ASME CODE

CLASSIFICATION FOR CONTAINMENT PENETRATIONS

HVAC-1 AND HVAC-2

By

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# PREFACE

Revision 1 to this Engineering Evaluation was prepared to incorporate an interpretation of the ASME Code from Reedy Associates. The interpretation pertains to the determination of the material thickness of a weldneck flange for the purpose of establishing if impact testing is required by Subsection NE of the ASME Boiler and Pressure Vessel Code.

Certain specific conclusions in the initial issue of this Engineering Evaluation were based on the use of the flange hub material thickness for the purpose of establishing if impact testing was required by Subsection NE of the ASME Boiler and Pressure Vessel Code. The ASME Code interpretation from Reedy Associates suggests that the material thickness at the flange weld bevel section be used to establish if impact testing is required by the ASME Code.

By applying the ASME Code interpretation from Reedy Associates and the subsequent use of the actual flange material thickness at the weld bevel section of the flange, it has been concluded that the weldneck flange material currently installed as part of Containment penetrations HVAC-1 and HVAC-2 is exempt from impact testing as permitted by Subsection NE, subparagraph NE-2311 in the 1986 edition of the ASME Boiler and Pressure Vessel Code.

The appropriate sections of this Engineering Evaluation have been revised to incorporate the Reedy Associates ASME Code interpretation and the resulting new conclusion.

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## 1.0 PURPOSE

The primary purpose of this Engineering Evaluation is to provide the pertinent ASME Code interpretations to establish the appropriate ASME Code classification for the new Containment penetration design which is specified in DCR 92-014. This evaluation also documents a material review and describes and documents the principal differences between the requirements of ASME Code Class 2 and Code Class MC from a Quality Assurance perspective.

## 2.0 BACKGROUND INFORMATION

The Station Technical Support department has requested Engineering to remove two CAP valves, 1-CAP-V-1 and 1-CAP-V-4 and to relocate these valves up stream from their current location. The current valve locations, system configuration and ASME Code classifications and Code boundaries are detailed on P&ID, 1-MAH-D20504. In place of these CAP valves, a new dual configuration penetration design is currently being evaluated by Systems Engineering. In plant modes 1 through 4, the new penetration design will be configured with a blind flange bolted to the end of the penetration sleeve. In this configuration, the penetration forms part of the primary Containment pressure boundary. In plant modes 5 and 6, the new penetration design will be configured with a transition spool piece which also bolts to the end of the penetration sleeve. In this configuration, the penetration forms part of the pressure boundary of the CAP system . The new, dual configuration penetration design is detailed on sketches 92-0014-2004 and 92-0014-2005 in DCR 92-014.

As part of the new penetration design, the ASME Code classification of the penetrations will be specified as ASME Code Class MC. The establishment of the ASME Code classification for these two Containment penetrations is the primary purpose of this Engineering Evaluation.

In plant modes 1 through 4, the new penetration design will not perform any mechanical system functions but will serve as a spare penetration and as such will only perform a Containment pressure boundary function. In plant modes 5 and 6, the new penetration design will be aligned with the Station fans, FN-34 and FN-35. In this configuration, the two penetrations will form part of the pressure boundary of the non-safety related CAP system.

As a result of the new Containment penetration design, the testing classification of the

two penetrations will also be changed from one which requires a Type C leak test to one which requires a Type B leak test. Refer to 10 CFR 50, Appendix J for the specific Containment penetration leakage testing requirements.

In the current configuration, the four CAP valves, 1-CAP-V-1,2,3,4 perform two separate, distinct functions. First, in plant modes 5 and 6 these valves function as part of the pressure boundary of the CAP system and secondly, in plant modes 1 through 4 these valves function as Containment isolation valves which is considered to be a safety related function. As Containment isolation valves these components are subjected to periodic seat leakage tests which are difficult to pass due to the size and internal construction of these 36 inch, butterfly valves. During the last refueling outage, the Station added one day to the outage schedule attempting to pass the required seat leakage tests. The Station T :chnical Support department feels that the new penetration design, which will be subjected to a Type B leak test as specified in Appendix J, will meet the specified leakage requirements. The new penetration design will provide a more reliable, leak tight Containment pressure boundary. These are the reasons for the new Containment penetration design for Containment penetrations, HVAC-1 and HVAC-2 as outlined above and as further specified in DCR 92-014.

The Seabrook Station Containment structure is classified as a Seismic Category I and American Nuclear Society (ANS) Safety Class 2 structure. The Containment structure was designed in accordance with the requirements of the Code for Concrete Reactor Vessels and Containments, ASME Boiler and Pressure Vessel Code, Section III, Division 2, dated January 1, 1975. ASME Code "N" stamping of the Containment structure was not required, as approved by the State of New Hampshire, Department of Labor. The ASME Design Specification for the Containment structure is 9763-006-80-1.

The Containment liner and penetration assemblies are designated as "Parts" in accordance with Subarticle CA-1420 of ASME III, Division 2 except that the Code "NPT" stamping was not required and a Fabricators Report of Certification was executed in lieu of an ASME Code Data Report. The portions of the Containment penetration sleeves backed by concrete, including the anchorage system were designed to the requirements of ASME Section III, Division 2. The portions of the Containment penetration sleeves extending beyond the concrete wall were designed to the requirements of ASME Section III, Division 1 in accordance with paragraph CC-3831.1

of Section III, Division 2. These portions of the penetration sleeves not backed by concrete are classified as Category One Transition Sections as defined in Subarticle CC-3830 of ASME III Division 2, and as such were designed to the requirements of Division 1, except that proof testing was in accordance with Article 6000 in Division 2. These two HVAC penetrations were designed and analyzed to meet the intent of subsection NE of ASME Section III as described in sections 3.8.2.3, 3.8.2.4 and 3.8.2.5 of the UFSAR. Additionally, according to the Piping Design Specification, these portions of the two HVAC penetration sleeves were designed to the stress requirements of ASME Section III, Subsection NC (Class 2) and Subsection NE (Class MC). Accordingly, the UE&C Containment penetration detail drawings typically detailed the portion of the penetration sleeves not backed by concrete as ASME Section III, Division 2. These Code Classes and Code boundaries on the penetration detail drawings are consistent with the Code requirements specified in the ASME Code and the ASME Design Specification for the Containment structure, 9762-006-80-1.

The "Code of Construction" for the ASME Section III, Division 1 piping systems at Seabrook Station was the 1977 edition with the Winter 1977 addendum to the Code. This was the original Code of Construction for the two Containment penetration joints which will be classified as ASME Code Class MC in DCR 92-014. The ASME Design Specification for the Station safety related Code piping systems is 9763-006-248-43. This was the applicable ASME Design Specification which was applied to the original design and installation of these HVAC penetrations.

## 3.0 DISCUSSION

### 3.1 ASME Code Interpretations

This section of the Engineering Evaluation provides the pertinent ASME Code interpretations to establish the appropriate ASME Code classification for the new Containment penetration design for Containment penetrations HVAC-1 and HVAC-2.

On the outside of Containment, the current configuration of the two Containment penetrations HVAC-1 and HVAC-2 consists of the penetration sleeve, a weldneck flange and a butterfly valve bolted to the weldneck flange. The ASME Code classifications of these items are as follows. According to the ASME Division 2 Code and the ASME Design Specification for the Containment structure, the portions of the penetration sleeves which extend beyond the concrete

are classified as Division 2 (designed to Division 1).

