www.usiter.org

USIPO APPROVAL SLIP

For signature of:
(Flag letter/document where signature is required.)

Title: **Technical Document, Drain Tank Information for Developing Design Basis of the Preliminary Design**

WBS No. (L-4): **1.2.1**	Required by Date: **7/13/11**
US ITER Document Number (when applicable): **US ITER 12106-TD0003-R02**	Routing for Approval Start Date: **7/7/11**
Author[1]: **Juan Ferrada**	Author Sign/Date: 7/8/11

√	Role[2]		Sign/Date	Notes/Comments, if any
	Technical Editor	Cindy Lundy		
✓	*Administrative Assistant (Formatting/proofing)* Highlight or Circle one:	Tonia McPeters Dina Clark Sherry Rowley Cerissa Gifford Pat Smith	SRowley 7/7/11	
✓	*WBS Team Leader*	Jan Berry	JBerry 7/7/11	SR
	Computer IIS Manager	Dan Ciarlette		
	Communications & HR Mgr	Bonnie Hébert		
	Procurement Manager	Jeff Geouque		
✓	*Chief Engineer*	Brad Nelson	7/20/11	
	Business Office Manager	Jama Hill		
	Project Controls Manager	Wayne Steffey		
✓	*Quality & ES&H Manager*	Frank Casella	7/21/11	
	Building Coordinator	Loretta Simpson		
	CS Systems Manager	Chris Rey		
	Magnets Sys Chief Engineer	Nicolai Martovetsky		
	Executive Secretary (ES)	Tonia McPeters	Signatures of Deputy/Project Manager must be coordinated through ES. All other approvals must be obtained prior to submittal to ES.	
	Deputy Manager	Suzanne Herron		
	Project Manager	Ned Sauthoff		

1. Author:
   - Obtains reviews/resolves comments prior to routing for final approval.
   - When required, obtains export control review and publications release review prior to routing for final approval. Include review approvals.
   - Identifies routing for approval/signature requirements. (Refer to Document Approval Matrix or other USIPO or ORNL procedures for guidance.)
   - Ensures all approvals are obtained prior to submittal to ES who coordinates the obtaining of signatures of Deputy and/or Project Manager.
2. Use check box to indicate whose approval/signature is required.
3. Type in name of individual of Others as Required.

US ITER 12106-TD0003-R02
PA 2.6P1A_B.US.01.0

DRAIN TANK INFORMATION FOR DEVELOPING DESIGN BASIS OF THE PRELIMINARY DESIGN

July 2011

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

US ITER 12106-TD0003-R02
PA 2.6P1A_B.US.01.0

DRAIN TANK INFORMATION FOR DEVELOPING DESIGN BASIS OF THE PRELIMINARY DESIGN

Juan J. Ferrada

Date Published: July 2011

Prepared by
Tokamak Cooling Water System
US ITER

Prepared by
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37831-6283
managed by
UT-BATTELLE, LLC
for the
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-00OR22725

DRAIN TANK INFORMATION FOR DEVELOPING DESIGN BASIS OF THE PRELIMINARY DESIGN

Juan J. Ferrada Tokamak Cooling Water Systems Engineer	7.8.2011 Date
Jan Berry WBS Team Leader, US ITER Cooling Water Systems	7-7-2011 Date
Brad Nelson Chief Engineer, US ITER	7-26-2011 Date
Frank Casella Quality & ES&H Manager, US ITER	7/21/11 Date

REVISION RECORD

Revision	Date	Description of Changes
00	1/7/2011	Original
01	3/23/2011	Completion of the information for the drain tank design basis report. Questions from AREVA have been answered from US ITER and ITER IO.
02	7/21/2011	The essential change in this version is the calculation of the working volume for the drain tanks. This version includes water volume calculations produced by AREVA. This revision also includes installation requirements from IO. Clarified seismic loads for the drain tank area.

TABLE OF CONTENTS

Page

LIST OF FIGURES ix

LIST OF TABLES xi

ACRONYMS xiii

1. INTRODUCTION 1

2. DRAIN TANK CAPACITY INFORMATION 3

2.1 WATER INVENTORY FOR NORMAL DRAIN TANKS 3

2.2 SAFETY DRAIN TANKS 6

2.2.1 Water Inventory for the Safety Drain Tanks 6

2.2.2 Analysis of the Calculations 8

2.2.3 Other Potential Liquid Volumes that May be Sent to the Safety Drain Tanks 8

2.3 DRAIN TANK PRELIMINARY DESIGN BASIS 8

2.3.1 Drain Tank Volume Estimate 8

2.3.2 Development of Final Design Basis for Drain Tanks 10

3. ADDITIONAL INFORMATION FOR THE DRAIN TANK DESIGN BASIS 11

3.1 DRAIN TANK CONFIGURATION 11

3.2 CONCEPTUAL APPROACH TO THE DRAIN TANK INSTALLATION 12

3.2.1 Installation Coinciding with Construction of B2 Level (Both B2 Level and Floor B2 are finished) 12

3.2.2 Delayed Installation after Construction of Ground Level 14

3.2.3 Installation Requirements 14

3.2.4 Construction of Ceiling on B2 that May Affect Installation Procedure 15

3.2.5 ITER Organization Preferred Solution for the Drain Tank Installation 15

3.2.6 Anchoring Tanks to Floor B2 15

3.3 THERMOHYDRAULIC CONDITIONS FOR THE DRAIN TANK DESIGN FOR NORMAL OPERATIONS 21

3.3.1 Normal Operation: Draining Only Primary Heat Transfer Systems 21

3.3.2 Normal Operation: Draining of Surplus Water Inventory During Water Baking 22

3.3.3 Normal Draining Operation: From Draining and Drying Operations 23

3.3.4 Analysis of Thermohydraulic Conditions for the Normal Operations of Drain Tanks 24

3.4 THERMOHYDRAULIC CONDITIONS FOR THE DRAIN TANK DESIGN FOR SAFETY OPERATIONS 29

3.5 DRAIN TANK INTERFACES 29

3.5.1 Interfaces to the Drain Tanks 30

3.5.2 Interfaces From the Drain Tanks 31

3.5.3 General Interfaces 31

3.6 DRAIN TANK FLOODING CONDITIONS 35

3.7 CLEANING PROVISIONS 35

3.8 DRAIN TANK CLASSIFICATION 35

3.8.1 Normal Drain Tanks (Two Tanks) 36

3.8.2 Safety Drain Tanks (Two Tanks) 37
3.8.3 Neutral Beam Injector Drain Tanks (One Tank) 38
3.8.4 Sump Tank (One Tank) 39
3.8.5 Rational for the Classification of the Fluid 41
3.9 DRAIN TANK REQUIREMENTS FROM SYSTEM REQUIREMENTS DOCUMENT 26 41
3.10 CHEMICAL COMPOSITION OF DRAIN WATER 41
3.10.1 Normal Operations 41
3.10.2 Safety Drain Operations 42
3.11 DESIGN CODE AND MATERIALS OF CONSTRUCTION 42
3.12 SEISMIC ANALYSIS 42
3.12.1 The Level B2 Spectrum Locations 43
3.12.2 Seismic Design and Classification 47
3.13 DRAIN TANK TEMPORARY STORAGE 50
4. GENERAL COMMENTS 51
5. REFERENCES 53
APPENDIX A. FUNCTIONAL REQUIREMENTS FOR THE SAFETY DRAIN TANKS A-1
APPENDIX B. INTERFACES WITH THE DRAIN TANKS B-1
APPENDIX C. QUESTIONS ASKED BY AREVA ON INFORMATION FOR THE DESIGN BASIS OF THE DRAIN TANKS C-1

