Comparison of AMS 2750 G vs AMS 20750 H

Provided by John Schmidt from ATI Forged Products

Now that the industry has seen version H of 2750, many ask themselves... "How is it different from version G?" What MTI loves about members, is someone always steps up and creates a shareable resource for members to use. We have attached a document that shares the changes from version G to H provided by a member Wisconsin. After MTI's Technical Standards leadership gave it a review, we wanted to share it with all members. Feel free to print off this this comparison of 2750 G and H and share it with your quality team. This is a very helpful document.

AMS2750 G to H Change Summary 7/30/24

1. **2.4.21**
   a. **G** 2.2.21 EXPENDABLE SENSORS
      Sensors where any portion of the thermoelements are exposed to the thermal process equipment environment.

   b. **H** 2.4.21 EXPENDABLE SENSORS
      Sensors where any portion of the thermoelements are exposed to the thermal process equipment environment. Sensors with braided fiberglass insulation or plastic insulation are not designed to be inserted into a closed protection tube as the confined space causes drift when the additives (e.g., Teflon, color dies, and other chemicals) burn off. Therefore, these sensors are expendable even when installed into a closed protection tube.

2. **2.4.25**
   a. **G** 2.2.25 FREQUENCY (INTERVAL)
      The calendar days between two consecutive calibrations, tests, or sensor replacement. In the context of this specification, the following shall apply

   b. **H** 2.4.25 FREQUENCY (INTERVAL)
      The calendar days from the day/date a calibration, test, or sensor replacement was performed and the next day/date a calibration, test, or sensor replacement is due (inclusive). In the context of this specification, the following shall apply:

3. **2.4.36**
   a. **G** 2.2.36 NON-EXPENDABLE SENSORS
      Sensors having no portion of the thermoelements exposed to the thermal process equipment environment.

   b. **H** 2.4.36 NONEXPENDABLE SENSORS
      Sensors having no portion of the thermoelements exposed to the thermal process equipment environment. Sensors with ceramic insulators over bare wire inserted into a closed protection tube to prevent exposure to the thermal process equipment environment are considered nonexpendable sensors.

4. **2.4.47**
   a. **G** 2.2.47 QUALIFIED OPERATING TEMPERATURE RANGE
   The nominal set point temperature range of thermal processing equipment where temperature uniformity has been tested within a qualified work zone and found to be compliant with required tolerances. The qualified operating temperature range represents the temperature range including ± min/max uniformity tolerances within which parts or raw material can be processed.

   b. **H** 2.4.47 QUALIFIED OPERATING TEMPERATURE RANGE
   The nominal set point temperature range of thermal processing equipment where temperature uniformity has been tested within a qualified work zone and found to be compliant with required tolerances (i.e., qualified operating temperature range = nominal range of TUS set points).

5. **2.2.84**
   a. **G** 2.2.84 USE (OF A SENSOR)
   One cycle of heating or cooling upon the sensor being placed into service (see 3.1.4.2, 3.1.7.2, 3.1.7.5, and 3.1.11.1 for examples).

   b. **H** 2.4.84 USE (OF A SENSOR)
   One cycle of heating or cooling upon the sensor being placed into service (see Table 5 note 5, 3.1.4.2, 3.1.7.2, 3.1.7.5, and 3.1.11.1).

6. **Table 3 - Sensor classification**

   a. **G**

Table 3 - Sensor classification[2]

Sensor Cover	Sensor Classification[1]
Fiberglass, plastic, or trade name	Expendable
Multiple hard fired ceramic beads	Expendable
Metal over-braid	Expendable
Shielded from the process atmosphere by a closed metal/ceramic protective tube	Non-expendable
Mineral insulated; metal sheathed (MIMS)	Non-expendable
Mineral insulated; metal sheathed (MIMS) with an exposed measuring junction	Expendable

Note:
[1] See definitions for expendable/non-expendable sensors.
[2] The configuration of the sensor at the time of manufacture or assembly shall determine its classification (e.g., fiberglass covered wire inserted into a closed metal protection tube is expendable, bare wire with ceramic insulators purchased installed inside a closed metallic protection tube is non-expendable).

   b. **H**

Table 3 - Sensor classification

Sensor Cover	Sensor Classification[1]
Fiberglass, plastic, or trade name	Expendable
Multiple hard fired ceramic beads	Expendable
Metal over-braid	Expendable
Shielded from the process atmosphere by a closed metal/ceramic protective tube	Nonexpendable
Mineral insulated; metal sheathed (MIMS)	Nonexpendable
Mineral insulated; metal sheathed (MIMS) with an exposed measuring junction	Expendable

[1] See definitions for expendable and nonexpendable sensors.

