ENCLOSURE 4

WCAP-17712, Revision 0, "Westinghouse SMR Test Plan"

(Non-Proprietary)

Westinghouse Non-Proprietary Class 3

WCAP-17712-NP
Revision 0

January 2013

PROJ0797

Westinghouse SMR Test Plan

Westinghouse

WCAP-17712-NP
Revision 0

Westinghouse SMR Test Plan

M. Randjelovic*
Research & Technology

C. Frepoli
Core Engineering

T. Kindred
Plant Analysis & Integration

W. Brown
Passive Plant Technology

January 2013

Reviewer: R. Wright*
Passive Plant Technology

Approved: R. Sisk*
SMR Licensing Manager

*Electronically approved records are authenticated in the electronic document management system.

Westinghouse Electric Company LLC
1000 Westinghouse Drive
Cranberry Township, PA 16066, USA

TABLE OF CONTENTS

LIST OF TABLES

1. **AP1000**® is a trademark or registered trademark of Westinghouse Electric Company LLC, its affiliates and/or its subsidiaries in the United States of America and may be registered in other countries throughout the world. All rights reserved. Unauthorized use is strictly prohibited. Other names may be trademarks of their owners.

LIST OF FIGURES

LIST OF ACRONYMS

ADS	Automatic Depressurization System
ADS-1	ADS Stage One
ADS-2	ADS Stage Two
CCFL	Counter Current Flow Limitation
CHF	Critical Heat Flux
CMT	Core Makeup Tank
CRDM	Control Rod Drive Mechanism
CSAU	Code Scaling, Applicability, and Uncertainty
CV	Containment Vessel
DVI	Direct Vessel Injection
FoM	Figure of Merit
ICP	In-containment Pool
IET	Integral Effects Test
iPWR	Integral PWR
IRWST	In-containment Refueling Water Storage Tank
IVR	In-vessel Retention
LBLOCA	Large Break LOCA
LOCA	Loss-of-Coolant Accident
LTCC	Long-term Core Cooling
MFIV	Main Feed Isolation Valve
MSIV	Main Steam Isolation Valve
OCP	Outside Containment Pool
PCCWST	Passive Containment Cooling Water Storage Tank
PIRT	Phenomena Identification and Ranking Table
PLS	Plant Control System
PMS	Protection Monitoring System
PORV	Power Operated Relief Valve
PRHR	Passive Residual Heat Removal
RCCA	Rod Cluster Control Assembly
RCP	Reactor Coolant Pump
RCS	Reactor Coolant System
RFA	Robust Fuel Assembly
RV	Reactor Vessel
SBLOCA	Small Break LOCA
SCV	Sump Coupling Valve
SDIV	Steam Drum Isolation Valve
SET	Separate Effects Test
SG	Steam Generator
SGDV	Steam Generator Depressurization Valve
SMR	Small Modular Reactor
SoK	State of Knowledge
UHS	Ultimate Heat Sink
W-SMR	Westinghouse Small Modular Reactor

EXECUTIVE SUMMARY

[

]^{a,b,c}

Table ES-1 High Safety and Low State of Knowledge Ranking Phenomena Recommendations (Ref. 1)

Component	Phenomenon	Testing Rationale

a,b,c

Table ES-1 High Safety and Low State of Knowledge Ranking Phenomena Recommendations (Ref. 1) (cont.)

Component	Phenomenon	Testing Rationale

a,b,c

Table ES-1 High Safety and Low State of Knowledge Ranking Phenomena Recommendations (Ref. 1) (cont.)

