Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

RAILWAY INVESTIGATION REPORT R09W0016

ROLLING STOCK DAMAGE WITHOUT DERAILMENT OR COLLISION

CANADIAN NATIONAL
FREIGHT TRAIN NUMBER M-30451-11
MILE 238.30, REDDITT SUBDIVISION
DUGALD, MANITOBA
14 JANUARY 2009

Canada

OCCURRENCE SUMMARY • **Rolling Stock Damage Without Derailment or Collision**
Canadian National
Freight Train Number M-30451-11
Mile 238.30, Redditt Subdivision
Dugald, Manitoba

R09W0016

EVENT

On 14 January 2009, a Canadian National freight train, proceeding at 4 mph, experienced undesired emergency braking and came to a stop. The train separated when a stub sill severed from one of its tank cars. There was no release of product, no derailment, and no injuries.

SAFETY ISSUES

The report highlights two safety issues:

- Complete information is not available to analyze failure trends and identify potential safety defects because there is no requirement to report cracked or broken tank car stub sills.
- As trains become longer and heavier, some older design specifications for car components may not be suitable.

TSB RECOMMENDATION

The Transportation Safety Board of Canada recommends that:

- The Department of Transport, in conjunction with the railway industry and other North American regulators, establish a protocol for reporting and analyzing tank car stub sill failures so that unsafe cars are repaired or removed from service.

SAFETY CONCERN

The Board is concerned that stub sills manufactured to older design criteria may be more susceptible to failure in today's railway operating environment consisting of longer, heavier trains and elevated in-train forces.

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The Transportation Safety Board of Canada (TSB) investigated this occurrence for the purpose of advancing transportation safety. It is not the function of the Board to assign fault or determine civil or criminal liability.

Railway Investigation Report

Rolling Stock Damage Without Derailment or Collision

Canadian National
Freight Train Number M-30451-11
Mile 238.30, Redditt Subdivision
Dugald, Manitoba
14 January 2009

Report Number R09W0016

Synopsis

On 14 January 2009, at approximately 0330 Central Standard Time, Canadian National freight train M-30451-11 was proceeding eastward at 4 mph when it experienced an undesired emergency brake application and came to a stop at Mile 238.30 of the Redditt Subdivision near Dugald, Manitoba. Subsequent inspection revealed that the train had separated and the A-end stub sill of dangerous goods tank car UTLX 37605, loaded with approximately 51 500 pounds of propylene (UN 1075), had severed and pulled out of the car. There was no release of product, no derailment, no track damage and no injuries.

Ce rapport est également disponible en français.

Cat. No. TU3-6/09-0016E
ISBN 978-1-100-16595-0

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1.0 Factual Information

On 14 January 2009, at 0203,[1] Canadian National (CN)[2] freight train M-30451-11 (the train) departed Winnipeg, Manitoba, destined for Toronto, Ontario. The train consisted of 3 locomotives and 72 cars (65 loaded and 7 empties); it was 4825 feet long and weighed 8971 tons. The crew consisted of a conductor and a locomotive engineer.

At approximately 0330, the train was proceeding eastward preparing to meet with CN train Q-10131-12. While accelerating slowly to a speed of 4 mph, an undesired emergency application of the train air brakes occurred and the train came to a stop at Mile 238.30 of the Redditt Subdivision near Dugald, Manitoba (see Figure 1).

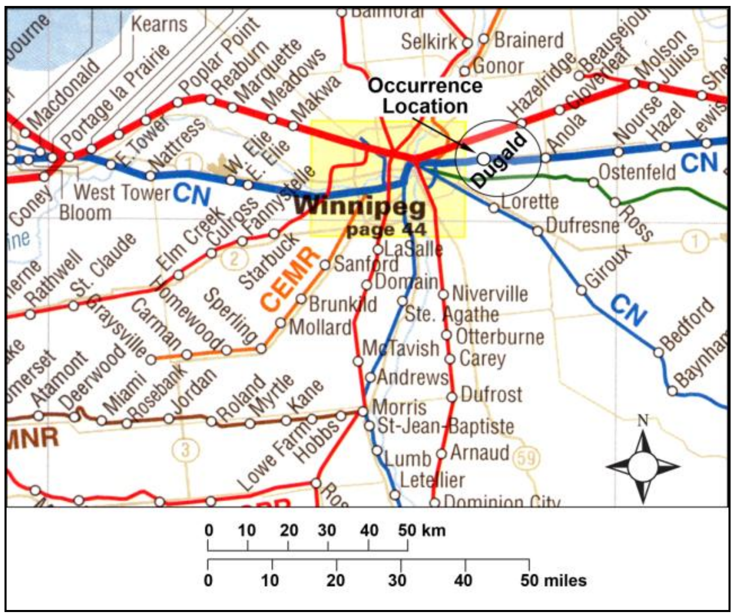

Figure 1. Map of the incident location (Source: Railway Association of Canada, *Canadian Railway Atlas*)

At the time of the occurrence, the sky was clear, the temperature was -29°C and the wind was from the northwest at 6 km/h.

1.1 Site Examination

After stopping, the crew performed emergency procedures and determined that the train had separated, with a distance of about 50 feet between the 41st and 42nd cars. The A-end stub sill of the 41st car, dangerous goods (DG) tank car UTLX 37605 loaded with approximately 51 500 pounds of propylene (UN 1075), had broken and severed just behind the rear draft gear stop blocks (see Photo 1). The severed portion of the stub sill assembly, which still contained the

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1 All times are Central Standard Time.

2 See Appendix C – Glossary for a list of abbreviations and acronyms used in this report.

draft gear, yoke and coupler, had pulled out of the car and remained attached to the east end of the 42nd car, DG tank car DLPX 19016 loaded with hydrogen peroxide (UN 2015). The stub sill was heavily bulged in the area of the draft stops.

Photo 1. Car UTLX 37605 missing A-end stub sill

Car UTLX 37605 was secured and isolated in a remote spur track awaiting product transfer. The failed stub sill assembly was forwarded to the TSB Laboratory for failure analysis.

1.2 *Particulars of the Track*

The Redditt Subdivision extends from Sioux Lookout, Ontario (Mile 0.0), westward to Winnipeg, Manitoba (Mile 251.53). Between Mile 237.19 and Mile 238.47, the track was tangent and oriented in an east-west direction with a 6510-foot-long siding adjacent to and south of the main track. The grade at the location was negligible. The track was in good condition. Train movements are governed by the Centralized Traffic Control System, in accordance with the *Canadian Rail Operating Rules* and are supervised by a CN rail traffic controller located in Toronto, Ontario. The single main track is classified as Class 4 according to the *Railway Track Safety Rules* with a maximum authorized speed of 50 mph for freight trains. Traffic consists of about 15 freight trains per day with annual tonnage totaling approximately 34 million gross tons.

1.3 *UTLX 37605 Movements and Repairs (Prior to Entering Canada)*

Tank car UTLX 37605 was loaded with propylene at Whiting, Indiana, United States, on 22 September 2008. The car was picked up and transported by Norfolk Southern Railroad (NS), interchanged with the Union Pacific Railroad (UP), which then delivered the car to Grelake, Texas, on 10 October 2008. After offloading, the car was released as a "residue"[3] car on 27 October 2008 destined for Whiting, Indiana. The car was interchanged with NS at Mitchell, Illinois, on 03 November 2008, then re-routed and interchanged from NS to UP at Proviso, Illinois, on 08 November 2008.

During an interchange inspection at Proviso on 19 November 2008, UP inspectors bad ordered car UTLX 37605 for a cracked A-end stub sill. On 24 November 2008, a temporary weld repair was made to the stub sill. The repair was not performed at a certified tank car facility. A UP home shop for repair card was placed inside the routing card holder indicating that the stub sill had been temporarily repaired, the car was prohibited from being humped[4] and it was to be transported as the rear car of a train. UP received authority from the car owner, Union Tank Car Company (UTLX), to move the car to a certified repair facility. The car was then waybilled to Procor in Sarnia, Ontario, Canada. No stencils indicating "HOME SHOP FOR REPAIR DO NOT LOAD" were applied to the car.

On 18 December 2008, car UTLX 37605 was interchanged from UP to CN at Proviso, Illinois. The next day, it was placed on departing CN train M-39091-19. The train consist and car waybill notes indicated that UTLX 37605 must be placed as the last car on the train as it was destined for home shop to repair a cracked A-end stub sill. These instructions stayed with the car in the United States as per the original waybill. The car was placed as the tail end car on two subsequent CN trains before reaching Canada. During this time, the car was handled in accordance with the United States Federal Railroad Administration (FRA) regulations.

1.4 UTLX 37605 Movements and Repairs (in Canada)

All subsequent car movements in Canada were performed by CN. Train M-38461-25 arrived at Sarnia on 26 December 2008 with UTLX 37605 on the tail end. After switching out a head-end block of cars, and completing a crew change, the train departed. The block of cars that contained UTLX 37605 was subsequently set off at London, Ontario, and then picked up by train A-43431- 26 and transported to CN's MacMillan Yard in Toronto, Ontario. While the UP home shop for repair card remained in the routing card holder, there were no "Do Not Hump" instructions electronically tagged to this car, at any time, on CN's systems.

Upon arrival at MacMillan Yard, UTLX 37605 received an inbound Certified Car Inspection (CCI), in accordance with Transport Canada (TC) *Railway Freight Car Inspection and Safety Rules*. CN inspectors bad ordered UTLX 37605 for a cracked A-end stub sill on 27 December 2008. Between 27 December 2008 and 02 January 2009, UTLX 37605 was switched seven times and humped four times before being placed on the repair track (E012).

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[3] Tank cars that have been unloaded after carrying dangerous goods are referred to as "residue" cars because there is always product residue remaining in the car unless it has been fully cleaned and purged.

[4] Rail traffic is distributed by flat switching or "humping" rail cars into various tracks for placement on different trains. "Humping" refers to an operation in which rail cars are pushed up a "hump" or hill, then uncoupled and allowed to roll free down an incline with both speed and direction to the appropriate track automatically controlled. During this process, they pass over a weigh scale.

