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RELAZIONE TECNICA

PASSIVE CONTAINMENT COOLING CONDENSER

EQUIPMENT REQUIREMENTS SPECIFICATION

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1	5.6.92	Sections 10, 11 and 12 expanded. Other changes for consistency with the design status.		BRUZZONE	LUMINI	BRANDA

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1. SCOPE

This specification defines the general functional, engineering and construction requ.rements for the Passive Containment Cooling Condenser Units.

2. APPLICABLE DOCUMENTS, CODES AND STANDARDS

The design of this equipment shall be in accordance with specific codes and regulations as follows:

a) Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (July 1989)

- Section II: Material Specifications

  a) Part A - Ferrous Materials
  b) Part B - Nonferrous Material
  c) Part C - Welding Rods, Electrodes and Filler Metals

- Section III, Division 1 and Division 2 - Subsection NCA - Nuclear Power Plant Components; General Requirements

- Section III, Division 1 - Subsection NB - Class I Components

- Section III, Division 1 - Subsection NF - Component Supports

- Section III, Division 1 - Appendicies

- Section V - Non-destructive Examination

- Section IX - Welding and Brazing Qualifications

- Section XI, Division 1 - Rules for Inservice Inspection of Nuclear Power Plant Components

b) 10 CFR 50 Appendix A "General Design Criteria for Nuclear Power Plants"

c) ANSI/ASME NQA-1-1983 and its Addenda (NQA-1a) Edition. (Quality Assurance Program Requirements for Nuclear Facility)

d) ANSI/ASME NQA-2-1983 Edition. (Quality Assurance Requirements for Nuclear Facility Applications)

e) US NRC Standard Review Plan 3.6.2 MEB 3-1, Rev. 2, June 1987

f) US NRC Regulatory Guide 1.29 - Seismic Design Classification (Rev. 3) - September 1978

g) TEMA - Mechanical Standards Class "R" Heat Exchangers

h) ANSI Standard B.16.25 "Butt-welding Ends" 1979

i) ANSI Standard N.18.2 "Nuclear Safety Criteria for the Design of Stationary Pressurized Water Reactor Plants" 1973

j) ANSI Standard N.18.2a "Revision and Addendum to ANSI n. 18.2 - 1973" 1975

k) ASTM Standard A 262 "Standard Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steel"

3. REFERENCE DOCUMENTS

a) Passive Containment Cooling System P&ID (107E5160) T15-1010

b) Passive Cont. Cooling System Des. Spec. (25A5160) T15-1010

c) Composite Design Specification (23A6723) A11-5299

d) Pressure Integrity of Nuclear Components A11-2029

e) Equipment Environmental Interface Data A11-4100

f) Low Pressure PCC Condenser Design Checklist - October 26, 1990

g) GEAN 060 - Outline of proposed testing of the SBWR Isolation Condenser and Passive Containment Cooling Heat Exchanger - November 2, 1990

h) GEMD 195 - HPIC/PCCS Design Information/Attachment D - February 1, 1991

i) ANGE 129 - HPIC & PCC Basic Design Requirements - April 17, 1991

j) GEAN 144 - PCC Basic Design Requirements - May 22, 1991

k) GEAN 146 - PCC Basic Design Requirements - May 23, 1991

l) GEAN 212 - IC and PCC Arrangement - Nov 18, 199[illegible]

m) QUIK-COMM 5535785 - May 27, 1992

n) Containment Configuration Data Book (25A5044) T10-1030

4. EQUIPMENT FUNCTION

The function of the Passive Containment Cooling System/Condenser (3 units) is to remove, in a passive way, core decay heat for a minimum of 72 hours post-LOCA, with containment pressure never exceeding its design pressure limit of 379.2 kPa(g) (55 psig), and with IC/PCC pool not being replenished.
The PCC Condenser is called upon to provide containment cooling at approximately one hour after a LOCA.

The Passive Containment Cooling Condenser (3 units) maintains the Containment within its pressure limits for design basis accidents.

The PCC System is an "Engineered Safety Feature" (ESF), and it is a safety related system.

5. DESIGN REQUIREMENTS

5.1. General Design Requirements

5.1.1. The Passive Containment Cooling Condenser shall be designed for 10 MWt nominal capacity and will be made of two identical modules.
The units shall be located in a large water pool positioned above, and outside, the SBWR primary containment (drywell).
The central steam pipe (10") is vertical and feeds, at the top end, two horizontal headers through two 8" pipes.
Steam is condensed inside 2" vertical tubes and condensate is collected in two lower headers.
The vent and the drain lines from each lower header shall be routed to the drywell through a single containment penetration.
The condensate drains in an annular duct around the vent pipe and then flows in a 4" line which connects to a larger 6" drain line which also receives flow from the other header.

5.1.2. The PCC unit shall be designed to remain in site, inside the IC/PCC pool for 60 years.
However the PCC Condenser tubes and headers shall be easily removable for replacement, if necessary, during plant shutdowns.

5.1.3. The PCC Condensers shall not fail in a manner that damages the safety related ICS/PCCS pool as a result of dynamic loads, including combined seismic, DPV/SRV or LOCA induced loads.
Failure of PCC Condenser whose rupture, while pressurized, can release steam into the IC/PCC pool (which is safety-related) shall be limited by either the 10" diameter limit, or by observing the special stress and fatigue usage limit as in ref. paragraph 2.d, or by proof testing using experimental stress analysis cyclic test limits of ASME III, Subarticle II-1500, using the thermal pressure, vibration and dynamic load cycling defined in paragraph 6 below.

5.1.4. The location of the PCC Condenser tubes in the PCC pool shall be such as to guarantee the required performance for 72 hours minimum, being the pool capacity 3640 m^3 and the pool depth 4.4 meters. 1

5.2. Classification of Components

The classification of the PCC Condenser, with respect to functional requirements and structural integrity, is given in Table I.

5.2.1. Safety Classification

The Passive Containment Cooling Condenser is an extension of the containment pressure boundary.
All PCC Condenser parts are to be considered of Safety Class II. Therefore, ASME Code Section III, Class II and Section XI requirements for design and accessibility of welds for in-service inspection apply.

5.2.2. Seismic Category

All Passive Containment Cooling Condenser parts are to be considered of Seismic Category I.

5.2.3. Quality Assurance

The Passive Containment Cooling Condenser must be in accordance with referenced documents 2.c and 2.d.

5.3. Thermal-hydraulic Design Requirements

5.3.1. Performance

Each Passive Containment Cooling Condenser shall be designed for 10 MWt heat removal capacity.
Tube surface has to be defined at the following conditions:

a) pure saturated steam at 134°C and 298 kPa (absolute);

b) water pool temperature at 102°C and atmospheric pressure.

5.3.2. Fouling

The PCC Condenser design shall account for a fouling factor of 0.00009 m^2°C/W (0.0005 hr ft^2°F/BTU) on the pool side and zero resistance on the primary tube side.

WHAT IS EXPECTED MAXIMUM CAPACITY? vs DESIGN CAP.

5.3.3. Tube Plugging

Because of the PCC Condenser operating conditions, no plugging margin shall be considered.

5.3.4. Primary Side Pressure Loss

The primary side pressure loss for PCC Condenser and vent line shall be limited to less than 850 mm of hot water (T= 71°C, consevatively).

5.4. Safety Requirements

5.4.1. The common cooling pool that PCC Condensers share with the IC's of the Isolation Condenser System (B32) is safety related.

5.4.2. As protection from missile, tornado and wind, the Passive Containment Cooling Condenser shall be located in a subcompartment of the safety related ICS/PCCS pool.
The units shall be separated such that damages to one PCC or IC unit will not functionally disable the other units.

5.4.3. The PCC Condensers shall not fail in a manner that damages the safety related ICS/PCCS pool as a result of dynamic loads, including combined seismic, DPV/SRV or LOCA induced loads.

5.5. Secondary Side Requirements

5.5.1. Tube Uncovering

The location of the PCC Condenser tubes in the IC/PCC pool should be such as to guarantee the required performance as well as to prevent the possibility of uncovering the tubes within 72 hours minimum from the initiating event, being the pool capacity 3640 m^3 and the pool depth 4.4 meters.

5.5.2. Pool Inventory Loss (Pool vent pipe)

The moisture content of the steam leaving the vent pipe shall not exceed 2% of the mass flow of the steam generated in the ICS/PCCS pool.

5.6. Layout Requirements

5.6.1. General Arrangement

The PCC Condenser shall be located above the drywell outside the primary containment.
The central steam supply line (10") penetrates the containment roof slab vertically and, at the top end, feeds two horizontal headers through two 8" pipes. The steam is condensed inside 2" vertical tubes and condensate is collected in two lower headers. From each lower header, the condensate return line and the non-condensable gases vent line, arranged in a single concentric tube, shall be routed to the drywell: the condensed steam shall be drained to the GDCS pool and the gas shall be vented to the suppression pool (wetwell space).

5.6.2. Arrangement Constraints

The location of the PCC Condenser units with their associated piping in the IC/PCC pool shall be compatible with the Containment Building layout limitations of and structural requirements for the drywell top slab, i.e.:

1. a maximum pool depth of 4.4 meters;
2. the steam supply, vent and drain pipes connecting to the PCC Condenser shall be routed through the containment roof slab.
3. the PCC Condenser pool subcompartment is defined as follows:
   a) gemetrical boundaries:
      - pool bottom elevation = 25300 mm
      - bottom elevation of the slab above pool = 31100 mm
      - rectangular base of 5450 mm by 5475 mm
   b) the PCC Condenser primary containment penetrations shall be located as follows:
      - 10" central steam pipe, as shown in figure 1;
      - 12" drain line and 8" vent line, concentric, as shown in figure 1.

6. OPERATING CONDITIONS

6.1. Normal Steady State Conditions

The normal steady state conditions for the PCC Condenser is the standby condition, during which:

a) the containment conditions are the following: air or nitrogen with 50% relative humidity in tubes; pressure of 0-13.8 kPa(g) (0-2 psig), temperature of 10°C to 60°C (50°F to 140°F);

b) the pool water is at the temperature 10°C to 60°C (50°F to 140°F).

