THE NON-ACCIDENT RELEASE RISK INDEX (NARRI)
Revision 6

Developed
Under the Direction
of
Association of American Railroads,
Hazardous Materials (BOE)
Working Committee

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Cause Codes Updated 12/19/07

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PREAMBLE

The North American Class 1 Railroads are proud to be active participants in the American Chemistry Council and the Canadian Chemical Producers Association's Responsible Care partnership, and we are committed to making rail transportation the safest mode for shipping chemicals. As we have implemented the elements of the program into our daily operations, we have also reviewed our policies, practices, and procedures for areas of improvement.

One area we designated for improvement is the Non-Accident Release program, and from that effort, we have developed a new process that will help reduce and eventually eliminate releases of hazardous materials while in rail transportation. The product is called the Non-Accident Release Risk Index (NARRI), which provides a means to review and study incidents in a multi-dimensional format by evaluating the critical risk elements that can occur in these types of releases.

NARRI is an industry-wide approach to measuring the severity of individual releases. Coupled with the frequency of release information, NARRI can be used as a trending tool to focus attention on important areas of concern for future improvement. The index will be a useful tool for the chemical and rail industries as we work in partnership to develop a strategy for improving tank car securement.

The following is a briefing paper illustrating the details and benefits of the program. We look forward to working with you on this important transportation safety initiative. NARRI will be another tool to share information and offer assistance to our customer's NAR prevention programs. It embraces the principles of Responsible Care and Transcaer, and improves the responsible management of chemicals.

ACKNOWLEDGEMENTS

The AAR Hazardous Materials (BOE) Working Committee would like to thank all those companies and individuals that participated in this project. The cross-functional make up of the NARRI Task Force, and the willingness of its participants to share willingly their collective knowledge and years of experience, will ensure that the final product meets its goal of moving closer toward the eventual elimination of non-accident releases of hazardous materials in rail transportation.

The Committee would also like to acknowledge the work of the American Chemistry Council and its members who have worked diligently over the last ten years to advance significant improvements in tank car securement and reduce the frequency of non-accident releases.

The members of the Committee are confident that by continuing to work closely with manufacturers and shippers of hazardous materials and utilizing the multi-dimensional risk attributes of the NARRI to review incidents, even greater improvements in safety can be achieved.

INTRODUCTION

The Non-Accident Release Risk Index (NARRI) is an industry-wide approach to measuring the severity of individual releases of hazardous materials. Coupled with frequency of release information, the NARRI can be used as a trending tool to help focus attention on important areas of concern for future improvement.

NARRI was jointly developed through consultation with representatives from all Class I Freight Railroads with operation in the United States and Canada, and the Association of American Railroads (AAR) under the auspices of the AAR Hazardous Materials (BOE) Working Committee. After the framework of factors and subfactors was developed, an extensive validation effort was undertaken to ensure that:

1. Scoring values were consistent across a broad array of NAR conditions. After reviewing over 50 case studies, a panel of experts in the field determined that the structure of the scoring produced valid and comparable results from NAR to NAR.
2. Scoring values were reproducible from individual to individual for the same NAR. In other words, the NARRI was based largely on objective, not subjective criteria.

To complete the NARRI, a scorer must have a clear understanding of the incident in question. Information can typically be found using first hand knowledge of the incident, field reports, DOT 5800.1 reports and/or shipping documents. Once a clear understanding is established, the mechanics of completing the NARRI are relatively simple and should take only a short amount of time. To facilitate entry of the NARRI scores into a master database maintained by the AAR, the following data recording guidelines should be used:

- Record the NARRI individual factor scores and the total score in the lower left corner of the Box IX (Description of Events) of the DOT 5800.1 report. Preface the scores with a “NARRI:” delimiter.
- Record the tank car NAR cause code several spaces to the right of the NARRI factors. Preface the code with a “Code:” delimiter.
- Record the Packaging Group Box 15 of the DOT 5800.1 report after the ID number.

Please type the entries or PRINT LEGIBLY AND CLEARLY to facilitate data entry.

The scoring values for each factor are summarized in a tally sheet suitable for field use (see Appendix A). Additionally, the following provides a more in depth discussion of the various factors and subfactors that comprise the NARRI.

A. PREVENTATIVE FACTORS

The preventative factor is intended to be neither a measure of risk nor consequence, but rather a rating of the preventablity of an individual NAR. The causes of a release during a NAR can be fundamentally traced to either a condition that could have been prevented through the careful application of standard practices, or to a condition, that while preventable, would not have been detected using standard practices. Thus, the two subfactors are:

- Obvious or blatant human or process failure that should have been prevented - A preventable failure is a failure that should have been observed and prevented prior to the packaging reaching transportation from the point-of-view of the person preparing the package for transportation. Examples of preventable failures include situations that should be noticeable by a casual observer or failure to follow accepted maintenance or inspection procedures. Failures that arise due to conditions encountered during transportation are not preventable under this definition, such as an internal lining or coating failure, or failure of a gasket under a bolted-flange closure. Likewise, failures that could have been found with a more stringent inspection or maintenance regime do not generally fall into this definition.

- All other non-accident releases - All failures that do not meet the above definition.

A list of NAR codes with default subfactor assignments has been developed (see Appendix B) and should be used for an initial assessment. However, professional judgement of the details of the particular NAR must be used in assigning the proper subfactor. The benefit of the doubt should be given to the shipper when assessing this factor. Thus, the "default" assignment should be the "All other non-accident releases" subfactor unless clear and convincing evidence to the contrary exists.

B. <u>SHIPPING PACKAGING FACTOR</u>

The shipping packaging factor is intended as a surrogate measure of the amount of material that could have been released to the environment under worst case scenario; thereby, compounding the exposure. The subfactors are:

- A Loaded Bulk Container

- A Residue Bulk Container

- A Loaded non-Bulk Container

- A Residue non-Bulk Container

According to 49CFR171.8, a bulk container is one in which hazardous materials are loaded with no intermediate form of containment and which has:

- A maximum capacity greater than 450 L (119 gallons) as a receptacle for a liquid;

- A maximum net mass greater than 400 kg (882 pounds) and a maximum capacity greater than 450 L (119 gallons) as a receptacle for a solid; or

- A water capacity greater than 454 kg (1000 pounds) as a receptacle for a gas as defined in 49CFR173.115.