On 03 January 2009, CN mechanical staff performed a temporary weld repair in preparation for forwarding the car to a certified tank car repair facility for stub sill repair. The welders who performed the work were not qualified to weld in the area of the repair and MacMillan Yard is not a certified tank car repair facility. Seven inches of weld was applied to each side of the A-end stub sill. After completing the temporary repair, mechanical staff requested disposition of the car from UTLX and were instructed that the car should be sent to Procor, in Sarnia, as per the original waybill. No “HOME SHOP FOR REPAIR DO NOT LOAD” stencils and no bad order cards were applied to the car. CN did not apply to TC’s Transport Dangerous Goods (TDG) Directorate for an estoppel[5] to move the car because it considered the car safe to move to Sarnia, because neither the tank shell nor appurtenances were damaged.

Between 05 January 2009 and 06 January 2009, UTLX 37605 was switched twice and humped two additional times. During humping operations, when the car was weighed, staff at the CN Customer Service Centre (CSC) in Winnipeg, Manitoba, noticed that it still contained 51 500 pounds of product. Subsequently, on 06 January 2009, staff changed the car load status from residue to loaded and the waybill destination was inadvertently changed from MacMillan Yard to CN’s Symington Yard in Winnipeg, Manitoba.

UTLX 37605 was switched twice more before being placed on train M-31331-08 destined for Winnipeg. On 08 January 2009, the car departed Toronto as the tail-end car and had a consist and waybill note that indicated that the A-end stub sill was cracked and had been temporarily repaired. The train arrived at Symington Yard in Winnipeg on 10 January 2009. The car received a CCI in Symington Yard and no defects were noted. Between 11 January 2009 and 13 January 2009, UTLX 37605 was switched twice and humped once more before the waybilled destination was changed to Procor, Sarnia. Once the car was routed back to Sarnia, the waybill and consist notes indicating the need for end-of-train placement disappeared from CN’s computerized Service Reliability Strategy (SRS) waybilling system. On 14 January 2009, the car was placed as the 41st car on train M-30451-11 that departed Symington Yard at 0203. One and a half hours later, the incident occurred.

After the incident, CN requested an estoppel from the TDG Directorate to move tank car UTLX 37605. On 21 January 2009, CN was granted the estoppel with restrictions for movement. No other estoppels were requested for this car while the car was in Canada, prior to the incident in Dugald. The car was subsequently transported to Symington yard and isolated on a back track.

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5 At the time of the incident, when a means of containment was considered unsafe to move, the shipper could have applied for an estoppel from TDG Directorate to move the car. An estoppel sets forth conditions that must be fulfilled in order for the operator to move the car (the amended TDG Act of June 2009 now refers to these as temporary certificates). Once the car gets to destination and is offloaded and/or repaired, the estoppel can be removed. This would have ensured that TC’s TDG Directorate was informed when DGs were moved in a non-compliant means of containment and that additional conditions were imposed to ensure safe handling.

In February 2009, CN attempted to transfer the remaining product. During this exercise, it became apparent that the product could not be transferred from the car and that the best method for removing the product was to flare it off. Flaring began on the morning of 22 June 2009 and was complete in the afternoon of 25 June 2009. The damaged residue tank car was then loaded on a flat car and transported to Procor in Sarnia for inspection.

1.5 Canadian National's Computerized Information Systems

SRS is CN's computerized waybilling system for managing all facets of car movement and tracking. The SRS system uses a number of condition or defect codes that provide information related to car disposition and car handling instructions. At the time of the occurrence, SRS was configured to record up to seven different, two-position alpha codes (for example, HQ).

To move a car from one location to another, a car is waybilled "to" and "from" with both fields filled in. While in MacMillan Yard, car UTLX 37605 was waybilled both "to" and "from" MacMillan Yard and was therefore repeatedly placed on a switch list for humping. Each time the car was humped, it was scaled, which showed that it contained approximately 51 500 pounds of product. Any car designated as empty or residue that has a content weight of over 35 000 pounds is flagged by the SRS system with an HQ code as well as the notation of "Hold for Desk Review." At CN's CSC, staff search all yards in the system looking for the HQ code. Once a car with the HQ code is identified, staff arrange for the appropriate car disposition, which sometimes means assigning additional codes to the waybill. Within SRS's coding system, handling codes are prioritized. However, a programming issue at the time of the occurrence caused codes in the 6th position to be inadvertently replaced regardless of priority when additional codes were added. Once the limit of seven codes was reached, the next code applied bumped the code in the 6th position off the list.

CN's Mechanical Department uses a SAP platform for record keeping and electronic tagging in place of physically attaching bad order cards to the side of a car. When a car is bad ordered, the car is electronically tagged in both the SRS and the SAP Mechanical systems. Once the car is repaired, the bad order status is removed from both systems and the car is returned to service. When temporary repairs are made to enable a car to be sent to a home shop for repair, the car bad order status is also removed so that the car can be moved to destination. While CN Mechanical staff had the ability to add "Do Not Hump" instructions to the system, in most cases, this is arranged by phone through the CSC or local car load staff. CN Mechanical staff did not apply "Do Not Hump" instructions to tank car UTLX 37605 because the car was destined for Sarnia from Toronto and was not intended to travel to Winnipeg.

1.6 Unloading Pressure Tank Cars

The manway assembly for this car included the manway and lid, 2 liquid valves, 1 vapour valve, 1 safety vent valve, a thermowell, a gauging device and the U-shaped eduction pipe. The eduction pipes fit into the bottom of the excess flow valves which in turn are welded to the bottom of the liquid valves. The eduction pipes are secured to the excess flow valve casings with 3/16-inch fillet welds (see Figure 2). The welds provide a seal and are not meant to be structural. The assembly is placed onto the car so that the liquid eduction pipe sits into two guides welded to the inside of the tank shell bottom. The guides prevent longitudinal pipe movement. The entire assembly is secured to the car by bolts on the top of the tank shell.

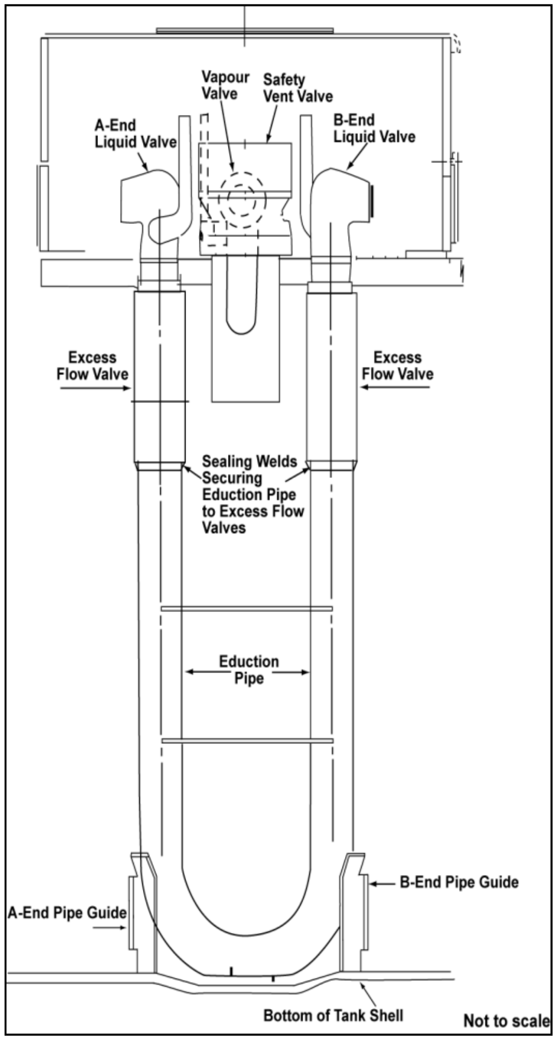

Figure 2. Eduction pipe arrangement

When unloading a pressure tank car, a small amount of air or inert gas pressure (5 to 10 psi above the pressure of the product in the car) is often applied to the tank through the vapour valve. The pressure forces product through an opening in the bottom of the eduction pipe up and out of the open A-end and B-end liquid valves of the car, which face the A-end and B-end of the car respectively.

A loss of eduction pipe integrity permits air or inert gas to move into a valve instead of product, which reduces the amount of product that can pass through the valve. This can significantly increase the time required to offload the car. If the offloading pressure equalizes, or the system sustains a complete loss of integrity, product would no longer be forced into the eduction line and offloading would cease.

In this occurrence, the Grelake, Texas, consignee had no scale and cars were not weighed before and after unloading. The company schedules loaded cars in and moves empty cars out at set durations. After the usual period of unloading, tank car UTLX 37605 was thought to have been unloaded and was then released as a residue car.

1.7 Inspection of Tank Car UTLX 37605

An inspection of UTLX 37605 was conducted on 07 October 2009 at Procor's tank car facility in Sarnia. When the manway was removed, there was no eduction pipe connected to the excess flow valves (see Photo 2).

Photo 2. UTLX 37605 manway (top) compared to a similar complete manway arrangement (bottom)

The inspection revealed the following:

- The sealing welds securing the eduction pipe to both the A-end and B-end excess flow valves had failed.
- The pipe guides were bent out of position and the eduction pipe was lying in the bottom of the car.
- The A-end guide itself was bent horizontally along the bottom of the tank. One of the welds securing the A-end guide was broken. The fracture surfaces were heavily oxidized, which suggests that they had been in this condition for some time.
- The B-end guide remained intact but was bent slightly out of position.
- Corresponding gouge marks were observed on the rim of the B-end liquid valve casing and the B-end pipe.

1.8 Association of American Railroads Field Manual of the Interchange Rules

To facilitate shipment of products, freight cars are interchanged freely between railways in North America provided that the cars meet the minimum requirements set forth in the Association of American Railroads (AAR) *Field Manual of the Interchange Rules*. When a car is interchanged, mechanical staff from the receiving railway may conduct an AAR inspection before accepting the car. Any car found with an AAR defect can be prohibited from interchange or bad ordered for repairs at that time.

The AAR rules that apply when interchanging cars with known AAR defects include:

- Rule 80 – When a Home Shop Stencil or decal is applied, the phrase "HOME SHOP FOR REPAIRS DO NOT LOAD" must be in at least 2-inch letters and applied to each side of the car adjacent to the car number.

- Rule 81 – On tank cars without continuous center sills (stub sill design), welding of cracks in the parent metal of the stub sill structural members, or in sill-to-pad welds, is not permitted if any portion of the cracks are within 12 inches of the attachment of the stub sill to the tank reinforcing pad except welding which is performed by welders qualified in accord with the AAR's Specifications for Tank Cars and by an AAR M-1002/M-1003 (tank car) certified facility.