LIST OF FIGURES

Page

Fig. 1. Pressure transient diagram. 7
Fig. 2. Temperature transient diagram. 7
Fig. 3. Mass transient diagram. 8
Fig. 4. Drain tank configuration. 11
Fig. 5. Front view of drain tank area. 11
Fig. 6. Basic preliminary dimensions of the drain tank area (units: m); height of space: 10.6 m. 12
Fig. 7. Drain tank installation at level B2 with mezzanine construction. 13
Fig. 8. Drain tank installation at level B2 with no mezzanine construction. 13
Fig. 9. Introduction of drain tanks. 14
Fig. 10. Drain tank transfer system. 15
Fig. 11. Direction of drain tank installation. 16
Fig. 12. Air pads in the drain tank installation. 16
Fig. 13. Proposal for air pad installation at the base of the tanks. 17
Fig. 17. Tank base detail for anchor bolt option. 19
Fig. 18. Slots for air pads. 19
Fig. 19. Air pads are located underneath spreader plates. 20
Fig. 20. Embedded plate detail. 20
Fig. 21. Option of temporarily removing bolts during installation. 21
Fig. 22. Draining of a Primary Heat Transfer System isolated from the in-vessel component. 22
Fig. 23. Excess water from water baking being drained into the corresponding drain tank. 22
Fig. 24. Gravity drain from Blanket and Divertor Primary Heat Transfer Systems (PHTSs). 23
Fig. 25. Charging gas before forced draining. 25
Fig. 26. Forced drain operation. 26
Fig. 27. Heat-up mode at higher pressure. 27
Fig. 28. Depressurization mode. 28
Fig. 29. Graphical representation of the drain tank interfaces. 30
Fig. 30. Drain tank flooding conditions. 35
Fig. 31. Classification for normal drain tanks. 37
Fig. 32. Classification for the safety drain tanks. 38
Fig. 33. Classification for the NBI drain tank. 39
Fig. 34. Classification of the sump tank. 40

Fig. 35. Level B2 spectrum locations. 43
Fig. 36. Floor response spectra (Node 46222), direction X broadened. 44
Fig. 37. Floor response spectra (Node 46222), direction Y broadened. 44
Fig. 38. Floor response spectra (Node 48494), direction X broadened. 45
Fig. 39. Floor response spectra (Node 48494), direction Y broadened. 45
Fig. 40. Floor response spectra (Node 47862), direction Z broadened. 46
Fig. 41. Floor response spectra (Node 47842), direction Z broadened. 46

LIST OF TABLES

Table **Page**

1. Summary of normal operation water inventory in the Tokamak Cooling Water System 3
2. Initial drain tank working water volumes 9
3. Extract of Table 1.4.1 from System Requirements Document 26 29
4. Tokamak Cooling Water System drain tank interfaces 32
5. Tokamak Cooling Water System—Draining and Refilling System 40
6. Coolant activation concentration for various ITER components and cooling systems 42
7. Extract of Annex 1 in ITER_D_2DRVPEv.1.1 48

ACRONYMS

ACP	activated corrosion products
ASN	L'Autorité de sûreté nucléaire (French nuclear regulatory body)
BLK	Blanket
CATIA	computer-graphics-aided three-dimensional interactive application
CCFL	counter-current-flow-limitation
CVCS	Chemical and Volume Control System
DA	domestic agency
DDD	Design Description Document
DIV	Divertor
DT	drain tank
ELM	edge localized mode
ESPN	Équipements Sous Pression Nucléaires
FMEA	Failure Modes and Effects Analysis
FW	First Wall
IBED	Integrated Blanket, ELM, Divertor
ICD	interface control document
IO	ITER Organization
IS	interface sheet
LOCA	loss of coolant accident
NBI	Neutral Beam Injector
N-VDS	Normal Vent Detritiation System
PBS	Plant Breakdown Structure
PCR	Project Change Request
PHTS	Primary Heat Transfer System
RAMI	reliability, availability, maintainability, inspectability
SC	seismic class
SIC	safety important components
SRD	System Requirements Document
TCWS	Tokamak Cooling Water System
VV	Vacuum Vessel
VVPSS	Vacuum Vessel pressure suppression system

1. INTRODUCTION

Tokamak Cooling Water System (TCWS) drain tanks (DTs) serve two functions: normal operation and safety operation. Normal DTs are used for regular maintenance operations when draining is necessary. Safety DTs are used to receive the water leaked into the Vacuum Vessel (VV) after an in-vessel loss of coolant accident (LOCA) event. The preliminary design of the DTs shall be based on the information provided by this document.

The capacity of the normal DTs is estimated based on the internal volume of in-vessel components [e.g., First Wall/Blanket (FW/BLK) and Divertor (DIV)]; Neutral Beam Injector (NBI) components; and TCWS piping, heat exchangers, electric heaters, pump casing, pressurizers, and valves. Water volumes have been updated based on 2004-design information, changes adopted because of approved Project Change Requests (PCRs), and data verification by US ITER and AREVA Federal Services, the US ITER A&E Company. Two tanks will store water from normal draining operations of the FW/BLK and DIV Primary Heat Transfer Systems (PHTSs). One tank will store water from normal draining operations of the NBI PHTS.

The capacity of the safety DTs is based on analysis of a design basis accident:[1] a large leak from in-vessel components. There are two safety DTs that will receive water from a VV LOCA event and drainage from the VV, as needed. In addition, there is one sump tank for the DIV that will be used for collecting drain water from the draining and drying processes and specifically for draining the DIV system as the DIV cassette lines are at a lower elevation than the DT connection point.

Information documented in this report must be refined and verified during the preliminary design of the DTs, and there are several aspects to be considered to complete the preliminary design. Input to these design considerations is discussed in this report and includes, but is not limited to, water inventory; operating procedures/maintenance; Failure Modes and Effects Analysis (FMEA); tank layout and dimensions, including design margin; classification under French Nuclear Pressure Directives, Équipements Sous Pression Nucléaires (ESPN); and adaptations for construction.

2. DRAIN TANK CAPACITY INFORMATION

2.1 WATER INVENTORY FOR NORMAL DRAIN TANKS

Normal DTs are provided to accommodate storage of coolant during maintenance and inspection, excess coolant from the PHTSs because of water volume expansion during baking operations, and residual coolant from forced draining and drying. The volume of water to be stored in these tanks is based on the volume of water contained in the following items for each PHTS.

- In-vessel VV component water holdup (FW/BLK and DIV)
- NBI water holdup
- PHTS piping and equipment water holdup
  - Piping
  - Pump
  - Heat Exchanger
  - Pressurizer

The water inventory is estimated based on the conceptual design, which was modified after the conceptual design review by design changes that were approved through PCRs as described below. Important changes to the 2004 baseline reduced the water volume and required DT capacity.

- PCR 154 resulted in redesign of heat exchangers moving the high-pressure, radioactive water from the shell side to the tube side of each heat exchanger. This design change resulted in the internal volume being reduced to about 1/3 of the original volume.[1]
- PCR 190 resulted in redesign of the VV PHTS. One pipe loop was eliminated and the size of the heat exchanger was reduced. PHTS equipment such as pressurizers and pumps were resized.[2,3]
- PCR 273 resulted in redesign of the FW/BLK and DIV PHTS. Four piping loops were combined in the vault, and one pair of heat exchangers, a pump, and one heater were added to meet reliability, availability, maintainability, inspectability (RAMI) requirements. With the progress of the preliminary design of the Integrated Blanket, ELM (edge localized mode), Divertor (IBED) system better information about the piping water volume has been obtained. AREVA has already designed piping congruent with PCR 273 and new liquid volume are available. This information is in Table 1.

Table 1 indicates the different water volumes required to size the DTs, the source of information, and a qualification of the information. Totals in Table 1 have been rounded to the next integer.

Table 1. Summary of normal operation water inventory in the Tokamak Cooling Water System

Item	Item description	Source of information	Qualification of information	Considering IBED internal volume (m^3)
1	BLK in-vessel component	SADL V5.2.6 (Table 3.1.1-1)	Assumed to be similar to current values	84
2	IBED PHTS Piping Volume	TDR-3005518-000, ITER TC WS IBED PHTS, NBI PHTS, and VV PHTS Volumes for Drain Tanks	AREVA	67

Item	Item description	Source of information	Qualification of information	Considering IBED internal volume (m^3)
4	Upper Pipe Chase BLK ring manifold	2004 design	US ITER TCWS recalculated values, 6 m/s	60
5	Upper Pipe Chase BLK branch piping	2004 design	US ITER TCWS recalculated values, 6 m/s	28
6	IBED PHTS Main Heat Exchanger	TDR-3005518-000, ITER TC WS IBED PHTS, NBI PHTS, and VV PHTS Volumes for Drain Tanks	AREVA	0.8
9	IBED PHTS Pump Casing	TDR-3005518-000, ITER TC WS IBED PHTS, NBI PHTS, and VV PHTS Volumes for Drain Tanks	AREVA	1.5
10	BED PHTS Pressurizer	TDR-3005518-000, ITER TC WS IBED PHTS, NBI PHTS, and VV PHTS Volumes for Drain Tanks		24.2
11	IBED PHTS Valves (DIV and BLK)	TDR-3005518-000, ITER TC WS IBED PHTS, NBI PHTS, and VV PHTS Volumes for Drain Tanks	AREVA	4
12	DIV in-vessel component	SADL V5.2.6 (Table 3.2.1-1)	Assumed to be similar to current design	23
14	DIV Lower Pipe Chase ring manifold	2004 design	US ITER TCWS recalculated values, 6 m/s	17
15	DIV Lower Pipe Chase branch piping	2004 design	US ITER TCWS recalculated values, 6 m/s	20
19-1	ELM coils	http://www.pppl.gov/~neumeyer/ITER_IVC/Design_Point.html		3
19-2	IBED CVCS Needs	Personal Communication with Giovanni Dell'Orco, June 2011		10
19-3	IBED PHTS Baking Heater	TDR-3005518-000, ITER TC WS IBED PHTS, NBI PHTS, and VV PHTS Volumes for Drain Tanks	AREVA	1
	SUBTOTAL			**343.5**
20	VV, port stub, port stub extension	DDD1.5 Vacuum Vessel[a]	DDD1.5 Vacuum Vessel[a]	235
21	VV PHTS Piping Volume Input	TDR-3005518-000, ITER TC WS IBED PHTS, NBI PHTS, and VV PHTS Volumes for Drain Tanks	AREVA	54.73

