199603 **CONTROL OF HEAT TREATING PROCESSES AND AUXILIARY EQUIPMENT** **W-HTX**

INDEX

5. FREQUENCIES FOR PROCESS MONITORS, LABORATORY CONTROLS, AND IN-PROCESS TESTS FOR INDUCTION AND FLAME PROCESSES

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1. DESCRIPTION AND REQUIREMENTS:

1.1 SCOPE: This Standard defines the requirements for the type and frequency of process monitors, laboratory controls, and in-process inspections and tests to be performed as part of the ongoing operation of production heat treating equipment and the maintenance of related records.

This Standard is applicable to the following Heat Treat Processes:

- Carburising/Carbonitriding/Carbon Correction
- Neutral Hardening - Atmosphere
- Tempering and Stress Relieving
- Nitriding/Nitrocarburising
- Annealing/Normalising
- Aluminum Solution Heat Treating/Age Hardening
- Brazing/Sintering
- Salt Bath Heat Treating
- Induction and Flame Hardening/Tempering/Annealing

This Standard applies to all production and service parts.

For parts whose heat treat characteristics are not identified by any of the above criteria, the minimum requirements for a specific type and frequency of process monitor, laboratory control, or in-process inspection or test will be specified.

CAUTION: APPROPRIATE PRECAUTIONS MUST BE TAKEN RELATIVE TO HEALTH AND SAFETY AND ENVIRONMENTAL HAZARDS. FORD FACILITIES SHALL CONTACT THE APPROPRIATE FORD MOTOR COMPANY HEALTH AND SAFETY AND ENVIRONMENTAL ACTIVITIES FOR SPECIFIC INFORMATION REGARDING SUCH PRECAUTIONS.

These monitoring and control tests are required to keep heat treating processes and processing equipment under control to produce parts that will meet Product Engineering requirements and functional tests. Regularly scheduled maintenance as well as equipment operating responsibilities of the production operator are not included.

The emphasis on process control is to provide indications that the process is stable or is drifting out of control or actually is out of control before part quality is adversely affected. It is expected that such process monitoring will be of value in maintaining process stability and in bringing a process back into control.

The responsible outside supplier or Company plant or division shall consider requirements for each individual part and decide whether the minimum requirements of this general Standard is adequate or whether they should prepare a more specific or detailed local process control standard for the individual part.

Exceptions to this Standard and alternative plans for control of heat treating processes may be used provided they afford adequate protection of a process currently proven to be stable and capable, and have the concurrence of the affected Ford Supplier Technical Assistant (STA) and/or Quality Planning Team and are documented in a control plan.

The objective of this Standard is to define the requirements and to encourage Best Practices which will assure a quality part as well as promoting continuous improvement relative to quality and productivity.

The principal concerns which are addressed by this Standard include:

. The heat treater must know the specification(s) to which the parts are to be heat treated.

. The processes used to heat treat the parts must be clearly defined.

. All parts must be heat treated to the defined process and specification.

. Monitoring of the process through the use of an approved control plan must be such to assure that the process is in control and is being improved in order to minimize variability as well as minimize the risk of out of specification parts.

. Incoming materials shall be specified and controlled in such a manner to assure a product which can be heat treated with minimum part variability.

1.2 SPECIFICATION OF REQUIREMENTS: The heat treater shall have an Engineering Drawing or a written specification listing the engineering requirements (e.g., incoming material, case depth, surface hardness, core hardness, etc.) of Ford parts processed.

1.3 PROCESS SPECIFICATION: The supplier shall establish a written process specification (complete with a control plan) for all processes used to heat treat parts supplied directly or indirectly to the Ford Motor Company. The specification shall completely describe the process and the pertinent variables and specify the principal operating parameters (e.g., temperature, cycle time, Carbon potential, etc.) and their acceptable ranges as part of the program to assure that the parts meet the requirements of the Engineering Drawing.

1.4 PROCESS AND QUALITY CONTROLS: Included in this Standard are the required checks, observations, and tests (including frequencies) to be performed to assure that the product is in conformance with the in-process and Engineering Drawing requirements.

- Section 2 describes those requirements relative to Furnace Processes and Section 3 describes the same requirements for both Induction and Flame Processes.
- Sections 2.1 and 3.1 include detailed descriptions of the process monitors which are normally done by production and/or maintenance personnel, usually requiring minimal testing apparatus, and often involving visual observations of monitoring equipment.
- Sections 2.5 and 3.5 cover the laboratory controls which normally require skilled operators and involve checks and tests of a more exact nature than those controls which are considered to be process monitors.
- Sections 2.6 and 3.6 cover the tests and inspections to be performed on heat treated parts or test samples.

An operations manual including emergency, start-up, shutdown, and general operating procedures should be readily available to the production supervisors and operators. It should also include process sheets, inspection sheets, control plan, trouble shooting guide, alerts, and other pertinent information needed by operating, inspection, and maintenance personnel. Rejects and scrap must be monitored as to cause and quantity to assist in prioritizing corrective action(s).

1.5 CONTROL PLAN: A written control plan as outlined in the current Ford Quality Standard is required for parts covered by this Standard.

1.6 STATISTICAL METHODS: The heat treater must demonstrate that the equipment used for the Heat Treatment process is under control and demonstrate that the process produces parts which comply with the print specifications.

1.7 CLEANLINESS OF PARTS PRIOR TO HEAT TREAT: Parts must be clean, free of rust, burrs and chips, and free from detrimental amounts of drawing, forming and/or rust preventative oils and lubricants prior to heat treatment.

These oils and lubricants may adversely affect the carbon potential of the furnace atmosphere or may interfere with the carburising or carbonitriding or quenching of the part. (Sulfur-containing oils and lubricants may have a detrimental effect on furnace and fixture life.)

2. FURNACE PROCESSES:

2.1 PROCESS MONITORING: As used in this Standard, process monitors are the observations, checks, and tests specified by Manufacturing Engineering, Plant Engineering, the Quality activity, and/or other designated activity, to be performed by inspectors, production operators, breakdown or lightup personnel, electricians, and/or other skilled trades personnel, to assure heat treating conditions are within process specifications and that the heat treating equipment is operating properly.

The following are descriptions of the process monitors incorporated into this Standard. The process must be monitored and the data recorded. Process instructions, control plans, and/or process sheets must be located in the department and available to the responsible operators, maintenance specialists, and/or other designated individuals. Frequencies for performing certain of these Process Monitors are specified in Section 4 of this Standard.