- Rule 92 – Cars to which temporary repairs are made to avert transfer of lading must be sent to a home shop specified by the car owner and that a "HOME SHOP FOR REPAIRS DO NOT LOAD" stencil or decal must be applied on each side of the car adjacent to the car number in at least 2-inch high letters.

- Rule 108 – Only partial or temporary repairs should be made in order to safely move a car home on its own wheels. As outlined in Rule 80, a "HOME SHOP FOR REPAIRS DO NOT LOAD" stencil or decal, must be applied on each side of the car adjacent to the car number. In addition, Bad Order—Home for Repair cards must be attached to each side of the car with the notation "HOME FOR REPAIRS – RULE 108 – DO NOT LOAD."

1.9 Railway Freight Car Inspection and Safety Rules

The *Railway Freight Car Inspection and Safety Rules* outline the minimum safety standards for freight cars operated by federally regulated railway companies. Part I – General, Subsection 3 of the rules defines a "bad order card" or "home shop card" as a railway company form that is affixed to a freight car to indicate maintenance requirements upon which safety defects identified during a safety inspection may be recorded. It further defines:

- A "bad order information system" as any method, computerized or otherwise, by which a railway company can control and protect the movement of a car with defects without the use of a bad order or home shop card; and

- A "safety inspection" (Certified Car Inspection or CCI) as an examination of a freight car while stationary by a certified car inspector or a person in charge as defined herein, to verify that it may be moved safely in a train, and to identify those defects listed in Part II of these Rules.

Subsection 4 notes (in part) that a railway company shall ensure that the freight cars it places or continues in service are free from all safety defects described in Part II of the rules. However, a railway car identified with safety defects may be moved to another location for repair, which includes unloading a car, when an authorized person in charge ensures the car is safe to move and a means to protect the car's safe movement is implemented. This protection includes identifying the defect for the employees involved in handling the car, the nature of the defects and the movement restrictions. It further outlines that the movement of a car with safety defects shall be controlled and protected by the use of a bad order information system, or by the use of a bad order or home shop card.

Part II, Subsection 15 (c) of the rules states (in part) that a railway company may not place or continue a car in service if a tank car stub sill:

- is broken;
- has any crack in the parent metal;
- has a transverse weld that is cracked more than 3 inches (76.2 mm) or is missing;
- has a longitudinal weld that is cracked more than 6 inches (152.40 mm) or is missing; or
- has a weld that is cracked or missing where the total length cannot be measured.

There is no requirement to report a cracked or broken stub sill to TC.

1.10 Transportation of Dangerous Goods Act and Regulations

The *Transportation of Dangerous Goods Act* (TDG Act) does not contain construction standards for tank cars. The Act's regulations reference the Canadian General Standards Board (CGSB) requirements set forth in the National Standard of Canada CAN/CGSB-43.147 – 2005 Standard for the "Construction, Modification, Qualification, Maintenance, and Selection and Use of Means of Containment for Transport, or the Handling, Offering for Transport, or Transporting of Dangerous Goods by Rail."

In this occurrence, the means of containment was tank car UTLX 37605. In accordance with the TDG Regulations, tank cars in service in Canada must meet the CAN/CGSB-43.147 – 2005 Standard. A cracked or broken stub sill does not meet the Standard.

Under the TDG Regulations:

- There is no requirement to report a cracked or broken stub sill.

- There is no requirement to apply a "HOME SHOP FOR REPAIR DO NOT LOAD" stencil to a tank car with stub sill damage.

- Section 3.5 (4) of the TDG Regulations states (in part) that "The quantity of dangerous goods in a means of containment may be described as "Residue — Last Contained" if that quantity is less than 10 per cent of the maximum fill limit of the means of containment."

1.11 Stub Sill Information

In tank cars, the tank shell is the car superstructure to which stub sills are fastened at each end of the tank shell by welding and/or bolting. The stub sills contain draft components and become the focal points for in-train dynamic buff and draft forces, as well as coupler vertical forces. Tank car stub sills must meet specific design criteria. These designs must meet minimum AAR standards as set out in AAR M1001, C-II, Chapter 6, but are otherwise specific to the car builder and the arrangements can vary in detail.

In the early 1990s, regulators in the United States and Canada became increasingly concerned with the high incidence of fractures and failures associated with stub sills. As a result, a number of Canadian Protective Directions and United States Emergency Orders were issued mandating safety inspections of the significant portion of the North American fleet. The AAR was requested to come up with a solution to the problem with its industry partners. To remedy the situation, the industry implemented a number of initiatives that resulted in the requirement that all tank car stub sills be inspected for cracking at least once every 10 years. There are various non-destructive test methods used for stub sill inspection. These inspection methods include visual, liquid dye penetrant, wet fluorescent magnetic particle and ultrasonic testing. The vast majority of these inspections are conducted visually, complemented with other non-destructive testing (NDT) methods only if a defect is noted. After each inspection, an AAR SS3 Stub Sill Inspection form must be completed. Repairs made to stub sills are documented on an AAR R-2 form. Both forms are submitted to the AAR.

1.12 Tank Car UTLX 37605 – Background

Union Tank Car Company (UTLX) was the owner and builder of car UTLX 37605. The car was a pressure tank car built in December 1970 to specification DOT 112A400W. This was an uninsulated carbon steel pressure tank car equipped with top and bottom shelf couplers. These types of cars are designed for loading of liquefied compressed gases and may also be used for other liquids. The 400 in the specification represents the tank test pressure in pounds per square inch. The car's specification was later changed to DOT 112J400W after fire-resistant insulation and jacketing was added. Stenciling applied to the car designated its contents as non-odorized propylene. The car was equipped with UTLZBN design stub sills. UTLX last performed a visual stub sill inspection, in accordance with AAR requirements, on 01 March 2004, during which no cracks were detected.

The tank heads and shell were constructed with AAR approved TC-128 Grade B steel. The shell was 0.728-inch-thick material while the heads were made of 0.750-inch-thick material. The car had gross weight on rail load (GRL) limit of 263 000 pounds; it had a light weight of 108 500 pounds with a capacity to carry either 154 500 pounds, or 128 272 litres, of product. Based on historical Wheel Impact Load Detector (WILD) data obtained by UTLX for this car, it was typically empty at 110 000 pounds and typically loaded at 240 000 pounds GRL. Since May 2008, the car made at least two trips with partial loads of about 160 000 pounds GRL, which correlates to approximately 51 500 pounds of product remaining in the car.

In September 2004, UTLX 37605 was involved in a minor derailment in which the B-end of the car was reported derailed. Railway billing records indicate that the B-end was lifted and the bearings of wheel sets number 1 and 2 were inspected. Tank jacket damage, consistent with the B-end being lifted, was observed during TSB inspection following the incident. There was no subsequent report of any damage or repair to the A-end of the car.

1.13 UTLZBN Stub Sill Design

UTLZBN stub sills were designed by UTLX and are constructed of A-572, non-normalized, Grade 50 steel. The design incorporates two Z-Beams, each with a weight of 41 pounds per foot, which are welded together longitudinally along the top. The assembly is secured by weld to a pad which in turn is welded to the tank shell. In the mid 1990s, the AAR design criteria for stub sills were modified to reflect changes in train operations and a move towards 286 000 pounds GRL capacity cars. Subsequently, UTLX replaced the UTLZBN design with a more robust stub sill design.

The new design incorporated two A-572 Grade 50 steel Z-Beams, each with a weight of 51 pounds per foot, which are normalized or control cooled. Stub sills constructed with this material are designated as the UTLZBG design. The requirements are outlined in the *AAR Manual of Standards and Recommended Practices*, Section C, S-259 (currently known as S-286) for tank cars. To date, there have been no catastrophic failures of the UTLZBG stub sill design.

Within the North American tank car fleet of approximately 325 000 cars, there are about 65 different stub sill designs. About 41 000 of these tank cars (13 per cent) are equipped with the UTLZBN stub sills; approximately 35 000 of these are in DG service.

1.14 Effect of In-Train Forces

Throughout the time that UTLZBN stub sills were constructed, an average train in main track service was about 5000 feet long and weighed 6000 to 7000 tons. In contrast, some of today's trains are over 12 000 feet long and weigh over 10 000 tons with associated increases in normal in-train buff and draft forces for conventional trains equipped with head-end power. These increased forces are distributed throughout the train and, in some cases, can result in rolling stock damage, train pull-aparts, and/or derailment. Consequently, in March 2010, the Board included "the operation of longer, heavier trains" as a safety issue in its Watchlist.

1.15 Other Stub Sill Failures

On 23 June 2008, a stub sill on tank car UTLX 37671 completely severed from the car during normal CN train operations in Wabamun, Alberta. Through normal AAR billing procedures, CN contacted UTLX to arrange disposition of the car. After discussions between CN and UTLX AAR billing staff, the car was subsequently scrapped with no record of the stub sill failure. At no time were UTLX fleet engineering staff consulted.

On 19 May 2009, tank car UTLX 27545 loaded with chlorine (UN 1017) was at a chemical plant in Bécancour, Quebec, for offloading when the consignee reported that the B-end stub sill was broken. The car was built in 1983 to the 105J500W specification and was equipped with a UTLZBN design stub sill. The last stub sill inspection on this car was performed in 2006. The broken stub sill was shipped to the TSB Laboratory for failure analysis.

A review of tank car stub sill failure records from CN and UTLX revealed that:

- In Canada and the United States, between January 2004 and June 2009, a total of 35 UTLX tank cars were reported with broken stub sills that had separated from the car. All of these stub sills were of the UTLZBN design. In 23 of the 35 cases, there was some indication of higher-than-usual impacts (see Appendix A – UTLX Reported Broken Stub Sills [January 2004 – June 2009]).

- In Canada, between January 2004 and June 2009, a total of 58 tank cars were bad ordered for cracked (50) or broken (8) stub sills. The stub sill failures occurred in different classes of tank cars carrying various products (see Appendix B – UTLX and CN Reported Cracked/Broken Stub Sills in Canada [January 2004 – June 2009]).

    - Of the 58 failed stub sills, 25 (43 per cent) were of the UTLZBN design.

    - Of the 25 UTLZBN stub sills, 17 were cracked and 8 had sustained catastrophic failure. A total of 22 of these stub sills had been in service for 20 years or more.

    - Of the 8 catastrophic failures, 6 had occurred within the 13-month period between May 2008 and May 2009. In a number of these cases, TC TDG Directorate was not informed that the failures occurred, nor were they required to be.

