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BNW MANUAL FOR DESIGN
AND CONSTRUCTION
OF SYSTEMS AND EQUIPMENT
CONTAINING LIQUID ALKALI METAL

JUNE 23, 1969

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BNW MANUAL FOR DESIGN AND CONSTRUCTION
OF SYSTEMS AND EQUIPMENT
CONTAINING LIQUID ALKALI METAL

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INTRODUCTION

As a consequence of the increasing involvement of BNW in programs requiring work with liquid sodium, an Alkali Metal Systems Review Committee was established by the BNW Safeguards Council in July of 1967. The Committee's purpose was to review current practices and to assure the availability of adequate guidelines, codes and standards to assure the safety of alkali metal systems and apparatus.

The Committee's investigation disclosed that firm guidelines and specific codes for construction and fabrication of sodium systems were not available. The national codes such as ASME or USAS were found to be inadequate or vague in regard to their application to alkali metal systems, and they generally did not provide design guidance for the higher temperatures of interest.

This manual is the result of the Committee's efforts to formulate a set of rules appropriate for interim guidance of BNW.

It is expected that this manual will be modified as new national codes are formulated or when the AEC Division of Reactor Development and Technology (RDT) publishes a liquid metal design code for vessels and/or piping.

Alkali Metal System Manual

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1. PURPOSE

The purpose of this manual is to establish guidelines for the classification of alkali metal systems and equipment and to provide rules, procedures and design requirements which will ensure the attainment of the required level of safety in completed facilities.

2. SCOPE

This manual applies to the design, construction and repair of liquid alkali metal systems and equipment and becomes effective for new construction or new repairs to existing equipment upon publication. This manual supersedes BNWL-MA-21 for liquid metal systems.

3. RESPONSIBILITIES

Each division is responsible for applying the requirements of this manual in compliance with O.G. 90-3-1 and applicable portions of O.G. 70-7-1. The division of responsibilities is as follows:

3.1 Divisions

It is the responsibility of each division to provide a system for implementing the Rules of Section 4 of this manual. Items which each division shall consider and which affect the division's overall liquid metal systems performance on design, construction and repair shall include, but not be limited to:

- a. Control purchase orders for complete specifications and requirements.
- b. Establish classification of alkali metal systems.
- c. Provide adequate design to appropriate codes.
- d. Provide design reviews where necessary.

- e. Fabricate and inspect to required standards.
- f. Document fabrication and repair histories.
- g. Do acceptance or performance testing as appropriate.
- h. Notify Quality Assurance and Standards of existence of pressure vessels, pressure piping, safety valves, etc., which will require inclusion in BNW's routine inspection program.

3.2 Quality Assurance & Standards

Quality Assurance and Standards will be responsible for overall BNW compliance on pressure systems and will provide guidance and help to each division as required. Quality Assurance and Standards will provide some services which are best centralized in order to provide consistency of practices throughout the divisions. Quality Assurance & Standards will be responsible for the following:

- a. Preparing and issuing Code Welding Manual, BNWL-MA-26.
- b. Preparing and issuing this manual on alkali metals, BNWL-MA-64.
- c. Preparing and issuing Pressure Systems Manual, BNWL-MA-21.
- d. Qualifying welders for ASME or RDT code work.
- e. Providing informal reviews and approvals as required in this manual.
- f. Periodically auditing the division to ascertain that it is complying with U.G. 90-3-1 and the requirements of this manual.
- g. Interpreting BNW manuals and other codes and standards.

- h. Granting code variances or approving the design and fabrication of non-standard systems.

3.3 Facilities Engineering

Facilities Engineering will provide the services of competent engineering specialists to assist the requesting divisions in regard to design and construction of liquid metal systems. The tasks assignable to Facilities Engineering include design and drafting of construction drawings, project engineering services, provision for formal design reviews, provision for inspection services, arrangement for third-party inspections of pressure vessels and safety valves and assistance on equipment surveillance.

4. RULES

4.1 System Classification

The alkali metal system shall be classified, if possible, to the variables listed in Table I. This table was designed to give an appropriate "Level of Fabrication and Inspection Requirements" commensurate with the magnitude of the hazard involved.

It is intended to apply to those portions of a system that are reasonably "permanent" and not subject to frequent design changes, such as a "test section." On occasion, certain portions of a system, such as a "test section," cannot be constructed to the rules of the design codes indicated for the rest of the system, and shall be termed non-standard. See paragraph 4.2.b for requirements for non-standard systems or test sections.

TABLE I
SYSTEM CLASSIFICATION

Type of System		Max. Temp.		Lbs. of Alkali Metal			Radio. Mat'l*		Neutron Irrad.		Level of Fabrica- tion & Inspection Requirements
		Up to 800F	800F & Over	0-10	10-300	300 & Over	Yes	No	Yes	No	
1	Encapsulation Devices	X	X	X				X		X	5
2	"	X	X	X			X		X	X	4
3	Static Pot Devices	X	X		X		X	X		X	4
4	Mechanical Testing Equipment		X		X		X	X		X	4
5	Small Flowing Loops	X	X	X			X	X		X	5
6	Intermediate Loops		X		X			X		X	3**
7	"		X		X		X			X	3** ***
8	Large Loops		X			X		X		X	3
9	"		X			X	X			X	2
10	In-Reactor Loops	X	X			X	X		X		1
11	Reactor		X			X	X		X		1

General Notes:

1. Melt stations operating at less than 500°F and containing over 50# shall be classified as Level 4. Shipping containers are not covered by this manual.
2. Deviations from the above table must be approved by QA&S and a Variance issued.
3. Equipment not listed above as a system type shall be referred to QA&S for classification to a comparable level of fabrication and inspection requirements with above table.
4. The above table is predicated on operation at 100 psig or less. For pressures over 100 psig combined with temperatures over 800°F, creep effects must be considered.
5. All equipment in the above table, except encapsulation devices requiring Level 5, require some type of containment for personnel protection, fire containment, equipment protection, or to localize the consequences of a leak. See Section A9.

* A non-radioactive₉ system is defined, for the purpose of this table, as one containing less than 2×10^{-9} curies/gm of radioactive materials dissolved or in suspension in liquid alkali metal. For determination of values above this amount, consult Radiation Standards Department, Safety & Standards Division.

** Level 4 if less than 50#. *** Concurrence of Radiation Standards Department.

4.2 Requirements for Level of Fabrication and Inspection Requirements

a. Standard Systems

The minimum requirements for "standard" systems or portions thereof, as required by this manual for each "Level of Fabrication and Inspection Requirements," are given in Table II. For a detailed description of the requirements, see Section 5., Discussion, and form BB-1060-006, Alkali Metal System Data Sheet. Additional specific requirements may be stated by customers.

b. Non-Standard Systems

It is recognized that because of the nature of BNW's work, there will be systems that cannot be designed or administered according to the requirements of Tables I and II. To provide for appropriate safety considerations and for design to good engineering practices, two routes are available for these non-standard systems, or portions of systems:

- . Approval of a "Code Variance Document," Form BB-1060-008.
- . Completion of and approval of a "Safety Evaluation Data Sheet for Non-Standard System," Form BB-1060-007.

It is intended that a variance is to be used to correct, change or modify the present ASME or USAS design codes when:

- . They are technically unsuitable for liquid alkali metal systems

TABLE II
REQUIREMENTS FOR LEVEL OF FABRICATION & INSPECTION REQUIREMENTS

(1) Level of Fab. & Inspection Req.		Design Codes						Mat'l Std.	Sup'l Insp.	Code Stamp	Des. Saf'y Rev.	Documentation Required (3)																						
		ASME Section VIII-1968, Div. 1 ASME Section III-1968, Class. A USAS B31.1.0-1967 USAS B31.7-1968 Draft, Class. I Code Cases AEC Supp. Regulatory Criteria						ASTM Standards ASME Section II Materials RDT-M Standards			As per N-320 As per RDT-F Series		(2) Vessels (N or U) Piping (NP)		Informal Formal		Purchase Orders Material Certification N-1, U-1 Forms etc. Duplicate X-ray Films NDT Procedures, Op. Certs. etc. Inspection Reports Stress Analysis Report Design Review Report Welding Procedures, Welder's Certs. Variances, Justifications As-Built Drawings w/Design Basis QA Reports Alkali Metal Data Sheet Safety Eval. Data Report Code Variance Document																	
5		S		S				S				S		S	S											S		S	S	S				
4		R		R				R	R			S		R			R	R	S	S	S					S	R		R	R	R			
3		R	S	R	S	S		R	R	S	S	R	S		R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R			
2			R		R	R	S	R	R	R	R	R	R		R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R			
1		R		R	R	R	R	R	R	R	R	R	R		R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R			

R = Required
S = Suggested

- Notes: 1. Deviation from the above table is permitted by approval of a "Variance," Form BB-1060-008.
2. Code Stamps are not required on Federal installations, but they are desirable where indicated in the above table.
3. This represents most of the documentation anticipated; however, it is not necessarily all inclusive.

- . They do not cover the size range of interest, such as small diameter tubing
- . Code stresses for materials of interest are not listed.

It is expected that QA&S will issue some general variances to cover recurring problems of code application common to more than one system.

The variance form can also be used to request a change in level requirement for a system from that indicated in Table I.

It is also recognized that certain standard system components used in liquid alkali systems do not in all respects conform to existing codes. In some cases codes do not exist. Here, the manufacturer's rating and good engineering practice should be followed. Examples of these types of items are bellows - sealed valves and electromagnetic pumps.

The Safety Evaluation Data Sheet for Non-Standard Systems is appropriate for systems in which:

- . The experiment involves construction of a short life "test section," perhaps being tested to failure
- . Prefabricated, off-the-shelf items are being evaluated and the specific material properties and compositions are not completely known.

This form provides for an evaluation of the hazards involved, the consequences of failure and for

agreement to be reached defining the precautions that must be considered before fabrication (and operation) can proceed on this system. Provided that the range of operation can be foreseen, this form covers all future changes within the variables permitted, without additional submission for approval beyond those indicated.

This mechanism is not to be used to circumvent the requirements of Tables I and II, where compliance with code is possible and represents good engineering practice.

5. DISCUSSION

5.1 Design Codes and the Level of Fabrication & Inspection Requirements

It is realized that the degree of care that goes into a liquid metal system should be some direct function of the cost and hazard potential of the system. This is not to say that one system is less safe than another, but that the user has greater confidence in the safety of a system in which greater attention to details has been provided. Table I covers most of the current uses at BNW and indicates the minimum quality that is required for each system. When the system variables have been defined, an appropriate numerical level of compliance can be selected. The levels range from 1 to 5, with the smaller number indicating the use of more restrictive codes and thus a greater amount of care. A higher level of care may always be selected if the user desires.

