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MATERIAL PROCESSING, AI-MSG MODIFICATION

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SPECIFICATION FOR

MATERIAL PROCESSING

AI-MSG MODIFICATION

1. SCOPE This specification establishes fabrication processing requirements such as cleaning, welding, brazing, and post-weld heat treating for the modification of the Atomics International (AI) Modular Steam Generator (MSG) for use in the Large Leak Test Rig (LLTR) for the study of sodium-water reactions.

2. DOCUMENTS

2.1 Applicable Documents The following documents of the exact issue shown, form a part of this specification to the extent specified in Sections 3, 4, and 5 of this specification. In the event of conflict between the documents referenced here and other detail content of this specification, the detail content of this specification shall be considered a superseding requirement.

The American Society of Mechanical Engineers (ASME)

ASME Boiler and Pressure Vessel Code

Section III	Nuclear Power Plant Components; 1971 Edition including Addenda through Winter 1972
Section IX	Welding Qualifications; 1971 Edition including Addenda through Winter 1972
ASME SFA-5.8	Specification for Brazing Filler Metal; 1971 Edition including Addenda through Winter 1972

AEC-Reactor Research and Development (RDT Standards)

RDT E 15-2T	Requirements for Nuclear Components (Supplement to ASME Boiler and Pressure Vessel Code, Section III); dated July 1971, with Amendments 1 through 5
RDT F 2-2	Quality Assurance Program Requirements; dated August 1973

2.1 Applicable Documents (Continued)

RDT F 5-1T	Cleaning and Cleanliness Requirements for Nuclear Components; dated February 1972, with Amendments 1 and 2
RDT F 6-5T	Welding Qualifications (Supplement to ASME Boiler and Pressure Vessel Code Section IX); dated July 1971 with Amendments 1 through 5
RDT F 7-2T	Preparation for Sealing, Packaging, Packing, and Marking of Components for Shipment and Storage; dated February 1969, with Amendments 1 and 2
RDT F 7-3T	Requirements for Identification Marking of Reactor Plant Components and Piping; dated February 1969.
RDT F 8-6T	Hoisting and Rigging of Critical Components and Related Equipment; dated August 1972, with Amendments 1 and 2

Military Specifications

MIL-C-81302 B	Cleaning Compound, Solvent, Trichlorotrifluoroethane

Atomics International Specifications

NA0107-019 A	Specification for Non-Critical Fusion Welding

3. REQUIREMENTS

3.1 Code Requirements The fabrication and examination of the MSG modification shall be in accordance with the rules of the ASME Boiler and Pressure Vessel Code (hereinafter referred to as the Code), Section III, Class 1.

3.2 Manufacturing Plan A manufacturing plan shall be prepared to assure a proper sequence of operations. The plan shall include:

The sequence relationship between the weld, braze, and heat treat requirements and other manufacturing processes.

Inspection hold points and operations.

The identification of supporting detailed procedures.

3.3 Processing Procedures (PP) Detailed procedures shall be prepared for processes such as welding, brazing, heat treating, cleaning, protection, and handling that govern the specific processes called out in the manufacturing plan. The PP shall define adequate handling procedures, including the devices and materials to be employed in safeguarding the handling.

3.4 Limitations on Material Removal Methods Mechanical methods of material removal shall be performed within the temperature limitations of the material and any post weld heat treatments that have been or will be applied to the part or detail. Austenitic stainless steel may be passivated prior to welding.

3.5 Welding In addition to the requirements of the Code (refer to 3.1), welding of pressure-retaining material and of material welded thereto shall also comply with the requirements of RDT E 15-2, with the following exceptions:

1. NNB-2121(e) Permitted Material Specifications. Subparagraph NNB-2121(e) shall not apply.

   NOTE: Additional material requirements from RDT Standards have been incorporated in Atomics International specifications.

2. ANB-4110 Introduction. Change the third sentence: "The manufacturer shall notify ..... further construction." to: "The manufacturer shall notify, at least five days in advance, the owner agent at those points the owner has requested the right to examine the construction processes and the manufacturer shall provide access to the owner agent at such points and shall delay further construction upon specific request of the owner."

3. ANB-4611 When Preheat is Necessary. Subparagraph (1)(a) shall be changed to: "The preheat temperature shall be maintained during welding."

