FEDERAL AVIATION AGENCY

Washington 25, D. C.

TECHNICAL STANDARD ORDER

Regulations of the Administrator

Part 514

SUBJECT: FIRE DETECTORS TSO-C11d

Technical Standard Orders for Aircraft Materials, Parts, Processes, and Appliances

Part 514 contains minimum performance standards and specifications of materials, parts, processes, and appliances used in aircraft and implements the provisions of sections 3.18, 4a.31, 4b.18, 6.18 and 7.18 of the Civil Air Regulations. The regulation uses the Technical Standard Order system which, in brief, provides for FAA-industry cooperation in the development of performance standards and specifications which are adopted by the Administrator as Technical Standard Orders, and a form of self-regulation by industry in demonstrating compliance with these orders.

Part 514 consists of two subparts. Subpart A contains the general requirements applicable to all Technical Standard Orders. These provisions are summarized below for the convenient reference of the public. Subpart B contains the technical standards and specifications to which a particular product must conform, and each Technical Standard Order is set forth in the appropriate section of Subpart B. The subject Technical Standard Order is printed below. ANY TECHNICAL STANDARD ORDER MAY BE OBTAINED BY SENDING A REQUEST TO FAA, WASHINGTON 25, D. C.

SUBPART A--GENERAL

This subpart provides, in part, that a manufacturer of an aircraft material, part, process, or appliance for which standards are established in Subpart B, prior to its distribution for use on a civil aircraft of the United States, shall furnish a written statement of conformance certifying that the material, part, process, or appliance meets the applicable performance standards established in this part. The statement of conformance must be signed by a person duly authorized by the manufacturer, and furnished to the Chief, Engineering and Manufacturing Division, Flight Standards Service, Federal Aviation Agency, Washington 25, D. C.

Subpart A also requires appropriate marking of materials, parts, processes, and appliances as follows:

(a) Name and address of the manufacturer responsible for compliance,

(b) Equipment name, or type or model designation,

(c) Weight to the nearest pound and fraction thereof,

(d) Serial number and/or date of manufacture, and

(e) Applicable Technical Standard Order (TSO) number.

In addition, Subpart A provides that no deviation will be granted from the performance stnadards established in Subpart B, and that the Administrator may take appropriate action in the event of noncompliance with Part 514.

§ 514.21 Fire detectors (thermal sensing and ionization sensing types) - TSO-C11d--(a) Applicability--(1) Minimum performance standards. Minimum performance standards are hereby established for fire detectors of the subject types which are required to be approved for use on piston and/or turbine engine-powered civil aircraft of the United States. New models of these types of fire detectors manufactured for use on civil aircraft of the United States on or after the effective date of this section, shall meet the standards specified in Federal Aviation Agency Standard "Fire Detectors (Thermal Sensing and Ionization Sensing Types)", dated August 1, 1961. Fire detectors approved prior to the effective date of this section, may continue to be manufactured under the provisions of their original approval.

(b) Marking. In lieu of information required in Subpart A (c), the alarm temperature shall be shown. Compliance of the detector with the piston or turbine engine requirements, or both, shall be designated by -P, -T, or -PT, respectively, as a suffix following the TSO designation, as: TSO-C11d-P.

(c) Data requirements. (1) The manufacturer shall maintain a current file of complete design data.

(2) The manufacturer shall maintain a current file of complete data describing the inspection and test procedures applicable to his equipment. (See paragraph (d) of this section.)

(3) Six copies each, except where noted, of the following shall be furnished to the Chief, Engineering and Manufacturing Division, Flight Standards Service, Federal Aviation Agency, Washington 25, D. C., with the statement of conformance certifying that the instrument conforms to this section.

(i) Manufacturer's operating instructions and equipment limitations.

(ii) Installation procedures with applicable schematic drawings, wiring diagrams, and specifications. Indicate any limitations, restrictions, or other conditions pertinent to the installation. These data shall include the following:

(a) Starting ambient temperature used in determining the response time (See section 7.1.1);

(b) Maximum allowable normal ambient temperature at the point of sensor location;

(c) Maximum allowable rate of temperature rise at point of sensor location as a result of normal operation;

(d) Operating voltage;

(e) Mounting or support method; and

(f) Maximum or minimum number of units or detector length which can be used in one circuit or one fire zone without adversely affecting sensitivity or causing false indications due to temperature associated with normal operation.

(iii) One copy of the manufacturer's test report.

(d) Quality control. Fire detectors shall be produced under a quality control system established by the manufacturer, which will assure that each detector is in conformity with the requirements of this section and is in a condition for safe operation. This sytem shall be described in the data required under paragraph (c)(2) of this section. A representative of the Administrator shall be permitted to make such inspections and tests at the manufacturer's facility as may be necessary to determine compliance with the requirements of this section.

(e) Effective date. August 30, 1961.

FEDERAL AVIATION AGENCY STANDARD

FOR

August 1, 1961

FIRE DETECTORS - THERMAL SENSING AND IONIZATION SENSING TYPES

1. PURPOSE: To specify minimum requirements for powerplant fire detection instruments for use in aircraft, the operation of which may subject the instrument to environmental conditions specified in paragraph 3.3.

