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Standard Test Method for Acoustic Emission Testing of Pressurized Containers Made of Fiberglass Reinforced Plastic with Balsa Wood Cores[1]

This standard is issued under the fixed designation E 1888; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers guidelines for acoustic emission (AE) tests of pressurized containers made of fiberglass reinforced plastic (FRP) with balsa cores. Containers of this type are commonly used on tank trailers for the transport of hazardous chemicals.

1.2 This test method is limited to cylindrical shape containers, 0.5 to 3 m in diameter, of sandwich construction with balsa wood core and over 30 % glass (by weight) FRP skins. Reinforcing material may be mat, roving, cloth, unidirectional layers, or a combination thereof. There is no restriction with regard to fabrication technique or method of design.

1.3 This test method is limited to containers that are designed for less than 0.520 MPa (75.4 psi) (gage) above static pressure head due to contents.

1.4 This test method does not specify a time interval between tests for re-qualification of a pressure container.

1.5 Containers that operate with a vacuum are not within the scope of this test method.

1.6 Repair procedures are not within the scope of this test method.

1.7 The values stated in both inch-pound and SI units are to be regarded separately as the standard. The values given in parentheses are for information only.

1.8 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* Specific precautionary statements are given in Section 8.

2. Referenced Documents

2.1 *ASTM Standards:*

E 543 Practice for Agencies Performing Nondestructive Testing[2]

E 750 Practice for Characterizing Acoustic Emission Instrumentation[2]

E 976 Guide for Determining the Reproducibility of Acoustic Emission Sensor Response[2]

E 1067 Practice for Acoustic Emission Examination of Fiberglass Reinforced Plastic Resin (FRP) Tanks/Vessels[2]

E 1316 Terminology for Nondestructive Examinations[2]

2.2 *SPI/CARP Standards:*

Recommended Practice for Acoustic Emission Testing of Fiberglass Reinforced Plastic Resin (FRP) Tanks/Vessels[3]

Recommended Practice for Acoustic Emission Testing of Fiberglass Reinforced Plastic Piping Systems[2]

2.3 *ANSI/ASNT Standards:*

SNT-TC-1A Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing[4]

ANSI/ASNT CP-189 Standard for Qualification and Certification of NDT Personnel[4]

2.4 *Military Standard:*

MIL STD 410 Nondestructive Testing Personnel Qualification and Certification[5]

2.5 *ASME Standard:*

Section V, Article 11, Boiler and Pressure Vessel Code[6]

3. Terminology

3.1 *Definitions*—With the exception of terms defined in 3.2, this test method incorporates by reference all terminology in Terminology E 1316 and Practice E 1067. First occurrences of terms defined herein are italicized.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *AE trend number*—a number used to designate trends in AE activity which are exhibited by structures during a set of repeated loading cycles (see 9.2).

3.2.2 *Minimum AE activity level*—that level of activity below which AE trend numbers are not robust indicators of the trend (see 9.1)

3.2.3 *test pressure (tp)*—the highest pressure used while testing a given container. The test pressure is 1.1 times the maximum allowable working pressure, MAWP (see Section 8).

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[1] This test method is under the jurisdiction of ASTM Committee E-07 on Nondestructive Testing and is the direct responsibility of Subcommittee E07.04 on Acoustic Emission Method.

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[2] *Annual Book of ASTM Standards*, Vol 03.03.

[3] Available from American Society for Nondestructive Testing, Inc., 1711 Arlingate Lane, Columbus, OH 43228–0518.

[4] Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

[5] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111–5094, Attn: NPODS.

[6] Available from American Society of Mechanical Engineers, United Engineering Center, 345 East 47th Street, New York, NY 10017.

4. Significance and Use

4.1 This test method does not rely on absolute quantities of AE parameters. It relies on trends of cumulative AE counts that are measured during a specified sequence of loading cycles. This test method includes an example of test settings and acceptance criteria as a nonmandatory appendix.

4.2 Acoustic emission (AE) counts were used as a measure of AE activity during development of this test method. Cumulative hit duration may be used instead of cumulative counts if a correlation between the two is determined. Several processes can occur within the structure under test. Some may indicate unacceptable flaws (for example, growing resin cracks, fiber fracture, delamination). Others may produce AE but have no structural significance (for example, rubbing at interfaces). Methodology described in this standard prevents contamination of structurally significant data with emission from insignificant sources.