According to 49CFR171.8, residue means the hazardous material remaining in a packaging, including a tank car, after its contents have been unloaded to the maximum extent practicable and before the packaging is either refilled or cleaned of hazardous material and purged to remove any hazardous vapors.

C. PRODUCT HAZARD FACTOR

The Product Hazard Factor is intended as a measure of how dangerous a material could be if released to the environment. The factor is based on the DOT hazard and packing group classification, with a few specific chemicals called out by name based on accumulated industry experience.

The DOT hazard classification system is a means of categorizing a hazardous material under the definitional criteria of 49CFR173 and the provisions of the 49CFR172.101 Table. A material may meet the defining criteria for more than one hazard class but is assigned to only one hazard class. A Hazard Class is the major division under the system. A Division is the minor subdivision under the system.

A packing group delineates the degree of danger presented by a hazardous material. Packing Group I indicates great danger; Packing Group II, medium danger; Packing Group III, minor danger. See 49CFR172.101(f).

Subfactors are:

Subfactor 1	• Division 1.1 • Division 1.2 • Division 1.3 • Division 2.3 • Division 5.2 (organic peroxides) • Division 6.1 Zones A & B, • Class 7 (Yellow III)
Subfactor 2	• Division 4.3 materials • Anhydrous Ammonia
Subfactor 3	• Packing Group I materials listed as Division 6.1 or Hazard Class 8
Subfactor 4	• Division 2.1 materials • Packing Group I materials with a Hazard Class 3 or 4 or Division 5.1 • Packing Group II materials with a Hazard Class 8 or Division 6.1
Subfactor 5	• Packing Group II materials with a Hazard Class 3 or 4 • Packing Group II materials with a Division 1.4, 1.5, 5.1 or 5.2, • Packing Group III materials with a Hazard Class 8 or Division 6.1
Subfactor 6	• Division 2.2 materials except Anhydrous Ammonia • Hazard Class 9 materials • Class 7 (Yellow II and White I) • Packing Group III materials with a Hazard Class of 3 or 4 or Hazard 5.1 • Combustible Liquids

D. EXTENUATING PRODUCT RISK FACTORS

The Extenuating Product Risk Factor is intended to provide a measure of refinement to the Product Hazard Factor. Various extenuating characteristics relating to the hazardous nature of the material

are evaluated to determine if added significance (beyond those assessed by the Product Risk Factor) should be assessed in the event of a NAR. **The subfactors are additive** (i.e., if more than one applies, add all for the final score for this factor). The following table outlines the subfactors:

Subfactor 1	The material is released is an environmentally sensitive chemical as defined by the AAR Circular OT-55. In general, these materials would pose significant environmental hazard when released even in small quantities. The current list of environmentally sensitive substances is: Allyl chloride Carbon Tetrachloride Chlorobenzene Chloroform o-Dichlorobenzene Dichloropropane Dichloropropane/ Dichloropropene mixture Dichloropropene Ethyl chloride Ethylene dibromide Ethylene dibromide/Methyl bromide mixture Ethylene dichloride Epichlorohydrin Methyl chloroform Methylene chloride Methylene chloride/Chloroform mixture Perchloroethylene Perchloroethylene/Trichloroethylene mixture Trichloroethylene
Subfactor 2	The material released is or creates a poison inhalation hazard excluding anhydrous ammonia and Division 2.3 and 6.1 Zone A and B materials. Division 6.1 (other than a PIH material) is addressed in the next subfactor. The Product Risk Factor already considered the fact that anhydrous ammonia and Division 2.3 and 6.1 Zone A and B materials are, or create, a gas that is a poison inhalation hazard.
Subfactor 3	The material released has a subsidiary Division 6.1 or Hazard Class 8.
Subfactor 4	The material released is a hazardous waste (i.e., subject to the Hazardous Waste Manifest Requirements of the U.S. Environmental Protection Agency specified in 40 CFR part 262).

E. ENVIRONMENTAL IMPACT FACTORS

The Environmental Impact Factor is intended to be a measure of the actual amount of material released to the environment. Liquids should be measure by the volume released. Solids should be measured by the weight released. Gases should be measured either by the weight released, or the liquid volume lost if it is a compressed liquid in transportation. Subfactors are:

Subfactor 1	1,001 gallons or greater (or) 10,000 or greater pounds released.
Subfactor 2	101 to 1,000 gallons or more (or) 1,001 to 10,000 pounds released.
Subfactor 3	11 to 100 gallons (or) 101 to 1,000 pounds released.
Subfactor 4	0 to 10 gallons (or) 0 to 100 pounds released.

Note that fractional values should be rounded up to the next higher whole number. Thus a release of 10.1 gallons would round up to 11 gallons released and be assigned a Subfactor 2.

F. HUMAN IMPACT FACTOR

The Human Impact Factor is intended as a rough measure on the actual effects of the NAR on human activities. Subfactors are:

- Any evacuation, regardless of who ordered it or why, of the yard, facility, and/or the general public areas or public roadways, not including isolation measures. As a direct result of the evacuation order, employees or the general public are displaced from their residence or place of work. Sheltering in place, isolation measures within the confines of the railyard/facility or standard measures to restrict access to the immediate vicinity of the release do not constitute an evacuation. Restriction of employee movement that adversely affects facility operations does constitute an evacuation.

- Death resulting from direct exposure to the product. The loss of life can occur during the initial release or initial response to the release. Loss of life during long-term clean-up activities is not included in this category. Loss of life due to circumstances surrounding the event, but not due directly to exposure to the product, is not included in this category. The affected individual may be an employee, contractor, responder, or member of the general public.