7. **3.1.4.6**
    a. **G** 3.1.4.6 Intervals between calibration or re-calibration temperatures provided by the calibration agency shall not exceed 250 °F or 140 °C for all sensors.

    b. **H** 3.1.4.6 Intervals between calibration or recalibration temperatures provided by the calibration agency shall not exceed 250 °F or 140 °C for all sensors. The fixed point calibration method in ASTM MNL12 or other internationally recognized standards may be used. No matter what standard is used, the calibration agency shall provide additional calibration points that do not exceed 250 °F or 140 °C for all sensors.

8. **Table 5 - Sensor reuse and recalibration**
    a. **G** ___

    b. **H** (5) Reuses: Example 1: Begin at room temperature, ramp to 900 °F or 480 °C for first TUS temperature, then ramp to 1200 °F or 650 °C for TUS max temperature, then cool back to room temperature. This is a single use.

        Example 2: Begin at room temperature, ramp to 1325 °F or 718 °C for first production temperature, then cool to 1150 °F or 621 °C for the second production temperature, then cool back to room temperature. This is a single use.
        Example 3: Begin at room temperature, ramp to 1900 °F or 1038 °C for first production temperature, then cool to 300 °F or 150 °C, then ramp up to 1100 °F or 593 °C for second production temperature, then cool back to room temperature. This is two uses even if the load remained closed inside the equipment.

9. **3.1.7.4**
    a. **G** 3.1.7.4 Records shall be maintained of the accumulated sensor reuse including sensor batch number, temperature, and use count.

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    b. **H** 3.1.7.4 Records shall be maintained of the accumulated sensor reuse including sensor batch number, temperature, and use count.

        Example 1: Sensors are replaced after a single use. Sensor batch number shall be recorded for the SAT and/or TUS.
        Example 2: Sensors are reused. Sensor batch number, temperature, and use count shall be recorded for each use.

10. **3.1.7.5**
    a. **G** 3.1.7.5 Base metal or refractory TUS sensors shall be limited to no more than the maximum number of uses defined in 3.1.7.3 for expendable sensors, Table 6 for non-expendable sensors, or 6 months from first use, whichever occurs first, and may be reused subject to the limitations of 3.1.6 and 3.1.8 that are:

b. **H** 3.1.7.5 Base metal or refractory TUS sensors shall be limited to no more than the maximum number of uses defined in 3.1.7.3 for expendable sensors, 270 uses for nonexpendable sensors, or 6 months from first use, whichever occurs first, and may be reused subject to the limitations of 3.1.6 and 3.1.8 that are:

11. 3.1.10.3

a. **G** 3.1.10.3 Records shall be maintained of the accumulated load sensor use above 500 °F or 260 °C including sensor batch number, load cycle, temperature, and use count. The use count shall include uses during SAT and TUS.

b. **H** 3.1.10.3 Records shall be maintained of the accumulated load sensor use above 500 °F or 260 °C including sensor batch number, load cycle, temperature, and use count. The use count shall include uses during SAT and TUS. When sensors are replaced after a single use, the sensor batch number shall be recorded and traceable to the load.

12. 3.2.1.4

a. **G** 3.2.1.4 Process recording data collection shall be a minimum of six data points for each recorded sensor during each time at temperature processing cycle not to exceed 10-minute intervals.

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b. **H** 3.2.1.4 Process recording data collection shall be a minimum of six data points for each recorded sensor during each time at temperature processing cycle not to exceed 10-minute intervals.

3.2.1.4.1 For cycles where the time at temperature is <6 minutes, the data collection shall be ≤ once per minute.

13. 3.2.1.5

a. **G** 3.2.1.5 Data collection intervals shall be sufficient to demonstrate conformance to cooling rate requirements.

b. **H** 3.2.1.5 Data collection intervals shall be sufficient to demonstrate conformance to soak time, heat-up, and cooling rate requirements, as applicable.