4.3 *Background Noise*—Background noise can distort interpretations of AE data and can preclude completion of a test. Test personnel should be aware of sources of background noise at the time tests are conducted. AE tests should not be conducted until such noise is substantially eliminated.

4.4 *Mechanical Background Noise*—Mechanical background noise is generally induced by structural contact with the container under test. Examples are: personnel contact, wind borne sand or rain. Also, leaks at pipe connections may produce background noise.

4.5 *Electronic Noise*—Electronic noise such as electromagnetic interference (EMI) and radio frequency interference (RFI) can be caused by electric motors, overhead cranes, electrical storms, welders, etc.

4.6 *Airborne Background Noise*—Airborne background noise can be produced by gas leaks in nearby equipment.

5. Basis of Application

5.1 *Personnel Qualification*:

5.1.1 NDT personnel shall be qualified in accordance with a nationally recognized NDT personnel qualification practice or standard such as ANSI/ASNT-CP-189, SNT-TC-1A, MIL-STD-410 or a similar document. The practice or standard used and its applicable revision shall be specified in the contractual agreement between the using parties.

5.1.2 Also, it is required that personnel performing acoustic emission testing of containers be trained, by attending a dedicated training course on the subject and passing a written examination. The training course shall include appropriate material for NDT Level II qualification according to ANSI/ASNT-CP-189 or SNT-TC-1A.

5.1.3 Personnel shall be trained/examined on the following topics:

5.1.3.1 Container construction and terminology,

5.1.3.2 Mechanisms of AE generation in FRP including containers within the scope of this test method,

5.1.3.3 AE instrumentation,

5.1.3.4 Container testing procedures, including loading requirements,

5.1.3.5 Date collection and interpretation, and

5.1.3.6 Test report and permanent record requirements.

5.2 *Qualification of Nondestructive Agencies*—If specified in the contractual agreement, NDT agencies shall be qualified and evaluated as described in Practice E 543. The applicable edition of Practice E 543 shall be specified in the contractual agreement.

5.3 *Time of Examination*—The time of examination shall be in accordance with 8.2 unless otherwise specified.

5.4 *Procedures and Techniques*—The procedures and techniques to be utilized shall be as described in this test method unless otherwise specified. Specific techniques may be specified in the contractual agreement.

5.5 *Reporting Criteria/Acceptance Criteria*—Reporting criteria/acceptance criteria shall be in accordance with Sections 9 and 10 unless otherwise specified.