2.1.1 INDICATED TEMPERATURE: All temperature controlling and indicating instruments on furnaces, generators, and quench systems shall be visually checked during the heat treat process for conformance to the set temperature of the process. On instruments with recording charts, the checker, at the time of the check, shall initial and date the face of the chart to verify the check or shall log in the same fashion as done with non-recording instruments. On non-recording instruments, the set temperature, indicated temperature, time, date, and checkers initials shall be recorded in a log book, data logger or other record provided for that purpose.

. In certain types of equipment, such as continuous draw furnaces, a fixed thermocouple may be inadequate to detect changes in heating pattern within the furnace chamber. A traveling thermocouple can be used to supplement fixed thermocouples by providing a thermal profile.

. The use of non-contact infrared thermometry (in addition to the conventional thermocouple) is recommended to monitor the temperature of the high heat zones of continuous furnaces.

. Continuous strip charts and/or data loggers are required for recording of temperature data. Use of such charts permit review of the temperature history of a furnace/operation over a period of time (e.g., a shift) to determine if there is unexpected/unwanted drifting or peaks/drops in temperature.

. Overtemperature and undertemperature (where applicable) controls can serve to alert the operator to gross process variations, can protect furnaces from damage and can prevent parts from being overheated. To be most effective, the overtemperature limit should not be set more than approximately 25°C (50°F) over the process set temperature.

2.1.2 STANDARDISED TEMPERATURE CONTROLLER: All instruments without built-in automatic self-compensation or constant voltage supply units must be manually checked and balanced daily against a standard. This manual standardisation shall be recorded in a log book, data logger or other record provided for that purpose.

2.1.3 TEMPERATURE MEASUREMENT DEVICES AND PROTECTION TUBES: There shall be a scheduled checking of temperature measurement devices and protection tubes on all heat treating furnaces, molten salt baths and auxiliary equipment (generators, etc.). For detailed procedures, see Section 6.0.

2.1.4 MONITOR OF THE FURNACE/GENERATOR OF CARBON BEARING ATMOSPHERE: All carbon-bearing atmospheres for use in carburising, carbonitriding, carbon correction, or neutral hardening furnaces must be controlled and monitored on a regular basis to assure conformance with the specified carbon potential. This shall be accomplished by one or more of the following methods:

. CO_2 Content
. Oxygen Partial Pressure
. Electrical Resistance of an Iron Test Wire
. Complete Gas Analysis
. Carbon Potential
. Dew Point (Not acceptable for parts designated as Control Items (∇)

at the frequency specified in Section 4 of this Standard.

The accuracy of instruments must be verified at a frequency sufficient to demonstrate control. The date and time of the verification shall be logged in an appropriate record.

For the processing of parts designated as Control Items (∇) using reactive carbon-bearing atmospheres, correlation must be determined and demonstrated between the control variable and the actual carbon potential of the furnace atmosphere.

For the processing of parts not designated as Control Items (∇), a periodic check should be used to verify that the routine monitor is providing accurate results.

Such correlation shall be initially determined and periodically verified by measurement of carbon potential using shim stock, carbon gradient bars, or other standard techniques, as identified in the control plan. The date and time of the verification shall be logged in an appropriate record. Correlation checks include the following:

- Carbon Gradient Check: The carbon gradient of the heat treating atmosphere and process shall be checked by the method described in Ford Laboratory Method AA 101-4 or equivalent. The test bars shall be processed concurrent with production parts to determine the carbon gradient. Normally this check is used with processes developing total case depths in excess of 0.4 mm (0.015 in).

- Carbon Shim Stock: The carbon potential of the heat treating atmosphere can be checked by the method described in Ford Laboratory Test Method AA 101-3 or equivalent. Test pieces shall be located in the furnace zone to be checked while production parts are being processed. If there is no diffusion cycle utilizing a different carbon potential, the test pieces may be processed with parts through the entire furnace cycle.

On atmosphere generators utilising a refrigerator, the refrigerator temperature must be monitored.

A program of routine furnace/generator burnouts must be employed, especially when a unit is used for carburising or carbonitriding.

NOTE: In some instances, the specified control system may not be applicable to a particular furnace or gas generator. It is the heat treater's responsibility to verify that the specified control will be effective with the unit in question. When equipment design prevents the monitoring of important properties (such as atmosphere quality) as specified, an alternative method may be used provided it affords equal protection and is included in the control plan which has been reviewed by the responsible Ford Supplier Technical Assistance (STA) Office and/or Quality Planning Team.

Furnace conditions must be checked to assure positive internal furnace pressure, to determine presence of air and gas leaks and to verify the condition of radiant tubes relative to burn throughs and cracks. (The internal furnace pressure can be verified by manometer or by visual confirmation in the instance of open retort or rotary retort furnaces.)

2.1.5 ATMOSPHERE FLOW RATE: All flowmeters shall be monitored for proper flow (as per the process specification) and the readings recorded.

2.1.6 ATMOSPHERE PURGING: When the process for which a furnace is being used is to be changed (for example: carburising to neutral hardening) the correct furnace atmosphere required for the new process must be fully developed within the furnace and confirmed by O_2 analyzer, gas analysis, CO_2, or resistance wire before production to the new process can be started.

To assure the atmosphere is free from ammonia, there shall be an adequate purge period after using an ammonia atmosphere before a Ford order not specifying ammonia enrichment of the atmosphere may be processed.

When changing over a furnace from one utilizing ammonia to one in which no ammonia is to be used, the ammonia supply line must be completely disconnected from the furnace and the open ends capped, to avoid any possibility of shut-off valve leakage. An alternative method utilizing a valve arrangement which will vent any ammonia from a leaking valve to the air rather than to the furnace may be employed. Record action in a log book, data logger or other record. Where applicable, quick disconnective couplings designed for use with ammonia may be utilized.

2.1.7 MONITOR OF AN AMMONIA ENRICHED ATMOSPHERE: All ammonia enriched atmosphere furnaces must be controlled and monitored on a regular basis to assure conformance with the specific dissociation rates through an analysis of percent dissociation. The date and time of the verification shall be logged in an appropriate record, along with any necessary corrective actions.

2.1.8 MONITOR OF THE SALT BATH: All salt bath equipment must be controlled and monitored on a regular basis including the temperature-control system, exhaust smoke from the combustion chamber of fuel-fired furnaces, and bath activity through a rapid performance test. The date and time of the verifications shall be logged in an appropriate record, along with any additions of fresh salt, water, and graphite cover material.

2.2 CONDITION OF QUENCH:

2.2.1 WATER-SOLUBLE POLYMER QUENCHANT: The quench system shall be checked to assure that quenchant temperature, concentration, suspended solids, pressure, and agitation adhere to the process specification and the checks recorded.

2.2.2 WATER QUENCHANT: The quench system shall be checked to assure that quenchant temperature, suspended solids, pressure, and agitation adhere to the process specification and the checks recorded.