The various codes which are considered are the following:

For Vessels

- . ASME Boiler Code, Section VIII, Div. 1.*, Unfired Pressure Vessels - 1968
- . ASME Boiler Code, Section III, Nuclear Vessels - 1968
- . AEC Tentative Supplementary Criteria for ASME Code-Constructed Nuclear Pressure Vessels

For Piping

- . USAS B31.1.0, Power Piping - 1967
- . USAS B31.7, Nuclear Piping - 1968 Draft

Pumps and Valves

- . ASME Draft Code for Pumps & Valves for Nuclear Power - Nov., 1968
- . USAS B16.5, Steel Pipe Flanges and Fittings (and Valves) - 1968

For Inspection

- . ASME Boiler Code, Section III, Appendix IX - 1968
- . USAS B31.7, Nuclear Piping, Appendix B
- . RDT F3-6, Non-Destructive Examination (Formerly S-934)

For Welding

- . ASME Boiler Code, Section IX, Welding Qualifications - 1968
- . RDT F6-1, Welding Standard (Formerly S-902)

* Note ASME Section VIII, Div. 2 - 1968 has been issued and is an alternate that uses the stress calculation techniques of Section III with higher allowable stress values. It may represent a saving in cost over Div. 1 on larger vessels, as well as providing a better vessel.

5.2 Levels of Fabrication and Inspection Requirements

Since code stress data exist only up to 1500°F in ASME Sections I and VIII, or in USAS B31.1.0, and only to 1200°F in code case 1331-4 and a proposed code case to B31.7 (See Appendix B), fabrication of equipment for service above 1500°F poses a special problem. Data do exist for the higher temperature range, but it must be used with care to make sure that all pertinent data such as creep effects, thermal ratcheting and cyclic phenomena are considered. These temperature limitations apply to all levels.

a. Level 5

Compliance with this level requires that materials be identified sufficiently as to type and ASTM or other specification so that appropriate design stresses can be selected for the material. Code compliance is not required, but suggested as a design guide. Informal review is suggested. Documentation of material certification and design review is suggested.

b. Level 4

All vessels of this level shall be designed and stamped to Section VIII, Div. 1 or Div. 2, Unfired Pressure Vessels if they fall within code jurisdiction. Piping shall be designed according to USAS B31.1.0-1967. Informal design safety review is required. Materials used shall be those listed in ASME Section II, or ASTM Standards which are allowed by USAS B31.1.0 or code cases.

c. Level 3

All vessels of this level shall be designed and stamped according to Section VIII, Div. 1 or Div. 2. Piping shall be designed to USAS B31.1.0. RDT specifications, ASME Section III, USAS B31.7 or Section VIII, Div. 2 should be considered for those critical applications where creep or cyclic stress need be considered and calculated. ASME Section VIII Code Stamp "U" is required on vessels only. Formal design safety review is required. A stress analysis report is required and will automatically be provided if the vessel is designed to ASME Section III, Section VIII, Div. 2 or if the piping is designed to USAS B31.7.

d. Level 2*

Vessels shall be designed to ASME Section III, Class A and to appropriate code cases if over 800°F. Piping shall be code stamped "NP" and designed to USAS B31.7, Class I or to a proposed code case if over 800°F and under 1200°F. The Section III Code Stamp "N" for vessels is required. Compliance with RDT Standards is required, where possible. A formal design safety review is required. Documentation shall be detailed and complete for each step.

* These requirements for Levels 1 and 2 are only minimums, and not intended to prescribe the complex legal and programmatic requirements necessary to obtain approvals by RDT, AEC and licensing authorities.

e. Level 1*

This level represents compliance with the highest standards that can be achieved with today's technology and is intended primarily for reactor primary systems. The ASME Section III and USAS B31.7 will form the base from which all aspects of the system will be upgraded by additional requirements as specified in RDT Standards and AEC regulatory requirements in effect. All procedures will be documented and a plan for quality assurance must be issued and followed from inception to completion of the project. Information on material properties under irradiation and validated stress calculation procedures must be used to compute combined stresses throughout the entire system. Documentation will be extensive and required at all stages of the project.

5.3 Material Selection and Standards

a. Description

Four different classes of material quality are specified in this manual. A brief description of each class follows, in order of increasing quality:

- . Any material of a known kind without further information as to specific composition. Example - any 300 series austenitic stainless steel. This

* See footnote, page 11

class may be used where Table II does not require one of the following classes.

- . Any material for which an ASTM specification and type is known. Example - ASTM A-213 TP 304. Physical and chemical certifications are required. These materials require additional NDT inspection for USAS B31.7 construction. Note that not all ASTM specifications are permissible for code construction, however.
- . Any material which is listed in the ASME Boiler and Pressure Vessel Code Section II, Materials. These materials require additional NDT inspection for ASME Section III construction. Example - SA 213 TP 304. Physical and chemical certifications are required as well as reports of the additional tests. In most cases, these material specifications are the same as the corresponding ASTM standard.
- . Any material which meets an RDT Standard. Material of this class is similar to the above class except it has additional inspection as specified by the RDT Standard. Example - RDT-M3-2 TP 304.

b. Discussion

The most common materials used for sodium systems are austenitic stainless steels of type 304 or 316. The designer must be cautious to use the material within the temperature range for which code stresses are published. For temperatures above 1400°F,

stainless steels will begin to scale badly and lose strength rapidly and high temperature alloys such as Inconel 600 should be considered. Other factors which may be necessary to consider are carburization, decarburization, general corrosion, stress corrosion cracking, chromium carbide precipitation, nickel mass transport, and nitrogen embrittlement. Materials which are unsuitable for alkali metal systems include a low melting alloy such as aluminum, copper, low carbon stainless steels if to be used above 800°F, and some non-ferrous alloys such as Monel.

Any material for which an allowable code stress is not listed in the ASME design codes may be usable with a "variance report," provided that data on physical properties can be supplied. The ASME Boiler Codes contain rules for establishing allowable stresses. A "Code Interpretation" can be requested of the ASME Boiler and Pressure Vessel Committee; and if approved, it will then become code material.

Used equipment or components, particularly when its past history is unknown, should be avoided or used only with extreme caution. Used equipment or components with a known history should meet the same material standards as for new materials.

The formal nuclear codes (Section III and B31.7) at present only cover rules for design up to 800°F.

For temperatures between 800°F and 1200°F, Code Case 1331-4 and proposed code case to B31.7 must be consulted (see Appendix C). At these higher temperatures, creep may be enhanced under cyclic effects and suitable stress analyses must be performed. Since sodium systems are inherently low pressure systems, the stresses on piping materials are primarily due to thermal effects. With a large coefficient of expansion for stainless steel, and the high temperature characteristic of sodium systems, stresses due to expansion become particularly important.

5.4 Supplemental Inspection (To Table II)

Even though material meets Section II Material Specification, of the ASME Boiler Code, Section III of the Code requires that it meet additional NDT tests for vessels. These requirements are given in detail starting at paragraph N-320 and cover the following:

- . N-321, NDT Examination of Plate
- . N-322, NDT Examination of Forgings and Bars
- . N-323, NDT Examination of Castings
- . N-324, NDT Examination of Pipe, Tubes, and Fittings
- . N-325, Examination of Bolts, Studs and Nuts.

Appendix IX of ASME Boiler Code, Section III covers quality control and nondestructive examination methods.

In the event that ferrous materials other than austenitic stainless steel are used, additional tests are required for determining the ductile-brittle transition temperature, as given in paragraphs N-331 and N-332.

For nuclear piping, allowable materials are listed in B31.7, paragraph 1-724; and the examinations required are summarized in Tables A.7(a), A.7(b), and A.7(c) in the appendix.

RDT Tentative Standard RDT F6-1, Appendix C, contains additional welding, purging and leak testing requirements for liquid metal systems. These requirements must be followed as well as those portions of RDT F6-1 which are appropriate.

Those vessels which are portions of the primary coolant system of a reactor must also meet the AEC Supplementary Regulatory Criteria for ASME code-constructed Nuclear Pressure Vessels as well as appropriate RDT and ASME codes and standards.

RDT Standards in the F series shall also be consulted for other requirements such as weld inspection and NDT requirements.

5.5 Code Stamping

A "Code Stamp" is a special symbol authorized by the ASME and applied to a vessel, or in some cases piping, which indicates that the equipment meets all the requirements of the code and has been tested in a prescribed manner. Only manufacturers who maintain a

Code Shop are permitted to have a code stamp. The stamp is applied directly to a vessel or pipe or to a permanently attached nameplate.

Various symbols are used, depending on the rules by which the vessel or piping was fabricated. Typical symbols are:

U = Unfired pressure vessel fabrication under Section VIII

UV = Safety and relief valve fabricated under Div. 1, Section VIII

N = Nuclear vessel fabricated under Section III

NV = Safety and relief valve fabricated under Section III

NP = Nuclear piping fabricated under USAS B31.7
(Available when B31.7 is formally adopted).

Vessels which do not fall within the code because of size or pressure rating may be code stamped if they otherwise meet all provisions of the code. Vessels installed on federal reservations are not required to be stamped, but it is usually desirable that they be.

5.6 Design Safety Reviews

In order to expedite the design safety reviews, rough drafts of Form BB-1060-006, Alkali Metal System Data Sheet, or Form BB-1060-007, Safety Evaluation Data Sheet for Non-Standard System, should be started in the conceptual design stage. Material requirements can then be defined early and procurement of long delivery items can be started

during the detailed design stage. It is necessary that the approval of the design safety reviews take place before fabrication is started to avoid "retro-fitting." Final approval of the design safety review cannot be accomplished until sufficiently detailed design drawings relating to the parts to be reviewed have been completed.

Two types of design safety reviews are specified in this manual:

- . An informal design safety review
- . A formal design safety review.

An informal design safety review is appropriate for items in which the consequence of failure does not represent a serious personnel hazard, a significant loss of programmatic time, or subsequent loss of BNW reputation. An informal review is not expected to require engineering design on the part of the reviewer, but only to concur that the design appears to be in order and contains the minimum requirements of this manual. The informal design review is accomplished by submitting Form BB-1060-006, Alkali Metal System Data Sheet, along with suitable drawings, to Quality Assurance and Standards for approvals as noted on the form.

A formal design safety review is an engineering review, made at least in part by persons not associated with the initial design being reviewed. Depending upon the size or complexity of the projects, new calculations may be performed to see that figures are in agreement.

