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MASTER

A STUDY OF
LMFBR SYSTEM INTERFACES

TECHNICAL REPORT 231

PREPARED FOR

U S ATOMIC ENERGY COMMISSION

CONTRACT NO AT(04-3)-781

BRAUN PROJECT 4122-W

UNITED NUCLEAR PROJECT 2351

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C F BRAUN & CO

Engineers

ALHAMBRA CALIFORNIA 91802

March 28, 1969

Mr H B Fry
Contracting Officer, Contract AT(04-3)-781
AEC San Francisco
2111 Bancroft Way
Berkeley, California 95704

BAL-41

Dear Mr Fry

SYSTEM INTERFACE REQUIREMENTS
TECHNICAL REPORT 231
LMFBR PIPING DESIGN GUIDE
AEC SAN FRANCISCO
PROJECT 4122-W

Transmitted herewith are two copies of the draft report covering studies of System Interfaces as related to sodium piping for LMFBR piping systems.

The purpose of the study was to clearly define all LMFBR system interfaces and to delegate the design responsibilities that each of these interfaces encompass.

A four-week period is allowed for review and return of comments to Braun. Comments should be mailed by April 25 to

C F Braun & Co
Dr R F Detman, Project Manager
Alhambra, California 91802

Yours very truly

Roger Detman
Project Manager

RFD IV

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Mr H B Fry

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CC Director, RDT, HQ
Asst. Director, Plant Engineering, RDT, HQ
RDT Senior Site Representative (AI) -2
Director, LMEC -8

File R F DETMAN

A STUDY OF
LMFBR SYSTEM INTERFACES

TECHNICAL REPORT 231

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Prepared for US Atomic Energy Commission

Contract No AT (04-3) -781

Braun Project 4122-W

United Nuclear Project 2351

C F BRAUN & CO

Alhambra California

March 28, 1969

PRELIMINARY
FOR REVIEW ONLY

A STUDY OF
LMFBR PIPING SYSTEM INTERFACES
TECHNICAL REPORT 231
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1 INTRODUCTION

C F Braun & Co has been awarded a contract⁽¹⁾ by the US Atomic Energy Commission for the development and verification of a Piping Design Guide for sodium-cooled fast breeder reactor power plants (LMFBR). The work is a Priority 1 Task under the LMFBR Program Plan⁽²⁾ prepared for the USAEC Division of Reactor Development and Technology (RDT) by the LMFBR Program Office, Argonne National Laboratory. It is identified in the Program Plan as Task 3-8.2, Development of Design Technology for Piping.

This Technical Report is directed towards ascertaining the degrees of constraint imposed on the piping by the system interfaces as identified. Design parameters will be established where possible. The study addresses itself to four broad areas of concern, (1) the equipment interface, (2) the in-line component interface, (3) the fluid interface, and (4) LMFBR program interfaces.

It is anticipated that the criteria developed in this Technical Report will be subject to revision and/or expansion as the work progresses. A review procedure has been established to ensure consistency between interdependent studies currently being performed under this and other task areas of the LMFBR Program Plan.

Under the review procedure, the Liquid Metal Engineering Center, (LMEC), is the coordinating agency. Technical Reports prepared by Braun under this contract will be distributed by LMEC to appropriate Review Agencies designated by USAEC. Comments from Review Agencies will be evaluated by Braun to determine their validity. Valid comments will then be incorporated into subsequent revisions to the Technical Reports.

(1) AT(04-3)-781, AEC San Francisco Operation Office (SAN)

(2) Liquid Metal Fast Breeder Reactor Program Plan, LMFBR Program Office, Argonne National Laboratory - AEC R&D Report, Reactor Technology, WASH-1101, August 1968

FIGURE 231-1 INTERRELATIONSHIP - TASK AREA 3 - COOLANT TRANSPORT AND STORAGE SYSTEMS

2 GENERAL DISCUSSION

2.1 DESCRIPTION OF LMFBR PIPING SYSTEM

In order to establish the extent of the piping system interfaces to which this report will be applicable, it will be appropriate to review the LMFBR system concepts at present being considered.

The LMFBR essentially comprises a relatively small and compact reactor core and fuel-control configuration, cooled by the upward flow of primary liquid sodium. Heat from the primary coolant is removed in an intermediate heat exchanger (IHX), and the coolant is then recycled back to the core by a primary pump. This circuit comprises the primary coolant loop. In the IHX, heat is transferred to a secondary sodium loop wherein the sodium is circulated by a secondary pump from the IHX to a steam generator and back to the IHX.

As presently visualized, the primary and secondary coolant loops in an LMFBR system would contain the following components.

1) Reactor	8) Steam Generators
2) IHX	9) Cover Gas Systems
3) Pumps	10) Sodium Surge Tanks
4) Valves	11) Radiation Shielding
5) Purification Systems	12) Surveillance Equipment
6) Sodium Storage Tanks	13) Instrumentation
7) Preheat System	14) Superheater

Two basic design concepts have so far been evolved - the pot (or pool) concept; and the loop concept.

In the pot-type system, the primary pump and IHX, together with the primary coolant piping, are located entirely within the reactor core containment vessel. The secondary pump and steam generator are located outside, the secondary coolant loop thus passing through the containment vessel wall to and from the IHX.