Item	Item description	Source of information	Qualification of information	Considering IBED internal volume (m^3)
22.	VV PHTS Primary Heat Exchanger	TDR-3005518-000, ITER TC WS IBED PHTS, NBI PHTS, and VV PHTS Volumes for Drain Tanks	AREVA	0.12
23.	VV PHTS Safety Heat Exchanger	TDR-3005518-000, ITER TC WS IBED PHTS, NBI PHTS, and VV PHTS Volumes for Drain Tanks	AREVA	0.04
25	VV PHTS Primary Pump Casing	TDR-3005518-000, ITER TC WS IBED PHTS, NBI PHTS, and VV PHTS Volumes for Drain Tanks	AREVA	1.45
26	VV PHTS Baking Heater	TDR-3005518-000, ITER TC WS IBED PHTS, NBI PHTS, and VV PHTS Volumes for Drain Tanks	AREVA	1
27	VV PHTS Safety Pump Casing	TDR-3005518-000, ITER TC WS IBED PHTS, NBI PHTS, and VV PHTS Volumes for Drain Tanks	AREVA	0.115
30	VV pressurizer	TDR-3005518-000, ITER TC WS IBED PHTS, NBI PHTS, and VV PHTS Volumes for Drain Tanks	AREVA	10.44
31	VV PHTS Volume Control Tank	TDR-3005518-000, ITER TC WS IBED PHTS, NBI PHTS, and VV PHTS Volumes for Drain Tanks	AREVA	32.39
32	VV PHTS Volume Control Tank Heat Exchanger	TDR-3005518-000, ITER TC WS IBED PHTS, NBI PHTS, and VV PHTS Volumes for Drain Tanks	AREVA	0.12
33	VV PHTS Volume Control Tank Pump	TDR-3005518-000, ITER TC WS IBED PHTS, NBI PHTS, and VV PHTS Volumes for Drain Tanks	AREVA	0.078
	SUBTOTAL			**335.5**
31	NBI internal components	2004 design[b]	US ITER TCWS recalculated values	10
32	NBI Piping Volume	TDR-3005518-000, ITER TC WS IBED PHTS, NBI PHTS, and VV PHTS Volumes for Drain Tanks	AREVA	87.21
33	NBI PHTS Main Heat Exchanger	TDR-3005518-000, ITER TC WS IBED PHTS, NBI PHTS, and VV PHTS Volumes for Drain Tanks	AREVA	5.31
34	NBI PHTS Main Pump Casing	TDR-3005518-000, ITER TC WS IBED PHTS, NBI PHTS, and VV PHTS Volumes for Drain Tanks	AREVA	0.3
35	NBI PHTS Low Flow Pump Casing	TDR-3005518-000, ITER TC WS IBED PHTS, NBI PHTS, and VV PHTS Volumes for Drain Tanks	AREVA	0.3

Item	Item description	Source of information	Qualification of information	Considering IBED internal volume (m^3)
36	NBI PHTS Pressurizer	TDR-3005518-000, ITER TC WS IBED PHTS, NBI PHTS, and VV PHTS Volumes for Drain Tanks	AREVA	5.22
	SUBTOTAL			**108.34**
37	**Total working volume for DIV and BLK (m^3)**			**343.5**
38	**Total working volume for VV (m^3)**			**335.5**
39	**Total working volume for NBI (m^3)**			**108.3**

[a]DDD 1.5 Vacuum Vessel, G15 DDD 04 01-06-25 R 0.1.
[b]DDD 1.5 Vacuum Vessel, 22 FPN2, October 13, 2009.

2.2 SAFETY DRAIN TANKS

The purpose of the safety DTs is to store the inventory of water that results from the design basis LOCAs that result in a large leak into the VV. Two safety DTs were designed to serve this purpose—the design is based on an analysis done by the ITER Organization (IO) Safety Group.[4] These tanks will also be used to store water from VV normal operations. IO has issued the document *Functional Requirements for the Safety Drain Tanks* that was approved by IO and is included in Appendix A of this document.

2.2.1 Water Inventory for the Safety Drain Tanks

The safety DTs are maintained in a partially evacuated condition (about 4 kPa) during plasma operation and are designed for washout after the contaminated liquid is transferred to the radioactive waste building. The VV coolant will be drained three times in the lifetime of the project, and the drained water will be stored in the safety DTs.

The IO Safety Group calculated the volume and thermal parameters of water spilled during a LOCA and the subsequent volume that must be drained from the VV.

This analysis establishes the basis for the safety DT capacity. Leonid Topilski, IO Safety Group, performed these calculations using the MELCOR code.[4,5]

Topilski's study considered that water drains from the lowest point of the DIV ports (–5.6 m) through eight pipes, each 50 mm in diameter and 2 m long (of nine valves in nine pipes, one valve is assumed failed to open), into the drain collector and then through the drain pipe (Din = 300 mm) to the DT. The drain pipe is attached to the DT at an elevation of –11.0 m. In the accident considered, it was assumed that water is spilled in the VV from three FW/BLK loops (total water holdup 383 m^3 [or ~360 tons] and total break area 0.02 m^2) and from the DIV loop (water holdup 141 m^3 [or ~132.5 tons] and break area 0.000157 m^2—1 cooling tube). Transient results for pressure are shown in Fig. 1, temperature transients are shown in Fig. 2, and mass transients are shown in Fig. 3. Appendix A describes the safety DT capacity calculated by the IO Safety Group.

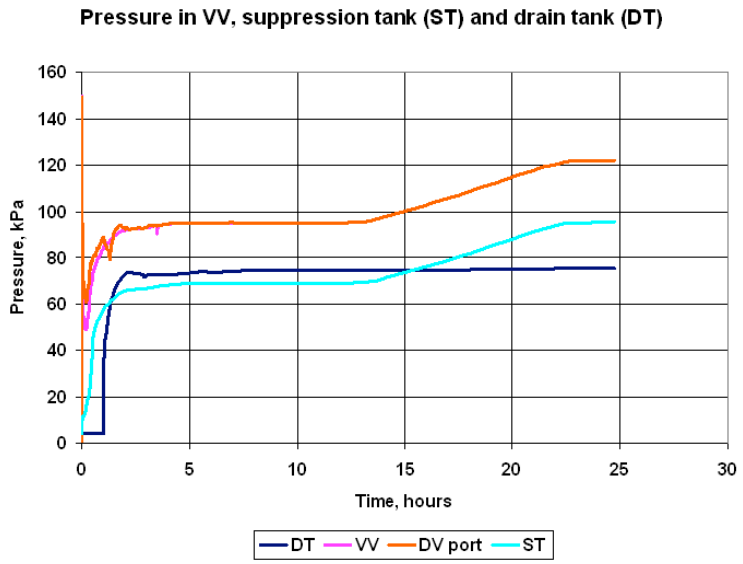


Fig. 1. Pressure transient diagram.