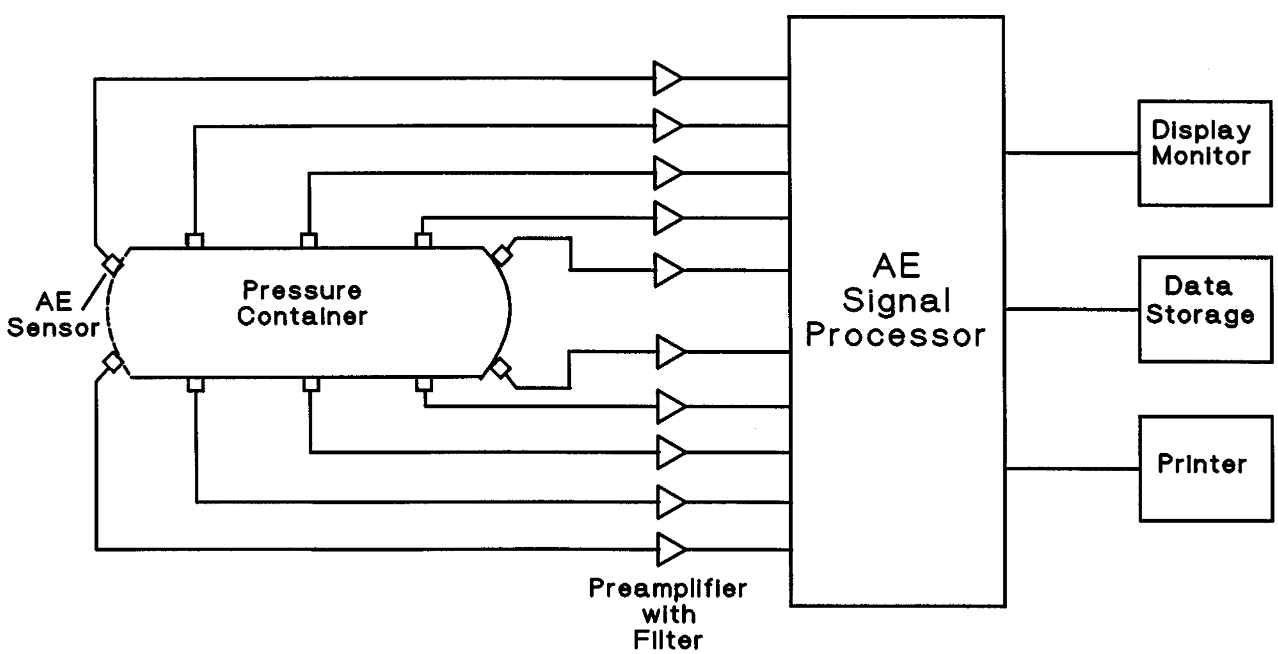


FIG. 1 Recommended Features of the Apparatus

5.6 *Reexamination of Repaired/Reworked Items*—Reexamination of repaired/reworked items shall be in accordance with Section 8 unless otherwise specified.

6. Apparatus

6.1 Recommended features of the apparatus required for this standard are provided in Fig. 1. Full specifications are in Annex A1.

6.2 Couplant must be used to acoustically connect sensors to the vessel surface. Adhesives that have acceptable acoustic properties and adhesives used in combination with traditional couplants are acceptable.

6.3 Sensors may be held in place with elastic straps, adhesive tape, or other mechanical means.

6.4 Sensor spacing shall be such that a standard 0.5 mm, 2H pencil lead break (See Guide E 976) on any part of a liquid filled container is detected by at least one AE sensor. A 0.3 mm, 2H pencil lead break may be used which would reduce the sensor spacing. Presence of heads, manholes, and nozzles shall be considered when sensor locations are selected. Fig. 2 shows a typical sensor location scheme.

6.4.1 *Attenuation Characterization*—Typical signal propagation losses shall be determined according to the following procedure. This procedure provides a relative measure of the attenuation but may not be representative of a genuine AE source. It should be noted that the peak amplitude from a mechanical pencil lead break may vary with surface hardness, resin condition and cure. Select a representative region of the vessel with clear access along the cylindrical section. Mount an AE sensor and mark off distances of 2.36 cm (6 in.) and 4.72 cm (12 in.) from the center of the sensor along a line parallel to the principal direction of the surface fiber. Select two additional points on the surface of the vessel at 2.36 cm (6 in.) and 4.72 cm (12 in.) along a line inclined 45 and 90° to the principal direction of the surface fiber, break pencil leads (0.3 mm 2H, rather then 0.5 mm to avoid possible saturation due to larger signal output) and record peak amplitude. All lead breaks shall be done at an angle of approximately 30° to the surface with a 2.54 mm lead extension. The attenuation data shall be retained as part of the original experimental record.

6.4.2 Record the distances from the center of the sensor to the points where hits are no longer detected. Repeat this procedure along lines inclined 45 and 90° to the direction of the original line. The data shall be retained as part of the original experimental record. The minimum distance from the sensor at which the pencil lead break can no longer be detected is known as the threshold distance.

6.5 Acoustic emission sensors are used to detect strain induced stress waves produced by flaws. Sensors must be held in contact with the vessel wall to ensure adequate acoustic coupling.

6.6 A preamplifier may be enclosed in the sensor housing or in a separate enclosure. If a separate preamplifier is used, cable length between sensor and preamplifier must not exceed 1.8 m (6 ft).

6.7 Power/signal cable length (that is, cable between preamplifier and signal processor) shall not exceed 150 m (500 ft).

6.8 Signal processors are computerized instruments with independent channels that filter, measure and convert analog information into digital form for display and permanent storage. A signal processor must have sufficient speed and capacity to independently process data from all sensors simultaneously. The signal processor should provide capability to filter data for replay.

6.9 A video monitor should display processed data in various formats. Display format may be selected by the examiner.

6.10 A data storage device, such as a floppy disc, may be used to provide data for replay or for archives.

6.11 Hard copy capability should be available from a graphics/line printer or equivalent device.

7. Calibration and Standardization

7.1 Perform annual calibration and verification of pressure transducer, AE sensors, preamplifiers (if applicable), signal processor (particularly the signal processor time reference) and AE electronic waveform generator. Adjust equipment so that it conforms to equipment manufacturer's specifications. Instruments used for calibrations must have current accuracy certification that is traceable to the National Institute for Standards and Technology (NIST).