In the loop-type concept, on the other hand, the primary pump and IHX are located outside the reactor containment vessel, the primary coolant piping passing through the vessel wall.

Because each of the concepts is being studied with almost equal attention at the present time, it will be necessary that this report be formulated to cover both concepts.

2.2 NECESSITY FOR DEFINING THE INTERFACE CRITERIA

In an LMFBR system, the sodium piping is physically connected with most of the system components. The piping system will therefore impose a number of constraints and limitations upon these system components, as well as having the system components impose constraints and limitations upon the piping system. Additionally, because the piping system in an LMFBR is so inherently extensive, the piping will impose a number of constraints and limitations upon the layout of the LMFBR structure itself.

Therefore, because of the number of pipe connections with associated system components and the overall piping system complexity, the need to identify and locate each of the physical and indirect piping system interfaces becomes apparent.

Further, because of the constraints and limitations imposed by the piping and system components upon each other, it becomes necessary, within the scope of this report, to clearly define the interface design responsibilities of the piping designer and system components manufacturers.

3 PUMP INTERFACES

3.1 LMFBR PUMP INTERFACE REQUIREMENTS

- a) The physical interface between the pump and the piping is the face of the nozzle furnished by the manufacturer.
- b) All interface connections for LMFBR pumps will be welded. For information on interface welding requirements refer to Section 14.
- c) The pump nozzle and the piping at the interface must be of identical wall thickness, diameter, concentricity and material. Alignment of the nozzle facings and tolerances on the weld bevel must be maintained.
- d) The pump manufacturer is responsible for providing the piping designer with the following information.
 - 1 Tables of maximum forces and moments that may be imposed by the piping at the interface
 - 2 Thermal expansion movements and rotations of the pump nozzle interface
 - 3 Forcing frequencies induced by the pump
- e) It shall be the piping designer's responsibility to assure that the forces and moments imposed upon the pump comply with the manufacturer's allowables. In special cases where the piping designer can not meet the pump manufacturer's allowable loads, a consultation between the pump manufacturer and the piping designer will be necessary in order to attempt to resolve the problem. If a compromise solution can not be obtained it will then become the system engineer's (engineer responsible for the design concept) responsibility to resolve the problem.
- f) The piping system must be designed to accommodate any horizontal or vertical movements at the interface connection from thermal expansion of the pump casing.
- g) The system engineer will be responsible for specifying the method of pump support. The piping designer must be informed of the pump support selected in order that proper allowances be made during the design stages of the piping system.

3.2 STANDARD CODE FOR PUMPS AND VALVES FOR NUCLEAR POWER

Refer to Section 4 of this report for topic discussion.

4 VALVE INTERFACES

4.1 VALVE INTERFACE REQUIREMENTS

- a) The physical interface between the valve and the piping system is at the weld that connects the valve nozzle to the piping.
- b) All interface connections for LMFBR valves will be welded. For information on interface welding requirements refer to Section 14.
- c) At the interface, the valve nozzle must be of identical wall thickness, diameter, concentricity and material to that of the piping. Valve manufacturer will be responsible for transition.
- d) The alignment tolerances between the piping and the valve must be maintained.
- e) Valves are defined as in-line components and as such must be designed to sustain the same forces and moments as the piping system. In special cases where the valve manufacturer cannot meet the allowable loads, a consultation between the valve manufacturer and the piping designer will be necessary to attempt to resolve the situation.
- f) Valve manufacturer must indicate to piping designer any orientation, valve support limitations, etc, that have detrimental effects upon valve performance.
- g) The piping designer will be responsible for actual valve location and orientation that are established by the LMFBR system design.

4.2 STANDARD CODE FOR PUMPS AND VALVES FOR NUCLEAR POWER

In response to the urgent need of the nuclear power industry and authorities, both local and federal, ASME established a committee in 1966 to formulate a code for the manufacture of pumps and valves for nuclear power. On November 19, 1968, ASME issued a Draft Code for Pumps and Valves for Nuclear Power for trial use and comment. This code, along with ASME Section III, Nuclear Vessels, and USAS B31.7, Nuclear Power Piping, completed the code coverage of equipment and components found for water moderated nuclear reactors.

4.2 STANDARD CODE FOR PUMPS AND VALVES FOR NUCLEAR POWER
Continued

- a) In its present form, Article 4 - Design covers only the design rules for valves. Similar rules for pumps are now under development and are tentatively scheduled for draft publication in the second half of 1969.
- b) The code was developed for water reactor applications. These rules are for pumps and valves operating at limited temperatures of 700 F for ferritic materials and 800 F for austenitic materials.
- c) The Ad Hoc Committee was not directed to prepare a code for liquid metal services. The new ASME code can only serve as a guide in the design of LMFBR pumps and valves that operate over 800 F since no high temperature code case is contemplated.
- d) It is important that pump and valve manufacturers, along with other involved in the LMFBR programs in the near future, develop design rules that can be applied to LMFBR pumps and valves.