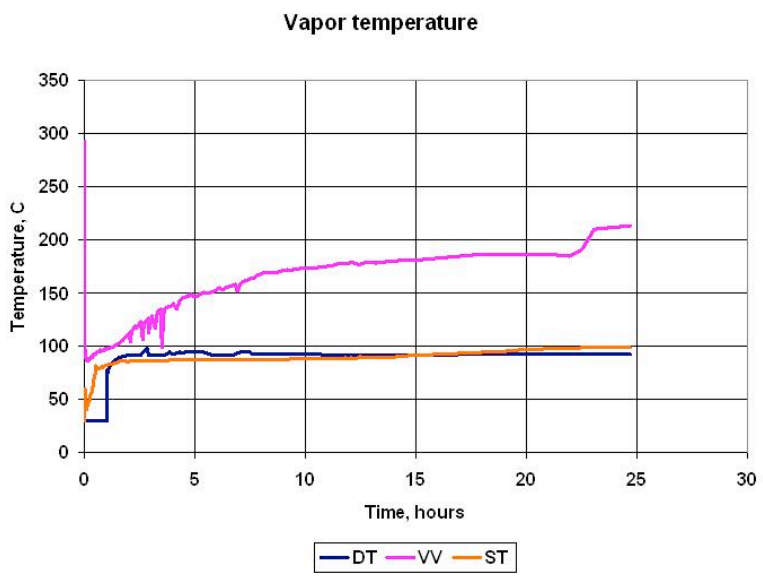


Fig. 2. Temperature transient diagram.

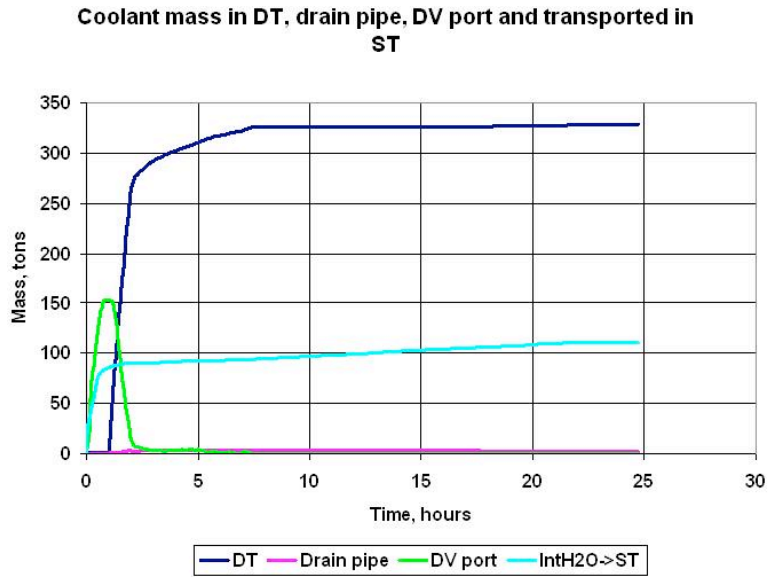


Fig. 3. Mass transient diagram.

2.2.2 Analysis of the Calculations

The design basis accidents establish that the maximum pressure in the DT is 80 kPa (0.080 MPa) and the maximum temperature is 94°C. Water mass drained into the DT is about 330 tons. When a LOCA occurs inside the VV, with 490 tons of water contained in four cooling loops comprising three FW/BLK loops and one DIV loop, about 440 tons of water are postulated to be spilled into the VV. About 110 tons of water turns to steam and is collected in the VV pressure suppression system (VVPSS) tank. The analysis establishes the basis for 330 tons of water to be drained to the safety DTs during this design basis accident. Calculations were made using the MELCOR code, which carries prediction uncertainties of about 10%–15% that are not included in the results of 330 tons.

2.2.3 Other Potential Liquid Volumes that May be Sent to the Safety Drain Tanks

After a LOCA event the water collected in the VV will be sent to the safety DTs via the safety drain lines after several hours have elapsed.

After a LOCA event inside the VV, the steam will be directed via two rupture disks in series to the VVPSS tank. However, after the event has occurred, the operator could decide to transfer the water collected in the VV to the safety DTs by gravity. This water will be sent to the Radwaste Building. This wastewater may have solids in suspension that will stay in the safety DT for some time. If this time is long (it has not been determined yet by IO operations), the solids could settle at the bottom of the tank with the potential for clogging the tank exit pipe.

2.3 DRAIN TANK PRELIMINARY DESIGN BASIS

2.3.1 Drain Tank Volume Estimate

Working Volume Analysis. Water working volume estimates for the normal operation FW/BLK and DIV DTs in Sect. 2.1 establish the basis for 343.5 m^3 of water storage space. The nitrogen space volume that will exist above the high level surface should be considered for the tank design. AREVA will provide design safety factors to determine the tank design volume based on best engineering practice, adhering to

the appropriate codes. The DIV is connected to a DT, which has a sump tank to assist draining and a sump pump to move the water because the level of the DIV cassettes is below the gravity drain line. Sump tank and pump are provided to transfer the water between normal DTs, providing a flexible design that allows options for managing water storage during maintenance. This sump tank is also used to collect drain water. IO would like to consider only one sump tank of 4 m^3 connected to the drying system. This request will be verified by the AREVA design.

The VV will be drained only three times over the lifetime of the project. The first time will be during commissioning and testing; the second, after nonradioactive operations during testing before radioactive operations; and the third, during decommissioning. The safety DTs will not be in use during these three maintenance periods. There is no need for separate VV DTs; the VV PHTS will be drained to the safety DTs. From Table 1, item 38, the working volume of water corresponding to the VV PHTS, piping, and in-vessel components is about 335.5 m^3, which can be contained in the safety DTs.[6,7] During the gravity drain of the VV there is a risk of insufficient height from the bottom of the Lower Pipe Chase to the level in the DT to permit a full drainage. Therefore the drain line from the VV can connect to the same sump tank by using an isolation valve. Thus, there will be one sump tank that can be used for both DIV and VV draining procedures. After each procedure the sump tank should be washed.

The water storage needs for the NBI are 96 m^3.

The diameter of all the tanks will be calculated to accommodate the DTs in the allocated space in the basement level of the Tokamak Building. AREVA will determine the DT dimensions based on the expected storage water volume and appropriate engineering practices. Table 2 indicates the number of tanks and their expected water working volumes.

Table 2. Initial drain tank working water volumes

	Number of tanks	Working water volume per tank (m^3)
FW/BLK and DIV Normal DTs	2	171.7
Safety DTs	2	171.5[a]
NBI Tank	1	108.3
Sump Tank DIV/BLK	1	4

[a]Per Appendix A, "Functional Requirements for the Safety Drain Tanks," the total design volume for the safety DTs should be calculated as 330 ton + 30% excess capacity.

The normal and safety drain tanks may be fabricated with the same dimensions. Although Table 2 indicates that these tanks have different volumes, the economics of having only one engineering set for the four tanks may be advantageous from a value engineering stand point. Because of a final design review chit, the normal and safety drain tanks are interconnected having the same volume. One constraint for the tank volume determination is that in some unforeseen event, the tanks should accommodate the water from all the in-vessel components in addition to cooling water piping, and PHTSs (RPrS, 3ZR2NC v1.0, Chapter 6.1, 89/115).

Normal Draining Operations. During normal draining operations, the drain tanks should be capable of accepting the total volume from the FW/BLK and DIV PHTS (343.5 m^3) as seeing in Sect. 2.1, as well as the VV PHTS (335.5 m^3). The total required capacity for this scenario is 679 m^3.

Safety Draining Operations. During safety draining operations, the safety drain tanks should be capable of accepting the volume drained to the tanks during a design basis LOCA, 330 tons + 30 % = 446 m^3 considering a temperature of water of 94°C.

2.3.2 Development of Final Design Basis for Drain Tanks

Several aspects must be considered to complete the final design of the DTs. Information documented in this report must be refined and verified during the preliminary design of the DTs. Input to these design considerations is discussed in this report and includes, but is not limited to, water inventory; operating procedures; FMEA; tank layout and dimensions, including design margin; classification under ESPN; and adaptations for construction. The design of the DTs shall be fully compliant to the Essential Safety Requirements (ESR) dictated by the ESP/ESPN French regulations (ref: European Directives (DESP 97/23/CE), the French decree 13-12-1999 (Annex 1), the Ministerial order 21-12-1999 and the French ministerial order on ESPN 12-12-2005 (Appendix 2 and 3 for levels N2 and N3). This means that the design of DTs can follow the ASME VIII Div. 2, but with additional specifications as required meeting ESP/ESPN French regulations. A guide for additional requirements, Compliance ASME Sec VIII Div 2 and ESP/ESPN (ITER_D_3E5HKQ v1.0) is provided for information.[8]

Equipment sizing (heat exchangers, pump casings, and pressurizers, as a minimum) and three-dimensional models of piping equipment layout will be completed by AREVA during preliminary design.

Operating procedures are evaluated to establish thermohydraulic requirements for the normal DTs. The FMEA, to be completed by AREVA, will evaluate system failure modes and establish whether DT thermohydraulic requirements encompass the design features needed to mitigate system failure modes. For example, are failure modes identified where the water to be drained cannot be cooled to 100°C before draining is required?

