INTERNATIONAL

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Standard Test Method for Acoustic Emission Testing of Insulated and Non-Insulated Aerial Personnel Devices with Supplemental Load Handling Attachments[1]

This standard is issued under the fixed designation F1430/F1430M; 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 describes a procedure for acoustic emission (AE) testing of aerial personnel devices (APDs) with supplemental load handling attachments.

1.1.1 *Equipment Covered*—This test method covers the following types of vehicle-mounted aerial personnel devices with supplemental load handling attachments:

1.1.1.1 Extensible-boom APDs,

1.1.1.2 Articulating-boom APDs, and

1.1.1.3 Any combination of 1.1.1.1 and 1.1.1.2.

1.1.2 *Equipment Not Covered*—This test method does not cover any of the following equipment:

1.1.2.1 Aerial personnel devices without supplemental load handling attachments,

1.1.2.2 Digger-derricks with platform,

1.1.2.3 Cranes with platform, and

1.1.2.4 Aerial devices with load-lifting capabilities located anywhere other than adjacent to the platform.

NOTE 1—This test method is not intended to be a stand-alone NDT method for the verification of the structural integrity of an aerial device. Other NDT methods should be used to supplement the results.

1.2 The AE test method is used to detect and area-locate emission sources. Verification of emission sources may require the use of other nondestructive test (NDT) methods, such as radiography, ultrasonics, magnetic particle, liquid penetrant, and visual inspection. (**Warning**—This test method requires that external loads be applied to the superstructure of the vehicle under test. During the test, caution must be taken to safeguard personnel and equipment against unexpected failure or instability of the vehicle or components.)

[1] This test method is under the jurisdiction of ASTM Committee F18 on Electrical Protective Equipment for Workers and is the direct responsibility of Subcommittee F18.55 on Inspection and Non-Destructive Test Methods for Aerial Devices.

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1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system ~~may~~are not ~~be~~necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the ~~other. Combining~~other, and values from the two systems ~~may result in non-conformance with the standard.~~shall not be combined.

1.4 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E94 Guide for Radiographic Examination Using Industrial Radiographic Film
E114 Practice for Ultrasonic Pulse-Echo Straight-Beam Contact Testing
E164 Practice for Contact Ultrasonic Testing of Weldments
E569 Practice for Acoustic Emission Monitoring of Structures During Controlled Stimulation
E650 Guide for Mounting Piezoelectric Acoustic Emission Sensors
E750 Practice for Characterizing Acoustic Emission Instrumentation
E976 Guide for Determining the Reproducibility of Acoustic Emission Sensor Response
E1316 Terminology for Nondestructive Examinations
E1417/E1417M Practice for Liquid Penetrant Testing
E1444/E1444M Practice for Magnetic Particle Testing
F914 Test Method for Acoustic Emission for Aerial Personnel Devices Without Supplemental Load Handling Attachments
F2174 Practice for Verifying Acoustic Emission Sensor Response

2.2 *Other Standards:*

ANSI A92.2 Standard for Vehicle-Mounted Elevating and Rotating Aerial Devices[3]
ASNT SNT-TC-1A Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing[4]

3. Terminology

3.1 *Definitions:*

3.1.1 *acoustic emission (AE)*—the class of phenomena whereby elastic waves are generated by the rapid release of energy from a localized source or sources within a material, or the transient elastic wave(s) so generated. Acoustic emission is the recommended term for general use. Other terms that have been used in AE literature include (*1*) stress wave emission, (*2*) microseismic activity, and (*3*) emission or acoustic emission with other qualifying modifiers.

3.1.2 *amplitude (acoustic emission signal amplitude)*—the peak voltage of the largest excursion attained by the signal waveform from an emission event.

3.1.3 *amplitude distribution*—a display of the number of acoustic emission events with signals that exceed an arbitrary amplitude as a function of amplitude.

3.1.4 *articulating-boom aerial device*—an aerial device with two or more hinged boom sections.

3.1.5 *attenuation*—the loss of energy per unit distance, typically measured as loss of signal peak amplitude with unit distance from the source of emission.

3.1.6 *channel*—an input to the main AE instrument that accepts a preamplifier output.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.
[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.
[4] Available from American Society for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlingate Ln., Columbus, OH 43228-0518, http://www.asnt.org.

3.1.7 *commoned*—two or more sensors interconnected such that the sensor outputs are electronically processed by a single channel without differentiation of sensor origin.

3.1.8 *count* also*acoustic emission count,,n*—the number of times the acoustic emission signal amplitude exceeds a preset threshold during any selected portion of a test.

3.1.9 *decibel (dB)*—the logarithmic expression of a ratio of two single peak amplitudes. A reference scale expresses the logarithmic ratio of a single peak amplitude to a fixed reference amplitude.

$$\text{Signal peak amplitude } (dB) = 20 \log_{10} (A_1/A_0)$$

where:

A_0 = 1 uV at the sensor output (before amplification), and
A_1 = peak voltage of the measured acoustic emission signal.

