ESG-DOE-13453

MATERIAL SELECTIONS FOR THE IVTM PORT PLUG, CRDL, AND SCRS STORAGE FACILITY FOR THE CRBRP

DOE Research and Development Report

APPLIED TECHNOLOGY

Any further distribution by any holder of this document or of the data therein to third parties representing foreign interests, foreign governments, foreign companies and foreign subsidiaries or foreign divisions of U.S. companies should be coordinated with the Deputy Assistant Secretary for Breeder Reactor Programs, Department of Energy.

Prepared for the United States
Department of Energy
under Westinghouse Subcontract 54-7A0-192906
under DOE Contract DE-AC15-76CL50003

Rockwell International

Atomics International Division
Energy Systems Group

Released for announcement in ATF. Distribution limited to participants in the LMFBR program. Others request from RRT DOE.

DISCLAIMER

DISCLAIMER

ESG-DOE-13453
LIQUID METAL FAST
BREEDER REACTOR
UC-79T

MATERIAL SELECTIONS FOR THE IVTM PORT PLUG, CRDL, AND SCRS STORAGE FACILITY FOR THE CRBRP

ESG-DOE--13453

TI85 026731

By

W. H. Friske

Prepared for the United States
Department of Energy
under Westinghouse Subcontract 54-7A0-192906
under DOE Contract DE-AC15-76CL50003

Rockwell International

Atomics International Division
Energy Systems Group
8900 De Soto Avenue
Canoga Park, California 91304

SUBCONTRACT: 54-7A0-192906
ISSUED:

DISTRIBUTION

This report has been distributed according to the category "Liquid Metal Fast Breeder Reactor," as given in the Standard Distribution for Unclassified Scientific and Technical Reports, DOE/TIC-4500, Rev. 73.

DISCLAIMER

ABSTRACT

This document describes the major components of the storage cells and their environments for the Clinch River Breeder Reactor Plant. Material selections and applicable specifications are recommended.

CONTENTS

TABLE

1.0 INTRODUCTION

The storage facility for the in-vessel transfer machine (IVTM) port plug, control rod drive line (CRDL), and secondary control rod system (SCRS) consists of three identical inerted storage cells. Two of the cells provide for the storage of the IVTM port plug, used CRDLs, or used SCRSs. The third cell provides storage for new CRDLs or new SCRSs only. The top of each cell has provisions for storage of auxiliary handling machine (AHM) floor valves.

The basic configuration of a storage cell is presented in Appendix A. The major components and their environments are described in Section 2.0. Type 304 stainless steel was selected for most of the components because it is highly resistant to atmospheric and sodium corrosion and can be readily cleaned to remove any radioactive contamination. For those applications where the corrosion properties of stainless steel are not required (e.g., plug, shielding), carbon steel has been selected.

2.0 MATERIALS SELECTIONS

2.1 THIMBLE

The thimble is a long (~600-in.) tubular vessel with an OD of 22 in. at the top, reducing in steps to about 6 in. at the bottom. The thimble is supported by a 68-in.-diameter flange at the top and is closed at the lower end. The ID of the vessel has machined surfaces which mate with the IVTM port plug or the AHM grapple adapter of the CRDL and SCRS to form a containment boundary. The top flange mates with the AHM floor valve for containment. The thimble is also provided with pipe fittings for argon gas inlet and outlets, pressure measurements, and seal leakage monitoring.

The environment inside the thimble within the containment boundary will be argon. Some sodium may also be introduced into the thimble when components are stored. The external environment between the thimble and the concrete pit will be reactor containment building (RCB) air. The maximum temperature will be about 250°F.

Type 304 stainless steel is recommended for all components. The use of stainless steel will minimize maintenance and decontamination operations and avoid the formation of corrosion products that could eventually find their way into the reactor. Carbon steel would be structurally acceptable and less costly, but it offers the disadvantages of potential oxidation during assembly and maintenance periods, more elaborate cleaning and decontamination procedures, and less reliability of sealing surfaces due to possible rusting or pitting.

As one potential area for cost reduction, consideration should be given to the use of a nickel-plated or weld-clad carbon steel for the top flange. Nickel plate could provide a corrosion-resistant surface comparable to that of stainless steel, but it has the disadvantage of possible chipping or spalling due to mishandling, dropping of tools, etc. Uniform coatings of nickel can be applied by commercial electroless nickel plating processes in O-ring grooves, bolt holes, or other recessed areas, as well as on plain surfaces. Further analyses should be made to determine if the substitution of either nickel plating or weld cladding would be cost effective.