All aspects of the system shall be checked for conformance to this manual and the codes and requirements contained therein. Authority to proceed to fabrication will be given upon approval of an Alkali Metal System Data Sheet, Form BB-1060-006 (or equivalent), preceded by a report of the formal design safety review committee.

The design safety review committee shall consist of a number of individuals, a minimum of three who were not associated with the original design (other than as consultants). These three or more individuals shall constitute a majority of the committee and should be selected from specialists in various fields such as:

- . Codes
- . Fluid flow
- . Heat transfer
- . Instrumentation
- . Materials
- . Operations
- . Safety
- . Stress analysis.

The chairman should provide committee members with drawings or data to review prior to a meeting. The results of the meeting should be acceptable to a majority of the committee and documented. The user organization is responsible for designating the chairman, selecting the committee members and providing funds for its operation according to the above procedure.

The design safety review committee may also review other matters, not the subject of this manual, such as operability, maintainability, design of experiments, or general suitability of the system to meet experimental requirements.

5.7 Documentation

The purpose of documentation is to render objective evidence that requirements have been met and to provide a permanent record of fabrication history.

The user is responsible to ensure that documentation requirements are met, and that appropriate copies are distributed and retained for the life of the equipment in permanent record storage such as the CVI Files. Each division is responsible to determine the manner in which its records shall be stored.

The following is a list of items which are appropriate for documentation (See Table II for those required):

- . Purchase orders
- . Chemical and physical certifications for materials used as parts of pressure containing systems or equipment
- . Completed ASME forms for code construction and piping completion records (see Appendix C)
- . X-ray films (manufacturer may be required to retain only limited time)
- . NDT test records
- . Inspector's reports (ITT inspectors, buyer's inspector, etc.)

- . Stress analysis report (including method used, computer code if used, and check of computer code by independent methods to verify its correctness)
- . Welding and NDT procedures
- . Welding and NDT personnel qualification records
- . Design safety review report (As well as any other design review reports)
- . As-built drawings
- . Record of repairs, justification of and authorization of any non-conformity from codes and standards.
- . Manufacturer's quality assurance plan
- . Heat treatment records and charts
- . Examinations and pneumatic or hydrostatic test records
- . Cleaning procedures
- . Completed Alkali Metal System Data Sheet, Form BB-1060-006
- . Completed Safety Evaluation Data Sheet for Non-Standard Systems, Form BB-1060-007.
- . Completed Code Variance Document, Form BB-1060-008.

5.8 Heat Treatment

Heat treatment after fabrication or welding is often required to relieve stresses and/or impart the corrosion resistance. For detailed requirements on heat treating, see the following:

- . ASME Boiler & Pressure Vessel Code, Section III, paragraph N-530
- . USAS B31.7, Nuclear Power Piping, paragraph 1-729.3 and paragraph 1-731

APPENDIX A

The following items represent areas where conformance is required in Table II or where application of the item represents good engineering practice for alkali metal systems.

They are:

<u>Paragraph</u>	<u>Description</u>	<u>Page</u>
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A1. Purchasing

Each division should review purchase orders for liquid metal systems and pressure equipment or materials to ensure that drawings and the necessary specifications are included and that current codes and standards are referenced. (Purchase of material for code construction without material certification, or to the wrong specification may make the material unacceptable for code applications, or require needless extra work and cost to later obtain the necessary certifications.)

Appendix C, page C1 provides a guide for preparation of purchase requisitions for pressure equipment or fabrication materials. Use existing national codes or standards, where applicable, when writing specifications.

Since purchase of nuclear grade components may require considerable lead time, it is important that they be ordered, and in sufficient number, as soon as the design has been approved. Where materials are purchased, they should be ordered to meet the applicable requirements of Tables I and II. It may also be necessary to perform welding procedure qualification tests and welder certification tests on the same or similar material. These quantities of extra material and sizes required must be estimated at the time of purchase.

Where welding or weldability tests are to be accomplished at the supplier's plant, the appropriate standards must be referenced on the purchase requisition.

A2. Fabrication

Prior to and during the fabrication of a pressure system, it is important that one person be assigned the responsibility for accountability for all materials supplied for inclusion in a pressure system. Materials must be identified at all times, and where required, records of material certifications must be traceable to final location in the system. Control must also be exercised over welding to be sure that proper procedures are available and are being used and that only the proper welding rod is used for each weld. A procedure should be established so that certified components, certified welders, and welds shall be identified either by permanent markings directly on the material or this information should be transferred to an as-built drawing.

The above procedure is required for level of fabrication and inspection requirement 1 to 4 and is optional for level 5.

For work conforming to Section III or RDT F 6-1, weldability tests may be required in addition to the use of qualified procedures and certified welders. See ASME Section III, paragraph N-540 or RDT F 6-1, Appendix A for these requirements.

A3. Equipment Requirements

A3.1 Mechanical Joints

The ideal alkali-metal system is an all welded system. However, in many cases this is not practical and metal mechanical joints must be used

with suitable precautions. The types of proprietary mechanical joints which have been commonly employed in alkali metal systems with some degree of success are: Swagelok, Conoseal, and Graylok. These joints are prone to leakage if they are subjected to thermal cycling.

Common gasket materials used in other applications such as gold, silver, platinum, etc. (noble metals) are not compatible with the alkali metals and should not be used. Copper can be used up to 450°F. Plastics, rubber, nylon, and teflon materials may not be employed as flange or gasket seal materials.

Soldered connections of all types are unsuitable for alkali metal systems and screwed joints are poor practice in nearly all applications.

A3.2 Valves

Valves to be utilized in an alkali metal piping system should be of packless bellows or freeze stem seal construction with all metal seats, and rated by the manufacturer for alkali metal service. Packed valves should not be used on alkali metal systems except for secondary protection of a bellows. Suitable gas or vacuum type valves may be used in the cover gas system.

A4. Inspection

In addition to the requirement for an inspector to observe construction of code pressure systems, formal third party inspection requirements are contained in

the ASME Boiler and Pressure Vessel Code and the RDT Standards. These must be followed exactly as specified in the design code. The codes also specify the minimum requirements.

It should be noted that ASME Boiler Code, Section III, USAS B31.7 and RDT F 306 are much more restrictive and detailed than ASME Section VIII or USAS B31.1.0 on non-destructive testing techniques, operator qualification and acceptance standards. Paragraph IX-420 of Section III, ASME Boiler Code, specifically covers operator qualification. NDT methods specified in the codes include:

- . Radiographic examination (X-ray)
- . Magnetic particle examination (good only on ferromagnetic material)
- . Liquid penetrant examination
- . Ultrasonic examination
- . Eddy current examination
- . Helium leak testing

The codes may give an option as to which of these non-destructive tests are to be used. The user must specify which tests are to be used, and often must select the acceptance standard. Particular attention should be given to the acceptability of tests as a function of geometry, materials, etc. All of the NDT examination methods are available at BNW from Customer Application Section, NDT Department.

A5. Welding

All code welds must be made by welders currently qualified for the specific joint. In addition, the procedures for the ASME Boiler and Pressure Vessel Code and RDT Standards must be met.

For all welding done according to the ASME Boiler Code or USAS Piping Codes, the rules are given in ASME Boiler Code Section IX, Welding. RDT Standards for welding are given in RDT F 6-1.

For either ASME or RDT work, each type or size of weld must be described in a "qualified welding procedure." A welding procedure is specific for the group number of the base metal, position, type of process, filler metal, thickness, joint type, etc. Any change from a specified range of any of these "essential variables" requires a new welding procedure. When a procedure has been found to meet certain standards, and is certified by QA&S, it becomes qualified. Once qualified, the procedure can be used repeatedly and indefinitely. The BNW Code Welding Manual, BNWL-MA-26, contains these certified procedures.

Welders are qualified by producing specific joints to qualified welding procedures and upon satisfactory mechanical, visual and NDT testing of such joint. For ASME or RDT code work, both the welder and the procedure must be qualified.

Depending upon the type of work performed with a three-month period, a welder may require requalification to

demonstrate that he has retained the skill necessary to produce a sound joint.

ASME requires requalification if the welder has not used the specific process, such as tungsten inert gas, within three months. RDT requires requalification when the welder has not used the welding procedure, or one essentially similar, within three months.

QA&S is responsible for qualifying welders. Qualification for RDT work also qualifies for ASME work, but not vice versa.

The NDT testing for each weld should be in accordance with the appropriate design code.

A6. Integrity Testing

A6.1 Code Requirements

Upon completion of a vessel or system, a pressure test is required. A pressure test with a "non-hazardous" fluid is desirable. In most cases of equipment for alkali metal systems, this will be an inert gas. If water is compatible with the equipment design and its future use to contain alkali metals, it is permissible from a code standpoint. A water hydrostatic test could be used to test individual components of a system prior to final test with an inert gas. If water is used, procedures must be developed to assure a dry, clean system before filling with any alkali metal. The water used for testing should be of high quality, such as grade "A" deionized water.

Depending upon code requirements, pressures required for the pressure test range from 1.20 to 1.50 times the design pressure, plus a correction for temperature. Precautions should be observed to allow the testing fluid and the vessel or system under test to equalize in temperature.

Ferritic materials have a finite possibility of brittle fracture if tested at too low a temperature. Care should be taken to conduct the pressure test at least 60°F above the nil-ductility temperature of the vessel material. Pressure testing at too high a pressure may damage the materials if the elastic limit is exceeded and permanent deformation takes place.

A6.2 Supplemental Tests

Since nearly all alkali metal systems require a high purity cover gas, these systems are usually evacuated and backfilled with inert gas. It is therefore prudent, but not code required, except in certain RDT F 6-1 Appendix C requirements, to either or both vacuum test or helium leak test the system. Suitable valving or points of attachment for these tests should be considered during the design. Helium leak detector specifications are given in RDT F 3-6.

a. Vacuum Leak Check

Alkali metal systems should be designed for evacuation and vacuum leak checking. All components and completed systems should be

evacuated, usually to a pressure of about 0.1 torr. The system or component is then valved off from the pumping system and the vacuum decay (or pressure rise) is recorded for various time intervals. If the pressure rise is large over a short period, it indicates either a leak or outgassing. The system prior to vacuum checking must be clean and dry to reduce the outgassing problems. It is preferable to evacuate a system overnight prior to performing the vacuum leak test to allow the system to outgas. Plotting the vacuum decay data (pressure vs. time) will yield a curve whose shape and slope will be indicative of external leakage and outgassing tendencies.