2. SCOPE. This standard covers the following basic types of fire detection instruments, or combinations thereof, intended for use in protecting aircraft powerplant installations, auxiliary powerplants, combustion heaters and other installations where fuel, oil, or similar fires may occur.

2.1 BASIC TYPES: Definition of

Type I. Thermal - Fixed Temperature, an instrument which will actuate an alarm signal when exposed to any temperature above a definite preestablished level.

Type II. Thermal - Rate of Rise, an instrument which will actuate an alarm signal when exposed to any rate of temperature change above a definite preestablished level.

Type III. Flame - Contact, an instrument which will actuate an alarm signal when exposed to physical contact with flame.

3. GENERAL REQUIREMENTS:

3.1 Materials and Workmanship:

3.1.1 Materials: Materials shall be of a quality which experience and/or tests have demonstrated to be suitable and dependable for use in aircraft instruments.

3.1.2 Workmanship: Workmanship shall be consistent with high grade aircraft instrument manufacturing practice.

3.2 Blank

3.3 Environmental Conditions: The following conditions have been established as design minimum requirements. Tests shall be conducted as specified in Sections 5, 6 and 7.

3.3.1 Temperature: When installed in accordance with the manufacturer's recommendations, the instrument shall function

over the range of ambient temperatures shown in Column A below and shall not be adversely affected by exposure to the temperatures shown in Column B below:

Instrument Location	A	B
Powerplant Compartments(Piston)	-30 to 130C	-65 to 130C
Powerplant Compartments(Turbine)	-30 to 150C	-65 to 150C
Pressurized Areas) Both types	-30 to 50C	-65 to 70C
Nonpressurized or) of	-55 to 70C	-65 to 70C
External Areas) Engine		

If instrument is intended for use in compartments where maximum ambient is higher than 130° C. for piston engines and 150° C. for turbine engines, appropriate special limits shall be selected for Columns A and B, and specified by the manufacturer.

3.3.2 Humidity: The instrument shall function and shall not be adversely affected when exposed to any relative humidity in the range from 0 to 95 percent at a temperature of approximately 32C.

3.3.3 Altitude: When installed in accordance with the instrument manufacturer's instructions, the instruments shall function from sea level up to the altitudes and temperatures listed below. Altitude pressures are per NACA Report 1235.

Instrument Location		
Powerplant Accessory Compartment	50,000'	(80C)
Pressurized Areas	15,000'	(50C)
Nonpressurized Areas	50,000'	(20C)

The instrument shall not be adversely affected following exposure to extremes in ambient pressure of 50 inches, and 3 inches, of mercury absolute, respectively.

3.3.4 Vibration: When installed in accordance with the instrument manufacturer's instructions, the instrument shall function and shall not be adversely affected when subjected to vibrations of the following characteristics:

PISTON ENGINES	Frequency Cycles per Second	Max. Double Amplitude In Inches	Maximum Acceler-ation
Airframe Structure Mounted	5-500	.050	10g
Shock-Mounted Panel	5- 50	.020	1.5g
Powerplant Mounted	5-500	.100	20g

TURBINE ENGINES	Frequency Cycles per Second	Max. Double Amplitude In Inches	Maximum Acceler-ation
Nacelle and Nacelle Mounts, Wings, Empennage and Wheel Wells	5-1000	0.036	10g
Fuselage			
Forward of Spar Area	5-500	0.036	2g
Center of Spar Area	5-1000	0.036	4g
Aft of Spar Area	5-500	0.036	7g
	500-1000	-----	5g
Vibration Isolated	5-50	0.020	1.5g
Racks	50-500	-----	0.5g
Instrument Panel	5-500	.030	1.0g

3.4 Radio Interference: The instrument shall not be the source of objectionable interference, under operating conditions at any frequencies used on aircraft, either by radiation or feedback, in electronic equipment installed in the same aircraft as the instrument.

3.5 Magnetic Effect: The magnetic effect of the instrument shall not adversely affect the operation of other instruments in the same aircraft.

4. DETAIL REQUIREMENTS:

4.1 Indication Means: The instrument shall be capable of actuating visual and/or aural alarm indicators.

4.2 Reliability: The instrument shall be of such design to withstand the mechanical and thermal shocks, and stresses incident to its use in aircraft. False alarm signals shall not be produced by the instrument as the result of variations in voltage to be encountered during operation of the aircraft, abnormal attitudes, contaminating atmospheres, ambient light conditions, accelerations which could be encountered during flight, landing and takeoff.

4.3 Integrity Test Means: The instrument shall be of such design to provide a means for testing the integrity of the instrument in flight.

4.4 Calibration Means: The instrument design shall be such that all calibration means be provided with tamper-proof seals.

4.4.1 Adjustable Detector Systems: Instruments which incorporate means for adjustment shall be tested to prove compliance with this standard, particularly paragraphs 7.2.1, 7.2.2, 7.2.3 and 7.12, throughout the range of adjustability.