7.2 Perform routine electronic evaluations on a monthly

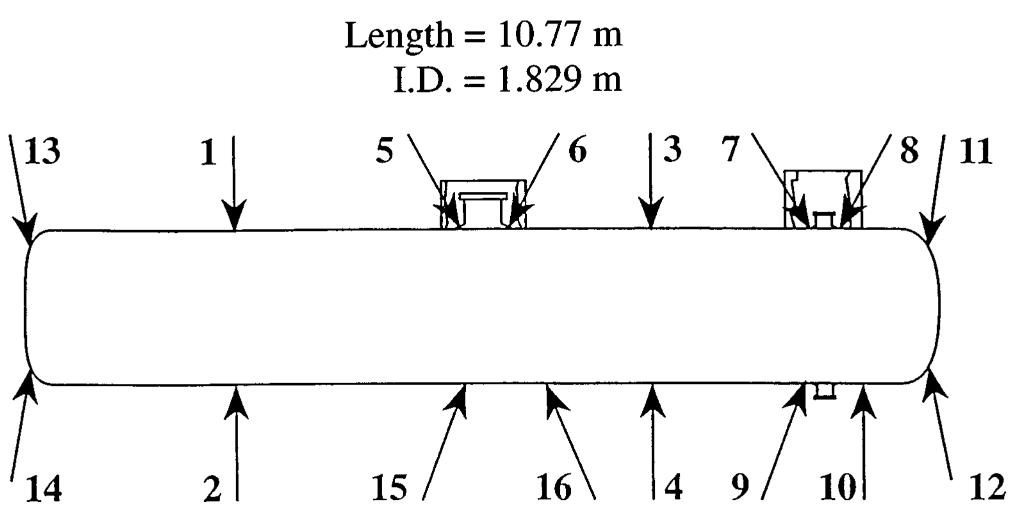


FIG. 2 Typical Test Configuration Showing AE Sensor Location on a Road Tanker

basis or at any time there is concern about signal processor performance. Use an AE electronic waveform generator in making evaluations. Each signal processor channel must respond with peak amplitude reading within ± 2 dB of the expected output value (based on input signal value and amplifier gain values).

7.3 Perform routine evaluation of each sensor on a monthly basis or at any time there is concern about the sensors performance. Record peak amplitude response and electronic noise level. Sensors can be stimulated by a pencil lead break or electronic waveform generator with a pulser. Replace sensors that are found to have peak amplitudes or electronic noise more than 5dB greater or less than the average of the group of sensors to be used during the examination.

7.4 A system performance check must be conducted immediately before and immediately after each examination. A performance check uses a mechanical device to induce stress waves into the vessel wall at a specified distance from each sensor. Induced stress waves stimulate a sensor in the same way as emission from a flaw. Performance checks verify performance of the entire system (including couplant).

7.4.1 The preferred technique for conducting a performance check is a pencil lead break. Lead should be broken on the vessel surface no more than 3.8 cm (1.5 in.) from the sensor. A 2H lead, 0.3 mm diameter, 2.54 mm long should be used (see Fig 4 of Guide E 976).

8. Procedure

8.1 Use liquid (normally water) for the pressure medium. Support containers that are not mounted on a truck frame (as closely as is practical) like in service. Support shall be such as to minimize extraneous noise. Test data are used to compute "AE trend numbers". These can be computed while the test is in progress. These are defined in 9.2.

8.1.1 Apply pre-test simulated AE to the (liquid filled) container 200 mm (7.9 in.) from each sensor. Include simulated AE counts in test reports. Make at least five lead breaks, along a 200 mm radius circle, around each sensor. Their average shall be at least N_c counts per lead break (see X2.2). If fewer counts are measured, examine the system and identify sensor, cable, electronics, coupling or vessel characteristic as cause for low sensitivity. If a system component caused low sensitivity, it should be corrected. If a structural characteristic caused low sensitivity, that should be reported with simulated AE counts.

NOTE 1—Low counts may indicate damaged structure.

8.2 *Loading*:

8.2.1 *Pre-Test Loading*:

8.2.1.1 New containers are pre-loaded to 1.15 times MAWP and pressure is held for 20 min, prior to the AE test. Vent all vessels for at least 15 h prior to the AE examination. Following that, test the container with the loading schedule in 8.2.2.

