INCREMENTAL CHANGE

Release Notification Date: 02/24/2023

SPM 70-44-04 HEAT TREAT EQUIPMENT CALIBRATION

DISCLAIMER

The Incremental Changes published by GE Aviation are considered Instructions for Continued Airworthiness. These Incremental Changes, along with the current Manual revision and published Temporary Revisions, constitute the latest Instructions for Continued Airworthiness.

GE Designated: -CONFIDENTIAL-

HIGHLIGHTS

HIGHLIGHT REFERENCE	DESCRIPTION OF CHANGE
sk70-44-04-370-002	Technical Change: Changed definitions, requirements and test methodology for heat treat equipment calibration.

TASK 70-44-04-370-001

1. General.

A. This standard practice deals with the set-up and qualification requirements of thermocouples, and furnace temperature uniformity/atmosphere performance. It will cover furnaces used to perform vacuum, inert gas, air, and hydrogen heat treatments.

2. Applicable Documents.

Subtask 70-44-04-370-001

A. Aerospace Material Specifications:

(1) AMS 2750, Pyrometry

B. American Society for Testing and Material:

(1) ASTM E 230, EMF Tables for Standardized Thermocouples

(2) ASTM E 220, Manufacturing and Calibration of Thermocouples

3. Definitions.

Subtask 70-44-04-370-002

A. Air Cool in Vacuum Furnace - When the rate specified is air cool or equal, the cooling rate shall be 30°F (17°C) per minute or greater to at least 1000°F (538°C).

B. Air, Oil, Water Cool/Quench - Describes the equivalent cooling rate range required, rather than the specific cooling medium which must be used. For example: Circulated argon in a vacuum furnace might be equivalent to air cool, while different polymer-water solution concentrations might be equivalent to oil or water quench, but equivalency must be demonstrated before substituting other methods to below 1000°F (538°C).

C. Control or Furnace Thermocouple - A thermocouple installed within the furnace volume which is used to control the heat input to the working zone.

D. Gas Dew Point - "Colder" or "better" dew point means "lower" impurity content. Required levels will usually be specified by the drawing or material specification, and unless otherwise stated

are maximum levels.

E. Heat Sink - A mass of material equivalent to the heat transfer characteristics of the thickest section of the part being heat treated. A thermocouple surrounded by the heat sink is expected to represent the "metal temperature."

F. Heat Treatment - A heating and cooling process that modifies or changes the inherent physical or metallurgical properties of a solid metal or alloy.

G. Leak-Up Rate Test - A test in which the furnace chamber is evacuated, isolated from the evacuation source, and the leakage determined within the system by observing the pressure rise for each unit of time. Note that the leak-up rate is expressed in microns/hour (1 micron of mercury = 1 x 10-3 torr).

H. Metal Temperature - The temperature specified on the drawing or material specification represents metal temperature, which is the actual temperature measured at the metal surface by a load thermocouple. At least one thermocouple shall be on the thickest section of the part.

I. Overtemperature Control - A furnace system which reduces or halts heat input by the furnace in response to a detected overtemperature condition.

J. Overtemperature Thermocouple - An independent thermocouple installed in the furnace volume which is used to monitor any overtemperature occurrences and generate an alarm or shut down heat input.

K. Vacuum Level - "Higher" or "better" vacuum means "lower" pressure. Required levels will usually be specified by Engine Shop Manual, and unless otherwise stated are maximum pressure levels. For conversion: 1 torr = 1 mm Hg = 133 pascals = 1000 microns.

L. Working Zone - The volume of the heated region of a furnace occupied by parts or material to be heat treated or brazed which demonstrates temperature uniformity within the specified temperature tolerances.

M. Load Thermocouple (Working Thermocouple) - Any thermocouple which is attached to the part or heat sink which is being heat treated.

4. Requirements/Test Methodology.

Subtask 70-44-04-370-003

A. Temperature Uniformity.

(1) Temperature uniformity shall be based on the single highest and single lowest corrected temperature readings from the Temperature Uniformity Survey (TUS) thermocouples within the survey period. Unless other requirements or temperature tolerances are specified, the temperature readings of all TUS thermocouples shall be within plus or minus 25°F (plus or minus 14°C) of the survey temperature.

(2) During heating to and holding at each survey temperature, no temperature reading from any thermocouple shall exceed the upper tolerance limit of the required temperature uniformity, i.e., no overshoots are permitted.

(3) Test Method.

NOTE: Furnace surveys may be performed with an empty furnace (no load) or with a full load, of representative hardware that will better define the temperature variations in the furnace's working zone.

(a) If furnace survey is performed with a full load, prepare furnace with a representative load of parts, fixtures, and suitable atmosphere.

(b) Distribute test thermocouples symmetrically within the furnace working zone as follows:

1 Use a minimum of 2 thermocouples in a furnace or 10 cu ft (0.28 cu m) of working zone volume or less.

2 Use a minimum of 8 thermocouples or one per 25 cu ft (0.78 cu m) of working zone, whichever is greater, in furnaces with working zone volumes of more than 10 cu ft (0.28 cu m).

(c) Test furnace at lowest and highest operating temperature, and at intermediate temperature(s) such that the difference between the next higher or lower test temperature is 600°F (333°C) or less.