- An employee, contractor, responder, or member of the public is hospitalized due to exposure to the direct product or as a result of activities involved in the initial response to the release. The hospitalization can occur during the initial release or initial response to the release. Hospitalization due to circumstances surrounding the event, but not due directly to exposure to the product, is not included in this category. Hospitalization during long-term clean-up activities is not included in this category.

- Exposure to product resulting in an injury meeting definition of FRA reportable injury whether it occurs to an employee, contractor, responder, or member of the public. A reportable injury is defined as an injury to one or more employee(s) which requires medical treatment or results in: restriction of work or motion for one or more days, or one or more lost work days; transfer to another job; termination of employment; or loss of consciousness; or any occupational illness of a railroad employee as diagnosed by a physician (Source: U.S. DOT/FRA, Accident/Incident Bulletin No. 164 Calendar Year 1995). Furthermore, the injury must have occurred during the release incident or the response to the release. Injuries that occur during long term clean-up activities are not included in this category.

- Exposure to product requiring decontamination or treatment and release from a medical facility and/or on-site first aid of an employee, contractor, unprotected responder, or member of the public. Decontamination of specially donned protective clothing by a responder are not included in this subfactor. Injuries requiring medical attention and/or first aid that meet the definition of FRA reportable (to an employee, contractor, responder, or the general public) are not included in this subfactor. Injuries that occur during long-term clean-up activities are not included in this category.

FORMULA: A (B+C+D) X (E+F) = NAR RISK INDEX

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Appendix A
Tally Sheet

APPENDIX A
NON-ACCIDENT RELEASE RISK INDEX

PART 1	
	POINT VALUE
A. PREVENTATIVE FACTOR (Use Highest Assigned Score Only):	
Obvious or blatant human or process failure that should have been prevented..	 5
All other non-accident releases.....	 2
B. SHIPPING PACKAGING FACTOR (Use Highest Assigned Score Only):	
Loaded bulk container.....	 5
Residue bulk container.....	 4
Loaded non-bulk container	 3
Residue non-bulk container	 1
C. PRODUCT HAZARD FACTOR (Use Highest Assigned Score Only):	
Division 1.1, 1.2, 1.3, 2.3, 5.2 (Organic Peroxides), 6.1(Zones A & B), and 7 (Yellow III)	 10
Division 4.3, Anhydrous Ammonia.....	 9
Class 8, 6.1, Packing Group I	 7
Division 2.1.....	 5
Class 3, 4, 5.1, Packing Group I	 5
Class 8, 6.1, Packing Group II	 5
Class 3, 4, Packing Group II	 3
Division 1.4, 1.5, 1.6, 5.1, 5.2, Packing Group II	 3
Class 8, 6.1, Packing Group III	 3
Division 2.2 (except Anhydrous Ammonia)	 1
Class 9, 7 (Yellow II & White I)	 1
Class 3, 4, 5.1, Packing Group III	 1
Combustible Liquids.....	 1
D. EXTENUATING PRODUCT HAZARD FACTOR (Add All Scores That Apply):	
Product is an environmentally sensitive chemical	 5
Product is a poison inhalation hazard (excluding class 2.3, Division 6.1, and Anhydrous Ammonia).....	 2
Product has a subsidiary hazard class of 6.1 or 8.....	 1
Product is a hazardous waste.....	 1
PART 2	
E. ENVIRONMENTAL IMPACT FACTOR (Use Highest Assigned Score Only):	
1,001 gallons or greater (or)10,001 pounds or greater released.....	 5
101 gallons to 1,000 (or) 1001 to 10,000 pounds released	 4
11 gallons to 100 gallons (or) 101 to 1,000 pounds released.....	 3
0 to 10 gallons (or) to 100 pounds released	 2
*Round up fractional values – thus 10.1 gallons rounds up to 11 gallons and be assigned a 3	
F. HUMAN IMPACT FACTORS (Use Highest Assigned Score Only):	
Evacuation of the yard, facility or public area and/or closure of public roadways (does not include isolation measures)	 4
Death resulting from exposure (to either employee or non-employee)	 10
Hospitalization due to exposure (admitted) (to either employee or non-employee).....	 7
Exposure to product resulting in injury meeting definition of FRA reportable (to either employee or non-employee)	 5
Exposure to product requiring decontamination or treatment and release from a medical facility and/or on-site first aid but not FRA reportable	 2
FORMULA: A(B+C+D) X (E+F) = INCIDENT SEVERITY INDEX	

Appendix B
NAR Tank Car Cause Codes

APPENDIX B
NAR TANK CAR CAUSE CODES
Rev 12/19/07

Part that leaked	Where it leaked	Why it leaked	Cause Code	Point Value
MANWAY				
Hinged & Bolted	Connection between manway nozzle and manway cover	Bolts/nuts - less than tool tight	200	5
		Bolts/nuts - missing	201	5
		Bolts/nuts - incorrect size	202	5
		Bolt(s) broken, new break with threads/nut missing	203	2
		Bolt(s) broken, old break with threads/nut missing and/or rusted	204	5
		Bolts/nuts - threads worn, cannot be secured	205	5
		Bolts/nuts cross-threaded	206	5
		Gasket missing	207	5
		Gasket misaligned	208	5
		Gasket deteriorated	209	5
		Gasket Incompatible	210	5
		Gasket incorrect size	211	5
Pressure Plate	Connection between manway nozzle and pressure plate	Bolts/nuts - less than tool tight	212	5
		Bolts/nuts - missing	213	5
		Bolts/nuts - incorrect size	214	5
		Bolt(s) broken, new break with threads/nut missing	215	2
		Bolt(s) broken, old break with threads/nut missing and/or rusted	216	5
		Bolts/nuts - threads worn, cannot be secured	217	5
		Bolts/nuts cross-threaded	218	5
		Mounting studs improperly applied	100	5
		Gasket missing	219	5
		Gasket misaligned	220	5
		Gasket deteriorated	221	5
		Gasket Incompatible	222	5
		Gasket incorrect size	223	5
FILL HOLE	Connection between fill hole nozzle and fill hole cover	Bolts/nuts - less than tool tight	224	5
		Bolts/nuts - missing	225	5
		Bolts/nuts - incorrect size	226	5
		Bolt(s) broken, new break with threads/nut missing	227	2
		Bolt(s) broken, old break with threads/nut missing and/or rusted	228	5