2.2.3 SOLUBLE OIL: The quench system shall be checked to assure that quenchant temperature, concentration, suspended solids, pressure, and agitation adhere to the process specification and the checks recorded.

2.2.4 OIL: The quench system shall be checked to assure that quenchant temperature, agitation, and visual condition of the oil adhere to the process specification and the checks recorded.

Flash and fire point checks of the quench oil are recommended to safeguard against possible contamination or dilution which could create a fire hazard.

2.2.5 SALT BATH: Molten salt systems shall be checked to assure that agitation (if specified), time parts are in the salt (in the instance of martemper and austemper operations), and salt temperature adhere to the process specification and the checks recorded.

2.2.6 BRINE AND CAUSTIC: Brine and caustic quench systems shall be checked to assure that agitation, quench temperature, and specific gravity adhere to the process specification and the checks recorded.

The time and temperature that parts are to remain in the quench media must be specified, monitored and logged.

CAUTION: Special attention must be given to assure that the quenchant is used within the appropriate temperature and concentration ranges that are compatible with the part/material being heat treated. Quenching characteristics of some quenchants can change significantly with relatively minor changes in temperature or concentration.

NOTE: Records of quench condition shall be recorded in a log book, data logger, or other record provided for that purpose.

NOTE: The listing of the minimum level of controls for the various quenchants shall not imply approval of a given quenchant for every part which is specified to be heat treated.

NOTE: A high and low temperature limit is required on quench systems.

NOTE: Any additions to the quench system must be recorded in a log book, data logger or other record provided for that purpose.

2.3 LOADING RATE AND CYCLE TIME: Furnace loading rate/cycle time shall be specified and monitored to assure thorough and uniform heating, correct time at temperature, uniform exposure to atmosphere gas, and uniform quenching of the load. The loading rates/cycle time as well as the time and date of the check and the checkers initials shall be recorded in a log book, data logger or other record provided for that purpose.

. A method such as event recorders which provide a record of furnace pushes or cycles must be used to indicate problems with delays in pushes or quenching, thereby alerting responsible personnel to possibly defective loads.

On batch furnaces in which the load is not automatically quenched, there shall be a timer and a warning system to alert the operator that it is time to quench the load.

On furnaces which have an integral quench system, there shall be a signal to alert the operator that a load or tray has been delayed between the furnace chamber and the quench media.

A maximum delay time between the quench and temper operations shall be specified and monitored in the control plan. Record action in a log book, data logger, or other record.

2.4 MATERIAL CONTROL: All production material must be carefully identified and controlled to assure that all process steps are carried out in the correct sequence, that no operations are missed and that similar parts or heat treated and non-heat treated parts are not mixed.

All containers used for transfer and/or transportation must be identified with part number and status (i.e., OK, reject, hold, etc. or as specified in plant procedures).

A program MUST be utilized in preventing shipment of rejected stock (or stock that is held for disposition). This may involve use of a locked crib for the quarantine of parts. Rejects and scrap must be monitored as to cause and quantity to assist in prioritizing corrective action(s). A written record must be provided as to stock disposition, through a log book, showing stock movement with disposition noted.

Containers with heat treated parts shall not be placed in such proximity to containers with non-heat treated parts that entire tubs may miss heat treatment or be double heat treated.

Close control of tubs/containers which are used to hold both non-heat treated as well as heat treated stock is necessary to minimize the risk that a few parts may be left in the container thereby missing heat treat or being heat treated twice.

Material from different steel mill heats or metals which require different austenitizing, quenching, or tempering times and/or temperatures SHALL NOT BE MIXED OR PROCESSED TOGETHER to ensure that a given lot is processed as necessary to attain the specified metallurgical properties.

2.5 LABORATORY CONTROLS: As used in this Standard, laboratory controls are the checks or tests of a more complex nature, generally specified by the Quality activity and usually performed by laboratory or quality activity personnel, to determine operating conditions and necessary corrections to maintain or achieve specified operation conditions. These tests and checks generally require specific test equipment (such as carbon potential and gradient, gas atmosphere analysis, etc.) and skilled operators.

For those laboratory controls performed within the heat treat department, appropriate testing instructions must be located in the area and must be available to the responsible individuals. Refer to Section 4 of this Standard for the required frequency of each laboratory control item.

2.5.1 CONCENTRATION OF WATER-SOLUBLE POLYMER QUENCHANTS: Polymer quenchant systems should be checked for concentration and suspended solids and the results recorded. The use of statistical control charts is recommended.

2.5.2 CLEANLINESS OF WATER QUENCH SYSTEMS: The system shall be checked for suspended solids and the results logged. Any additives shall be monitored and the results recorded to preclude build-up to levels which may adversely affect the quenching properties of the water.

2.5.3 SOLUBLE OIL QUENCHANTS: Soluble oil quenchant systems should be checked for concentration and suspended solids and the results recorded. The use of statistical control charts is recommended only for concentration.

2.5.4 CONDITION OF QUENCH OIL: Quench oil systems shall be checked to determine their suitability for continued service. Check the oil for water content, viscosity, and amount of suspended solids formed from oxidation and contamination. Quenchability checks using a quenchometer or a hot wire test may be substituted for the suspended solids and viscosity checks. The results shall be recorded in a log book, data logger or comparable record.

Flash and fire point checks of the quench oil are recommended to safeguard against possible contamination or dilution which could create a fire hazard.

2.5.5 SALT BATH ANALYSIS AND CONTAMINANTS: The salt baths shall be checked for proper analysis (i.e. contaminants, melting point, etc.) and for any contaminants which may adversely affect bath performance in accordance with the applicable specification. The results shall be recorded in a log book or comparable record.

2.5.6 BRINE AND CAUSTIC QUENCH SOLUTIONS: Brine and caustic quench solutions shall be checked for concentration and suspended solids and the data logged. Recording of concentration levels on statistical control charts is recommended for concentration and/or specific gravity.

2.6 IN-PROCESS TESTS: As used in this Standard, in-process tests are tests and inspections performed on heat treated parts or test samples to evaluate the output of a heat treating process.

The following are descriptions of the in-process tests incorporated into this Standard. The in-process tests must be performed and the data recorded. Inspection and test instruction sheets for these controls shall be located in the heat treat department or laboratory as appropriate and available to the responsible individuals. Refer to Section 4 of this Standard for the frequency and sample size for each in-process test.

2.6.1 MICROSTRUCTURE: Samples of heat treated parts shall be examined under high magnification to assure that the microstructure conforms to Engineering Drawing and/or process requirements. The minimum magnification shall be 100X.

