49 CFR Parts 173 and 179

[Docket No. HM-174; Amdt. No. 173-172, 179-34]

## Shippers; Specifications for Railroad Tank Cars

**AGENCY:** Materials Transportation Bureau (MTB), Research and Special Programs Administration, DOT.

**ACTION:** Amendment of final rule.

**SUMMARY:** This document amends a final rule issued under this Docket which established certain construction standards for railroad tank cars used to transport hazardous materials. This amendment provides an option for safety relief valve sizing for DOT specification 105J tank cars built after February 29, 1984 to transport ethylene oxide. Under current requirements, those class 105J cars must be equipped with a safety relief valve that has a discharge capacity calculated in accordance with a formula designed for compressed gases in uninsulated tanks. This amendment provides that specification 105J tank cars used to transport ethylene oxide may be equipped with a safety relief valve of lesser discharge capacity when additional high temperature thermal protection of the tank is provided. This action is taken by MTB in response to a petition for reconsideration of the final rule submitted by the Association of American Railroads (AAR).

**EFFECTIVE DATE:** This amendment is effective on March 1, 1984.

**FOR FURTHER INFORMATION CONTACT:** Philip Olekszyk, Office of Safety, Federal Railroad Administration, 400 Seventh Street, SW., Washington, D.C. 20590, (202) 426-0897.

**SUPPLEMENTARY INFORMATION:** On January 26, 1981 (46 FR 8005), MTB issued a final rule establishing certain construction standards for DOT specification 105 tank cars built to carry specified hazardous materials. The construction standards include a safety valve sizing requirement for those tank cars built to carry ethylene oxide. The final rule required that each DOT specification 105 tank car used to transport ethylene oxide and constructed after August 31, 1981, must have a safety valve sized in accordance with 49 CFR 179.105-7.

MTB received several petitions for reconsideration of the final rule. These petitions addressed, among other things, the safety valve sizing requirement for tank cars used to transport ethylene oxide. The petitioners argued that the larger safety valve for ethylene oxide would be less safe because of that commodity's peculiar characteristics. They also argued that the valve sizing equation in the rule should not be applied because ethylene oxide is a liquid while the equation is designed for gases.

While MTB and the Federal Railroad Administration (FRA) were not persuaded that these arguments were adequately supported, the compliance date was extended from September 1, 1981, until September 1, 1982 (46 FR 42678), then from September 1, 1982, until September 1, 1983 (47 FR 38697), and finally from September 1, 1983, until March 1, 1984 (48 FR 39630).

The extensions were granted to permit the AAR Tank Car Committee (AAR Committee) and other interested parties an opportunity to study the question of safety valve sizing for ethylene oxide and to submit the results for review and consideration. During the past two years, the AAR Committee conducted an extensive study of safety valve sizing. A final report was furnished to MTB and FRA earlier this year and has been placed in the Docket.

### AAR Safety Relief Valve Report

The AAR Report is a comprehensive study of safety valve sizing and of the railroad accident environment. The report does address ethylene oxide safety valve sizing, but the overall analysis and conclusions of the AAR Report have equal validity for other materials. The AAR Report does not attempt to make the case, originally offered to justify the extension of the compliance date, that ethylene oxide should be treated differently as a result of peculiar chemical or physical properties. Rather, the AAR Report attempts to make the case that the safety relief valves currently used on DOT specification 105 and 111 tank cars transporting ethylene oxide and liquefied flammable gases (LFG) are adequately sized for railroad accident fire environments when used in conjunction with high temperature thermal insulation that meets the requirements of 49 CFR 179.105-4.

FRA and MTB have determined that the data and analysis do not support the conclusion that the current valves are adequately sized and, therefore, will not further extend the compliance date for equipping new construction ethylene

oxide tank cars with large capacity safety relief valves. However, as a result of the extensive analyses by AAR and FRA on the relationship of thermal insulation and safety valve sizing, adequate data are available to establish an optional approach that will permit continued use of the current valves on new ethylene oxide tank cars if additional thermal insulation is added.

**Summary Technical Analysis of the AAR Report**

The AAR Report discusses the functions of safety relief valves and design considerations for these valves; summarizes the equations that govern the flow of nonflashing liquids, saturated vapors, and flashing liquids through valves; reviews 49 technical papers dealing with various aspects of safety relief valves; reviews the results from selected pool fire simulation tests; and summarizes the results of subcooled water flow tests of two safety relief valves. The report also includes a description of computer programs developed by the AAR Committee to analyze the effects of fire engulfment on a tank car. The programs predict the temperatures and pressures of the tank car and the flow rate through the valves. The programs can treat both the case of the tank car remaining upright and the case of its being overturned. The programs can take account of a wide variety of fire environments, loading conditions, and insulation properties. The report includes selected case studies using the computer programs which purport to show the adequacy of the safety relief valves used on existing propane and ethylene oxide tank cars.