5. TEST CONDITIONS:

5.1 Atmospheric Conditions: Unless otherwise specified, all tests required by this standard, shall be conducted at an atmospheric pressure of approximately 29.92 inches of mercury and at an ambient temperature of approximately 25C and at a relative humidity of not greater than 85 percent. When tests are conducted with the atmospheric pressure or the temperature substantially different from these values, allowance shall be made for the variation from the specified conditions.

5.2 Vibration: (To minimize friction): Unless otherwise specified, all tests for performance may be conducted with the instrument subjected to a vibration of 0.002 to 0.005 inch double amplitude at a frequency of 1500 to 2000 cycles per minute. The term double amplitude as used herein indicates the total displacement from positive maximum to negative maximum.

5.3 Vibration Equipment: Vibration equipment shall be such as to allow vibration to be applied along each of three mutually perpendicular axes of the instrument at frequencies and amplitudes consistent with the requirements of paragraph 3.3.4.

5.4 Power Conditions: Unless otherwise specified, all tests shall be conducted at a power rating recommended by the manufacturer.

5.5 Test Position: Unless otherwise specified, the instrument shall be mounted and tested in its normal operating position.

5.6 Flame Temperature Measurement and Flame Size: All flame temperatures shall be measured by using chromel-alumel thermocouples of 18 gauge wire. The thermocouple bead shall be at the center of the flame and the two wires leading to the bead shall be parallel and extend for a distance of 3 inches horizontally into the flame. The nature and size of the flame and the method of test shall be as specified in Figures 2-1, 2-2, 2-3 and 2-4. The thermocouple and the test article shall be the same distance from the burner face, to assure that the test article is exposed to the temperature measured.

6. INDIVIDUAL PERFORMANCE REQUIREMENTS: All instruments or

components of such shall be subjected to whatever tests the manufacturer deems necessary to demonstrate that production articles comply with this standard including the following requirements where applicable.

6.1 Sensitivity and Calibration: The sensor shall be tested as specified in paragraph 7.1, or in an equivalent manner which will test the response sensitivity and calibration.

6.2 Dielectric: Each instrument shall be tested by the methods of inspection listed in paragraphs 6.2.1 and 6.2.2.

6.2.1 Insulation Resistance: The insulation resistance measured at 200 volts D. C. for five seconds between all electrical circuits connected together and the metallic case shall not be less than 5 megohms. Insulation resistance measurements shall not be made to circuits where the potential will appear across elements such as windings, resistors, capacitors, etc., since this measurement is intended only to determine adequacy of insulation.

6.2.2 Overpotential Tests: Equipment shall not be damaged by the application of a test potential between electrical circuits, and between electrical circuits and the metallic case. The test potential shall be a sinusoidal voltage of a commercial frequency with an R.M.S. value of five times the maximum circuit voltage or per paragraphs 6.2.2.1 or 6.2.2.2, whichever applies. The potential shall start from zero and be increased at a uniform rate to its test value. It shall be maintained at this value for five seconds, and then reduced to a uniform rate to zero.

Since these tests are intended to assure proper electrical isolation of the circuit components in question, these tests shall not be applied to circuits where the potential will appear across elements such as windings, resistors, capacitors, etc.

6.2.2.1 Hermetically sealed instruments shall be tested at 200 volts R.M.S.

6.2.2.2 Circuits that operate at potentials below 15 volts are not to be subjected to overpotential tests.

7. QUALIFICATION PERFORMANCE REQUIREMENTS: The number of instruments to be tested shall be as many as the manufacturer deems necessary to demonstrate compliance with the requirements of this section. The tests on each instrument shall be conducted consecutively in the order

listed, and after the tests have been initiated, further adjustments to the instrument shall not be permitted. A false alarm signal occurring during any of the tests shall disqualify the instrument from further testing. A response time test per paragraph 7.1 shall be conducted after each test, except paragraphs 7.2, 7.2.1, 7.2.3 and 7.12. In conducting the test of paragraph of 7.12, the instrument(s) tested need not be the same instrument(s) being subjected to the entire series of qualification tests.

7.1 Response Time and Calibration: Each instrument shall be subjected to the response time and calibration tests listed below applicable to the particular type or combinations thereof. Instruments shall be tested by the application of the test flame to a single unit type sensor or to a 6" length of a continuous type sensor. For instruments in which the sensitivity is affected by the number of sensing elements, by the length of the sensing element (for continuous types), or by other factors which may be varied from one installation to another, all response time tests shall be conducted with the least sensitive configuration to be used. The unit sensor or segment of continuous sensor exposed to the test flame shall be that most critical for response time.

7.1.1 Response Time Test --- Types I, II, and III: The sensor of the instrument shall be exposed to a maximum temperature test flame of 1100° C. as specified in Figure 2. The ambient temperature from which the test is started shall be room temperature, except a higher starting ambient temperature may be used if the sensor is specified for use only in locations where the ambient temperature will not, under continuous operating conditions, decrease below this value. The response time of all types shall not exceed five (5) seconds.