Example: If the lowest operating temperature is 800°F (427°C) and the highest operating temperature is 2400°F (1316°C):

Select 1350°F (732°C) and 1900°F (1038°C) as possible intermediate tests.

(d) Read and record temperature indications of all test and furnace control thermocouples at 2-minute intervals or less starting at 100°F (55°C) below first survey temperature.

(e) Continue recording temperature measurements for a minimum of 30 minutes following indication of thermal equilibrium period.

B. Recording Instrumentation and Thermocouples.

(1) Thermal Controls.

(a) Ensure that all temperature measuring instruments have an indicated temperature measuring accuracy of ± 0.5 percent of the maximum temperature measured over the entire furnace operating range.

(b) Thermocouples must be in accordance with ASTM E 220, ASTM E 230 or any other internationally recognized standard.

(c) Furnace must have overtemperature protection, and overtemperature sensors which notify the operator in response to an overtemperature condition.

(d) Test Method - Temperature sensors and recording devices will be calibrated per the procedure of AMS 2750 sections 3.1 (Temperature Sensors) and 3.2 (Instrumentation) unless specified otherwise herein.

(2) Vacuum Controls.

(a) For cold cathode vacuum instrument use, the vacuum sensing element shall be cleaned on a regular basis. Cold cathode vacuum gauges shall be calibrated before and after any

cleaning or adjustment.

(b) Thermoconductivity type gages (thermocouple, Pirani, thermister, etc.) which you may or may not be calibrate shall be used to measure pressure of 1 x 10-3 torr (one micron of mercury) (0.13 Pa) or higher. Ionization gages (hot ion or cold cathode) or any other vacuum gage that can be calibrated shall be used to measure pressures less than 1 x 10-3 torr (one micron of mercury) (0.13 Pa). The chamber vacuum sensors shall be located on the furnace chamber wall or between the furnace chamber and the diffusion pump and as close to the furnace chamber as practicable.

(c) Test Method.

1 Vacuum indicating instrument calibration shall be in accordance with manufacturer's recommendations. Calibration shall include the vacuum sensor, control panel, and when present the vacuum recorder.

2 The vacuum sensor which utilizes a mechanical or thermal conductivity principle for pressure measurement shall not come under calibration control.

3 Vacuum sensors which utilize an ionization principle for pressure measurement shall be under calibration control.

4 Calibration of the system shall be performed at a minimum of 3 test pressures spanning range of use.

(3) Dew Point Measurement.

(a) The measurement shall be taken at an accessible point where gas enters the single furnace farthest from the source of the gas.

(b) Test Method - Calibration of dew point measurement equipment shall be over the range of use. The equipment performance shall be within the limits supplied by the equipment manufacturer.

C. Furnace Atmosphere.

(1) Vacuum.

(a) The furnace must be able to maintain a pressure of 1 x 10-3 torr (0.13 Pa) or lower at temperature. Leak-up rate shall be less than 30 microns of mercury per hour.

(b) Test Method - A leak-up rate test shall be performed with the furnace at an initial pressure below 5 x 10-4 Torr (0.5 micron of mercury or 0.06 Pa), isolated from the effects of the pumping system. All pressure measuring equipment must be checked in accordance with manufacturer's recommendations.

(2) Inert Gas Atmosphere and Quenching.

(a) The gas supply shall be argon or nitrogen of 99.98 percent by volume purity and a dew point of -60°F (-51°C) or colder. This shall be monitored at the point as close as possible to where the gas enters the furnace, or at the farthest point from the source of gas when multiple furnaces are used.

(b) Dew point measurements shall be taken whenever the gas supply is replenished.

(c) Test Method - A pressurized leak check of the quenching system at its maximum operating pressure using a suitable chemical leak detector may also be used to qualify the system.

WARNING: HYDROGEN GAS MIXED WITH AIR MAY EXPLODE AT TEMPERATURES BELOW 1400°F (760°C).

(3) Hydrogen Gas.

(a) The gas supply shall be hydrogen gas of 99.95 percent by volume purity and a dew point of -60°F (-51°C) or colder measured at an accessible point where gas enters the single furnace farthest from the source of the gas.

(b) Test Method - See test method for inert gas.

(4) Air (oxidizing atmosphere).

(a) Furnace atmosphere is air.

D. The furnace interior and all holding fixtures used in furnace must be kept clean and free of contaminants which could be detrimental to parts being heat treated. Furnace bake out shall be performed every seven days for a minimum of one hour and at 50°F (28°C) above the highest temperature of use since the previous bake out.

5. Quality Control.

Subtask 70-44-04-370-004

A. Calibration of equipment shall be accomplished using equipment which is traceable to an internationally recognized standards organization.

B. Frequency of calibration and verification of equipment capability on a regular basis will be established in the maintenance and quality plan/system for the facility in question. This frequency will be established to insure that the equipment can reliably and consistently produce the needed tolerances required to process materials.

C. Record the detailed results of the approved tests in a log document. Record, at least, the following:

(1) Furnace identification.

(2) Instrumentation procedures including thermocouple type and placement.

(3) Vacuum or gas purity records.

(4) Temperature records.

(5) Mass of furnace loads.

(6) Schematic of furnace survey load.

(7) All calibration records.

(8) Traceability for thermocouples wire material.