5 VESSEL INTERFACES

5.1 TYPES OF LMFBR VESSELS

- a) Reactor
- b) Intermediate Heat Exchanger (IHX)
- c) Steam Generator
- d) Superheater
- e) Sodium Storage Tank
- f) Sodium Surge Tank
- g) Purification System Vessels

5.2 VESSEL INTERFACE REQUIREMENTS

- a) The physical interface between the vessel and the piping system is at external vessel connection provided for the attachment of piping.
- b) All interface connections between vessels and piping will be welded. For information on interface weld requirements refer to Section 14.
- c) The vessel engineer will provide vessel nozzles that are of identical wall thickness diameter, concentricity and material to that of the piping system.
- d) The alignment between the piping system and vessel nozzles must be maintained.
- e) The vessel and nozzle shall be designed to sustain all imposed design loads resulting from the connecting piping system. The piping designer will inform the vessel manufacturer of nozzle load data.
- f) The piping system must be designed to accommodate any horizontal and vertical movements of the vessel nozzle due to thermal expansion of the vessel shell.
- g) The system engineer must specify all provisions that must be made if it is deemed necessary that surge tank connection piping include internal baffling to spoil thermal convection currents.
- h) In the piping stress analysis, credit should be taken for localized deflection of the vessel shell at the nozzle connection. This deflection of the shell is caused by the piping system reactions on the vessel nozzle.

6 PIPE SUPPORT INTERFACES

6.1 PIPE SUPPORT INTERFACE REQUIREMENTS

- a) The physical interface between the piping and the support is located at the point the pipe support is attached to a structural member that is provided for load support.
- b) At locations that support loads are carried, the design of support structure will be the structural engineer's responsibility.
- c) The structural engineer must inform the piping designer of the location of major structural supports that are available. The piping designer must notify the structural engineer of any additional supports that are needed to carry the piping loads.
- d) The piping designer will provide the structural engineer with the amounts of maximum loads, location of loads, and details of the attachment methods.
- e) The structural engineer must then inform the piping designer what structural deflections will result from the various support loads.
- f) The piping designer will inform the system engineer and structural engineer of the space requirements necessary for
 - (1) the physical accommodation of the pipe support equipment,
 - (2) the amount of accessibility in order to adjust and maintain the support system after erection.

7 ENVIRONMENTAL INTERFACES

7.1 FLUID

The System Engineer will provide the piping designer with sources of information for obtaining the specific values listed below. Some information, pertaining to the range of values, that is presently available has been listed in Topical Report 110.

7.1.1 TEMPERATURES Design temperatures are needed to permit the piping designer to establish allowable stress limitations. Pipewall temperature differentials are required in order to calculate secondary and peak thermal stresses during steady state and transient operation. Specific temperature data required are listed below.

- a) Design temperature and plant operating cycles.
- b) Range of operating temperatures as a function of time at all pipe sections.
- c) Temperature transients
 - Range - initial and final
 - Direction - positive or negative
 - Rate - °F/sec
 - Time - duration of transient
 - Number of cycles
- d) Temperature differences at connections of auxiliary systems.
- e) Temperature difference between sodium and external environment to determine heat losses.

7.1.2 PRESSURES The internal pressure representing the most severe condition of coincident pressure and temperature together with the primary bending stresses are required to establish the basic pipewall thickness for a LMFBR piping system. In addition, transient and/or accident conditions can produce pressure fluctuations, surges, and overpressure resulting in overstressing the pipe, pipe rupture and extensive damage. The piping designer must have data on the source, magnitude and duration of all transient conditions to adequately design the piping system.

Detailed data required are given below.

- a) Maximum system working pressure.
- b) Pressure drops between components and through in-line components.

7.1.2 PRESSURES Continued

- c) Magnitude of pressure fluctuations.
- d) Maximum pressure surge and duration due to component operation, e.g., valve closing.
- e) Maximum overpressure and duration due to sodium-water reaction.
- f) Maximum overpressure due to melting sodium between frozen sections of sodium.

7.1.3 FLOW System flow rates must be specified for the selection of pipe size. Piping designers must be informed of any sodium velocity or Reynolds number limitations.

If flow fluctuations are expected due to special pump characteristics, an oscillating flow control device, or any other known source, the expected magnitudes and frequencies of such flow oscillations should be identified. The piping system natural frequencies should be sufficiently different from the forcing frequencies identified to avoid vibration problems.

7.1.4 SODIUM PURITY For several reasons the piping designer must be informed of the minimum level of sodium purity that will be maintained in the system. These are as follows.

- a) Sodium Chemistry - must be specified so that corrosion allowances for pipewall thickness and mechanical properties for pipe materials can be established. Impurity levels should be provided for normal operation as well as for expected impurity excursions. Of special concern are oxygen and carbon activity. These and other chemistry aspects are discussed further in Topical Report 228 - Piping Materials for LMFBR Plants.
- b) Particulates - could play a role in erosion processes and should be identified. Also particulates may potentially form deposits in smaller diameter piping or branch connections that will have detrimental effects on performance.
- c) Gas Entrainment - could be the cause of vibration and additional corrosion. Peak pressures developed during flow transients could be significantly affected by entrained gas.