1.16 TSB Laboratory Examination

The TSB Laboratory conducted an analysis of the failed stub sill from tank cars UTLX 27545 and UTLX 37605. A summary of the results is presented below.

1.16.1 Stub Sill Failure (B-End) on Tank Car UTLX 27545

The examination revealed the following:

- Repairs consistent with a previous B-end derailment were observed. There were jacket patches, car bolster repairs, contact between the axle and the draft gear carrier plate bolts and repairs to the B-end platform. Residues consistent with a previous liquid dye penetrant inspection (LPI) were observed on the tank-to-pad weld and the pad-to-head brace weld. There was no residue on the head brace-to-sill weld.

- The stub sill failed in successive overstress fractures.

  - The oldest and therefore primary failure was the left side head brace-to-sill fracture. Although most of the fracture surface details had been obliterated by corrosion and rubbing of mating fracture faces, pockets containing chevrons indicated that the direction of crack propagation was outboard, toward the coupler. Extensive corrosion damage precluded determination of the origin of this fracture.

  - A metallurgical discontinuity, which resembled a delamination or seam, was observed in the parent stub sill material. A fracture adjacent to the discontinuity exhibited clear fracture details. The reduced level of corrosion indicated that this fracture likely occurred sometime later and is considered secondary. The discontinuity itself was likely not the cause of the primary fracture but did serve to locate secondary fractures.

  - The absence of corrosion and the presence of defined fracture features of both the horizontal fracture on the right side of the stub sill and the vertical fractures down the sides of the stub identify these as being the most recent fractures.

- The absence of gross plastic deformation combined with the initiation location and crack propagation direction of the secondary fractures suggests that torsional stresses played a role in the overstress rupture of the subject stub sill. The inherent axial stiffness of tank cars combined with the prior derailment damage suggests that high torsional stresses may have occurred in a previous event.

1.16.2 Stub Sill Failure (A-End) on Tank Car UTLX 37605

The examination revealed the following:

- A significant amount of plastic deformation was observed on the sides adjacent to the fracture. The draft gear stop reinforcing ribs had buckled and torn away from both sides of the stub sill and the draft gear stops were deformed. The striker face and coupler carrier exhibited damage that was consistent with impact forces from the coupler. All of these features are consistent with long-term heavy impact damage (see Photo 3).

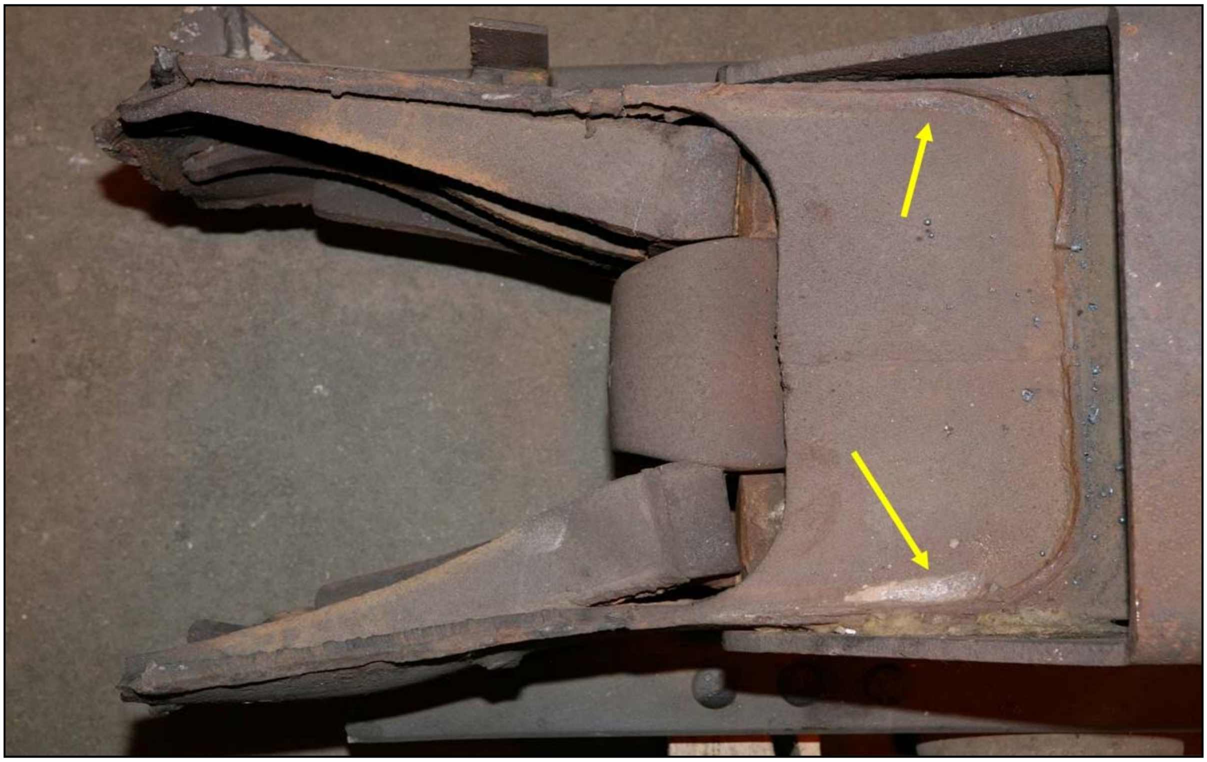

Photo 3. Top of stub sill showing plastic deformation. Head brace-to-sill contact is visible (arrows).

- The A-end draft gear was removed and examined. It was a Cardwell Westinghouse Mark 50, reconditioned in August 1998 by Independent Draft Gear in Farrel, Pennsylvania. It was installed in UTLX 37605 by Procor in Sarnia, Ontario, in October 1998. The rear of the draft gear housing had mushroomed and exceeded dimensional tolerances. Prior to disassembly, the draft gear passed a qualitative 36 000-pound impact test. Disassembly of the draft gear revealed that:
    - Both tapered stationary plates were installed backwards such that the tapered friction face did not match with the wedge shoe.
    - A new 20-degree centre wedge was installed with an old 12-degree spring seat.
    - The four corner coil springs failed the free length measurement.[6]
    - The left-side outer stationary plate, both internal stationary plates and both wedge shoes were worn beyond condemnable limits.

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6 This test involves removing the springs and measuring their length with the springs standing free. Springs that do not meet the minimum length requirements are considered condemnable under reconditioning criteria.

- The stub sill failed in successive overstress fractures (see Photo 4).

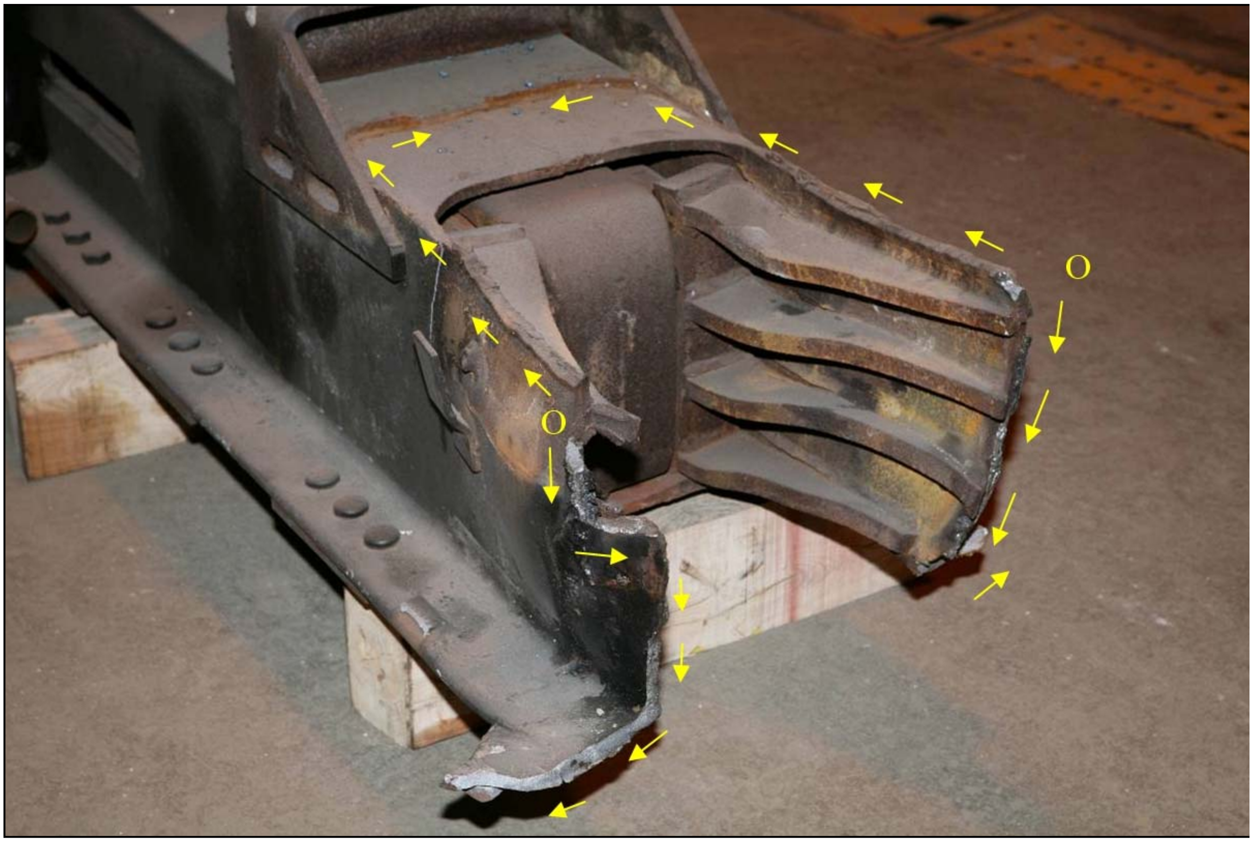

Photo 4. View of stub sill fracture, left side. Origin areas are indicated with "O" and the directions of crack propagation are indicated with arrows.

- The primary failure was the head brace-to-sill fracture. Corrosion and rub damage was observed between the mating fracture surfaces, which suggest that the fracture existed for some time prior to the final failure. The fracture initiated in the stub sill material near the extremities of the top reinforcing rib of both rear draft stops. The fracture then propagated rapidly outboard, towards the coupler, on both sides separating the head brace from the stub sill.

