Tank Car Safety Initiatives
Federal Railroad Administration

LOOKING FORWARD

Qualification Program–Critical Crack Size and Non-Destructive Testing Method

Critical flaw size is not a new concept in the rail industry. In the preamble of final rule HM-201 (60 FR 49048, 1995), the U.S. Department of Transportation (DOT) discussed critical crack size in a principal structure element as related to the determination of inspection and test intervals. In the discussion, it was pointed out that common procedures for non-destructive testing (NDT) allow for two opportunities to inspect an item before predicted failure. Using this rationale, in conjunction with FRA research and an assumed number of miles travelled by a tank car annually, led DOT to establish the 10-year qualification interval. Additionally, the final rule introduced requirements for a Quality Assurance Program (QAP). A tank car facility was required to develop a QAP that included procedures for evaluating inspection and test procedures, including the accessibility of the area to be inspected and the sensitivity of the NDT method. The word "sensitivity" was subsequently added to Title 49 Code of Federal Regulations (CFR) 179.7(b)(10) to ensure the adequacy and repeatability of the NDT method. It is evident that DOT contemplated the relationship between the critical crack size, crack growth rate, the capabilities of the inspection and test method to detect a crack, and inspection intervals.

Seventeen years later, the requirements for the qualification of tank cars were amended in the final rule HM-216B (77 FR 37962). This final rule places the onus squarely on the tank car owner to develop a qualification program that will ensure the design level of reliability and safety of the tank car throughout the prescribed qualification interval. Tank cars now operate at a higher gross rail load and experience higher in-train forces. They likely accumulate more miles annually and, according to data gathered during the Federal Railroad Administration's (FRA) coupling speed project, they are experiencing high-speed impacts. Accordingly, tank car owners must continue to evaluate and consider the relationship between critical flaw size, crack growth rate, and the capabilities of a particular NDT method. This is fundamental to developing an effective qualification program. FRA will audit tank car owners and evaluate their qualification program, examining how they have matched the critical crack size and crack growth rate with the NDT method in determining the inspection interval.

Communication between Tank Car Owners, Lessees, and Facilities

Title 49 CFR 180.513(b) requires tank car facilities to obtain permission from the equipment owner prior to performing work on the owner's equipment. Permission can be obtained by using the owner's supplied qualification or maintenance procedures, or the owner can give written permission that allows the facility to use procedures provided by others. Tank car facilities must have a written record of this agreement with the tank car owner. This is a straightforward arrangement when an owner sends a tank car to a repair facility. However, when a leased tank car is serviced by a mini-shop or mobile unit at the facility of a customer or supplier of the lessee, the communication between the facility and the owner becomes difficult. Regardless, the requirements for obtaining the permission of the equipment owner apply. It is incumbent upon the facilities, owners, lessees, and other parties involved to establish the lines of communication and institute agreements to ensure work performed on the equipment is done in a manner approved by the tank car owner. FRA considers this fundamental to a successful qualification

program as well as the facility's QAP and, accordingly, will evaluate the robustness of these arrangements during our audits.

Tank Car Facility Procedures and Owner's Procedures
Tank car owners have the choice of providing NDT procedures or approving procedures provided by others. If an owner requires specific NDT procedures be followed in their qualification program, they must determine whether a tank car facility can perform each procedure to the required level of reliability and sensitivity prior to sending a tank car in for inspection. Further, owners that provide procedures to the facilities must also provide procedures for evaluating the inspection and test technique employed. They have the option of approving the facility's procedures, ensuring that the procedures and facility personnel are capable of achieving the required reliability and sensitivity. Tank car facilities must have a process qualification record (PQR) and probability of detection (POD) curve for all NDT methods they employ. The PQR and POD should be based on the facility's lowest performer. Otherwise, the facility must align NDT personnel with the tank car owner's requirements based on the capabilities of each individual (see critical crack size).