**FRA and MTB Assesment of the AAR Report**

The FRA and MTB assessment of the AAR Report, which has been placed in the docket, is summarized below.

The AAR Report confirms two key findings of a 1970 research study sponsored by FRA: (1) The overturned tank car accident scenario, in which the safety valve releases liquid rather than vapor, should be considered in the sizing of relief valves, and (2) the thermal conductance of insulation systems should be estimated at elevated temperatures. The report also contains useful information on design considerations and functions of safety relief valves.

The AAR Report makes two general recommendations with which MTB and FRA concur. First, the AAR recommends basing the allowable tank pressure on a percentage of the tank test pressure. Second, the AAR recommends that either (a) the theoretical burst strength of the tank not exceed the tank pressure within a reasonable time or (b) if the theoretical burst strength does exceed the tank pressure, the tank should be empty when this occurs.

The computer program developed by the AAR for propane tank cars could be a useful guide for sizing relief valves. The computer program developed by the AAR for ethylene oxide greatly simplifies the physical phenomena; despite this simplification, that program could also be a useful guide for sizing relief valves if the results are cautiously interpreted.

MTB and FRA's primary reservations about the AAR Report are the assumptions made concerning (a) the heat flux from the fire to the tank car, (b) the effective thermal conductance of the jacket insulation in a fire, and (c) the allowable test pressure.

The AAR Report assumes that the tank car is only one fourth engulfed in the fire and, therefore, that the heat flux to the tank is about 8,000 BTU/(hr ft$^2$). In a study sponsored by FRA and conducted by IIT Research Institute (IITRI), it was found that a heat flux of about 25,000 BTU/(hr ft$^2$) is necessary to correlate the data obtained in full-scale fire tests of liquefied petroleum gas tank cars. The IITRI results are also consistent with a fire data analysis sponsored by FRA and conducted by Cornell Aeronautical Laboratory.

The AAR Report assumes a value of 2.3 BTU/(hr ft$^2$ °F) for the effective thermal conductance of the jacket insulation satisfying the requirements of 49 CFR 179.105-4. The report does not explain how this 2.3 value was derived. However, in separate correspondence, the AAR has stated that they based this 2.3 value on a preliminary evaluation by IITRI. In this preliminary evaluation, IITRI assumed small heat losses from the back of the test plates used in pool fire simulation test. In a later evaluation of these tests, IITRI has revised the plate heat loss estimates and has obtained a conductance value of 4.0.

The AAR has also submitted a report dated May 27, 1983, and entitled "Thermal Conductances of Fire Protection Insulations for Tank Cars." This report concludes that, based on laboratory thermal conductivity measurements, two thermal shield systems that passed the 800°F/100 minute pool fire simulation test would result in an overall system conductance of 2.3 BTU/(hr ft$^2$ °F) in a fire environment. MTB and FRA believe that these laboratory tests have not been demonstrated to be an acceptable simulation of railroad pool fires and that the DOT pool fire simulation tests are the best available simulation.

The AAR Report uses an allowable tank pressure of 120 percent of the tank test pressure. MTB and FRA believe it is illogical to specify a tank test pressure for undamaged, unheated tank cars and then optimistically assume that tank cars in an accident environment can withstand 120 percent of tank test pressure.

Using these extremely optimistic assumptions, the AAR Report concludes that the safety valves on existing propane and ethylene oxide tank cars are adequate. Using the more fully analyzed and conservative safety assumptions of the IITRI study, the MTB and FRA conclude that the existing valves are not adequate. MTB and FRA conclude that the safety valve/thermal protection combinations mandated in the final rules for Dockets HM-144 (42 FR 46308) and HM-174, and proposed in the NPRM for Docket HM-175 (48 FR 16188), are justified. However, based on the IITRI calculations, MTB and FRA are allowing an option whereby additional thermal protection can be provided so that the ethylene oxide safety valve currently used can continue to be used.

**Optional Approach for Ethylene Oxide**

For pressure tank cars, DOT requires (49 CFR 179.100-15) that the total safety relief valve discharge capacity must be sufficient to prevent building up pressure in the tank in excess of 82½ percent of the tank test pressure or 10 psi above the start-to-discharge pressure, whichever is higher. There are similar requirements (49 CFR 179.200-18, 49 CFR 179.300-15, 49 CFR 179.400-18, and 49 CFR 179.500-12) for other types of tank cars. (The Department permits certain pressure tank cars carrying certain compressed gases to have a valve discharge capacity that would allow a build up of pressure to 90 percent of the tank test pressure. (49 CFR 179.102-11)) The DOT safety valve requirements for rail tank cars are similar to the valve requirements for stationary tanks in the American Society of Mechanical Engineers (ASME) Code Section VIII, Division 1. The ASME Code requires that, if a tank may be exposed to a fire or other unexpected external source of heat, the pressure-relieving capacity must limit the pressure to 80 percent of the hydrostatic test pressure.