Acoustic Emission Reference Scale

dB Value	Voltage At Sensor Output	Voltage At Integral Preamp Sensor Output (40-dB Gain)
0	1 µV	100 µV
20	10 µV	1 mV
40	100 µV	10 mV
60	1 mV	100 mV
80	10 mV	1 V
100	100 mV	10 V

3.1.10 *insulated aerial personnel device (IAPD)*—any device (extensible or articulating) which is designed primarily to position personnel and may be equipped with a supplemental load handling attachment.

3.1.11 *event (acoustic emission event)*—a local material change giving rise to acoustic emission.

3.1.12 *event count (N_e)*—the number obtained by counting each discerned acoustic emission event once.

3.1.13 *extensible-boom aerial device*—an aerial device, except the aerial ladder type, with a telescopic or extensible boom.

3.1.14 *first-hit*—a mode of operation of AE monitoring equipment in which an event occurring on one channel will prevent all other channels from processing data for a specified period of time. The channel with a sensor closest to the physical location of the emission source will then be the only channel processing data from that source.

3.1.15 *insulated aerial device*—an aerial device designed with dielectric components to meet a specific electrical insulation rating.

3.1.16 *insulator*—any part of an aerial device such as, but not limited to, the upper boom, lower boom or supporting structure, made of a material having a high dielectric strength, usually FRP or the equivalent.

3.1.17 *noise*—any undesired signal that tends to interfere with the normal reception or processing of the desired signal.

3.1.18 *non-destructive testing*—the examination by various means of devices and their components without alteration of the original components, so that they may function as before.

3.1.19 *non-overcenter*—the feature of an aerial device is such that the upper boom cannot travel past vertical orientation with respect to the ground.

3.1.20 *overcenter*—the feature of an aerial device is such that the upper boom travels past vertical orientation with respect to the ground.

3.1.21 *qualified personnel*—personnel who, by possession of a recognized degree, certificate, professional standing, or skill, and who, by knowledge, training, and experience, have demonstrated the ability to deal with problems relating to the subject matter, the work, or the project.

3.1.22 *rated boom capacity (RBC)*—the maximum allowable capacity of the boom which is calculated by combining the platform capcity and the capacity of the supplemental load handling attachment at zero degrees and fully retracted.

3.1.23 *signal (emission signal)*—a signal obtained by detection of one or more acoustic emission events.

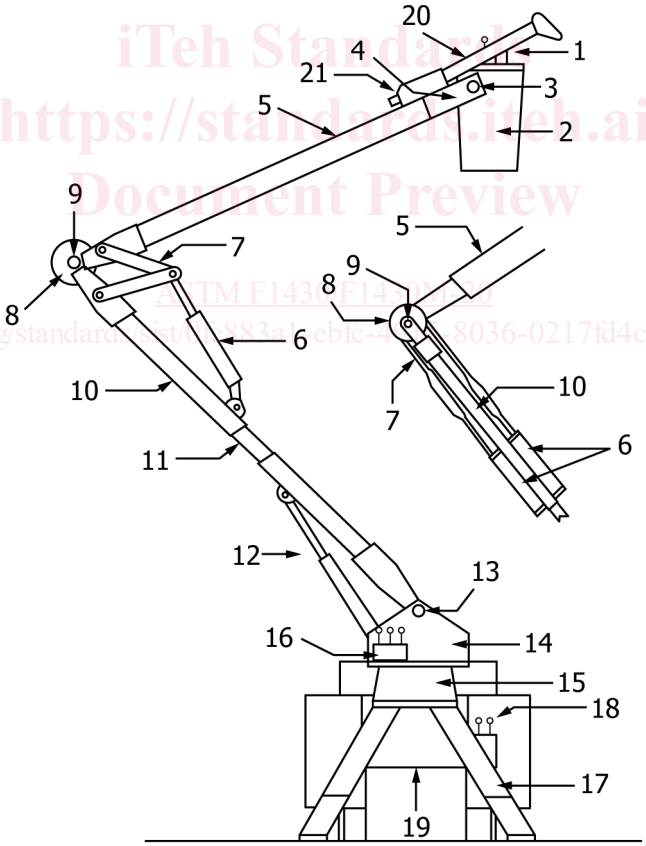
3.1.24 *supplemental load*—a load which may be affixed to a supplemental load-handling attachment on an insulated aerial personnel device.

3.1.25 *supplemental load attachment capacity (SLAC)*—the maximum allowable load, as stated by the aerial device manufacturer, which may be affixed to the supplemental load-handling attachment at specified positions of the attachments.