Lease Arrangements and Contractual Responsibility for Compliance
Service equipment owners and interior coating or lining owners are defined as parties financially responsible for the maintenance of their equipment. Tank car owners are defined as parties whose reporting marks are on the tank cars. Financial responsibility for maintenance and qualification is not specifically addressed in the Hazardous Materials Regulations (HMR). In many cases, tank cars are leased to shippers. In some of these cases, the lease agreement specifically identifies the party responsible for the qualification of the tank car, which could be the lessee. As a private business decision, a tank car owner may delegate the responsibility for qualification of their tank car to a lessee. However, for purposes of compliance and enforcement of the HMR, the Department may hold either the tank car owner or lessee, or both, liable if either or both parties are found to have not complied with the requirements of the HMR. The tank car owner must identify conditions that make the tank car unsafe for transportation. These conditions are the focus of the owner's qualification program. If that owner delegates authority for the qualification of tank cars to a lessee, they must ensure that the lessee's qualification program calls for inspection of areas of concern.

Continuing Analysis and Surveillance System
Per 49 CFR 180.509(a), a tank car owner must ensure that a tank car facility inspects and/or tests each item, evaluates each item according to acceptable results, marks the tank car, and prepares documentation in accordance with the HMR, the Association of American Railroads (AAR) (AAR) Specification for Tank Cars, and the owner's qualification program. This is not limited to performing an initial audit; it is an ongoing effort. FRA recommends that tank car owners develop system to survey and analyze the tank car facilities performing work on their cars. The frequency of the analysis and surveillance of a tank car facility by any tank car owner should correspond with the number of tank cars inspected or repaired for that owner.

Qualification Following Maintenance
An owner must identify conditions that make the tank car, the interior coating or lining, or the service equipment unsafe for transportation, affect the railworthiness, and/or reduce the design level of reliability and safety. The qualification program includes information about where, how, and when to inspect, as well as the acceptance criteria to ensure that the safety, railworthiness, and reliability of the tank car or appurtenance is maintained. A qualified tank car is one that conforms to the applicable specification and is expected to remain in conformance until the next inspection. Per 49 CFR 180.509(b)(1), any maintenance performed because the tank car shows evidence of a condition that makes it unsafe for transportation requires that the tank car be subsequently qualified regardless of the compliance dates in the HMR. Maintenance in 49 CFR 180.503 includes repairs necessary to ensure an in-operation specification until the tank car's next qualification.

FRA believes that there are numerous defective conditions, such as defective manway bolts (requiring replacement) that make a tank car unsafe for transportation, that are often repaired without the requisite qualification being performed to ensure the work conforms to the owner's acceptance criteria. As such, tank car owners must, as part of their qualification programs, develop procedures for the qualification following maintenance of features of tank cars covered by the owners' qualification program. This includes tasks such as replacement of manway eyebolts.

DOT Specification and AAR Specification Tank Cars
In 2005, the Pipeline and Hazardous Materials Safety Administration (PHMSA) issued a letter responding to questions about the primacy of tank car specification markings. In their letter, PHMSA clearly stated that the stamped specification was the "crucial marking" and that the HMR applied to all tank cars stamped with a DOT specification. FRA understands that there are a number of tank cars built to DOT specification and stenciled with an AAR classification. These cars are currently operating at a gross rail load of 286,000 pounds based on the provisions of the Tank Car Manual (Chapter 3, 3.1.1). Per the authority conferred in 49 CFR 179.13, FRA must approve the operation of a DOT-specification tank car at a gross rail load exceeding 263,000 pounds and up to 286,000 pounds. Accordingly, we will consider continued operation of existing tank cars at a gross rail load of up to 286,000 pounds.

A related matter is the classification of hazardous materials. The HMR permits the transportation of certain hazardous materials in tank cars constructed to AAR specifications. FRA is concerned that an appropriate effort is not being made to ensure proper classification of certain hazardous materials and, in some cases, hazardous materials is being classified to invoke this provision and in turn avoid the gross rail load limitations in the HMR. For example, per 49 CFR 173.150(f), a flammable liquid with a flash point greater than 100 °F can be reclassified as a combustible liquid and, as a result, many of the requirements for packaging do not apply, such as gross rail load limitations. There are generally two methods used to load crude oil into tank cars: transloading and loading from bulk storage tanks. The crude oil comes from a number of sources and may have a significant range of properties such as flammability. When questioned about the classification during recent audits, crude oil facilities indicated that they simply defer to the shipping name (classification) on a material safety data sheet.