6.2. Transient Operating Conditions and Test Conditions

The expected transient conditions during the component lifetime which shall be analyzed for their effect upon the PCC Condenser, are listed in the following subsections:

6.2.1. Upset Conditions (Moderately Frequent Transients)

ASME Code Section III, Class 2, Level B Service Conditions limits apply for the following:

a) [illegible] steam and gas mixture (steam, nitrogen, oxygen and hydrogen) heatup cycles where pressure and temperature in the tubes increases to 379.2 kPa(g), 151°C (55 psig, 303°F) (see figure 2 for pressure versus time plot).
Pool water coolant temperature outside the tubes rises from 10°C to 100°C (50°F to 212°F).

b) 1[illegible] equivalent dynamic load excitation input cycles (including seismic) with 10 response acceleration cycles per excitation cycle (see figures 3 and 4).

6.2.2. Faulted Condition (Postulated Accident) - Case 1

Maximum combined SSE, DPV/SRV, and LOCA loads (see figures 5 and 6) concurrent with a pressure and a temperature of 379.2 kPa(g), 151°C (55 psig, 303°F). ASME Section III, Class 2, Level C Service Condition stress limits apply for this load combination.
Special verifications in particular areas in order to guarantee the functionality of the equipment shall be provided.
Occurrences: less than or equal to 10E-06 events/year.

6.2.3. Faulted Condition (Postulated Accident) - Case 2

The steam and gas mixture (steam, nitrogen, oxygen and hydrogen) pressure and temperature in the tubes increases as in the cycle above (para. 6.2.1.a) during the initial 380 sec. (see figure 2 for pressure versus time plot). Thereafter, the pressure and temperature in the tubes increase to 758.5 kPa(g), 171.1°C (110 psig, 340°F) in 72 hours. Pool water coolant temperature outside the tubes rises from 10°C to 100°C (50°F to 212°F).
ASME Section III, Class 2, Level C Service Condition stress limits apply for this load combination.
Special verifications in particular areas in order to guarantee the functionality of the equipment shall be provided.
Occurrences: less than or equal to 10E-06 events/year.

6.2.4. Test Conditions

a) Containment pneumatic pressure test cycles at 448.2 kPa(g) (65 psig) and ambient temperature (49°C max. (120°F max.)). Occurrences: 1.
b) Containment pneumatic leakage tests (ref. para. 2.b, Appendix J, Type A tests) at 379.2 kPa(g) (55 psig) and ambient temperature (49°C max. (120°F max.)). Occurrences: 30.
c) PCC Condenser pneumatic post maintenance leakage tests at 758.5 kPa(g) (110 psig) and ambient temperature (60°C max. (140°F max.)). Occurrences: 60.

7. MECHANICAL DESIGN REQUIREMENTS

7.1. Code Design Requirements

Overall equipment parts: ASME Section III Class II.

7.2. Thermal Stress and Fatigue Analysis

A thermal stress evaluation shall be performed in accordance with ASME Code Section III rules using the special design stress limits defined for the applicable materials.
An assesment of the fatigue resistance of the equipment shall be made, taking into account all the specified cycling loads; consideration shall also be given to flow induced vibration and cyclic venting of non-condensable gases.

7.3. Design Conditions

- Design Pressure 758.5 kPa (g) (110 psig)
- Design Temperature 171°C (340°F).
- Design life 60 years

The temperature design value is based on the drywell response to a design basis loss-of-coolant-accident.

7.4. Support Reactions

The support foot reactions are those forces, at the point of attachment of the external support, that each support foot shall sustain without exceeding the stress intensity limits of ASME III, Class II.
The umbrella reactions for each foot shall be evaluated and are to be used in the PCC Condenser design.

7.5. Flow Induced Loads

The PCC Condenser shall be designed to minimize the effect of flow induced loads. The potential for flow induced vibration damage shall be assessed at the exchange tube bundle and at weld attachment locations between tubes and headers.
Potentiality for vibrations arise from:
- the primary steam and condensate flow inside tubes;
- the secondary flow outside the exchange tubes, due to natural circulation of the PCC pool subcompartment.

Experimental evidence of absence of induced vibrations might be considered satisfactory.

7.6. Nozzle Loads

Nozzle loads are those forces, at the point of attachment of piping to the PCC Condenser headers, resulting from differential thermal growth, seismic and LOCA conditions.
The preliminary nozzle loads at the PCC Condenser interfaces with the piping lines are assumed to be as defined in Table II.
Additionally the thermal stresses caused by pipe-material differences or size discontinuity shall be included.

7.7. Dynamic Analysis Criteria

The Floor Response Spectrum method shall be used. The response spectra shown in figures 3 and 4 apply for dynamic loads resulting from combination of OBE and DPV/SRV loads (upset conditions).
The response spectra shown in figures 5 and 6 apply for dynamic loads resulting from combination of SSE, DPV/SRV and LOCA loads (component emergency conditions).
A three directional dynamic excitation shall be considered.
The Square Root of the Sum of the Square (SRSS) combination of modal contributions shall be performed.

7.8. Loading Conditions

The PCC Condenser and its component parts shall be designed to withstand the loads resulting from the combinations defined in Table III.

8. MAINTENANCE REQUIREMENTS

- No preventive maintenance actions are expected to be performed during normal plant operation.

- The PCC Condenser headers pool and piping shall be arranged so that the heat exchanger tubes can be plugged if needed. Plugging will be done during plant shutdown.

- If there is considerable damage to some component part of the PCC Condenser, each module of the unit shall be easily removable, after cutting the feed and drain lines.

- The pool water in the PCC Condenser subcompartment shall be removable without emptying the entire ICS/PCCS pool.

9. SERVICE REQUIREMENTS

9.1. Water Chemistry

The PCC Condenser shall be designed to operate satisfactorily with the water chemistry indicated in Table IV.

10. CONTROLS, TESTS, INSPECTIONS AND INSERVICE INSPECTION REQUIREMENTS

10.1. General

Applicable Non Destructive examination methods are: Ultrasonic (UT), Radiographic (RT), Magnetic Particle (MT), Liquid Penetrant (PT), Eddy Current (ET), Visual Examination (VT), Leak Testing. Before NDE begins, the Supplier shall prepare NDE procedures and drawings or sketches detailing the essential variables of the applicable method. The procedures shall be consistent with applicable Codes and Standard and shall be submitted to the Customer for approval.
In addition to the requirements of ASME Code Section III NC, the following requirements apply.

10.2. Procurement Controls

Controls shall be performed consistent with procurement specification requirements. The following specific requirements apply.

10.2.1. Headers and Headers Covers

Forgings shall be examined according to ASME Code, Sect. V Art. 23, SA - 745 "Standard practice for ultrasonic examination of austenitic steel forgings" with the following additional requirements.

10.2.1.1. Preparation of forgings

The headers hollow forgings shall be UT examined after heat treatment and after rough-machining to provide cylindrical surfaces for radial examination; the ends of forgings shall be machined perpendicular to the axis of the forgings for the axial examination.

The headers covers forgings shall be UT examined after heat treatment and after rough-machining to provide faces flat and parallel to one another.
The surface roughness of exterior finish shall not exceed 250 micro in. (6.3 micron).
The UT shall be performed prior to drilling holes, tapers, grooves or machining sections to contour extruded nozzles.

10.2.1.2. UT Procedure

The headers hollow forgings shall be radially and axially scanned using straight beam technique.
In addition the hollow forgings shall be examined by angle beam technique from the outside diameter in two perpendicular directions.
The headers covers forgings shall be UT examined using a straight beam from at least one flat face and radially from from the circumference.
If radial penetration is not possible due to attenuation or to the curved shape of the cover, angle beam examination directed radially may be substituted in place of radial straight beam.

10.2.1.3. Quality Level

The applicable quality level for straight beam examination shall be SA-745 Par. 12.1.1.1 (a) QL-1, for angle beam examination shall be SA-745 Par.12.1.2.1 QA-1.

10.2.1.4. Acceptance Criteria

Acceptance criteria for straight beam examination shall be in accordance with SA-745 Par. 12.1.1.1, for angle beam examination shall be in accordance with SA-745 Par.12.1.2.

10.2.2. Distributor

Fittings for Distributor shall be Ultrasonic examined after final heat treatment according to ASME Code Sect. III, Div. 1 NC-2550 with the following additional requirements.

10.2.2.1. The surface roughness of exterior finish shall not exceed 250 micro in. (6.3 micron).

10.2.2.2. Fitting shall be examined in two circumferential directions, as defined in NC-2552.1, and in two axial directions.

10.2.2.3. The reference specimen shall be in accordance with NC-2552.3 (a) and (b) with the following additional requirements.

- The reference specimen shall contain two axial standard defects (notches), on the outside and inside surfaces, and two circumferential standard defects (notches), on the outside and inside surfaces.

- Notches shall be 5% of nominal wall thickness (or 0.10 mm whichever is larger) in depth, 60 degrees V-shaped and 25 mm or less long.

10.2.2.4. Repair of defects by welding is not permitted.

10.2.3. Pipes

Pipes for main steam line, feed line and drain line shall be Ultrasonic examined after final heat treatment and before bending according to ASME Code Sect. III, Div. 1 NC-2550 with the following additional requirements.

10.2.3.1. The surface roughness of exterior finish shall not exceed 250 micro in. (6.3 micron).

10.2.3.2. Pipes shall be examined in two circumferential directions, as defined in NC-2552.1, and in two axial directions.

10.2.3.3. The reference specimen shall be in accordance with NC-2552.3 (a) and (b) with the following additional requirements.

- The reference specimen shall contain two axial standard defects (notches), on the outside and inside surfaces, and two circumferential standard defects (notches), on the outside and inside surfaces.