14. Table 7 – Instruments and instrument calibration

a. **G** Secondary standard instrument ... Use
Limited to laboratory calibration of field test instruments, SAT sensors, TUS sensors, load sensors, and control, and recording sensors(8)

b. **H** Secondary standard instrument ... Use
Limited to laboratory calibration of field test instruments, SAT sensors, TUS sensors, load sensors, and control and recording sensors(8) (see 3.2.2.6)

15. **Table 7 – Instruments and instrument calibration**
    a. **G** Control, over-temperature, recording, data acquisition instrument(7)

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    b. **H** Control, over-temperature, recording, data acquisition instrument(7)(11)
    Removed Mechanical or Thermal element
    11) For thermal processing equipment that has documented “out of use/service” periods beyond the due date and extension days in Table 22, calibration of process instrumentation shall be performed before being returned to service.

16. **3.2.3.4**
    a. **G** 3.2.3.4 Calibration shall be performed in the as-found condition taking into account any applied and documented offsets at a minimum of three simulated sensor inputs at the minimum, maximum and at least one point in the middle third of the entire qualified operating temperature range to document the as-found condition.

    _____

    b. **H** 3.2.3.4 Calibration shall be performed in the as-found condition, taking into account any applied and documented offsets, at a minimum of three simulated sensor inputs (at the minimum, maximum, and at least one point in the middle third of the entire qualified operating temperature range) to document the as-found condition.

        Example 1: A Class 2 ±10 °F furnace with a qualified operating temperature range of 300 to 1200 °F requires calibration at the Minimum = 300 °F, at the Maximum = 1200 °F, and at least 1 point in the middle third = 600 to 900 °F.
        Example 2: A Class 2 ±6 °C furnace with a qualified operating temperature range of 200 to 1100 °C requires calibration at the Minimum = 200 °C, at the Maximum = 1100 °C, and at least 1 point in the middle third = 500 to 800 °C.

17. **3.2.3.5**
    a. **G** 3.2.3.5 For equipment that does not have a defined qualified operating temperature range (e.g., quench tanks and refrigeration equipment), calibration shall be performed at a minimum of three simulated sensor inputs at the minimum, maximum and at least one point in the middle third of the operating range used.

    b. **H** 3.2.3.5 For equipment that does not have a defined qualified operating temperature range (e.g., quench tanks and refrigeration equipment), calibration shall be performed at a minimum of three simulated sensor inputs at the minimum, maximum, and at least one point in the middle third of the operating range used. Users shall have the ability to identify the operating range used for each piece of quench and/or refrigeration equipment.

18. 3.2.3.16

a. G 3.2.3.16 As an alternative to 3.2.3.14 or 3.2.3.15, a defined digital synchronization of digital recording instruments and data acquisition systems or external timing devices, to NIST or other international equivalent, via satellite, internet, or telephonic systems at least monthly to support a ±1 min/h accuracy is acceptable.

b. H 3.2.3.16 As an alternative to 3.2.3.14 or 3.2.3.15, a defined digital time synchronization of digital recording instruments and data acquisition systems or external timing devices to NIST or other international equivalent via satellite, internet, or telephonic systems at least monthly to support a ±1 min/h accuracy for digital recording instruments and/or ±1 sec/min for external timing devices is acceptable.

19. 3.2.3.18

a. G _____

b. H 3.2.3.18 Correction Factors for Instruments
3.2.3.18.1 Extrapolation of calibration correction factors above the highest calibration temperature and below the lowest calibration temperature is prohibited by any calibration source except NIST or other internationally recognized standards organization.
3.2.3.18.2 Interpolation of correction factors between two known calibration points is permitted using the linear method. Alternatively, the correction factor of the nearest calibration point shall be used. Whichever method is used shall be defined and applied consistently.