7.1.2 Calibration Test - Type I Only: The preadjusted operating temperature of the instrument specified by the manufacturer shall be that determined as the temperature at which an alarm signal occurs when the instrument is exposed in an essentially gradient-free medium starting from room temperature with a low rate of temperature rise which will not affect the calibration.

7.2 False Alarm Due to Rate of Temperature Change: The tests of paragraphs 7.2.1 and 7.2.2 shall be conducted in a temperature controlled airstream moving at a velocity of 250 feet per minute plus or minus 25 f.p.m. No alarm signal shall occur.

7.2.1 False Alarm Due to Local Temperature Rise: The sensor shall be subjected to various combinations of rates of temperature rise and durations of these rates of rise shown in the shaded area in Figure 3(a). This test shall be conducted simulating conditions due to local overheating. No alarm signal shall occur.

7.2.2. False Alarm Due to General Temperature Rise: The test of 7.2.1 shall be repeated using Figure 3(b): The test shall be conducted simulating conditions due to a general temperature rise throughout compartment where the sensor may be located. No alarm signal shall occur.

7.2.3 False Clearing of Alarm Due to Partial Extinguishing of Fire: With the instrument arranged to test the response time, in accordance with paragraph 7.1, the test flame shall be applied for 30 seconds. The test flame shall then be masked so as to reduce its effective area of approximately 50 percent. For detector types I, II and III, the sensor should be centrally located such that when 50 percent of the flame is masked, 50 percent of the sensor is also masked. The alarm signal shall not clear. After an additional 30 seconds, the flame shall be removed entirely and the alarm signal shall clear within 30 seconds.

7.3 Vibration.

Resonance: The instrument, while operating, shall be subjected to a resonant frequency survey of the appropriate range specified in paragraph 3.3.4 in order to determine if there exists any resonant frequencies of the parts. The amplitude used may be any convenient value that does not exceed the maximum double amplitude and the maximum acceleration specified in paragraph 3.3.4.

The instrument shall then be subjected to vibration at the appropriate maximum double amplitude or maximum acceleration specified in paragraph 3.3.4 at the resonant frequency for a period of one hour in each axis.

When more than one resonant frequency is encountered with vibration applied along any axis, a test period may be accomplished at the most severe resonance or the period may be divided among the resonant frequencies, whichever shall be considered most likely to produce failure. The test period shall not be less than one-half hour at any major resonant mode.

When resonant frequencies are not apparent within the specified

frequency range, the instrument shall be vibrated for two hours in accordance with the vibration requirements schedule (Section 3.3.4) at the maximum double amplitude and the frequency to provide the maximum acceleration.

Cycling. The instrument, while operating, shall be tested with the frequency cycled between limits specified in Section 3.3.4 in 15-minute cycles for a period of one hour in each axis at an applied double amplitude specified in paragraph 3.3.4 or an acceleration specified in 3.3.4 whichever is the limiting value.

7.4 Water Spray: The instrument components which are to be located outside the pressurized area of the aircraft shall be subjected to the following tests:

7.4.1 Simulated Rain: The component shall be subjected to a spray of water to simulate rain for a period of three hours. The component shall not be dried prior to testing per paragraph 7.1.

7.4.2 Salt Spray: The instrument components which are to be installed in exposed portions of the aircraft shall be subjected to a finely atomized spray of 20 percent sodium chloride solution for 50 hours. At the end of this period, the component shall be allowed to dry and may then be cleaned prior to conducting the test per paragraph 7.1.

7.5 Humidity: The instrument shall be mounted in a chamber maintained at a temperature of 70±2C and a relative humidity of 95±5% for a period of six hours. After this period, the heat shall be shut off and the instrument shall be allowed to cool for a period of 18 hours in this atmosphere in which the humidity rises to 100% as the temperature decreases to not more than 38C. This complete cycle shall be conducted:

a. Five times for components located in uncontrolled temperature areas.

b. Once for components located in controlled temperature areas.

Immediately after this cycling, there shall be no evidence of damage or corrosion which affects performance.

7.6 Fuel and Oil Immersion: The instrument components which are to be installed in engine compartments or other locations in the aircraft where it may be contaminated by fuel or oil shall be subjected to the following tests:

7.6.1 Fuel Immersion: The component shall be thoroughly immersed in normally leaded 100 octane fuel or turbine engine fuel, as appropriate, at approximately room temperature and then allowed to drain for one (1) minute before being tested per paragraph 7.1. No cleaning other than the drainage as specified shall be accomplished prior to conducting subsequent tests.

7.6.2 Oil Immersion: The test procedure outlined in paragraph 7.6.1 shall be conducted with used MIL-O-7808 oil (turbine engine oil) or SAE #50 (piston engine oil), as appropriate.

7.7 Sand: The instrument components which are to be located in externally exposed portions of the aircraft (such as in nacelles, wheel wells, etc.) shall be subjected to a sand laden airstream flowing at a constant rate of 2-½ pounds per hour for four (4) hours. The airstream shall be formed of sand that has been sifted through a 150 mesh screen and the particles shall come in contact with all parts of the component being tested. The test chamber shall be equivalent to that shown in Figure I.