Industry has demonstrated concern about the survivability of general purpose tank cars involved in derailments and the widening gap between these cars and those carrying materials poisonous by inhalation. In September of 2011, the AAR implemented requirements for tank cars built for the transportation of Packing Group I and II materials with proper shipping names "Petroleum Crude Oil," Alcohols, n.o.s.," and "Ethanol and Gasoline Mixture." The requirements include a number of design enhancements intended to improve the survivability of the tank cars.

Without proper classification of, in this example, crude oil, there is a reasonable chance that the material is not appropriately packaged, resulting in an increased risk to safety and the environment. FRA will therefore continue to investigate the classification procedures during audits and inspections and consider additional enforcement efforts.

LOOKING BACK

One-Time Movement Approvals

As of April 15, the Hazardous Materials Division has received 1,513 one-time movement approval (OTMA) requests for calendar year 2013. Our specialists have reviewed 255 of the requests. Of those, the breakdown of the OTMA categories is as follows: 200 OTMA-1, 28 OTMA-2, and 27 OTMA-3. FRA has received 1,250 OTMA-3 notifications.

Root Cause Analysis

When required, the submission of the root cause analysis (RCA) is the responsibility of the grantee. The primary elements of an RCA are a detailed statement of the problem, factors contributing to the problem, cause of the factors (if a cause can be determined), and steps taken to prevent recurrence. FRA does not expect that every element be performed by the grantee in every instance. For example, in the case of defective service equipment, the tank car facility performing the repair or inspection would likely be responsible for identifying the factor contributing to the problem and possibly the cause of the factors. The grantee would then be required to compile all the required information and provide the steps taken to prevent recurrence. Recent FRA audits show that tank car facilities are receiving fewer than 10 percent of the OTMAs covering noncompliant tank cars.

FRA continues to review the RCA reports submitted by grantees in response to the requirements specified in the OTMAs. The findings provide FRA with some important understanding about how the grantees are interpreting the requirement for an RCA report.

The RCA reports reviewed include the following types of "failures":

- Overloaded tank cars
- Leaks from bottom outlet valves
- Issues with pressure relief valves (including the breakage of stems and springs)

Principal Findings from the Study of RCA Reports

- The format of the reports is not uniform. Several of the reports do not prominently display the OTMA reference number (sometimes it's completely absent) and the pages are not numbered. The content is not organized uniformly or consistently. In some cases, it is difficult to locate the important findings.
- The quality of the RCA reports ranges from excellent to very poor.
    - The "excellent" reports include a discussion of the events leading to failure, details of the failure (with sketches, drawings, and color photographs), and probable causes leading to the failure along with the corrective actions to be implemented to prevent the recurrence of such failures.
    - The "poor" RCA reports are generally devoid of physical illustrations of failures, statements of what was done to evaluate the failures, and a detailed discussion of the probable causes and proposed corrective actions, if any, that would be taken. Some of these are single-page reports and contain only a statement of what happened. No discussion of the cause of failure is provided.
- In some reports, the failure is attributed to phenomena that are either too general or not defensible (e.g., extreme overpressure, without discussing how such an event could occur).
- Most RCA reports don't completely specify corrective actions, especially when the failures are complex, as in the case of pressure relief valve part breakage in tank cars servicing certain products (example: alcohols n.o.s., crude petroleum products, etc.).
- Typically, only in the case of overweight cars is there any substantial discussion on implementing corrective action (modifying standard operating procedures, additional and frequent calibration of scales, retraining of product loading personnel, etc.).

In general, FRA is concerned that grantees do not develop and/or execute corrective actions. If corrective actions had been implemented, over the past several years, we should have seen a progressive decrease in incidents such as bottom outlet valve leaks and a reduction in the number of pressure relief valve failures. However, an assessment of the data suggests an opposite trend.