- Secondary fractures occurred down the sides of the stub sill and had been weld repaired. The welds extended about ten inches up each side and stopped at the tank jacket, less than four inches from the tank shell. The general shape of the weld deposits suggests that the stub sill was plastically deformed at the time of the last repair.

- Final fracture occurred when the repair welds fractured and the remainder of the sill separated.

- The stub sill had a bracket affixed to the sill just outboard of the head brace. This bracket mates with a similar one on the car jacket. The B-end of the car shows the original configuration (see Photo 5). Examination of the A-end bracket indicated that the welds attaching it to the stub sill were original and had not been disturbed. This suggests that the bracket was in place during the last stub sill inspection (2004), which would have made visual inspection of the lower head brace weld difficult at best.

Photo 5. Bracket covering head brace

2.0 Analysis

2.1 Introduction

Neither the handling of train M-30451-11 nor track infrastructure in the vicinity of the occurrence played a role in this incident. The analysis will focus on the movements of tank car UTLX 37605, waybilling and car tracking systems, tank car stub sill failures and TC TDG Regulations.

2.2 The Incident

After DG tank car UTLX 37605 was bad ordered by UP, it was placed as the tail-end car on successive trains until 14 January 2009, when it was placed as the 41st of 72 cars on train M-30451-11 in Winnipeg. As the train proceeded eastward destined for Toronto, it accelerated slowly to about 4 mph until an undesired emergency application of the train air brakes occurred. Under normal operating conditions, the A-end stub sill of car UTLX 37605, located in the 41st position of the 72-car train, broke just behind the rear draft gear stop blocks and separated from the car, resulting in an undesired emergency brake application.

UTLX 37605 had a visual stub sill inspection in March 2004 with no defects noted. By November 2008, the A-end stub sill had fractured and displayed a significant amount of deformation which was consistent with long-term heavy impact damage. The stub sill failed after successive overstress fractures. The primary failure was the head brace-to-sill fracture. Corrosion and rub damage to the mating fracture surfaces suggests that the fracture existed, and went undetected, for some time prior to the failure. The fracture initiated on the interior of the sill, near the extremities of the top reinforcing rib of both rear draft stops, and then propagated rapidly outboard, separating the head brace from the stub sill. The location of the initial fracture origin made its early detection unlikely. The fractures then progressed down the sides of the stub sill and were temporarily weld repaired, twice. Final failure occurred in the temporary weld repairs when normal draft forces exceeded the load capacity of the remaining stub sill cross-section.

A UP home shop for repair card was placed inside the UTLX 37605 routing card holder on 24 November 2008. The card noted that the A-end stub sill had been temporarily repaired, prohibited the car from being humped and required it to be transported as the rear car of a train. While the defect card remained inside the routing holder, there were no “Do Not Hump” instructions electronically tagged to this car, at any time on CN systems. UTLX 37605 arrived in Sarnia as the tail-end car of CN train M-38461-25 on 26 December 2008. However, even though the car had arrived at its waybilled destination, it remained on the train, and departed Sarnia after a change of train crew.

UTLX 37605 was subsequently transported to CN’s MacMillan Yard in Toronto. The car was again bad ordered for a cracked A-end stub sill, and between 27 December 2008 and 02 January 2009, was switched seven times and humped four times before the stub sill was weld repaired. After the repair, the car was again waybilled to Sarnia. Because the temporary repairs were complete, the bad order status was removed from CN’s systems and the car was essentially returned to service with only waybill and consist notes. Between 05 January 2009 and 06 January 2009, the car was switched twice and humped two more times before CN noticed that it still contained 51 500 pounds of product.

On 06 January 2009, the CN CSC changed the car load status from residue to loaded and the waybill destination was inadvertently changed from Sarnia to Winnipeg. As per waybill and consist notes, the car was subsequently placed as the tail-end car on CN train M-313331-08 destined for Winnipeg. Upon arrival, UTLX 37605 was switched twice and humped again before its destination was changed to Sarnia and the car placed in the 41st position on CN train M-30451-11 on 14 January 2009.

After receiving the car in interchange, tank car UTLX 37605 remained in service for 27 days. During this time, there were numerous opportunities to intervene, prohibit the car from being humped and safely transport to Sarnia. However, deficiencies in CN's waybilling and car tracking systems permitted the car to be placed on 6 different trains, switched at least 13 times and humped 7 times with a severely damaged and cracked A-end stub sill.

At the time of the occurrence, SRS was capable of recording up to seven different, two-position alpha codes. However, the system was not functioning properly and, consequently, when additional codes were applied, the code in the 6th position was bumped off the list. Therefore, when the car was routed back to Sarnia from Winnipeg, the application of the routing code automatically removed the *tail end only* restriction from tank car UTLX 37605. With the restriction removed, the car was placed in the 41st position of CN train M-30451-11, where the A-end stub sill subsequently failed after the train departed Winnipeg.

2.3 Temporary Repairs and Estoppels

The UTLX 37605 A-end stub sill had been temporarily weld repaired by UP, and then a second time by CN after it had bad ordered the car and humped it four times with a broken stub sill. The repair welds to the sides of the stub sill were performed after the head brace had separated and there was already extensive sill deformation. The welding stopped at the jacket at a point less than four inches from the tank shell. The weld repairs were performed by staff not qualified to weld on tank cars at a facility that was not approved to perform the repair.

In both cases, the car owner approved movement of the car following the temporary repair. Both AAR Rule 108 and Subsection 4 of the *Railway Freight Car Inspection and Safety Rules* permit the partial or temporary repairs in order to safely move a car home on its own wheels.

The extensive damage that was already present on the A-end stub sill is considered a non-conformity under the TDG Regulations and a safety defect under the *Railway Freight Car Inspection and Safety Rules*. Therefore, at a bare minimum following the temporary repair, an estoppel should have been obtained before UTLX 37605 was moved. However, CN did not apply to the TDG Directorate for an estoppel until after the failure occurred.

In situations like this, an estoppel fulfills several purposes. It protects the handling railway from prosecution for moving a non-compliant car. Once an estoppel is obtained, the railway DG supervisor also becomes involved and is responsible for monitoring and tracking the car. The estoppel also provides a means for the TDG Directorate to track a damaged DG tank car and ensure its safe handling. Had an estoppel been obtained, there would have been additional overview to facilitate the safe handling of UTLX 37605 and the risk of failure would have been reduced.

2.4 UTLZBN Stub Sill Failures

There are approximately 65 different stub sill designs on some 325 000 tank cars in North America. About 41 000 of these tank cars (13 per cent) are equipped with the UTLZBN design stub sills. The two stub sills inspected on UTLX 37605 demonstrated features consistent with heavy impact damage during handling. Furthermore, the industry acknowledges that, during their service life, all tank cars can periodically be exposed to rough handling and stub sill failures can occasionally occur.

One might expect that stub sill failures would be proportional to the number of cars in service with a specific stub sill design. For example, if a particular stub sill design represents 10 per cent of the population, it should account for about 10 per cent of the failures. In this case, cars equipped with UTLZBN design stub sills represent 13 per cent of the total tank car population; yet, since January 2004, they account for 34 per cent (17 of 50) of the cracked stub sills and 100 per cent (8 of 8) of the broken stub sills in Canada. This suggests that the UTLZBN stub sill design has an increased risk of failure.

In 65 per cent of the reported failures (23 of 35), there was evidence of higher-than-usual impact. While rough handling can play a role in stub sill failures, it is also likely that today's operating environment is a contributing factor. Increases in train length and tonnage have resulted in associated increases in normal in-train buff and draft forces for conventional trains equipped with head-end power. There are ways to minimize in-train forces through the use of additional measures such as distributed power and more rigorous train marshalling. However, without these additional measures, the operation of longer, heavier trains equipped with head-end power increases the risk of damaging tank car stub sills manufactured to older design criteria, which may then be more susceptible to failure.

2.5 Reporting of Failed Stub Sills

It is difficult to access accurate numbers on stub sill failures because there is no single repository for that information. In this case, even the car owner was unsure as to how many cars equipped with its UTLZBN stub sill design had failed. After a stub sill failure, decisions as to car disposition are normally made by the AAR billing department of the respective companies. In cases where tank cars sustain broken stub sills, the cars are often scrapped because of their age and the car owner's engineering group is not always consulted. Consequently, tank cars are scrapped with no record of the stub sill failure occurring. As a result, car owners, the AAR and regulators may not have adequate information with regards to the frequency and critical nature of these stub sill failures.

Stub sill AAR R-2 repair reports and SS3 inspection reports do not necessarily capture cracked or broken stub sill information. In addition, there is no requirement to report a cracked or broken DG tank car stub sill to the AAR or to the regulator. In contrast, the AAR requires that standard reports be completed and submitted for various mechanical component failures, including axles (MD-12), wheels (MD-115), overheated roller bearings (MD-11), and truck sides and bolsters. These reports are regularly evaluated and, in some cases, have resulted in safety-related circulars being issued by the AAR for the recall or monitoring of potentially defective components. Without an industry or regulatory protocol to record and analyze data on cracked or broken DG tank car stub sills, there is an increased risk that problematic stub sills (in particular, designs susceptible to failure) will not be identified and will remain in service.

2.6 Stub Sill Inspection

The primary fracture for both stub sills examined occurred in the head brace-to-sill weld. While the sampling is small, this suggests that thorough stub sill inspection in this area is critical to detect cracks during mandated stub sill inspections. During examination of the B-end stub sill from car UTLX 27545, residues consistent with a previous liquid dye penetrant inspection (LPI) were observed on the tank-to-pad weld and the pad-to-head brace weld, but no residue was present on the head brace-to-sill weld. In the case of A-end stub sill from UTLX 37605, part of the brace-to-sill weld was obscured by a bracket that remained in place during the 2004 stub sill inspection. Furthermore, the fracture origins for UTLX 37605 were near the extremities of the top reinforcing rib of both rear draft stops, on the interior of the sill, in areas that are difficult to inspect visually.

Cracks periodically occur in all types of tank car stub sill designs. Consequently, the industry has taken steps to detect cracked stub sills before they fail by requiring that stub sill inspections be performed on all tank cars at least every 10 years. There are various non-destructive test methods in place for these inspections, but the vast majority of them consist of only a visual examination with other non-destructive testing (NDT) methods performed only if a defect is noted. Other industries (for example, aviation and marine) use NDT methods other than visual as the first line of inspection for critical components. Relying primarily on visual detection of cracks in an area prone to fracture may not offer the desired safeguard for early detection of an impending stub sill failure. Visual examination is limited by the visual acuity of the inspector, and the effectiveness of the examination is further affected by areas that are difficult to access or that have components remaining in place during the exam. While visual inspections at 10-year intervals may be adequate for most tank car stub sills, it may not be sufficient for tank cars equipped with UTLZBN design stub sills, which have an increased risk of failure.