7.8 High Temperature Operation: The instrument shall be subjected to the applicable high ambient temperature listed in Column A of paragraph "3.3.1 Temperature" for a period of 48 hours (electrical equipment energized). Where the highest recommended operating temperature exceeds those of Column A, this higher temperature shall be used. The instrument shall meet, while at that temperature(s), the performance test of paragraphs 7.1 and 7.1.1.

7.9 Low Temperature Operation: Same as requirement 7.8 above, except substitute "low" for "high." The instrument shall then meet, at that temperature, the performance tests described in paragraphs 7.1 and 7.1.1, except that a maximum response time of ten seconds is acceptable for this test.

7.10 Altitude Effects:

7.10.1 High Altitude and Rate of Climb: The instrument shall be subjected to a pressure that is varied from normal atmospheric pressure to an altitude pressure equivalent to 50,000 feet at a rate of not less than 3,000 feet per minute. The instrument shall be maintained at the altitude pressure equivalent to 50,000 feet for a period of 48 hours. The instrument shall then be returned to sea level conditions and then tested per paragraph 7.1. Sealed components shall not leak as a result of exposure to this pressure and a leak test shall be demonstrated by immersion in water.

7.10.2 Low Altitude: The instrument shall be subjected to the same test as outlined in paragraph 7.10.1, except that the pressure shall be maintained at an altitude pressure equivalent to -1000 feet and that the rate of pressure variation need not be as specified therein.

7.10.3 Pressurization Test: The components which are to be located in a pressurized area shall be subjected to an external pressure of 50 inches of mercury absolute for a period of 15 minutes. The response time test of the instrument per paragraph 7.1 shall be conducted while the component involved is under this pressure.

7.11 Voltage Variation: The instrument shall be operated with the voltage cycled between 75 and 110 percent of the rated voltage. The instrument shall then be test per paragraph 7.1 under these conditions. Compliance with the provisions of paragraph 4.2 shall also be demonstrated.

7.12 Clearance Time: The instrument components which are to be installed in a fire zone shall be subjected to a flame of a temperature of 1100° C. minimum for two periods of one minute each. The flame shall be as specified in Figure 2. The component shall be cooled to approximately room temperature or to the ambient temperature permitted in paragraph 7.1 after each exposure to the flame. The component shall then be exposed to the flame a third time. An alarm signal shall occur not to exceed five (5) seconds after each exposure to the flame. During cooling of the component after the first two exposures to flame, the alarm shall clear in not more than 45 seconds after the flame has been removed after each exposure. The established air velocity over the sensor shall be zero during the cooling portion of this test, except a specific higher velocity may be established providing the sensor is specified for use in areas where the air velocity under normal operating conditions will not decrease below this value. Artificial means of cooling the component shall not be used until after the alarm has cleared. A manual resetting means may be used to clear the alarm provided it is demonstrated that the resetting means will clear the alarm only if the flame has been removed. After the third exposure of the component to flame, the instrument need not be capable of further operation. During this test, the sensor shall be subjected to vibration with frequency and amplitude as specified in paragraph 7.3.