Future Steps Considered

- Develop an RCA report format template and include it with the OTM approval letter, when an RCA report submission is required.
- Include in the OTMA letter a reiteration of the required submission date of the RCA report and the possible enforcement actions for noncompliance.
- Reject RCA reports submitted without discussions or proposals for corrective actions.

Tank Car Quality Assurance Team

Table 1 provides a summary of the Tank Car Facility Quality Assurance Team inspection results since its inception, related specifically to the QAP. The results include the number of defects noted relative to the requirements of 49 CFR 179.7 along with the annual number of facilities audited, cars identified as needing corrective repair, and facilities withdrawing their certification or registration.

Table 1: Quality Assurance (QA) Inspection Results

49 CFR 179.7	***Description***	***2010***	***2011***	***2012***	***2013***	***Totals***
(a)(1)	Finished product meets specs and regulations	12	20	29	2	63
(a)(2)	Can detect nonconformity	19	31	22	4	76
(a)(3)	Prevents recurrence of non-conformities	3	14	6	1	24
(b)(1)	QA authority and responsibilities	7	7	6	1	21
(b)(2)	QA Organization	1	9	2	2	21
(b)(3)	Document control	30	57	81	20	188
(b)(4)	Material ID & Documentation	50	89	11	38	288
(b)(5)	Inspection and test plan	12	29	20	7	68
(b)(6)	Process control	25	36	28	10	99
(b)(7)	Nonconformity control	3	9	10	1	23
(b)(8)	M-1002 applicability	24	59	58	19	160
(b)(9)	Personnel qualification	6	16	18	4	44
(b)(10)	Process capability	3	14	10	6	33
(b)(11)	Calibration of inspection and test equipment	24	62	90	22	198
(b)(12)	Maintenance of records	4	17	19	4	44
(c)	NDE personnel qualification	11	23	43	4	81
(d)	Written procedures provided	9	29	24	9	71
(e)	Training	53	47	50	13	163
(f)	Operate according to QA plan	3	0	8	0	11
	Facilities audited (*Jan 1-Mar 31)	59	87	96	26*	268
	Cars for corrective repair	102	248	501	67	918
	Withdrawn Cert/Reg.	16	22	16	0	54

Personnel

Phani Raj

For more than 30 years, Dr. Phani Raj has been the president and principal engineer of Technology & Management Systems, Inc. (TMS), a consulting company specializing in hazardous materials and chemical safety and the development of safety standards and regulations. He holds SM and Ph.D. degrees in mechanical engineering from Harvard University and an MBA from Northeastern University. For over 20 years, Dr. Raj has been a member of the National Fire Protection Association's Standards Committees on LNG and LPG. He also served on the "Tank Car Design Review Committee" of the Nuclear Regulatory Commission/ Transportation Research Board (TRB). He is an emeritus member of the TRB's Transportation of Hazardous Materials Committee (AC310). Dr. Raj has taught graduate chemical engineering courses at the Massachusetts Institute of Technology and the Worcester Polytechnic Institute and holds a visiting professorship position at the Texas A&M University. He is the principal author of over 150 technical reports and has published over 65 peer-reviewed technical papers.

Lawrence (Mel) Massaro

Mr. Mel Massaro joined FRA in July of 2004 as the radioactive/hazardous materials inspector in Region 2. His duties as the radioactive materials inspector covered FRA Regions 1, 2, and 3, where he worked with radioactive materials shippers, railroads, and State and Federal agencies. In September of 2011, he was asked to testify at Harvard Medical Center to President Obama's Blue Ribbon Commission on America's Nuclear Future. Prior to joining FRA, Mr. Massaro worked 5 years as a hazardous materials inspector for the Pennsylvania Public Utility Commission's Rail Safety Division. He has a diverse railroad background that includes working for the Nittany and Bald Eagle Railroad, the Everett Railroad Company, and Penn Central Railroad/Consolidated Rail Corporation.