2.7 Bad Order Information Systems

Subsection 4 of the *Railway Freight Car Inspection and Safety Rules* specifies that "the movement of a car with safety defects shall be controlled and protected by the use of a bad order information system, or by the use of a bad order or home shop card." In accordance with these rules, CN uses an electronic system to identify and track freight cars with safety defects. This removes the requirement for CN to physically affix "Home Shop" decals or bad order cards to freight cars. AAR rules 80, 92 and 108 all require that stencils or decals with the phrase "HOME SHOP FOR REPAIRS DO NOT LOAD" be applied to each side of the car, adjacent to the car number.

When car UTLX 37605 was interchanged from UP to CN at Proviso, Illinois, on 18 December 2008, there were notations on the waybill for safe car handling; however, there were no stencils or decals applied to the car.

Electronic Bad Order Information Systems are, in many cases, an improvement over the manual (that is, more labour intensive) systems. However, this may not be the case when cars with safety defects carrying DGs are involved. Due to the nature of the products involved, cars transporting DGs have additional risks that railway personnel should be aware of to ensure safe handling. From the time the car was received by CN on 18 December 2008 until the A-end stub sill failed on 14 January 2009, there were a number of opportunities to identify and properly handle this car. Yet, it went virtually unnoticed in the field until the incident occurred. This suggests that an over-reliance on a solely electronic bad order system eliminates important secondary defences for DG tank cars. The absence of visual cues, such as bad order cards or "HOME SHOP FOR REPAIR" stencils that alert railway personnel to car conditions that require special attention, increases the risk that damaged cars can remain in service.

2.8 *Identifying Residue Tank Cars*

The TDG Regulations indicate that a DG tank car may be described as "residue" if the quantity of the product remaining in the tank car is less than 10 per cent of its maximum fill limit. Generally, a 100-ton freight car has a GRL of 263 000 pounds and a light weight of about 63 000 pounds. A car with this capacity would be able to carry 200 000 pounds (100 tons) of product. Using this model, a 100-ton car containing less than 20 000 pounds of DG product would be classed as a "residue" while product weighing over 20 000 pounds would be considered a "load." This is not necessarily true for DG tank cars. Tank car UTLX 37605 had a GRL of 263 000 pounds and a light weight of 108 500 pounds. Due to the weight of the car, it was limited to carrying 154 500 pounds of product. Therefore, according to TDG Regulations, this car should be considered a load any time it contains more than 15 450 pounds of product.

The United States consignee had no weigh scale and normally moved cars based at scheduled intervals. Using this procedure, after a set time, it was assumed that UTLX 37605 was empty and it was moved without any verification by the consignee or the railways. Had the weight of the car been noted during humping operations, or otherwise, the offloading problem may have been detected earlier. Between May 2008 and January 2009, this car was misidentified as an "empty" (United States) or a "residue"(Canada) car by at least three different Class 1 railways, on multiple train consists and waybills. During numerous switching, humping and repair operations, the car was handled by various railway staff who were unaware that the car still contained at least 51 500 pounds of propylene, which equates to about 45 per cent of its load capacity. The lack of an integrated system that verifies the loaded condition of a DG tank car presents a risk of misidentifying a car as "residue" when significant amounts of product remain. This has a commensurate risk to railway employees and first responders who may not be adequately informed on the dangers of transporting that volume of product.

2.9 *Difficulties Unloading UTLX 37605*

Historical WILD records identified that UTLX 37605 had been travelling partially loaded since May 2008, indicating that the problem with the eduction piping had likely originated before then and was present at that time. Due to the improperly reassembled A-end draft gear, the gear's ability to absorb high buff and draft forces was likely compromised. Under these conditions, forces would be transferred through the stub sill to the tank car body and appurtenances. One of the welds securing the A-end eduction pipe guide to the tank shell failed and the guide bent completely out of position. With the A-end guide out of position at the bottom of the car, the bottom of the eduction pipe began to move with the buff and draft movements of the car. This resulted in the failure of the sealing weld that secured the B-end pipe to the liquid valve. Corresponding gouge marks observed on the pipe end and the rim of the liquid valve casing suggest that the B-end pipe became displaced from the valve casing and partially lodged on the bottom of the valve rim.

With the B-end pipe displaced from the liquid valve, the car could not be fully pressurized and consequently was only partially unloaded by the Grelake, Texas, consignee in October 2008. The fact that the car was able to be partially unloaded in October 2008 but could not be unloaded following the incident of 14 January 2009 suggests that the eduction pipe completely disconnected from the valves in that three-month period. During this time, the car was subject to regular switching until it ended up in CN's MacMillan Yard in Toronto where it was repeatedly humped with a cracked A-end stub sill. During this period of handling, it is likely that the weld securing the eduction pipe to the A-end valve failed and the pipe fell to the bottom of the tank. Subsequently, no product could be offloaded from the car in Winnipeg after the incident.

2.10 Draft Gear Assembly

Two of the internal components of the UTLX 37605 A-end draft gear were installed in reverse when it was reconditioned in 1998. This improper assembly reduces the dampening effect of the draft gear and can result in higher-than-usual impacts during normal switching and humping operations. Although the draft gear passed the qualitative impact test before disassembly, it may not have done so when first assembled. It is believed that the performance of the draft gear may have improved as the mating surfaces wore in and the contact area approached that of a properly assembled draft gear.

However, the improperly assembled draft gear may have played a role in the deformation of, and damage to, the stub sill. The extensive deformation and tearing of the draft gear lugs as well as the stub sill sides indicate that the car experienced long-term, higher-than-usual impact forces. This suggests that, periodically, the draft gear may not have functioned as intended. Given these circumstances, the reduced dampening effect of the improperly assembled draft gear could have contributed to the stub sill damage.

The following TSB Laboratory reports were completed:

LP048/2009 – Examination of Failed A-end Stub Sill from UTLX 37605

LP081/2009 – Examination of Failed B-end Stub Sill from UTLX 27545

These reports are available from the Transportation Safety Board of Canada upon request.

3.0 Conclusions

3.1 Findings as to Causes and Contributing Factors

1. The incident occurred under normal operating conditions, when the A-end stub sill of car UTLX 37605, located in the 41st position of the 72-car train, broke just behind the rear draft gear stop blocks and separated from the car, resulting in an undesired emergency brake application.

2. The stub sill failed after successive overstress fractures. The fracture initiated near the extremities of the top reinforcing rib of both rear draft stops and then propagated down the sides. The sides were weld repaired and the final failure occurred in the welds when normal draft forces exceeded the capacity of the remaining stub sill cross-section.

3. UTLX 37605 was not set off at its destination of Sarnia, Ontario (December 2008), even though it was the tail-end car on the train that had stopped in Sarnia for a crew change.

4. Deficiencies in Canadian National's (CN) waybilling and car tracking systems permitted tank car UTLX 37605 to be placed on 6 different trains, switched at least 13 times and humped 7 times with a severely damaged and cracked A-end stub sill.

5. When UTLX 37605 was routed back to Sarnia from Winnipeg, Manitoba, the application of the routing code automatically removed the *tail end only* restriction. With the restriction removed, the car was placed in the 41st position of CN train M-30451-11, where the A-end stub sill subsequently failed after the train departed Winnipeg.

3.2 Findings as to Risk

1. Had an estoppel been obtained, there would have been additional overview to facilitate the safe handling of UTLX 37605 and the risk of failure would have been reduced.

2. Statistics for stub sill failures in Canada suggest that, since 2004, the UTLZBN stub sill design has an increased risk of failure.

3. Without additional measures to minimize in-train forces, the operation of longer, heavier trains equipped with head-end power increases the risk of damaging tank car stub sills manufactured to older design criteria that may then be more susceptible to failure.

4. Without an industry or regulatory protocol to record and analyze data on cracked or broken dangerous goods tank car stub sills, there is an increased risk that problematic stub sills (in particular, designs susceptible to failure) will not be identified and will remain in service.

5. While visual inspections at 10-year intervals may be adequate for most tank car stub sill inspections, it may not be sufficient for tank cars equipped with UTLZBN design stub sills that have an increased risk of failure.

6. An over-reliance on a solely electronic bad order system eliminates important secondary defences for dangerous goods tank cars. The absence of visual cues, such as bad order cards or "HOME SHOP FOR REPAIR" stencils, which alert railway personnel to car conditions that require special attention, increases the risk that damaged cars can remain in service.

7. The lack of an integrated system that verifies the loaded condition of a dangerous goods tank car presents a risk of misidentifying a car as "residue" when significant amounts of product remain. This has a commensurate risk to railway employees and first responders who may not be adequately informed on the dangers of transporting that volume of product.

3.3 Other Findings

1. The B-end eduction pipe of car UTLX 37605 had become displaced from the liquid valve. Consequently, the car could not be fully pressurized and could only be partially unloaded.

2. Car UTLX 37605 was repeatedly humped with a cracked A–end stub sill. During this period of handling, the weld securing the eduction pipe to the A-end valve failed and the eduction pipe fell to the bottom of the tank. Consequently, no product could be offloaded from the car following the incident.

3. The reduced dampening effect of the improperly assembled draft gear could have contributed to the stub sill damage.

4.0 Safety Action

4.1 Action Taken

4.1.1 TSB Rail Safety Advisory 08/09

On 10 November 2009, the TSB issued Rail Safety Advisory (RSA) 08/09. The RSA identified that cars equipped with UTLZBN design stub sills represent 13 per cent of the total tank car population. Yet, since January 2004, they account for 29 per cent (17 of 58) of the cracked and broken stub sills and 100 per cent (8 of 8) of the broken stub sills in Canada. Given the risks associated with an in-service failure of a tank car stub sill, the RSA indicated that Transport Canada (TC) may wish to review the adequacy of the current stub sill inspection criteria for tank cars equipped with the UTLZBN design.