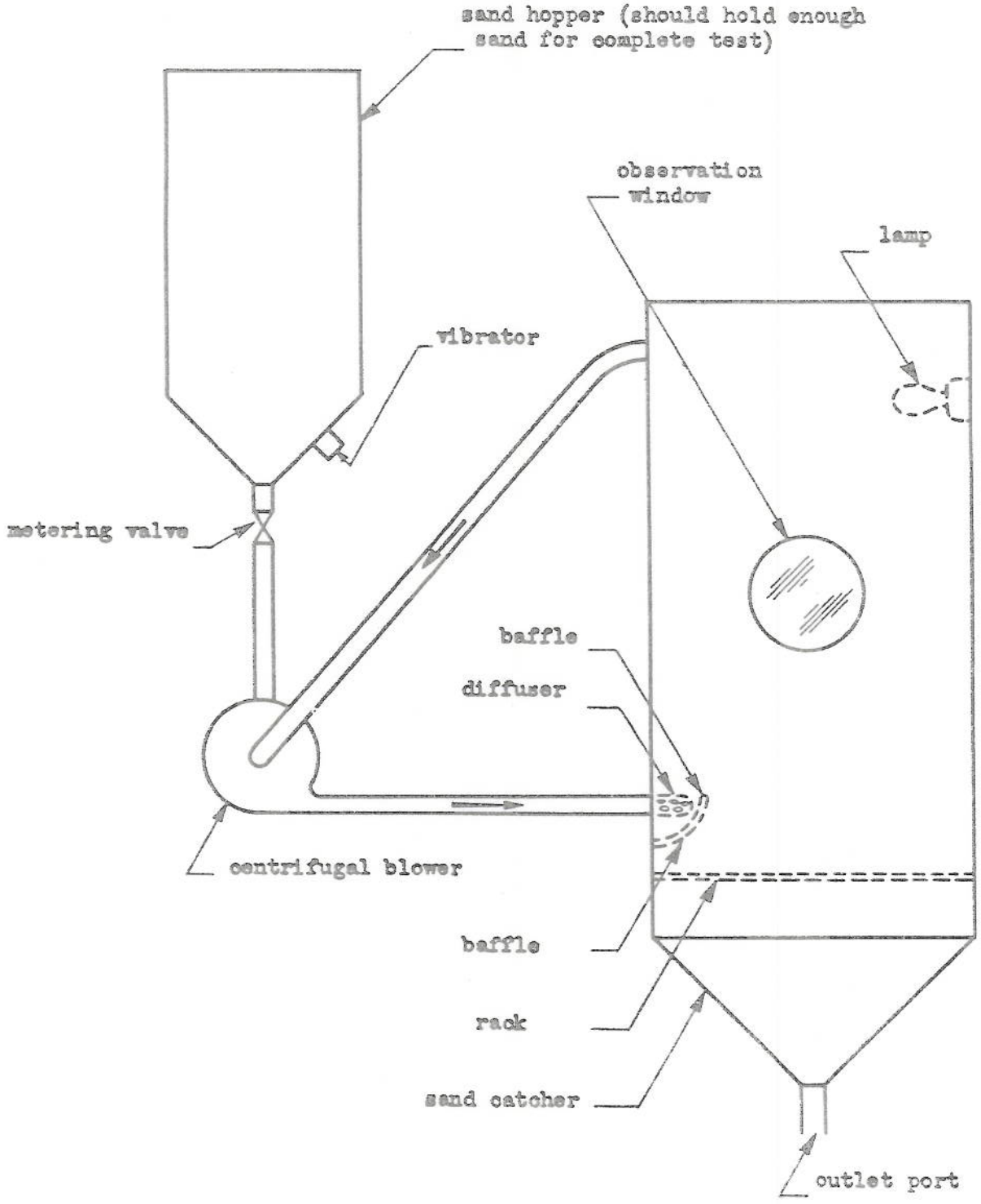

FIGURE 1
Schematic Sand Test Arrangement (Ref. Section 7.8)