4. NNB-4660 Test Plates. The entire subsubarticle, including Paragraphs NB-4661, NB-4662, and NB-4663 shall not apply.

3.5.1 Welding Qualification Except for tube-to-tubesheet welds, all procedures, welders, and welding operators used for welding of pressure-retaining materials shall be qualified in accordance with the Code, Section IX, supplemented by RDT F 6-5. The qualification test articles shall be subjected to the same thermal treatments as the welds they represent. This includes the preheat where required and the post-weld heat treatment (PWHT) where required. The PWHT time at temperature of the qualification tests shall be equal to the anticipated total time allocated for the PWHT of actual hardware that will require repeat of the PWHT, after repair or rework.

3.5.1.1 Tube-To-Tubesheet Welds Demonstration of tube-to-tubesheet welds shall utilize a simulated tube-to-tubesheet test assembly, 3 inch thickness minimum, typical hole spacing as the MSG, with a minimum of four tubes. The demonstration test assembly shall be subjected to the same thermal treatments as the welds they represent (refer to 3.5.1). The demonstration welds shall be examined visually, by magnetic particle or liquid penetrant, and by metallography. A minimum of three welds shall be sectioned and polished for metallographic examination. Evidence of cracking in the welds shall be cause for rejection, preparation of a new test assembly, and examination.

3.5.2 Weld Joint Configuration Weld procedures shall be prepared for each weld joint configuration in accordance with the requirements of RDT F 6-5.

3.5.3 Weld Preheat Temperatures Preheat temperatures for production welding shall be as follows:

P-8 Materials	60F Minimum	350F Maximum.
P-5 Materials	400F Minimum	500F Maximum.

3.5.4 Non-Pressure Boundary Materials Welding of non-pressure boundary materials may be performed in accordance with Specification NA0107-019.

3.6 Post Weld Heat Treatment Post weld heat treatment for the welded assembly of the P-5 material section of the MSG shall be in accordance with the requirements of the Code (refer to 3.1), Paragraph NB-4623, as supplemented by RDT E 15-2.

3.6.1 Initial Furnace Temperature The temperature of the furnace, if used, shall not exceed 600F at the time the component is placed into the furnace.

3.6.2 Rate of Heating Above 600F, the rate of heating shall not be more than 400F per hour divided by the maximum metal thickness of the welded base material in inches. The rate of heating shall not exceed 400F per hour.

3.6.2.1 Component Temperature Variation During the heating period there shall not be a greater variation in temperature throughout the portion of the component being heated than 250F within any fifteen-foot interval of length. For local heating (3.6.6), allowable temperature gradient outside the PWHT band shall be established by stress analysis.

3.6.3 Minimum Holding Temperature and Time The component or component piece shall be held at 1300 ± 50F for one hour per inch of weld thickness (minimum one-half hour).

NOTE: The holding time at the soaking temperature shall be defined as that time when all thermocouples located in the areas of the welds being heat treated are within the soaking temperature range.

3.6.3.1 Component Temperature Variation During the holding period, the temperature throughout the heated part of the component shall not differ from the temperature used for the weld qualification test plate by more than minus 25F or plus 50F.

3.6.4 Furnace Atmosphere Control During heating, holding, and cooling periods, the atmosphere shall be controlled to avoid excessive oxidation of the surface of the component.

3.6.5 Cooling Rate Above 600F Above 600F, cooling shall be done in a closed furnace or cooling chamber at a rate not greater than 500F per hour divided by the maximum metal thickness of the welded base metal in inches. The cooling rate shall not exceed 500F per hour. From 600F the component may be cooled in still air.

3.6.6 Local Heating When it is not practical to postweld heat treat the complete component in one or more furnace heats, any circumferential joints not previously postweld heat treated may be locally postweld heat treated by heating a circumferential band that includes such joints. Heating shall be done in a manner that will ensure the required uniformity. The width of the heated band on each side of the greatest width of the finished weld shall be not less than two times the weld metal thickness. The portion outside the heating device shall be protected so that the temperature gradient will not cause structural damage to the component. This procedure may also be used for postweld heat treatment of portions of components after repairs. Temperature measurements shall be made on that part outside the heating device to define the gradient.