Heating the component or system to 300 to 400°F while it is being evacuated usually will eliminate the outgassing problem in a short time.

b. Helium Leak Check

Alkali metal systems should be able to pass a helium leak detection test. The test should be conducted with a mass spectrometer type leak detector which has been calibrated with a standard calibrated leak. Tracer gas to be used will be that which can be detected by the leak detector in use, usually helium. Two methods, vacuum testing and pressure testing, may be employed. The

most common method is by evacuating the system with the mass spectrometer on line and spraying the tracer gas (helium) on the exterior of the piping and watching for a leak indication. It is advisable on larger systems to conduct the leak detection on components prior to their assembly in the system. All leaks detectable by the mass spectrometer should be repaired. Helium leak detection usually follows vacuum leak detection tests.

Tracer gases employed should be stable inert gases. Gases such as freon are unsuitable.

A7. Pressure Relief

Every pressure system, as defined by code, must have some protection from over-pressurization, or means of assuring that excessive pressures cannot be generated.* The pressure relief device prevents over-pressurization of the system due to a malfunction of the cover gas pressure regulator or to operator errors in liquid level and/or temperature control. Isolation valves between the cover gas supply and the liquid metal loop are permissible, but isolation valves must not be placed between the pressure relief device and the alkali metal system it is protecting.

* For sealed systems such as capsules, calculations showing the relationship between temperature and pressure along with adequate temperature control, as specified in part A8., will suffice.

Pressure relief devices should be tested for oxygen in-leakage and rejected if the oxygen in-leakage rate exceeds a value that could lead to alkali metal oxide plugging of the gas lines or vapor traps in that system.

The required capacity and the relieving pressure of a safety or relief valve are given in paragraphs UG-125 or N-910.3 of Sections VIII and III respectively of the ASME Boiler Code. Similar information on rupture discs is given in paragraphs UG-127 and N-912 of Section VIII and III respectively. The ratings for relief valves are somewhat different from those for rupture discs. Rupture discs often fail at a considerably lower pressure if the temperature is greater than that for which the disc was rated.

The discharge from the relief device should not be restricted unless the resulting pressure drop is taken into account in its capacity rating. The exhaust is preferably released directly to the atmosphere or to a suitable exhaust system.

A8. Temperature Control

To minimize the possibility of operation at excessive temperatures, system temperatures should be controlled by suitable instrumentation with temperature measuring elements placed in appropriate locations. In most instances, it is also desirable to have two independent measuring systems to assure that at least one control system will function properly to maintain temperatures within an allowable range.

Sensing thermocouples, or their equivalent, should be located at the point of maximum temperature of each section or zone of the system. The controls should limit power to the system's heaters in that section or zone and give an audio or visual alarm to the operator indicating malfunction of the system.

The method of attachment of skin type thermocouples is important for an accurate temperature measurement. Beading the thermocouple junction and fusion welding the bead to the pipe wall is a common method of attachment. The fusion bead then becomes part of the pipe wall. The weld bead should be evaluated to assure that any cracks in the bead do not propagate into the pipe wall.

Another method of attachment is by resistance welding the thermocouple wire to the piping wall. Care must be exercised in selecting the proper current settings for the attachment. Too high a current can cause thinning or even melting of the pipe wall.

Alkali metal systems should be designed to allow sequential preheating starting from a gas space, to preclude overstressing the piping by expanding liquid alkali metal against frozen ends. A preheating schedule should be adopted for each system and a sequence of line heating followed.

Heating should begin with the alkali metal storage tanks and progress from there throughout the system. A maximum preheat temperature should be adopted and adhered to during the preheat phase. Sufficient

thermocouples must be installed to monitor the temperature to assure proper sequence of operation. Bellows-sealed valves are highly susceptible to bellows failure due to improper heating sequence.

A9. Safety Considerations

The location of a pressure system with respect to other systems will have a great influence on operational safety and convenience. In assigning the "levels of fabrication and inspection requirements," it was assumed that most alkali metal equipment and all alkali metal equipment containing radioactive material would have shielding or confinement. Proximity of water and water floor drains must be evaluated in terms of possible hazards. Fire protection must be considered early in the design in order to either eliminate as many fire hazards as possible, or to minimize any damage a fire could cause. Appropriate measures should be taken to control the products of combustion and access to emergency electrical power disconnects, emergency dumps to storage tanks, and ventilation should be considered.

Industrial Safety should be consulted for advice and approval on locations and matters affecting personnel safety, including location of emergency exits and fire protection. AEC approval is required for project proposals. In addition, BNW requires that facilities as described in O.G. 70-6-1 shall have approval of the BNW Safeguards Council prior to submission to the AEC.

For advice and approval of systems containing radioactivity greater than 2×10^{-9} curies per gm of alkali metal, the Radiation Standards Department should be consulted. Systems containing over 300 curies of radioactivity, or 1/3 critical mass, must be approved by the Nuclear Safety Department. (See O.G. 70-5-1 and BNWL-MA-25.)

Items which are vital to the safe design and operation of an alkali metal system include the following suggestions:

A9.1 Catch Pans

A metal catch pan should be placed under each system containing molten alkali metal. This catch pan should be sized to hold the maximum volume of alkali metal that could be spilled in the event of a piping or vessel failure. The catch pan should be fabricated from carbon steel material and be unpainted. Normal practice is to fill this pan with vermiculite to act as an absorbent material in case of a spill or leak.

A9.2 Containment

A metal enclosure should be placed around a system containing alkali metal to deflect a spray or steam into the catch pan in the event of a piping or vessel failure. The enclosure need not be completely sealed. Sliding steel panels or doors may be used to isolate the system from the rest of the work area, but allow easy access for maintenance. The

enclosure should be ducted to an exhaust system to remove smoke in the event of a fire. If the inventory of alkali metal is such that a fire could release significant quantities of alkali metal oxides, a filtration or water-scrubbed system may be necessary to prevent release to the atmosphere.

Where radioactivity levels could be encountered in a sodium fire, proper ventilation and filtration of the exhaust gas must be made in accordance with the radiation procedures established for the test so as to not exceed standards for radioactivity release. Where it cannot be reasonably established that adequate filtration of radioactivity is possible, provisions should be made to preclude the possibility of fire by blanketing the system with inert gas.

A9.3 Automatic Shutdown to Fail Safe Condition

Systems containing significant quantities of alkali metal should be instrumented with automatic controls for unattended normal operation, and should include malfunction monitoring instrumentation that will automatically put the system into a safe condition if a malfunction occurs. The following items should be considered for inclusion in the fail system:

- . Excessive temperature at each point where maximum allowable design temperatures could be exceeded by some malfunction

- . Smoke in the enclosure
- . Alkali metal leak
- . Loss of flow if such loss could cause overheating or other malfunction
- . Loss of safety circuit power
- . Electrical short or overvoltage.

The appropriate response to the above events should be determined on a case by case basis.

A9.4 Expansion Tanks

Alkali metal systems should incorporate an expansion space adequate to hold at least 1-1/2 times the calculated volume increase which will occur when the alkali metal is heated.

A9.5 Level Measurement

The expansion tank of alkali metal systems should be instrumented with a level measuring device to assure the system is not over filled and that there is adequate expansion volume.

A9.6 Dump Tanks

Provisions for emergency dump tanks should be made in all forced convection loops containing significant quantities of alkali metal. The dump tank prevents the gravity drainage of the system through a leak, which could feed a fire for some length of time. With emergency dump provisions, the bulk of the alkali metal can be prevented from leaking out, thus minimizing the magnitude of a leak or fire.

A10. Code Variance

The following procedure shall be used if it is necessary to deviate from code or other requirements as explained in paragraph 4.2.b. of this manual. Exceptions shall be recorded on Code Variance Form AB-1007-048 and shall be submitted by the user to QA&S. (See Appendix C.) The Code Variance requires approval by the Assistant Director for Safety and Standards before authority is given to operate the system. The user is responsible for supplying justification for the request for a Code Variance.

APPENDIX B

B1. Definitions

AEC Supplementary Regulatory Criteria for ASME Code-Construction Nuclear Pressure Vessels - Additional requirements imposed by AEC's regulatory staff in cooperation with the Advisory Committee on Reactor Safeguards.

Alkali Metal System Data Sheet - A document delineating the pertinent features of an alkali metal system and setting forth the classification, codes, material specifications, fabrication and inspection requirements, and design safety review. (See Form BB-1060-006.)

As-Built Drawings - Those drawings showing the final and actual as fabricated or installed pressure system and/or components.

ASME Boiler and Pressure Vessel Code - The latest edition of the code formulated by the American Society of Mechanical Engineers for the construction of boilers and other pressure vessels. The rules are continually modified or updated by addenda and case interpretations. The various sections which deal with specific subjects are:

- . Section I, Power Boilers
- . Section II, Material Specifications, Part A Ferrous, Part B Nonferrous
- . Section III, Nuclear Vessels
- . Section IV, Low Pressure Heating Boilers

- . Section VII, Recommended Rules for Care of Power Boilers
- . Section VIII, Div. 1, Pressure Vessels
- . Section VIII, Div. 2, Alternate Rules for Pressure Vessels
- . Section IX, Welding Qualifications

ASA Code for Pressure Piping - Now superseded by USA Standard Code for Pressure Piping.

ASTM - American Society for Testing and Materials publishes standards for a variety of materials and for testing methods. The complete set currently contains 32 volumes. New issues are published at least every three years, some annually. The latest issue is dated 1968 and 1969.

Buyer - A person or component requesting a purchase.

Code Case - An interim report by the appropriate ASME Boiler Code Committee to cover rules for design or construction which were not covered in the last issue of the ASME Boiler Codes. The code cases will eventually be printed or revised as part of the next issue of that section to which it pertains. Code cases are just as proper and legal to use as are the boiler codes.

Code Shop - A fabrication plant that complies with provisions of the ASME Pressure Vessel Code and where the American Society of Mechanical Engineers permits the use of the official ASME code symbols and stamps. A Code Shop is not necessarily qualified for all sections of the code.

Code Variance Form - A document delineating the design features and design calculations, operating hazards, and precautions for a non-code pressure system.

Code Vessels and Systems - Those vessels constructed within the scope of the ASME Pressure Vessel Code and carrying the official ASME Pressure Vessel Code Stamp. A code vessel can be constructed to various sections of the code such as Section I, Power Boilers; Section III, Nuclear Vessels or Section VIII, Division I or II, Unfired Pressure Vessels. Vessels which fall outside the code because of size, pressure, etc., may be coded if desired. (Since BNW is on a federal reservation, where code stamps are not required, vessels or systems constructed to all code requirements except for stamping will be defined in this manual as a code system or vessel.)

Level of Fabrication and Inspection Requirements - The quality and/or design required to properly construct alkali metal facilities as defined by this manual.

Formal Design Safety Review - A documented engineering review of all design aspects of a pressure system in order to assure that the design will meet the requirements established by this manual.