DTs are categorized as nuclear pressure equipment under ESPN. IO is responsible for equipment classification under ESPN and has documented the classification for the normal and safety DTs.
Tank capacities proposed in Table 2 are the best estimate before the preliminary design is completed and are to be used as a guide for the preliminary design. Changes to these values, especially the NBI tank, are possible—final dimensions must be established during preliminary design. Final tank size determination will also consider that the total drain tank capability should not be less than 1000 m^3. The RPrS document specifies that the drain tank have a total capacity of 1000 m^3.[9]

An operational feature that the DTs need to have to operate appropriately is vortexing prevention. During refill, vortexing could cause undissolved nitrogen ingestion into the CVCS pumps. A tank bladder might also be something to consider (provides barrier between blanket gas and fluid). A nitrogen blanket may be unnecessary if a bladder is used; however, the use of a plastic bladder needs to be studied.

3. ADDITIONAL INFORMATION FOR THE DRAIN TANK DESIGN BASIS

3.1 DRAIN TANK CONFIGURATION

The DTs of the FW/BLK, DIV, and NBI PHTSs are vertical type. These five tanks will be installed in the north part of B2 level of the Tokamak building as illustrated in Fig. 4. Figure 5 illustrates the front view of the DT area showing the position of a mezzanine where the VV PHTS equipment will be located.

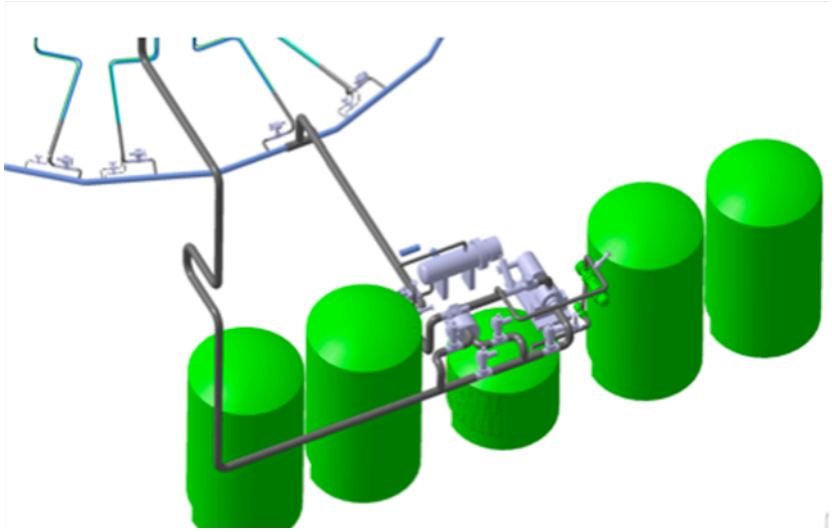


Fig. 4. Drain tank configuration.

Fig. 5. Front view of drain tank area.

For this DT configuration, three refilling pumps are necessary: one for the FW/BLK and DIV normal DTs, one for the NBI DT, and one for the safety DTs. Figure 6 indicates preliminary measurements for the DT area. AREVA will have to refine these measurements based on the computer-graphics-aided three-dimensional interactive application (CAD software) (CATIA) drawings. Figure 6 also shows the sump tank.

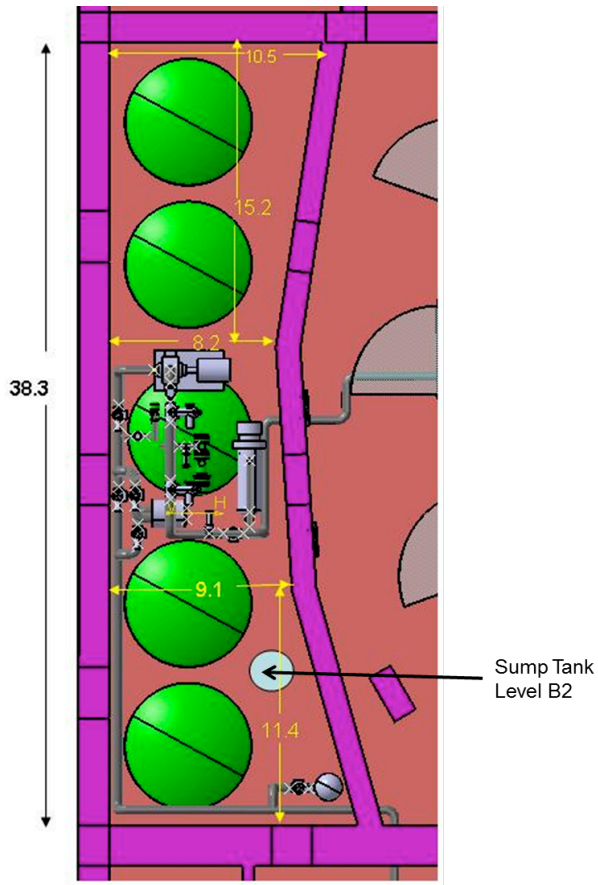


Fig. 6. Basic preliminary dimensions of the drain tank area (units: m); height of space: 10.6 m.

3.2 CONCEPTUAL APPROACH TO THE DRAIN TANK INSTALLATION

The size of the DTs will require that the installation be performed during the construction of the building. Several installation scenarios must be considered that depend on the delivery date of the tanks. The two general scenarios are (1) installation coinciding with the construction of the ground level of the building and (2) delayed installation after the B1 level concrete is finished.

3.2.1 Installation Coinciding with Construction of B2 Level (Both B2 Level and Floor B2 are finished)

This is the preferred and most conservative option, and it assumes that the tanks will be in place when the B2 level is finished. There are two possible variations on this installation scenario, and the decision on the installation procedure will depend on whether the construction of the mezzanine on the DT area is completed. The possibility of combining the cooling needs of the ELM coils with the FW/BLK and DIV

PHTSs is being studied under PCR-273. This decision, in addition to a thorough analysis of the available vault space and safety considerations, will determine whether the VV PTHS will be installed on top of the mezzanine or in the vault area.

Mezzanine is Constructed. This option dictates that the VV PTHS cannot be installed in the vault area, and the installation of the DTs needs to follow a specific sequence. Figure 7 illustrates the three phases of installation for this option. First, two of the large tanks are moved into place using IO moving platforms; second, the mezzanine is constructed; and third, the NBI and the other two large tanks are moved into place. This option requires careful coordination between IO and US ITER related to scheduling tank delivery and construction of the building.

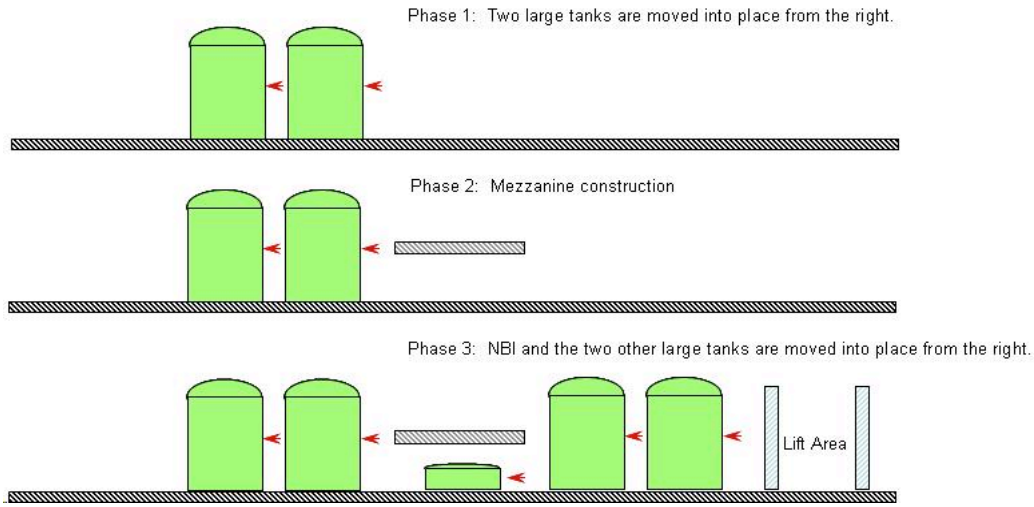


Fig. 7. Drain tank installation at level B2 with mezzanine construction.

Mezzanine is not Constructed. This is a straightforward option where the DTs are moved into place one after the other as illustrated in Fig. 8.