8.2.1.2 Treat containers that have been repaired like new containers.

8.2.1.3 Do not pre-load containers that were taken from service.

8.2.2 *Test Loading*:

8.2.2.1 Test pressure shall be equal to 1.1 times MAWP pressure. The load schedule shall be as shown in Table 1 and Fig. 3.

8.2.2.2 Uniformly apply load at a rate less than 10 % of the test pressure per minute. Load rate shall be as uniform as possible. Remove load, uniformly, at a rate no greater than 10 % of the test pressure per minute.

8.2.2.3 Background noise should be minimized. Minimize false AE from liquid entering the container during loading by reducing flow rate.

8.2.2.4 Monitor noise from the environment during an initial hold period of at least 10 min. If background noise cannot be eliminated prior to data acquisition, interrupt the test. Correct background noise problems before test is resumed or repeated.

8.2.2.5 Duration of hold periods at test pressure shall be at least 20 min and shall be constant (± 1 %) throughout the test. Duration of all other hold periods shall be 5 min. Pressure fluctuations during hold period shall be limited to ± 1 % of test pressure or 2 kPa (0.3 psi), whichever is greater. If pressure has exceeded ⅔ test pressure, and test sequence has been interrupted for more than 30 min, release pressure and do not resume the test until 15 h have passed.

8.3 *Zone Location*—AE sources are located by noting which sensor first indicates occurrence of an AE event. The source is located near that sensor. Misleading results can be caused by effects of liquid in the container, fiber orientation on stress wave propagation paths, or differences in characteristics of AE signal processor channels. Also the number of sensors used (that is, sensor location density) must be considered when zone location is used effectively.

9. Interpretation of Results

9.1 *General*—Cumulative AE counts from each signal processor channel are used to determine structural integrity of containers. AE trend numbers are measures of trends in AE activity that are observed over repeated loadings. Relative magnitudes of trend numbers from cycle to cycle are used to make accept/reject decisions. Pressure levels and hold durations must be the same if trend number are to be meaningful. Furthermore, AE activity must exceed a certain minimum level before a trend number can be meaningful. If less than minimum AE activity is recorded, the trend number cannot be used. The demarcation value of minimum AE activity, for each channel is:

$$n = 12 \times C \quad (1)$$

where: C is the average AE count from all lead breaks made during execution of the procedure 8.1.

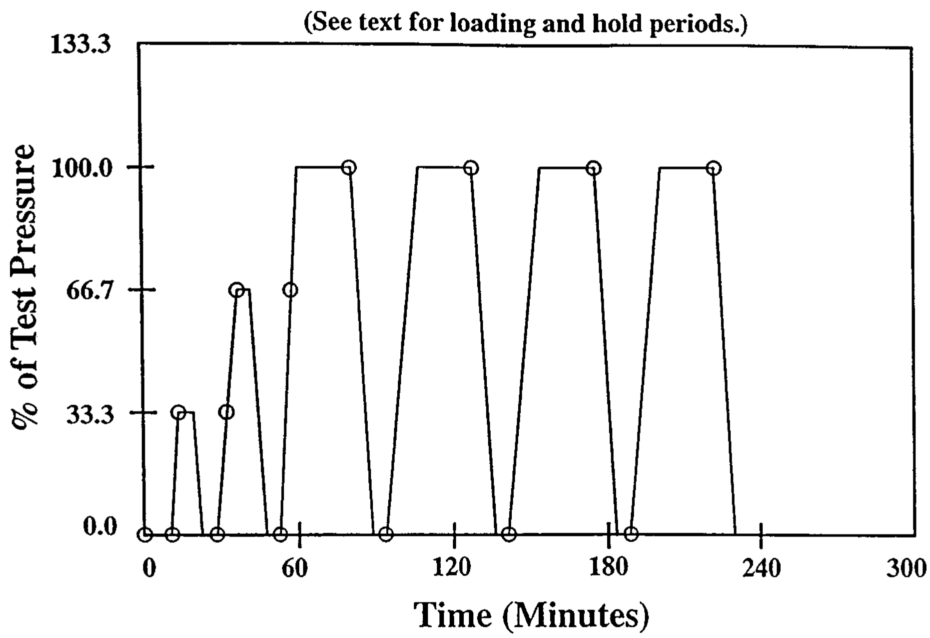
9.2 *Definition of AE Trend Number*:

9.2.1 In general, an AE trend number is defined as follows:

$$Z_c^{\,i,j} = A_c^{\,i,j} / A_c^{\,f,j} \quad (2)$$

TABLE 1 Load Schedule

Cycle Number	Maximum Pressure
1	⅓ Test Pressure
2	⅔ Test Pressure
3 to 6	Full Test Pressure



NOTE 1—Circles indicate points at which AE data must be recorded.

