Designation: E 582 – 88 (Reapproved 1999)

Standard Test Method for Minimum Ignition Energy and Quenching Distance in Gaseous Mixtures[1]

This standard is issued under the fixed designation E 582; 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 the determination of minimum energy for ignition (initiation of deflagration) and associated flat-plate ignition quenching distances.[2] The complete description is specific to alkane or alkene fuels admixed with air at normal ambient temperature and pressure. This method is applicable to mixtures of the specified fuels with air, varying from the most easily ignitable mixture to mixtures near to the limit-of-flammability compositions.

1.2 Extensions to other fuel-oxidizer combinations, and to other temperatures and pressures can be accomplished with all the accuracy inherent in this method if certain additional conditions are met: (*a*) mixture stability and compatibility with bomb, seal, and other materials is established through time tests described in Section 9; (*b*) the expected peak pressure from the test is within the pressure rating of the bomb (established as required by the particular research laboratory); (*c*) spark breakdown within the bomb is consistent with Paschen's law for the distance being tested; (*d*) the temperature, including that of the discharge electrodes, is uniform; and (*e*) if the temperature is other than ambient, the energy storage capacitance required is less than about 9 pF.

1.3 This method is one of several being developed by Committee E-27 for determining the hazards of chemicals, including their vapors in air or other oxidant atmospheres. The measurements are useful in assessing fuel ignitability hazards due to static or other electrical sparks. However, the quenching distance data must be used with great prudence since they are primarily applicable to the ignition stage and therefore, represent values for initial pressure and not the smaller values existing at higher pressures.

1.4 *This standard should be used to measure and describe the properties of materials, products, or assemblies in response to heat and flame under controlled laboratory conditions and should not be used to describe or appraise the fire hazard or fire risk of materials, products, or assemblies under actual fire conditions. However, results of this test may be used as elements of a fire risk assessment which takes into account all of the factors which are pertinent to an assessment of the fire hazard of a particular end use.*

1.5 *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 safety precautions are listed in Section 5.

2. Summary of Method

2.1 Known quantities of stored electrical energy are discharged into a known fuel-air mixture at a known spark-gap length. Visual inspection indicates whether the mixture is ignited and flame propagates through the test reaction vessel. Sufficient tests are conducted to determine the minimum ignition energy versus stoichiometry and flat-plate ignition quenching distance versus stoichiometry for the mixture under investigation.

3. Significance and Use

3.1 The minimum energies provide a basis for comparing the ease of ignition of gases. The flatplate ignition quenching distances provide an important verification of existing minimum ignition energy data and give approximate values of the propagation quenching distances of the various mixtures. It is emphasized that maximum safe experimental gaps, as from "flame-proof" or "explosion-proof" studies, are less than the flat-plate ignition quenching distances.

4. Apparatus

4.1 *Reaction Vessel*—The recommended reaction vessel is manufactured according to the specifications of Fig. 1 and Fig. 2. This is a spherical vessel, manufactured of Type 304 stainless steel, and passivated after machining. The spherical geometry maximizes the useable spark-gap length for a given vessel volume. The reaction vessel provides for opposed mounting of the spark electrodes which permits rapid and convenient variation of the gap length without the necessity for

[1] This test method is under the jurisdiction of ASTM Committee E-27 on Hazard Potential of Chemicals and is the direct responsibility of Subcommittee E27.04 on Flammability and Ignitability of Chemicals.