Consideration was given to the possibility of corrosion damage due to sodium or other contamination introduced into the thimble. Any sodium that might drip off a component would collect in the bottom of the thimble. It is credible that this sodium could be converted to sodium oxide by oxygen in the argon atmosphere and to sodium hydroxide by the presence of moisture. In certain concentrations, sodium hydroxide can cause stress corrosion cracking of either austenitic stainless steel or carbon steel. The temperature-concentration curves for this mode of corrosion are shown in Appendix B. It was concluded that the probability of such caustic SCC occurring in the thimble was very small, particularly with the use of stainless steel as the material of construction. This conclusion was based on the following factors:

- The temperature will not exceed ~197°F under "worst conditions" and will be well below the threshold temperature of ~240°F at ~40% concentration.
- There will be no applied stresses at the bottom of the thimble. The only tensile stresses present will be residual stresses in the weldment of the cap to the pipe.
- The time period in which the contamination sodium will be at the maximum temperature will be short, probably not more than a few hours. Stress corrosion can occur rapidly under optimum conditions of very high tensile stresses and critical corrosive environments; however, under less ideal conditions, the time for stress corrosion to occur is significantly longer. For marginal conditions, this time can be in the thousands of hours. For less than marginal conditions, as expected in this situation, SCC may not occur during any credible time period.
- The conditions of low-temperature, low-stress levels, and short residence times make stress corrosion a highly improbable occurrence, even if ideal caustic concentrations (also highly improbable) are attained.

2.2 STORAGE PLUG

The storage plug, a 30-in.-long cylindrical solid section, seals the cell and limits radiation when the cell is empty (it is not used during normal operating and refueling periods). It will be exposed to the internal argon atmosphere and to RCB air. The temperature of the plug will not exceed 250°F.

It is recommended that the storage plug be made of a carbon steel forging. The storage plug should be electroless nickel-plated, after machining, to provide a corrosion-resistant surface. Alternatively, the plug could be stainless steel clad, using a weld overlay, before machining.

2.3 COVER PLATE ASSEMBLY

The cover plate assembly mates with the thimble top flange. It will be exposed to the internal argon atmosphere and to RCB air.

The sealing surfaces of the cover plate, which mates with the Type 304 stainless steel of the current thimble flange design, should also be stainless steel. The cover plate assembly design utilizes a thin stainless steel seal plate, together with a thicker carbon steel cover plate. The carbon steel cover plate surfaces will be exposed only to RCB air and should be nickel-plated, painted, or otherwise protected from surface oxidation.

2.4 SHIELD RINGS

These rings are for shielding purposes only and are positioned external to the thimble in the RCB air atmosphere. The recommended material is carbon steel with some form of protection from corrosion provided (e.g., paint, nickel plate).

2.5 ELASTOMERIC MATERIALS

The selected O-ring material is Buna-N. It is recommended for temperature applications to 140°F but can withstand higher temperatures (to 240°F) for short times. An evaluation of elastomer materials and materials selection for System 41 applications is given in Ref. 1.

2.6 LUBRICANTS

The recommended lubricant for O-ring seals is Dow Corning DC-55.

The recommended lubricant for threaded fasteners is "Nickel-Never-Seez." This lubricant has been extensively tested by HEDL and found to be superior to the Neolube types of lubricants.

---

[1] R. Sarraf and K. Cozens, "Material Selections for Elastomeric Seals in System 41," ESG-DOE-13438 (1984)

3.0 CONCLUSIONS AND RECOMMENDATIONS

1. Material selection recommendations are summarized in Table 1.

2. It is recommended that an analysis be made for the possible use of nickel-plated or stainless weld-clad carbon steel for top flange applications. If cost effective, there is no technical reason why either could not be substituted for stainless steel.