FIG. 3 Recommended Loading Schedule for Testing Pressure Containers Using AE Monitoring

where:

i = cycle number (it ranges from 1 to 6),
j = load level:
 j= 1, load is ⅓ test pressure
 j= 2, load is ⅔ test pressure
 j= 3, load is test pressure,
c = signal-processor channel number,
f = first cycle where pressure level "j" is reached, and
$A_c^{i,j}$ = cumulative AE counts in cycle "i", from load = 0, to load level "j" including hold periods (where applicable).

With trend numbers, AE activity is normalized with respect to activity during the initial cycle, at a given load. An example of calculation of trend numbers from test data is shown in Appendix X1. Trend number must be calculated to two decimal places.

9.3 *Use of Trend Numbers*:

9.3.1 *Load Levels j = 1 and 2*—Calculate trend numbers as data becomes available during a test. However, these numbers shall not be basis for acceptance or rejection. These numbers may be used to detect potential critical situations. If AE trend numbers decrease at a given load as cycle number increases, the container is probably acceptable. If they do not decrease special caution is warranted; test personnel may decide to terminate the test.

9.3.2 *Full Test Pressure (Load Level j=3)*—Use for acceptance or rejection by following the steps in Appendix X3. If AE trend numbers decrease at a given load as cycle number increases, the container is probably acceptable. If they do not decrease, special caution is warranted; test personnel may decide to terminate the test.

10. Report

10.1 As a minimum requirement, a test report shall identify and describe; the container, test conditions, test date and results from pencil lead breaks (before and after test). Also, include test instrumentation and names of company and personnel that perform the test shall be included in the report. Include a sketch that shows sensor locations. Detail sensor mounting and coupling. Show the demarcation value, *n*. Tabulate test results as shown in Appendix X1. A sample test report layout is shown in Appendix X4.

11. Precision and Bias

11.1 Precision of the results from this test method will be influenced by many external factors such as background noise, material variations, previous stress history, calibration of instrumentation, contents of tank, and tank wall surface protection.

11.2 This test method is used to determine if a container is structurally sound in its present condition or if follow-up NDT is needed before that determination can be made. Bias of this test method generally leads to follow-up inspection of more areas than those that actually have significant flaws.

12. Keywords

12.1 acoustic emission; balsa core; composite pressure vessel; tank trailer

ANNEX

(Mandatory Information)

A1. INSTRUMENTATION SPECIFICATIONS

A1.1 *Sensors*:

A1.1.1 AE sensors shall be resonant in a 100 to 300 kHz frequency band.

A1.1.2 Sensitivity shall be greater than –77 dB (referred to 1V/microbar, determined by face-to-face ultrasonic method) over the frequency range 100 to 300 kHz.

A1.1.3 Sensitivity within the 100 to 300 kHz range shall not vary more than 3 dB over the intended range of temperatures in which sensors are used.

A1.1.4 Sensors shall be shielded against electromagnetic interference through proper design practice or differential (anticoincidence) element design, or both.

A1.1.5 Sensors shall be electrically isolated from conductive surfaces by means of a shoe (a wear plate).

A1.2 *Signal Cable*:

A1.2.1 The sensor signal cable that connects sensor and preamplifier shall not be longer than 1.8 m (6 ft). Integral preamplifier sensors meet this requirement. They have inherently short, internal, signal cables.

A1.2.2 Signal cable shall be shielded against electromagnetic interference. Standard coaxial cable is generally adequate.

A1.3 *Couplant*

A1.3.1 Couplant shall provide adequate ultrasonic coupling efficiency throughout the examination.

A1.3.2 Couplant must be temperature stable over the temperature range intended for use.

A1.3.3 Adhesives may be used if they satisfy ultrasonic coupling efficiency and temperature stability requirements.