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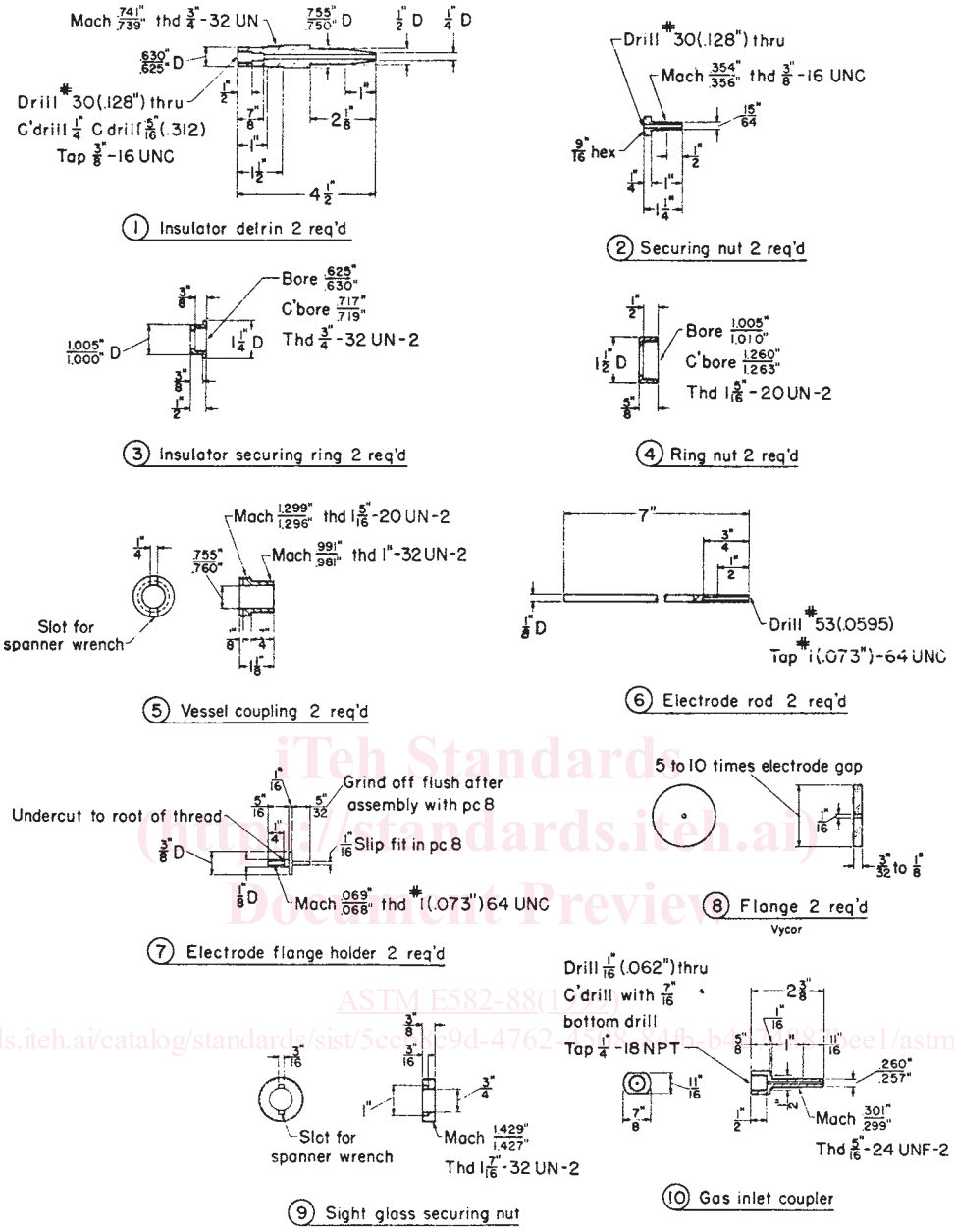
[2] Litchfield, E. L., Hay, M. H., Kubala, T. S., and Monroe, J. S.," Minimum Ignition Energy and Quenching Distance in Gaseous Mixtures,'' BuMines, R. L. 7009, August 1967, 11 pp.