20. 3.2.5

a. G 3.2.5 Instrumentation Calibration Results and Records
3.2.5.1 A label or labels affixed to or in close proximity to the instrument shall indicate the most recent successful calibration. As a minimum, the label(s) shall include:
a. Instrument number or furnace number.
b. Date the calibration was performed.
c. Due date of the next calibration.
d. Identification of the technician who performed the calibration.
e. Indication of any limitations or restrictions of the calibration. A notation such as “see report” is acceptable.

b. H 3.2.5 Instrumentation Calibration Results and Records
3.2.5.1 The most recent successful calibration status shall be readily accessible at or in close proximity to the thermal processing equipment. As a minimum, the information shall include:
a. Instrument number or furnace number.
b. Date the calibration was performed.
c. Due date of the next calibration.
d. Identification of the technician who performed the calibration.
e. Indication of any limitations or restrictions of the calibration. A notation such as “see report” is acceptable.

21. 3.2.6.1.2

a. **G** 3.2.6.1.2 The maximum cumulative correction offset shall not exceed the uniformity tolerance for the thermal processing equipment or ±5.0 °F or ±2.8 °C for refrigeration and quench instruments. (e.g., a Class 2 furnace instrument is limited to a maximum correction offset of ±10.0 °F or ±6.0 °C).

b. **H** 3.2.6.1.2 The maximum cumulative correction offset shall not exceed the uniformity tolerance for the thermal processing equipment or ±10.0 °F or ±6.0 °C for refrigeration and quench instruments. (e.g., a Class 2 furnace instrument is limited to a maximum correction offset of ±10.0 °F or ±6.0 °C).

22. 3.2.6.1.8

a. **G** _____

b. **H** 3.2.6.1.8 When correction and/or modification offsets are implemented or changed, the effect of the new offset value over the entire qualified operating temperature range shall be evaluated. Objective evidence that the new offset value would not cause a failure of any other calibration, SAT, or TUS shall be documented.

23. 3.3.7

a. **G** 3.3.7 For multiple control zone furnaces with <225 ft3 or 6.4 m3 in total qualified work zone volume, it is acceptable to treat the furnace qualified work zone volume as a single control zone for locating hot and cold temperature recording sensors (Type A or C instrumentation) and determining the number of load sensors required, regardless of the number of control sensors (Type A or B instrumentation) when the longest dimension of width, length, diameter, or height is no more than three times any of the other dimensions.

b. **H** 3.3.7 For multiple control zone furnaces with <225 ft3 or <6.4 m3 in total qualified work zone volume, it is acceptable to treat the furnace qualified work zone volume as a single control zone (see Table 10) for locating hot and cold temperature recording sensors (Type A or C instrumentation) and determining the number of over-temperature and load sensors required, regardless of the number of control sensors (Type A or B instrumentation), when the longest dimension of width, length, diameter, or height is no more than three times any of the other dimensions.

24. Table 11 & 12 – Parts and Raw material furnace class, instrument type, and SAT interval

a. **G** Furnace Class 6 and Type: E % of Reading: N/A

b. **H** Furnace Class 6 and Type: D, E % of Reading: ±1.0

25. 3.4.1.2

a. **G** 3.4.1.2 The SAT shall be performed on all control and recording systems required by the applicable instrumentation type, as well as any additional recording systems used for parts and raw material acceptance in each control zone of each piece of thermal processing equipment used for production heat treatments.

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b. H 3.4.1.2 The SAT shall be performed on all control and recording systems required by the applicable instrumentation type, as well as any additional recording systems used for parts and raw material acceptance in each control zone of each piece of thermal processing equipment used for production heat treatments.

3.4.1.2.1 Load sensors are not required to be in contact with parts, raw material, or any representation of parts or raw material during the SAT.

26. 3.4.2.2

a. G 3.4.2.2 For equipment that has documented “out of use/service” periods, a new SAT shall be performed on all applicable systems before being returned to service.

b. H 3.4.2.2 For equipment that has documented “out of use/service” periods beyond the due date and extension days in Table 22, a new SAT shall be performed on all applicable systems before being returned to service.