According to the original UE&C Piping Erection Isometric drawing 9763-F-409301,and the current NAESCO P&ID 1-MAH-D20504, the weldneck flanges, weld joints and butterfly valves are classified as ASME Code Class 2 and ANS Safety Class 2. The weldneck flange material was certified to the requirements of ASME Class 2 with supplemental impact testing. The butterfly valves were ASME Code stamped as Class 2 components. A review of the original construction documents has determined that the field welding and radiographic examinations of the welds which joint the weld neck flanges to the penetration sleeves (FW001 and FW006) were performed to ASME Class 2 requirements.

A new, dual configuration penetration design is currently being evaluated by Systems Engineering. In plant modes 1 through 4, the configuration of the new penetration design will consist of the existing penetration sleeve, weldneck flange and a new blind flange bolted to the weldneck flange. Under the new penetration design, the ASME Code classification of the penetration sleeves and the weldneck flanges will be ASME Code Class MC with an ANS Safety Class 2 designation. The ASME Code Class for the new blind flanges and bolting material will also be ASME Code Class MC and will also have an ANS Safety Class 2 designation. The new penetrations will be analyzed and designed to meet the intent of ASME Section III, Subsection NE. This approach is consistent with the approach taken by UE&C to the original design of these penetrations and is also consistent with the design methodology described in the UFSAR.

The ASME Code classification and associated Code boundaries for the new penetration design is established based on three, separate independent ASME Code interpretations all of which reached a common conclusion that ASME Code Class 2 or Code Class MC are Code acceptable classifications for the new penetration design. A discussion of the three ASME Code interpretations is as follows.

3.1.1 Engineering Programs Group Interpretation

The first Code interpretation was provided by the NAESCO Engineering Programs Group. The initial task was to establish the appropriate ASME Code classification for the new Containment penetration design which is proposed in DCR 92-014. The investigation determined

that this type of penetration design, which only functions as a primary Containment pressure boundary and is not associated with any piping, mechanical or electrical systems, was typically classified as Code Class MC by the original Containment Designer, UE&C. Examples of similar types of penetration designs which were classified as Code Class MC, are the Containment Equipment Hatch, Personnel Air Locks and the Fuel Transfer Tube Hatch.

However, a review of ASME Section III, Subsection NE concluded that the ASME Code permits the Owner/Designer to classify these types of penetration designs as either Code Class 1, 2 or MC. This conclusion was based on Figure NE-1120-1 (a) and the requirements specified in Article NE-1000.

The final conclusion from the Engineering Programs Group was that ASME Section III, Subsection NE permits the Owner/Designer to classify Containment penetrations such as the new, Seabrook Station Containment penetration design as ASME Code Class 1, 2 or MC.

3.1.2 UE&C Interpretation

In order to confirm the ASME Code interpretation from the Engineering Programs Group, the original Seabrook Containment Designer UE&C was contracted and their interpretation of the ASME Code regarding the Code classification of the new Containment penetration design was solicited.

The written response from UE&C (Attachment A) stated that the designation of the weldneck flange and blind flange as Class MC would be consistent with the original Seabrook design for spare penetrations. Reference was made to Figure NE-1120-1 which shows that for a capped penetration the cap can be Code Class 1, 2 or MC.

This ASME Code interpretation from the original Containment Designer UE&C provided an independent confirmation that ASME Code Class 2 or Code Class MC are Code acceptable classifications for the new penetration design. In addition, this Code interpretation supported the position that the existing, installed weldneck flanges were acceptable by Code for the new penetration design.

3.1.3 Reedy Associates Interpretation

The ASME Code interpretations from the Engineering Programs Group and UE&C were evaluated by Engineering management and it was decided to obtain a third ASME Code interpretation from another, independent ASME Code authority. Reedy Associates were contracted to provide this final Code interpretation. Reedy Associates was selected due to Mr. Roger Reedy's extensive participation on several ASME Section III Code Committees and his renown reputation regarding the application and interpretations of the ASME Boiler and Pressure Vessel Code. In the nuclear industry, Mr. Roger Reedy is considered to be one of the foremost authorities on the ASME Section III Code.

The written response from Reedy Associates (Attachment B) stated that the intent of ASME Section III, Subsection NE, Subarticle NE-1120 as applied to the new Seabrook penetration design, is that the weldneck flange, blind flange and bolting material may be classified as either Code Class 2 or Code Class MC.

This third, ASME Code interpretation from Reedy Associates provided another independent interpretation of the ASME Code which was consistent with the two previous interpretations in that according to the ASME Code, the new penetration design can be classified as either ASME Code Class 2 or Code Class MC.

3.2 ASME Material Review

In order to utilize the existing, installed weldneck flanges as part of the new penetration design, a review of the original installation records and the material certification was necessary. The Engineering Programs Group requested the services of the Nuclear Quality Group to perform this task.

The NQG's review of the original installation records included a review of the welding records, installation procedures, NDE procedures and acceptance criteria. This review confirmed that the installation, which was performed to ASME Code Class 2 requirements also complies with ASME Code Class MC requirements. However, a review of the material certification for the weldneck flange in piping line # 1-CAP-9301-1-157-36, established that the material complied

with ASME Code Class 2 requirements but did not comply with ASME Code Class MC requirements. Specifically, it was initially reported that the material impact properties of the weldneck flange reported on the certified material test report did not meet the minimum energy values required by Subsection NE of the ASME Code. Using the actual 0.875 inch flange hub thickness from the existing, installed weldneck flange, Subsection NE requires the material to meet the energy values specified in Table I-10.0 of Appendix I. Appendix I specifies energy values of 20 ft-lbs for the average of the three specimens with no one individual specimen less than 15 ft-lbs. The reported energy values on the certified material test report are 9-9-10 ft-lbs.

Based on the above data, it was initially concluded that the new penetration design for Containment penetration HVAC-2 could not be classified as ASME Code Class MC unless the existing, installed weldneck flange was replaced. Accordingly, it was then recommended that the new penetration design be classified as ASME Code Class 2 as justified by the three ASME Code interpretations outlined in this Engineering Evaluation. This recommendation was also justifiable since the 1977 edition with the Winter 77 addendum of ASME Section III, Subsection NC for Code Class 2 applications does not specifically require impact testing. In Subsection NC, Subarticle NC-2311(a), states that the Design Specification shall state whether or not impact testing is required. Paragraph 2.3.2.1 in the ASME Design Specification for the Seabrook Station Code Piping Systems, 9763-006-248-43, states in part that impact testing for Code Class 2 and 3 carbon steel, pressure boundary material is not required.

An interpretation of the ASME Code from Reedy Associates was obtained after the initial issue of this Engineering Evaluation. The Code interpretation pertained to the determination of the material thickness of the weldneck flange for the purpose of establishing if impact testing was required by Subsection NE of the ASME Boiler and Pressure Vessel Code. The ASME Code interpretation from Reedy Associates suggests that the material thickness at the weld bevel section of the flange be used to establish if impact testing was required by Subsection NE of the Code. By applying the ASME Code interpretation from Reedy Associates and the subsequent use of the actual 0.375 inch flange thickness at the weld bevel section of the flange instead of applying the thicker flange hub thickness of 0.875 inch, it is concluded that the weldneck flange material currently installed as part of Containment penetrations HVAC-1 and HVAC-2 is exempt from impact testing as permitted by Subsection NE, subparagraph NE-2311 in the 1986 edition of the

of the ASME Boiler and Pressure Vessel Code. Refer to Attachment D which documents the Code interpretation from Reedy Associates.

An evaluation of the weldneck flange material with the low impact properties was performed by the Engineering Programs group with input from other Engineering groups and a materials consultant from UE&C. The results of this evaluation are as follows.