- Notches shall be 5% of nominal wall thickness (or 0.10 mm whichever is larger) in depth, 60 degrees V-shaped and 25 mm or less long.

10.2.3.4. Repair of defects by welding is not permitted.

10.2.4. Tubes

Tubes shall be examined before bending according to the requirements of the previous Par. 10.2.3. (Pipes).
As an alternative to the Ultrasonic examination, an Eddy Current examination according to NC-2554, shall be made.
After bending, tubes shall be PT examined according to ASME Code Sect. III Div. 1 NB-2556.

10.3. <u>Welds Control</u>

Welds control shall be performed in accordance with the prescriptions of ASME Code Sect. III, Div. 1 NC-5000 and consistent with approved procedures.
Additionally:

a) circumferential butt welded joint in piping shall be examined by the radiographic and the liquid penetrant method;

b) tube-to-headers welds shall be surface examined by the liquid penetrant method and volumetric examined by radiographic method;

c) headers to supports full penetration corner welds shall be surface examined by the liquid penetrant method and volumetric examined by ultrasonic method.

10.4. Assembling Controls

Controls shall be performed during the overall assembling, in order to verify that:

- tubes are properly positioned in the corresponding header holes;
- dimensions and tolerances are consistent with approved manufacturing drawings;
- all parts which will become inaccessible, are properly positioned and fixex and/or welded and inspected;
- inner surfaces are properly cleaned.

10.5. Hydrotest

Hydrostatic tests shall be performed on the PCC modules and subassemblies in accordance with ASME Code Sect. III.
Final hydrostatic test of the overall unit shall be performed at site.

10.6. Leak Testing

Leak test shall be performed on the PCC modules in accordance with ASME Code Sect. V Art. 10 APPENDIX V "Helium mass spectrometer test - tracer probe and hood techniques". The component is acceptable when no leakage is detected that exceeds the allowable rate of 1 x 10E-04 std cm^3/sec (1 x 10E-04 millibar liter/sec).

10.7. Visual and Dimensional Examination

The PCC and its parts shall be subjected to visual and dimensional examination to verify conformance with the drawings and all of the requirements of this specification which do not involve tests.

10.8. Inservice Inspection Requirements

- ISI amount shall be minimized during the design phase (e.g.: by reducing the number of welds).

- During plant outages routine ISI is required for the PCC Condenser, according to ASME Code Section III and Section XI (requirements for design and accessibility of welds).

- PCC Condenser removal for routine inspection is not required.

- Ultrasonic inspection is required for PCC Condenser tube/header welds.

- PCC Condenser tubes shall be inspected by the Eddy current method.

- Inspection and leak testing will be done during refueling outages.

11. MATERIAL REQUIREMENTS

Materials listed in Paragraph 11.1 below are acceptable for the application when used in proper relationship with other materials.

11.1. Acceptable Materials

All materials shall be austenitic stainless steel and shall be subjected to the requirements of ASME Code (ref. 2.a), Appendix 3 of this document, and the following paragraphs.

11.1.1. In the final fabrication condition, wrought austenitic stainless steel shall be in the solution heat treated condition. Heat treatment shall be done at 1040/1150 °C metal temperature, followed by a approved cooling process.
Localized heat treatment is not permitted unless qualified for a specific application.

11.1.2. Grain size and uniformity shall be controlled in the material to provide adequate UT inspectability, where required.

11.1.3. Material shall be tested to verify freedom from sensitization according to ASTM A 262 Practice A (ref. 2.k).

11.1.4. Hardness of cold worked row materials shall not exceed 92 HRB. Hardness shall be controlled during fabrication by process control of bending, cold forming, straightening or other similar operations.

11.1.5. Pressure boundary materials

a) Pipes for main steam line.
Pipes material shall be SA-312 TP304L with the Carbon content not exceeding 0.020%.
The tubes shall be seamless, hot finished and in solution heat-treated conditions according SA-312.

b) Fittings for distributor.
Fittings material shall be SA-403 WP 304L, Class WP-S with Carbon content not exceeding 0.020%.
Fittings shall be furnished in heat-treated conditions.

c) Pipes for feed lines.
See previous Par. a).

d) Hollow forgings for Headers.
Forgings material shall be SA-182 F304L with the Carbon not exceeding 0.020%.
Material shall be melted by vacuum furnace followed by electroslag-consumable remelting and furnished in heat-treated conditions according to SA-182 Par. 5.3.
Heat treatment of forging may be performed before machining.
Distributor shall not be machined directly from bar stock. 1

e) Forgings for Headers Covers.
See previous Par. d).

f) Boltings for Header.
Boltings material shall be SA-193 B8.

g) Tubes.
Tubes material shall be SA-213 TP 304L with the Carbon content not exceeding 0.020%.

h) Pipes for Drain Lines and Vent lines.
See previous Par. a).

i) "Y" forgings for Steam line and for Drain Lines.
See previous Par. d).

l) Forgings for Drain Lines nozzles.
See previous Par. d).

m) Flanges for Steam Pipe and Drain/Vent lines.
Flanges material shall be SA-182 F304.

n) Instrumentation nozzles.
Material for instrumentation nozzles (2" complete with flange and 1/4" NPT) shall be SA-182 F304L with Carbon content not exceeding 0.020%.

11.1.6. Non-Pressure boundary materials

The material for non-pressure retaining parts shall be in accordance with the applicable ASME or ASTM Specifications.
The material for vent line intake shall be SA-312 TP304, the material for vent line intake cover, for supports and saddles shall be SA-240 Type 304.
Boltings items for vent intake flange and cover shall be SA-193 B8.

11.2. Unacceptable Materials

Contamination of the PCC with sulphur, lead, low melting point metals, their alloys, and their compounds shall be proibited during fabrication, testing, shipping or erection. Where a satisfactory substitute material free of such contaminants cannot be found, the use of such substance for processing and fabricating metals at room temperature is permissible providing alla surfaces, crevices, blind holes, etc., are thoroughly cleaned to remove the contaminant prior to any operation involving elevated temperatures.
The Supplier shall submit to the Customer, for approval, a detailed Cleaning Procedure. This procedure shall contain specific informations to assure reliable cleaning process of the materials and components during all stages of manufacturing.

11.3. Gaskets

Gaskets shall be metallic O - rings of the self-energized type provided with retainer clips.
The O - rings shall be manufactured, worked, tested, inspected and certified according to the production standards of a qualified manufacturer.
Material shall be 321 Stainless Steel. 1

12. FABRICATION REQUIREMENTS

12.1 General

Manifacturing technology in process of work of the PCC Condenser shall be high level.

The principal manufacturing documents are listed below.
The following list is for guidance purpose and is not necessarily comprehensive.

- Planning
- Engineering schedule
- Procurement and Fabrication Drawings
- Fabrication plan and description of the activity
- Procurement Specifications
- Control Specifications
- Manufacturing procedure Specifications
- Welding Specifications
- Welding book
- Final Manufacturing Report to be submitted to the Customer after completion of the PCC and before its shipping to the plant site
- Technical Manual

12.2 Fabrication

Manufacturing procedures shall meet the general requirements listed in Table I and the prescriptions detailed hereinafter.

12.2.1. Material Procurement

Material procurements shall be carried out to meet the prescriptions of Paragraph 11. and according to the relevant specifications, approved, if required, by the Customer.

12.2.2. Thermal cutting

Thermal cutting of pressure retainig materials and weld preparation shall be made by plasma cutting process only.
No other type of thermal cutting is admitted.
After cutting, a minimum of 1.0 mm of material shall be removed by machining or grinding.

12.2.3. Welding

Welding procedures and weld procedure / operator qualifications shall be consistent with ASME Code Section IX.

12.2.4. Heat Treatment

Heat treatments shall be in accordance with Appendix 3.
The values of the main parameters of these treatments shall be reported to the Customer.

12.2.5. Repair Welding

Repair to welds - They may proceed without prior Customer approval, provided that the repair procedures are consistent with welding specification requirements and that the repair is properly recorded. Weld repairs shall not be done more than twice.

Repair to base material - No repair to base material shall proceed without prior Customer approval.

12.2.6. Surface Protection

A detailed Surface Protection Procedure shall contain specific informations to assure reliable process control of the materials and components during all stages of manufacturing.
The surface protection treatment shall be provided for manufacturing time, according to the prior program to be established by the Supplier.

Exposure of austenitic stainless steel to substances containing chloride or fluoride ions is to be avoided.
Where manufacturing or inspections processes necessitate exposure to chloride or fluoride ions, all finished surfaces that may have been so exposed shall be thoroughly cleaned with approved cleaners or solvent to ensure freedom from contaminants.
Grit blasting shall not be performed on surfaces in contact with water.

12.2.7. Cleaning

Manufacturing and welding procedures shall include precautions against contamination by such items: mercury, lead, zinc, cadmium or other low melting point metals.
All surfaces shall be cleaned prior to heat treatment.
Welding procedures shall prevent the contamination of the the deposited weld metal by a temperature sensitive crayon.
No cleaning of hot formed austenitic stainless steel material by acid pickling shall be performed.
Water used for cleaning or testing the component shall be according to applicable procedure.
Cleaning procedures, solvent specifications and packaging procedures shall be submitted to the Customer for approval.

TABLE I

PASSIVE CONTAINMENT COOLING CONDENSER CLASSIFICATION

ANSI Safety Classification	Class 2
ASME Code Classification	Class 2
Quality Assurance	Group B
Seismic Category	1

TABLE II

PRELIMINARY NOZZLE LOADS FOR PCC CONDENSER DESIGN

Load (note 1)	Plant Condition		
	1 and 2	3	4
Axial or Shears Transverge [N]	0.050 Ap Syp	0.055 Ap Syp	0.07 Ap Syp
Bending Moments [N mm]	0,25 Zp Syp	0.30 Zp Syp	0.35 Ap Syp
Torsional Moment [N mm]	0.25 Zp Syp	0.30 Zp Syp	0.35 Ap Syp

NOTE 1: The six components of nozzle loads are assumed to be applied simultaneously.