7.1.5 RADIOACTIVITY For pool type systems, neutron fluxes must be specified to establish to what extent, if any, the design values for mechanical properties of the pipe materials must be modified to account for fast neutron flux embrittlement.

It is not expected that neutron or gamma heating will be of concern to the pipe designer. However, if there are unusual circumstances for which such heating is significant, they should be identified.

For the primary system piping, it is important to specify radiation sources, such as ^{24}Na saturation levels, ^{22}Na as a function of time, fission product activities and radioactive mass transfer deposits, to define accessibility limits so that the piping designer can provide properly for surveillance, instrumentation, maintenance and repair.

Similar information should be provided for the secondary system, if it was contemplated that operation with a limited leak of primary sodium into secondary sodium at the intermediate heat exchanger would be permitted.

8 INSTRUMENTATION INTERFACE

8.1 INSTRUMENT INTERFACE LOCATION

- a) In-Line Instrumentation - The interface between the piping system and in-line instruments is located at the nozzle connection provided for the attachment of piping. A typical example of this type of instrument would be venturi flow nozzle.
- b) External Instruments - The interface between the piping system and external instruments is located at the point of attachment on the pipe's external surface. These types of instruments do not require penetration of the pipewall. Examples of this type instrument would be a skin-temperature thermocouple.
- c) Instruments Requiring Branch Connections - The interface between the piping system and branch connected instruments is located at the point the instrument is attached to a provided pipe branch connection. These types of instruments require penetration of the pipewall. A pressure sensor bellows is a typical example of this type of instrument.

8.2 INSTRUMENT INTERFACE REQUIREMENTS

- a) All instrument interface connections will be welded. For welding interface requirements refer to Section 14 of this report.
- b) All in-line instrumentation is classified as an in-line component and therefore must meet the same requirements as stipulated for valves in Section 4.
- c) The piping designer will be responsible for providing satisfactory branch connections for attaching various instrumentation.
- d) The instrument engineer will provide information pertaining to any orientation or location limits that must be followed to insure proper operation and performance of the instruments.
- e) The piping designer will be responsible for the actual location and orientation of the instruments within the piping system.
- f) Instrumentation must be designed to accommodate all piping system movements due to thermal expansion. The piping designer will provide the instrument engineer with the movement data at the instrument connection.

8.2 INSTRUMENT INTERFACE REQUIREMENTS Continued

- g) Instrumentation material must be compatible with that of the LMFBP pipe at the interface connection.
- h) Instrumentation systems for surveillance will be covered in Section 9.

9 SURVEILLANCE SYSTEM REQUIREMENTS

Later - Pending the completion of Topical Report 243 - Surveillance
Methods

10 PURIFICATION SYSTEM INTERFACES

10.1 INTERFACE LOCATION

The physical interface locations between the purification system piping and the purification system components have been previously defined under Pumps - Section 3, Valves - Section 4, Vessels - Section 5, and Instrumentation - Section 8 of this report.

10.2 PURIFICATION SYSTEM INTERFACE REQUIREMENTS

- a) The piping designer will be responsible for the design of the purification system piping.
- b) The piping designer will be responsible for location and orientation of equipment, in-line components and instrumentation in the purification system.
- c) The pump interfaces in the purification system must meet the same requirements as those given for pumps in Section 3 of this report.
- d) The in-line component interfaces in the purification system must meet the same requirements as those given for valves in Section 4 of this report.
- e) The vessel interfaces in the purification system must meet the same requirements as those given for vessels in Section 5 of this report.
- f) The instrumentation interfaces in the purification system must meet the same requirements as those given for instrumentation in Section 8 of this report.

11 PREHEAT SYSTEM INTERFACES

11.1 PREHEAT INTERFACE LOCATION

- a) Radiant Preheating - The physical interface, for this type of preheat method, is located at the junction box where the electrical power supply wires connect to electrical terminals of the resistance heating elements.
- b) Tubular Preheaters - The physical interface utilizing this preheat method will be defined as located at the junction box where the electrical power supply wires connect to the electrical terminals of the resistance heating elements.
- c) Annular Fluid Preheaters - The physical interface using the preheat method will be located at the point that the hot gases are ducted into the annular jacket surrounding the sodium piping.
- d) Heat Tracing Preheaters - The physical interface for this preheat method is located at the point the hot fluid lines from the heating system attaches to the small diameter carrier pipes.

11.2 PREHEAT INTERFACE REQUIREMENTS

- a) For electrical preheater systems, the piping designer will specify the necessary electrical power requirements for maintaining desired sodium pipe temperature levels.
- b) For hot gases or fluid preheat systems, the piping designer will specify the fluid or gas input temperatures and flow rate requirements that will be necessary for maintaining desired sodium pipe temperature levels.
- c) The electrical wiring, gas ducting, and fluid pipes from the heater must be designed to accommodate all piping system movements. The piping designer will provide the anticipated pipe movement information.

12 COVER GAS SYSTEM INTERFACE

On the basis of current LMFBR design concepts there is no direct interface between the piping system and the cover gas system during normal operation.

Further study will be required to determine the impact of cover gas and purge gas systems on piping materials during plant shutdowns and during the repair of installed piping.

