Enhanced Tank Car Standards and Operational Controls for High Hazard Flammable Trains (HM-251)
## History

<table>
<thead>
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<th>Event</th>
<th>Date/Details</th>
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<tr>
<td>AAR Task ForceT87.5</td>
<td>P-1577 – March 9, 2011</td>
</tr>
<tr>
<td></td>
<td>CPC-1230 – July 26, 2011</td>
</tr>
<tr>
<td>T87.6</td>
<td>August 17, 2011 (first meeting)</td>
</tr>
<tr>
<td>CPC-1232</td>
<td>August 31, 2011</td>
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<tr>
<td>NPRM</td>
<td>August 1, 2014 (79 FR 45016)</td>
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<td>ANPRM</td>
<td>September 6, 2013 (78 FR 54849)</td>
</tr>
<tr>
<td>Final Rule</td>
<td>May 8, 2015 (89 FR 26644)</td>
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Elements of Rule

Classification
Routing/Notification
Speed Restrictions
Braking
Tank Car Specifications
Scope of Rule

- **High Hazard Flammable Train (HHFT)**
  - 20 or more loaded cars in a continuous block
  - 35 loaded cars throughout the train

- **High Hazard Flammable Unit Train (HHFUT)**
  - 70 or more loaded tank cars in a single train
Classification

• Sampling and testing program for unrefined petroleum products
  o Frequency of sampling/testing
  o Sample prior to offering/changes
  o Sampling method
  o Test methods
  o Quality control measures
  o Duplicate samples
  o Criteria for modification of program
  o Other methods

• Certify, document, and make available to DOT

• 49 CFR Section 173.41
Routing

• Risk assessment
  o Routing analysis (27 safety and security factors)
  o Select a route based on its findings

• Notification
  o Contact information for State and/or regional fusion centers and State, local, and tribal officials
  o Request information related to the routing of hazardous materials through their jurisdictions
  o May 7, 2014 Emergency Restriction/Prohibition Order remains in effect
  o Subject of future NPRM (HM-251B)

• 49 CFR § 174.310 (1)
Speed Restriction

• HHFT
  o 40 mph in High Threat Urban Area (§ 1580.3)
    ▪ Unless all tank cars meet new standards
  o 50 mph otherwise
  o 49 CFR § 174.310 (2)
Braking

• Effective date (HHFT)
  - Two-way end-of-train device (§ 232.5) or
  - Distributed Power (§ 229.5)
  - Speed > 30 mph

• January 1, 2021 (HHFUT)
  - Class 3 PGI material (Bakken Crude oil)
  - Speed > 30 mph
  - Electronically controlled Pneumatic Brakes (49 CFR Part 232, Subpart G)
  - Not buffer cars
Braking

• January 1, 2023
  o All HHFUTs (includes denatured alcohol)

• Buffer cars counted in determine effective and operative brakes (§ 232.609)

• Alternate brakes systems may be approved (49 CFR Part 232, Subpart F)

• § 174.310(3)
Tank Car Specification

• New cars constructed after October 1, 2015
  o Specification standard
  o Performance standard
  o DOT 117J

• Existing car to be retrofitted
  o Specification standard
  o Performance standard
  o DOT117R

• Prescribed retrofit schedule
• Retrofit reporting
New Tank Cars

• Specification Standard (DOT117)
  o TC-128 Minimum shell/head thickness – 9/16”
  o Tank head puncture resistance system – § 179.16(c)
  o Thermal protection system – § 179.18
  o Bottom outlet valve – prevent in intended actuation during a derailment
  o Top fittings protection – AAR’s Tank Car Manual, E 10.2.1)
  o 49 CFR Part 179, Subpart D
New Tank Cars

• **Performance Standard (DOT117P)**
  - Shell - 12” x 12” indenter: 12 mph
  - Tank head – 18 mph
  - Thermal protection system – § 179.18
  - Bottom outlet valve – prevent in intended actuation during a derailment
  - Top fittings protection – AAR’s Tank Car Manual, E 10.2.1)
  - § 179.202-12
Tank Car Schematic