Ap - Cross sectional area of pipe metal, $[mm^2]$
Syp - Tensile yield strenght of pipe material at design temperature, [MPa]

Zp - Section modulus of pipe, $[mm^3]$

TABLE III

LOAD COMBINATION CRITERIA

Plant Conditions	Load Combination	Service Level
--	Deadweight, Design Pressure, Design Temperature, OBE	Design
1	Deadweight, Normal Conditions	A (Normal)
2,3,4	Deadweight, LOCA Opeating Conditions, OBE + DPV/SRV Dynamic Load	B (Upset)
4	Case 1 Deadweight, LOCA Operating Conditions, SSE + DPV/SRV + LOCA Dynamic Load	C (Faulted)
4	Case 2 Deadweight, Severe Accident Operating Conditions	C (Faulted)
Test	Deadweight, Test Pressure + Temperature	Test

TABLE IV

WATER QUALITY

(See Notes 1 & 2)

REACTOR WATER QUALITY PARAMETER	SYSTEM DESIGN
Chloride (ppb)	20.0
Sulfate (ppb)	20.0
Conductivity** at 25°C (μS/cm)	0.3 (1.2*)
Silica (ppb as SiO_2)	1000.0
pH at 25°C min	6.2 (5.6*)
max	8.0 (8.6*)
CORROSION PRODUCT METALS (ppb)	
Fe Insoluble	20.0
Soluble	
Cu Total	1.0
All Other Metals	9.0
Sum	30.0

* Operating values change to these values during plant shutdown. Otherwise, operating and shutdown design values are the same.

** Does not include an incremental conductivity value of 0.8μS/cm at 25°C due to carbon dioxide from air in water stored in tanks open to the atmosphere.

Note 1: The values given are for reactor water quality during reactor operation and shutdown except as noted by asterisk.

Note 2: PCC pool water quality is the same as reactor water quality at shutdown design values.

FIGURE 1 (1)

PCC CONDENSER POOL SUBCOMPARTMENT

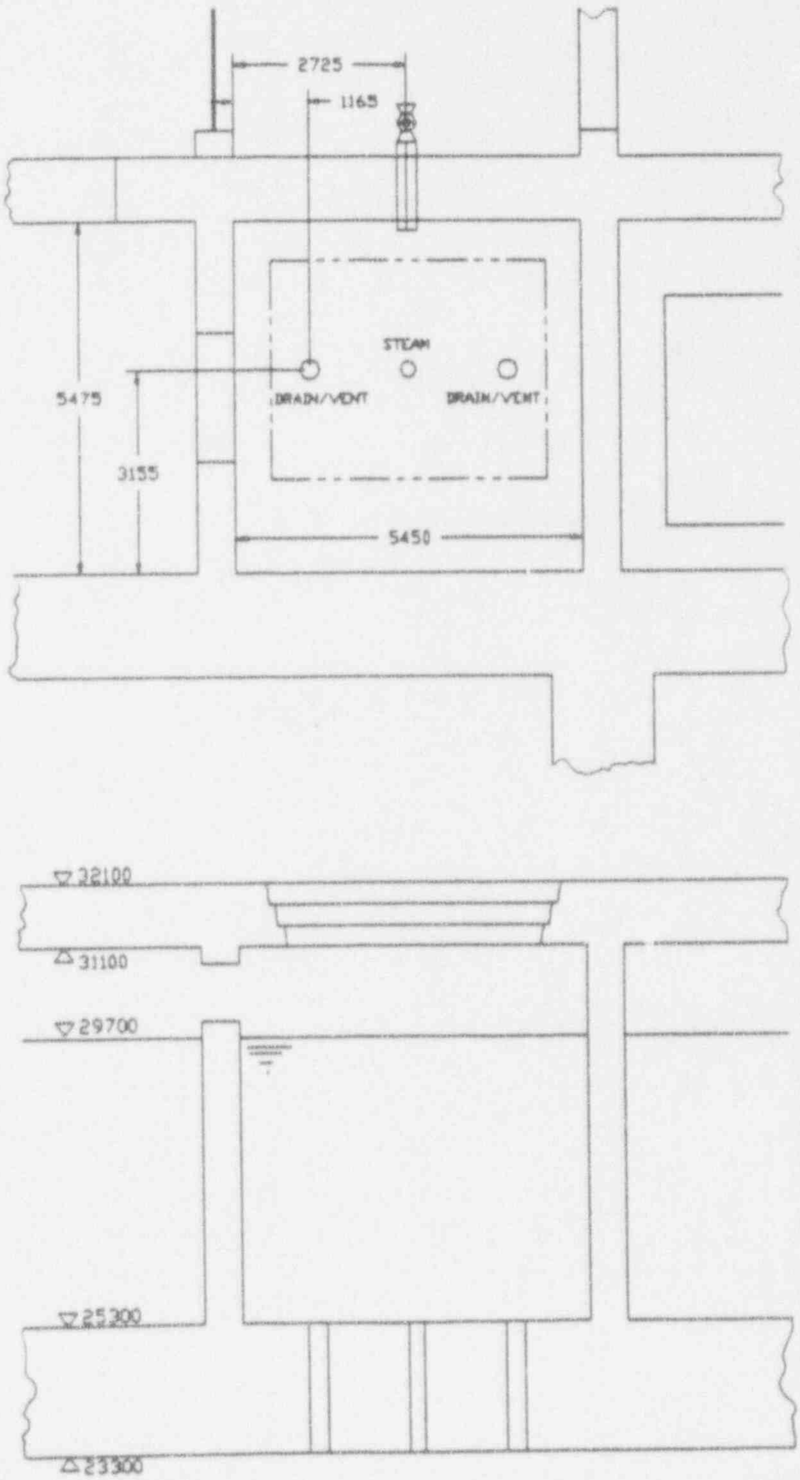


FIGURE 2

CONTAINMENT PRESSURE RESPONSE TO A MSLB

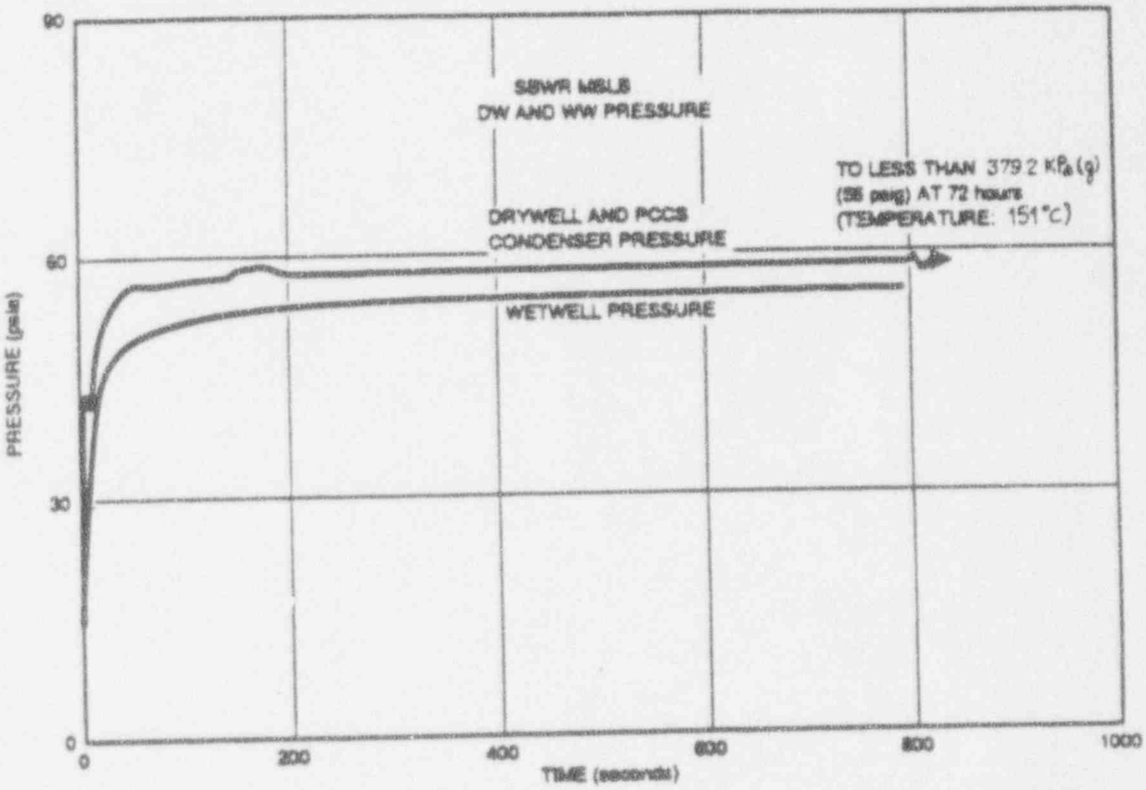
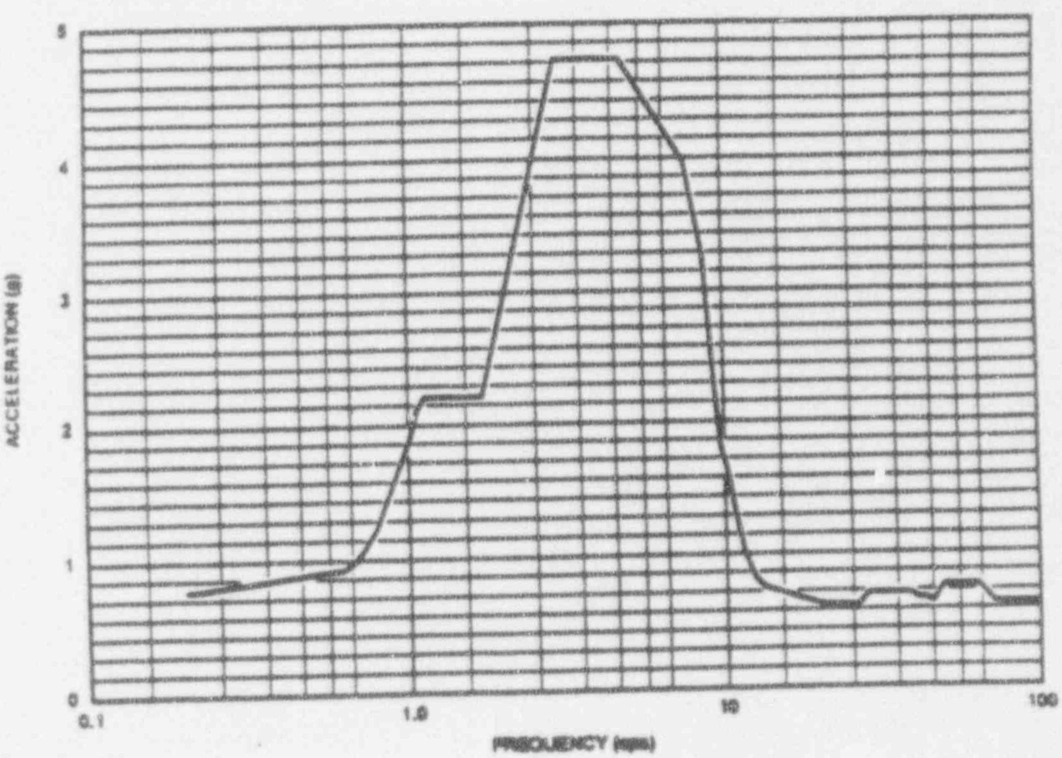