Visual standards in the form of photomicrographs are required for use as an aid in examining microstructures. Record results on a laboratory report or other record system.

2.6.2 HARDNESS: Checks shall be performed on parts after heat treating to assure conformance to Engineering Drawing or in-process specification requirements and the results logged. The heat treater shall maintain average and range or other statistical charts as appropriate for hardness to detect trends in the process and to serve as a quality record. File, Rockwell, or Brinell tests will be used as indicated on the Engineering Drawing. Accuracy of hardness testing machines must be checked at least daily by use of a standard block in the range of hardnesses being produced and the quality record noted to that effect.

Hardness test equipment shall be cleaned and calibrated at least annually.

The hardness scale specified on the Engineering Drawing shall be used unless the affected Product Engineering Office permits the use of an alternative hardness scale and the change is noted in the control plan. Surface hardness testing with files (refer to SAE J864), where an indentation hardness test is not specified and/or for purposes of corroboration, shall only be used if authorized by the affected Ford Supplier Technical Assistance (STA) and/or Quality Planning Team.

When tempering is done immediately after the quenching operation, the testing may be done after tempering rather than after both quenching and tempering.

2.6.3 CASE DEPTH: Checks shall be made for proper case depth as specified by the Engineering Drawing or in-process specification and the results logged. Case depth may be checked on production parts or may be made on representative test bars provided correlation to production parts has been established. Case depth records shall be maintained on average-range or other statistical charts as appropriate to detect trends in the process and to serve as a quality record. Case depth shall be checked as total or effective case depth as required by the Engineering Drawing or specification.

3. INDUCTION AND FLAME PROCESSES:

3.1 PROCESS MONITORING: As used in this Standard, process monitors are the observations, checks, and tests specified by Manufacturing Engineering, Plant Engineering, the Quality activity, and/or other designated activity, to be performed by the inspectors, production operators, electricians, and/or other skilled trades personnel, to assure heat treating conditions are within process specifications and that the heat treating equipment is operating properly. These checks and tests are usually performed with minimal testing apparatus and are frequently, visual observations.

The following are descriptions of the process monitors incorporated into this Standard. The process must be monitored and the data recorded. Process instructions, control plans, and/or process sheets must be located in the department and available to the responsible operators, maintenance specialists, and/or other designated individuals. Frequencies for performing certain of these Process Monitors are specified in Section 5 of this Standard.

3.1.1 HEATING PARAMETERS: All temperature controlling (ref. temperature indication materials, optical pyrometers, etc.) and indicating instruments (ref. energy monitors, kilowatt meters, timers, etc.) on induction units shall be visually checked during the heat treat process for conformance. On instruments with recording charts, the checker, at the time of the check, shall initial and date the face of the chart to verify the check or shall log in the same fashion as done with non-recording instruments. On non-recording instruments, the set temperature, indicated temperature, time, date, and checkers initials shall be recorded in a log book, data logger or record provided for that purpose.

3.1.2 ATMOSPHERE FLOW RATE: Flow rates/pressures of the gases (e.g., acetylene, propane, methylacetylene propadiene, methane, and oxygen) used in hardening shall be monitored and the readings recorded. The oxygen-to-fuel ratio shall also be monitored and recorded.

3.2 CONDITION OF QUENCH:

3.2.1 WATER-SOLUBLE POLYMER QUENCHANT: The quench system shall be checked to assure that quenchant temperature, concentration, suspended solids, pressure, and flow rate and pattern adhere to the process specification and the checks recorded.

3.2.2 WATER QUENCHANT: The quench system shall be checked to assure that quenchant temperature, suspended solids, pressure, and flow rate and pattern adhere to the process specification and the checks recorded.

3.2.3 SOLUBLE OIL: The quench system shall be checked to assure that quenchant temperature, concentration, suspended solids, pressure, and flow rate and pattern adhere to the process specification and the checks recorded.

3.2.4 OIL: The quench system shall be checked to assure that quenchant temperature, agitation, and visual condition of the oil adhere to the process specification and the checks recorded.

Flash and fire point checks of the quench oil are recommended to safeguard against possible contamination or dilution which could create a fire hazard.

CAUTION: Special attention must be given to assure that the quenchant is used within the appropriate temperature and concentration ranges that are compatible with the part/material being heat treated. Quenching characteristics of some quenchants can change significantly with relatively minor changes in temperature or concentration.

NOTE: Records of quench condition shall be recorded in a log book, data logger, or other record provided for that purpose.

NOTE: The listing of the minimum level of controls for the various quenchants shall not imply approval of a given quenchant for every part which is specified to be heat treated.

NOTE: A high and low temperature limit is required on quench systems.

NOTE: Any additions to the quench system must be recorded in a log book, data logger, or other record provided for that purpose.

3.3 LOADING RATE AND CYCLE PARAMETERS: Induction operations and flame processing operations (hardening, tempering, and annealing) shall have a specified loading rate and/or heating time and/or energy input, quench time, and delay time (between heating and quenching, if applicable) which are to be monitored where applicable. Energy monitors must be verified daily for proper operation, and the results logged. These parameters shall be checked and the results appropriately logged along with the time and date of the check and the checker's initials.

A maximum delay time between the quench and temper operations shall be specified and monitored in the control plan, where applicable. Record action in a log book, data logger or other record.

3.4 MATERIAL CONTROL: All production material must be carefully identified and controlled to assure that all process steps are carried out in the correct sequence, that no operations are missed and that similar parts or heat treated and non-heat treated parts are not mixed.

All containers used for transfer and/or transportation must be identified with part number and status (i.e., OK, reject, hold, etc. or as specified in plant procedures).

A program MUST be utilized in preventing shipment of rejected stock (or stock that is held for disposition). This may involve use of a locked crib for the quarantine of parts. Rejects and scrap must be monitored as to cause and quantity to assist in prioritizing corrective action(s). A written record must be provided as to stock disposition, through a log book, showing stock movement with disposition noted.

Containers with heat treated parts shall not be placed in such proximity to containers with non-heat treated parts that entire tubs may miss heat treatment or be double heat treated.

Close control of tubs/containers which are used to hold both non-heat treated as well as heat treated stock is necessary to minimize the risk that a few parts may be left in the container thereby missing heat treat or being heat treated twice.

Material from different steel mill heats or metals which require different austenitizing, quenching, or tempering times and/or temperatures SHALL NOT BE MIXED OR PROCESSED TOGETHER to ensure that a given lot is processed as necessary to attain the specified metallurgical properties.

3.5 LABORATORY CONTROLS: As used in this Standard, laboratory controls are the checks or tests of a more complex nature, generally specified by the Quality activity and usually performed by laboratory or quality activity personnel, to determine operating conditions and necessary corrections to maintain or achieve specified operation conditions.