In the DOT regulations cited above, the fire characteristics and accident situations that the safety valves must protect against are not explicitly stated. In 1973 FRA conducted a full-scale fire test of a DOT specification 112A 340W tank car, without thermal protection,

filled with propane. In this test the tank car was upright, the safety valve was discharging vapor, and the car was engulfed in a pool fire. The maximum pressure attained was 357 psig (105 percent of the test pressure).

A study by the Railway Progress Institute and AAR of eight DOT specification 112 and 114 tank cars without thermal protection that were involved in actual railroad fires indicates that in several of those cases the tank car pressure apparently exceeded the DOT pressure specifications. In an analytical study sponsored by FRA and conducted by Cornell Aeronautical Laboratory, it was concluded that "the consequences of inadequate relief capacity—overpressure—as a contributor to car failure could be effectively masked by evidence of fire and mechanical damage. Common post-accident test * * * will not reveal this condition." It was further concluded in the study that "reputed observations at derailment sites of relief flow from cars which subsequently ruptured indicated that the flow may have been substantially reduced from that anticipated for a fully-opened valve."

To mitigate the problems with inadequate safety relief valve capacity, the Department undertook research and then initiated regulatory action. In 1973 FRA sponsored a full-scale pool fire test of an upright DOT specification 112 tank car filled with propane and equipped with thermal protection and a large capacity safety valve. In this test the maximum pressure reached was 320 psig (94 percent of the tank test pressure), and the thermal protection used was less than that required in 49 CFR 179.105–4. MTB and FRA believe that had the tank car in this test been equipped with the 49 CFR 179.105–4 thermal protection, the pressure would not have exceeded the permissible pressure limits.

Based on the IITRI calculations discussed above, MTB and FRA believe that the standard safety valve/thermal protection requirements promulgated in the final rules of Dockets HM–144 and HM–174 and proposed in the NPRM of Docket HM–175 will result in compliance with 49 CFR 179.100–15 or 49 CFR 179.102–11 for tank cars that remain upright in railroad fires.

Research sponsored by FRA and conducted at Cornell Aeronautical Laboratory, U.S. Air Force Rocket Propulsion Laboratory, the University of Maryland, and IITRI demonstrates that, for the same fire environment, the valve sizing requirements for a tank car that is overturned and therefore discharging liquid from the safety valve will usually be greater than the valve sizing requirements for a tank car that is upright. In promulgating past valve sizing requirements, MTB and FRA believed (and still believe) that strict compliance with the requirements of 49 CFR 179.100–15 or 49 CFR 179.102–11 for overturned tank cars in fires would lead to unreasonably large relief valves. The IITRI calculations indicate that the large capacity safety valve/thermal protection will result in satisfactory safety for overturned ethylene oxide tank cars. For 105A 100W or 111A 100W ethylene oxide tank cars the maximum tank pressure will slightly and temporarily exceed the prescribed pressure limit of 85 psig, but the predicted pressures quickly recede to below the 85 psig level. For 105A 200W and 105A 300W ethylene oxide tank cars there are no predicted pressure problems using the large capacity safety valve/thermal protection.

FRA and MTB have analyzed the IITRI calculations to determine if an acceptable option can be developed to allow the use of 1100 standard cubic feet per minute (scfm) (at 85 psig) safety relief valves on new ethylene oxide tank cars. The IITRI calculations indicate that if the thermal protection were increased, the safety performances would be satisfactory. These thermal protection/safety valve combinations would result in excessive pressures, but by the time these pressures are reached, the fires should be greatly diminished in intensity or under control. In addition, the use of the additional thermal protection would provide more protection in torch fires and less chance of an autoignition of ethylene oxide in torch and pool fires than would the standard thermal protection/safety valve combination. MTB and FRA believe these benefits compensate for the higher pressures.

MTB and FRA have selected a minimum value of 550°F in the 100 minute pool fire test for the thermal protection required if the small 1100 scfm valve is used on ethylene oxide tank cars. The IITRI calculations indicate no clear cut break point in the range between 500°F and 600°F in terms of dramatic safety differences. MTB and FRA believe that the 550°F valve will provide a margin of safety to compensate for the simplifying assumptions made in the IITRI calculations.