FIGURE 3

UPSET CONDITION - DYNAMIC LOAD RESPONSE SPECTRA

- HORIZONTAL -

(Service Level B limits apply)



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Progetto project	Identificativo document no.	Rev. rev.	Pagina page
SBWR	SBW 5280 TNIX N015 000	1	43

FIGURE 4

UPSET CONDITION - DYNAMIC LOAD RESPONSE SPECTRA

- VERTICAL -

(Service Level B limits apply)

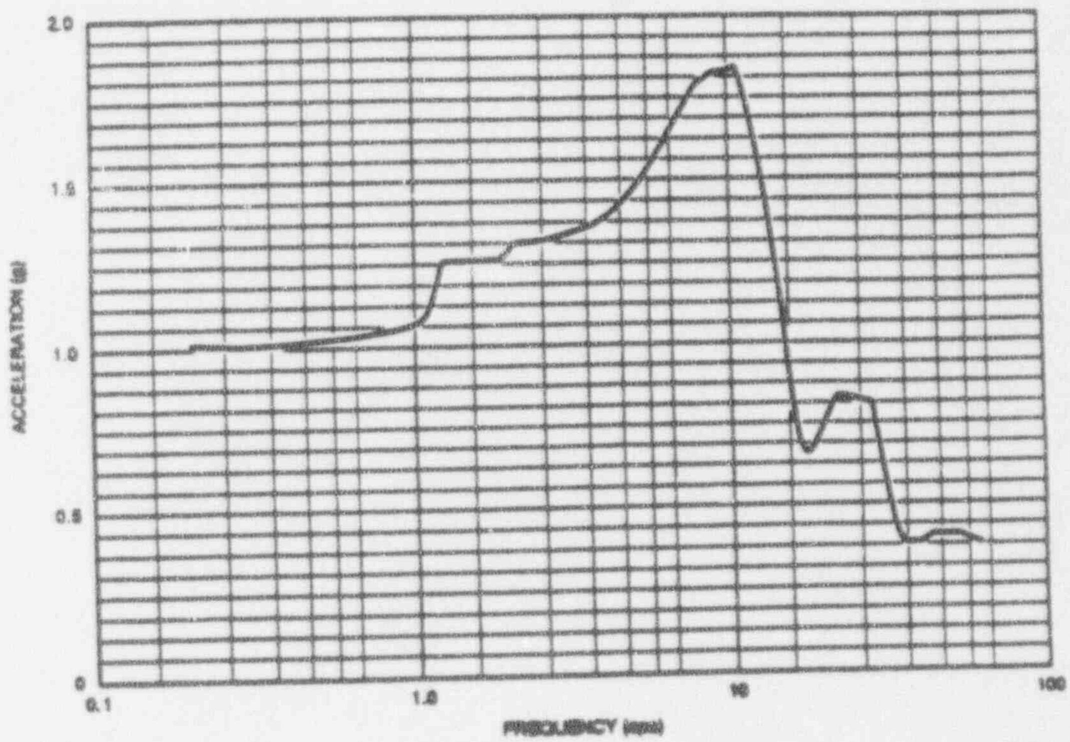


FIGURE 5

FAULTED CONDITIONS - DYNAMIC LOADING

- HORIZONTAL -

(Service Level C limits apply)

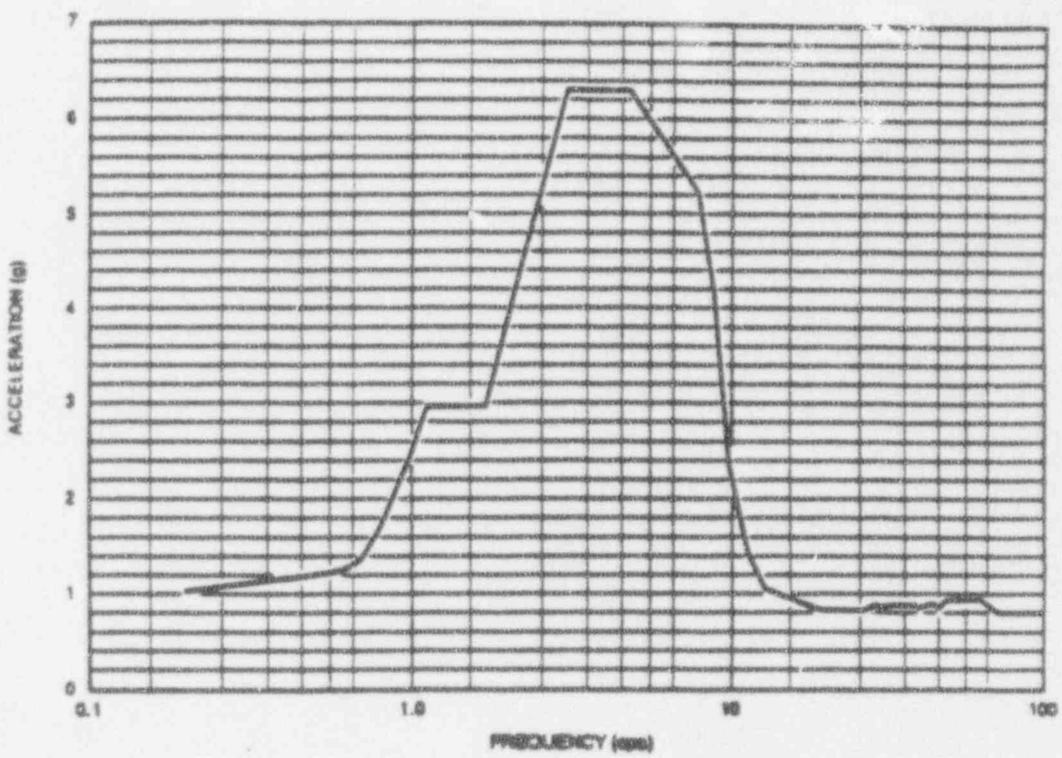
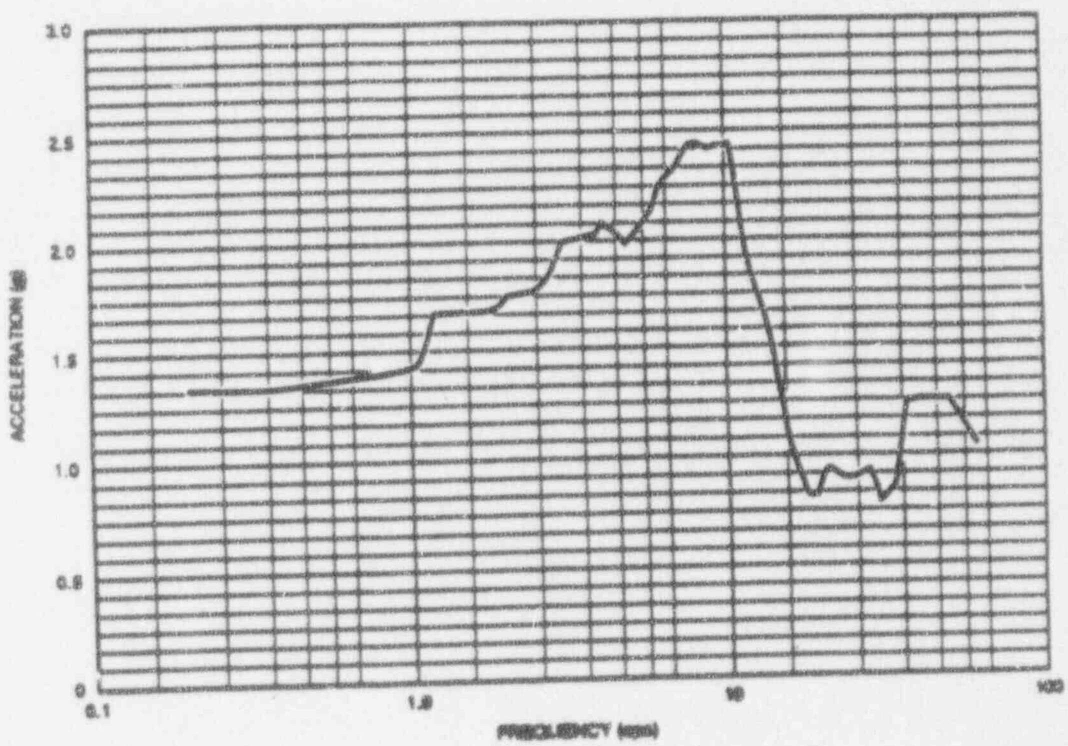


FIGURE 6

FAULTED CONDITIONS - DYNAMIC LOADING

- VERTICAL -

(Service Level C limits apply)



APPENDIX 3

SBWR MATERIALS REQUIREMENTS

FOR

AUSTENITIC STAINLESS STEEL MATERIALS

IN

PASSIVE CONTAINMENT COOLING CONDENSER

JUNE 28, 1991

3.2. Wrought Austenitic Stainless Steels

3.2.1. Requirements of this section shall apply to all wrought austenitic stainless steel (such as Types 304 and 316) components exposed to water or steam environment at temperatures over 100°C, unless specified otherwise.