Head shield

Pressure relief device

Bottom outlet valve

Tank shell

FRA – Office of Railroad Safety
11/18/2015
Shell and Head

9/16” thick shell of TC-128 steel (normalized)
Head Shields

½” thick full height head shields
Thermal Protection

Thermal resistance so that there will be no release of lading within the tank car except through the PRV for **100 minutes in a pool fire** or 30 minutes in a torch fire.
Bottom outlet valve

BOV handle must disengage so the valve does not open during derailment
Retrofit Tank Cars

• **Specification Standard (DOT117R)**
  
  o Minimum shell/head thickness – 7/16”
  o Tank head puncture resistance system – § 179.16(c)
  o Thermal protection system – § 179.18
    ▪ Jacket is required (basis of all modeling)
  o Bottom outlet valve – prevent unintended actuation during a derailment
  o § 179.202-13
<table>
<thead>
<tr>
<th>Car specification /Service</th>
<th>U.S. Retrofit Timeline</th>
<th>Car specification /Service</th>
<th>Canadian Retrofit Timeline</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOT111 (NJ)/PGI</td>
<td>January 1, 2017</td>
<td>DOT111 (NJ)/Crude Oil</td>
<td>May 1, 2017</td>
</tr>
<tr>
<td></td>
<td>January 1, 2018</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DOT111 (J)/PGI</td>
<td>March 1, 2018</td>
<td>DOT111 (J)/Crude Oil</td>
<td>March 1, 2018</td>
</tr>
<tr>
<td>CPC-1232 (NJ)/PGI</td>
<td>April 1, 2020</td>
<td>CPC-1232 (NJ)/Crude Oil</td>
<td>April 1, 2020</td>
</tr>
<tr>
<td>DOT111 (NJ)/PGII</td>
<td>May 1, 2023</td>
<td>DOT111 (NJ)/Ethanol</td>
<td>May 1, 2023</td>
</tr>
<tr>
<td>DOT111 (J)/PGII</td>
<td>May 1, 2023</td>
<td>DOT111 (J)/Ethanol</td>
<td>May 1, 2023</td>
</tr>
<tr>
<td>CPC-1232 (NJ)/PGII</td>
<td>July 1, 2023</td>
<td>CPC-1232 (NJ)/Ethanol</td>
<td>July 1, 2023</td>
</tr>
<tr>
<td>CPC-1232 (J)/PGI and II and all remaining cars in PGIII</td>
<td>May 1, 2025</td>
<td>CPC-1232 (J)/PGI and II all remaining cars in other flammable liquid service</td>
<td>May 1, 2025</td>
</tr>
</tbody>
</table>
Retrofit Reporting

- Owners of non-jacketed DOT111 cars
- PGI service in HHFT
- Unable to meet January 2017 deadline
- Report by March 1, 2017
  - DOT117R
  - DOT117P
  - DOT111 (not retrofitted)
  - DOT117
  - ECP (ready/equipped)
- § 174.310(5)
Alignment with Transport Canada

• Retrofit schedule
  o U.S. based on packing group
  o TC based on commodity

• Applicability
  o U.S.-HHFT
  o TC single tank car

• ECP
  o U.S. required for HHFUT after January 1, 2021 (PGI), and May 1, 2023 (PGII/III)
  o Not yet required. TC orally committed to ECP brakes.
Questions?

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TC 117 Tank Car Standard
TC 117 Tank Car Standard

Development of a new class of tank car has been a priority for Transport Canada.