27. 3.4.8.2

a. G 3.4.8.2 Periodic calibration of control and/or recording instruments in accordance with 3.2.3.5 and meeting the requirements of Table 7 shall be performed from the point at which the sensor will be connected (including the instrument/extension wire/connector) and one of the following three options are met.

b. H 3.4.8.2 Alternate SAT Method

Periodic calibration of control and/or recording instruments as stated in 3.2.3.4 or 3.2.3.5, as applicable, and meeting the requirements of Table 7 shall be performed from the point at which the sensor will be connected (including the instrument/extension wire/connector) and one of the following three options are met:

3.2.3.4 Calibration shall be performed in the as-found condition, taking into account any applied and documented offsets, at a minimum of three simulated sensor inputs (at the minimum, maximum, and at least one point in the middle third of the entire qualified operating temperature range) to document the as-found condition.

3.2.3.5 For equipment that does not have a defined qualified operating temperature range (e.g., quench tanks and refrigeration equipment), calibration shall be performed at a minimum of three simulated sensor inputs at the minimum, maximum, and at least one point in the middle third of the operating range used. Users shall have the ability to identify the operating range used for each piece of quench and/or refrigeration equipment.

28. 3.4.8.3

a. G 3.4.8.3 The frequency of documenting the results of the alternate SAT shall be the lesser of either one of the following:

- The replacement frequency of the control or recording sensor.
- The frequency of calibration of the control or recording instrument.

b. H 3.4.8.3 Alternate SAT Frequency
The alternate SAT method shall be performed and documented when any of the following occurs:

- Systems utilizing individually calibrated sensors require the alternate SAT upon replacement of each sensor.
- Systems utilizing sensors from the same calibrated roll/spool require an alternate SAT upon replacement of the roll/spool.
- Calibration of the system instrument (control or recording).

29. 3.4.9.6.3

a. G 3.4.9.6.3 If the weekly relationship exceeds 2.0 °F or 1.1 °C, then 4.4 shall apply.
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b. H 3.4.9.6.3 If the weekly relationship exceeds 2.0 °F or 1.1 °C, then one of the following options
shall apply:
3.4.9.6.3.1 A successful SAT using one of the other methods (comparison or alternate) shall be performed before returning to production.
3.4.9.6.3.2 After 4.5, 4.6, 4.7, and 4.8 are completed, the SAT waiver relationship shall be reestablished by performing a TUS at all required temperatures of the initial TUS. The TUS interval shall continue at the interval in use at the time of the last periodic TUS.

30. 3.4.10.4

a. G 3.4.10.4 Instrument recalibration including any correction offset of the control or recording instrument calibration is permitted within the maximum limitations of Table 15 or 16. The effect of this adjustment over the entire qualified operating temperature range shall be evaluated and objective evidence that the correction offset would not cause a failure of any other calculated SAT or TUS shall be documented. The requirements of 3.4.2.2 and 4 shall apply.

b. H 3.4.10.4 Instrument recalibration or adjustment, including any correction offset of the control or recording instrument calibration, is permitted within the maximum limitations of Table 15 or Table 16. The effect of this recalibration or adjustment over the entire qualified operating temperature range shall be evaluated and objective evidence that the correction offset would not cause a failure of any other calculated SAT or TUS shall be documented. The requirements of 3.4.2.3 and Section 4 shall apply.

31. 3.4.11.1 e.

a. G 3.4.11 SAT Results and Records
3.4.11.1 Comparison SAT (see 3.4.7)
e. Set point of the thermal processing equipment during the SAT.

b. H 3.4.11 SAT Results and Records
3.4.11.1 Comparison SAT (see 3.4.7)
e. Set point of the thermal processing equipment during the SAT. The test temperature shall be documented as the SAT set point for thermal processing equipment that does not have a set point temperature.

32. Table 15 & 16 – Parts and Raw materials furnace class, instrument type, and TUS interval

a. G Furnace Class 6 and Type: E

b. H Furnace Class 6 and Type: D, E

33. 3.5.2.4

a. G _____

b. H 3.5.2.4 For thermal processing equipment used only at a single set point temperature, the TUS shall be performed at that single temperature.

34. Table 17 - Minimum number of TUS sensors and required locations

a. G _____

b. H (1) The location of TUS sensors for ≥3 ft^3 to <225 ft^3 may be used for volumes <3 ft^3.