3.2.2. All materials shall be purchased to specifications prepared for SBWR service. If the components cannot be solution heat treated after welding or other heat treating operation, unless qualified, the carbon content of the material shall not exceed 0.020%.

3.2.3. Solution Heat Treatment of Austenitic Stainless Steels

a) In the final fabrication condition, wrought austenitic stainless steel parts shall be in the solution heat treated condition. The recommended solution heat treatment is heating to the temperature range of 1040°C to 1150°C with a hold time designed to achieve full solutionizing while minimizing grain growth. Heat treatment shall immediately be followed by quenching or cooling below 205°C such that sensitization is avoided. For crevice applications Type 316L is preferred to Type 304L and for parts for service even at or below 100°C, solution heat treatment and water quenching must be done. Alternate method of quenching such as air quench, are allowed provided the process is qualified and controlled with sensitization tests required in this specification.

b) Localized heat treatment of austenitic stainless steel is not permitted unless qualified for a specific application.

3.2.4. Sensitization

Welding of wrought Type 300 series austenitic stainless steel is considered to cause sensitization. Sensitized wrought austenitic stainless steel shall not be used. Austenitic stainless is considered to be sensitized if it has been heated within the temperature range between 430°C and 980°C regardless of the subsequent cooling rate. When heated above 430°C, the austenitic stainless steel material shall be solution heat treated in accordance with Paragraph 3.2.3. Type 316(NG) or Type 316L and Type 304(NG) or Type 304L material with 0.020 percent maximum carbon is exempt from this requirement during welding provided it is in a solution heat treated condition prior to welding.

3.2.5. Austenitic Stainless Steel Pipe or Tubing

Wrought austenitic stainless steel pipe or tubing shall be Type 304(NG), Type 304L, Type 316(NG), and Type 316L to an applicable SBWR materials specification. For parts that cannot be solution heat treated after welding, only Type 304L or Type 304(NG) for non-creviced parts, or Type 316(NG) or Type 316L for creviced parts with 0.020 percent maximum carbon material shall be used. Other stainless steels qualified for SBWR service such as Type 347 Modified are also acceptable.

3.2.5.1. Cold bending or forming shall be controlled such that hardness in the final fabricated condition shall not exceed Rockwell B 90 for Type 304(NG) and Type 304L and Rockwell B92 for Type 316(NG) and Type 316L. Hardness values shall be reported on the Materials Test Report. Brinell hardness equivalent to Rockwell B may be used.

3.2.5.2. Bending of Austenitic Stainless Steel U-Tubes

a) U-Tubes shall be cold bent. The ovality of a U-tube at any cross-section shall not exceed ten percent of the nominal tube diameter. A qualification sample of the smallest bend radius shall be sectioned to verify the minimum wall thickness requirement specified on the drawing.

b) All U-tubes with a bend radius less than twenty times the tube diameter shall be solution annealed. The solution annealing temperature shall be 1040°C to 1150°C followed by water quenching or air cooling to below 205°C within five minutes. This stress-relief annealing process shall be qualified per 1.6g. Qualification shall be performed on tubing sections taken from the middle of a U-bend and the hot/cold transition region.

c) The inside diameter of the tubes shall be in a thoroughly clean condition before stress relief anneal of the tube bends. The outside diameter of the tubes in the bent area plus 300 mm on each side shall be thoroughly cleaned in unused acetone immediately prior to stress relief annealing of the tube bends.

d) The solution anneal shall include the tube bends plus 150 mm on each side of the bends. The tubes shall be purged internally with a suitable protective atmosphere of twice the volume of the tube before starting localized heat treatment. The inside of the tubes shall be protected with a protective atmosphere during the entire heat treatment. The flow shall be maintained for a sufficient time to ensure a bright tube ID free of scale and oxidation. The tubes shall be supported during heat treatment to prevent warpage.

e) Stainless Steel U-tubes shall not be pickled after solution annealing. A light oxide film on the outside surface of a U-tube is acceptable. Smears on tubes from resistance heating clamps shall be removed. Only clean stainless steel wire brushes, wool, or other approved mechanical cleaning devices shall be used on stainless steel tubing.

f) The U-bent tubes shall be hydrostatically tested after bending and solution annealing.

g) The OD surface of all U-tubes shall be liquid penetrant examined after bending, solution annealing, and hydrostatic testing.

3.2.5.3. Induction Bending of Pipe

Induction bending of pipe shall be qualified based on the bend radius and the pipe diameter for components to be bent to bend radii of 5D and less. Each heat of material shall be qualified by bending a test piece and subjecting it to high sensitivity U.T. examination and destructive examination for microfissures.

3.2.6. Welding Materials for Austenitic Stainless Steel

Filler metals for welding austenitic stainless steels shall be selected to be compatible with the base metal(s) to be welded. Filler metal shall be procured in accordance with applicable ASME Code Requirements. Acceptable filler metal Types are 308L, 309L, 309MoL, 316L and 316LC.

3.2.6.1. Ferrite Control

For all stainless steel welding materials including consumable inserts for components which operate 100°C the ferrite content shall be not less than 5% (or 5 FN) for each individual reading, and the average shall be not less than 8%. Maximum ferrite content shall not exceed 20%. Ferrite content shall be determined on undiluted weld deposits. Ferrite measurements shall be made in accordance with the magnetic measurement requirements described in ASME Section III, Paragraph NB2433. The ferrite content and the method used for its determination shall be reported in the Material Test-Report for austenitic stainless steel weld metal.

3.2.7. Austenitic Stainless Steel Welds

3.2.7.1. Heat Input Controls

Welding heat input controls are required for all welds including repair welds, overlay/cladding welds, weld bead straightening, and joining carbon or low alloy steel to stainless steel. Austenitic stainless steel components solution heat treated after welding are exempt from these requirements.

a) For manual GTAW and SMAW, heat input shall be limited by weaving and welding technique controls. Non-weaving (stringer bead) welding techniques shall be used where possible. Weaving and technique shall be controlled to meet the equivalent of heat input limits of paragraph 3.2.7.1.b.

b) For automatic (or machine) welding and manual welding with processes other than GTAW or SMAW, welding heat input shall not exceed 44000 joules/cm calculated according to the following formula:

$$\text{Heat Input} = \frac{\text{Voltage}^{(1)}\ \text{(Volts)} \times \text{Current}^{(2)}\ \text{(Amps)} \times 60}{\text{Travel Speed (cm per Minute)}}$$

NOTES:

(1) This heat input is based on the voltage at the arc. Voltage may, however, be measured at the welding power supply. If the heat input limit is exceeded when voltage is measured at the welding power supply, the voltage may be reduced by an amount equal to the voltage drop between the power supply and the arc. This voltage drop shall be determined by direct measurement for each power supply, welding process, and cable combination.

(2) For pulsing current applications, the weighted average current, according to the formula below shall be used to calculate the heat input.

$$\text{Weighted Average Current} = \frac{\text{(High Pulse Current} \times \text{High Pulse Time)} + \text{(Low Pulse Current} \times \text{Low Pulse Time)}}{\text{High Pulse Time} + \text{Low Pulse Time}}$$

3.2.7.2. The maximum interpass temperature shall be 180°C for all stainless steel welds.

3.2.7.3. Socket welds and seal welds shall use the GTAW process (with filler metal added) for at least the root layer(s). Protective gas back purging is not required.

3.2.7.4. Dissimilar Metal Welds

For austenitic stainless steel to carbon steel weld joints, the carbon steel side shall be clad (or the weld joint completed) with 309 type weld filler material per the requirements of Paragraph 3.2.6.

Post weld heat treatment of the clad carbon steel may be required, depending on the wall thickness. If cladding is done, the joint may be completed with the 309 type material or other weld materials listed in Paragraph 3.2.6.

Ferrite content and weld heat input requirements of Paragraphs 3.2.6.1 and 3.2.7.1 respectively shall be met.

3.2.8. Intergranular Attack (IGA) shall be controlled per the requirements of GE specification E50YP11 for all wrought austenitic stainless steel which during operation is wetted with water at temperature above 100°C.

IGA control shall be applied to raw material and subsequently after any heat treatment above 815°C and any pickling operations. Where a minimum depth of 0.8 mm of material will be removed from all wetted surfaces after the final heat treatment, no IGA control is required. Results are to be noted in the Materials Test Report.

3.2.9. All solution heat treated wrought material for service above 100 C shall be tested for sensitization per the requirements of GE specification E50YP20.

As a minimum, one specimen representing each heat treat lot shall be tested for sensitization. The material tested shall be heat treated with the lot it represents. The Materials Test Report for the material shall note the results of these tests.

3.2.10. Grinding Controls

These requirements shall apply to final fabricated surfaces to be exposed to reactor water. Abrasive grinding of stainless steel heat-affected zones shall be minimized to the extent possible.

Care shall be taken to confine grinding to the weld metal only and limit grinding of the adjacent base metal to that required to meet the fabrication and examination requirements of the ASME Code, this specification, the equipment requirement specification, or support drawing. Grinding abrasives and wire brushes for stainless steel and nickel-chrome-iron alloy shall not have been used previously on materials other than stainless steel or nickel-chrome-iron alloy. For wrought austenitic stainless steel surface to be exposed to reactor water, if any grinding is done and not followed with solution heat treatment, the surface shall be polished to remove the grinding marks to obtain a final surface finish of 0.8 mm or finer.