		Bolts/nuts - threads worn, cannot be secured	229	5
		Bolts/nuts cross-threaded	230	5
		Mounting studs improperly applied	101	5
		Fill hole cover misaligned or not properly applied	102	5
		Gasket missing	231	5
		Gasket misaligned	232	5
		Gasket deteriorated	234	5
		Gasket Incompatible	235	5
		Gasket incorrect size	236	5
		Locking bar loose, less than tool tight	237	5
		Locking bar threads worn, cannot be secured	238	5
		Locking bar warped/bent - will not properly seat the closure	103	5
	Connection to cover plate	Weld broken/cracked	239	5
		Corrosion	240	5
		Other	241	5
LIQUID LINE - WITHOUT VALVE	Connection between liquid line and closure (blind) flange	Closure (blind) flange bolts/nuts - less than tool tight	242	5
		Closure (blind) flange bolts/nuts - missing	243	5
		Closure (blind) flange bolts/nuts - incorrect size	244	5
		Closure (blind) flange bolt(s) broken, new break with threads/nut missing	245	2
		Closure (blind) flange bolt(s) broken, old break with threads/nut missing and/or rusted	246	5
		Closure (blind) flange bolts/nuts - threads worn, cannot be secured	247	5
		Closure (blind) flange bolts/nuts cross-threaded	248	5
		Closure (blind) flange gasket missing	104	5
		Closure (blind) flange gasket misaligned	105	5
		Closure (blind) flange gasket deteriorated	106	5
		Closure (blind) flange gasket incompatible	107	5
		Closure (blind) flange gasket incorrect size	108	5

	Connection between liquid line and closure cap	Closure cap missing	250	5
		Closure cap incorrect size	251	5
		Closure cap threads worn, cannot be secured	252	5
		Closure cap cross-threaded	253	5
		Closure cap broken/cracked	109	5
		Closure cap - less than tool tight	249	5
	Connection between liquid line and closure plug	Closure plug missing	110	5
		Closure plug incorrect size	111	5
		Closure plug threads worn, cannot be secured	112	5
		Closure plug cross-threaded	113	5
		Closure plug broken/cracked	114	5
		Closure plug less than tool tight	115	5
LIQUID LINE/LIQUID VALVE	Connection between valve and closure (blind) flange	Closure (blind) flange bolts/nuts missing, valve open	254	5
		Closure (blind) flange bolts/nuts missing, valve closed	255	5
		Closure (blind) flange bolts/nuts incorrect size, valve open	256	5
		Closure (blind) flange bolts/nuts incorrect size, valve closed	257	5
		Closure (blind) flange bolts/nuts threads worn, cannot be secured, valve open	258	2
		Closure (blind) flange bolts/nuts threads worn, cannot be secured, valve closed	259	5
		Closure (blind) flange bolts/nuts cross-threaded, valve open	260	5
		Closure (blind) flange bolts/nuts cross-threaded, valve closed	261	5
		Closure (blind) flange bolts/nuts broken/cracked, valve open	262	5
		Closure (blind) flange bolts/nuts broken/cracked, valve closed	263	5
		Closure (blind) flange gasket missing	264	5
		Closure (blind) flange gasket misaligned	265	5
		Closure (blind) flange gasket deteriorated	266	5
		Closure (blind) flange gasket incompatible	267	5
		Closure (blind) flange gasket incorrect size	268	5

Closure (blind) flange	Broken/cracked	269	5
Connection between valve and manway cover plate	Mounting flange bolts/nuts less than tool tight	270	5
	Mounting flange bolts/nuts missing	271	5
	Mounting flange bolts/nuts incorrect size	272	5
	Mounting flange bolts broken, new break with threads/nut missing	273	2
	Mounting flange bolts broken, old break with threads/nut missing and/or rusted	274	5
	Mounting flange bolts/nuts threads worn, cannot be secured	275	5
	Mounting flange bolts/nuts cross-threaded	276	5
	Mounting studs improperly applied	116	5
	Valve seat/face plate grooved	695	5
	Connection (mounting) flange gasket missing	277	5
	Connection (mounting) flange gasket misaligned	278	5
	Connection (mounting) flange gasket deteriorated	279	5
	Connection (mounting) flange gasket incompatible	280	5
	Connection (mounting) flange gasket incorrect size	281	5
Connection of threaded valve to tank car	Valve less than tool tight	282	5
	Valve threads worn, cannot be secured	283	5
Connection of pipe flange to liquid line	Pipe flange bolts/nuts less than tool tight	284	5
	Pipe flange bolts/nuts missing	285	5
	Pipe flange bolts/nuts incorrect size	286	5
	Pipe flange bolts broken, new break with threads/nut missing	287	5
	Pipe flange bolts broken, old break with threads/nut missing and/or rusted	288	2
	Pipe flange bolts/nuts threads worn, cannot be secured	289	5
	Pipe flange bolts/nuts cross-threaded	290	5