The impact values reported on the CMTR for the existing, installed weldneck flange material are below the minimum required by Subsection NE of the ASME Code but are acceptable for the Containment penetration application conditions based on the five factors identified below.

1.0 The reported impact values are typical for SA/A 105 material and are not indicative of inferior, poor quality or defective material. Refer to Table 1 in Attachment C which identifies impact-related values for three similar grades of steel having a similar chemistry to that of SA/A 105 material.

2.0 All other mechanical properties and the chemical composition of the material as reported on the CMTR are in full compliance with the requirements of the SA/A 105 material specification.

3.0 Inservice, the material will be subjected to very low strain rates compared to the impact testing strain rates. The very low strain rates were calculated based on a maximum stress of 3200 PSI and a maximum loading rate of 5 PSIG per hour during the ILRT. The strain rates resulting from the ILRT loads were determined to be the governing condition even though during accident conditions (DEPS), (DECL), (DEHL), the strain rates in Containment are greater than the ILRT strain rates. At the start of these accidents the corresponding Containment temperature is approximately 50 degrees F higher than the peak ILRT temperature. The weldneck flange material will be over 100 degrees F above it's impact transition temperature at the start of these accidents.

Fracture requirements for ferritic bridge steels similar to SA/A 105 material consider dynamic (impact) loading if strain rates are on the order of 10/sec and slow loading rates

at 1E-5/sec or below. The weldneck flange material will experience maximum loading rates three orders of magnitude below the criterion for slow loading rates. Therefore, it is concluded that the impact properties reported on the CMTR which were established from dynamic loading conditions are not a valid technical consideration since they do not represent the actual inservice conditions.

4.0 The minimum service temperature for the material is 50 degrees F which is 75 degrees F above the -25 degrees F test temperature which the reported impact tests were performed at. The Code required impact test temperature is 30 degrees F below the lowest service temperature which in this application would be 20 degrees F.

The predicted impact properties under slow loading conditions would be approximately 18 ft-lbs at -25 degrees F and 25 ft-lbs at 20 degrees F. The 25 ft-lbs predicted impact property which is based on actual inservice slow loading conditions at the appropriate minimum service temperature of 20 degrees F , complies with the ASME Code requirements in Subsection NE. Once again, it is concluded that the impact properties reported on the CMTR which were established at a temperature 75 degrees F below the minimum service temperature of the material are not a valid technical consideration since they were established well below the minimum temperature required by the ASME Code. Refer to Figure 2 in Attachment C for the curves used to establish the predicted impact properties which are noted above.

5.0 The weldneck flange material is classified as ASME Code Class MC in accordance with Subsection NE of the ASME Code. Based on the ASME Code interpretation from Reedy Associates, utilizing the 1986 edition of the ASME Code, it is concluded that the weldneck flange material which forms part of Containment penetrations HVAC-1 and HVAC-2 is exempt from impact testing based on the thickness of the flange material. Hence, the impact properties reported on the CMTR are not applicable based on the actual thickness of the weldneck flange material since the Code exempts material of this thickness from impact testing.

3.3 ASME Code Class Evaluation

This section of the Engineering Evaluation will describe the principal differences between the requirements of ASME Section III, Code Class 2 and Code Class MC from a Quality Assurance perspective. The approach which was taken was to first, establish the specific ASME Code edition and addendum to be used in the evaluation; second, establish the specific Quality Assurance criteria to be used as the baseline of the evaluation; third, identify the specific ASME Code requirements from Subsections NC, NE and the General Requirements of Section III for each of the Quality Assurance criteria included in the evaluation; and finally, describe the results of each Code Class evaluation.

The 1977 edition with the Winter 1977 addendum of the ASME Section III, Division 1 Code were selected for this Engineering Evaluation. This edition and addendum was selected since this was the original Code of Construction for the two Containment penetration joints which will be classified as Code Class 2 in DCR 92-014.

Subsections NC, NE and the General Requirements of Section III were reviewed and the following Quality Assurance criteria were selected as the baseline of the evaluation.

- Quality Assurance Program Requirements
- Material Requirements
    - Pressure Retaining Materials
    - Certification of Materials
    - Material Identification
    - Welding and Brazing
    - Examination and Repairs
    - Material Manufacturers Quality System Programs
- Examination Requirements
- Testing Requirements
- Nameplate, Stamping and Report Requirements

3.3.1 Quality Assurance Program Requirements

The Quality Assurance Program requirements for ASME Class 2 applications are specified in Subarticle NA-3700, Material Manufacturer's and Material Supplier's Quality System Program and Subarticle NA-4000, titled Quality Assurance.

The Quality Assurance Program requirements for ASME Class MC applications are specified in the same Code Subarticles as those for Class 2.

There are no differences in the Quality Assurance Program requirements for ASME Class 2 and Class MC applications. The ASME Quality Assurance Program requirements for MM, MS, N, NPT and NA Certificate Holders are the same for the design, fabrication, manufacture and installation of Code Class 1, 2, CS and MC items.

3.3.2 Material Requirements

The Code Material Requirements for ASME Class 2 applications are specified in Article NC-2000. The pressure retaining material requirements are specified in Subarticle NC-2120, the certification requirements are specified in Subarticle NC-2130, the material identification requirements are specified in Subarticle NC-2150, the welding and brazing requirements are specified in Subarticle NC-2400, the impact testing requirements are specified in Subarticle NC-2300, the requirements for examination and repairs are specified in Subarticle NC-2500 and the Material Manufacturer's Quality System Program requirements are specified in NC-2600.

The Code Material Requirements for ASME Code Class MC applications are specified in Article NE-2000. The specific material requirements are specified in Subarticles NE-2120, NE-2130, NE-2150, NE-2400, NE-2300, NE-2500 and NE-2600.

The principal difference between the general requirements for materials in NC-2110 and NE-2110 is that the term pressure retaining materials as used in Subsection NC includes valve bodies, bonnets and disks; pump casings and covers. These specific component parts are not included in the term for pressure retaining materials in Subsection NE.

For pressure retaining materials and attachment materials, Subarticle NC-2121 mandates the use of the material specifications given in Table I-7.0 while NE-2121 mandates the use of the material specifications given in Table I-10.0. Both tables include ferritic steels, austenitic steels, high nickel and copper alloys and bolting materials for the respective Code Class. However, the list of material specifications given in Table I-7.0 for Class 2 applications is much more extensive than the list of material specifications given in Table I-10.0 for Class MC applications. The more

extensive list of material specifications in Table I-7.0 represents product forms for component parts which are not typically included within the scope of Subsection NE. In addition, Table I-10.0 includes impact testing values for ferritic steels for Class MC applications whereas Table I-7.0 does not include any impact testing values for Class 2 applications.

Subarticle NC-2121 mandates the use of the material specifications given in Table I-1.0 for vessels which are designed to the alternate design rules of NC-3200. Subsection NE does not include any alternate design rules in Article NE-3000 or any associated, additional material requirements in NE-2000.

Other differences are that Subarticle NE-2121 includes specific material conditioning requirements for certain thicknesses of pressure retaining ferritic steels whenever the material is not impact tested. Also, Subarticle NE-2127 includes specific requirements for clad plate materials which are not included in Article NC-2000.

Both Subarticles NC-2128 and NE-2128 are titled "Bolting Material". Subarticle NC-2128 mandates the use of Tables I-7.3 or I-1.3 for the list of acceptable bolt and stud materials. Subarticle NE-2128 does not include or reference any bolt or stud material requirements but is limited to identifying specific nut and washer requirements. It appears that reference to Table I-10.3 for acceptable bolt and stud materials for Class MC applications was errantly omitted from Subarticle NE-2128 and the other subarticles in Article NE-2000.