3.2.11. Stress Rule Application for Wrought Austenitic Stainless Steels

The stress rules are applicable to all creviced components made of wrought austenitic stainless steel (SUS 300 series) and Nickel-Chrome-Iron alloy materials which operate exposed to reactor water at temperatures over 100°C.

A crevice is defined in Paragraph 3.2.12. A simplified approach to stress rule application is shown in a flow chart presented in Figure 1. The Stress Rule Index (SRI) calculation shall be made for the most highly stressed joint in an assembly. If acceptable, then all other joints (less stressed than the first one) in the assembly are also acceptable.

3.2.11.1. The following stress rules must be met by all creviced components.
The criteria shall be applied considering the worst substained (*) stress intensity case.

If the criterion is not met, reapply the same rule considering the worst sustained principal tensile stress case.

3.2.11.2. For all applications independent of neutron flounce.

$$A = \frac{P_m + P_b}{S_y} + \frac{Q + F + (RESID)}{S_y + 0.002E}$$

≤ 0.7 for creviced SS 304, SS 304L, SS 316, SS 316L, SS 304(NG), SS 316(NG)

≤ 1.0 for creviced and sensitized 308L, no stress rule is required for non-sensitized 308L.

For uncreviced stainless steel, no limit is applicable for IGSCC.

Where:

(*)A "sustained" stress is defined as 1000 hours or longer during the design life of the component.

P_m = primary membrane stress intensity

P_b = primary bending stress intensity

S_y = material minimum ASME Code yield stress at temperature

Q = secondary stress intensity

(RESID) = Residual Stress - defined below

F = peak stress intensity

E = elastic modulus of the material at service temperature per ASME Code.

Definition of (RESID)

a) Within 25 mm of weld (RESID) shall be assumed to be equal to the appropriate value from Figure 2.

b) In all other locations, (RESID) is defined as follows where S_t is the summation of all compressive stresses.

RESID = 0 if $S_t < S_y$

= $S_t - S_y$ if $S_y < S_t < 2S_y$

= S_y if $S_t > 2S_y$

3.2.11.3. Socket welds in 75 mm diameter pipe or less are exempt from the criteria of Paragraph 3.2.11.

3.2.12. Crevice Application

A crevice is defined by Figures 3 and 4 and Paragraph 3.2.12.1.

3.2.12.1. Examples for translating the 3 dimensional crevice definition into 3 dimensions.

a) Drawing (a) shows that for a closed bottom configuration with one surface exposed to the bulk solution, the length is to be ignored. Thus, for a given width and depth, any length is a crevice.

b) & c) Drawing (b) and (c) illustrate cases where two surfaces are exposed to bulk solution. In order to be considered a crevice for a given width both of the other dimensions must fall above the file in Figure 3. This is because for any point in the gap a line can be drawn to the bulk solution which is less than or equal to the shorter edge dimension.

d) Non-orthogonal configurations like Figure (d) present a different problem. In this drawing no constant width or depth is present. In cases such as this, the depth should be the distance to the point farthest from the bulk solution and the width should be the average width.

e) & f) For through-drilled holes, the depth to be used in determining whether a crevice exists, is half the actual depth. Again, this is the longest distance to the bulk solution.

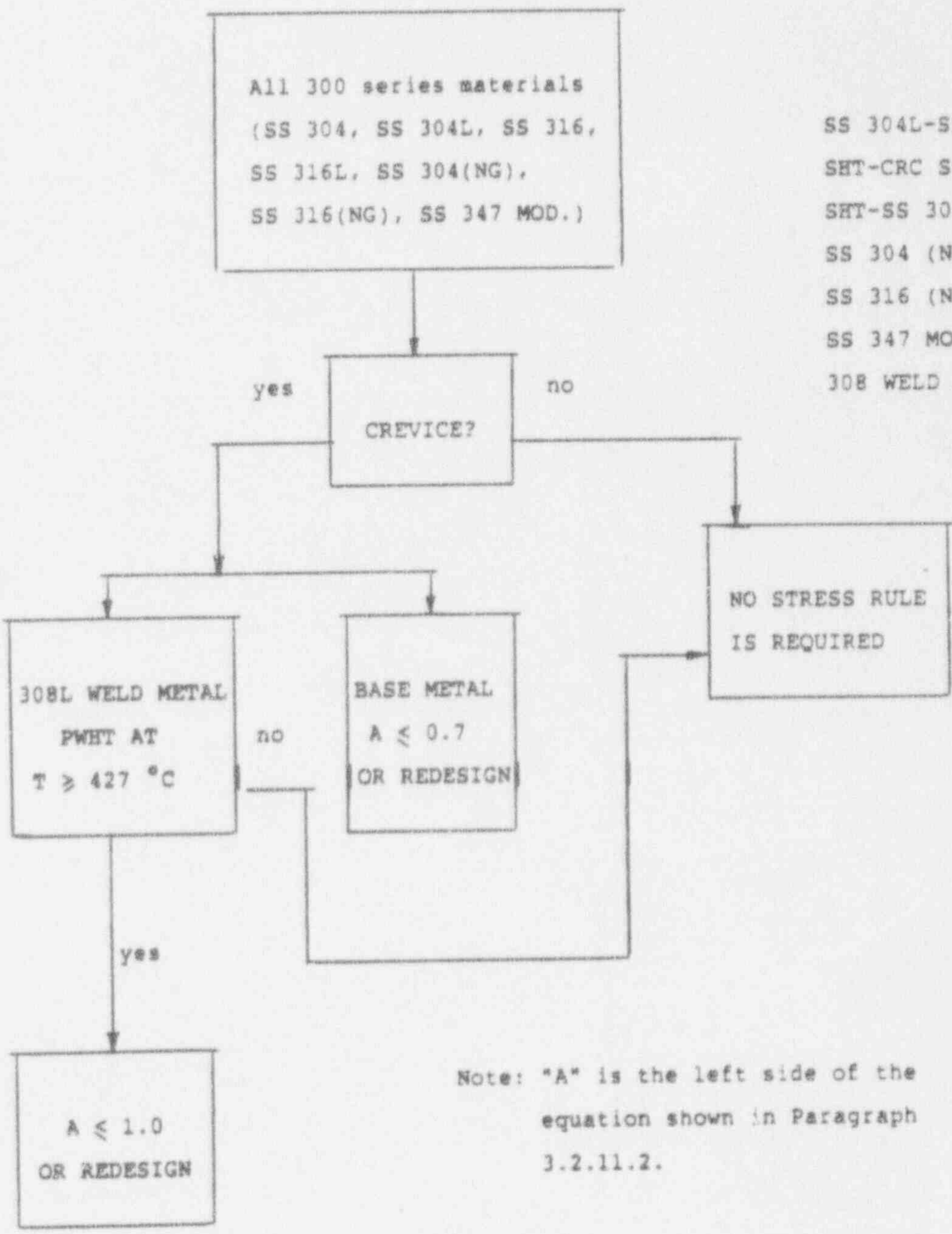
g) & h) For parallel plates, exposed to bulk solution on the whole perimeter, the depth is half of the shortest edge dimension, or the shortest dimension to the bulk measured from the point farthest from the bulk.

3.2.12.2. If it can be shown experimentally or analytically that flow induces one volume exchange per hour then the configuration is not a crevice.

The requirement applies to austenitic stainless steel material where the concern is crevice stress corrosion cracking.