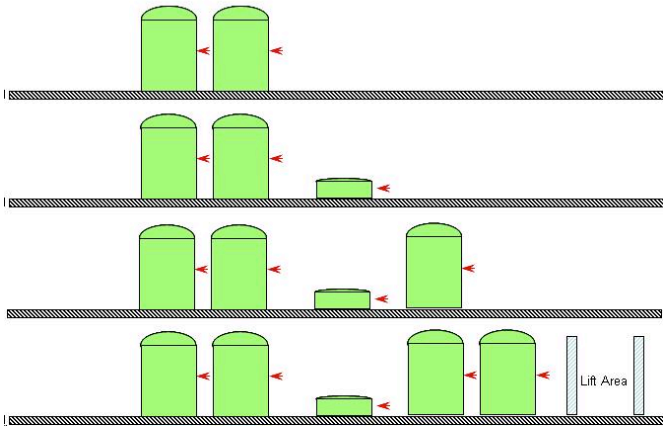


Fig. 8. Drain tank installation at level B2 with no mezzanine construction.

3.2.2 Delayed Installation after Construction of Ground Level

This option assumes that level L1 is finished. The current thinking is that the installation of five vertical tanks can be carried out by a mobile crane, which could be located outside and to the north of the building. The transportation path will be through temporary openings in the slab of B1 level, the slab of L1 level, and perhaps the slab of L3 level (if necessary, depending on the timetables for building construction and equipment delivery). These five tanks will be placed in position by an up-to-down method.

For the installation of DTs, there are several options. One is to use the elevator well, which is 11.5 m by 6.98 m. The tanks will be lifted from their temporary storage area by a mobile crane and lowered to the B2 level through the elevator well. With the help of an air pallet and a temporary rigging device, the tanks will be ground transported and placed in final position as depicted in Fig. 9. If this approach is accepted, the DTs could potentially be delivered at a later date. There are also two variations on the delayed installation scenario that depend on the need to construct the mezzanine.

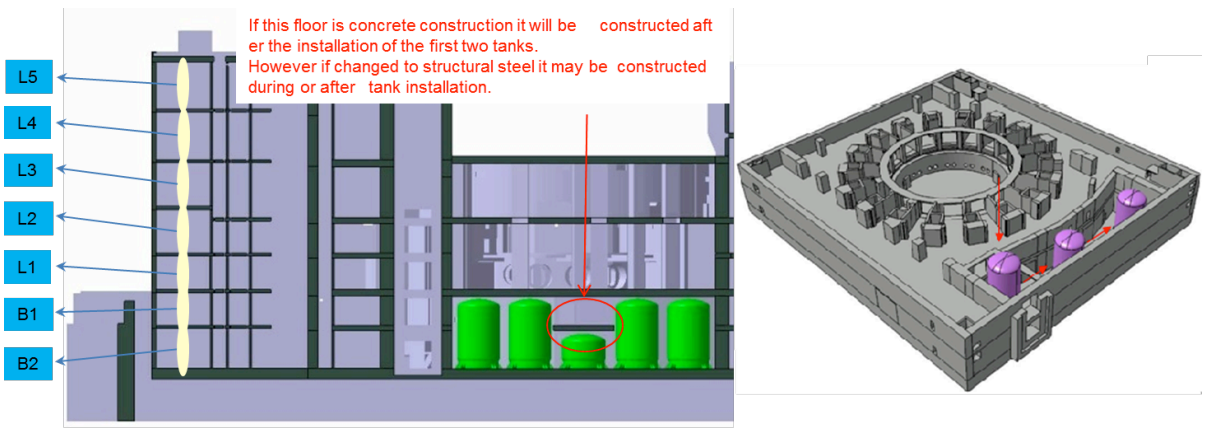


Fig. 9. Introduction of drain tanks.

3.2.3 Installation Requirements

After a DT is lowered vertically through the elevator shaft to the B2 level, the tanks will be moved horizontally using air pallets that will be provided by IO during the installation process. Temporary brackets for attaching air pads to the tanks will be provided by US ITER. Specifications for the temporary brackets will come from IO. Other general requirements for the DTs are

- DTs should include support skirts at their bases
- DTs are to be provided with lifting lugs to permit the crane to lift and lower the tanks in their vertical position to the B2 level
- DT design should accommodate access gap in skirts to underside of tank
- overall DT height (with the air transport pads) should be compatible with the net height in the room (10.7 m)

3.2.4 Construction of Ceiling on B2 that May Affect Installation Procedure

The latest information from the IO Construction Group indicated that the ceiling on B2 has to be finished before the DTs are positioned on B2. This information will have to be considered in the design.[10]

3.2.5 ITER Organization Preferred Solution for the Drain Tank Installation

Based on the latest information from the IO Construction Group, the sequence for the DT installation would be (1) finish B2 floor, (2) finish the ceiling on B2 floor, (3) install the two normal operation DTs, (4) construct the mezzanine, (5) install the NBI DT, and (6) install the safety DTs. The lift shaft will be used to move the tanks to the B2 level. The mezzanine on B2 floor may not be constructed because the equipment that was originally here will now be in the vault area; however, a final decision has not been made yet and the mezzanine could also be constructed with steel structure.

3.2.6 Anchoring Tanks to Floor B2

The IO Assembly Group has suggested the use of embedded threads to anchor the tanks to the B2 floor and at the same time share the use of available air pallets.

In February 2011, the IO Mechanical Assembly Group provided suggestions on how to anchor the DTs to the floor of B2 level in the DT area.[10] What follows is a sequence of steps for the drain tank installation and a detail of the suggested anchoring systems.

Transfer System. A 500 T crane with 180 T counter weight will be used to transfer the tanks through the vertical shaft as shown in Fig. 10.

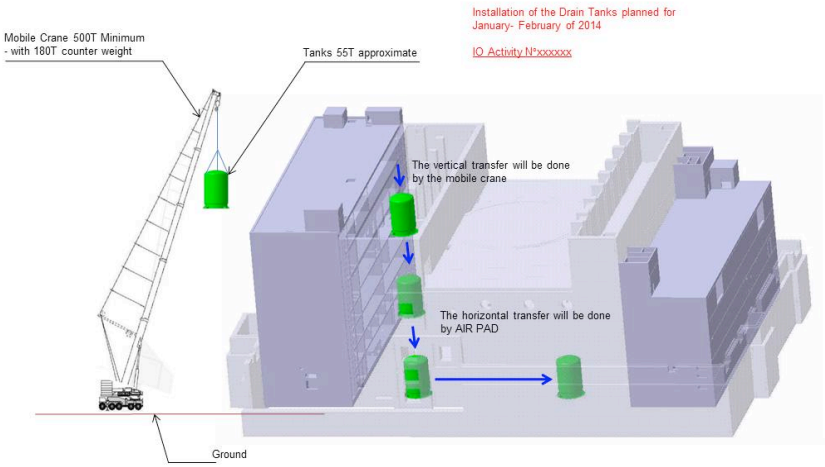


Fig. 10. Drain tank transfer system.

Direction of Installation. Figure 11 shows the movement direction of the drain tanks. Air pads will be used under the drain tank to move them from one position to another inside the drain tank room as shown in Fig 12.

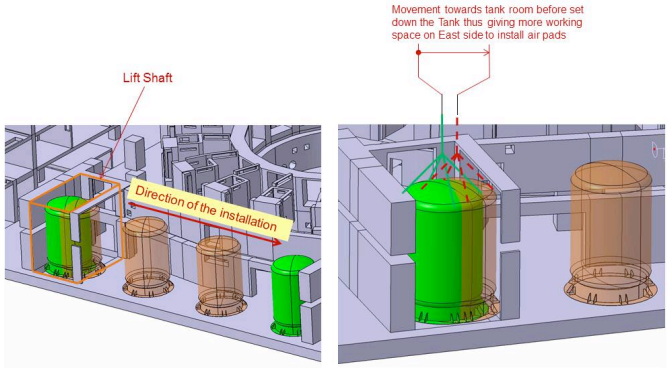


Fig. 11. Direction of drain tank installation.

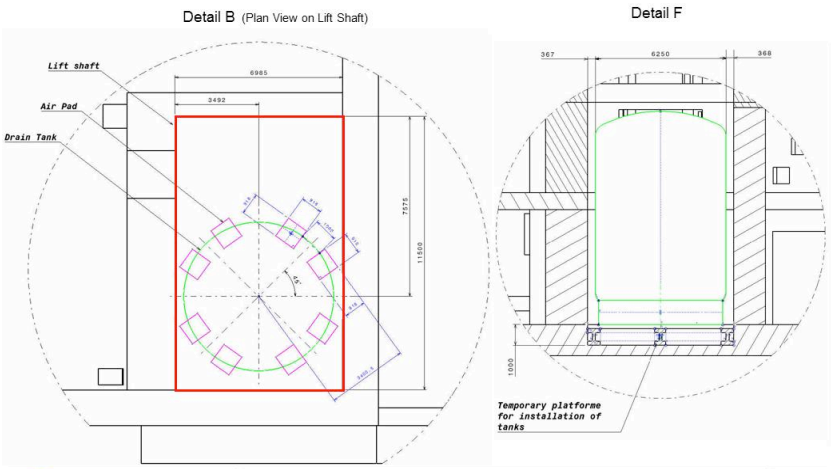


Fig. 12. Air pads in the drain tank installation.