The Code requirements for certification of material specified in Subarticles NC-2130 and NE-2130 are identical. The Code requirements for material identification specified in Subarticles NC-2150 and NE-2150 are also identical.

The Code welding material requirements in Subarticles NC-2400 and NE-2400 are identical. The Code brazing material requirements are specified in Subarticle NC-2450 for Class 2 applications while Article NE-2400 does not include any specific requirements for brazing materials for Class MC applications.

The Code requirements for material impact testing are specified in Subarticles NC-2311

and NE-2311. Subarticle NC-2311 states that the Design Specification shall state whether or not impact testing is required for pressure retaining materials while NE-2311 identifies the specific materials for which impact testing is required for Class MC applications. Both Subarticles include similar conditions when impact testing is not required by Code.

Subsection NC-2311 includes specific impact testing requirements for martensitic high alloy chromium (series 4xx) steels and precipitation-hardening steels which are not included in Article NE-2000.

The Code required impact test procedures specified in Subarticle NC-2320 and NE-2320 are identical. The Code test requirements and acceptance standards for impact tests specified in Subarticle NC-2330 and NE-2330 are significantly different. Subarticle NC-2330 includes specific impact test requirements based on material thicknesses and also includes a separate table for the acceptance standards. Subarticle NE-2330 includes more general impact test requirements and for other than bolting material, references Table I-10.0 for the acceptance standards.

For other than bolting material, the acceptance standards for impact testing specified in NC-2330 for Class 2 applications is more stringent than the acceptance standards specified in NE-2330 for Class MC applications. However, for bolting material the acceptance standards for impact testing specified in NC-2345 and NE-2345 are identical.

The Code material requirements for examination and repair of pressure retaining material are specified in Subarticles NC-2500 and NE-2500. The Code examination and repair requirements for plate, forgings and bars; wrought seamless and welded (without filler metal) tubular products and fittings; tubular products and fittings welded with filler metal are the same.

The Code material requirements in Subarticles NC-2500 and NE-2500 for the examination and repair of statically and centrifugally cast products are different in that Subarticle NC-2570 includes alternate magnetic particle or liquid penetrant examinations in lieu of radiographic examination for certain sizes of pumps and valves. In addition, Subarticle NC-2577.2 includes specific radiography requirements applicable to pumps and valves and NC-2579.4 includes specific examination requirements applicable to repair welds in certain specific materials used in

the construction of Class 2 pumps and valves. There are no similar pump and valve examination requirements specified in Article NE-2000.

The Code requirements for examination of bolts, studs and nuts specified in Subarticles NC-2580 and NE-2580 are identical.

The Code requirements for the Material Manufacturer's Quality System Programs specified in NC-2600 and NE-2600 are identical except that NC-2600 includes additional small product exemptions for material for pumps and valves with inlet pipe connections 2" nominal pipe size and less.

3.3.3 Inspection Requirements

The Code Inspection Requirements for ASME Class 2 applications are specified in Article NA-5000, General Requirements for Authorized Inspection Agencies and Inspectors.

The Code Inspection Requirements for ASME Class MC applications are specified in the same Code article as that for Class 2.

There are no differences in the ASME Code Inspection Requirements for ASME Class 2 and Class MC applications. From an ASME Code perspective and as used in this Engineering Evaluation, Inspection Requirements are those Code duties assigned to the Authorized Nuclear Inspection Agency and its certified, Authorized Nuclear Inspectors (ANI).

3.3.4 Examination Requirements

The Code Examination Requirements for ASME Class 2 applications are specified in Article NC-5000, titled Examination.

The Code Examination Requirements for ASME Class MC applications are specified in the Article NE-5000 which is also titled Examination.

The principal differences between the general requirements of NC-5100 and NE-5100 are that NC-5100 includes specific penetrameter requirements for radiographic examinations whereas

NE-5100 imposes the penetrameter requirements specified in Article 2 of Section V of the ASME Code. This results in Subsection NC requiring a higher sensitivity for radiographs of certain material thicknesses. In addition, NC 5100 imposes ASME Section V Article 10, paragraph T-1030 for gas and bubble formation testing criteria while Article NE-5000 does not impose any specific leak testing criteria. The general requirements of NC-5100 also include specific examination requirements for Class 2 vessels designed to the alternate design rules of NC-3200 and nondestructive examination requirements for atmospheric and 0 to 15 PSI storage tanks. Subsection NE does not include any alternate design rules in Article NE-3000 or any associated examination requirements in Article NE-5000. Subsection NE does not include any examination requirements for storage tanks.

Subarticles NC-5130 and NC-5140 include specific requirements for examinations of weld edge preparation surfaces and examination requirements for openings cut in vessels designed to the alternate design rules in subarticle NC-3200. Subarticle NE-5600 includes examination requirements for vessel materials which are similar but different than the examination requirement in NC-5130. In general, NE-5610 imposes additional visual examinations and liquid penetrant or magnetic particle examinations of material which are not imposed by NC-5130. Subarticle NE-5600 does not include any examination requirements for vessels designed to the alternate design rules of NC-3200.

Subarticle NC-5200 includes specific examination requirements for vessel joints and other, separate examination requirements for joints in piping, pumps and valves. Subarticle NE-5200 does not specifically identify piping, pump or valve examination requirements but does specify examination requirements based on the Code category of the weld joint.

One significant difference between the NC and NE examination requirements is that Article NE-5000 includes special exceptions for radiographic examinations which are not permitted by NC-5000. However, NC-5277 does include special exceptions for radiographic examinations, but the application is limited to certain specific joints in penetration assemblies. Subarticle NE-5200 also includes specific examination requirements for inaccessible welds while Article NC-5000 does not address inaccessible welds.

Other differences are that Subarticle NE-5200 requires radiographic examination for all Code category A,B,C and D butt weld joints while NC-5200 does not impose radiographic examinations for all Code category joints. Subarticle NC-5200 requires radiographic examinations for certain material thicknesses and types of weld joints. Subarticle NC-5250 identifies specific examination requirements for vessels designed to the alternate design rules of NC-3200. As previously noted, Subsection NE does not include any alternate design rules in Article NE-3000 or any associated examination requirements in Article NE-5000.

The radiographic, ultrasonic, magnetic particle and liquid penetrant acceptance standards specified in Subarticles NC-5300 and NE-5300 are identical. Subarticle NC-5300 also includes visual acceptance standards for brazed joints, acceptance standards for metallographic examination of specially designed welded seals and gas and bubble formation testing criteria. These topic are not addressed in Article NE-5000.

The Code requirements for the qualifications of nondestructive examination personnel specified in Subarticles NC-5500 and NE-5500 are identical.

Other differences between Articles NC-5000 and NE-5000 are that NC-5000 includes examination requirements for expansion joints which are not included in NE-5000. In addition, Subarticle NE-5600 includes specific vessel material examination requirements which are not included in Article NC-5000.

### 3.3.5 Testing Requirements

The Code Testing Requirements for ASME Class 2 applications are specified in Article NC-6000 titled Testing.

The Code Testing Requirements for ASME Class MC applications are specified in Article NE-6000 which is also titled Testing.

The principal differences between the general requirements of NC-6100 and NE- 6100 are that the scope of NE-6100 applies to vessels and appurtenances constructed or installed under

the rules of Subsection NE while the scope of NC-6100 applies to components, appurtenances and systems constructed or installed under the rules of Subsection NC. In addition, NE-6112 (b) includes provisions for a preliminary pneumatic test at a pressure not to exceed one-tenth (1/10) the test pressure as a means of locating major leaks while NC-6112 (b) includes similar provisions except that the test pressure shall not exceed 25 PSI. The general requirements in NC-6100 also includes specific testing requirements applicable to testing of systems which are not included in NE-6100.