Informal Design Safety Review - A limited audit of a design to see that code requirements of this manual have been specified. The user shall be responsible for furnishing design calculations which may be checked for correctness.

Non-Coded Pressure System - A system not built in accordance with the ASME Pressure Vessel Code or USAS Code for Pressure Piping.

Pressure Piping Completion Record - A form for documenting the drawings, materials, fabrication, inspection and testing of a code pressure piping system. (See Form BB-1060-009.)

Pressure Vessel - A vessel usually larger in volume and diameter than the piping which is connected to it and designed to contain a fluid. A pressure vessel is one complete structure, designed and constructed as a unit.

Pressure Piping - Piping used to construct pressure systems and/or as connections between pressure vessels.

Pressure Systems - Pressure vessels, pressure piping accessories equipment such as pumps, compressors and instrumentation, which together form a complete piece of equipment for research, process or plant utility nature.

Quality Assurance - All those planned and systematic actions necessary to provide adequate confidence that a structure, system, or component will perform satisfactorily in service.

Quality Control - Those quality assurance actions related to the physical characteristics of a material, component, or system which provide a means to control

the quality of the material, component, or system to predetermined requirements.

Qualified Welder - A welder who is currently certified to have the knowledge and skill necessary to meet the requirements of ASME Section IX or RDT F 6-1 for a specified range of materials or conditions. Requalification of a welder may be necessary every three months.

Qualified Welding Procedure - An instruction for making a welded joint of a certain specified type which has been proven by laboratory tests to meet the requirements of ASME Section IX and/or RDT F 6-1. Once a procedure is qualified, it may be used indefinitely.

RDT Standard - A standard issued by the AEC's Division of Reactor Development and Technology. Many standards are currently prepared by ORNL for materials and for water type reactors. Present and future work by RDT includes many standards originated or reviewed by LMEC pertaining to liquid metals. QA&S maintains a complete file of all RDT Standards as they are issued.

Safety Evaluation Data Sheet for Non-Standard System - A document delineating the reasons for deviation from code requirements and setting forth the requirements for design and/or operation to minimize the hazards. (See Form BB-1060-007.)

Seller - Vendor or vendor's agent selling equipment to Battelle-Northwest.

Third Party Inspector - The representative of a recognized insurance or inspection company performing impartial inspection of pressure components or systems for code shops or Battelle-Northwest.

User - The person or component responsible for the use of a pressure component or system.

USA Standard Code for Pressure Piping - Rules for design and construction of piping systems and is sponsored and published by the American Society of Mechanical Engineers. It previously consisted of ASA B31.1, 1955, which is being revised, expanded and upgraded in eight separate sections. The new codes consist of:

B31.1.0-1967, Power Piping

B31.2-1968, Industrial Gas and Air Piping Systems

B31.3-1966, Petroleum Refinery Piping

B31.4-1966, Liquid Petroleum Transportation Piping Systems

B31.5-1966, Refrigeration Piping

B31.6 (In Prep.), Chemical Process Piping Systems

B31.7 (Trial copy issued Feb., 1968), Nuclear Power Piping with June, 68 Errata

B31.8-1968, Gas Transmission and Distribution Piping

APPENDIX C

C1. Purchase Requisition Checklist for Material Suitable
for Pressure Systems

Check or complete the appropriate items on pages C-1 to C-6 which are to be typed on the requisition. Specifications may be included as a part of the requisition if they are less than two pages in length; otherwise they should be prepared as a separate attachment. See Operating Guide 110-2-2 and DG-510-AC. If the cost is over \$25,000, see O.G. 110-2-1.

1. Material to be Furnished With Quotation

Each bidder shall furnish with his quotation _____ copies of bulletins, drawings, or data sheets to include the following information:

- ☐ Dimensional Drawings, Illustrative Cuts, etc.
- ☐ Performance Curves and/or Data
- ☐ Seller's Specifications
- ☐ The above information is required to evaluate the seller's bid. Failure of the seller to furnish the required information shall cause his bid to be rejected as non-responsive.

2. Inspection (Other than code specified inspections)

Inspection by a BNW representative is required:

- ☐ During Fabrication
- ☐ During Testing
- ☐ Prior to Shipment

Receiving Inspection by:

- ☐ ITT Inspection Section
- ☐ Author or Coauthor
- ☐ Other

___ 3. Approval Data

Within thirty (30) days after receipt of the purchase order, and prior to the start of fabrication, the seller shall furnish to the buyer for approval ___ sets of drawings, including drawings showing critical wall thicknesses of parts subject to internal pressure and shall include the following:

___ Material lists

___ Calculations

___ Codes and standards used

and a letter of transmittal. Fabrication shall not start until drawings submitted above, or as later modified, are approved by the buyer.

___ 4. Certified Design Data (choose one)

___ Within fifteen (15) days after receipt of the purchase order,

___ Within fifteen (15) days after the return of the approval data (see No. 3) to the seller, certified bulletins, drawings, or data sheets shall be furnished by the seller, and shall include the following information:

___ copies of dimensional drawings

___ copies of specifications

___ copies of installation instructions

___ copies of circuit diagrams.

___ 5. Certified Data

Within fifteen (15) days after shipment of the purchase order, certified bulletins, drawings, or data sheets shall be furnished by the seller, and shall include the following required information:

- ____ Copies of ASME Form ____ U-1, ____ U-1a, ____ U-4, ____ N-1,
____ N-1a, ____ N-4, ____ NP-1, ____ UV-1, ____ NV-1.

6. Performance Tests

The following performance test shall be performed at

- _____ Manufacturer's plant
 _____ BNW
 _____ Other

before acceptance by BNW of material furnished on this order:
(add test required)

7. Codes and Criteria

The following codes shall apply to material furnished and/or fabricated on this order:

- ASME Boiler Code, Section III, Nuclear Vessels, 1968
- ASME Boiler Code, Section VIII, Div. 1, Unfired Vessels, 1968

- ___ ASME Boiler Code, Section VIII, Div. 2, Unfired Vessels, 1968
- ___ ASME Boiler Code, Section IX, Welding Qualifications, 1968
- ___ USAS B31.1.0 - 1967, Power Piping
- ___ USAS B31.7 - Feb. 1968 Draft, Nuclear Power Piping
- ___ RDT F 6-1, Welding Standard
- ___ RDT F 2-2, Quality Control System Requirements
- ___ RDT F 3-1, Inspection System Requirements
- ___ RDT F 3-2, Calibration System Requirements
- ___ RDT F 3-6, Non-Destructive Test Methods
- ___ ASME Code Stamp Required (Specify Pertinent Section)
- ___ AEC Supplementary Regulatory Criteria for ASME Code-Constructed Nuclear Pressure Vessels

8. Material Specifications for Stainless Steel Suitable for Pressure Systems (other materials require different specifications.)

All material of each category furnished on this order shall meet the following ASTM, ASME Section II or RDT standards. Type, grade, heat treatment condition, supplementary requirements, etc., must be specified. Extra material for destructive tests may be required for ASME Section III, USAS B31.7, or RDT welding tests.

<u>Pipe</u>	<u>Tubing</u>	<u>Bar (all shapes)</u>
___ ASTM A312-64	___ ASTM A213-66	___ ASTM A276-67
___ ASME SA-312	___ ASME SA-213	___ ASTM A479-63
___ ASTM A376-64	___ ASTM A249-65	___ ASME SA-479
___ ASME SA-376	___ ASME SA-249	___ RDT M7-3
___ ASTM A430-64	___ RDT M3-2	
___ ASME SA-430		<u>Welding Fittings</u>
___ RDT M3-3	<u>Sheet & Plate</u>	___ ASTM A403-67
	___ ASTM A240-63	___ ASTM A182-68
	___ ASME SA-240	___ ASME SA-182
	___ RDT M5-1	___ RDT M2-5

Forgings & Flanges

___ ASTM A182-68
___ ASME SA-182
___ RDT M2-2

Castings

___ ASTM A351-65
___ ASME SA-351
___ RDT M4-2

Welding Rod

___ ASTM A371-62T (Bare)
___ ASTM A-298-62T (Covered)
___ RDT M1-2 (Bare)
___ RDT M1-1 (Covered)

Bolting

___ ASTM A193-66 (Bolts)
___ ASTM A194-68 (Nuts)
___ RDT M6-3

___ 9. Dimensional Standards

Material furnished in this order shall conform to the following USA dimensional standards:

___ B1.1-1960, Unified Screw Threads
___ B2.1-1960, Pipe Threads (Except Dryseal)
___ B2.2-1960, Dryseal Pipe Threads
___ B16.5-1968, Steel Pipe Flanges and Flanged Fittings
___ B16.9-1964, Wrought Steel Butt-Welding Fittings
___ B16.10-1957, Valves
___ B16.11-1966, Forged Steel Fittings, Socket Welding and Threaded
___ B16.20-1963, Ring Joint Gaskets
___ B16.25-1964, Butt Welding Ends
___ B16.28-1964, Short Radius Elbows
___ B18.2.1-1965, Bolts and Screws
___ B18.2.2-1965, Nuts
___ B36.10-1959, Wrought-Steel and Wrought-Iron Pipe
___ B36.19-1965, Stainless Steel Pipe
___ B36.46-1967, General Requirements for Carbon, Ferritic Alloy, and Austenitic Alloy Steel Tubes (ASTM A450-66)

___ 10. Material Identification

Each item furnished on this order shall be permanently marked and shall include the following information:

- a) Manufacturer's name or identification
- b) Alloy type
- c) Specification number
- d) Heat number
- e) Lot number

___ Marking as required by RDT F7-1

___ Marking as required by RDT F7-3

___ Marking as required by USAS B31.7, paragraph 1-723.1.3

___ Marking as required by ASME, Section III, paragraph N-334.2

___ 11. Shipment Packing

___ The seller shall crate material for safe shipment

___ The seller shall crate material for safe shipment to be approved by BNW inspector before being released to the shipper.

___ The seller shall pack material to RDT Standard F 7-2 (buyer must specify parts to apply).

___ 12. Bid Review

Review of bids by co-author is required prior to purchase.

___ 13. Suggested Vendors

- a. _____
- b. _____
- c. _____

C2. Proposed Code Case for Class I Nuclear Piping for Temperatures Above Those Provided for in Draft USAS B31.7 (February, 1968)

C2.1 Inquiry

Under what rules shall Class I Nuclear Piping be constructed whose design temperatures exceed those for which allowable stress values are given in Draft B31.7 (February 1968).?