		Pipe flange gasket missing	291	5
		Pipe flange gasket misaligned	292	5
		Pipe flange gasket deteriorated	293	5
		Pipe flange gasket incompatible	294	5
		Pipe flange gasket incorrect size	295	5
	Valve stem	Loose packing retainer	296	2
		Insufficient packing	297	2
		Stem worn/broken/cracked/bent	691	2
		Valve open due to missing or insuffient tied downs (argon)	692	5
		Ball broken/cracked	693	2
	Valve body	Broken/cracked	298	2
		Corrosion	299	2
		Other	300	2 or 5
	Closure cap	Missing, valve open	301	5
		Missing, valve closed	302	5
		Incorrect size, valve open	303	5
		Incorrect size, valve closed	304	5
		Threads worn, cannot be secured, valve open	305	5
		Threads worn, cannot be secured, valve closed	306	5
		Cross-threaded, valve open	307	5
		Cross-threaded, valve closed	308	5
		Broken/cracked, valve open	309	5
		Broken/cracked, valve closed	310	5
		Less than tool tight, valve open	117	5
		Less than tool tight, valve closed	118	5
	Closure plug	Missing, valve open	311	5
		Missing, valve closed	312	5
		Incorrect size, valve open	313	5
		Incorrect size, valve closed	314	5
		Threads worn, cannot be secured, valve open	315	5
		Threads worn, cannot be secured, valve closed	316	5
		Cross-threaded, valve open	317	5
		Cross-threaded, valve closed	318	5
		Broken/cracked, valve open	319	5
		Broken/cracked, valve closed	320	5
		Less than tool tight, valve open	119	5
		Less than tool tight, valve closed	120	5
AIR INLET - WITHOUT VALVE	Connection between air inlet and closure (blind) flange	Closure (blind) flange bolts/nuts - less than tool tight	321	5
		Closure (blind) flange bolts/nuts - missing	322	5

		Closure (blind) flange bolts/nuts - incorrect size	323	5
		Closure (blind) flange bolt(s) broken, new break with threads/nut missing	324	2
		Closure (blind) flange bolt(s) broken, old break with threads/nut missing and/or rusted	325	5
		Closure (blind) flange bolts/nuts - threads worn, cannot be secured	326	5
		Closure (blind) flange bolts/nuts cross-threaded	327	5
		Closure (blind) flange gasket missing	121	5
		Closure (blind) flange gasket misaligned	122	5
		Closure (blind) flange gasket deteriorated	123	5
		Closure (blind) flange gasket incompatible	124	5
		Closure (blind) flange gasket incorrect size	125	5
	Connection between air inlet/vapor line and closure cap	Closure cap missing	329	5
		Closure cap incorrect size	330	5
		Closure cap threads worn, cannot be secured	331	5
		Closure cap cross-threaded	332	5
		Closure cap broken/cracked	126	5
		Closure cap less than tool tight	328	5
	Connection between liquid line and closure plug	Closure plug missing	127	5
		Closure plug incorrect size	128	5
		Closure plug threads worn, cannot be secured	129	5
		Closure plug cross-threaded	130	5
		Closure plug broken/cracked	131	5
		Closure plug less than tool tight	132	5
AIR INLET/VAPOR VALVE	Connection between air inlet/vapor valve and closure (blind) flange	Closure (blind) flange bolts/nuts missing, valve open	333	5
		Closure (blind) flange bolts/nuts missing, valve closed	334	5
		Closure (blind) flange bolts/nuts incorrect size, valve open	335	5
		Closure (blind) flange bolts/nuts incorrect size, valve closed	336	5

	Closure (blind) flange bolts/nuts threads worn, cannot be secured, valve open	337	5
	Closure (blind) flange bolts/nuts threads worn, cannot be secured, valve closed	338	5
	Closure (blind) flange bolts/nuts cross-threaded, valve open	339	5
	Closure (blind) flange bolts/nuts cross-threaded, valve closed	340	5
	Closure (blind) flange bolts/nuts broken/cracked, valve open	341	5
	Closure (blind) flange bolts/nuts broken/cracked, valve closed	342	5
	Closure (blind) flange gasket missing	343	5
	Closure (blind) flange gasket misaligned	344	5
	Closure (blind) flange gasket deteriorated	345	5
	Closure (blind) flange gasket incompatible	346	5
	Closure (blind) flange gasket incorrect size	347	5
Closure (blind) flange	Broken/cracked, valve closed	348	5
Connection between valve and manway cover plate	Mounting flange bolts/nuts less than tool tight	349	5
	Mounting flange bolts/nuts missing	350	5
	Mounting flange bolts/nuts incorrect size	351	5
	Mounting flange bolts broken, new break with threads/nut missing	352	2
	Mounting flange bolts broken, old break with threads/nut missing and/or rusted	353	5
	Mounting flange bolts/nuts threads worn, cannot be secured	354	5
	Mounting flange bolts/nuts cross-threaded	355	5
	Mounting studs improperly applied	133	5
	Valve seat/face plate grooved	694	5
	Connection (mounting) flange gasket missing	356	5
	Connection (mounting) flange gasket misaligned	357	5
	Connection (mounting) flange gasket deteriorated	358	5

	Connection (mounting) flange gasket incompatible	359	5
	Connection (mounting) flange gasket incorrect size	360	5
Connection of threaded valve to tank car	Valve less than tool tight	361	5
	Valve threads worn, cannot be secured	362	5
Connection of pipe flange to vapor line	Pipe flange bolts/nuts less than tool tight	363	5
	Pipe flange bolts/nuts missing	364	5
	Pipe flange bolts/nuts incorrect size	365	5
	Pipe flange bolts broken, new break with threads/nut missing	366	2
	Pipe flange bolts broken, old break with threads/nut missing and/or rusted	367	5
	Pipe flange bolts/nuts threads worn, cannot be secured	368	5
	Pipe flange bolts/nuts cross-threaded	369	5
	Pipe flange gasket missing	370	5
	Pipe flange gasket misaligned	371	5
	Pipe flange gasket deteriorated	372	5
	Pipe flange gasket incompatible	373	5
	Pipe flange gasket incorrect size	374	5
Valve stem	Loose packing retainer	375	2
	Insufficient packing	376	2
	Stem worn/broken/cracked/bent	696	2
	Valve open due to missing or insuffient tied downs (argon)	697	5
	Ball broken/cracked	698	2
Valve body	Broken/cracked	377	2
	Corrosion	378	2
	Other	379	2 or 5
Closure cap	Missing, valve open	380	5
	Missing, valve closed	381	5
	Incorrect size, valve open	382	5
	Incorrect size, valve closed	383	5
	Threads worn, cannot be secured, valve open	384	5
	Threads worn, cannot be secured, valve closed	385	5
	Cross-threaded, valve open	386	5
	Cross-threaded, valve closed	387	5
	Broken/cracked, valve open	388	5