- Following the Lac-Mégantic incident, Canada’s Transportation Safety Board (TSB) concluded that existing rail car standards are not sufficiently crash resistant/robust to withstand the forces in an accident.
- On April 23, 2014, the Minister of Transport announced that Canada would establish new rail car safety standards and phase-out legacy tank cars used to transport flammable liquid tank cars starting on May 1, 2017.
- Canada has worked with the U.S. to develop a new tank car standard.
- On May 20, 2015, the new TC 117 Tank Car Standard was published as an amendment to the Transportation of Dangerous Goods Regulations in the Canada Gazette, Part II as SOR/2015-100.
A New Class of Tank Car – TC 117

The TC 117 specifications are harmonized between Canada and the U.S. and include the following safety features:

- The new TC-117 tank car is required to be constructed as a thermally protected, jacketed tank car with steel that is 9/16" of an inch thick and full head shields. A jacket will be added as an outer cover on the exterior of the shell to keep insulation in place and provide additional strength and reinforcement. These features provide improved puncture resistance, structural strength and fracture resistance.

- New mandatory top fitting protection will cover the valves on top of the tank car, guarding against damage in the event of an incident.

- New full head shields will help protect the ends of the tank car from being punctured by equipment or collisions with adjacent rail cars in the event of excessive end impact or derailment. Previous standards of the class 111 tank cars did not require head shields in most cases.

- New enhanced bottom outlet valve must remain closed and not leak during an incident.

- Thermal protection increases the survivability of tank cars in the event of a fire. The new thermal protection required for the TC-117 must be able to withstand exposure to a 100-minute pool fire and a 30-minute jet fuel fire without rupturing.
Harmonized Canada-U.S. Standards

- In addition to a new class of rail tank car (TC 117), the amendments include retrofit requirements for existing TC/DOT 111 and TP14877/CPC 1232 tank cars.
  - Coordinated Canada – U.S. requirements.
  - Includes both a performance based approach as well as a prescriptive standard for industry.

- Implementation timelines and retrofit schedules have been harmonized as closely as practicable recognizing fleet size and industry capacity.
  - Implementation between May 1, 2017, and April 2025, phased-in according to risk.
  - Only time variance is the initial May 1, 2017, deadline as the U.S. has determined that industry capacity does not permit them to meet that date; some other Canadian timeframes have changed from initial consultations to match the U.S. and industry capacity.
# Tank Car Retrofit Implementation Timelines

<table>
<thead>
<tr>
<th>Canadian Implementation Dates</th>
<th>Flammable Liquid</th>
<th>Tank Car Type Removed From Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 1, 2017</td>
<td>Crude Oil</td>
<td>Legacy DOT-111 Non-Jacketed</td>
</tr>
<tr>
<td>March 1, 2018</td>
<td>Crude Oil</td>
<td>Legacy DOT-111 Jacketed</td>
</tr>
<tr>
<td>April 1, 2020</td>
<td>Crude Oil</td>
<td>CPC-1232 Non-Jacketed</td>
</tr>
<tr>
<td>May 1, 2023</td>
<td>Ethanol</td>
<td>Legacy DOT-111 Non-Jacketed &amp; Jacketed</td>
</tr>
<tr>
<td>July 1, 2023</td>
<td>Ethanol</td>
<td>CPC-1232 Non-Jacketed</td>
</tr>
<tr>
<td>May 1, 2025</td>
<td>Crude Oil &amp; Ethanol</td>
<td>CPC-1232* Jacketed</td>
</tr>
<tr>
<td>May 1, 2025</td>
<td>Flammable Liquids Other Than Crude Oil &amp; Ethanol</td>
<td>Legacy DOT-111 &amp; CPC-1232* Non-Jacketed &amp; Jacketed</td>
</tr>
</tbody>
</table>

*: most jacketed CPC-1232 tank cars will meet the requirements of the TC117R specification with very minor changes, if any.
Recognizing their already higher standard, TC proposed a prescriptive retrofit standard for CPC1232/TP14877 tank cars to provide clear direction to industry as to how to achieve an equivalent level of safety and if they wish to remain in flammable liquid service.

1. Jacket and thermal protection
   - The tank car must have a 3mm (gauge 11) thick steel jacket.
   - The jacket must be made of ASTM A1011 steel, or steel of an equivalent standard.
   - The jacket must be weather-resistant.
   - The tank must be insulated or thermally protected to meet the requirements of clause 8.2.7 of TP14877; (30 minutes jet fire, 100 minutes pool fire).