C2.2 Reply

In the opinion of the committee, piping constructed for Class I applications under Draft B31.7 (February 1968) whose design temperatures exceed those for which allowable stresses are given in Draft B31.7 (February 1968) shall be limited to those materials listed in Tables A-1 and A-2 of Draft USAS B31.7 (February 1968) and shall be designed, constructed, and examined in accordance with the rules of Draft USAS B31.7 (February 1968) with the following modifications:

- a. In general, it must be recognized that designing to the standards of Draft USAS B31.7 (February 1968) for high-temperature operation frequently requires analytical techniques and knowledge of material behavior not presently contained in the Code.

Therefore, the following precautions shall be taken:

- . . . When structural deformations and instability can affect the safety of the piping, limits for these deformations shall be given in the Design Specifications and calculations to show compliance with these limits shall be included in the Stress Report. In particular, if freedom from progressive deformation of the type discussed in

Subdivision F-105.2 is to be assured, the rules of those paragraphs shall be supplemented by calculations in which creep deformations and structural instability are considered.

- . The limits given herein for primary stress intensity are applicable to materials for which the stress required to produce long time rupture of notched specimens under steady load at service temperature is no lower than the stress required to rupture unnotched specimens under the same conditions. If it is not feasible to use such materials, consideration should be given to reducing the allowable primary stress intensity and/or limiting stress concentrations.
- . The designer shall consider local overstrain as described in F-105.2.2.
- b. The allowable value of general primary membrane stress intensity, S_m , (Subdivision F-104.1) shall be the allowable stress given in Table A.2 in USAS B31.1.0 for the material at the design temperature. For materials not listed in USAS B31.1.0, use the allowable stresses in Section VIII, Division 1 of the ASME Boiler and Pressure Vessel Code.
- c. Except as provided in paragraph f below, the allowable value of local membrane stress intensity (Subdivision F-104.2) shall be $1.5S_m$.

- d. . When stresses are calculated on an elastic basis, the allowable value of primary membrane plus primary bending stress intensity shall be:

$$1.5S_m - \left(\frac{T - T_c}{200} \right) (0.17S_m + 0.33S) \quad \text{for } T_c \leq T \leq T_c + 200,$$

and

$$1.33 S_m - 0.33S \text{ for } T \leq T_c + 200$$

where T = design temperature, °F

T_c = 700°F for carbon and low-alloy steels and 800°F for austenitic stainless steels and nickel-chrome-iron alloy,

S_m = allowable value of general primary membrane stress intensity (see paragraph b above)

S = Calculated value of primary membrane stress intensity

- . When stresses are calculated on an inelastic basis, the allowable value of primary membrane plus primary bending stress intensity at any time during the specified life of the piping shall be S_m .
- e. Except as provided in paragraph f below, the allowable value of primary plus secondary stress intensity (Subdivision F-104.4) shall be the higher of three times S_m or three times the allowable S_a value at 10^6 cycles for the metal temperature involved, as determined in paragraph g below.
- f. In lieu of satisfying the stress intensity limits of paragraphs c and e above, the structural action may be analyzed on a plastic basis, including creep deformations, and the design shall be considered to

be acceptable if the deformations which occur do not exceed the specified limits (See subparagraph a. . above).

- g. The design fatigue curves of Draft USAS B31.7 (February 1968), Figures 1-705.3.3(a) and 1-705.3.3(b) are not applicable at temperatures above the limits of 700°F for carbon and alloy steels and 800°F for austenitic stainless steel and those non-ferrous alloys listed in Tables A.1 and A.2 of Draft USAS B31.7 (February 1968), and the curves of Figures 1 and 2 of this case shall be used in their place to determine the allowable S_a values in designing for higher temperatures. Values for temperatures intermediate between the curves shown may be interpolated. The fatigue curve to be used shall be that corresponding to the maximum metal temperature occurring during the cycle at the point on the piping being analyzed. The fatigue curves of Figure 1 and Figure 2 are based on limited data and may not adequately account for hold time at temperature.

Note: The S_a values of Figure 1 are based primarily on test data from 2-1/4% Cr-1% Mo steel and are believed to be acceptable for ductile carbon and low-alloy steels having nominal Cr content not exceeding 5%. The S_a values of Figure 2 are based primarily on test data from austenitic stainless steel and are believed to be also applicable to nickel-chrome-iron alloy. If data are submitted to the committee for the establishment of allowable fatigue stresses for other materials, it should be noted that special alloying elements or heat treatments used to improve creep resistance frequently

have a deleterious effect on resistance to strain cycling. Therefore, data showing superior creep resistance or other strength properties shall only be acceptable for substantiating S_a values when such data includes the results of strain-controlled fatigue tests at the design temperature.

- h. Thermal expansion data and moduli of elasticity shall be determined from Appendices B and C of USAS B31.1.0. Coefficients of thermal conductivity and thermal diffusivity shall be in accordance with Table A.4 of Appendix A of Draft USAS B31.7 (February 1968).
- i. Piping subject to external pressure shall conform to the design rules of Article I-II of Section III of the ASME Boiler and Pressure Vessel Code, except that the design temperature limitations in step 4 of paragraphs I-1120, I-1130 and I-1150 shall not apply.
- j. Brazing shall not be used in piping for service above 700°F.

Fig. 1. Allowable Amplitude of Alternating Stress Intensity, S_a , for Carbon and Alloy Steels Through 5% Cr With Metal Temperatures up to 1100°F

Fig. 2. Allowable Amplitude of Alternating Stress Intensity, S_a , for Austenitic Stainless Steels, Nickel-Iron-Chromium, and Nickel-Chrome-Iron with Metal Temperatures up to 1200°F

CASE 1331-4

INTERPRETATIONS OF ASME BOILER AND PRESSURE VESSEL CODE

Approved by Council August 15, 1967

Case 1331-4

(Special Ruling)

Nuclear Vessels in High Temperature Service

Section III

Inquiry: Under what rules shall Class A nuclear vessels be constructed whose design temperatures exceed those for which allowable stress values are given in Section III?

Reply: Rules covering the construction of Class A nuclear vessels which are to operate at temperatures above those now provided for in Section III are in preparation by the Committee. In the interim, it is the opinion of the Committee that such vessels shall be constructed of the materials and to the rules of Section III with the following modifications and precautions:

(1) In general, it must be recognized that designing to the standards of Section III for high-temperature operation frequently requires analytical techniques and knowledge of material behavior not presently contained in the Code. Therefore, the following precautions shall be taken:

(a) When deformations can affect the safety of the vessel, limits for these deformations shall be given in the Design Specification (N-141) and calculations to show compliance with these limits shall be included in the Stress Report (N-142). In particular, if freedom from progressive deformation of the type discussed in N-417.3 and N-417.4 is to be assured, the rules of those paragraphs shall be supplemented by calculations in which creep deformations are considered.

(b) The limits given herein for primary stress intensity are applicable to materials for which the stress required to produce long time rupture of notched specimens under steady load at service temperature is no lower than the stress required to rupture unnotched specimens under the same conditions. If it is not feasible to use such materials, consideration should be given to reducing the allowable primary stress intensity and/or limiting stress concentrations.

(2) The allowable value of general primary membrane-stress intensity, S_m , (N-414.1) shall be the allowable stress given in Section I for the material at the design temperature. For materials not listed in Section I, the allowable stress from Section VIII, Division 1, shall be used. The allowable stress values and external pressure charts for materials covered by Code Case interpretations for Section I and/or Section VIII, Division 1, may be used even though the Case interpretation is stated to be not applicable to Section III.

(3) Except as provided in paragraph (6) below, the allowable value of local membrane stress intensity (N-414.2) shall be $1.5 S_m$.

(4) (a) When stresses are calculated on an elastic basis, the allowable value of primary membrane plus primary bending stress intensity shall be:

$$1.5 S_m - \left(\frac{T - T_c}{200} \right) (0.17 S_m + 0.33 S)$$

$$\text{for } T_c \leq T \leq T_c + 200$$

$$\text{and } 1.33 S_m - 0.33 S \text{ for } T > T_c + 200$$

where T = design temperature, F

T_c = 700 F for carbon and low-alloy steels and 800 F for austenitic stainless steels and nickel-chrome-iron alloy

S_m = allowable value of general primary membrane stress intensity (see (2) above)

S = calculated value of primary membrane stress intensity.

(b) When stresses are calculated on an inelastic basis, the allowable value of primary membrane plus primary bending stress intensity at any time during the specified life of the vessel shall be S_m .

(5) Except as provided in paragraph (6) below, the allowable value of primary-plus-secondary stress intensity (N-414.4) shall be the higher of three times S_m or three times the allowable amplitude of fatigue stress at 10^6 cycles for the metal temperature involved, as determined in (7) below.

(6) In lieu of satisfying the stress intensity limits of (3) and (5) above, the structural action may be analyzed on a plastic basis, including creep deformations, and the design shall be considered to be acceptable if shakedown occurs, as opposed to progressive deformation, and if the deformations which occur prior to shakedown do not exceed any specified limits. (See (1)(a) above).

(7) The design fatigue curves of Section III (Figs. N-415(a) and (b)) are

not applicable at temperatures above the limits of N-222(a), and the curves of Figs. 1 and 2 of this Case shall be used in their place. Values for temperatures intermediate between the curves shown may be interpolated. The fatigue curve to be used shall be that corresponding to the maximum metal temperature occurring during the cycle at the point on the vessel being analyzed.

NOTE: The S_a values of Fig. 1 are based primarily on test data from $2\frac{1}{2}$ Cr - 1 Mo steel and are believed to be conservative for ductile carbon and low-alloy steels having nominal Cr contents not exceeding 5%. The S_a values of Fig. 2 are based primarily on test data from austenitic stainless steel and are believed to be also applicable to nickel-chrome-iron alloy. If data are submitted to the Committee for the establishment of allowable fatigue stresses for other materials, it should be noted that special alloying elements and heat treatments used to improve creep resistance frequently have a deleterious effect on resistance to strain cycling. Therefore, data showing superior creep resistance or other strength properties are not acceptable for substantiating S_a values. In order to be acceptable, such data shall include the results of strain-controlled fatigue tests at the design temperature.

(8) Vessels and tubular products subject to external pressure shall conform to the design rules of Article I-11 of Section III.

CASE (continued) 1331-4

INTERPRETATIONS OF ASME BOILER AND PRESSURE VESSEL CODE

Fig. 1 Design Fatigue Strength, S_a , for Carbon and Low-Alloy Steels Thru 5% Cr up to 1100°F

Fig. 2 Design Fatigue Strength, S_a , for High-Alloy Steels and Nickel-Chrome-Iron Alloy up to 1200°F

BB-1060-006.1 (5-69) AEC-RL RICHLAND, WASH.