		Broken/cracked, valve closed	389	5
		Less than tool tight, valve open	134	5
		Less than tool tight, valve closed	135	5
	Closure plug	Missing, valve open	390	5
		Missing, valve closed	391	5
		Incorrect size, valve open	392	5
		Incorrect size, valve closed	393	5
		Threads worn, cannot be secured, valve open	394	5
		Threads worn, cannot be secured, valve closed	395	5
		Cross-threaded, valve open	396	5
		Cross-threaded, valve closed	397	5
		Broken/cracked, valve open	398	5
		Broken/cracked, valve closed	399	5
		Less than tool tight, valve open	136	5
		Less than tool tight, valve closed	137	5
RECLOSING PRESSURE RELIEF DEVICE	Connection between base of valve and manway cover plate	Mounting flange bolts/nuts less than tool tight	400	5
		Mounting flange bolts/nuts missing	401	5
		Mounting flange bolts/nuts incorrect size	402	5
		Mounting flange bolts broken, new break with threads/nut missing	403	2
		Mounting flange bolts broken, old break with threads/nut missing and/or rusted	404	5
		Mounting flange bolts/nuts threads worn, cannot be secured	405	5
		Mounting flange bolts/nuts cross-threaded	406	5
		Mounting studs improperly applied	138	5
		Mounting flange gasket missing	407	5
		Mounting flange gasket misaligned	408	5
		Mounting flange gasket deteriorated	409	5
		Mounting flange gasket incompatible	410	5
		Mounting flange gasket incorrect size	411	5
	Valve Seat	O-Ring missing	412	5
		O-Ring misaligned	413	5
		O-Ring deteriorated	414	5
		O-Ring incompatible	415	5
		O-Ring incorrect size	416	5
		O-Ring chemical degradation	664	5
		O-Ring installation damage	665	5

		O-Ring overcompression	666	5
		O-Ring extrusion and/or nibbling	667	5
		O-Ring spiral failure	668	5
		O-Ring explosive decompression	669	5
		O-Ring abrasion	670	5
		O-Ring contamination	671	5
		O-Ring compression set	672	5
		Broken Spring	417	2
		Bent/broken Stem	418	2
		Overloaded tank	419	5
		Missing	699	5
		Hydraulic Surge	700	5
		O-Ring retainer nut loose	701	2
		Valve not seating properly	702	2
RECLOSING PRESSURE RELIEF DEVICE (External)	Valve body	Broken/Cracked	420	2
		Corrosion	421	2
		Other	422	2 or 5
NON-RECLOSING PRESSURE RELIEF DEVICE	Connection of threaded valve to tank car	Valve less than tool tight	423	5
		Valve threads worn, cannot be secured	424	5
	Connection between base of valve and manway cover plate	Mounting flange bolts/nuts less than tool tight	425	5
		Mounting flange bolts/nuts missing	426	5
		Mounting flange bolts/nuts incorrect size	427	5
		Mounting flange bolts broken, new break with threads/nut missing	428	2
		Mounting flange bolts broken, old break with threads/nut missing and/or rusted	429	5
		Mounting flange bolts/nuts threads worn, cannot be secured	430	5
		Mounting flange bolts/nuts cross-threaded	431	5
		Mounting studs improperly applied	139	5
		Mounting flange gasket missing	432	5
		Mounting flange gasket misaligned	433	5
		Mounting flange gasket deteriorated	434	5
		Mounting flange gasket	435	5

		incompatible		
		Mounting flange gasket incorrect size	436	5
	Opening in center of pressure relief device or under pressure relief cap/cover	Frangible disc missing	437	5
		Frangible disc misaligned	438	5
		Frangible disc corroded	439	5
		Frangible disc incorrect size	440	5
		Frangible disc ruptured	441	2
		Incorrect size frangible disc ruptured	140	5
VACUUM RELIEF VALVE	Connection of threaded valve to tank car	Valve less than tool tight	442	5
		Valve threads worn, cannot be secured	443	5
	Connection between base of valve and manway cover plate	Mounting flange bolts/nuts less than tool tight	444	5
		Mounting flange bolts/nuts missing	445	5
		Mounting flange bolts/nuts incorrect size	446	5
		Mounting flange bolts broken, new break with threads/nut missing	447	2
		Mounting flange bolts broken, old break with threads/nut missing and/or rusted	448	5
		Mounting flange bolts/nuts threads worn, cannot be secured	449	5
		Mounting flange bolts/nuts cross-threaded	450	5
		Mounting studs improperly applied	141	5
		Mounting flange gasket missing	451	5
		Mounting flange gasket misaligned	452	5
		Mounting flange gasket deteriorated	453	5
		Mounting flange gasket incompatible	454	5
		Mounting flange gasket incorrect size	455	5
	Vacuum relief valve cap/cover	O-Ring missing	456	5
		O-Ring misaligned	457	5
		O-Ring deteriorated	458	5
		O-Ring incompatible	459	5
		O-Ring incorrect size	460	5
		O-Ring chemical degradation	673	5

		O-Ring installation damage	674	5
		O-Ring overcompression	675	5
		O-Ring extrusion and/or nibbling	676	5
		O-Ring spiral failure	677	5
		O-Ring explosive decompression	678	5
		O-Ring abrasion	679	5
		O-Ring contamination	680	5
		O-Ring compression set	681	5
	Valve seat	Broken Spring	461	2
		Bent/broken stem	462	2
		Overloaded tank	463	5
		Hydraulic Surge	703	5
		Valve stuck open	704	2
		Valve missing	705	5
	Valve body	Broken/cracked	464	2
		Corrosion	465	2
		Other	466	2 or 5
CONTINUOUS VENT (Hydrogen Peroxide Cars)	Vent Body	Membrane Failure	714	2
		Hydraulic Surge	715	5
CLOSED GAUGING DEVICE	Connection of fitting to manway cover plate	Mounting flange bolts/nuts less than tool tight	467	5
		Mounting flange bolts/nuts missing	468	5
		Mounting flange bolts/nuts incorrect size	469	5
		Mounting flange bolts broken, new break with threads/nut missing	470	2
		Mounting flange bolts broken, old break with threads/nut missing and/or rusted	471	5
		Mounting flange bolts/nuts threads worn, cannot be secured	472	5
		Mounting flange bolts/nuts cross-threaded	473	5
		Mounting studs improperly applied	142	5
		Mounting flange gasket missing	474	5
		Mounting flange gasket misaligned	475	5
		Mounting flange gasket deteriorated	476	5
		Mounting flange gasket incompatible	477	5
		Mounting flange gasket incorrect size	478	5