For those laboratory controls performed within the heat treat department, appropriate testing instructions must be located in the area and must be available to the responsible individuals. Refer to Section 5 of this Standard for the required frequency of each laboratory control item.

3.5.1 CONCENTRATION OF WATER-SOLUBLE POLYMER QUENCHANTS: Polymer quenchant systems should be checked for concentration and suspended solids and the results recorded. The use of statistical control charts is recommended.

3.5.2 CLEANLINESS OF WATER QUENCH SYSTEMS: The system shall be checked for suspended solids and the results logged. Any additives shall be monitored and the results recorded to preclude build-up to levels which may adversely affect the quenching properties of the water.

3.5.3 SOLUBLE OIL QUENCHANTS: Soluble oil quenchant systems should be checked for concentration and suspended solids and the results recorded. The use of statistical control charts is recommended only for concentration.

3.5.4 CONDITION OF QUENCH OIL: Quench oil systems shall be checked to determine their suitability for continued service. Check the oil for water content, viscosity, and amount of suspended solids formed from oxidation and contamination. Quenchability checks using a quenchometer or a hot wire test may be substituted for the suspended solids and viscosity checks. The results shall be recorded in a log book, data logger or comparable record.

Flash and fire point checks of the quench oil are recommended to safeguard against possible contamination or dilution which could create a fire hazard.

3.6 IN-PROCESS TESTS: As used in this Standard, in-process tests are tests and inspections performed on heat treated parts or test samples to evaluate the output of a heat treating process.

The following are descriptions of the in-process tests incorporated into this Standard. The in-process tests must be performed and the data recorded. Inspection and test instruction sheets for these controls shall be located in the heat treat department or laboratory as appropriate and available to the responsible individuals. Refer to Section 5 of this Standard for the frequency and sample size for each in-process test.

3.6.1 MICROSTRUCTURE: Samples of heat treated parts shall be examined under high magnification to assure that the microstructure conforms to Engineering Drawing and/or process requirements. The minimum magnification shall be 100X.

Visual standards in the form of photomicrographs are required for use as an aid in examining microstructures. Record results on a laboratory report or other record system.

3.6.2 HARDNESS: Checks shall be performed on parts after heat treating to assure conformance to Engineering Drawing or in-process specification requirements and the results logged. The heat treater shall maintain average and range or other statistical charts as appropriate for hardness to detect trends in the process and to serve as a quality record. File, Rockwell, or Brinell tests will be used as indicated on the Engineering Drawing. Accuracy of hardness testing machines must be checked at least daily, by use of a standard block in the range of hardnesses being produced and the quality record noted to that effect.

Hardness test equipment shall be cleaned and calibrated at least annually.

The hardness scale specified on the Engineering Drawing shall be used unless the affected Product Engineering Office permits the use of an alternative hardness scale and the change is noted in the control plan. Surface hardness testing with files (refer to SAE J864), where an indentation hardness test is not specified and/or for purposes of corroboration, shall only be used if authorized by the affected Ford Supplier Technical Assistance (STA) and/or Quality Planning Team.

When tempering is done immediately after the quenching operation, the testing may be done after tempering rather than after both quenching and tempering.

3.6.3 CASE DEPTH: Checks shall be made for proper case depth as specified by the Engineering Drawing or in-process specification and the results logged. Case depth must be checked on production parts. Case depth records shall be maintained on average-range or other statistical charts as appropriate to detect trends in the process and to serve as a quality record.

3.6.4 INDUCTION/FLAME PATTERN: The surface and cross-sectional pattern shall be checked as required by the Engineering Drawing or in-process specification.

4. FREQUENCIES FOR PROCESS MONITORS, LABORATORY CONTROLS, AND IN-PROCESS TESTS FOR FURNACE PROCESSES:

ACTUAL FREQUENCIES WILL BE DEVELOPED BY PROCESS DATA AND BECOME PART OF THE CONTROL PLAN.

	Carburising/Carbonitriding Carbon Correction	
	Batch	Continuous
PROCESS MONITOR TEST FREQUENCIES:		
Check indicated temperature (Par. 2.1.1)	Every 2 hrs & after any change	Every 2 hrs & after any change
Monitor of furnace atmosphere (Par. 2.1.4, 2.1.5, 2.1.6)	Each batch & after any change	Twice/shift & after any change
. Dew Point (only for non-Control Item parts), CO_2, Carbon Potential, etc.		
. Flow Rate		
Check condition of quench media (Section 2.2)	Each shift	Each shift
. Temperature, Agitation, Visual Condition, Time, etc.		
Check time in furnace, cycle time or belt speed (Par. 2.3)	Each batch	Twice/shift & after any change
Check load size or loading rate (Par. 2.3)	Each batch	Twice/shift & after any change
LABORATORY CONTROL TEST FREQUENCIES:		
Quench Media (Section 2.5)		
. Polymer Quenchants (Par. 2.5.1)		
Concentration	Daily	Daily
Suspended solids	Semiannual	Semiannual
. Water (Par. 2.5.2)		
Suspended solids	Semiannual	Semiannual
. Soluble oil (Par. 2.5.3)		
Concentration	Daily	Daily
Suspended solids	Semiannual	Semiannual
. Oil (Par. 2.5.4)		
Water content, suspended solids, viscosity and quenchability	Semiannual	Semiannual
. Flash and Fire Points	Semiannual	Semiannual
. Salt (Par. 2.5.5)		
Analysis & Contaminants	Semiannual	Semiannual
. Brine or Caustic (Par. 2.5.6)		
Concentration and/or Specific Gravity	Daily	Daily
Suspended solids	Semiannual	Semiannual
IN-PROCESS TEST FREQUENCIES:		
Microstructure (Par. 2.6.1)	Monthly	Monthly
Surface hardness (Par. 2.6.2)	Each batch	Twice/shift
Core hardness (Par. 2.6.2)	Each batch/WS	Twice/shift/WS
Case depth (Par. 2.6.3)	Each batch	Twice/shift