The differences between the hydrostatic testing requirements of NC-6200 and NE-6200 are in the area of test pressures. Specifically, NC-6221 requires completed components and appurtenances other than piping systems to be hydrostatically tested at a pressure not less than 1.5 times the system design pressure and 1.25 times the system design pressure for completed systems. NE-6221 requires completed vessels and appurtenances to be hydrostatically tested at a pressure not less than 1.35 times the design pressure multiplied by the lowest ratio (for materials of which the item being tested is constructed) of the permissible allowable stress value, S, at the test temperature of the item being tested to its design allowable stress value, S, at the design temperature (NE-3112.2).

The differences between the pneumatic testing requirements of NC-6300 and NE-6300 are also in the area of test pressures. Specifically, NC-6321 requires pneumatic test pressures for systems, components and appurtenances except storage tanks to be not less than 1.25 times the system design pressure. NE-6321 requires pneumatic test pressures to be not less than 1.10 times the design pressure of the vessel or appurtenance, multiplied by the lowest ratio (for the materials of which the item being tested is constructed) of the permissible allowable stress value, S, at the test temperature of the item being tested to the design allowable stress value, S, for the design temperature (NE-3112.2).

There are no differences between the pressure test gage requirements of NC-6400 and NE-6400.

Subarticle NC-6500 identifies specific testing requirements applicable to atmospheric and 0 to 15 PSI storage tanks. Subsection NE does not include any testing requirements for storage

tanks.

Subarticle NC-6600 identifies specific hydrostatic testing requirements applicable to vessels designed to the alternate design rules specified in NC-3200. Subsection NE does not include any alternate design rules in Article NE-3000 or any associated hydrostatic testing requirements in Article NE-6000.

Subarticle NC-6700 identifies specific pneumatic testing requirements applicable to vessels designed to the alternate design rules specified in NC-3200. As noted above, Subsection NE does not include any alternate design rules in Article NE-3000 or any associated pneumatic testing requirements in Article NE-6000.

Subarticle NE-6700 includes specific testing requirements for electrical and mechanical penetration assemblies. Subsection NC does not include any specific testing requirements for electrical or mechanical penetration assemblies.

Subarticle NC-6900 identifies specific requirements for proof tests to establish design pressures. Subsection NE does not include any requirements for proof testing to establish design pressures.

3.3.6 Nameplate, Stamping and Report Requirements

The Code Nameplate, Stamping and Data Report Requirements for ASME Class 2 applications are specified in Article NC-8000 and Article NA-8000 in the General Requirements for Section III.

The Code Nameplate, Stamping and Data Report Requirements for ASME Class MC applications are specified in Article NE-8000 and additional requirements are also specified in Article NA-8000 in the General Requirements for Section III.

Both ASME Subsections NC and NE endorse Article NA-8000 for the Nameplate, Stamping and Report Requirements. However, Article NE-8000 which is applicable to Class MC applications includes additional "N" and "NPT" stamping requirements for Containment Vessels,

Parts and Appurtenances. Also, Article NE-8000 specifies additional information for the Containment Vessel nameplate and the Certificate Holders Code Data Report.

4.0 SAFETY EVALUATION

This Engineering Evaluation predominantly deals with the establishment of the appropriate ASME Code Classification for the new Containment penetration design for the two HVAC penetrations, HVAC-1 and HVAC-2. The complete details of the new penetration design including the recommended ASME Code classification will be specified in DCR 92-014. As part of DCR 92-014, a complete 10 CFR 50.59 Safety Evaluation will be executed and will address all safety aspects of the new Containment penetration design. Hence, it has been determined that no further safety evaluation discussion is needed in this Engineering Evaluation.

5.0 CONCLUSIONS

The final conclusions of this Engineering Evaluation are based on the reviews of the applicable subsections of the ASME Codes, Code Interpretations, pertinent component Design Specifications and input from the various Engineering Group and two independent contractors. The final conclusions are as follows.

5.1 Subsection NE permits the Owner/Designer to classify Containment penetrations such as the new Seabrook Station Containment penetration design as ASME Code Class 1,2 or MC.

5.2 ASME Code Class MC is an acceptable Code Class for the new Seabrook Station Containment penetration design and this Code classification has been confirmed by three, separate independent Code interpretations.

5.3 The new penetrations will be analyzed and designed to meet the intent of ASME Section III, Subsection NE. This approach is consistent with the approach taken by UE&C to the original design of these penetrations and is also consistent with the design methodology described in the UFSAR.

5.4 The impact values reported on the CMTR for the existing, installed weldneck flange in piping line #1-CAP-9301-1-157-36 are acceptable for the Containment penetration application conditions.

5.5 According to Subsection NE of the ASME Code, based on the actual material thickness, the weldneck flange material which forms part of Containment penetrations HVAC-1 and HVAC-2 is exempt from impact testing.

5.6 The Code Quality Assurance requirements and Inspection requirements for ASME Code Class 2 and Code Class MC are the same.

5.7 Subsection NE identifies specific materials for which impact testing is required while Subsection NC states that the component Design Specification shall state whether or not impact testing is required.

5.8 The various Subarticles in Subsection NC include additional Code requirements for vessels designed to the alternate design rules of NC-3200 which are not included in Subsection NE since Subsection NE does not address alternate design rules.

5.9 There are numerous differences between the Examination requirements specified in Subsections NC and NE. The differences are based on specific factors such as material thicknesses, category of weld joint, design rules and type of component.

5.10 The principal differences between the Testing requirements of Subsections NC and NE are the specified hydrostatic and pneumatic test pressures.

5.11 Subsection NE includes additional "N" and "NPT" Stamping, Nameplate and Code Data Report requirements which are not included in Subsection NC.

## 6.0 REFERENCES


6.1 The 1977 edition with the Winter 1977 addendum of ASME Section III, Division 1, Subsections NC, NE and the General Requirements of Section III Division 1 and 2.

6.2 The January 1, 1975 edition of the Code for Concrete Reactor Vessels and Containments, ASME Boiler and Pressure Vessel Code, Section III, Division 2.

6.3 The Containment Design Specification, 9763.006-80-1.

6.4 The Design Specification for Nuclear Power Plant Piping Systems, 9763-006-248-43.

6.5 The Specification for Containment Equipment Hatch and Personnel Air Locks, 9763-006-15-2.

6.6 The Specification for Containment Liners, 9763-006-15-1.

6.7 NAESCO P&ID, Miscellaneous Air Handling Containment & Purges ( Detail CAP & COP ), 1-MAH-D20504.

6.8 NAESCO sketch, Duct Details at Previous Locations of CAP-V1 & CAP-V4, sketch SKD-920014-2004.

6.9 UE&C Containment Air Purge Piping Erection Isometric 1-CAP-9300-1, drawing 409301.

6.10 UE&C Containment Structure Piping Penetration Details, drawings 805575, 805574, 805578.

6.11 UE&C Containment Liner Penetration Schedule, drawing 101497.

6.12 UE&C Containment Liner Vertical Wall, drawing 101495, Pipe Sleeve Detail 101495C, for Air Duct Penetrations.

6.13 Foreign Print # 10556-01, PDM Equipment Hatch Details, PDM Shop Fabrication drawing #18.

6.14 Foreign Print # 10382-02, PDM Material Specification MS-7.29.4 For ASME SA 516 Grade 60, ASME Section III, Division 1 Subsection NE and Division 2, Subsection CC.