	Body	Broken/cracked pipe	479	2
		Corrosion	480	2
		Other	481	2 or 5
OPEN GAUGING DEVICE	Connection of fitting to manway cover plate	Mounting flange bolts/nuts less than tool tight	482	5
		Mounting flange bolts/nuts missing	483	5
		Mounting flange bolts/nuts incorrect size	484	5
		Mounting flange bolts broken, new break with threads/nut missing	485	2
		Mounting flange bolts broken, old break with threads/nut missing and/or rusted	486	5
		Mounting flange bolts/nuts threads worn, cannot be secured	487	5
		Mounting flange bolts/nuts cross-threaded	488	5
		Mounting studs improperly applied	143	5
		Mounting flange gasket missing	489	5
		Mounting flange gasket misaligned	490	5
		Mounting flange gasket deteriorated	491	5
		Mounting flange gasket incompatible	492	5
		Mounting flange gasket incorrect size	493	5
	Connection of valve body to pipe nipple	Valve less than tool tight	494	5
		Valve threads worn, cannot be secured	495	5
	Connection of pipe nipple to slip tube	Bent/broken pipe nipple	496	2
		Insufficient packing	497	2
		Packing gland nut tool tight	498	2
		Packing gland nut less than tool tight	144	5
	Needle valve plug	Missing, valve open	499	5
		Missing, valve closed	500	5
		Incorrect size, valve open	501	5
		Incorrect size, valve closed	502	5
		Threads worn, cannot be secured, valve open	503	5
		Threads worn, cannot be secured, valve closed	504	5
		Cross-threaded, valve open	505	5
		Cross-threaded, valve closed	506	5

		Broken/cracked, valve open	507	5
		Broken/cracked, valve closed	508	5
SAMPLE LINE	Connection of valve body to pipe nipple	Broken/damaged sample line pipe	511	2
	Connection of pipe nipple to pressure plate	Broken/damaged sample line pipe nipple	512	2
	Closure plug	Missing, valve open	513	5
		Missing, valve closed	514	5
		Incorrect size, valve open	515	5
		Incorrect size, valve closed	516	5
		Threads worn, cannot be secured, valve open	517	5
		Threads worn, cannot be secured, valve closed	518	5
		Cross-threaded, valve open	519	5
		Cross-threaded, valve closed	520	5
		Broken/cracked, valve open	521	5
		Broken/cracked, valve closed	522	5
		Less than tool tight, valve open	145	5
		Less than tool tight, valve closed	146	5
	Valve stem	Loose packing retainer	523	2
		Insufficient packing	524	2
THERMOMETER WELL	Thermometer well cap	Damaged thermometer well pipe	525	2
		Loose cap	526	5
		O-Ring missing	527	5
		O-Ring misaligned	528	5
		O-Ring deteriorated	529	5
		O-Ring incompatible	530	5
		O-Ring incorrect size	531	5
		O-Ring chemical degradation	682	5
		O-Ring installation damage	683	5
		O-Ring overcompression	684	5
		O-Ring extrusion and/or nibbling	685	5
		O-Ring spiral failure	686	5
		O-Ring explosive decompression	687	5
		O-Ring abrasion	688	5
		O-Ring contamination	689	5
		O-Ring compression set	690	5
	Connection between thermometer well nipple and manway cover plate	Broken thermometer well nipple	532	2

STUFFING BOX FOR BOTTOM OUTLET VALVE	Cover of stuffing box	Loose packing gland nut	533	2
		Insufficient packing	534	2
BOTTOM OUTLET VALVE	Connection between valve and tank car	Mounting flange bolts/nuts less than tool tight	535	5
		Mounting flange bolts/nuts missing	536	5
		Mounting flange bolts/nuts incorrect size	537	5
		Mounting flange bolts broken, new break with threads/nut missing	538	2
		Mounting flange bolts broken, old break with threads/nut missing and/or rusted	539	5
		Mounting flange bolts/nuts threads worn, cannot be secured	540	5
		Mounting flange bolts/nuts cross-threaded	541	5
		Mounting studs improperly applied	147	5
		Mounting flange gasket missing	542	5
		Mounting flange gasket misaligned	543	5
		Mounting flange gasket deteriorated	544	5
		Mounting flange gasket incompatible	545	5
		Mounting flange gasket incorrect size	546	5
	Valve stem	Loose packing retainer	547	2
		Insufficient packing	548	2
		Stem worn/broken/cracked/bent	706	2
		Not completely closing	707	5
		Ball broken/cracked	708	2
	Valve body	Cracked	549	5
		Corrosion	550	5
		Other	551	2 or 5
	Connection between bottom outlet valve and closure (blind flange)	Closure (blind) flange bolts/nuts missing, valve open	552	5
		Closure (blind) flange bolts/nuts missing, valve closed	553	5
		Closure (blind) flange bolts/nuts incorrect size, valve open	554	5
		Closure (blind) flange bolts/nuts incorrect size, valve closed	555	5