   (accommodations may be required on retrofit cars because of clearance issues)

2. Tank Material and Minimal Thickness
   - The minimum thickness is 11.1 mm (7/16 in.).
3. Head Shields
   ➢ Tank cars must have full head shields of 12.7 mm (½ in) thick steel (structural or pressure vessel steel).

4. Braking:
   ➢ No ECP braking requirements

5. Bottom Outlets Valves
   ➢ In the case of a tank car equipped with a bottom outlet valve, the valve handle – unless stowed separately – is designed to bend or break free on impact without the valve opening, or is designed so that all of the handle is located within the bottom discontinuity protective structure.
TC also proposed a performance standard for new car construction and for retrofits that would provide for an equivalent level of safety for older DOT-111 tank cars to meet the new tank car standard and to continue to be used in flammable liquid service:

A) **For tank car heads**
   ➢ The end structures of tank cars must be able to withstand the frontal impact of a loaded freight car, including the coupler, at a speed of 8.05 m/s (18 mph). Transport Canada expects that, in order for a tank car to meet retrofit puncture resistance standards for tank car heads, any test performed must demonstrate that there was no leaking through the shell or head due to this impact. The test is successful if there is no visible leak from the standing tank car for at least one hour after impact.

   This performance standard replaces the need for head shields and thicker steel.

   

B) **For tank car shells**
   ➢ The shell structure of tank cars must be able to withstand the side impact of a loaded freight car, including the coupler, at a speed of 5.36 m/s (12 mph). Transport Canada expects that, in order for tank car side puncture resistance to meet the retrofit resistance standard, any test performed must demonstrate that there was no leaking through the shell or head due to this impact. The test is successful if there is no visible leak from the standing tank car for at least one hour after impact.

   This performance standard replaces the need for thicker steel.

C) **Alternative methods of testing**
   ➢ Tank car manufacturers and tank car owners could use computer modeling to validate their new designs or retrofit packages. Therefore, the testing required to validate the performance criteria may be substituted by numerical modelling and simulation if the model and simulation methods are acceptable to Transport Canada, and if the model and simulation were validated by test data.

   The tests in A) and B) can be substituted by C).
# Tank Car Comparison

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Older Legacy DOT 111 tank cars</th>
<th>DOT-111 (CPC1232)/TP14877 built since 2011</th>
<th>New TC/DOT 117 standard (published in CG II as SOR/2015-100)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Head Shields</td>
<td>No</td>
<td>Half</td>
<td>Full</td>
</tr>
<tr>
<td>2. Top Fitting Protection</td>
<td>Optional</td>
<td>Mandatory</td>
<td>Mandatory</td>
</tr>
<tr>
<td>3. Thermal Protection (Jacket)</td>
<td>Optional</td>
<td>Optional</td>
<td>Mandatory</td>
</tr>
<tr>
<td>4. Thickness of Steel</td>
<td>11.1 mm (7/16inch)</td>
<td>12.7 mm (1/2 inch) for non-jacketed cars</td>
<td>14.3 mm (9/16 inch) minimum</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11.1 mm (7/16 inch) for jacketed cars</td>
<td></td>
</tr>
<tr>
<td>5. Performance Standard for Bottom Outlet Valves</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>6. Performance Standard for Thermal Protection, Top-Fitting Protection and Head and Shell Puncture Resistance</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>
ENHANCED SAFETY FEATURES

The new **TC-117 TANK CAR** standard includes several enhanced safety features to protect communities along Canada's railways.

- **3/8" Steel Jacket**
- **3/16" Thermal Blanket**
- **3/8" Full Head Shield**
- **3/8" Thicker Steel Shell and Heads**

The new TC-117 tank car is required to be constructed as a thermally protected, jacketed tank car with steel that is 9/16" of an inch thick and full head shields. A jacket will be added as an outer cover on the exterior of the shell to keep insulation in place and provide additional strength and reinforcement. These features provide improved puncture resistance, structural strength and fracture resistance.

- **New mandatory top fitting protection** will cover the valves on top of the tank car, guarding against damage in the event of an incident.