On 14 December 2009, TC responded that the TSB findings point to a number of issues that TC is currently investigating further, together with the United States Federal Railroad Administration (FRA), the Association of American Railroads (AAR), and tank car builders, in order to obtain a better comprehension of these potential problems and determine if any short-term or long-term regulatory action is required. TC will continue to monitor tank car stub sills closely, particularly those with the features outlined in the TSB RSA.

With respect to the "adequacy of the current stub sill inspection criteria for tank cars," TC outlined its current program related to stub sill inspection. TC will assess the need to improve this process with respect to procedures, frequency and/or monitoring compliance.

On 07 December 2009, a conference call was held to discuss the UTLZBN stub sill issue. Call attendees included representatives from the TSB, TC's Transport Dangerous Goods Directorate, FRA and AAR. After discussion, it was determined that the Union Tank Car Company (UTLX) participation was required for further follow-up. On 16 December 2009, a second call that also involved UTLX was held. A UTLX presentation provided a briefing on the UTLZBN stub sill. After discussion, it was determined that further follow-up and analysis was required.

4.1.2 TSB Rail Safety Information Letter 06/09

On 16 December 2009, the TSB issued Rail Safety Information Letter (RSI) 06/09. The RSI identified that the A-end draft gear of car UTLX 37605, a Cardwell Westinghouse Mark 50, had been assembled incorrectly during reconditioning in August 1998. The improper draft gear assembly would have resulted in reduced dampening and increased impact forces during operations, which likely contributed to the damage sustained by the A-end stub sill.

On 22 January 2010, TC responded that the improper assembly of this draft gear during reconditioning was an issue of quality control. As such, with the TSB submission of RSI 06/09 to the AAR, the appropriate steps can be taken to ensure compliance with the suitable quality control practices.

4.1.3 Action Taken by Canadian National

The following safety action was initiated by Canadian National (CN) following this incident:

- CN implemented a new feature in its waybilling system (SRS) that would permit up to 20 different codes to be retained.

- During the investigation, CN indicated that empty cars in bad order status were not being weighed during humping operations. CN has since corrected this problem in its SRS system.

- CN is testing a process that uses its Wheel Impact Load Detector network to identify cars that have in excess of 20 000 pounds of product remaining in the car en route.

- CN has implemented enhancements in its Smart Yard systems at MacMillan Yard that permit Mechanical staff to apply a Do Not Hump (DNH) code directly to a bad order car. This Mechanical DNH code will not be modifiable. If a Hump list has already been sent to the Transportation Department, Smart Yard will automatically re-send a new list containing the DNH car information. The DNH code will not be sent to SRS and will be automatically removed when the car is released from bad order status.

4.1.4 Action Taken by the Union Tank Car Company

The following safety action was initiated by the Union Tank Car Company (UTLX) following this incident:

- UTLX re-evaluated its ongoing head shoe maintenance program to consider information regarding UTLZBN stub sill function. As a result, UTLX has expanded the range of cars requiring enhanced weld maintenance to specific car builds with the UTLZBN draft sill from 1970 through 1978, 1981 and 1986 for pressure tank cars and from 1970 through 1973 for non- pressure cars. The expanded population of cars is projected to be 1900.

- UTLX will implement a higher level of non-destructive testing (NDT) at the head brace connection to the draft sill. Although visual inspection is an acceptable method of NDT, it is recognized that this area is vital to the survivability of the tank car structure. UTLX plans to use either liquid penetrant or magnetic particle on this area for UTLZBN stub sill SS3 inspections.

- UTLX will implement an inspection of weld connection of the siphon pipe to the excess flow valves on cars that show signs of stub sill damage.

4.1.5 Action Taken by the Association of American Railroads

The following safety action was initiated by the Association of American Railroads (AAR) following this incident:

- The AAR Tank Car Committee opened a private docket to review the performance of this type of sill. The AAR Tank Car Committee will continue working with UTLX on how to identify and correct this condition during maintenance and at other times.

- An AAR Tank Car Committee Task Force is investigating improved NDT inspection methods for tank cars in general. The failure to catch this defect prior to failure and the adequacy of the owner's maintenance program are being discussed by the AAR Tank Car Committee.

4.2 Action Required

4.2.1 Tracking Tank Car Stub Sill Failures

The AAR requires railways to complete and submit standard reports for various mechanical component failures, including axles (MD-12), wheels (MD-115), roller bearings (MD-11), truck sides and bolsters. These reports are regularly evaluated by the AAR. In some cases, the evaluation has resulted in the issuance of AAR circulars for the recall or monitoring of potentially defective components.

With regards to tank car stub sills, car owners ensure that a SS3 Form is completed for each tank car stub sill inspection. Similarly, an R-2 Form is completed for repairs to tank car stub sills resulting from non-accidental buckles, corrosion, and cracks. While these reports are submitted to the AAR, they are not reviewed to identify emerging trends in stub sill failures. Furthermore, older tank cars are often scrapped after a stub sill failure (that is, badly cracked or broken stub sill) due to the associated cost of repair. In these circumstances, no R-2 Form is completed because the stub sill is not repaired. Consequently, information on stub sill failures is not always consistently recorded, nor is it analyzed for safety defects.

Within the North American tank car fleet of approximately 325 000 cars, about 41 000 of these (13 per cent) are equipped with UTLZBN stub sills. Approximately 35 000 of the tank cars equipped with UTLZBN stub sills are in dangerous goods service. In Canada, between January 2004 and June 2009, 58 tank cars were bad ordered for cracked stub sills (50) or broken stub sills (8). Although tank cars equipped with UTLZBN design stub sills only represent 13 per cent of the tank car population, for the 5.5-year period starting January 2004, these tank cars accounted for 34 per cent of the cracked stub sills (17 of 50) and 100 per cent of the broken stub sills (8 of 8). In many of these cases, TC had no information, or limited information, regarding these failures because there is no requirement to report them.

Unlike axles and wheels, there is no requirement for a railway to report a cracked or broken tank car stub sill to the AAR. In Canada, there is no regulatory requirement to report such failures under the *Railway Freight Car Inspection and Safety Rules* or, for tank cars carrying dangerous goods, under the *Transportation of Dangerous Goods Act*. Due to this situation, inconsistent reporting of stub sill failures has occurred, likely resulting in the underrepresentation of these failures. Without an industry or regulatory protocol to document tank car stub sill failures, a stub sill design that is susceptible to failure may not be identified in a timely manner. Therefore, the Board recommends that:

> The Department of Transport, in conjunction with the railway industry and other North American regulators, establish a protocol for reporting and analyzing tank car stub sill failures so that unsafe cars are repaired or removed from service.

R10-01

4.3 *Safety Concern*

4.3.1 *Association of American Railroads Stub Sill Design Criteria*

In North America, between January 2004 and June 2009, UTLX reported 35 UTLZBN stub sill failures in which the stub sill completely severed. Eight of these failures (23 per cent) occurred in Canada. The remaining 27 failures occurred in the United States on 5 different Class 1 railroads. In all cases, the cars were constructed in or before 1995 and the UTLZBN stub sills met the AAR design criteria in place at the time of car construction.

In the mid-1990s, the AAR design criteria for stub sills were modified to reflect changes in operations. Subsequently, UTLX replaced the UTLZBN design with the more robust UTLZBG stub sill design. Since that time, while the UTLZBN stub sills have continued to fail at a higher-than-usual rate, there have been no reported catastrophic failures of UTLZBG stub sills.

The industry notes that cracks will develop in many stub sills during their service life, hence the need for regular inspection. However, in 65 per cent of the reported failures, UTLX noted that there had been evidence of higher-than-usual impact. Although rough handling will play a role in stub sill failures, it is likely that today's railway operating environment also contributes to these failures.

In recent years, the typical environment for train operation has significantly changed. Prior to the mid-1990s when UTLZBN stub sills were constructed, an average train in main-track service was about 5000 feet long and weighed 6000 to 7000 tons. Some of today's trains are over 12 000 feet long and weigh over 10 000 tons. With the significant increase in average train length and weight, there have been associated increases in normal in-train forces for conventional trains equipped with head-end power. Consequently, in March 2010, the Board included "the operation of longer, heavier trains" as a safety issue in its Watchlist.

As train operations evolve, the industry and the regulator need to ensure that rolling stock design criteria improve to keep pace with operational changes. This includes monitoring older designs, such as the UTLZBN stub sills, to ensure that the equivalent level of safety is maintained. The Board is concerned that stub sills manufactured to older design criteria may be more susceptible to failure in today's railway operating environment consisting of longer, heavier trains and elevated in-train forces.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 07 July 2010.

Visit the Transportation Safety Board's Web site (www.bst-tsb.gc.ca) for information about the Transportation Safety Board and its products and services. There you will also find links to other safety organizations and related sites.

Appendix A – UTLX Reported Broken Stub Sills (January 2004 – June 2009)