	Closure (blind) flange bolts/nuts threads worn, cannot be secured, valve open	556	2
	Closure (blind) flange bolts/nuts threads worn, cannot be secured, valve closed	557	5
	Closure (blind) flange bolts/nuts cross-threaded, valve open	558	5
	Closure (blind) flange bolts/nuts cross-threaded, valve closed	559	5
	Closure (blind) flange bolts/nuts broken/cracked, valve open	560	5
	Closure (blind) flange bolts/nuts broken/cracked, valve closed	561	5
	Closure (blind) flange gasket missing	562	5
	Closure (blind) flange gasket misaligned	563	5
	Closure (blind) flange gasket deteriorated	564	5
	Closure (blind) flange gasket incompatible	565	5
	Closure (blind) flange gasket incorrect size	566	5
Closure (blind) flange	Broken/cracked	567	5
Bottom outlet cap	Missing, valve open	568	5
	Missing, valve closed	569	5
	Incorrect size, valve open	570	5
	Incorrect size, valve closed	571	5
	Threads worn, cannot be secured, valve open	572	5
	Threads worn, cannot be secured, valve closed	573	5
	Cross-threaded, valve open	574	5
	Cross-threaded, valve closed	575	5
	Broken/cracked, valve open	576	5
	Broken/cracked, valve closed	577	5
	Less than tool tight, valve open	148	5
	Less than tool tight, valve closed	149	5
	Bottom outlet cap gasket missing	578	5
	Bottom outlet cap gasket misaligned	579	5
	Bottom outlet cap gasket deteriorated	580	5
	Bottom outlet cap gasket incompatible	581	5
	Bottom outlet cap gasket incorrect size	582	5

	Bottom outlet closure plug	Missing, valve open	583	5
		Missing, valve closed	584	5
		Incorrect size, valve open	585	5
		Incorrect size, valve closed	586	5
		Threads worn, cannot be secured, valve open	587	5
		Threads worn, cannot be secured, valve closed	588	5
		Cross-threaded, valve open	589	5
		Cross-threaded, valve closed	590	5
		Broken/cracked, valve open	591	5
		Broken/cracked, valve closed	592	5
		Less than tool tight, valve open	150	5
		Less than tool tight, valve closed	151	5
BOTTOM OUTLET AUXILIARY VALVE	Connection of auxiliary valve to bottom outlet valve	Valve less than tool tight	712	5
		Valve threads worn, cannot be secured	713	5
		Mounting flange bolts/nuts less than tool tight	593	5
		Mounting flange bolts/nuts missing	594	5
		Mounting flange bolts/nuts incorrect size	595	5
		Mounting flange bolts broken, new break with threads/nut missing	596	2
		Mounting flange bolts broken, old break with threads/nut missing and/or rusted	597	5
		Mounting flange bolts/nuts threads worn, cannot be secured	598	5
		Mounting flange bolts/nuts cross-threaded	599	5
		Mounting studs improperly applied	152	5
		Mounting flange gasket missing	600	5
		Mounting flange gasket misaligned	601	5
		Mounting flange gasket deteriorated	602	5
		Mounting flange gasket incompatible	603	5
		Mounting flange gasket incorrect size	604	5
		Mounting flange gasket incorrect size	604	5
	Auxiliary valve stem	Loose packing retainer	605	2
		Insufficient packing	606	2
		Stem worn/broken/cracked/bent	709	2
		Not completely closing	710	5
		Ball broken/cracked	711	2
	Auxiliary valve body	Cracked	607	2

		Corrosion	608	2
		Other	609	2 or 5
	Auxiliary valve closure plug	Missing, valve open	610	5
		Missing, valve closed	611	5
		Incorrect size, valve open	612	5
		Incorrect size, valve closed	613	5
		Threads worn, cannot be secured, valve open	614	5
		Threads worn, cannot be secured, valve closed	615	5
		Cross-threaded, valve open	616	5
		Cross-threaded, valve closed	617	5
		Broken/cracked, valve open	618	5
		Broken/cracked, valve closed	619	5
		Less than tool tight, valve open	153	5
		Less than tool tight, valve closed	154	5
	Auxiliary valve cap	Missing, valve open	620	5
		Missing, valve closed	621	5
		Incorrect size, valve open	622	5
		Incorrect size, valve closed	623	5
		Threads worn, cannot be secured, valve open	624	5
		Threads worn, cannot be secured, valve closed	625	5
		Cross-threaded, valve open	626	5
		Cross-threaded, valve closed	627	5
		Broken/cracked, valve open	628	2
		Broken/cracked, valve closed	629	5
		Less than tool tight, valve open	155	5
		Less than tool tight, valve closed	156	5
HEATER COILS	Closure cap	Damaged coils	630	5
		Loose cap	631	5
WASHOUT	Connection between washout plate and tank car	Mounting flange bolts/nuts less than tool tight	632	5
		Mounting flange bolts/nuts missing	633	5
		Mounting flange bolts/nuts incorrect size	634	5
		Mounting flange bolts broken, new break with threads/nut missing	635	2
		Mounting flange bolts broken, old break with threads/nut missing and/or rusted	636	5
		Mounting flange bolts/nuts threads worn, cannot be secured	637	5
		Mounting flange bolts/nuts cross-threaded	638	5
		Mounting studs improperly applied	157	5

		Mounting flange gasket missing	639	5
		Mounting flange gasket misaligned	640	5
		Mounting flange gasket deteriorated	641	5
		Mounting flange gasket incompatible	642	5
		Mounting flange gasket incorrect size	643	5
	Tell-tale plug	Loose plug	644	5
SUMP	Connection of sump to tank car	Weld failure	645	2
	Body	Cracked	646	2
		Corrosion	647	2
		Other	648	2 or 5
TANK	Seam connection	Weld failure	649	2
	Stub sill	Separation from tank	650	2
		Weld failure	651	2
	Shell	Crack/ weld failure	652	2
		Rubber lining failure	653	2
		Lining/product incompatible	654	2
	Head	Crack/Weld failure	655	2
		Rubber lining failure	656	2
		Lining/product incompatible	657	2
	Jacketed Car	Cause undetermined	658	2
OTHER		Commodity self-ignited	659	2
		Commodity polymerized	660	2
		Vandalism	661	2
OTHER (DESCRIBE)	Other (Describe location of leak)	Other (Describe cause of leak)	662	2 or 5
	Argon/Nitrogen	Other (Describe cause of leak)	716	2 or 5