3.1.26 For definitions of other terms in this test method, refer to Terminology E1316.

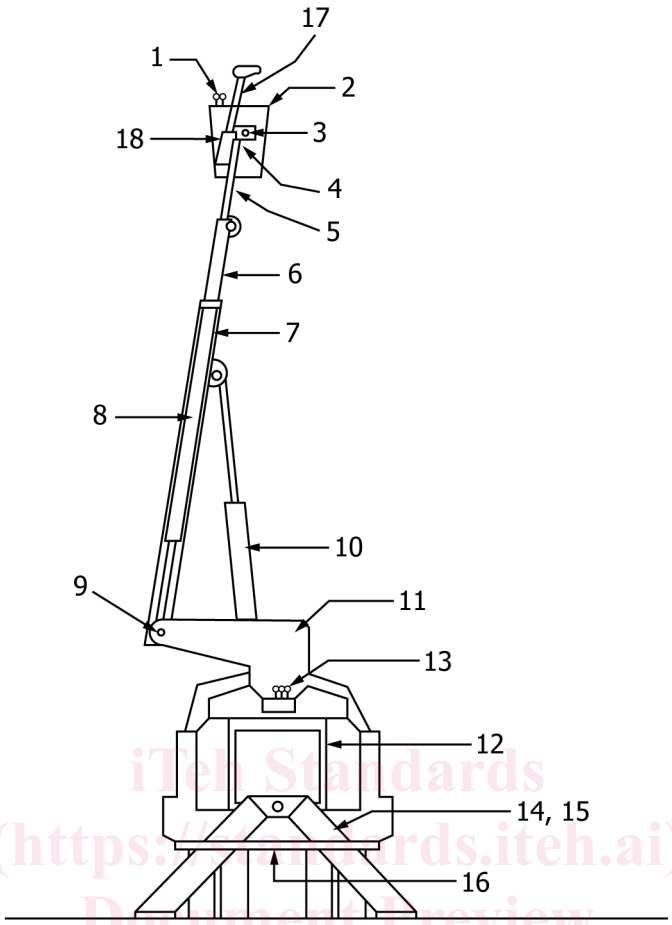
3.2 *Definitions of Terms Specific to This Standard:* (see Fig. 1 and Fig. 2):

3.2.1 *elbow*—the structure connecting the upper boom to the lower boom, about which one boom articulates relative to the other.



1. Upper Controls
2. Platform
3. Platform Pin
4. Upper Boom Tip
5. Upper Boom
6. Upper Boom Cylinder
7. Upper Boom Drive Mechanism
8. Elbow
9. Elbow Pin
10. Lower Boom
11. Lower Boom Insulator
12. Lower Boom Cylinder
13. Lower Boom Pin
14. Turntable
15. Pedestal
16. Lower Controls
17. Outriggers
18. Outrigger Controls
19. Stabilizers
20. Supplemental Load Handling Attachment Arm
21. Supplemental Load Handling Attachment Bracket

FIG. 1 Articulating-Boom APD Nomenclature Diagram



1. Upper Controls
2. Platform
3. Platform Pin
4. Upper Boom Tip
5. Upper Boom
6. Intermediate Boom
7. Lower Boom
8. Extension Cylinder
9. Lower Boom Pin
10. Lift Cylinder
11. Turntable
12. Pedestal
13. Lower Controls
14. Outriggers
15. Outrigger Controls
16. Stabilizers
17. Supplemental Load Handling Attachment Arm
18. Supplemental Load Handling Attachment Bracket

FIG. 2 Extensible-Boom APD Nomenclature Diagram

3.2.2 *elbow pin*—the horizontal pin about which the upper boom rotates relative to the lower boom.

3.2.3 *lift cylinder*—the hydraulic cylinder that lifts the lower boom and the extensible boom(s).

3.2.4 *lower boom*—the structural member, attached to a turntable or base, that supports the upper boom.

3.2.5 *lower-boom cylinder*—the hydraulic cylinder that articulates the lower boom.

3.2.6 *lower-boom insulator*—the part of the lower boom made of high-dielectric strength material (usually fiberglass reinforced plastic or equivalent).

3.2.7 *lower-boom pin*—the horizontal pin about which the lower boom is raised and lowered relative to the turntable.

3.2.8 *outriggers*—the structural members that, when properly extended or deployed on firm ground, assist in stabilizing the vehicle on which the aerial device is mounted.

3.2.9 *pedestal*—the stationary base of the aerial device that supports the turntable.

3.2.10 *platform*—the personnel-carrying component of an aerial device, such as a bucket, basket, stand, or equivalent.

3.2.11 *platform pin*—the horizontal pin about which the platform rotates relative to the upper boom.

3.2.12 *rated platform capacity (RPC)*—the maximum load as stated by the manufacturer for which an aerial device is designed to operate, consisting of the combined weight of the personnel and all items carried on or in the platform.