TABLE 1

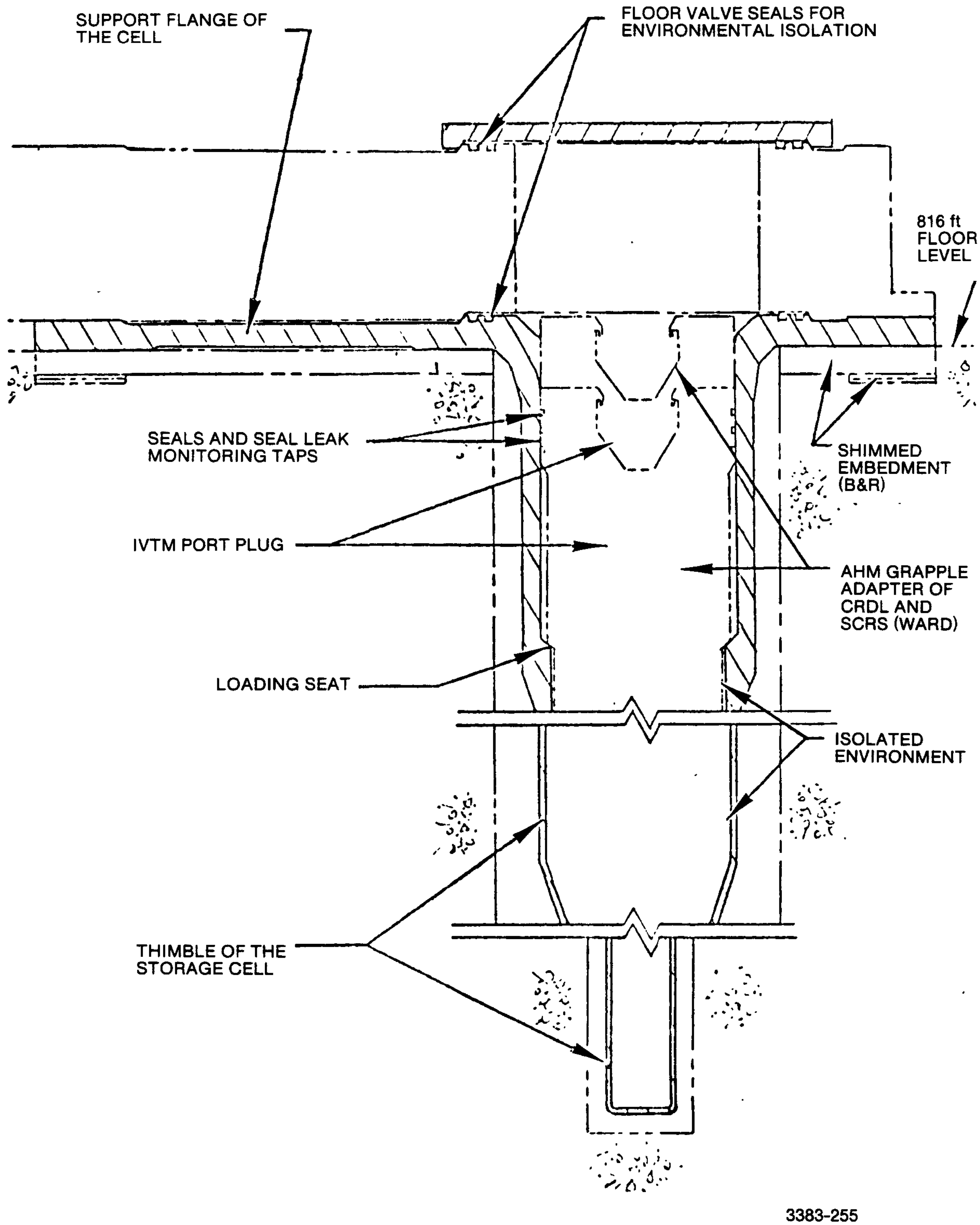
MATERIAL SELECTION RECOMMENDATIONS--STORAGE CELLS

	Material	Form	Specification
Thimble			
Shell	TP 304 SS	Pipe	ASTM A 312
	F 304 SS	Forgings	ASTM A 182
Reducers	TP 304 SS	Fittings	ASTM A 403
Nozzles	TP 304 SS	Fittings	ASTM A 403
Top flange	304 SS	Plate	ASTM A 240
Storage plug	Carbon steel	Forging	ASTM A 266
Cover plate assembly			
Seal plate	304 SS	Plate	ASTM A 240
Cover plate	Carbon steel	Plate	ASTM A 283 or ASTM A 36
Shield rings	Carbon steel	Forging	ASTM A 266
O-ring seals	Buna-N	(Parker E 741-75)	
Lubricants			
Threads	"Nickel-Never Seez"		
Seals	Dow Corning DC-55		
Bolts	Alloy steel	Bolting	ASTM A 325
	304 SS		ASTM A 293