#	Date of Event	UTLX Car No.	Built Date	Stub Sill Design	Railway	Previous High Impact	Current High Impact	Type of Damage	Prior Derail	Prior Derail Date
1	20-Aug-04	UTLX 24746	1981	UTLZBN	NS			Severed		
2	3-Jan-04	UTLX 24986	1977	UTLZBN				Severed		
3	25-Mar-09	UTLX 27545	1983	UTLZBN	CN			Severed		
4	6-Sep-06	UTLX 30438	1971	UTLZBN	UP	Y	Y	Severed		
5	1-Jun-05	UTLX 37552	1970	UTLZBN	ALS	Y		Severed		
6	19-Nov-05	UTLX 37571	1970	UTLZBN	Conrail			Severed		
7	14-Jan-09	UTLX 37605	1970	UTLZBN	CN	Y	Y	Severed	Y	9/12/2004
8	23-Jun-08	UTLX 37671	1970	UTLZBN	CN	Y	Y	Severed		
9	14-Jan-08	UTLX 60672	1981	UTLZBN	NS	Y	Y	Severed		
10	3-Jan-04	UTLX 60896	1980	UTLZBN	CN	Y		Severed		
11	13-Dec-07	UTLX 60990	1984	UTLZBN	UP	Y	Y	Severed		
12	4-Mar-09	UTLX 61069	1984	UTLZBN	BN	Y	Y	Severed		
13	1-Sep-06	UTLX 61074	1984	UTLZBN	CSX	Y	Y	Severed		
14	27-Jan-09	UTLX 61428	1984	UTLZBN	CN	Y		Severed		
15	24-Feb-05	UTLX 65832	1981	UTLZBN	CSX		Y	Severed		
16	1-Dec-07	UTLX 66267	1980	UTLZBN	CN	Y	Y	Severed		
17	29-Sep-04	UTLX 66466	1981	UTLZBN	CSX			Severed		
18	1-Aug-04	UTLX 67501	1981	UTLZBN	CSX		Y	Severed		
19	3-Jan-04	UTLX 67978	1980	UTLZBN	CSX			Severed		
20	21-Feb-05	UTLX 70690	1978	UTLZBN	CN			Severed		
21	3-Jan-04	UTLX 70999	1977	UTLZBN	CN	Y	Y	Severed		
22	20-Dec-07	UTLX 71847	1977	UTLZBN	CN			Severed		
23	23-Feb-06	UTLX 72430	1975	UTLZBN	BNSF	Y	Y	Severed		
24	11-Nov-05	UTLX 72978	1974	UTLZBN	CSX	Y	Y	Severed		
25	17-Dec-04	UTLX 74687	1970	UTLZBN	UP			Severed		
26	3-Jan-05	UTLX 74803	1971	UTLZBN	UP			Severed		
27	26-Dec-08	UTLX 74862	1970	UTLZBN	CSX		Y	Severed		
28	1-Jun-06	UTLX 74927	1971	UTLZBN	BN			Severed		
29	27-Feb-06	UTLX 76054	1972	UTLZBN	CSX	Y	Y	Severed		
30	5-Nov-04	UTLX 91136	1979	UTLZBN	CSX		Y	Severed		
31	17-Feb-04	UTLX 92495	1979	UTLZBN	UP		Y	Severed		
32	11-Oct-08	UTLX 92711	1979	UTLZBN	CN	Y	Y	Severed		
33	12-Dec-08	UTLX 125023	1988	UTLZBN	ONT			Severed		
34	16-Nov-08	UTLX 201160	1989	UTLZBN	CN		Y	Severed		
35	28-May-08	UTLX 600316	1989	UTLZBN	OVR	Y	Y	Severed		

Failures in Canada

Appendix B – UTLX and CN Reported Cracked/Broken Stub Sills in Canada (January 2004 – June 2009)

#	Car	Tank Car Specification	Stub Sill Design	Car Built Date	Bad Order Date	Years - Built to Bad Order	Bad Order Location
1	BTRX 3010	112J340W	UTLZBN	June 1966	4-Oct-2004	38 1/3	Toronto, ON
2	CGTX 64231	112J340W	GAT098	Jan. 1974	19-Jun-2004	30 ½	Melville, SK
3	CGTX 64269	112J340W	HST098	Nov. 1978	15-Jul-2005	26 2/3	Dartmouth, NS
4	CGTX 64276	112J340W	HST098	Nov. 1978	14-Jul-2005	26 2/3	Truro, NS
5	CGTX 65049	105J300W	GAT098	Dec. 1977	4-Jun-2008	30 ½	Sarnia, ON
6	CGTX 68020	112J400W	HST098	Apr. 1971	14-Apr-2009	38	Moncton, NB
7	CGTX 70592	111A100W2	TRNTY3	Dec. 1988	18-Sep-2007	18 ¾	Scotford, AB
8	CITX 34742	112J340W	NACDEF	July 1970	30-Dec-2004	34 ½	Sarnia, ON
9	DCTX 30089	112J3400W	ACF100	Sep. 1969	25-Aug-2008	39	Moncton, NB
10	DUPX 20055	112S400W	GAT18B	Dec. 1967	27-Apr-2005	37 1/3	Toronto, ON
11	GATX 15730	111A100W1	GAT098	June 1978	8-Nov-2006	29 ½	Sarnia, ON
12	GATX 25618	112J340W	GAT098	Nov. 1971	6-Nov-2006	35	Sarnia, ON
13	GATX 40706	112J340W	GAT098	Oct. 1970	11-Mar-2006	35 1/3	Sarnia, ON
14	GATX 40730	112J340W	GAT098	Nov. 1970	6-Dec-2005	35	Sarnia, ON
15	GATX 41214	112J340W	GAT098	Aug. 1971	30-Sep-2004	33	Toronto, ON
16	GATX 46190	111A100W1	GAT098	May 1977	13-Dec-2004	27 ½	Winnipeg, MB
17	GATX 47151	111A100W1	GAT098	Apr. 1975	31-Jan-2004	29 ¾	Toronto, ON
18	GATX 51521	111A100W1	UTLZBN	Aug. 1986	14-Oct-2005	29 ¼	Toronto, ON
19	GATX 55491	112J340W	GAT098	Aug. 1970	18-May-2007	36 ¾	Sarnia, ON
20	GATX 74091	112J340W	GAT098	Feb. 1969	12-Jun-2007	38 1/3	Sarnia, ON
21	GATX 74194	112J340W	GAT098	Mar. 1969	11-Apr-2005	36	Sarnia, ON
22	GATX 89712	111A100W1	GAT020	Dec. 1994	21-Jul-2007	12 ½	Toronto, ON
23	GATX 90111	112J340W	UTLZBN	July 1967	6-Jan-2007	39 ½	Sarnia, ON
24	GATX 91194	112J340W	GAT098	Oct. 1967	30-Mar-2005	37 1/3	Sarnia, ON
25	GATX 92585	112J340W	GAT098	Sep. 1968	30-Dec-2004	36 ¼	Sarnia, ON
26	GATX 92591	112J340W	GAT098	Sep. 1968	20-Feb-2006	37 1/3	Montréal, QC
27	GLNX 34404	105J400W	RICRIC	Aug. 1976	21-Mar-2009	33 ½	Sarnia, ON
28	PLCX 220763	111A100W1	GAT098	Sep. 1971	17-Nov-2005	34 ¼	Valleyfield, QC
29	PPRX 33730	114J340W	GAT098	Jan. 1970	11-Dec-2006	37	Winnipeg, MB
30	PROX 37629	112J340W	PROZBN	Oct. 1970	29-Aug-2004	34	Toronto, ON
31	PROX 41069	111A100W1	UTLZBN	Jan. 1982	23-Aug-2005	23 ½	Winnipeg, MB
32	PROX 77787	111A60W1	PROZBN	Jan. 1975	26-Mar-2006	31	Edmonton, AB
33	PROX 90337	112J340W	PROZBN	Jan. 1969	22-Jun-2004	35 ½	Scotford, AB
34	PROX 90618	112J340W	PROZBN	Jan. 1969	23-Aug-2007	38 ½	Regina, SK
35	SAUX 755	112J400W	ACF200	Jan. 1973	14-Jan-2004	31	Edmonton, AB

#	Car	Tank Car Specification	Stub Sill Design	Car Built Date	Bad Order Date	Years - Built to Bad Order	Bad Order Location	
36	SRIX 80212	111A100W1	GAT098	Feb. 1969	18-Feb-2004	35	Sarnia, ON	
37	UTLX 11428	111A100W2	UTLZBN	June 1979	2-Jun-2007	28	Toronto, ON	
38	UTLX 11530	111A100W2	UTLZBN	May 1979	18-Aug-2005	26 ¼	Toronto, ON	
39	UTLX 11575	111A100W2	UTLZBN	May 1979	21-Jun-2007	28	Toronto, ON	Severed
40	UTLX 15008	111A100W2	UTLZBN	June 1978	1-May-2006	28	Toronto, ON	
41	UTLX 27545	105J500W	UTLZBN	July 1983	1-May-2009	26	Bécancour, QC	
42	UTLX 28464	105J200W	UTLZBN	1972	18-Oct-2005	33	Sarnia, ON	
43	UTLX 37605	112J400W	UTLZBN	Dec. 1970	14-Jan-2009	38	Winnipeg, MB	Severed
44	UTLX 37671	112J340W	UTLZBN	Nov. 1970	23-Jun-2008	38	Wabamun, AB	Severed
45	UTLX 42962	111A100W6	UTLZBN	April 1983	11-Sep-2008	25 1/3	Oakville, ON	
46	UTLX 61428	111A100W3	UTLZBN	August 1984	29-Jan-2009	24 ½	Sarnia, ON	Severed
47	UTLX 70690	111A100W3	UTLZBN	1978	21-Feb-2005	27	Edmonton, AB	Severed
48	UTLX 70999	111A100W3	UTLZBN	1977	3-Jan-2004	27	Canada	Severed
49	UTLX 74602	111A100W1	UTLZBN	Feb. 1973	11-Jul-2007	24 1/3	Toronto, ON	
50	UTLX 76075	111A100W3	UTLZBN	Aug. 1972	14-Jul-2007	35	Toronto, ON	
51	UTLX 81547	112J340W	UTLZBD	May 1966	23-Oct-2004	38 ½	Sarnia, ON	
52	UTLX 89581	112J340W	UTLZBN	1968	20-Dec-2004	36	Ottawa, ON	
53	UTLX 92711	105J300W	UTLZBN	Nov. 1979	15-Oct-2008	29	Sarnia, ON	
54	UTLX 200537	111A60W7	UTLZBN	Nov. 1987	1-May-2009	22	Bécancour, QC	
55	UTLX 200546	111A60W7	UTLZBN	April 1989	1-Mar-2009	20	Vancouver, BC	
56	UTLX 201160	111A100W1	UTLZBN	Oct. 1989	17-Nov-2008	19	Capreol, ON	Severed
57	UTLX 600316	111A100W3	UTLZBN	May 1989	28-May-2008	19	Petawawa, ON	Severed
58	UTLX 645758	111A100W1	UTLZBN	May 1995	29-Jan-2009	11 2/3	Sarnia, ON	

Appendix C – Glossary

AAR	Association of American Railroads
CN	Canadian National
CCI	Certified Car Inspection
CGSB	Canadian General Standards Board
CSC	Customer Service Centre
DG	dangerous goods
DNH	Do Not Hump
FRA	Federal Railroad Administration (United States)
GRL	gross weight on rail load
LPI	liquid dye penetrant inspection
NDT	non-destructive testing
NS	Norfolk Southern Railroad
RSA	Rail Safety Advisory
RSI	Rail Safety Information Letter
SRS	Service Reliability Strategy (CN's computerized waybilling system)
TC	Transport Canada
TDG	transportation of dangerous goods
TDG Directorate	Transport Dangerous Goods Directorate (Transport Canada)
TSB	Transportation Safety Board of Canada
UN	United Nations
UP	Union Pacific Railroad
UTLX	Union Tank Car Company
WILD	Wheel Impact Load Detector
°C	degrees Celsius