- **New full head shields** will help protect the ends of the tank car from being punctured by equipment or collisions with adjacent rail cars in the event of excessive and impact or derailment. Previous standards of the class 111 tank cars did not require head shields in most cases.

- **Thermal protection** increases the survivability of tank cars in the event of a fire. The new thermal protection required for the TC-117 must be able to withstand exposure to a 100-minute pool fire and a 30-minute jet fuel fire without rupturing.

- **New enhanced bottom outlet valve** must remain closed and not leak during an incident.
New Tank Car Requirements DOT/TC-117

- 9/16” shell
- 11 gage (~1/8”) jacket
- DOT 49 CFR §179.18 / TC 8.2.7 thermal protection
- Top fittings protection
- Full height ½” head shield
- Bottom outlet handle protection
- Appropriate pressure relief device
- Applicable to new cars constructed after October 1, 2015 (for DOT only applies to cars in HHFT service)
Retrofit Tank Car Requirements
DOT/TC 117-R

- 7/16” or ½” shell (depending upon whether retrofitting a non-jacketed DOT/TC-111 or CPC-1232)
- 11 gage (~1/8”) jacket
- DOT 49 CFR§179.18 / TC 8.2.7 thermal protection
- Top fittings protection - whatever is on the car being retrofitted
- Full height ½” head shield
- Bottom outlet handle protection
- Appropriate pressure relief device
Retrofit Tank Car Requirements
DOT/TC 117-P

- Puncture resistance
  - Minimum side impact 12MPH when impacted at the longitudinal and vertical center by a rigid 12” x 12” indenter with a weight of 286K#
  - Minimum head impact 18MPH when impacted at the center of the head by a rigid 12” x 12” indenter with a weight of 286K#
- Thermal protection system
- Bottom outlet handle protection
- Top fittings protection
<table>
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<th>US Tank Car Service(^1)</th>
<th>Transport Canada Tank Car Service</th>
<th>Retrofit Deadline</th>
</tr>
</thead>
<tbody>
<tr>
<td>NJ DOT-111 in PGI</td>
<td>NJ TC-111 in CO</td>
<td>DOT 1/1/18(^2)</td>
</tr>
<tr>
<td>J DOT-111 in PGI</td>
<td>J TC-111 in CO</td>
<td>3/1/18</td>
</tr>
<tr>
<td>NJ CPC-1232 in PGI</td>
<td>NJ CPC-1232 in CO</td>
<td>4/1/20</td>
</tr>
<tr>
<td>NJ DOT-111 in PGII</td>
<td>NJ TC-111 ethanol</td>
<td>5/1/23</td>
</tr>
<tr>
<td>JK DOT-111 in PG II</td>
<td>JK TC-11 in ethanol</td>
<td>5/1/23</td>
</tr>
<tr>
<td>NJ CPC-1232 in PGII</td>
<td>NJ CPC-1232 ethanol</td>
<td>7/1/23</td>
</tr>
<tr>
<td>JK CPC-1232 in PGI &amp; II</td>
<td>JK CPC-1232 in CO &amp; ET and all PGIII (PRV &amp; BH)</td>
<td>5/1/25</td>
</tr>
</tbody>
</table>

\(^1\) The DOT requirements are tied to high hazard flammable train service i.e. 20 or more tank cars loads in a block or 35 or more in the train.

\(^2\) The 1/1/17 date triggers a reporting requirement for shippers to report the # of DOT tank cars they own or lease that have and have not been retrofitted.
Enhanced Braking

- Require HHFTs to have in place a functioning two-way end-of-train (EOT) device or a distributive power (DP) braking system

- Require any high-hazard flammable unit train (HHFUT) — a train comprised of 70 or more loaded tank cars containing Class 3 flammable liquids traveling at greater than 30 mph — transporting at least one packing group I flammable liquid be operated with an electronically controlled pneumatic (ECP) braking system by January 1, 2021.

- Require all other HHFUTs be operated with an ECP braking system by May 1, 2023.