3.2.13 *stabilizers*—a means to assist in stabilizing the vehicle, such as outriggers, torsion bars, and spring lockouts.

3.2.14 *supplemental load-handling attachment (Jib)*—a device(s) affixed to the upper-boom tip area which is designed to lift and or position materials.

3.2.15 *supplemental load-handling attachment bracket*—the apparatus which affixes the supplemental load handling attachment to the IAPD.

3.2.16 *turntable*—the rotating base of the aerial device that supports the boom(s).

3.2.17 *upper boom*—the structural member, attached to the lower boom, that supports the platform.

3.2.18 *upper-boom cylinder*—the hydraulic cylinder that articulates the upper boom.

3.2.19 *upper-boom drive mechanism*—means, such as linkage, cables, sheaves, and gears, used to produce upper-boom articulation.

3.2.20 *upper-boom tip*—the end of the upper boom to which the platform is attached.

3.3 *Abbreviations:*

3.3.1 *AE*—Acoustic Emission

3.3.2 *APD*—Aerial Personnel Device(s)

3.3.3 *FRP*—Fiberglass Reinforced Plastic

3.3.4 *Jib*—Supplemental Load Handling Attachment

3.3.5 *NDT*—Nondestructive Testing

3.3.6 *RBC*—Rated Boom Capacity

3.3.7 *RPC*—Rated Platform Capacity

3.3.8 *SLAC*—Supplemental Load Attachment Capacity

4. Summary of Test Method

4.1 This test method consists of applying a predetermined load to an APD while it is being monitored by sensors that are sensitive to acoustic emissions (AE) caused by active defects. These acoustic emissions can be generated by, but are not limited to, the following: crack nucleation movement or propagation in the metal components; or matrix crazing, delamination or fiber breakage of the fiberglass reinforced plastic (FRP) material; or both.

4.2 The APD is loaded at a uniform rate until a predetermined load is reached, which is held for a period of time. The load is removed and the cycle is repeated. Acoustic emissions are monitored during both cycles and the data is evaluated.

5. Significance and Use

5.1 This test method provides a means of evaluating acoustic emissions generated by the rapid release of energy from localized sources within an APD under controlled loading. The resultant energy releases occur during intentional application of a controlled predetermined load. These energy releases can be monitored and interpreted by qualified individuals.

5.2 This test method permits testing of the major components of an aerial device under controlled loading. This test method utilizes objective criteria for evaluation and may be discontinued at any time to investigate a particular area of concern or prevent a fault from continuing to ultimate failure.

5.3 This test method provides a means of detecting acoustic emissions that may be defects or irregularities, or both, affecting the structural integrity or intended use of the aerial device.

5.4 Sources of acoustic emission found with this test method shall be evaluated by either more refined acoustic emission test methods or other nondestructive techniques (visual, liquid penetrant, radiography, ultrasonics, magnetic particle, etc.). Other nondestructive tests may be required to locate defects present in APDs.

5.5 Defective areas found in aerial devices by this test method should be repaired and retested as appropriate. Repair procedure recommendations are outside the scope of this test method.

6. Personnel Qualifications

6.1 This test method shall be performed by qualified personnel. Qualification shall be in accordance with an established written program, consistent with the established format of ASNT SNT-TC-1A for training, qualification, and certification of personnel for conducting AE testing.

NOTE 2—Personnel performing subsequent nondestructive evaluation (visual, liquid penetrant, radiography, ultrasonic, magnetic particle, etc.) on aerial devices should be certified in accordance with ASNT SNT-TC-1A guidelines.

6.2 Acoustic emission test personnel shall be familiar with the design, manufacture, and operation of aerial devices. Relevant information is contained in ANSI A92.2 and manufacturers' operating and service manuals.

7. Acoustic Emission Instrumentation

7.1 The AE instrument shall be capable of data acquisition from discrete channels within a frequency band of 20 to 200 KHz. The number of AE instrument channels shall be determined by the attenuation characteristics of the aerial device in order to provide coverage of those components identified in Table 1. A detailed description of instrumentation characteristics is included in Annex A1.

NOTE 3—Use of a minimum of ~~8~~ten channels does not necessarily imply total coverage of the components identified in Table 1. The instrument should be capable of recording the following: time, events, counts, amplitude, and load. Hard copy records shall be provided by the instrument or available through a direct interface.

8. Test Preparation

8.1 Prior to the AE test, perform a visual observation of the aerial device to determine as far as practicable that the components to be tested are free from any condition that may prohibit the test or adversely affect test results.

8.2 The components to be monitored in an APD shall include but not be limited to those listed in Table 1. Additional channels and sensors may be used to supplement the minimum test requirements and improve location resolution.

8.3 Position the sensors on the FRP and metal portions of the components identified in Table 1. The extent of the coverage is