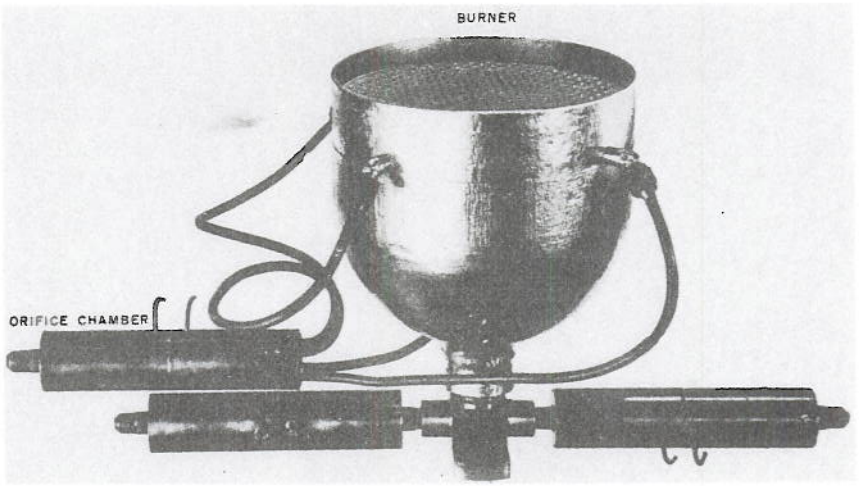

Figure 2-1. Standard Burner Assembly

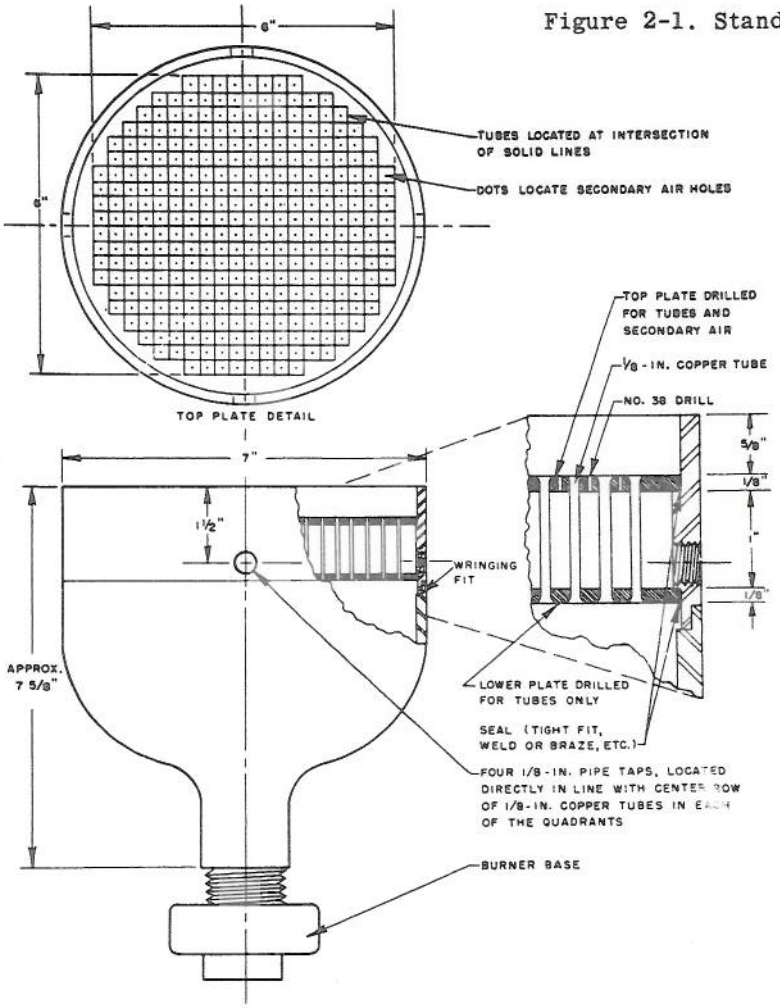

Figure 2-2. Standard Burner

Standard Burner Assembly.

The complete standard burner assembly is shown in Fig. 2-1. Details of the components of this assembly are given in Figs. 2-2, 2-3, and 2-4.

Fig. 2-2 shows the details of the burner and the burner grill which consists of two plates connected by 1/8-inch copper tubes. Gas and air are mixed in the burner base and travel upward through the tubes. The burning takes place above the top plate of the burner. Cooling air is admitted to the burner through the four 1/8-inch pipe-tapped holes between the plates of the burner grill. This air passes upward through the No. 38 drill holes in the top plate and serves as a means for controlling the overall temperature of the flame. The location of the four 1/8-inch pipe-tapped holes is critical. They must be located directly in line with the center row of 1/8-inch copper tubes in each of the four quadrants. Improper location of these connections will result in an unequal radial distribution of cooling air and will affect the distribution of the flame temperature in a like manner.

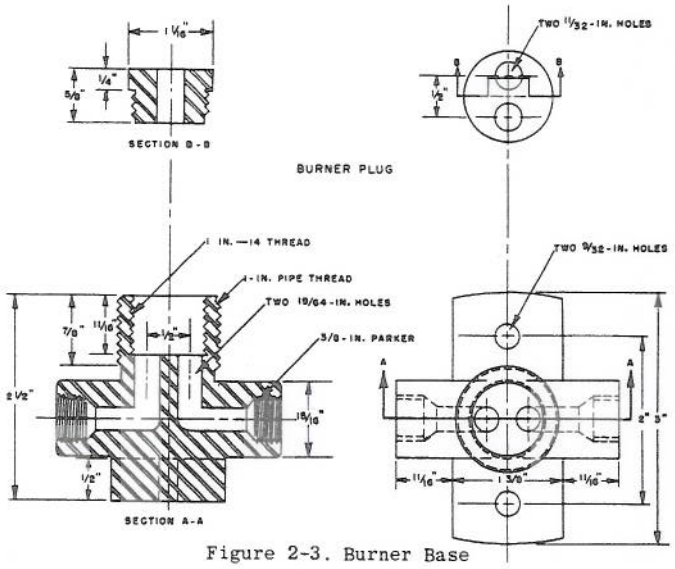

Figure 2-3. Burner Base

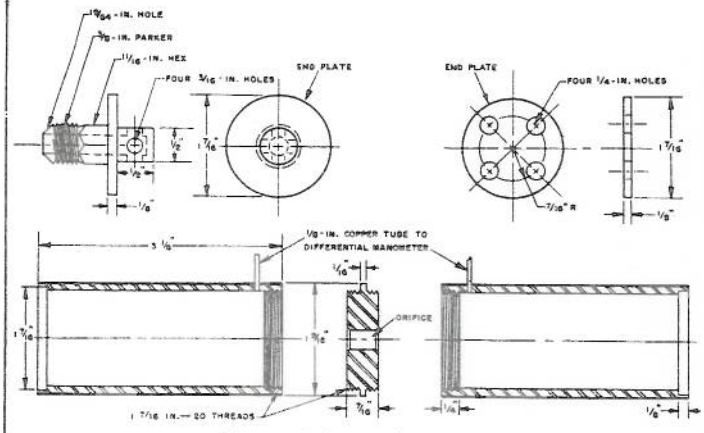

Figure 2-4. Orifice Chamber

Fig. 2-3 shows the details of the burner base. When the two 11/32-inch-diameter holes in the burner plug are drilled, care should be taken that the center line connecting these holes will be at right angles to the center line connecting the two 19/64-inch diameter holes in the base. When these 11/32-inch diameter holes are properly located, the 19/64-inch-diameter holes cannot be seen when one looks vertically downward into the burner base. This misalignment of holes aids in the mixing of the gas and air before they ascend to the burner grill.