	Neutral Hardening-Atmosphere	
	Batch	Continuous
PROCESS MONITOR TEST FREQUENCIES:		
Check indicated temperature (Par. 2.1.1)	Every 2 hrs & after any change	Every 2 hrs & after any change
Monitor of furnace atmosphere (Par. 2.1.4, 2.1.5, 2.1.6)	Each batch & after any change	Twice/shift & after any change
. Dew point (only for non-Control Item parts), CO_2, Carbon Potential, etc.		
. Flow Rate		
Check condition of quench media (Section 2.2)	Each shift	Each shift
. Temperature, Agitation, Visual Condition, Time, etc.		
Check time in furnace, cycle time or belt speed (Par. 2.3)	Each batch	Twice/shift & after any change
Check load size or loading rate (Par. 2.3)	Each batch	Twice/shift & after any change
LABORATORY CONTROL TEST FREQUENCIES:		
Quench Media (Section 2.5)		
. Polymer Quenchants (Par. 2.5.1)		
Concentration	Daily	Daily
Suspended solids	Semiannual	Semiannual
. Water (Par. 2.5.2)		
Suspended solids	N/A	N/A
. Soluble oil (Par. 2.5.3)		
Concentration	Daily	Daily
Suspended solids	Semiannual	Semiannual
. Oil (Par. 2.5.4)		
Water content, suspended solids, viscosity and quenchability	Semiannual	Semiannual
. Flash and Fire Points	Semiannual	Semiannual
. Salt (Par. 2.5.5)		
Analysis & Contaminants	Semiannual	Semiannual
. Brine or Caustic (Par. 2.5.6)		
Concentration and/or Specific Gravity	Daily	Daily
Suspended solids	Semiannual	Semiannual
IN-PROCESS TEST FREQUENCIES:		
Microstructure (Par. 2.6.1)	Monthly	Monthly
Surface hardness (Par. 2.6.2)	Each batch	Twice/shift
Core hardness (Par. 2.6.2)	Each batch/WS	Twice/shift/WS
Case depth (Par. 2.6.3)	Each batch/WS	Twice/shift/WS

	Tempering & Stress Relieving	
	Batch	Continuous
PROCESS MONITOR TEST FREQUENCIES:		
Check indicated temperature (Par. 2.1.1)	Every 2 hrs & after any change	Every 2 hrs & after any change
Monitor of furnace atmosphere (Par. 2.1.4, 2.1.5, 2.1.6)	N/A	N/A
. Dew point(only for non-Control Item parts), CO_2, Carbon Potential, etc.		
. Flow Rate		
Check condition of quench media (Section 2.2)	N/A	N/A
. Temperature, Agitation, Visual Condition, Time, etc.		
Check time in furnace, cycle time or belt speed (Par. 2.3)	Each batch	Twice/shift & after any change
Check load size or loading rate (Par. 2.3)	Each batch	Twice/shift & after any change
LABORATORY CONTROL TEST FREQUENCIES:		
Quench Media (Section 2.5)		
. Polymer Quenchants (Par. 2.5.1)		
Concentration	N/A	N/A
Suspended solids	N/A	N/A
. Water (Par. 2.5.2)		
Suspended solids	N/A	N/A
. Soluble oil (Par. 2.5.3)		
Concentration	N/A	N/A
Suspended solids	N/A	N/A
. Oil (Par. 2.5.4)		
Water content, suspended solids, viscosity and quenchability	N/A	N/A
. Fire and Flash Points	N/A	N/A
. Salt (Par. 2.5.5)		
Analysis & Contaminants	N/A	N/A
. Brine or Caustic (Par. 2.5.6)		
Concentration and/or Specific Gravity	N/A	N/A
Suspended solids	N/A	N/A
IN-PROCESS TEST FREQUENCIES:		
Microstructure (Par. 2.6.1)	Monthly	Monthly
Surface hardness (Par. 2.6.2)	Each batch/WS	Twice/shift/WS
Core hardness (Par. 2.6.2)	Each batch/WS	Twice/shift/WS
Case depth (Par. 2.6.3)	Each batch/WS	Twice/shift/WS

	Nitriding/Nitrocarburising	
	Batch	Continuous
PROCESS MONITOR TEST FREQUENCIES:		
Check indicated temperature (Par. 2.1.1)	Every 2 hrs & after any change	Every 2 hrs & after any change
Monitor of nitrogen enriched atmosphere (Par. 2.1.7)	Each batch & after any change	Twice/shift & after any change
. Percent dissociation		
Check condition of quench media (Section 2.2)	N/A	N/A
. Temperature, Agitation, Visual Condition, Time, etc.		
Check time in furnace, cycle time or belt speed (Par. 2.3)	Each batch	Twice/shift & after any change
Check load size or loading rate (Par. 2.3)	Each batch	Twice/shift & after any change
LABORATORY CONTROL TEST FREQUENCIES:		
Quench Media (Section 2.5)		
. Polymer Quenchants (Par. 2.5.1)		
Concentration	N/A	N/A
Suspended solids	N/A	N/A
. Water (Par. 2.5.2)		
Suspended solids	N/A	N/A
. Soluble oil (Par. 2.5.3)		
Concentration	N/A	N/A
Suspended solids	N/A	N/A
. Oil (Par. 2.5.4)		
Water content, suspended solids, viscosity and quenchability	N/A	N/A
. Fire and Flash Points	N/A	N/A
. Salt (Par. 2.5.5)		
Analysis & Contaminants	N/A	N/A
. Brine or Caustic (Par. 2.5.6)		
Concentration and/or Specific Gravity	N/A	N/A
Suspended solids	N/A	N/A
IN-PROCESS TEST FREQUENCIES:		
Microstructure (Par. 2.6.1)	Monthly	Monthly
Surface hardness (Par. 2.6.2)	Each batch	Twice/shift
Core hardness (Par. 2.6.2)	Each batch/WS	Twice/shift/WS
Case depth (Par. 2.6.3)	Each batch	Twice/shift

	Annealing/Normalising	
	Batch	Continuous
PROCESS MONITOR TEST FREQUENCIES:		
Check indicated temperature (Par. 2.1.1)	Every 2 hrs & after any change	Every 2 hrs & after any change
Monitor of furnace atmosphere (Par. 2.1.4, 2.1.5, 2.1.6)	Each batch & after any	Twice/shift & after any
. Dew point (only for non-Control Item parts), CO_2, Carbon Potential, etc.	change/WA	change/WA
. Flow Rate		
Check condition of quench media (Section 2.2)	N/A	N/A
. Temperature, Agitation, Visual Condition, Time, etc.		
Check time in furnace, cycle time or belt speed (Par. 2.3)	Each batch	Twice/shift & after any change
Check load size or loading rate (Par. 2.3)	Each batch	Twice/shift & after any change
LABORATORY CONTROL TEST FREQUENCIES:		
Quench Media (Section 2.5)		
. Polymer Quenchants (Par. 2.5.1)		
Concentration	N/A	N/A
Suspended solids	N/A	N/A
. Water (Par. 2.5.2)		
Suspended solids	N/A	N/A
. Soluble oil (Par. 2.5.3)		
Concentration	N/A	N/A
Suspended solids	N/A	N/A
. Oil (Par. 2.5.4)		
Water content, suspended solids, viscosity and quenchability	N/A	N/A
. Fire and Flash Points	N/A	N/A
. Salt (Par. 2.5.5)		
Analysis & Contaminants	N/A	N/A
. Brine or Caustic (Par 2.5.6)		
Concentration and/or Specific Gravity	N/A	N/A
Suspended solids	N/A	N/A
IN-PROCESS TEST FREQUENCIES:		
Microstructure (Par. 2.6.1)	Monthly	Monthly
Surface hardness (Par. 2.6.2)	Each batch/WS	Twice/shift/WS
Core hardness (Par. 2.6.2)	Each batch/WS	Twice/shift/WS
Case depth (Par. 2.6.3)	N/A	N/A