13 SHIELDING INTERFACES

13.1 SHIELDING INTERFACE LOCATION

The physical interface between the shielding and the piping system is located at the point that piping penetrates the primary or secondary radiation shielding.

13.2 SHIELDING INTERFACE REQUIREMENTS

- a) The piping designer will be responsible for providing the shielding engineer with maximum load values the piping system will impose upon the shielding.
- b) The piping designer will provide the shielding engineer with anticipated pipe movement data due to vibration and thermal expansion, so that the shielding engineer can determine the necessary clearances between the shield and piping to prevent mechanical interferences.
- c) The piping designer will inform the shielding engineer with anticipated in-line component movement data. The shielding engineer will be responsible for providing penetrations in the shielding for in-line component extension shafts with the necessary clearances to prevent mechanical interference between the shielding and extension shafts.
- d) For pool-type reactors, the shielding engineer will be responsible for evaluating the relative thermal expansion between the primary shield and the piping system.
- e) For pool-type reactors, the shielding engineer will indicate, to the piping designer, the expected radiation levels that will be present at the primary piping.

14 INTERFACE WELDING REQUIREMENTS

The piping designer shall be responsible for selection and specification of the welding process, qualification tests, weld bevel configuration, cleaning methods, and dimensional tolerances that are used at all interface connections.

For more detail information on welding requirements refer to Technical Report 220, A Review of Fabrication and Installation Requirements for LMFBR Piping.

15 LMFBR AND OTHER PROGRAM INTERFACES

In the development of the Piping Design Guide, it is imperative that information which is being developed under related programs be incorporated into the Guide, if it is to serve as an up-to-date document. An attempt has, therefore, been made to identify other programs which are expected to generate information which will be of benefit to the Guide.

A brief description as to the type of applicable information which may become available from each related program is given in the following.

15.1 LMFBR PROGRAM - USAEC

The Components Section of the LMFBR Program Plan (Wash 1103) identifies other LMFBR program tasks which have a direct bearing on the design of sodium piping. An interrelationship diagram for the Task Area 3-8, Coolant Transport and Storage Systems is shown in Figure 1 on Page 2.

The Process and Instrumentation diagrams and plant layouts which will be developed under other tasks will define the piping requirements.

The development of fabrication technology will assist the piping designer in selecting pipe configurations and specifying installation processes.

The development of valves and expansion devices, which are in-line components, will affect pipe geometries and loadings. The successful development of expansion devices, in particular, would have an enormous effect on pipe design. In preparing the Piping Design Guide, it is presently assumed that thermal expansion between fixed points must be accommodated by the flexibility of the pipe itself, without generating excessive loads at the connections to other components.

It will be necessary to coordinate the development of a Piping Design Guide with such other Major Tasks as Instrumentation and Control, Sodium Technology and Quality or Reliability Assurance.

15.2 LIQUID METAL PIPING PROGRAM - FOREIGN

There are several foreign reactor sodium cooled plants and/or facilities which are presently in operation or planned for operation in the near future. Although these plants were not designed specifically for the testing of the piping, the experience gained from the operation of such plants can be invaluable in preparation of a Piping Design Guide. For example, the piping failures experienced in these plants provide the piping designer with information so that similar failures can be avoided in future plants.

A list of such programs is as follows.

United Kingdom - Piping experience with the Dounreay Fast Reactor (DFR) and the development of the Prototype Fast Reactor (PFR)

France - Piping experience with Rapsodie and associated development and development of Phenix

Federal Republic of Germany - Piping experience with KNK and associated development and development of the Fast Breeder Reactor (FBR)

Netherlands - Piping experience at the Central Technical Institute of TNO

Italy - Piping experience with CNEN supported development of sodium cooled reactors

Japan - Piping experience at Japan Atomic Energy Research Institute (JAERI) and Power Reactor and Nuclear Fuel Development Corporation (PNC)

15.3 WATER REACTOR PIPING PROGRAM

The USAEC is sponsoring several investigations which are concerned with water reactor piping. These studies are concerned principally with the rupture of piping for BWR and PWR plants. However, the data obtained from these studies provide basic information on pipe material behavior under certain loading conditions.

The activities in Japan pertaining to the manufacture of piping will be of interest and any information should be interfaced with the LMFBR program.

15.3 WATER REACTOR PIPING PROGRAM Continued

The programs are as follows.

USAEC

- a) Reactor primary coolant rupture study (GE)
- b) Investigation of the initiation and extent of ductile pipe rupture (BMI)
- c) Nuclear Safety Research and Development Program Design Criteria for Piping, Pumps and Valves

FOREIGN

- a) Program to establish the foundation for manufacture of special pipes for BWR and PWR (Sumitomo)
- b) Problem in manufacture of large diameter SS pipes (Tokyo Electric Power)

15.4 PROFESSIONAL SOCIETY PROGRAMS

The professional societies, such as the ASME, ASTM, Metal Properties Council, Welding Research Council and American Petroleum Institute, financially support and sponsor many activities which are directly applicable to the design of piping systems. These activities are controlled and guided through the various committees, subcommittees and task groups of the Societies. They cover every phase involved in the design of a piping system, e.g., mechanical properties, material specification, fabrication, erection, elevated temperature design, corrosion, standards, reliability, etc. Committees, subcommittees and task groups which are engaged in these activities are identified below.