Fig. 2-4 shows the details of an orifice and of an orifice chamber. Three are required. Two of these orifice chambers have end plates with the 3/8-inch Parker thread fittings on both ends and are fastened directly into the burner base. The third orifice chamber has an end plate with a Parker thread fitting on one end and the plate with four 1/4-inch-diameter holes in the other end. This end of the chamber is connected to the burner by four copper tubes, each 1/4 inch in outside diameter (OD) and 13 1/2 inches long. One of the orifice chambers connected to the base is for measuring the gas supplied to the burner and has an orifice 5/32 (0.01625) inch in diameter. The other orifice chamber connected to the base is for measuring the mixing air supplied to the burner and has an orifice 1/4 (0.25) inch in diameter. The third orifice chamber connected to the burner by four 1/4-inch OD copper tubes is for measuring cooling air supplied to the burner and has an orifice 5/16 (0.3125) inch in diameter.

The gas should deliver approximately 2500 British thermal units (BTU) per cubic foot. The burner should consume 26 cubic feet of gas per hour for the 2000°F (1100°C) flame. The flame produced should be uniform and steady with no yellow tips.

The differential manometer readings of the pressure drops across the orifice should be:

1. Gas orifice (5/32-inch diameter), 0.99 inch of water.
2. Mixing-air orifice (1/4-inch diameter), 9.25 inches of water.
3. Cooling-air orifice (5/16-inch diameter), 11.0 inches of water.

In order that the burner might produce the right amount of heat, the differential pressure for the gas and the mixing air should be accurately controlled. A slight variation in the cooling air may be necessary in order to obtain the proper temperature.

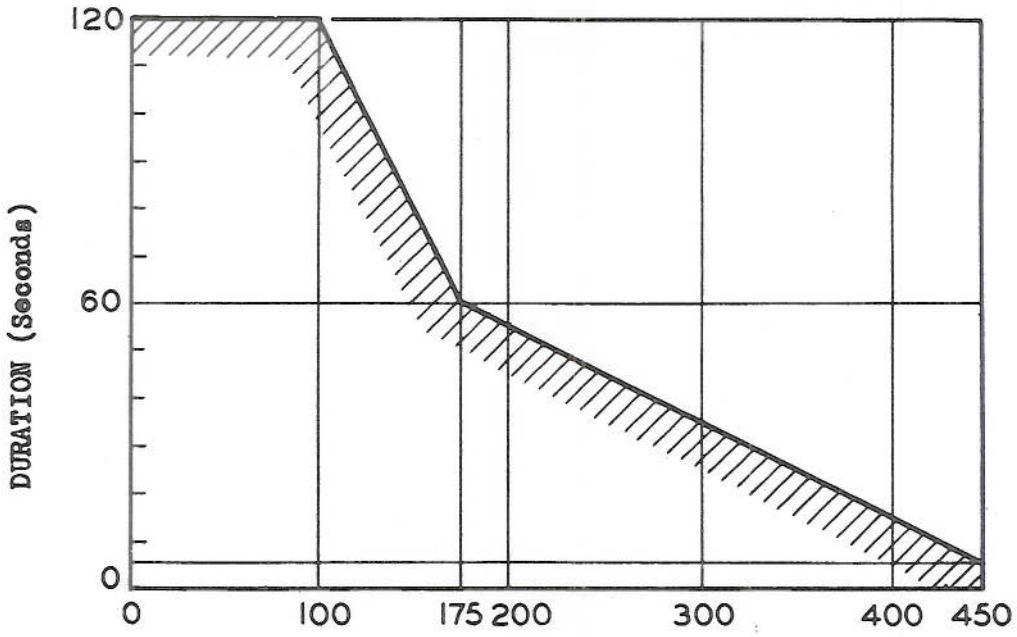

FIGURE 3 (a)

Local temperature rise condition
(Ref. Section 7.2.1)

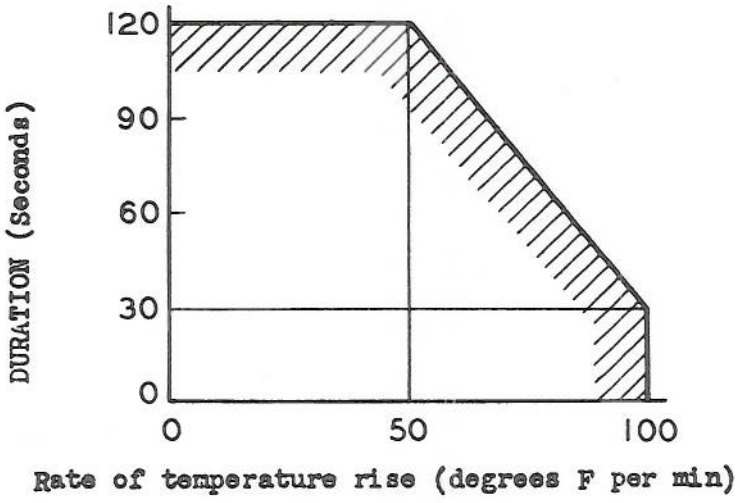

FIGURE 3 (b)

General temperature rise condition
(Ref. Section 7.2.2)

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