5444D/1jm

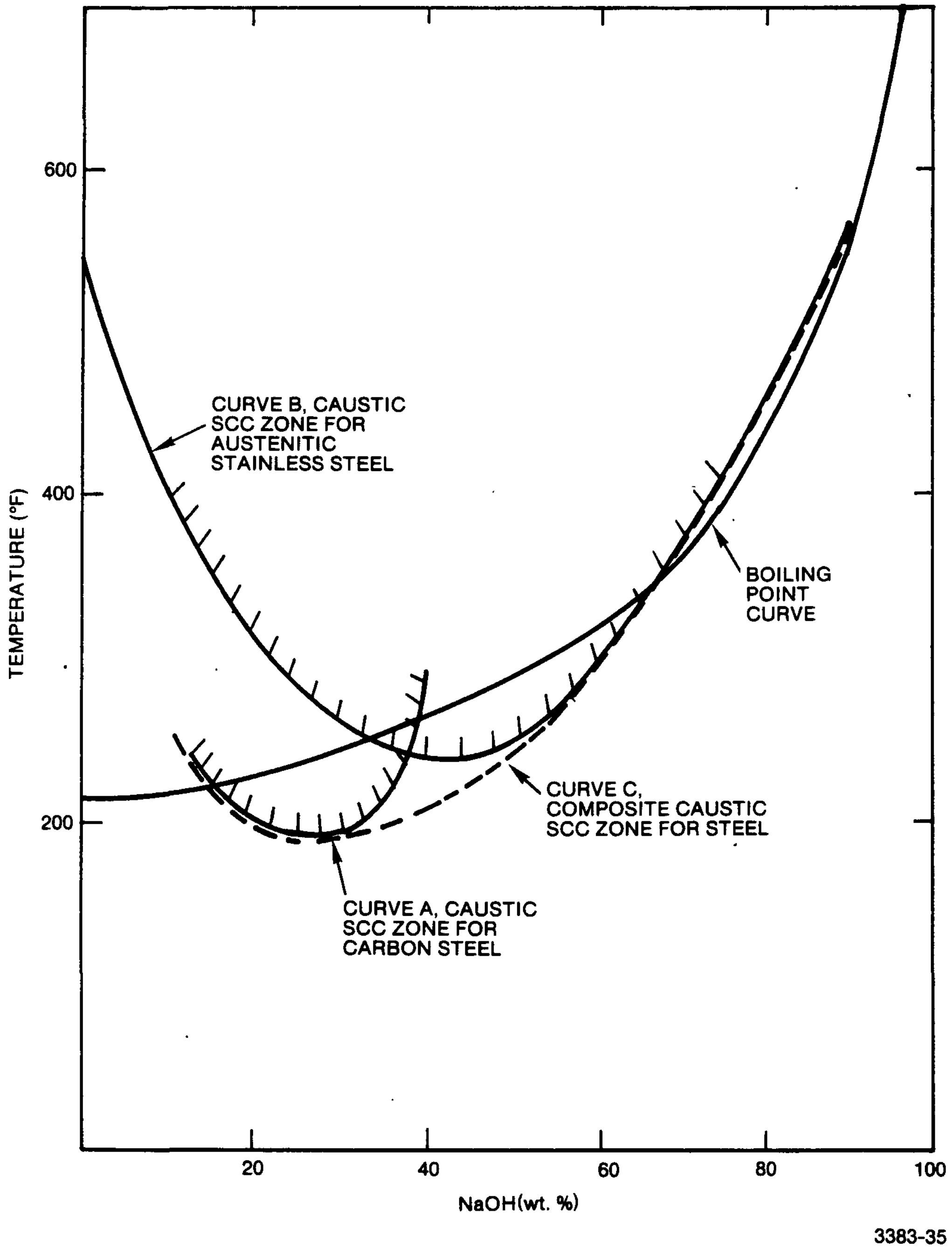
APPENDIX A

BASIC CONFIGURATION OF THE STORAGE CELLS



APPENDIX B

BOUNDARIES OF CAUSTIC SCC DANGER ZONES



5444D/1jm