ASME

Boiler and Pressure Vessel Committee

- a) S/C on Material Specifications
S/G on Steel Tubular Products
- b) S/C on Properties of Metals
S/G on Toughness
S/G on Fatigue Strength
S/G on Strength Steel High Temperature Alloys

15.4 PROFESSIONAL SOCIETY PROGRAMS Continued

- c) S/C on Nuclear Power
- d) S/C on Welding
- e) S/C on Design
 - S/G on Design Rules
 - S/G on Elevated Temperature Design
 - S/G on Design Analysis
- f) S/C on Nondestructive Testing

ASME

Committee B31, Code for Pressure Piping

- a) S/C on Power Piping
- b) S/C on Nuclear Power Piping
- c) S/C on Fabrication, Assembly and Erection
- d) S/C on Inspection and Testing
- e) S/C on Standards and Specifications
- f) S/C on Materials and Stresses
- g) S/C on Mechanical Design
 - S/G on Weight Effects, Thermal Expansions,
Expansion Flexibility
 - S/G on Intersections
 - S/G on Design Criteria - Design of Components

ASTM

Committee on Corrosion of Metal

- a) S/C on Corrosion of Nuclear Materials
- b) S/C on Stress Corrosion Cracking and Corrosion Fatigue
- c) S/C on High Temperature Corrosion

15.4 PROFESSIONAL SOCIETY PROGRAMS Continued

ASTM

Committee on Steel

- a) S/C on Pipe
- b) S/C on Steel Tubing

ASTM

Committee on Iron-Chromium, Iron-Nickle and Related Alloys

- a) S/C on Specification for Tubular Products
- b) S/C on Nuclear Applications

Committee on Fatigue

Committee on Nondestructive Testing

- a) S/C on Ultrasonic Testing - Section K, Pipe and Tubing

The Metal Properties Council*

- a) S/C on Engineering Properties of Boiler and Pressure Vessel Materials
- b) S/C on Properties of Quenched and Tempered Steels for the Design of High Strength Engineering Structures
- c) S/C on Low Cycle Fatigue
- d) S/C on Relaxation Behavior of Bolting and Piping Materials
- e) S/C on Effects of Irradiation on the Properties of Metals
T/G on Effects of Irradiation on the Properties of Metals
T/G on Fracture Toughness Characteristics in Metals

* See Appendix I for the following.

- a) What the Metal Properties Council has done and is doing.
- b) Publications now in manuscript - October 1, 1968.
- c) Publications planned for 1969 and 1970.

15.4 PROFESSIONAL SOCIETY PROGRAMS Continued

ASTM

Welding Research Council

- a) S/C to Develop Stress Indices for Piping, Pumps and Valves
- b) S/C on Plastic Fatigue Strength
- c) S/C on Significance of Weld Discontinuities

ASTM - ASME - MPC

- a) Joint Committee on Effects of Temperature on the Properties of Metals

American Petroleum Institute

Division of Production - Committee on Standardization of Tubular Goods

- a) S/C on Casing, Tubing and Drill Pipe
 - T/G on Fracture Toughness
- b) S/C on Line Pipe
 - T/G on High Strength Casing
 - T/G on Nondestructive Testing
 - T/G on Welding and Weld Testing
 - T/G on Performance Properties of Casing and Tubing
 - T/G on Property Control Requirements

Division of Refining

A listing of applicable committees, subcommittees, task groups, etc., was not available.

16 BIBLIOGRAPHY

- 1 Draft USA Standard Code For Pressure Piping, Nuclear Power Piping, USAS B31.7, ASME, New York, issued for trial use and comment, February 1968.
- 2 Liquid Metal Fast Bleeder Reactor Program Plan, LMFBR Program Office, Argonne National Laboratory - AEC R&D Report, Reactor Technology, Wash-1101, August 1968.
- 3 ASME Boiler and Pressure Vessel Code, Section III, Rules for Construction of Nuclear Vessels, 1968 Edition, ASME, New York, 1968.
- 4 Draft ASME Standard Code for Pumps and Valves for Nuclear Power, ASME, New York, issued for trial use and comment, November 1968.
- 5 Crean, L E, and Parkins, W E Liquid Metal Cooled Reactors, Reactor Handbook, Volume IV, Engineering, Interscience Publishers, New York, 1964.
- 6 Optimization and Design Studies, Sodium Pump Test Facility (SPTF), Conceptual System Design Description, Appendix B-6, C, H, I-4 C F Braun & Co, CFB-2964-112, November 17, 1967.
- 7 Conceptual System Design Description III, Instruments and Controls (SPTF), C F Braun & Co, CFB-2964-103, November 17, 1967.
- 8 Conceptual System Design Description VIII, Sodium Sampling and Purification Systems (SPTF), C F Braun & Co, CFB-2964-108, November 17, 1967.
- 9 Company-Related Data for Meeting with C F Braun & Co Representatives, Rockwell Manufacturing Company, Pittsburgh, Pennsylvania, November 12, 1968.
- 10 Landler G, Sodium Components Test Installation Feasibility Study Report. Primary Sodium Piping Design Without Bellows, Atomics International, Canoga Park, California, June 21, 1966.
- 11 Landler, G, Sodium Component Test Facility Feasibility Study Report. Secondary Sodium Piping Design Without Bellows, Atomics International, Canoga Park, California, May 2, 1966.
- 12 Peters, N T, Development of the Primary System for the Enrico Fermi Atomic Power Plant, Atomic Power Development Associates, Inc, June 1968.