35. 3.5.10

a. G 3.5.10 TUS Data Collection
3.5.10.1 Data collection shall begin when the temperature of all TUS and furnace sensors are ≤100 °F or 55 °C below each TUS temperature so that any TUS or furnace sensor failing to reach the lower TUS tolerance or exceed the upper TUS tolerance can be detected. For TUS temperatures of 200 °F or 93 °C and below, data collection shall begin at the ambient temperature of the furnace or refrigeration equipment prior to the start of heating (or cooling for refrigeration equipment). If the furnace or refrigeration equipment is pre-stabilized, data collection shall begin prior to the TUS sensors being inserted.
3.5.10.2 Once data collection begins, temperature data shall be recorded from all TUS sensors at a frequency of at least one set of readings every 2 minutes for the duration of the TUS.

b. H 3.5.10 TUS Data Collection
3.5.10.1 Data collection shall begin when the temperature of all TUS and furnace sensors are at least 100 °F or 55 °C below each TUS temperature so that any TUS or furnace sensor failing to reach the lower TUS tolerance or exceed the upper TUS tolerance can be detected. This is not applicable to salt bath or other thermal processing equipment that is maintained at a single set point. For TUS temperatures of 200 °F or 93 °C and below, data collection shall begin at the ambient temperature of the furnace or refrigeration equipment prior to the start of heating (or cooling for refrigeration equipment). If the furnace or refrigeration

equipment is pre-stabilized, data collection shall begin prior to the TUS sensors being inserted.
3.5.10.2 Once data collection begins, temperature data shall be recorded simultaneously from all TUS sensors at a frequency of at least one set of readings every 2 minutes for the duration of the TUS.

36. 3.5.15.2

a. G 3.5.15.2 The hot and cold recording sensors do not require relocation if either of the following conditions is met:

3.5.15.2.1 The temperature uniformity results do not exceed one half of the maximum temperature uniformity tolerance for the applicable furnace class at all temperatures surveyed. The intent of this requirement is that the TUS results do not exceed 1/2 of the uniformity tolerance in either direction from the set point temperature. Note: A TUS modification offset may be used to center the TUS results to meet the above requirement, see Figure 2.

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b. H 3.5.15.2 The hot and/or cold recording sensors do not require relocation if either of the following conditions is met:

3.5.15.2.1 The temperature uniformity results do not exceed one half of the maximum temperature uniformity tolerance for the applicable furnace class at all temperatures surveyed. The intent of this condition is that the TUS results do not exceed 1/2 of the uniformity tolerance in the cold direction from the set point temperature to evaluate the cold recording location and that the TUS results do not exceed 1/2 of the uniformity tolerance in the hot direction from the set point temperature to evaluate the hot recording location. The hot and cold locations are to be assessed individually.
Example: Furnace Class 2 ±10 °F and the TUS results showed that both the hot and cold locations changed. The TUS results were -4.0 °F to +5.5 °F. This means that the cold location does not need to be relocated, but because the TUS results exceeded the half tolerance in the positive direction, the hot location does not pass this test.
NOTE: A TUS modification offset may be used to center the TUS results to meet the above requirement for both locations (see Figure 2).

37. 3.5.15.2.2

a. G 3.5.15.2.2 The difference between the measured temperature at the current hot and cold recording sensor locations and the actual respective hottest and coldest measured locations does not exceed the maximum SAT difference for the applicable furnace class (see Tables 11 and 12). The intent of this requirement is that the maximum and minimum TUS sensor readings during the 30-minute TUS soak, recorded and corrected by the TUS recorder, are compared to the furnace recording of the current hot and cold recording sensors at the same time, and shall not exceed the applicable SAT difference. See Figure 3.

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b. H 3.5.15.2.2 The difference between the measured temperature at the current hot and/or cold

recording sensor locations and the actual respective hottest and coldest measured locations does not exceed the maximum SAT difference for the applicable furnace class (see Tables 11 and 12). The intent of this condition is that the maximum and minimum TUS sensor readings during the 30-minute TUS soak, recorded and corrected by the TUS recorder, are to be compared to the furnace recording of the current hot and cold recording sensors as close to the same time as possible given the data collection rates of the furnace and field test recorders and shall not exceed the applicable SAT difference. See Figure 3. Example: The cold position passed the first test, but the hot position did not pass the first test. Therefore, the hottest corrected TUS temperature is compared to the temperature of the current furnace hot location at the time. If the difference is ≤ the Max SAT difference, then the hot location does not need to be relocated.