A1.4 *Preamplifier*

A1.4.1 Preamplifier shall have noise level no greater than 7 microvolts rms (referred to a shorted input) within the bandpass range.

A1.4.2 Preamplifier gain shall vary no more than ± 1dB within the frequency band and temperature range of use.

A1.4.3 Preamplifier shall be shielded from electromagnetic interference.

A1.4.4 Preamplifiers of differential design shall have a minimum of 40 dB common mode rejection.

A1.4.5 Preamplifier shall include a bandpass filter with a minimum of 24 dB/octave signal attenuation above and below the 100 to 300 kHz frequency band.

A1.5 *Power/Signal Cable*—Power/Signal cables provide power to preamplifiers and conduct amplified signals to the main processor. These shall be shielded against electromagnetic interference. Signal loss shall be less than 1 dB per 30 m (100 ft) of cable length. Standard coaxial able is generally adequate. Signal loss from a power/signal cable shall be no greater than 3dB.

A1.6 *Power Supply*—A stable, grounded, power supply that meets signal-processor manufacturer's specification shall be used.

A1.7 *Signal Processor*:

A1.7.1 Electronic circuitry gain shall be stable within ± 2dB in the temperature range 40 to 100°F (4.4 to 37.8°C).

A1.7.2 Threshold shall be accurate within ± 2dB.

A1.7.3 Measured AE parameters shall include: threshold crossing counts, peak amplitude, arrival time and duration for each event. Also, vessel internal pressure shall be measured.

A1.7.4 AE Count measurements shall be accurate within ± 5 %.

A1.7.5 Peak amplitude shall be accurate within ± 2dB.

A1.7.6 Arrival time at each channel shall be accurate to within ± 1.0 microseconds.

A1.7.7 Duration shall be accurate to within ± 10 microseconds.

A1.7.8 Parametric voltage readings from pressure transducers shall be accurate to within ± 5 % of marked service pressure.

APPENDIXES

(Nonmandatory Information)

X1. EXAMPLE OF TEST DATA

X1.1 Full data-set including AE trend numbers in a typical test for cycles 3 to 6 (see Table X1.1) (at the test pressure level). ΣNLT refers to cumulative AE counts above the signal detection threshold.

X1.1.1 This pressure container passed the test.

X1.2 Full data-set including AE trend numbers in a typical test for Cycles 3 to 6 (see Table X1.2) (at the test pressure level). ΣNLT refers to cumulative AE counts above the signal detection threshold

X1.2.1 This pressure container did not pass the test.

TABLE X1.1 Example of Test Data for Passed Test Number

CH Number	Cycle Number 3		Cycle Number 4		Cycle Number 5		Cycle Number 6	
	ΣNLT	Z	ΣNLT	Z	ΣNLT	Z	ΣNLT	Z
1	38 990	1.00	2345	0.06	609	0.02	250	0.01
2	24 510	1.00	3090	0.13	346	0.01	705	0.03
3	56 600	1.00	3604	0.06	411	0.01	1,236	0.02
4	13 668	1.00	851	0.06	303	0.02	298	0.02
5	37 015	1.00	4035	0.11	663	0.02	360	0.01
6	25 670	1.00	5202	0.20	1,114	0.04	582	0.02
7	37 396	1.00	2004	0.05	889	0.02	257	0.01
8	19 705	1.00	2616	0.13	702	0.04	607	0.04
9	17 947	1.00	2208	0.12	1,136	0.06	379	0.02
10	71 558	1.00	2921	0.04	495	0.01	395	0.01
11	8597	1.00	1117	0.13	154	0.02	119	0.01
12	42 995	1.00	2680	0.06	657	0.02	200	0.01
13	2558	1.00	192	0.08	133	0.05	32	0.01
14	6277	1.00	505	0.08	198	0.03	119	0.02
15	4403	1.00	210	0.05	37	0.01	64	0.02
16	12 101	1.00	932	0.08	78	0.01	86	0.01