APPENDIX

WHAT THE METAL PROPERTIES COUNCIL
HAS DONE AND IS DOING

WHAT THE METAL PROPERTIES COUNCIL HAS DONE AND IS DOING

I FOR MATERIALS FOR BOILERS AND PRESSURE VESSELS

- 1) Assemble data on carbon and alloy steels by mail solicitation. Pooled this with material on hand with the ASME Boiler and Pressure Vessel Code Committee.
- 2) Now analyzing and arranging this material for publication, scheduled for October, 1968.
- 3) Analyzing accumulated data of the Boiler and Pressure Vessel Code Committee and the Joint Committee to make it available to engineers in useable form. First of probably six volumes now in process of publication.
- 4) Conducting a review (using computer equipment) to see how well this accumulated data supports standard parametric methods of projection. Results will be published this Fall.
- 5) Instituted a two year program to develop a method of parametric evaluation superior to those now in use.
- 6) Started a testing program of certain aluminum alloys, results to be published in about a year. This program includes creep and stress rupture data using the most recent techniques.
- 7) Sponsored a symposium at an ASME-AWS Annual Meeting on the Properties of Weld Deposited Metal at Elevated Temperatures. This has been published by ASME.
- 8) Sponsoring with the Joint Committee a symposium on Creep and Creep Testing to be held October 14th at the Metals Congress.
- 9) Planning new data solicitation on certain alloy steels presently widely used in pressure vessel construction.

II FOR INCREASING OUR KNOWLEDGE ON HOW TO UTILIZE QUENCHED AND TEMPERED STEELS PARTICULARLY AT ELEVATED TEMPERATURES, IN WELDED CONSTRUCTION, AND IN HOSTILE ENVIRONMENT.

- 1) Sponsored a symposium at an ASME Petroleum Division Meeting which was published by that organization.

- 2) Conducted an analysis of the papers at the symposium, together with bibliography, and published this through ASME.
- 3) Initiated a long time elevated temperature testing program on 4 1/2 inch thick quenched and tempered chrome molybdenum steel plate. This program will yield data on embrittlement as well as on creep and stress rupture. First results should appear in about two years.
- 4) Planning extension of the program to other alloys.

III FOR OBTAINING DATA ON LOW CYCLE FATIGUE CHARACTERISTICS OF METALS

- a) As applied to central station power generation equipment and petroleum refining and chemical processing equipment.
- b) New data on fatigue characteristics of certain aluminum alloys.
- 1) Obtained a chrome moly vanadium steel turbine rotor forging, and some chrome molybdenum steel large diameter heavy walled pipe. Started a program of thoroughly testing this material for identification, preparatory to a program of precisely cycled fatigue testing. The fatigue testing program will begin in December.
- 2) Started a testing program of certain aluminum alloys using new sophisticated equipment and techniques.

IV FOR STUDYING THE EFFECTS OF THE RATE OF LOADING ON THE STRENGTH OF METALS

- 1) Instituted a cooperative program with three company laboratories which are testing three metals at various temperatures and rates of loading to establish guideposts for a larger program.
- 2) Planning a symposium on this subject in 1969.
- 3) Conducted a search in existing data banks and assembled an extensive bibliography on the subject. Studies all data bank references and prepared an interpretive report on the subject which is now in process of publication.

- 4) Intends to use the interpretive report and the cooperative program as a basis for a larger scale program starting in 1969.
- 5) Initiated a testing program of aluminum alloys at extremely high rates of loading.
- 6) Planning a testing program of aluminum alloys at low rates of loading.

V TO DETERMINE THE RELAXATION CHARACTERISTICS OF METALS

- 1) Search in existing data banks, plus a mail solicitation has brought forth a large amount of data plus previously unpublished reports which are now being analyzed first for publication; and, second, for setting up whatever program might be needed. Program to begin in 1969.
- 2) An interpretive report is now in preparation for publication this Fall.
- 3) Studies are being made for the optimum presentation of data, preparatory to completely revising the current work on this subject. (ASTM)
- 4) A symposium and a workshop session on this subject are planned for 1968 and 1969.
- 5) A testing program on relaxation characteristics of aluminum alloys has been started which will be completed in about a year.

VI TO ANALYZE THE EFFECTIVENESS OF SURVEILLANCE TEST PROGRAMS TO DETERMINE THE EFFECTS OF IRRADIATION ON THE PROPERTIES OF METALS

- 1) Formed a Task Group and a Subcommittee to guide MPC activities in this area.
- 2) Has assumed responsibility of gathering and analyzing surveillance test data from power installations.
- 3) A publication is in preparation on this subject. This will be the first published analysis of actual surveillance test data.