	Aluminum Alloy Castings Solution Heat Treating/Age Hardening	
	Batch	Continuous
PROCESS MONITOR TEST FREQUENCIES:		
Check indicated temperature (Par. 2.1.1)	Every 2 hrs & after any change	Every 2 hrs & after any change
Monitor of furnace atmosphere (Par. 2.1.4, 2.1.5, 2.1.6)	Each batch & after any change	Twice/shift & after any change
. Dew Point (only for non-Control Item parts), CO_2, Carbon Potential, etc.		
. Flow Rate		
Check condition of quench media (Section 2.2)	Each shift/WA	Each shift/WA
. Temperature, Agitation, Visual Condition, Time, etc.		
Check time in furnace, cycle time or belt speed (Par. 2.3)	Each batch	Twice/shift & after any change
Check load size or loading rate (Par. 2.3)	Each batch	Twice/shift & after any change
LABORATORY CONTROL TEST FREQUENCIES:		
Quench Media (Section 2.5)		
. Polymer Quenchants (Par. 2.5.1)		
Concentration	Daily/WA	Daily/WA
Suspended solids	Semiannual/WA	Semiannual/WA
. Water (Par. 2.5.2)		
Suspended solids	Semiannual/WA	Semiannual/WA
. Soluble oil (Par. 2.5.3)		
Concentration	N/A	N/A
Suspended solids	N/A	N/A
. Oil (Par. 2.5.4)		
Water content, suspended solids, viscosity and quenchability	N/A	N/A
. Flash and Fire Points	Semiannual/WA	Semiannual/WA
. Salt (Par. 2.5.5)		
Analysis & Contaminants	N/A	N/A
. Brine or Caustic (Par. 2.5.6)		
Concentration and/or Specific Gravity	N/A	N/A
Suspended solids	N/A	N/A
IN-PROCESS TEST FREQUENCIES:		
Microstructure (Par. 2.6.1)	Monthly	Monthly
Surface hardness (Par. 2.6.2)	Each batch	Twice/shift
Core hardness (Par. 2.6.2)	Each batch/WS	Twice/shift/WS
Case depth (Par. 2.6.3)	N/A	N/A

	Brazing/Sintering	
	Batch	Continuous
PROCESS MONITOR TEST FREQUENCIES:		
Check indicated temperature (Par. 2.1.1)	Every 2 hrs & after any change	Every 2 hrs & after any change
Monitor of furnace atmosphere (Par. 2.1.4, 2.1.5, 2.1.6)	Each batch & after any	Twice/shift & after any
. Dew point (only for non-Control Item parts), CO_2, Carbon Potential,etc.	change/WA	change/WA
. Flow Rate		
Check condition of quench media (Section 2.2)	N/A	N/A
. Temperature, Agitation, Visual Condition, Time, etc.		
Check time in furnace, cycle time or belt speed (Par. 2.3)	Each batch	Twice/shift & after any change
Check load size or loading rate (Par. 2.3)	Each batch	Twice/shift & after any change
LABORATORY CONTROL TEST FREQUENCIES:		
Quench Media (Section 2.5)		
. Polymer Quenchants (Par. 2.5.1)		
Concentration	Daily/WA	Daily/WA
Suspended solids	Semiannual/WA	Semiannual/WA
. Water (Par. 2.5.2)		
Suspended solids	Semiannual/WA	Semiannual/WA
. Soluble oil (Par. 2.5.3)		
Concentration	Daily/WA	Daily/WA
Suspended solids	Semiannual/WA	Semiannual/WA
. Oil (Par. 2.5.4)		
Water content, suspended solids, viscosity and quenchability	Semiannual/WA	Semiannual/WA
. Fire and Flash Points	Semiannual/WA	Semiannual/WA
. Salt (Par. 2.5.5)		
Analysis & Contaminants	Semiannual/WA	Semiannual/WA
. Brine or Caustic (Par. 2.5.6)		
Concentration and/or Specific Gravity	Daily/WA	Daily/WA
Suspended solids	Semiannual/WA	Semiannual/WA
IN-PROCESS TEST FREQUENCIES:		
Microstructure (Par. 2.6.1)	Monthly/WA	Monthly/WA
Surface hardness (Par. 2.6.2)	Each batch/WS	Twice/shift/WS
Core hardness (Par. 2.6.2)	Each batch/WS	Twice/shift/WS
Case depth (Par. 2.6.3)	N/A	N/A

	Salt Bath Heat Treating Batch
PROCESS MONITOR TEST FREQUENCIES:	
Check indicated temperature (Par. 2.1.1)	Every 2 hrs & after any change
Monitor of salt bath (Par. 2.1.8)	Every batch &
. Bath activity, exhaust smoke analysis, etc.	after any change
Check condition of quench media (Section 2.2)	Each shift
. Temperature, Agitation, Visual Condition, Time, etc	
Check time in furnace, cycle time or belt speed (Par. 2.3)	Each batch
Check load size or loading rate (Par. 2.3)	Each batch
LABORATORY CONTROL TEST FREQUENCIES:	
Quench Media (Section 2.5)	
. Polymer Quenchants (Par. 2.5.1)	
Concentration	Daily/WA
Suspended solids	Semiannual/WA
. Water (Par. 2.5.2)	
Suspended solids	Semiannual/WA
. Soluble oil (Par. 2.5.3)	
Concentration	Daily/WA
Suspended solids	Semiannual/WA
. Oil (Par. 2.5.4)	
Water content, suspended solids, viscosity and quenchability	Semiannual/WA
. Flash and Fire Points	Semiannual/WA
. Salt (Par. 2.5.5)	
Analysis & Contaminants	Semiannual/WA
. Brine or Caustic (Par. 2.5.6)	
Concentration and/or Specific Gravity	Daily/WA
Suspended solids	Semiannual/WA
IN-PROCESS TEST FREQUENCIES:	
Microstructure (Par. 2.6.1)	Monthly
Surface hardness (Par. 2.6.2)	Each batch/WS
Core hardness (Par. 2.6.2)	Each batch/WS
Case depth (Par. 2.6.3)	Each batch/WS

N/A - Not Applicable
WA - When Applicable
WS - When Specified

5. FREQUENCIES FOR PROCESS MONITORS, LABORATORY CONTROLS, AND IN-PROCESS TESTS FOR INDUCTION AND FLAME PROCESSES:

ACTUAL FREQUENCIES WILL BE DEVELOPED BY PROCESS DATA AND BECOME PART OF THE CONTROL PLAN.