TABLE X1.2 Example of Test Data for Failed Test

CH number	Cycle Number 3		Cycle Number 4		Cycle Number 5		Cycle Number 6	
	ΣNLT	Z	ΣNLT	Z	ΣNLT	Z	ΣNLT	Z
1	481	. . .	4367	1.00	705	0.16	207	0.05
2	892	1.00	428	0.48	181	0.20	7	0.01
3	3474	1.00	5347	1.50	2367	0.68	243	0.07
4	2562	1.00	5766	2.25	519	0.20	1145	0.45
5	240	. . .	194	. . .	47	. . .	44	. . .
6	1677	1.00	882	0.53	1049	0.63	859	0.51
7	2906	1.00	1125	0.39	1264	0.43	958	0.33
8	6389	1.00	5905	0.92	2960	0.46	1120	0.18
9	3885	1.00	1017	0.26	1129	0.29	396	0.10
10	2685	1.00	1377	0.51	1180	0.44	420	0.16
11	2682	1.00	1161	0.43	956	0.36	598	0.22
12	19 757	1.00	13 633	0.69	10 745	0.54	9020	0.46
13	849	1.00	454	0.53	526	0.62	516	0.61
14	278	. . .	61	. . .	26	. . .	126	. . .
15	5241	1.00	1299	0.25	540	0.10	444	0.08
16	2971	1.00	4199	1.41	762	0.26	1330	0.44

X2. EXAMPLE OF INSTRUMENTATION SETTINGS AND ACCEPTANCE CRITERIA

X2.1 *Example Instrumentation Settings*:

X2.1.1 *Sensor Sensitivity*—– 77 dB ref. 1V/ubar – 150kHz.

X2.1.2 *Couplant*—Silicone grease

X2.1.3 *Preamplifier Gain*—40 dB (x100).

X2.1.4 *Preamplifier Filter*—100 to 300 kHz bandpass.

X2.1.5 *Power/Signal Cable Length*—150 m (500 ft.)

X2.1.6 *Signal Processor Threshold*—40 dB (for example, 1uV = 0 dB at preamplifier input.

X2.1.7 *Signal Processor Filter*—100 to 300 kHz bandpass.

X2.1.8 *Dead Time*—10 ms.

X2.1.9 *Background Noise*— < 27 dB (for example, 1uV = 0 dB at preamplifier input).

X2.1.10 *Sensitivity Check*— > 80 dB (for example, 1uV = 0 dB at preamplifier input).

X2.2 N_c = 30 minimum acceptable average of AE counts when performing test as indicated in 8.1

X3. CONTAINER ACCEPTANCE APPROACH

X3.1 Container acceptance decisions are based on the following cycle analysis approach:

X3.1.1 *Cycle 3*—If $A_c^{3,3}$ is less than or equal to n for all c, then go to Cycle 4, otherwise calculate all trend numbers $Z_c^{3,3}$ and then go to Cycle 4.

X3.1.2 *Cycle 4*—If $A_c^{4,3}$ is less than or equal to n, for all c, then go to Cycle 5, otherwise calculate all trend numbers $Z_c^{4,3}$ and then go to Cycle 5.

X3.1.3 *Cycle 5*—If $A_c^{5,3}$ is less than or equal to n, for all c, then go to Cycle 6, otherwise calculate all trend numbers $Z_c^{5,3}$ and then go to Cycle 6.

X3.1.4 *Cycle 6*—If $A_c^{6,3}$ is less than or equal to n, for all c, then accept the container, otherwise calculate all trend numbers $Z_c^{6,3}$. If $Z_c^{6,3}$ is less than or equal to 0.30 for all c then accept the container. Otherwise, reject the container.

X4. TEST REPORT LAYOUT

X4.1 The test report layout is as follows:

1. Container Identification
   A. Item No. ____________________
   B. Material ____________________
   C. Manufacturer ____________________ S/N____________________
   D. Design Code/Standard ____________________
2. Test Date: ____________________ Test Location: ____________________
3. Test Fluid ____________________ Fluid Temp: ____________________
4. Stressing Sequence: New Tank ____________________ In-service Tank ____________________
5. Maximum Stress Relative to Maximum Operating Load: ____________________
6. Test Operator(s): Inspection Company ____________________
   Inspector(s): ____________________
7. Test Threshold: ____________________
8 Test Instrument: ____________________ S/N ____________________
9 Sensor Model: ____________________
   Response to Simulated AE: N_{c1}= ____, N_{c2} = ____, N_{c3}= ____ . . . ., C = ____
10. Sensor Locations - (include sketch)
11. Demarcation values: n_1= ____, n_2= ____, n_3= ____ .... (must be > 12 x C)
12. Test Results Tabulation (as per Appendix X1) attach to test report.
13. Date of most recent calibration of instrumentation: ____________________
14. Notes: ____________________
   ____