SYSTEM FABRICATED BY

WELDERS CERTIFIED

☐ NO☐ YES,☐ ASME SECTION IX☐ RDT F6-1

PREHEAT REQUIRED

☐ NONE☐ YES, TO _____ °F

POST WELD HEAT TREATMENT

☐ NONE☐ YES _____ HRS. AT _____ °F

VISUAL FITUP AND WELD INSPECTION

☐ NO☐ YES, BY _____

NDT WELD INSPECTION

☐ DYE PENETRANT PER _____

SPOT

100%

ACCEPTANCE STANDARD

☐☐☐ RADIOGRAPHIC EXAMINATION PER _____☐☐☐ ULTRASONIC EXAMINATION PER _____☐☐☐ HELIUM LEAK CHECK PER _____☐☐☐ VACUUM LEAK CHECK _____☐☐

REMARKS

SAFETY REVIEW (CHOOSE ONE AS REQUIRED BY BNWL-MA-64)

INFORMAL

THE FOLLOWING CERTIFY THAT THE ABOVE SYSTEM APPEARS TO CONFORM TO THE APPLICABLE RULES OF BNWL-MA-64 AND APPROVAL IS HERE BY GIVEN TO PROCEED WITH FABRICATION ACCORDING TO THE CODES, SPECIFICATIONS AND INSPECTIONS NOTED HEREIN:

DIVISION

DATE

USER AND/OR ENGINEER

SAFETY AND STANDARDS

QUALITY ASSURANCE AND STANDARDS

SAFETY AND STANDARDS

(1)

RADIATION STANDARDS

(2)

NUCLEAR SAFETY

SAFETY AND STANDARDS

FORMAL

A DESIGN SAFETY REVIEW WAS HELD ON _____ IN WHICH THE ALKALI METAL SYSTEM WAS REVIEWED FOR CONFORMANCE TO BNWL-MA-64 AND THE DESIGN CODES CONTAINED THEREIN.

MEMBERS OF THE DESIGN REVIEW COMMITTEE WERE:

NAME	ORGANIZATION	NAME	ORGANIZATION

CHAIRMAN			

A REPORT OF THE DESIGN REVIEW COMMITTEE WAS ISSUED ON _____, TITLE OR

DOCUMENT NUMBER _____

AND IS ATTACHED TO THIS DATA SHEET.

APPROVALS (FOR FORMAL REVIEW ONLY)

	DIVISION	DATE
DESIGNER		
OPERATOR		
USER		
USING DIVISION MANAGER		
INDUSTRIAL SAFETY	SAFETY AND STANDARDS	
QUALITY ASSURANCE AND STANDARDS	SAFETY AND STANDARDS	
(1) RADIATION STANDARDS	SAFETY AND STANDARDS	
(2) NUCLEAR SAFETY	SAFETY AND STANDARDS	

BB-1060-007 (5-69) AEC-RL RICHLAND, WASH.

(OVER)

REQUIREMENTS TO BE MET PRIOR TO USE OF NON-STANDARD PORTION OF SYSTEM**1. REVIEW OF TEST, EXPERIMENT OR CHANGE BY:**

	EACH CHANGE		EACH CHANGE BEYOND RANGE PERMITTED IN 3 BELOW	
	YES	NO	YES	NO
ENGINEER	☒	☐	☒	☐
SUPERVISOR	☐	☐	☐	☐
INDUSTRIAL SAFETY	☐	☐	☐	☐
OTHER	☐	☐	☐	☐

2. WRITTEN RECORDS REQUIRED (IN PERMANENT AND AUDITABLE FORM)

☐ CHANGES NOTED IN LOG BOOK OR NOTE BOOK.	☐ PRESSURE TEST OR PROOF TEST.
☐ AS BUILT DRAWINGS.	☐ HELIUM LEAK TEST.
☐ COPIES OF PURCHASE ORDERS.	☐ MANUFACTURER'S CERTIFICATION OF RATING.
☐ MATERIAL AND/OR FABRICATION HISTORY.	☐

3. RANGE OF VARIABLES PERMITTED FOR NON-STANDARD PART OR PORTION OF SYSTEM

TEMPERATURE UP TO _____ OF _____	PRESSURE UP TO _____ PSIG	THERMAL CYCLING, RATE OR MAGNITUDE	PORTION OF SYSTEM COVERED
SIZE OF TUBING, CONNECTIONS, ETC.			
MATERIALS PERMITTED			

4. SAFETY REQUIREMENTS (CHECK THOSE REQUIRED)

☐ WRITTEN OPERATING PROCEDURES	☐ ACCESS LIMITED TO FOLLOWING CONDITIONS:
☐ JOB HAZARD BREAKDOWN	☐ METAL PANS WITH VERMICULITE UNDER EXPERIMENTAL PORTION
☐ PROTECTIVE CLOTHING	WITH _____ CAPACITY.
☐ STEEL PERSONNEL SHIELDING BARRIER	☐ FOLLOWING FIRE FIGHTING EQUIPMENT AVAILABLE
AROUND _____	☐ OTHER

APPROVALS

THE FOLLOWING CERTIFY THAT THEY HAVE REVIEWED THE ABOVE DESCRIBED SYSTEM AND CONCUR IN THE ABOVE REQUIREMENTS FOR FABRICATION AND OPERATION OF THE NON-STANDARD SYSTEM OR PORTION THEREOF AS DESCRIBED ABOVE:

	DIVISION	DATE
USER		
OPERATOR		
USING DIVISION MANAGER		
INDUSTRIAL SAFETY		
QUALITY ASSURANCE AND STANDARDS		
(1) RADIATION STANDARDS		
(2) NUCLEAR SAFETY		

SAFETY AND STANDARDS

SAFETY AND STANDARDS

SAFETY AND STANDARDS

SAFETY AND STANDARDS

BATTELLE-NORTHWEST RICHLAND, WASHINGTON		CODE VARIANCE DOCUMENT	VARIANCE NUMBER
AREA	BUILDING	EQUIPMENT NUMBER OR NAME	

DESCRIPTION OF EQUIPMENT			
☐ PLANT FABRICATED	FABRICATOR		
☐ PURCHASED			
☐ NEW	IF	☐ MODIFIED	MODIFICATIONS DONE BY
☐ USED	USED:	☐ NOT MODIFIED	
OTHER DESCRIPTION (SIZE, MATERIAL, WALL THICKNESS ETC)			
DESIGN CONDITIONS		OPERATING CONDITIONS	
PSIG, °F		PSIG, °F	
SPECIFICATIONS AND DRAWINGS			

V A R I A N C E	
THE EQUIPMENT AS DESCRIBED ON THIS DOCUMENT DEVIATES FROM NATIONAL CODES OR BNW PRESSURE SYSTEMS MANUAL BECAUSE (USE ADDITIONAL SHEETS IF NECESSARY)	
JUSTIFICATION FOR VARIANCE (USE ADDITIONAL SHEETS IF NECESSARY)	

A P P R O V A L S		
PREPARED BY	FOR	DATE
REVIEWED BY	DATE	
FACILITIES AND ENGINEERING		
APPROVED BY	DATE	
SPECIALIST, PRESSURE SYSTEMS, QA&S		
APPROVED BY	DATE	
MANAGER, SAFETY AND STANDARDS DIVISION		

BATTELLE **B** **NORTHWEST**
 BATTELLE MEMORIAL INSTITUTE PACIFIC NORTHWEST LABORATORY
 POST OFFICE BOX 999 / RICHLAND, WASHINGTON 99352

PRESSURE PIPING COMPLETION RECORD

AREA NO.	BUILDING OR FACILITY NO.	LOCATION	DATE
DESCRIPTION OF PIPING (IF NECESSARY USE ADDITIONAL SHEETS)			
MAX. ALLOWABLE WORKING PRESSURE _____ PSI	TEMPERATURE _____ F	PRESSURE RELIEF DEVICES INSTALLED IN ACCORDANCE WITH USAS B31.1,0-1967 ☐ YES ☐ NO	RELIEF SET PRESSURE _____
PIPE MATERIAL SPECIFICATIONS (ASTM, ETC.)			
ORIGINAL CONSTR.	MODIFICATION	REPAIR	JOB ORDER (PROJ. NO., CONTRACT NO., OR W.O. NO.)
FABRICATOR (NAME OF PLANT FORCE FACILITY, COST PLUS FF CONTRACTOR, LUMP SUM CONTRACTOR)			
WELDING DONE IN ACCORDANCE WITH QUALIFIED WELDING PROCEDURE NOS.			
FILLER MATERIAL (ASTM AND TYPE)			
WELDER'S OR WELDING OPERATOR'S WELD IDENTIFICATION NO. AND DATE LAST QUALIFIED			
TEST PERFORMED:			
☐ SECTION	☐ 100 %	☐ SPOT	☐ X-RAY
☐ FLUID PENETRANT			
☐ OTHER (DESCRIBE) _____			
HYDROSTATIC TEST PRESSURE _____	PSI & TEMP. _____ F	MET TEST REQS. _____	
REMARKS:			
CERTIFICATION			
FABRICATOR	UNIT	DATE	
ENGINEER	UNIT	DATE	
THIRD PARTY INSPECTOR	UNIT	DATE	
WE CERTIFY THAT THE PIPING SYSTEM DESCRIBED HEREIN CONFORMS TO THE REQUIREMENTS OF USAS B31. 1,0-1967 CODE FOR PRESSURE PIPING			
PRESSURE SYSTEMS SPECIALIST			DATE

(Over)

-C24-
FORM U-1 (back)

BNWL-MA-64

18. INSPECTION Manholes, No. _____ Size _____ Location _____
OPENINGS: Handholes, No. _____ Size _____ Location _____
Threaded, No. _____ Size _____ Location _____
19. SUPPORTS: Skirt _____ Lugs _____ Legs _____ Other _____ Attached _____
(Yes or No) (Number) (Number) (Describe) (Where & How)

20. REMARKS: _____

(Brief description of purpose of the vessel, as Air Tank, After Cooler, Jacketed Cooker, etc. State contents of each part.)

We certify that the statements made in this report are correct and that all details of design, material, construction, and workmanship of this vessel conform to the ASME Code for Pressure Vessels, Section VIII, Division I.

Date _____ 19 _____ Signed _____ (Manufacturer) By _____

Certificate of Authorization Expires _____

CERTIFICATE OF SHOP INSPECTION

VESSEL MADE BY _____ at _____

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State or Province _____ and employed by _____ of _____ have inspected the pressure vessel described in this manufacturer's data report on _____ 19 _____, and state that to the best of my knowledge and belief, the manufacturer has constructed this pressure vessel in accordance with the applicable sections of the ASME Boiler and Pressure Vessel Code.