Component	Phenomenon	Testing Rationale

a,b,c

1 INTRODUCTION

1.1 WESTINGHOUSE SMR PLANT DESCRIPTION

[

]^{a,b,c}

[

]^{a,b,c}

[

]a,b,c

1.2 WESTINGHOUSE SMR APPROACH TO SBLOCA MITIGATION

[

]a,b,c

[

]^{a,b,c}

Table 1-1 Westinghouse SMR Component Descriptions

Component	Description

a,b,c

Table 1-1 (cont.) Westinghouse SMR Component Descriptions

Component	Description

a,b,c

Table 1-1 (cont.) Westinghouse SMR Component Descriptions

Component	Description

a,b,c

Table 1-2 Westinghouse SMR Important Dimensions

Parameter	Value

a,b,c

Table 1-3 Westinghouse SMR Normal Operating Conditions

Parameter	Value

a,b,c

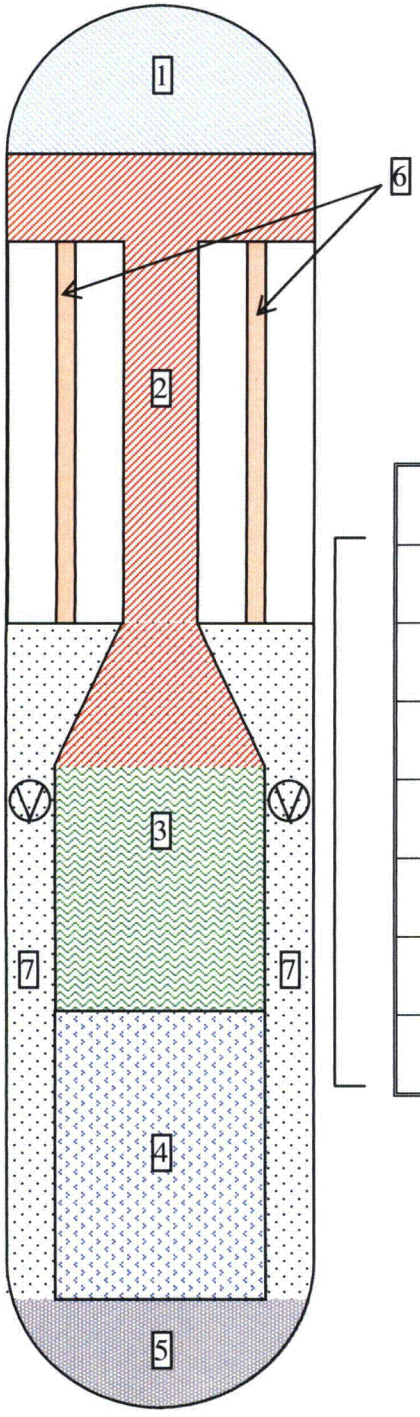
Table 1-4 Comparison of Systems and Components to Perform Safety Functions between AP1000 Plant and the Westinghouse SMR

Safety Function	AP1000 Plant	Westinghouse SMR
Short-term reactivity control	Control rods	
Long-term reactivity control	Boration by CMTs (2)	
Decay heat removal	PRHR HX (1) which removes heat from the reactor coolant system (RCS) to the in-containment refueling water storage tank (IRWST).	
Long-term makeup water supply	IRWST (1) with transition to sump recirculation	
Automatic depressurization	Four stages of automatic depressurization system (ADS) valves are used to provide a means to depressurize the RCS and permit gravity injection from the IRWST and sump.	
Ultimate heat sink	Passive containment cooling system (PCS) consisting of a PCCWST (1) located at the top of the shield building. Heat removal capability is provided by the PCS for 72 hours following a design basis accident.	