APPENDIX 3 - FIGURE 1

FLOW CHART OF STRESS RULES

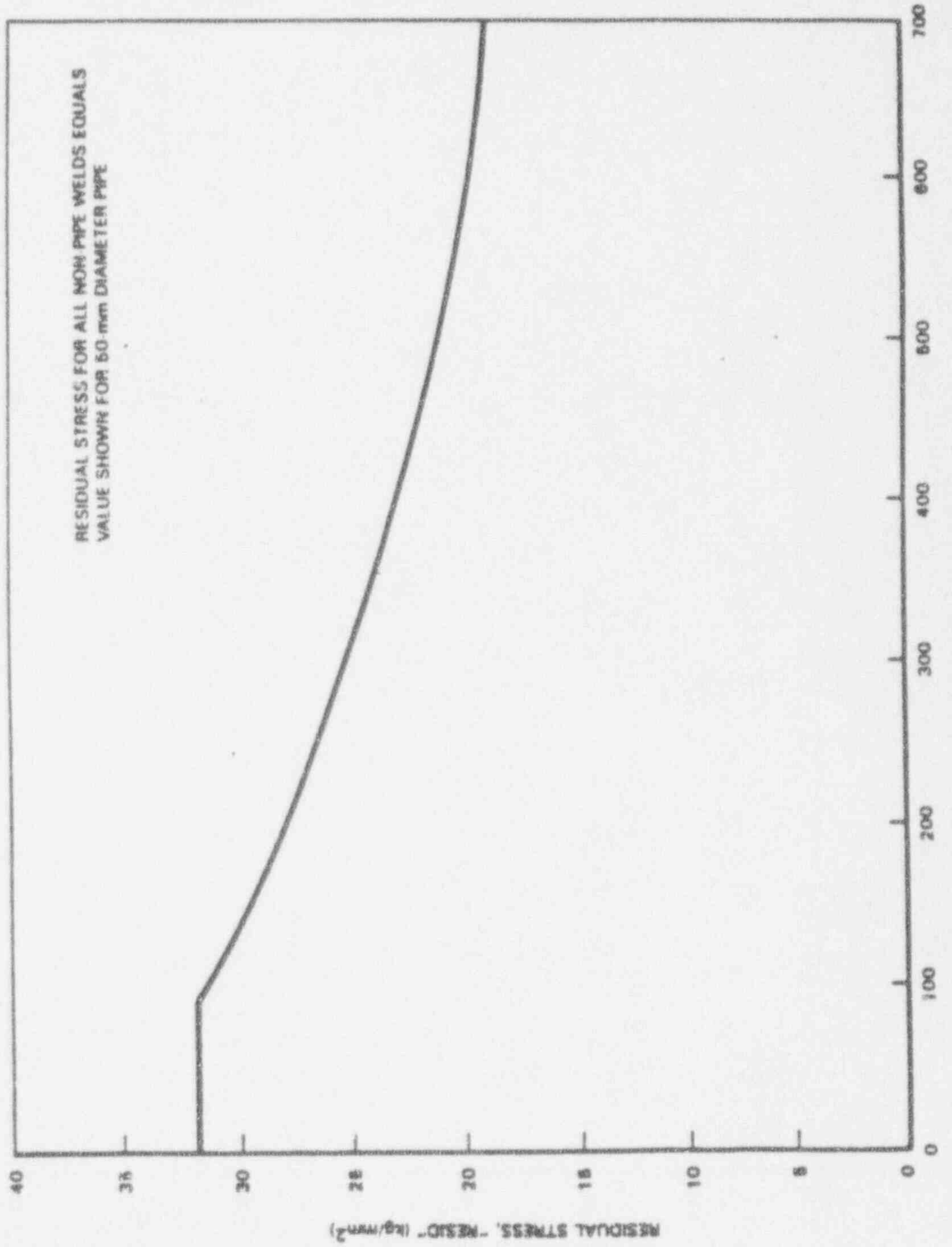


SS 304L-SS 316L
SHT-CRC SS 304
SHT-SS 304
SS 304 (NG)
SS 316 (NG)
SS 347 MOD.
308 WELD METAL

Note: "A" is the left side of the equation shown in Paragraph 3.2.11.2.

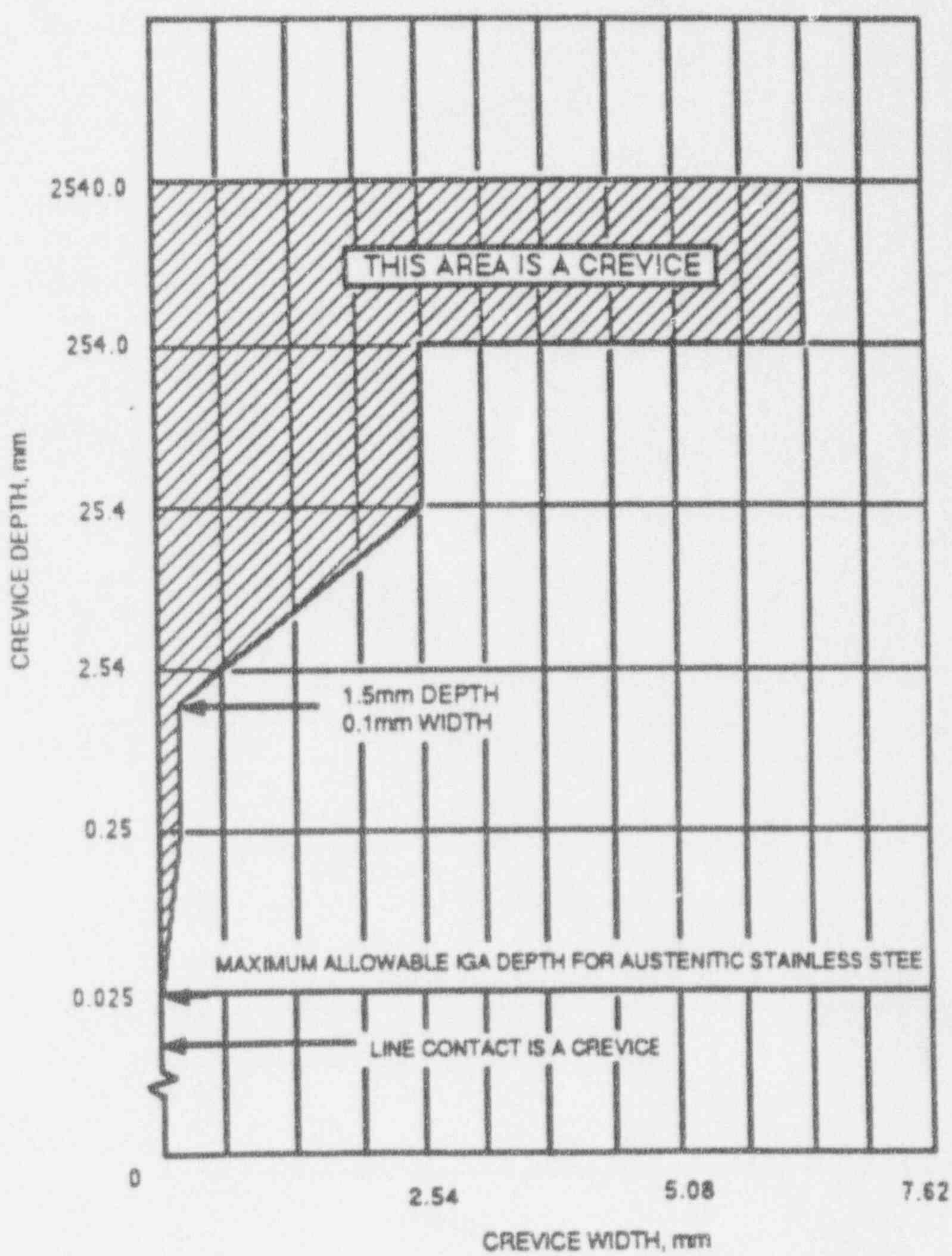
APPENDIX 3 - FIGURE 2

WELD RESIDUAL STRESS ASSUMPTION FOR ANNEALED STAINLESS STEEL SS 304, SS 304L, SS 316 AND SS 316L



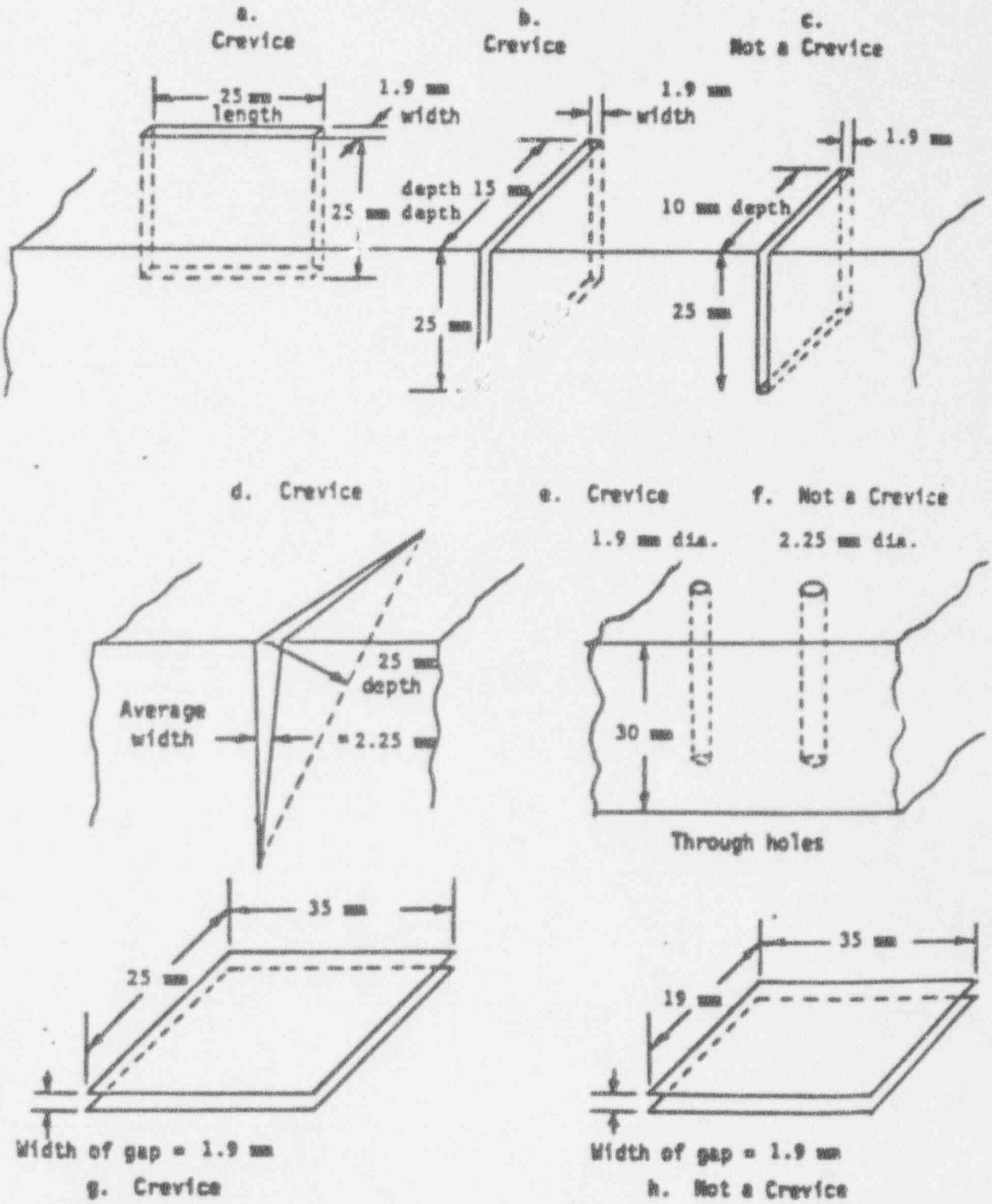
APPENDIX 3 - FIGURE 3

CREVICE DEFINITION



APPENDIX 3 - FIGURE 4

EXAMPLES OF THREE DIMENSIONAL CREVICES



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SBWR DOCUMENT DATA TRANSMITTAL

EDT No. ANGE-0361

a) ANSALDO
SBW 5280 TNIX N015 000 Rev.1 (06/05/92)
Passive containment cooling condenser equipment requirement specification
WBS 3.3.3.1.2