6.15 Foreign Print # 10381-01, PDM Material Specification MS-7.29.3 For ASME SA 516 Grade 60, ASME Section III, Division 1 Subsection NE and Division 2, Subsection CC plus 100 % UT Examination.

6.16 Foreign Print # 95662-01, Dravo Shop Fabrication Sketches # E-2936-1553, E-2936-1551, 36" Class 150 Weldneck Flanges.

6.17 UE&C calculation # 9763-C-01-SO-01-F, HVAC Containment Penetrations, dated May 1980.

6.18 NRC Regulatory Guide 1.57, Design Limits and Loading Combinations for Metal Primary Containment System Components, June 1973.

6.19 Service Environment Chart, Drawing 1-NHY-300219, Revision 22.

6.20 Station Operating Procedure EX1803.001, Reactor Containment ILRT - Type A.

6.21 NRC NUREG-0577, Potential for Low Fracture Toughness and Lamellar Tearing in PWR S.G. and R.C.P. Supports.

6.22 Seabrook Station UFSAR Section 3.8 Design of Category I Structures and Section 6.2.6 Containment Leak Rate Testing.

6.23 The 1986 edition of ASME Section III, Subsection NE.

7.0 ATTACHMENTS

7.1 Attachment A - UE&C letter from B.B.Scott to T.P.Vassallo Jr. dated December 22,1992, QA-92-104, ASME Code Questions.

7.2 Attachment B - Reedy Associates letter from Roger F. Reedy to T. P. Vassallo, Jr. dated February 2, 1993, NAC-93-001 ASME Code Interpretations.

7.3 Attachment C - UE&C Letter from T.G. Mudge to J. M. Vargas dated February 26, 1993, QA-93-024.

7.4 Attachment D - Notes of Telephone Conversation between T. P. Vassallo, Jr. and Roger Reedy dated March 26, 1993.

ATTACHMENT A

UE&C LETTER DATED DECEMBER 22, 1992

United Engineers & Constructors Inc.
30 South 17th Street
Post Office Box 8223
Philadelphia, PA 19101

215 422 3000
Telex 83 4203
Telecopier 215 422 4648

**United Engineers & Constructors**
A Raytheon Company

December 22, 1992

QA-92-104

Mr. T. P. Vassallo
North Atlantic Energy
Services Corp.
P. O. Box 300
Seabrook, NH 03874

Dear Mr. Vassallo:

Subject: Seabrook Station
Containment Penetrations -
ASME Code Questions

At your request we have reviewed a proposed Seabrook detail for Containment Penetrations HVAC 1 AND HVAC 2. It is our understanding that the following two ASME Code related questions are being asked.

1. Can the existing weldneck flange and the new blind flange be designated Class MC for plant operating modes 1-4 and the weldneck flange still be designated MC when connected with piping and valves during plant operating modes 5-6? The concern is that ASME Code Section NE-1120 precludes piping, pumps and valves from Class MC designation.

2. Can the Owner recertify the weldneck flange material from Class 2 to Class MC?

Our informal opinions based on reading of Code requirements follow. (The opinions expressed below do not address the technical or economic feasibility of the proposed modification.)

1. NCA-1110 states that equipment which does not serve the purpose of producing and controlling an output of thermal energy from nuclear fuel and those associated systems essential to the functions and overall safety of the nuclear power system need not be constructed to Section III. It is our understanding that when functioning in plant operating modes 5-6 the HVAC system is not safety related. Therefore, it would seem that the concern with Class 2 designation in modes 5-6 is not relevant. Designation of the weldneck flange and blind flange as Class MC is consistent with the original Seabrook design for spare penetrations.

Reference is made to Fig. NE-1120-1 which shows that for a capped penetration the cap can be Class 1, 2 or MC. This provides the option of maintaining the weldneck flange as Class 2.

2. Material purchased for use in a system must meet the Code requirements for the designated system class (i.e. 1, 2, MC). The material is not specifically certified to Code Class. Therefore, the weldneck flange can be used on a Class MC system if and when it meets all the Code Class MC requirements (i.e. material and fabrication requirements). Recertification of the material is not required. However, documentation should be on file showing that the requirements of MC have been met.

In summary, the proposed modification of the HVAC systems by the Owner under Section XI appears to meet Code requirements. All work must be performed under the Owner's QA program and be approved by the Authorized Nuclear Inspector. ANI approval would appear to be the key to proceeding with the modification as planned.

If additional questions still remain, it is suggested that an ASME General Requirements Subgroup member be solicited for an opinion or a more formal Code Inquiry be submitted.

If we can be of any further assistance, please call the writer on (215) 422-3532.

Very truly yours,

B.B. Scott

B. B. Scott - Manager
Quality Management & Services

BBS/jgm

ATTACHMENT B

REEDY ASSOCIATES LETTER DATED FEBRUARY 2, 1993

REEDY ASSOCIATES, INC.
ENGINEERING MANAGEMENT CONSULTANTS

February 2, 1993
NAE-93-001

Mr. Ted Vassallo, Jr.
North Atlantic Energy Service Corporation
Seabrook Nuclear Plant
PO Box 300
Seabrook, NH 03874

Dear Ted,

This letter is to summarize the results of our evaluation of your Code inquiry regarding removal of the CAP valves and reclassification of portions of the process piping system. Your inquiries have been restated, and your background information is attached, for your convenience.

INQUIRY (1):

Is the ASME MC Code classification detailed on page 5 consistent with ASME Code requirements or should the weld neck flange, blind flange, and bolting material (items 2, 3, 4, and 5) be classified as ASME Code Class 2 or other ASME Code Class?

REPLY (1):

Section III, Subsection NE (1992 Edition) provides guidance for Code Classification in NE-1120. NE-1120 (and Figure NE-1120-1) provide that piping which is part of the containment system and which penetrates or is attached to the containment vessel may be classified as Class 1 or 2 by the Design Specification. NE-1132.2(g) permits making the boundary between the Class MC and the Class 1 or 2 items farther from the containment vessel when specified in the Design Specification.

It is our opinion that the intent of NE-1120, as applied to this case, is that the weld neck flange, blind flange, and bolting material may be classified either Class 2 or MC, because the penetration is Class MC. Although the weld neck flange was originally classified Class 2, the Owner may choose to designate the weld neck flange, blind flange, and bolting material Class MC, by revising the Design Specification to so state.

15951 LOS GATOS BLVD., SUITE 1 • LOS GATOS, CALIFORNIA 95032 • (408) 356-6300

INQUIRY (2):

Under the rules of ASME Section XI, is it permissible for the Owner that is not a Certificate Holder to reclassify material originally certified to ASME Class 2 requirements in an ASME Class MC application, provided the material is reconciled by the Owner to meet all of the requirements of ASME Section III, Subsection NE?

REPLY (2):

Section XI does not contain any rules or guidance for reclassification of material. It is our opinion that the Owner may treat Class 2 material as complying with the requirements of Class MC by reconciling the differences between the Class 2 and Class MC requirements for the product form and application. For example, the reconciliation would have to take in to account any differences in impact test requirements and required nondestructive examination.

If you have any comments or questions, please do not hesitate to call.

Sincerely,

Roger F. Reedy, P.E.
President

BACKGROUND INFORMATION

The Seabrook Station containment structure was designed in accordance with the requirements of the Code for Concrete Reactor Vessels and containments, ASME Boiler and Pressure Vessel Code, Section III, Division 2, dated January 1, 1975. The portions of the containment penetration sleeves not backed by concrete were designed in accordance with the requirements of ASME Section III, Division 1. The Code of Construction for the ASME Section III, Division 1 process piping systems was the 1977 Edition with the Winter 1977 Addenda. Accordingly, your responses should be based on the 1977 Edition with the Winter 1977 Addenda, Code which was the original Code of Construction for the containment penetration joints.