3.7 Brazing Brazing of instrument penetrations of the MSG shell shall be in accordance with the requirements of the Code (refer to 3.1), Subarticle NB-4500, and except for the braze filler alloy, as supplemented by RDT E 15-2. The braze filler alloy shall be in accordance with ASME SFA-5.8, AWS Classification BNi-7. Brazing shall be completed prior to welding of any 2.25 Cr - 1.00 Mo alloy steel to the brazed assembly. The ferritic alloy steel shall not be subjected to the brazing cycle for (Code) pressure-retaining applications. Brazing of instrumentation to non-pressure retaining material shall also comply with these requirements, with the exception that brazing may include such components fabricated from 2.25 Cr - 1.00 Mo alloy steel.

3.8 Cleaning

3.8.1 Cleanliness Requirements Fabrication shall be conducted to facilitate cleaning and inspection for cleanliness, and to minimize contamination. Shop dust, debris, and contaminants such as cutting fluids, welding slag, and other processing compounds shall be removed at intervals compatible with the fabrication or assembly operation. Surfaces that have been final cleaned shall be maintained in a clean condition up to and including their assembly into components.

3.8.2 Acceptance Criteria for Cleanliness Components submitted for final inspection shall be clean to the extent that no contamination of any surface is visible, without magnification, to a person with normal visual acuity, natural or corrected. Illumination in inspection areas shall provide a glare-free light intensity of at least 100 foot-candles on the surfaces being inspected. A wiping technique shall be used to determine the cleanliness of surfaces of components that cannot be visually inspected because of inaccessibility or geometry. The cleanliness of the surfaces shall be evaluated by wiping with a clean lint-free unbleached cloth, either dry or

3.8.2 Acceptance Criteria for Cleanliness (Continued)

moistened (but not saturated) with technical grade alcohol or acetone. Discolaration of the wiping cloth or a change in the appearance of the wiped surface shall be cause for rejection except where it can be shown that the discoloration is not due to harmful contaminants; i.e., metal oxides other than rust, which may cause discoloration, are generally not considered harmful. Irridescent temper films resulting from heat treatment and tightly adherent black oxide films that occur on the backside of weld need not be removed. Loosely adherent rust should be removed by brushing or by wiping with lint-free unbleached cloth, either dry or moistened with technical grade alcohol or acetone.

3.8.3 Precautions

3.8.3.1 Exposure to Contaminated Atmospheres The MSG shall be protected from rain, salt air, or blowing dust during fabrication and temporary storage. The relative humidity of the atmosphere surrounding the MSG shall not exceed 40 percent. During non-working periods (nights, week-ends, or days when no work is planned) openings to the MSG shell-side shall be sealed with plastic sheet and the shell-side of the MSG shall be purged with 25 to 50 cubic feet of a dry protective gas. The gas may be argon, helium, nitrogen, carbon dioxide, or mixtures of these gases.

3.8.3.2 Stainless Steels For austenitic stainless steels which may have been sensitized by exposure to temperatures in the range of 800F to 1600F, precautions shall be taken to avoid intergranular attack or stress corrosion in the sensitized areas should the component be subsequently exposed to oxidizing agents such as nitric acid or halide environments such as salt air.

3.8.3.3 Welding and Brazing Precautions shall be taken to control spatter and to remove smoke and fumes produced by welding and brazing operations. The base material shall be cleaned for a distance of at least two inches on each side of the joint edge-preparation.

3.8.3.4 Heating Precautions shall be taken to prevent contamination of surfaces during or prior to heat-treating, welding, hot-forming, and other high-temperature operations.

3.8.3.5 Mercury Control During the manufacturing processes, tests, and inspections, the component or system shall not have come in direct contact with mercury or any of its compounds nor with any mercury-containing devices employing a single boundary of containment. Permanent florescent lighting fixtures or fixtures employing mercury vapor lamps which contain the equivalent of or less mercury per lumen than a comparable fluorescent lamp shall be fitted with a continuous panel or continuous diffuser to prevent pieces of the lamp from dropping on the component in the event of lamp breakge. Portable lighting fixtures employing fluorescent or mercury vapor lamps such as drop lights are prohibited. When calibrating test equipment such as manometers, a single boundary may not be achievable; in such cases a cold-trap shall be used and the instrument proven to be free of mercury contamination after calibration and prior to use.

3.8.3.6 Exclusion of Foreign Materials Extreme care shall be taken during fabrication to prevent contamination by foreign materials. Temporary plugs or seals conforming to the requirements of Section 7.2 or RDT F 7-2 shall be installed to keep contaminants out of a clean component during subsequent fabrication and storage. Precautions shall be taken to prevent such temporary plugs and seals from being inadvertently left in the component when shipped.