	Induction and Flame Operations Hardening/Tempering/Annealing
PROCESS MONITOR TEST FREQUENCIES:	
Check heating parameters (Par. 3.1.1)	Twice/shift & after any change
Monitor of atmosphere (Par. 3.1.2)	Each shift & after any change/WA
Check condition of quench media (Section 3.2)	Each shift & after any change
Energy Monitor Verification	Each shift & after any change
LABORATORY CONTROL TEST FREQUENCIES:	
Quench Media (Section 3.5)	
. Polymer Quenchants (Par. 3.5.1)	
Concentration	Daily
Suspended solids	Semiannual
. Water (Par. 3.5.2)	
Suspended solids	Semiannual
. Soluble oil (Par. 3.5.3)	
Concentration	Daily
Suspended solids	Semiannual
. Oil (Par. 3.5.4)	
Water content, suspended solids, viscosity and quenchability	Semiannual
. Fire and Flash Points	Semiannual
IN-PROCESS TEST FREQUENCIES:	
Microstructure (Par. 3.6.1)	Monthly/WA
Surface Hardness(Par. 3.6.2)	Twice/shift & after any change/WS
Core Hardness (Par. 3.6.2)	Twice/shift & after any change/WS
Case depth (Par. 3.6.3)	Twice/shift & after any change/WS
Induction/Flame pattern (Par. 3.6.4)	Twice/shift & after any change/WS

N/A - Not Applicable
WA - When Applicable
WS - When Specified

6. THERMOCOUPLE, TEMPERATURE INSTRUMENTATION, AND PROTECTION TUBE CHECKING AND REPLACEMENT PROCEDURE:

6.1 GENERAL: Thermocouples which are exposed to high temperature in various environments are subject to change in their original characteristics. These changes cause erroneous temperatures to be indicated by pyrometric instruments to which the thermocouples are connected, thus causing loss of process control.

Rapid deterioration of thermocouple accuracy may sometimes be traced to a defective (leaking) protection tube, or to contaminating material which has been accidentally introduced into the tube or carried in on the thermocouple itself.

Good heat treating control practice, therefore, requires regularly scheduled checking of both thermocouples and tubes in all heat treating furnaces and auxiliary equipment (gas generators, etc.).

6.2 SCOPE: This procedure describes the practices and frequency of checking of thermocouples and protection tubes according to the following equipment categories:

a) Heat Treat Furnaces and Related Equipment such as Atmosphere Generators.
b) Molten Salt Baths used in Heat Treating Operations.

Alternative plans for the assurance of thermocouple and instrument accuracy may be used provided they afford protection at least equal to this plan and have the concurrence of the affected Ford Supplier Technical Assistance (STA) and/or the Quality Planning Team and are documented in a control plan.

6.3 EQUIPMENT FOR CHECKING SERVICE THERMOCOUPLES: Equipment used for checking consists of a suitable verification instrument, test thermocouples and so-called "primary standard" reference thermocouples as described below.

6.3.1 VERIFICATION INSTRUMENT: The verification instrument shall be calibrated and certified annually and shall be traceable to the relevant National/International Standards.

6.3.2 PRIMARY STANDARD THERMOCOUPLES: These are certified thermocouples of precisely known calibration for specific temperatures and should be traceable to a Bureau of Standards calibration. They should be confined to the laboratory and used only for calibration of test thermocouples.

6.3.3 TEST THERMOCOUPLES: These are the working "standard" thermocouples used in checking those in service on the furnaces or auxiliary equipment. Such test thermocouples must be homogeneous and uncontaminated so that temperature - e.m.f. relationships are reliable.

6.3.3.1 SOURCES FOR TEST THERMOCOUPLES: Test thermocouples may be made by the user from new thermocouple wire properly matched, but must first be qualified against a primary standard and tagged with the deviation prior to use. Qualification should be made at the approximate temperatures at which the test thermocouple will be checking heat treating equipment.

If a heat treating source does not have equipment and technique for preparing its own test thermocouples as described above, certified, calibrated and tagged thermocouples are available from reliable suppliers of pyrometric equipment.

6.4 RULES OF PROCEDURE IN CHECKING SERVICE THERMOCOUPLES AND TEMPERATURE INSTRUMENTATION:

6.4.1 An independent, portable verification instrument shall be used.

6.4.2 The calibrated test thermocouple shall be placed adjacent to the service thermocouple with the two junctions within 50 mm (2 in) of each other. Allow sufficient time after inserting the test thermocouple for equilibrium conditions to prevail.

6.4.3 Service Thermocouples should be checked in place, at their normal operating temperatures. The check shall not be made by removing the thermocouples from the normal operating temperature and checking it at a lower temperature. This practice can result in an inaccurate measurement of drift and damaging thermal shock.

6.5 ALLOWABLE TEMPERATURE DEVIATION: Service thermocouples must check within +/- 5°C (+/- 10°F) from true temperature as determined by the test couple calibration. Replacement shall be made when this tolerance is exceeded at time of testing. Rechecking of the installed replacement thermocouple at that time is also required.

6.6 FREQUENCY OF CHECKING AND THE REPLACEMENT OF THERMOCOUPLE AND PROTECTION TUBES IN FURNACES, SALT BATHS, AND RELATED EQUIPMENT:

6.6.1 Calibrate the Heat Treatment Thermocouples and instruments annually, or when necessary, to the relevant National/International Standards.

6.6.2 At the time of making thermocouple checks (or changes), a visual check of the protection tube condition shall also be made. When an abnormally large difference in reading of the service couple vs. test couple is found (or brittleness, or discoloration of the thermocouples is observed), the tube is suspect.

6.6.3 Because of severity of attack on protection tubes in many salt baths and because of difference in assembly, it is suggested that the checks be made by immersing a test thermocouple and tube assembly into the bath alongside the service tube and couple.

6.7 RECORDING OF TEST RESULTS AND REPLACEMENT DATES:

6.7.1 TEST RESULTS: The test results of the instrument, thermocouple, and protection tube checks shall be appropriately logged.

6.7.2 REPLACEMENT DATES: The date that a given thermocouple or protection tube is replaced shall be recorded.