The Seabrook Station Technical Support department has requested Engineering to remove CAP valves, 1-CAP-V-1 and 1-CAP-V-4 and to relocate these valves upstream from their present location. The existing valve locations, system configuration, and ASME Code Classifications and boundaries are detailed on the enclosed P&ID, 1-MAH-D20504. In place of the CAP valves, an alternative blind flange style penetration end detail is currently being evaluated by Engineering. A copy of the alternative blind flange style penetration end detail is also enclosed for your information. Refer to page 5.

In conjunction with relocation of these valves, the ASME Code Classification of these two penetrations will be changed from Class 2 to Class MC. This change in ASME Code Classification is the primary issue of this inquiry. In plant modes 1 through 4, the blind flange style penetration end detail will not perform any mechanical system functions but will perform a containment isolation function. In plant modes 5 and 6, the blind flanges will be removed and the penetrations will be aligned with the Station fans, FN-34 and FN-35. In this configuration, these two penetrations will form part of the non-safety-related CAP system and as such, do not provide any safety related functions.

As part of this change, the classification of these two penetrations will also be changed from one which requires a Type C leakage test to one which requires a Type B leakage test. Refer to 10 CFR 50, Appendix J for the containment penetration leakage testing requirements.

Under the existing configuration, these four CAP valves perform two functions. First, these valves perform a non-safety-related function as part of the CAP system, and secondly, they function as containment isolation valves, which is considered to be a safety related function. As containment isolation valves, these valves are subjected to periodic seat leakage tests, which are difficult to pass due to the internal construction of these 36-inch butterfly valves. During the last refueling outage, the Station added four days to the outage schedule trying to pass the required seat leakage tests. The Station Technical Support department feels that the alternative blind flange style penetration end detail, which will be subjected to a Type B leakage test as specified in Appendix J, will easily meet the specified leakage requirements. These are the reasons for the proposed changes to the two containment penetrations HVAC-1 and HVAC-2 as outlined above.

ATTACHMENT C

UE&C LETTER DATED FEBRUARY 26, 1992

United Engineers & Constructors Inc
30 South 17th Street
Post Office Box 8223
Philadelphia, PA 19101

215 422 3000
Telex 83 4203
Telecopier 215 422 4648

**United Engineers & Constructors**
A Raytheon Company

February 26, 1993

QA-93-024

Mr. J. M. Vargas
Manager of Engineering
North Atlantic Energy
Services Corporation
P. O. Box 300
Seabrook, NH 03874

Dear Mr. Vargas:

Subject: Seabrook Station
Containment Penetration HVAC-2
Evaluation of Flange Impact Properties

Enclosed is a report documenting the results of the subject evaluation.

If you have any questions or comments concerning this matter, please contact me at (215) 422-4630.

Very truly yours,

Thomas G Mudge

T. G. Mudge
Manager, Quality Engineering

TGM/jgm

Enclosure

cc: T.P. Vassallo (w/encl.) - NAESC
B.B. Scott - 02U1
Letter Log

UNITED ENGINEERS & CONSTRUCTORS

30 SOUTH 17TH STREET

PHILADELPHIA, PA

# CONTAINMENT PENETRATION HVAC-2

# EVALUATION OF FLANGE IMPACT PROPERTIES

# SEABROOK POWER STATION

# NORTH ATLANTIC ENERGY SERVICE CORPORATION

February 19, 1993

PREPARED BY: J. A. Janiszewski
J. A. Janiszewski, P.E.

APPROVED BY: T. G. Mudge
T. G. Mudge

UNITED ENGINEERS & CONSTRUCTORS

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February 19, 1993

PREPARED BY: J. A. Janiszewski
J. A. Janiszewski, P.E.

APPROVED BY: T. G. Mudge
T. G. Mudge

## Introduction

As part of a system configuration change at Seabrook Station, the class of containment penetration HVAC-2 is being changed. The new classification requires impact testing of the material. The flange supplied for HVAC-2 is made of material conforming to ASME SA-105. Existing impact data for this flange shows energy absorption of 10 ft-lb at -25$^{o}$F.

UE&C was requested to evaluate the existing impact data and flange properties to determine what effect the impact properties would have on serviceability of the flange with the reclassification.

## General Approach

A fitness for service viewpoint should be used as the guiding philosophy. Code requirements for materials are based on worst case conditions of loading rate and stresses, and impact testing temperature is below the lower bound service temperature. If the material meets these conservative conditions, its acceptability is confirmed. Since the reported impact values for -25oF do not meet the code requirements, additional engineering evaluation is required.

In order to project the properties of the flange on the HVAC-2 penetration at Seabrook, two steps are necessary. First, the actual service conditions were evaluated to determine what are appropriate testing and service parameters. Second, material properties was projected based on available data and published relationships. The overall thrust of the evaluation is to determine that the material properties meet requirements at the actual service conditions.

## Service/Testing Conditions

The impact testing for this flange was done at a temperature of -25oF. The code requirements are for testing to be done at a point 30oF below the lowest service temperature. For this system, the lowest service temperature is 50oF. Therefore, the appropriate testing temperature is 20oF, or 45oF higher than the test point.

Charpy impact testing uses a rapid loading rate to obtain maximum constraint in the material. This results in a lower bound figure for energy absorption. In actual service, however, this flange sees considerably lower loading rates and dynamic impact values do not represent the material's behavior. At the highest stress conditions during containment leak rate testing, the containment pressure of 49.6 psig results in a pressure stress of 3200 psi on the thinnest part of the flange. The reported pressure rise in the containment is not to exceed 5 psi/hour. Thus, the minimum time to apply the test pressure is 10 hours.

At a stress of 3200 psi, the strain in the flange steel would be approximately 1.1E-4 in/in. Applying this over 10 hours results in a strain rate of approximately 3E-9in/in/sec. Fracture requirements for ferritic bridge steels, similar in microstructure and strength to A-105, consider dynamic (impact) loading if strain rates are on the order of 10/sec., and slow loading rates at 1E-5/sec. and below. This flange therefore sees loading rates three orders of magnitude below the criterion for slow loading rates. The effect of change in loading rates is discussed below.

Material Properties

Charpy impact testing is used to characterize the toughness of steels by measuring the energy absorbed in fracture. When tested over a range of temperatures, ferritic steels exhibit a characteristic "S"-shaped curve of energy absorption similar to Figure 1. Code requirements for testing at a single temperature serve to establish a single point on this curve.

The typical Charpy curve is based on testing done at a high loading rate characterized as "impact" conditions. However, if the loading rate is changed to reflect rates seen in actual service, the energy absorption curve shifts. This results in higher energy absorption at lower temperatures. The slow-bend curve of Figure 1 shows the typical shift for a steel similar to A-105.

The magnitude of the impact to slow bend shift is dependent on the yield strength of the steel and can be calculated from the relationship

Tshift = 215 - 1.5 X yield strength (Ref. 1)

Complete typical impact curves for A-105 material have not been commonly published and were not obtained. Curves are published

for similar construction steels in Reference 1. Table 1, below, lists three similar grades of steel whose curves are published, along with the known actual properties for the HVAC-2 flange.

Since the yield strength and energy absorption at -25°F most closely match between the A-302-B material and the actual values for the HVAC-2 flange, the A-302-B curve was used for projecting the properties.