VII TO DETERMINE THE PROPERTIES OF ALUMINUM AND TITANIUM IN
LARGE SECTIONS

- 1) A Task Group has gathered data on this subject from manufacturers. It is being analyzed by Air Force facilities for inclusion in their Manual, following which it will be arranged and published.
- 2) Further plans are being made to supplement existing data.

VIII IN THE FIELD OF FRACTURE CHARACTERISTICS

- 1) Organized a Task Group which is determining the role MPC is to play in this area.
- 2) Set up two test programs for aluminum alloys, which are under consideration for early implementation.

IX IN THE FIELD OF CORROSION

- 1) Organized a Task Group which is considering what MPC might do regarding corrosion characteristics of metals.

X WITH REGARD TO THE JOINT COMMITTEE

- 1) MPC now raises funds for the ASTM-ASME-Joint Committee on the Effects of Temperature on the Properties of Metals.
- 2) This Committee has just published a work on superalloys.
- 3) Planning a number of symposia in 1969, as well as two important research programs.
- 4) Has just started a unique program to obtain actual data on the relation of notch effect to the size of specimens.

THE METAL PROPERTIES COUNCIL

Publications Now in Manuscript - October 1, 1968

- 1 Analysis of Data on Stainless Steels - G V Smith
Revised edited manuscript to be circulated to ASTM
Publication Board members 9/23/68
- 2 Symposium on Parametric Analysis of Creep Test Data
Some manuscripts on hand, balance promised 12/1
For publication by ASM, first by Report System, second
by Metals Engineering Quarterly. Expect to distribute
January, 1969.
- 3 Bibliography of Low Cycle Fatigue - B Wundt
Approved 9/18/68 by ASTM for publication by microfiche.
May appear subsequently as part of another work. Date
of publication to be announced.
- 4 Interpretive Report on Effects of Strain Rate - H Voorhees
Reviewed 9/18/68 by ASTM Publications Board. Request made
that Summary and Conclusions be enlarged. To be scheduled
on receipt of report from Publications Board.
- 5 The Use of Elevated Temperature Properties in the Design of
Pressure Vessels for the Chemical Industries - G V Smith
Submitted to A.I.Ch.E. September 13, 1968.
- 6 Symposium on "Superalloys" Arranged by Joint Committee
Held in September, 1968 at Seven Springs, Pennsylvania
- 7 Symposium on "Beryllium and Its Alloys: Arranged by
Joint Committee Held in June 1968 at Annual Meeting of ASTM
- 8 Symposium of "Effect of High Pressure Gaseous Hydrogen on
Metals and Alloys" To be held in October, 1968, Metals Congress
Arranged by Joint Committee.
- 9 Symposium on "Biaxial Behavior of Alloys" Arranged by Joint
Committee Held in June, 1968 at Annual Meeting of ASTM.

THE METAL PROPERTIES COUNCIL

Publications Planned for 1969 and 1970

For 1969

- 1 Properties of Carbon Steels - G V Smith
Data collected by solicitation, manuscript in preparation,
for submission to Subcommittee 1 in December, 1968.
- 2 Properties of Certain Low Alloy Steels - G V Smith
Data collected by solicitation, manuscript for submission
to Subcommittee 1 in June, 1969.
- 3 Application of Various Parameters to the Analysis of Creep
Test Data - J W Freeman - Preliminary document was submitted
and it was agreed to extend the work and make a final report.
Scheduled to submit to Subcommittee 1 in June 1969.
- 4 A Program for Evaluating Elevated Temperature Characteristics
of Quenched and Tempered Steels - S Sangdahl and H Voorhees
Manuscript to submit to Subcommittee 2 in June, 1969.
- 5 Interpretive Report on Certain Aspects of Low Cycle Fatigue of
Particular Interest in Power Generation and in Process Equipment
for Chemical and Petroleum Industries - B Wundt - Submit to
Subcommittee 3 in January, 1969.
- 6 A Program for Determining Low Cycle Fatigue Characteristics
B Wundt - To submit to Subcommittee 3 in March, 1969.
- 7 Symposium on Total Creep Versus Strain Rate - Scheduled for
October, 1969 - Metals Congress
- 8 Revision of STP on Relaxation - H Voorhees
Data solicited, manuscript in preparation. Submit to
Subcommittee 5, in January, 1969.
- 9 Creep Relaxation of Metals - H Voorhees - Data and reports on
hand. Submit to Subcommittee 5 in May, 1969.
- 10 Symposium on Relaxation in Metals - Schedules for ASME Annual
Meeting - December, 1969.
- 11 A Manual of Surveillance Testing - L Steele - Manuscript to be
submitted to Subcommittee 6 in January, 1969.
- 12 Analysis of Results of Surveillance Testing - L Steele
Manuscript to be submitted to Subcommittee 6 in July, 1969.

Publications Planned for 1969 and 1970

For 1969 Continued

- 13 Properties of Aluminum in Large Sections
 Data now being processed by DMIC at Battelle. To be
 reviewed on completion.
- 14 Symposium on New High Strength Stainless Steels
 Arranged by the Joint Committee. Being held at ASM
 "Westec" meeting, March, 1969.