By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the pressure vessel described in this manufacturer's data report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date _____ 19 _____

Inspector's Signature

Commissions

Nat'l Board, State, or Province and No.

CERTIFICATE OF FIELD ASSEMBLY INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State or Province _____ and employed by _____ of _____

_____ have compared the statements in this manufacturer's data report with the described pressure vessel and state that parts referred to as data items _____, not included in the certificate of shop inspection have been inspected by me and that to the best of my knowledge and belief the manufacturer has constructed and assembled this pressure vessel in accordance with the applicable sections of the ASME Boiler and Pressure Vessel Code. The described vessel was inspected and subjected to a hydrostatic test of _____ psi.

By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the pressure vessel described in this manufacturer's data report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date _____ 19 _____

Inspector's Signature

Commissions

Nat'l Board, State, or Province and No.

FORM N-1 MANUFACTURERS' DATA REPORT FOR NUCLEAR VESSELS As required by the Provisions of the ASME Code Rules

1. Manufactured by _____
(Name and address of Manufacturer)

2. Manufactured for _____
(Name and address of Purchaser)

3. Type _____ Kind _____ Vessel No. (_____) (_____) Nat'l Bd. No. _____ Yr. Built _____
(Horiz. or Vert.) (Tank, Jacketed, Heat Ex.) (Mfrs. Serial No.) (State & State No.)

Items 4-8 incl. to be completed for single wall vessels, jackets of jacketed vessels, or shells of heat exchangers.

4. Shell: Material _____ T.S. _____ Nominal Thickness _____ in. Corrosion Allowance _____ in. Diam. _____ ft. _____ in. Length _____ ft. _____ in.
(Kind & Spec. No.) (Min. of range specified)

5. Seams: Long _____ H.T.¹ _____ X.R. _____ Efficiency _____ %
(If Class B)

Girth _____ H.T.¹ _____ X.R. _____ No. of Courses _____

6. Heads (a) Material _____	T.S. _____	(b) Material _____	T.S. _____
Location (Top, bottom, ends)	Thickness	Crown Radius	Knuckle Radius
		Elliptical Ratio	Conical Apex Angle
		Hemispherical Radius	Flat Diameter
			Side to Press. (Convex or Concave)
(a) _____	_____	_____	_____
(b) _____	_____	_____	_____

If removable, bolts used _____ Other fastening _____
(Material, Spec. No., T.S., Size, Number) (Describe or attach sketch)

7. Jacket Closure _____
(Describe as ogee & weld, bar, etc. If bar give dimensions, describe or sketch)

8. Constructed for operating press ² _____ psi at Max. temp _____ °F at temp. of _____ °F
 °F Charpy Impact _____ ft-lb
 Pneumatic Hydrostatic or } Test
 Combination } Pressure _____ psi

Items 9 and 10 to be completed for tube sections.

9. Tube Sheets: Stationary. Material _____ Diam. _____ in. Thickness _____ in. Attachment _____
(Kind & Spec. No.) (Subject to press.) (Welded, Bolted)

Floating. Material _____ Diam. _____ in. Thickness _____ in. Attachment _____
(Kind & Spec. No.)

10. Tubes: Material _____ O.D. _____ in. Thickness _____ inches or gage _____ Number _____ Type _____
(Kind & Spec. No.) (Straight or U)

Items 11 to 14 incl. to be completed for inner chambers of jacketed vessels, or channels of heat exchangers.

11. Shell: Material _____ T.S. _____ Nominal Thickness _____ in. Corrosion Allowance _____ in. Diam. _____ ft. _____ in. Length _____ ft. _____ in.
(Kind & Spec. No.) (Min. of range specified)

12. Seams: Long _____ H.T.¹ _____ X.R. _____ Efficiency _____ %
(Welded, Dbl., Single) (Yes or No) (If Class B)

Girth _____ H.T.¹ _____ X.R. _____ No. of Courses _____

13. Heads: (a) Material _____	T.S. _____	(b) Material _____	T.S. _____	(c) Material _____	T.S. _____
Location	Thickness	Crown Radius	Knuckle Radius	Elliptical Ratio	Conical Apex Angle
					Hemispherical Radius
					Flat Diameter
					Side to Press. (Convex or Concave)
(a) Top, bottom, ends	_____	_____	_____	_____	_____
(b) Channel	_____	_____	_____	_____	_____
(c) Floating	_____	_____	_____	_____	_____

If removable, bolts used (a) _____ (b) _____ (c) _____ Other fastening _____
(Material, Spec. No., T.S., Size, Number) (Describe or attach sketch)

14. Constructed for specified operating press ² _____ psi at Max. temp _____ °F at temp. of _____ °F
 Charpy Impact _____ ft-lb
 Pneumatic Hydrostatic or } Test
 Combination } Pressure _____ psi

¹ If Postweld Heat-Treated

² List other internal or external pressures with coincident temperature when applicable.

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FORM N-1 (back)

BNWL-MA-64

Items below to be completed for all vessels where applicable.

15. Safety Valve Outlets: Number _____ Size _____ Location _____

16. Nozzles:

Purpose (Inlet, Outlet, Drain)	Number	Diam. or Size	Type	Material	Thickness	Reinforcement Material	How Attached
_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____

17. Inspection Manholes, No. _____ Size _____ Location _____
Openings: Handholes, No. _____ Size _____ Location _____
Threaded, No. _____ Size _____ Location _____

18. Supports: Skirt _____ Lugs _____ Legs _____ Other _____ Attached _____
(Yes or No) (Number) (Number) (Describe) (Where & How)

19. Remarks: _____

(Brief description of service for which vessel was designed)

CERTIFICATION OF DESIGN

Design information on file at _____
Stress analysis report on file at _____
Design specifications certified by _____ Prof. Eng. _____ State _____ Reg. No. _____
Stress analysis report certified by _____ Prof. Eng. _____ State _____ Reg. No. _____

We certify that the statements made in this report are correct and that all details of material, design, construction, and workmanship of this pressure vessel conform to the ASME Code for Nuclear Vessels.

Date _____ 19 _____ Signed _____ (Manufacturer) Dy _____

Certificate of Authorization Expires _____

CERTIFICATE OF SHOP INSPECTION

VESSEL MADE BY _____ at _____
I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State or Province of _____ and employed by _____ of _____
have inspected the pressure vessel described in this manufacturer's data report on _____ 19 _____, and state that to the best of my knowledge and belief, the manufacturer has constructed this pressure vessel in accordance with the ASME Code for Nuclear Vessels.
By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the pressure vessel described in this manufacturer's data report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.
Date _____ 19 _____
Inspector's Signature _____ Commissions _____ National Board or State and No. _____

CERTIFICATE OF FIELD ASSEMBLY INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State or Province of _____ and employed by _____ of _____
have compared the statements in this manufacturer's data report with the described pressure vessel and state that parts referred to as data items _____, not included in the certificate of shop inspection have been inspected by me and that to the best of my knowledge and belief the manufacturer has constructed and assembled this pressure vessel in accordance with the ASME Code for Nuclear Vessels. The described vessel was inspected and subjected to a hydrostatic test of _____ psi.
By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the pressure vessel described in this manufacturer's data report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.
Date _____ 19 _____
Inspector's Signature _____ Commissions _____ National Board or State and No. _____

FORM NP-1 DATA REPORT FOR NUCLEAR PIPING
(As Required by the Provisions of the USAS B31.7 Code Rules)

1. Manufactured by _____ Order No. _____
(Name and Address of Fabricator)
2. Manufactured for _____ Order No. _____
(Name and Address)
3. Owner _____ 4. Location _____
5. Piping System Identification _____
(a) Shop Drawing No. _____ Prepared by _____
6. Design Conditions of Piping _____ psi _____ °F Specified by _____
(Pressure) (Temperature) (Name of Co. & Rep.)
7. The Design Complies with USAS B31.7 Chapter II, Class I II III.
(circle one)
 - (a) Design Information on file at _____
 - (b) Design Specification certified by _____
Prof. Engr. State Reg. No.
 - (c) Stress Analysis Report on file at _____
 - (d) Stress Analysis Report certified by _____
Prof. Engr. State Reg. No.
8. The Materials comply with USAS B31.7, Chapter 1-III; Chapter 2-III; Chapter 3-III
(circle one)

Mark No.	I.P.S.	Manufacturer	Material Manufacturer
(a) Piping			
1.			
2.			
3.			
4.			
(b) Fittings			
1.			
2.			
3.			
4.			
(c) Flanges			
1.			
2.			
(d) Special Component			
1.			
2.			
3.			
4.			
9. The Fabrication and Inspection complies with USAS B31.7, Chapters 1-V and 1-VI; 2-V and 2-VI; 3-V and 3-VI (circle one).
 - (a) Number of spool pieces _____ Number of Butt Welds _____
 - (b) Shop Hydrostatic Test _____ psi
 - (c) Certificate of Authorization No. _____

We certify the statements of items Nos. 8 and 9 in this data report to be correct.

Date _____ Signed _____ By _____
(Fabricator) (Q. C. Representative)

CERTIFICATE OF SHOP INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State of _____ and employed by _____ of _____ have inspected the piping described in this data report on _____ 19____, and state that to the best of my knowledge and belief, the manufacturer has constructed this piping in accordance with the applicable sections of the USAS B31.7 Code for Nuclear Power Piping.

By signing this certificate, neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the piping described in this data report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date _____ 19____

(Inspector) Commissions _____ (State and No.)

10. Description of Field Erection and Inspection

(a)	Mark No.	I. P. S.	Number of Spool Pieces	Number of Butt Welds
1.	_____	_____	_____	_____
2.	_____	_____	_____	_____
3.	_____	_____	_____	_____
4.	_____	_____	_____	_____

(b) Field Hydrostatic Test _____ psi
(c) Certificate of Authorization No. _____

We certify that the field erection and inspection as described above complies with USAS B31.7, Chapters 1-V and 1-VI; 2-V and 2-VI; 3-V and 3-VI (circle one).

Date _____ Signed _____ By _____
(Fabricator) (Q. C. Representative)

Our Certificate of Authorization expires _____

CERTIFICATE OF FIELD ASSEMBLY INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State of _____ and employed by _____ of _____ have compared the statements in this data report with the described piping and state that the parts referred to as data items _____ not included in the certificate of shop inspection have been inspected by me and that to the best of my knowledge and belief the manufacturer and/or assembler has constructed and assembled this piping in accordance with the applicable sections of the USAS B31.7 Code for Nuclear Power Piping. The described piping was inspected and subjected to a hydrostatic test of _____ psi.

By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the piping described in this data report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date _____ 19____

(Inspector) Commissions _____ (State and No.)