38. 3.5.17

a. G 3.5.17 Radiation Survey

3.5.17.1 For all aluminum alloy thermal processing equipment used above 800 °F or 427 °C where the heat source (e.g., electrical elements or gas tubes) is located in the furnace walls, ceiling, or floor, a radiation survey shall be performed at the maximum operating temperature used during production. The radiation survey shall be performed initially and after any equipment repair or modifications including furnace relocation that could affect the radiation characteristics of the heat source.

3.5.17.2 The radiation survey sensor(s) shall be in addition to the required number of TUS sensors. The radiation survey and the initial or periodic TUS may be performed simultaneously.

b. H 3.5.17 Radiation Survey

When required by the applicable material or process specification, a radiation survey shall be performed as follows:

3.5.17.1 Where the heat source (e.g., electrical elements or gas radiant tubes) is located in the furnace walls, ceiling, or floor, and the heat source has either a direct line of sight to the work zone or is only separated from the work zone by a single sheet of metal, a radiation survey shall be performed at the maximum operating temperature used for aluminum during production. The radiation survey shall be performed initially and after any equipment repair or modifications, including furnace relocation, that could affect the radiation characteristics of the heat source.

3.5.17.2 The radiation survey sensor(s) shall be in addition to the required number of TUS sensors. The radiation survey and the initial or periodic TUS may be performed simultaneously or separately.

39. 3.5.18

a. G _____

b. H 3.5.18 TUS Interval Deviations
3.5.18.1 The user is allowed to have thermal processing equipment exceed the allowable TUS interval, including any extension days in Table 22, with the approval from each applicable cognizant engineering or quality organization. When the TUS is next performed, it shall include all required temperatures of the initial TUS and at the highest and lowest traverse speed for continuous and semi-continuous furnaces. The TUS interval shall continue at the interval in use at the time of the last periodic TUS.
3.5.18.2 For thermal processing equipment that has been documented as being "out of use/service" beyond the next TUS due date and any extension days in Table 22, a periodic TUS shall be performed before being returned to service. The TUS interval shall continue at the interval in use at the time the equipment was taken "out of use/service".

40. 3.8

a. G 3.8 Rounding
3.8.1 All rounding shall be applied in accordance with a documented procedure and used in a consistent manner.
3.8.2 Rounding to the number of significant digits imposed by the requirement is permitted in accordance with ASTM E29 using the absolute method or other equivalent international standards.
3.8.3 The rounding method built into commercial spreadsheet programs is also acceptable.
3.8.4 All specified limits in this specification are absolute and out of tolerance test data cannot be rounded into tolerance.
3.8.5 Rounding shall only be applied to the final calibration or test result.

b. H 3.8 Rounding
3.8.1 If used, rounding shall be applied in accordance with a documented procedure and used in a consistent manner.
3.8.2 Rounding to 0.1 °F or 0.1 °C in accordance with ASTM E29, other equivalent international standards or commercial software programs is acceptable.

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41. 4.2

a. G 4.2 Third party (external) pyrometry service provider companies shall have a quality system accredited to ISO/IEC 17025 from an ILAC (International Laboratory Accreditation Cooperation) recognized regional cooperation body. The scope of accreditation shall include the laboratory standards and/or field service (for testing and calibration activities) as applicable.

b. H 4.2 Third-party (external) pyrometry service provider companies shall have a quality system accredited to ISO/IEC 17025 from an ILAC (International Laboratory Accreditation Cooperation) recognized regional cooperation body. The scope of accreditation shall include the laboratory standards and/or field service (for testing and calibration activities), as applicable. This applies to third-party providers performing calibrations or tests at the user's site or in their own laboratory.

42.4.4

a. **G** 4.4 Equipment that is affected by any calibration or test failing to meet applicable requirements, or that has exceeded the allowable interval including any extension period defined in Table 22, shall be removed from service.

Table 22 - Permitted calibration/test interval extension

b. **H** 4.4 Equipment that is affected by any calibration or test failing to meet applicable requirements, or that has exceeded the allowable interval including any extension period defined in Table 22, shall be removed from service (i.e., production shall not begin once the extension days expire).

Table 22 - Permitted calibration/test interval extension