Installation of Tanks Using Air Pads. Once a tank is lowered into the B2 level floor through the shaft, air pads are accommodated at the bottom of the tanks. The air pads require 200 mm in height to be accommodated (68 mm thickness + 132 mm for the hard wood spreader pack). This distance is required to permit the extraction of the pads (these dimensions do not include manufacturer tolerances) after the DTs' installation at the proper locations in the DT room. If there is inadequate tank clearance, IO has provided a requirement for the air pad installations as shown in Figs. 13, 15, and 18.[11] Figure 14 indicates the vendor information for the air pads. Figure 15 shows another view of the proposal from ITER IO on locations of air pads at base of the tank to facilitate moving tank into final position.

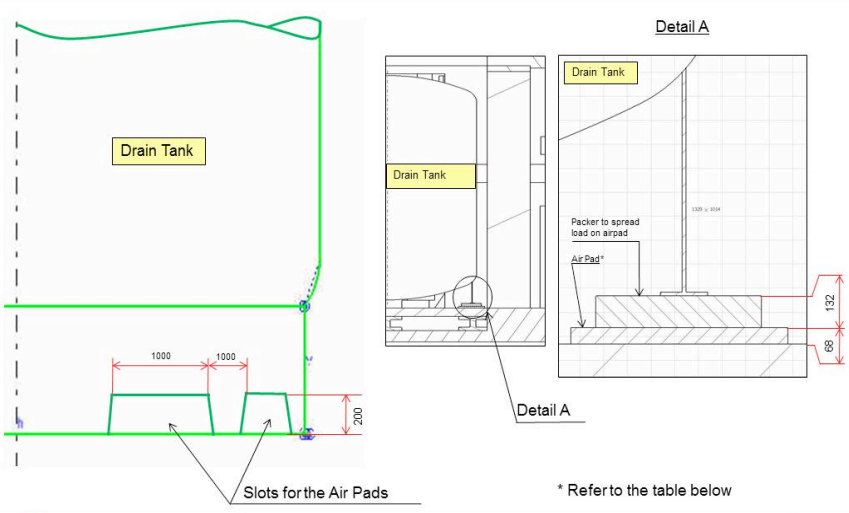


Fig. 13. Proposal for air pad installation at the base of the tanks.

AeroGo

Air Caster Rigging Systems Chart - METRIC

Model	System Capacity (kg) (1)	Number of Load Modules	Dimensions of each Load Module L x W x H (mm)	Lift Height (mm)	Operating Pressure (kg/cm2) (2)	Recommended Air Volume (L/sec) (3)
4K8NL	1,814	4	206 x 206 x 48	10	1.8	26
6K8NL	2,721	6	206 x 206 x 48	10	1.8	40
4K8NHDL	3,628	4	206 x 206 x 48	9	3.5	40
4K12NL	4,535	4	308 x 308 x 48	19	2.1	46
6K8NHDL	5,442	6	206 x 206 x 48	9	3.5	59
6K12NL	6,803	6	308 x 308 x 48	19	2.1	69
4K15NL	7,710	4	384 x 384 x 48	22	2.1	46
4K12NHDL	9,070	4	308 x 308 x 48	19	4.2	53
6K15NL	11,565	6	384 x 384 x 48	22	2.1	69
4K21NL	12,698	4	537 x 537 x 51	29	1.8	40
6K12NHDL	13,605	6	308 x 308 x 48	19	4.2	79
4K15NHDL	15,420	4	384 x 384 x 48	22	4.2	66
6K21NL	19,048	6	537 x 537 x 51	29	1.8	59
6K15NHDL	23,129	6	384 x 384 x 48	22	4.2	99
4K27NL	25,397	4	689 x 689 x 62	35	2.1	73
4K21NHDL	29,025	4	537 x 537 x 51	32	4.2	83
6K27NL	38,095	6	689 x 689 x 62	35	2.1	109
4K36NL	43,537	4	918 x 918 x 68	44	2.1	96
6K21NHDL	43,537	6	537 x 537 x 51	32	4.2	124
4K27NHDL	50,794	4	689 x 689 x 62	38	4.2	159
6K36NL	65,306	6	918 x 918 x 68	44	2.1	144
6K27NHDL	76,190	6	689 x 689 x 62	38	4.2	238
4K48NL	87,075	4	1222 x 1222 x 68	67	2.1	102
4K36NHDL	90,703	4	918 x 918 x 68	48	4.2	178
6K48NL	130,612	6	1222 x 1222 x 68	67	2.1	154
6K36NHDL	136,054	6	918 x 918 x 68	48	4.2	268
4K48NHDL	163,265	4	1222 x 1222 x 68	64	4.2	198
6K48NHDL	244,898	6	1222 x 1222 x 68	64	4.2	297

(1) Load must be positioned so individual Aero-Caster capacities are not exceeded.
(2) Recommended supply pressure: 25 psig above rated operating pressure.
(3) Air maximum load on required smooth troweled and sealed concrete or equivalent. (Includes large **Reserve Factor**).

Link to the *AeroGo* air-pad website as a suggested system for consideration for moving drain tanks into final position

http://www.aerogo.com/pages/load-module-systems.html

Proposal for moving tanks is 8 air pads

iter china eu india japan korea russia usa | Drain Tanks Installation | Page 17 of 17

Fig. 14. Air pad specification sheet.

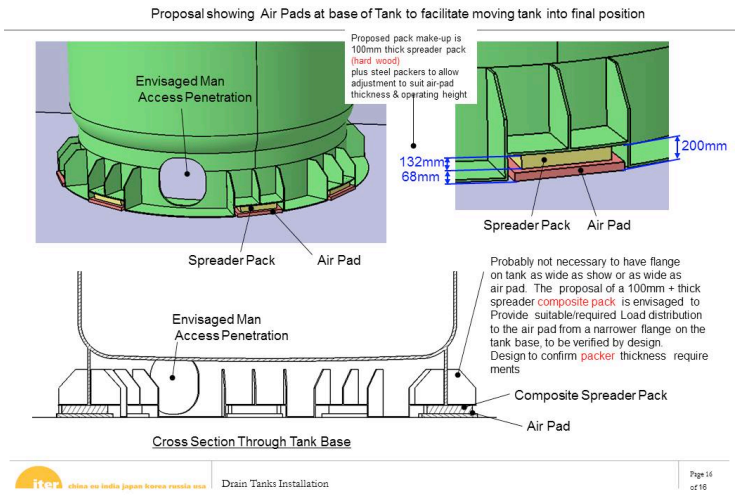


Fig. 15. Air pads location to facilitate moving tank into final position

Anchor Proposal. IO has several proposals for anchoring the drain tanks. Figure 16 illustrates the option of anchoring the tanks by embedding a plate.

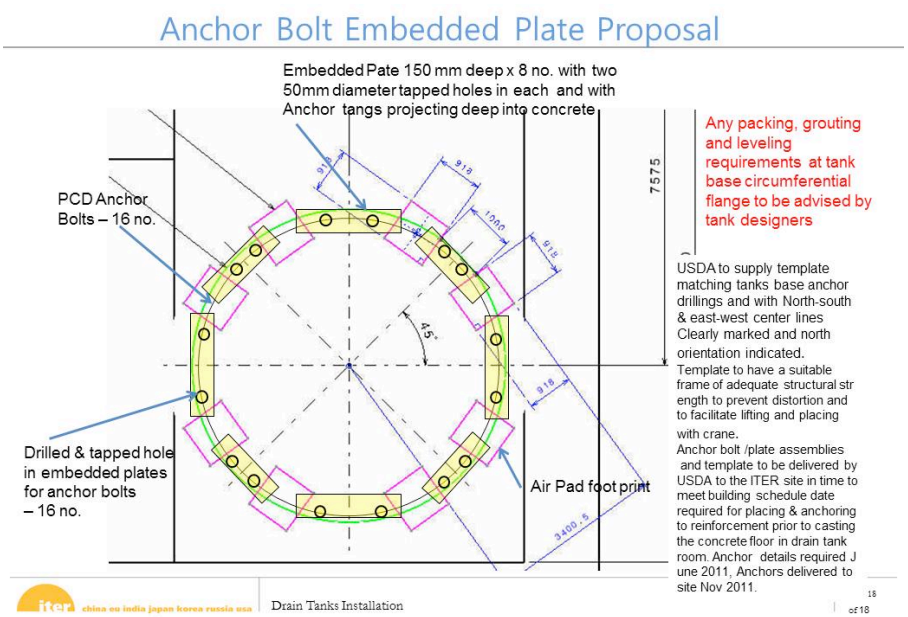


Fig. 16. Anchor bolt embedded plate option.