3.8.4 Cleaning Process

3.8.4.1 Cleaning Agents Cleaning agents and solvents used for in-process cleaning or for final cleaning shall be technical grade or better. Halogenated cleaning agents and solvents, except TCTFE meeting the requirements of MIL-C-81302, shall not be used for cleaning or degreasing of austenitic stainless steel. RDT F 5-1, Grade C or better water shall be used for mixing cleaning solutions. When rinsing or flushing is required as a final step in final cleaning, Grade C water may be used for preliminary rinses or flushes. Grade B or better water shall be used for the final rinse or flush.

3.8.4.2 Mechanical Cleaning Mechanical cleaning shall be performed in such a manner that particles will fall away from the equipment to preclude particles from entering the component. Where mechanical cleaning cannot be performed in a manner that particles fall away from the equipment, a vacuum hose or dirt catcher shall be employed. A vacuum hose may also be employed near the work to remove fine airborne particles. Completed components shall be cleaned as required to remove any particles resulting from operations such as grinding, polishing, filing, deburring and brushing. Mechanical cleaning tools such as grinding, polishing, filing, deburring and brushing tools shall be clean and shall not have been used on aluminum, copper, lead or materials containing lead or lead compounds, or other low melting point materials. Separate sets of tools shall be maintained and used as follows:

One set of tools shall be used on carbon and low alloy steels only.

One set of tools shall be used on corrosion resistant materials only.

In order to preclude contamination of corrosion resistant materials with free iron, these tools shall not have been previously used on carbon or low alloy steel materials. These sets of tools shall be clearly marked to identify their intended use in accordance with a system specified by the activity performing work and shall be segregated according to their intended use.

3.9 MSG Handling Jigs, fixtures, slings, and rings shall be provided for the manipulation of the MSG during fabircation. Rings, eyebolts, and other lifting or handling fixtures shall not be made from low tensile strength materials such as cast iron, cast steel, bronze, or any brittle material. After cleaning, items shall be transported and handled in a manner to prevent recontamination and physical damage.

3.10 Marking and Identification Marking of parts, subassemblies, and assemblies shall be in accordance with RDT F 7-3 as shown on engineering drawing. Where the location of the marking is optional on the engineering drawing, the details shall, where possible, be assembled in such a manner that the identification is visible after assembly. Paints and marking inks shall not be used on item surfaces.

4. QUALITY ASSURANCE PROVISIONS

4.1 Inspections and Tests Quality assurance activities in accordance with Section III, Class 1 of the Code (refer to 3.1) and RDT F 2-2, Sections 1, 2, 4, 5, and 8 shall be planned and implemented to assure conformance with the requirements of this specification. When duplicate quality assurance activities are specified, only one activity is required provided that the minimum requirements of both the Code and RDT F 2-2 are satisfied. Inspections and tests as required to determine conformance with the requirements of Section 3 shall be fully documented.

4.1.1 Weld Inspection Containment welds (as defined by the design specification) shall be examined in accordance with the Code, Section III, Class 1, and RDT E 15-2. Final examinations shall be performed following final heat treatment and machining.

5. PREPARATION FOR DELIVERY

5.1 Handling Extreme care shall be observed in lifting and handling of the completely modified MSG. Handling and lifting shall be performed in accordance with RDT F 8-6 and the applicable procedure. Critical lifts, as defined in the applicable procedure, shall not be performed without verification that all applicable requirements have been met.

6. NOTES AND DATA

6.1 PP Submittal Detailed procedures prepared in accordance with 3.3 shall be submitted prior to start of the specific processes defined by the procedures.

6.2 Records A current and complete file on all data recorded during processing and inspection shall be maintained, including:

Manufacturing Production Orders (MPO's).

Heat Treat charts.

Weld repair maps.

Non-Destructive Test (NDT) reports.

Discrepancy reports.

Welding and non-destructive testing qualified personnel records.

6.2.1 Records of Heat Treatment All heat treatment recorded data, including heat treat atmosphere, temperature measurement locations, and the furnace charts or data from furnace charts, shall be submitted. The charts or data shall show time versus temperature for heating, holding, and cooling. Temperature measurements shall be made at a sufficient number of locations on the component to assure that the temperature gradients will not exceed the limits specified.