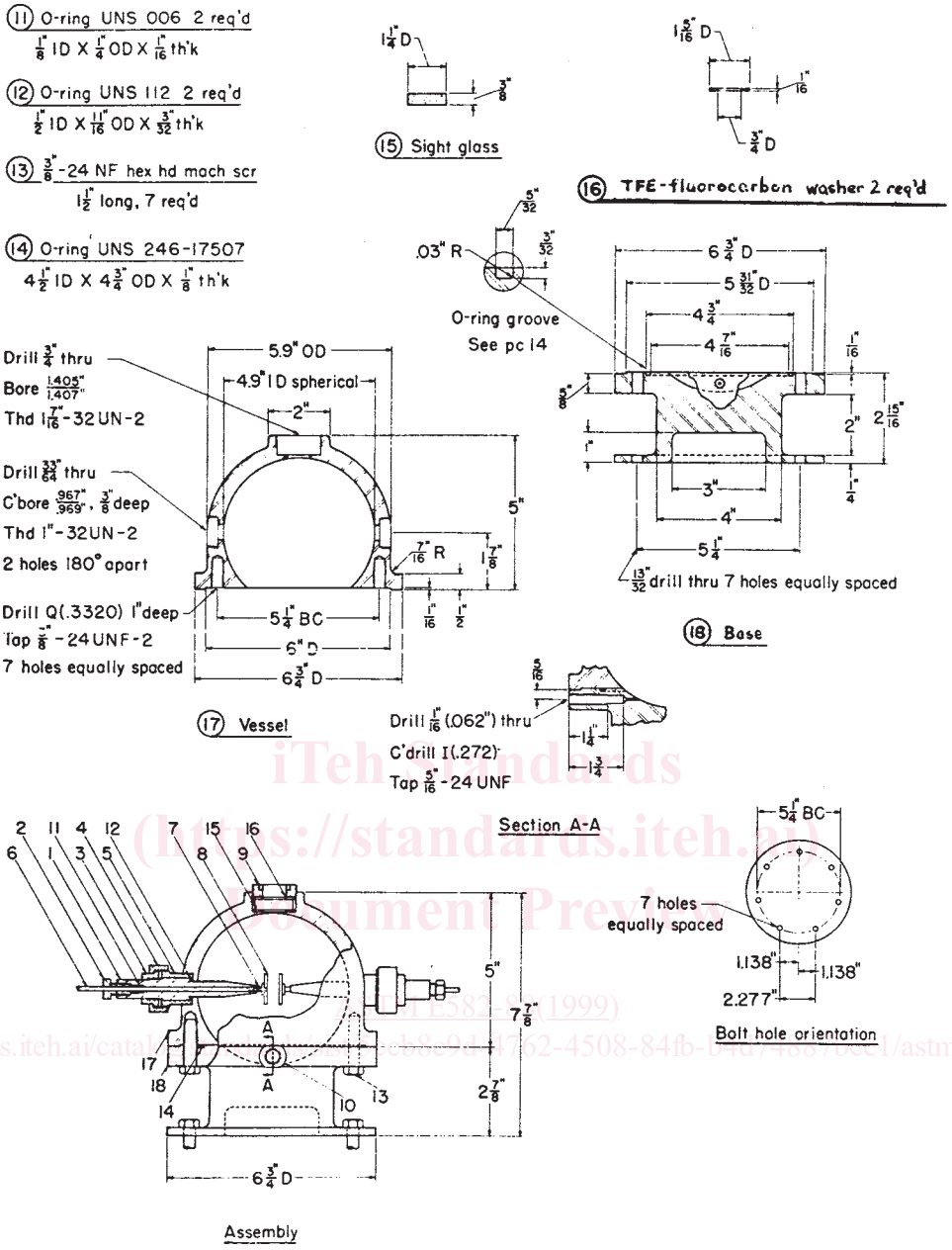
NOTE 1—Tolerance is ± 0.010 in., unless noted.
NOTE 2—Break all sharp edges.
NOTE 3—Material is Type 304 stainless steel.
NOTE 4—Thread depth is 75 to 80 %.
NOTE 5—1 in. = 25.4 mm.

FIG. 1 Electrode Assembly (I)

opening the vessel. The input orifice (Fig. 2, Section *A-A*) is located so that the gases are introduced approximately tangentially to the vessel walls, thus providing a turbulent swirling motion that facilitates mixing. A sight glass permits direct observation of flame initiation and propagation throughout the reaction volume.

4.2 *Electrode Assembly*:

4.2.1 The electrodes (Fig. 1) have metal tips flanged with glass plates. The tips screw into ⅛-in. stainless steel rods which extend through inserts in the bomb walls to permit external electrical connections. Gas seals are provided between the reaction vessel and the inserts and between the inserts and the ⅛-in. rods by O-ring seals (see Fig. 2, Assembly). The glass flange material should be either borosilicate or high silica and the flanges should be fastened to the stainless steel tips with a thin layer of epoxy cement. The facing surfaces should be planar and coplanar to 0.001 in. (0.025 mm) or 1 % of the intended test gap, whichever is larger.



NOTE 1—Tolerance is ± 0.010 in., unless noted.
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NOTE 3—Material is Type 304 stainless steel.
NOTE 4—Thread depth is 75 to 80 %.
NOTE 5—1 in. = 25.4 mm.

FIG. 2 Electrode Assembly (II).

4.2.2 Two inserts are required to carry the ⅛-in. rods through the walls of the reaction vessel. At least one of these inserts must be made of high-electrical resistivity insulating material. Hard rubber, phenolic plastic, poly(methyl methacrylate) (PMMA), and many other materials are suitable for use with the alkane and alkene fuels. In the excepted cases (other similarly energetic fuels), the insulating material must not react with or absorb the fuel being tested.

4.2.3 Where the test arrangement is optimized through the use of a "double-ended'' power supply, (see Fig. 3(b)) two insulating inserts are required. Otherwise, one of the inserts may be machined from Type 304 stainless steel.

4.2.4 Insulation between the two electrodes should exceed 10^{12} Ω as discussed in 4.3.3.

4.2.5 Measurement of the gap width is made by available techniques and implements most suitable for the gap distance