Reduced Operating Speeds

• Restrict all HHFTs to 50-mph in all areas
• Require HHFTs that contain any tank cars not meeting the enhanced tank car standards required by this rule operate at a 40-mph speed restriction in high-threat urban areas defined the Transportation Security Administration’s regulations at 49 CFR 1580.3. - See more at: http://www.dot.gov/mission/safety/rail-rule-summary#sthash.TYrDYTvD.dpuf
More Accurate Classification of Unrefined Petroleum-Based Products

- Document sampling and testing program for all unrefined petroleum-based products, such as crude oil
- Certify that programs are in place, document the testing and sampling program outcomes, and make information available to DOT personnel upon request. - See more at: http://www.dot.gov/mission/safety/rail-rule-summary#sthash.TYrDYTvD.dpuf
Rail routing - Risk Assessment

- Railroads operating HHFTs would be required to perform a routing analysis that considers, at a minimum, 27 safety and security factors and select a route based on its findings - these planning requirements are prescribed in 49 CFR § 172.820

Rail routing – Information Access

- Ensures that railroads notify State and/or regional fusion centers, and that State, local and tribal officials who contact a railroad to discuss routing decisions are provided appropriate contact information for the railroad in order to request information related to the routing of hazardous materials through their jurisdictions

Improvement in Conditional Probability of Release

*This graph displays CPR>100 which represents the conditional probability of release (CRP) for large releases, defined as those greater than 100 gallons.

Note: The conditional probability of release for each tank car was calculated by the RSI-AAR Railroad Tank Car Safety Research and Test Project, a cooperative program by the Railway Supply Institute (RSI) and the Association of American Railroads (AAR)

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Improvement in multi-car release performance is dramatic
## North American Tank Car Fleet

<table>
<thead>
<tr>
<th></th>
<th>Crude Oil</th>
<th>Ethanol</th>
<th>FL Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of tank cars in North America</td>
<td></td>
<td></td>
<td>389,969¹</td>
</tr>
<tr>
<td>Total number of DOT-111’s</td>
<td></td>
<td></td>
<td>270,448¹</td>
</tr>
<tr>
<td>Non Jacketed DOT-111’s</td>
<td>5,957²</td>
<td>27,098²</td>
<td>49,591²</td>
</tr>
<tr>
<td>Jacketed DOT-111’s</td>
<td>1,107²</td>
<td>73²</td>
<td>5,650²</td>
</tr>
<tr>
<td>Non Jacketed CPC-1232’s</td>
<td>15,640²</td>
<td>1,333²</td>
<td>18,643²</td>
</tr>
<tr>
<td>Jacketed CPC-1232’s</td>
<td>12,862²</td>
<td>394²</td>
<td>14,251²</td>
</tr>
<tr>
<td>Total</td>
<td>35,584²,³</td>
<td>28,898²,³</td>
<td>84,135²,³</td>
</tr>
</tbody>
</table>

### Notes:
1. Total number of tank cars and DOT-111’s are from UMLER
2. Including cars making at least one loaded shipment 1ˢᵗ quarter 2015
3. Some cars transported more than one type of commodity in the study period so column totals are not additive
4. FL = Flammable Liquids

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Issues with HM-251

- ECP Brakes
  - No substantial evidence to support a safety justification for mandating ECP brakes, which will not prevent accidents
  - DOT report- “Given that this is based on a limited simulation set, the results could be a bit optimistic and should be taken with a grain of salt.”
  - 100 percent dependent on the actions of rail customers or tank cars owners
  - trains moving 30 mph will compromise network capacity by at least 30 percent
Issues with HM-251 (cont.)

• **Applicability**
  - DOT rule is applicable to cars in HHFT’s / HHFUT’s
  - TC rule is based on commodity

• **Thermal protection requirement**
  - Thermal protection system vs. thermal blanket
AAR Interchange Rule

• AAR is in the process of implementing an interchange rule to fix the issues with the rule:
  • Applicability
  • Top fittings protection
  • Thermal protection
Thank You

Questions?

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