The 302-B curves for dynamic and slow-bend testing are sketched in Figure 2. The following characteristics of the dynamic curve should be noted:

1- At -25oF, the indicated absorbed energy is approximately 10 ft-lb. This is similar to the reported value for HVAC-2 flange and validates the similarity of the two materials for purposes of this preliminary analysis.

2- At 20oF, the impact value is approximately 15 ft-lb.

The temperature shift between the curves is expressed at the temperature where the tangents to the lower shelf and transition

Table 1

Published Impact-Related Values for Various Structural/Pressure Vessel Steels

| Property | Grade of Steel<br>A-36 | A-302-B | ABS-C | A-105 |
|---|---|---|---|---|
| Charpy Energy | | | | |
| -25°F | 5 | 10 | 10 | 10* |
| 20°F | 12-13 | 15 | 42 | |
| Yield Strength | 36 | 50 | NS | 62.4* |
| Dynamic/Slow Bend Shift, oF | | | | |
| Calculated | 161 | 140 | 161 | 121 |
| Published | 175 | 160 | 130 | |

*- Actual Seabrook data/based on Seabrook HVAC-2
NS- Not specified

zones of the dynamic curve intersect. In this diagram, that temperature is approximately 50oF. The shift is dependent on material yield strength and for the Seabrook yield strength of 62.4 ksi would predict a 121oF shift. The published A-302-B curve actually shows a shift of about 160oF. Thus, the static curve for A-105 would be expected to lie to the right of the A-302-B curve, as sketched in the broken line.

From the broken line curve, the predicted impact properties under slow loading conditions would be approximately 18 ft-lb at -25oF and 25 ft-lb at 20oF.

Conclusions

1- The loading rate actually seen by the HVAC-2 flange is well below the rate considered to be representative of slow strain rate loading.

2- At the actual slow strain loading conditions, the predicted energy absorption is 25 ft-lb at 20oF.

Reference

1- S. T. Rolfe and J. M. Barsom, Fracture and Fatigue Control in Structures, Prentice-Hall, 1977.

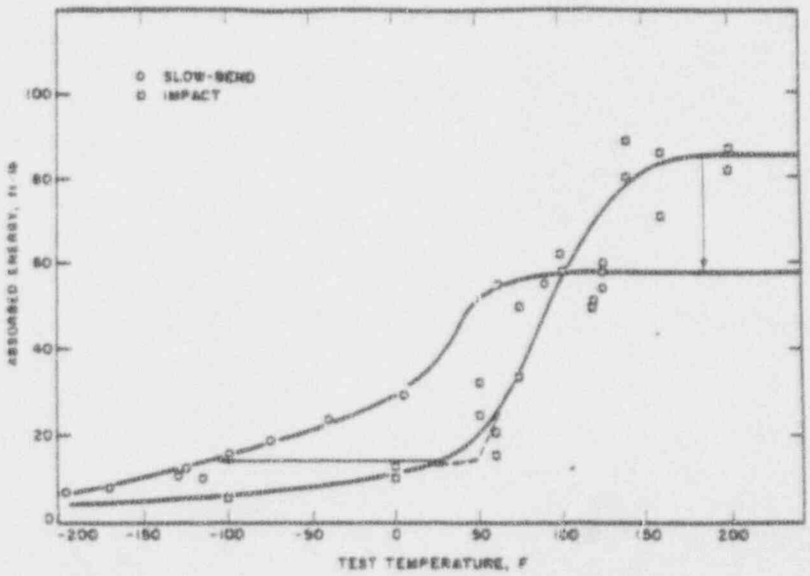


Figure 1- Typical Charpy Impact and Slow-Bend Curves for Ferritic Steels (Ref. 1, Figure 4.46)

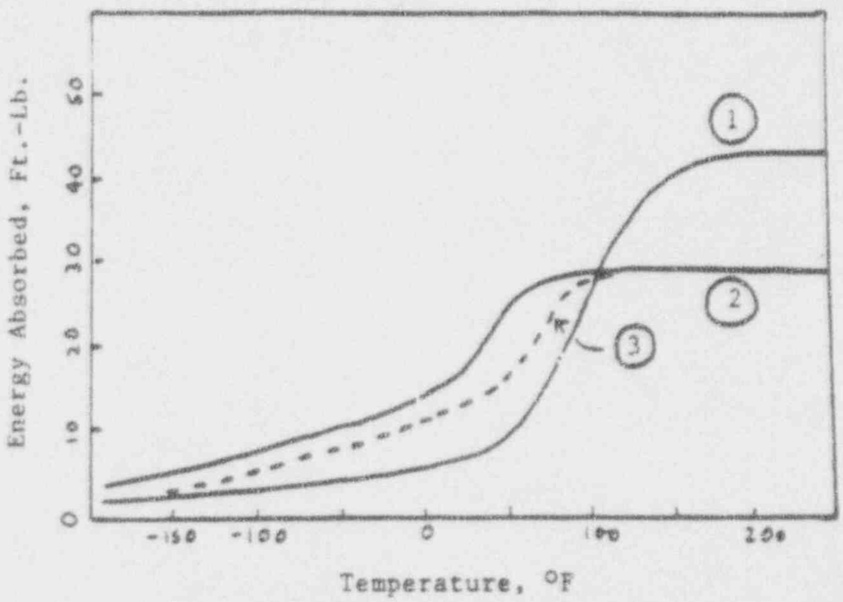


Figure 2- Projected Slow-Bend Impact Properties Based on A-302-B Steel (sketched from Ref. 1, Figure 4.46)

(1) - Dynamic, A-302-B Data
(2) - Slow Bend, A-302-B Data
(3) - Slow Bend, A-105 Calculation

ATTACHMENT D

NOTES OF TELEPHONE CONVERSATION

NOTES OF TELEPHONE CONVERSATION

FROM: T. P. Vassallo, Jr. DATE: 03/26/93

TO: Roger Reedy TIME: 2:30 P.M.

SUBJECT: DETERMINATION OF WELDNECK FLANGE MATERIAL THICKNESS

I called Reedy Associates to discuss what weldneck flange material thickness should be used to determine if impact testing is required by Subsection NE of the ASME Boiler and Pressure Vessel Code.

The following specific inquiry was presented to Roger Reedy for his evaluation.

INQUIRY:

In the 1986 edition of Section III Subsection NE, subparagraph NE-2311, there are specific exemptions from impact testing of pressure retaining material. In part, the Code exempts material with a nominal section thickness of 5/8 inches or less where the thickness is taken as follows:

"....for flanges use the maximum shell thickness with the butt welding hub; ...."

For a weldneck flange, what thickness should be used to determine if the 5/8 inch impact test exemption applies? Should the thickness at the weld bevel or the flange hub thickness be used to determine if the flange is exempt from impact testing? The thickness at the weld bevel is 0.375 inch and the thickness at the flange hub is 0.875 inch.

RESPONSE:

Use the 0.375 inch flange thickness at the weld bevel section to determine if impact testing is required by Code. Since the stresses in the flange hub are less than the stresses in the weld bevel section, the thinner section should be used. This approach is based on engineering judgement that there would be sufficient strength in the hub section due to the thickness of the material.

I then asked Roger Reedy the basis for the 5/8 inch impact testing value specified in Subsection NE of the Code. Roger Reedy indicated that the 5/8 inch value resulted from a decision of by an ASME Code committee to only utilize full size impact test specimens. Since the smallest, full size impact testing specimen permitted by the testing standard is 5/8 inch, the Code adopted the 5/8 inch value into Subsection NE of the ASME Code.

END OF ENGINEERING EVALUATION