a,b,c

a,b,c

Figure 1-1 Schematic of Safety Systems Design



Parameter	Value

a,b,c

Figure 1-2 Reactor Vessel Regions

a,b,c

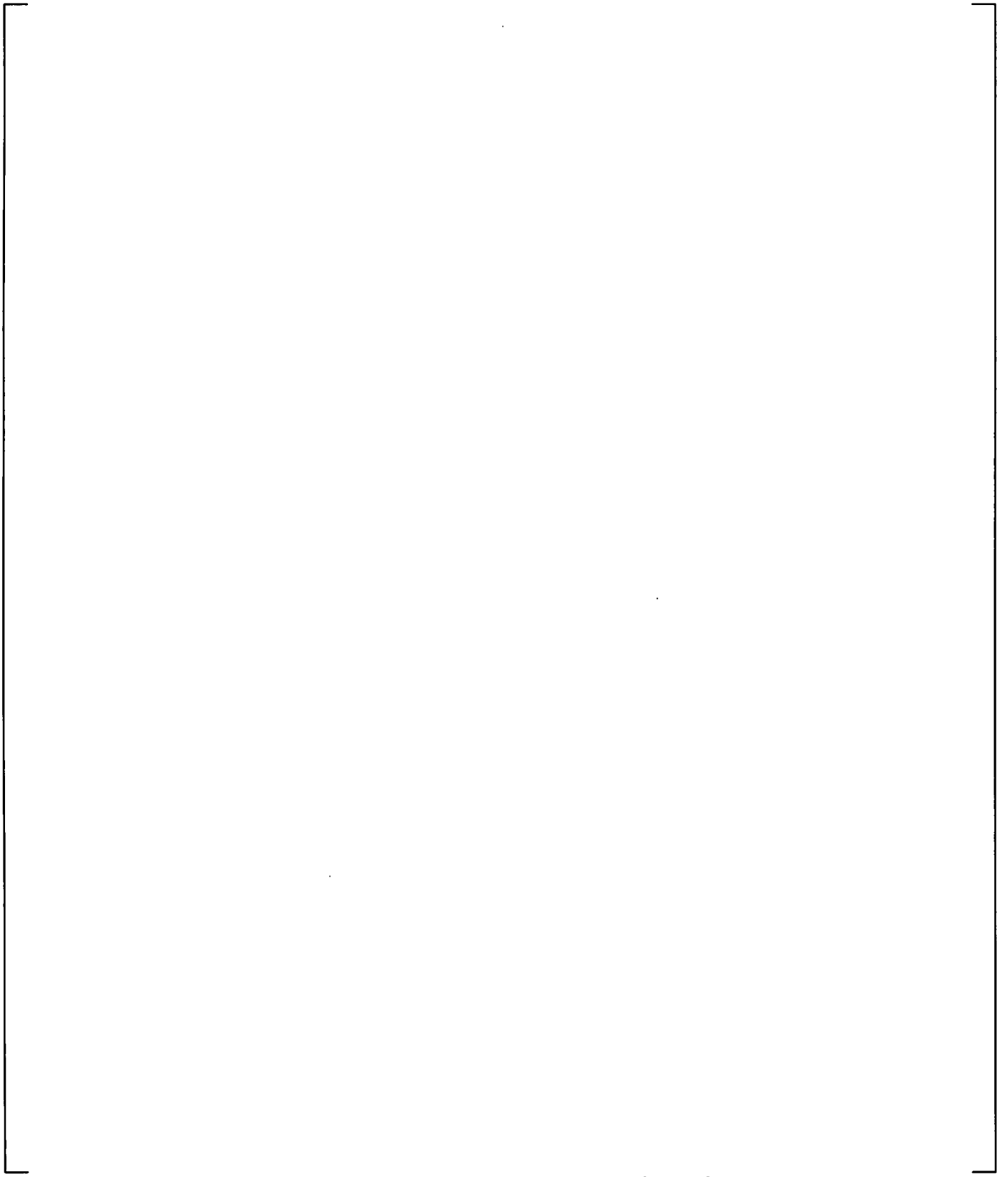


Figure 1-3 Illustrations of Westinghouse SMR ICP

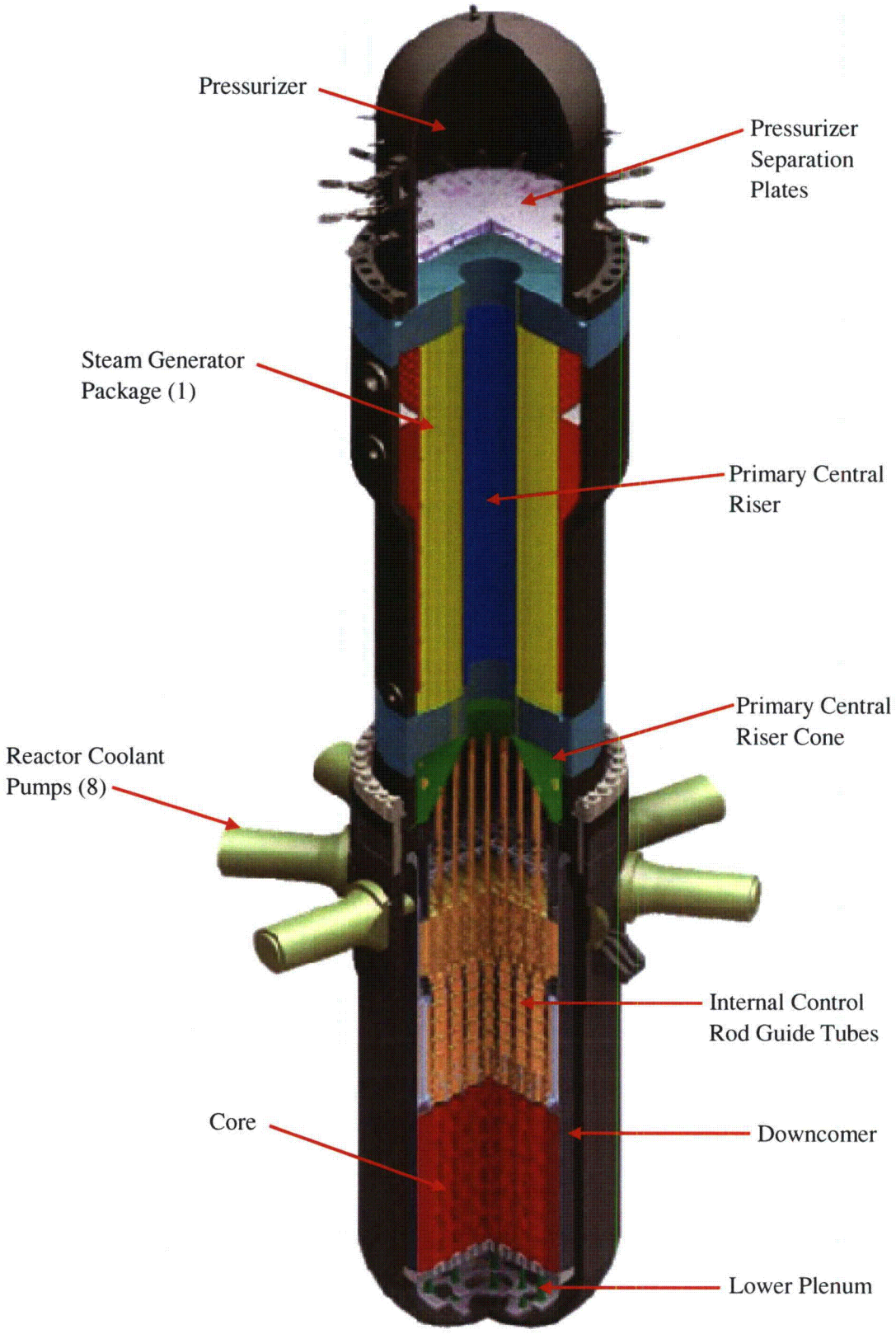


Figure 1-4 Illustration of Westinghouse SMR RV with Quarter Cutaway

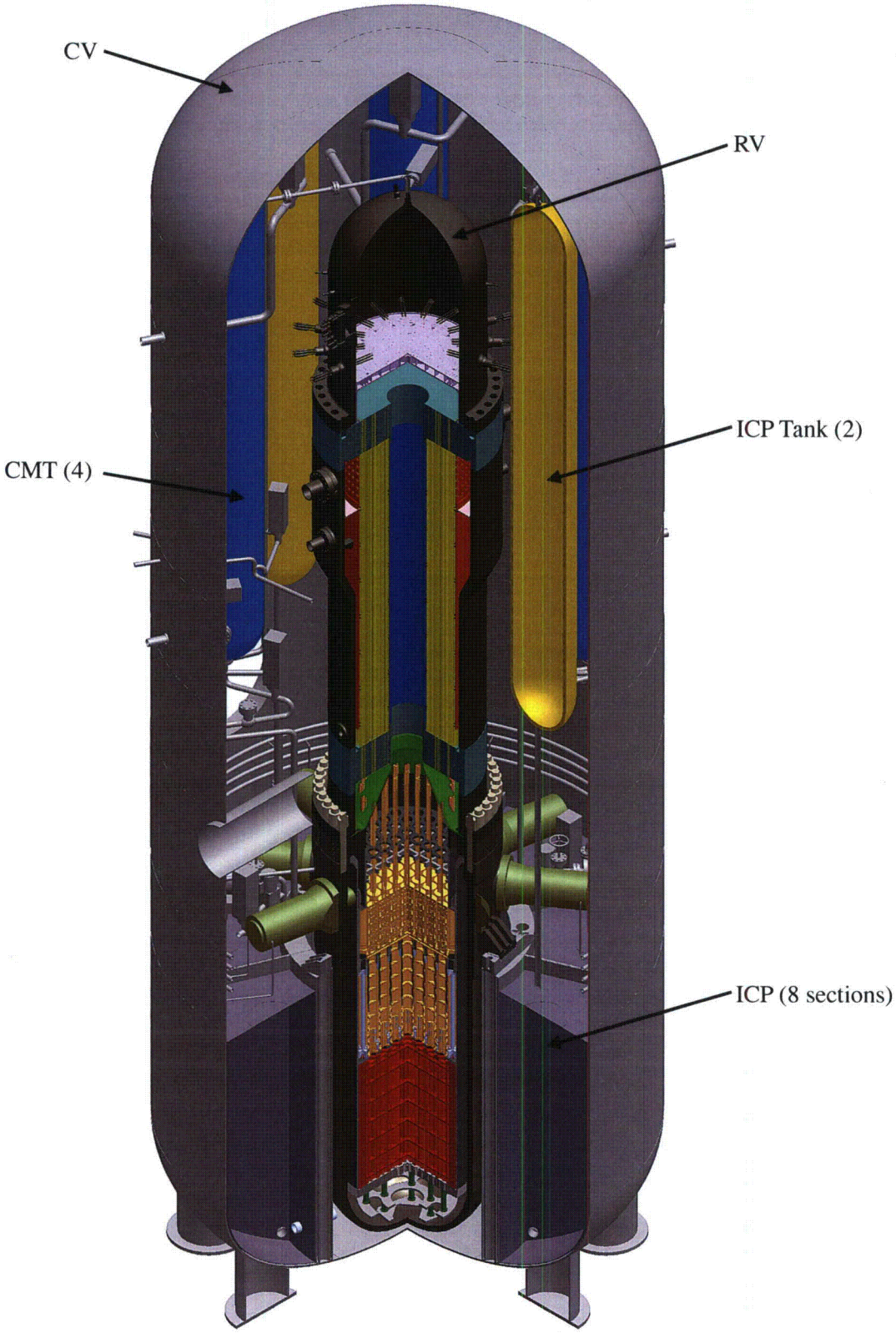


Figure 1-5 Illustration of Westinghouse SMR CV with Quarter Cutaway