**Section-By-Section-Analysis**

*Section 173.124 Ethylene oxide*

Paragraph (a)(5)(ii) of § 173.124 is revised to clarify that DOT specification 105 tank cars built after August 31, 1981, and before March 1, 1984, are not required to have a safety valve sized in accordance with § 179.106–2(c)(4). The several extensions of the compliance date for the large capacity safety relief valve for new construction ethylene oxide cars (49 CFR 179.102(a)(9)) could create confusion about the application of § 173.124(a)(5)(ii). The language change does not result in any substantive change, but merely clarifies the relationship between § 173.124 and § 179.102–12.

*Section 179.105–7 Safety relief valves*

Current § 179.105–7 establishes safety valve sizing requirements. The requirements are applicable to DOT specification 105 tank cars by virtue of § 179.106–2(c)(4), which requires that DOT specification 105J tank cars be equipped with a safety relief valve that meets the requirements of § 179.105–7. Thus, the § 179.105–7 safety valve sizing requirements will apply to DOT specification 105 tank cars built after February 29, 1984, to transport ethylene oxide since those tank cars must be constructed in accordance with specification 105J.

The amendment to § 179.105–7 in this document provides an optional method to meet the safety valve sizing requirement. In addition to sizing the valve according to the formula prescribed in section A8.02 of Appendix A of the AAR Specifications for Tank Cars applicable to compressed gases in non-insulated tanks, a valve with a capacity of at least 1100 scfm at 85 psi may be used in conjunction with a thermal protection system that will pass the pool fire simulation tests prescribed in § 179.105–4(d) with none of the thermocouples on the uninsulated scale of the steel plate indicating a temperature in excess of 550°F. According to the industry, an 1100 scfm valve is the size currently used on ethylene oxide tank cars.

Note that the option is not related to date of construction. Thus, any DOT specification 105 tank car used to transport ethylene oxide could be modified to specification 105J. Similarly, cars currently being built may be fitted with the option and marked as DOT specification 105J cars.

Note also that revised § 179.105–7 includes DOT specification 111 tank cars. Inclusion of specification 111 tank cars does *not* impose any burden. Section 179.105–7 does not require any specification 111 tank car to be equipped with a valve sized according to § 179.105–7. The requirement for any specification 111 tank car to have a valve sized in accordance with

§ 179.105–7 would result only from a separate regulatory action where that issue is fully addressed. Inclusion of the reference to specification 111 tank cars means only that the option of using additional thermal insulation instead of a larger capacity safety relief valve would be available for a specification 111 tank car in the same way as it is available for specification 105 tank cars.

**List of Subjects in 49 CFR Parts 173 and 179**

Railroad safety.

In consideration of the foregoing, Parts 173 and 179 of Title 49, CFR, are amended as follows:

## PART 173—SHIPPERS—GENERAL REQUIREMENTS FOR SHIPMENTS AND PACKAGINGS

1. In § 173.124, paragraph (a)(5)(ii) is revised to read as follows:

**§ 173.124 Ethylene oxide.**

(a) * * *

(5) * * *

(ii) Each specification 105 tank car built after August 31, 1981, and before March 1, 1984, used for the transportation of ethylene oxide, must conform to DOT specification 105J, except for the safety relief valve requirements of § 179.106–2(c)(4). Each specification 105 tank car built after February 29, 1984, used for the transportation of ethylene oxide, must conform to DOT specification 105J.

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## PART 179—SPECIFICATIONS FOR TANK CARS

2. In § 179.105–7, paragraph (c) is added to read as follows:

**§ 179.105–7 Safety relief valves.**

* * * * *

(c) Notwithstanding paragraph (a) of this section, § 179.100–15, and § 179.200–18, the relieving or discharge capacity of the safety relief valve on a specification 105 or 111 tank car built to transport ethylene oxide may be as low as 1100 scfm at 85 psi if—

(1) The tank is equipped with a thermal protection system in accordance with § 179.105–4; and

(2) In all of the three consecutive simulation pool fire tests required by paragraph (d) of § 179.105–4, none of the thermocouples on the uninsulated side of the steel plate indicates a plate temperature in excess of 550°F.

(49 U.S.C. 1803, 1804, 1808; 49 CFR 1.53, Appendix A to Part 1)

Note.—MTB has determined that this document is not a "major rule" under the terms of Executive Order 12291 or a significant regulation under DOT's regulatory policy and procedures (44 FR 11034) and does not require an environmental impact statement under the National Environmental Policy Act (49 U.S.C. 4321, *et seq.*). I certify that this final rule does not have a significant economic impact on a substantial number of small entities because the overall economic impact of this amendment is minimal. A regulatory evaluation and environmental assessment for the action taken in HM–174 are available for review in the docket.

Issued in Washington, D.C. on January 24, 1984.

L. D. Santman,

*Director, Materials Transportation Bureau.*

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