downloaded and reviewed. The VHCL# 1 signal log extrapolation shows "The operator entered the YAT track circuit at 14:50:34 hours. When the train proceeded from YAT to 9BT, the last signal indication at the YE8 signal was horizontal amber. There is no record that the signal indication had changed to lunar prior to the train proceeding from YAT to 9BT. The last command to switch 5 (YE5) was to switch to the normal position. The loss of normal point detection at 14:53:52 was not proceeded by a command to go to the reverse position. The switch did not detect reverse point after the train passed over it."

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The SCADA 11-16-09 playback video, DVR file FWD\_2\_Seciton\_b\_111a 2009116\_144958\_1.SBE, LRV 134 DVR, LCC Channel One Audio Log, and DVR LRV 111B were reviewed. Some screen shots from the SCADA playback video and LRV DVR were taken to illustrate points.

Weekday train schedules, Operator Daily Report Sheet, Sound transit Link CRS Operator sign-in sheet, Link Train Pullout and LCC Communications Logs were reviewed. Drawings were reviewed of the Yard Entrance and the July 2008 Signal System Single Line Track Diagram and Daily Activity Report.

Standard Operating Procedures, Standard Maintenance Procedures, and the All Hazards Check list were reviewed. Operator KCID #20480 training records and evaluations were also reviewed.

The data supports with the Transit Safety Officer's analysis that operator error was the root cause of the derailment.

### **RULEBOOK AND SOP VIOLATIONS**

The Operator made the following procedural and rulebook violations:

- Rulebook:
  - R4.1, Stop Indications – When any signal displays a “Stop” indication, the train shall be stopped before passing the signal and not proceed until receiving a proceed signal aspect or authorization to proceed from LCC. (Operator did not call for a signal prior to entering the mainline. (Signal YE8))
  - R5.1, Observance of Switch Points – Operators shall observe that both switch points are properly aligned for the route desired before proceeding through the switch.
  - R5.3, Crossovers – Do not commence movement over any crossover unless all switches are aligned for the move and the train signal is displaying the correct aspect.
  - R5.5, Trailing Point Switches – When making a trailing point movement through a switch, the train must not make a reverse move and change directions until the entire consist has passed through the entire switch.
  - R5.6, TRAILING POINT SWITCHES MISALIGNED- A train may not be operated through a trailing point switch in the misaligned position.
- SOP 5.5, 4.0 Procedures: The operator is responsible to visually verify that all switches are lined for the intended routing.

The LCC controllers made the following procedural and rulebook violation:

- Rulebook:
  - R5.5, Trailing Point Switches – When making a trailing point movement through a switch, the train must not make a reverse move and change directions until the entire consist has passed through the entire switch.

### **CORRECTIVE ACTION**

The following items have already been implemented as preventive measures against this type of accident reoccurring:

- The pull out procedure has been amended by a train order that states: “Trains will not proceed past the YE8 or call a route onto the mainline until permission has been given by LCC. Before

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proceeding past the YE8 train operators will report the route called and the aspect of the YE8 signal to the LCC.”

- Rules R 5.1, Observance of Switch Points, and R 5.5, Trailing Point Switches, have been added to the Rail Operation bulletin.

The items below are recommendations to prevent reoccurrence of this accident:

- Redesign system so that if a train violates a stop signal when in street running mode and entering ATP territory, the train will come to a complete stop prior to entering the ATP territory. Suggest that the train goes into ATP prior to YE8 signal.
- Place a MUTCD “Stop” and “Call LCC” signs (stacked) at the YE8 loop. (Should be done at signal YE 6 as well).
- Eliminate the two calls (“32, R” and the “32, Call”) at signal YE 8 for northbound left diverging moves. Suggest use of a “32, R”, call for the northbound diverging move.
- Alarm the SCADA system with an audible alarm that is triggered by abnormal track conditions such as a switch out of correspondence.
- Program the SCADA screen to reflect cross hatching when a switch is out of correspondence per the SCADA Central Operator Training Guide, Document No. 01820-P-110-2-ST, rev 0.1 page 26 Track window diagram.
- Create and implement a LCC SOP on train derailment controller actions.
- A SCADA simulator should be used as a part of the LCC training curriculum and emergency scenarios included.

## **DEFINITIONS**

*Automatic Train protection (ATP)* – An electronic system which automatically initiates a braking command to prevent an Operator from entering into an unsafe condition at an interlocking or whenever closing within the safe braking distance of the train ahead. The ATP system is bi-directional

*Controller* – The designated employee on duty in the LCC having authority over all train movements and bus movements in the Downtown Seattle Transit Tunnel, train movements in non-DSTT areas, other activities affecting train movements and other support systems that effect operations.

*Facing point* – When viewing the switch the points are facing towards the vehicle.

*Interlocking* – An arrangement of signals, switches and control apparatus interconnected to provide a route and prevent conflicting train movement.

*Link Control Center (LCC)* – The primary location for controlling, monitoring and dispatching the entire Central Link Light Rail system including light rail trains and bus operations in the Downtown Seattle Transit Tunnel.

*Operator* – The employee having direct control and responsibility for the safe movement of a rail vehicle.

*Supervisory Control and Data Acquisition (SCADA)* – A communications system which allows LCC to monitor and operate field devices.

*Switch* – a set of track components enabling train movement from one track to another.

*Switch Point* – Tapered rails that are moveable and designed to fit against the stock rail to divert the train onto another track.

*Track Circuit* – A section of track electrically isolated for the purpose of detecting train presence.

*Trailing point* – When viewing the switch, the points are facing away from the vehicle.

*Train to Wayside Communications (TWC)* – A two way communication system between the light rail vehicle and the signaling system.



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**ACRONYMS**

YA = Yard A  
YB = Yard B  
YC = Yard C  
YE = Yard Entrance  
OMF = Operations and Maintenance Facility

**APPENDIX**

1. Train Order 11-16-2009 – A
2. Daily Activity Report 11-16-09
3. Link Train Pullout 11-16-09
4. LCC Communications Log 11-16-09, Stations 1 and 2
5. Photographs
6. Signal Log (Signal Bungalow PC VHLC#1 ) 11-16-09
7. Infrastructure Status prior to Resuming Revenue Service 11-16-09
8. LRV 111 Event Recorder graph 11-16-09
9. Central Link Incident Report #263
10. Accident Report #2009LR0023
11. Field Supervisor's Response Report (ID #556,
12. SCADA Log
13. Operators Daily Report Sheet
14. Dispatch Sign-in Sheet
15. KCM Run LRVd
16. Student Operating Time Log
17. SCADA Screens video playback

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Report Author/Investigator

Vicki Smith-Jones,  
KCM Rail System Safety Chief

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Transit Safety Supervisor

Michael Lemeshko,  
KCM Transit Safety Supervisor