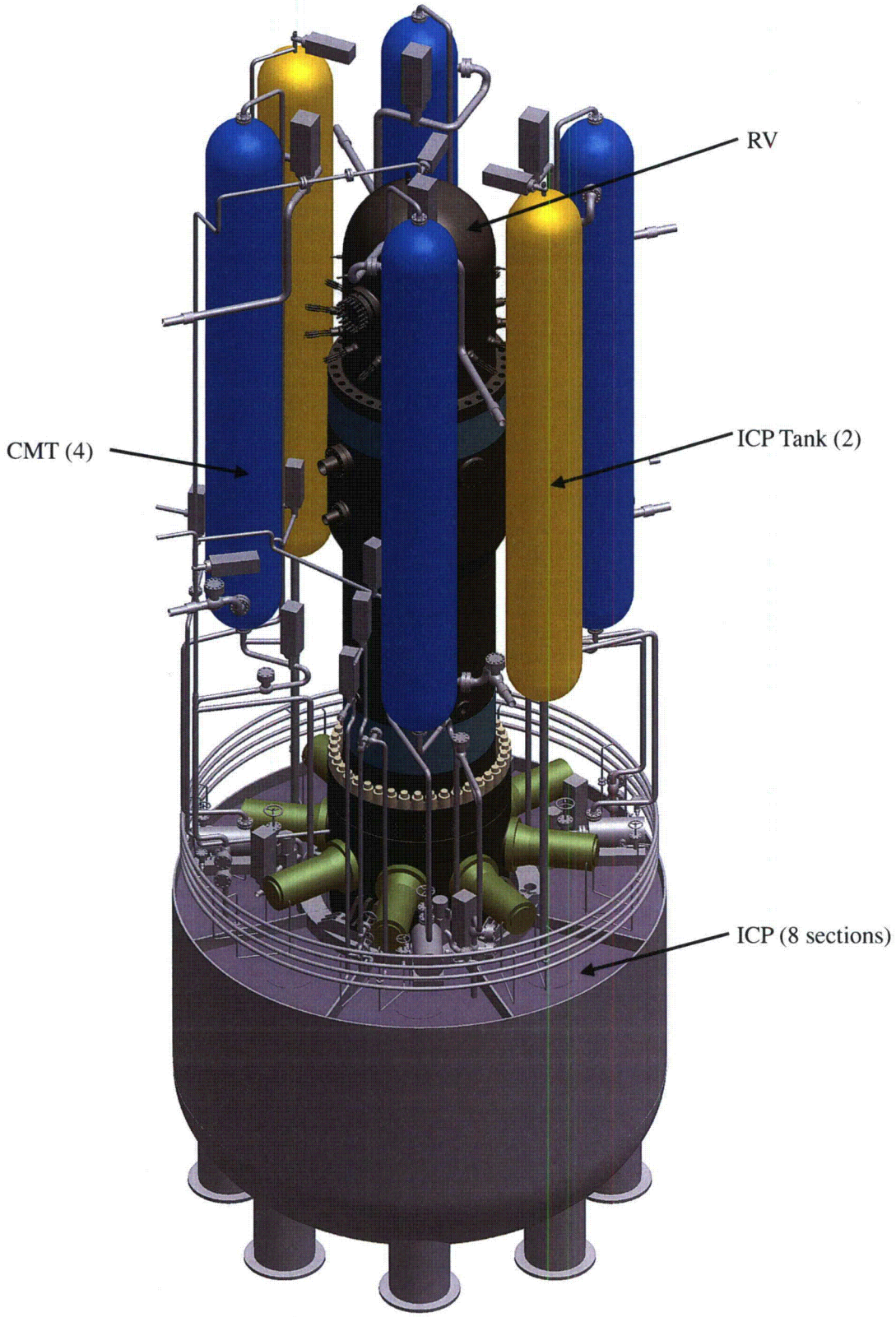


Figure 1-6 Illustration of Westinghouse SMR CV with Full Cutaway

2 TEST SPECIFICATIONS

2.1 OVERALL TEST PLAN

The objective of the Westinghouse SMR test plan is to address the knowledge gaps identified in the SMR SBLOCA PIRT (Reference 1). To that end, two test programs have been proposed:
[

]a,b,c

2.2 INTEGRAL EFFECTS TEST

The integral effects test is designed to address the knowledge gaps identified in Reference 1. [

]a,b,c

Table 2-1 Characteristics of the SPES Test Facility at SIET S.p.A. in Piacenza, Italy a,b,c

Addendum 1 details the Westinghouse SMR integral effects test.

2.3 SEPARATE EFFECTS TEST

[

]a,b,c

[

]a,b,c

3 SUMMARY AND CONCLUSIONS

3.1 SUMMARY

[

]^{a,b,c}

4 REFERENCES

1. WCAP-17573-P, Rev. 1, "Westinghouse SMR Small Break LOCA Phenomena Identification and Ranking Table," Westinghouse Electric Company LLC.

2. WCAP-14309, Rev. 2, "SPES-2 Tests Final Data Report," March 1995.

3. W.L. Brown, et al., "**AP1000** Lower Head Flow Evaluations," Penn State Applied Research Laboratory File No.: 10-038, August 2010.

4. W.L. Brown, et al., "**AP1000** Reactor Vessel Refill Study," Penn State Applied Research Laboratory File No.: 10-009, February 2010.