Tank Base Anchor Bolt. IO has proposed a tank base for the anchor bolt as shown in Fig. 17.

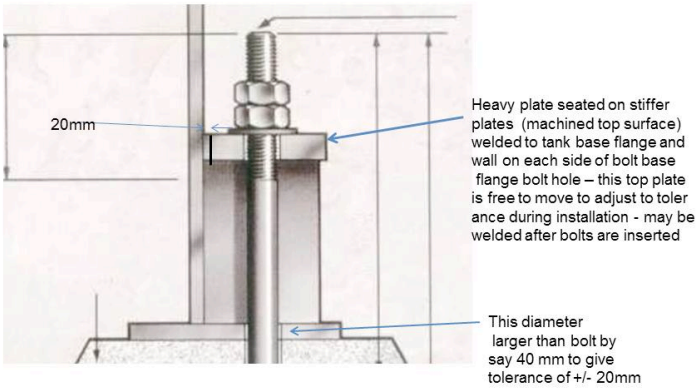


Fig. 17. Tank base detail for anchor bolt option.

Slots for Air Pad. Air pads will be accomodated in slots as illustrated in Fig. 18.

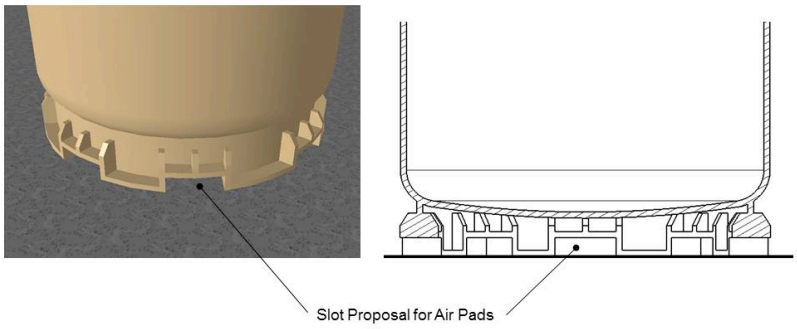


Fig. 18. Slots for air pads.

Using Spreader Plates. Spreader plates will be used on top of the air pads as illustrated in Fig. 19. The term plate and pack are used interchangeable.

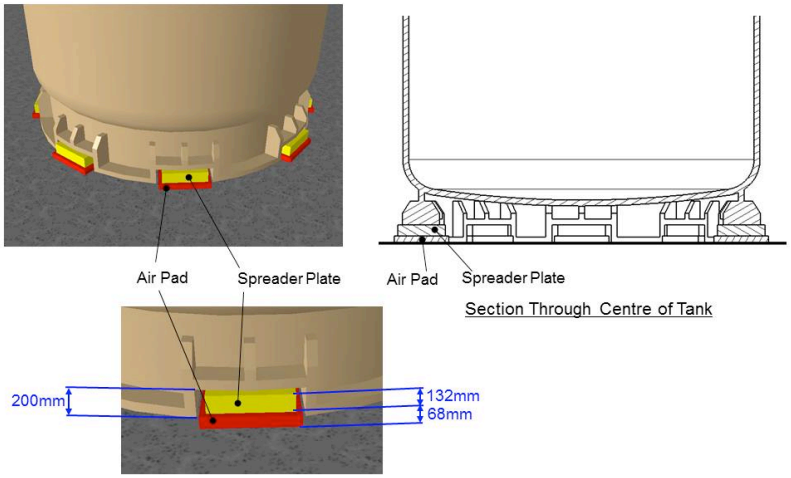


Fig. 19. Air pads are located underneath spreader plates.

Details of Embedded Plate. An embedded plate option is shown in Fig. 20.

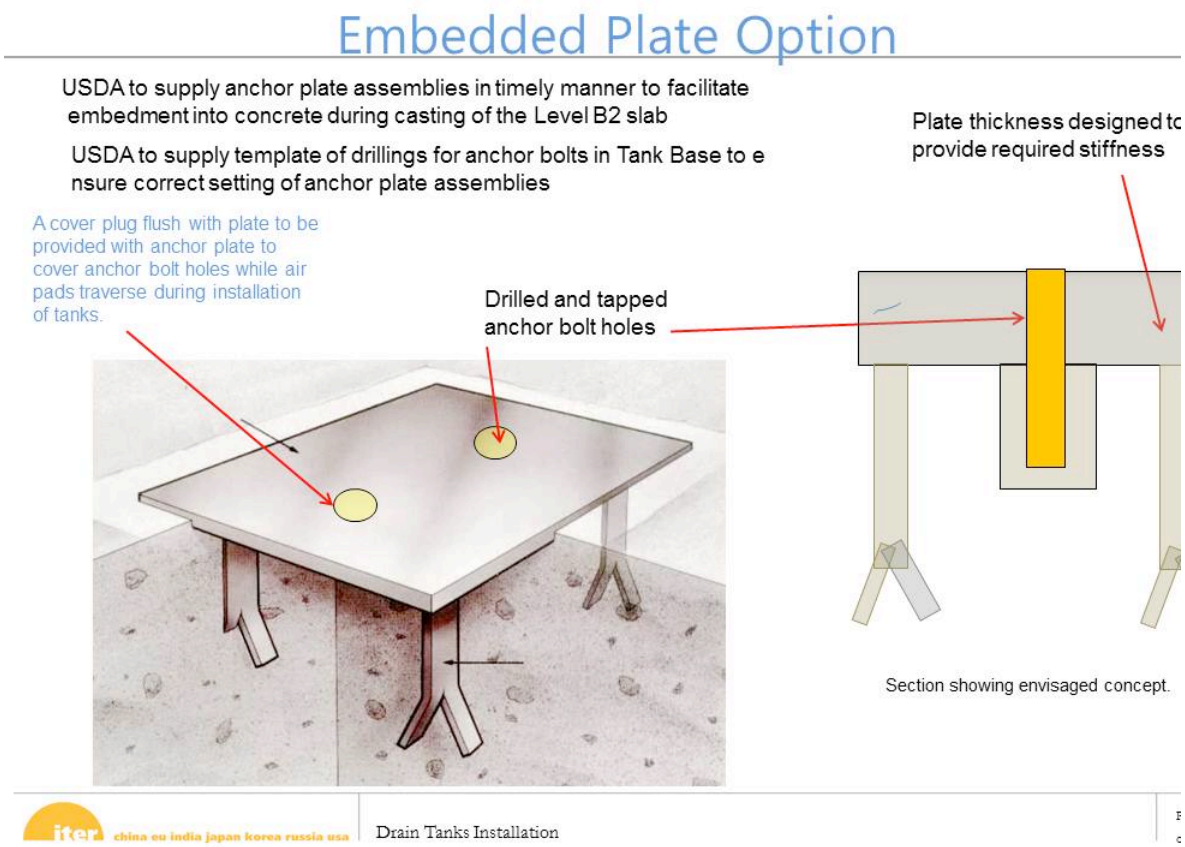


Fig. 20. Embedded plate detail.

Temporarily Removing Bolts. IO has also presented an option of temporarily removing bolts during the installation process as shown in Fig 21. However, a detail to cover sleeve would be required while air pads traverse.

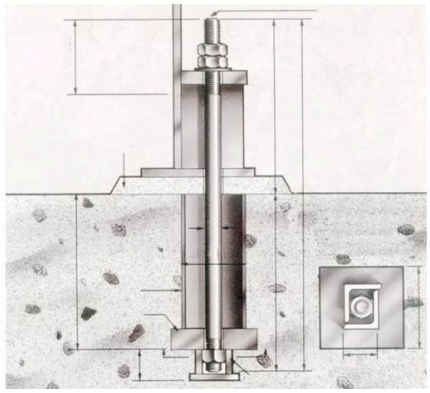


Fig. 21. Option of temporarily removing bolts during installation.

3.3 THERMOHYDRAULIC CONDITIONS FOR THE DRAIN TANK DESIGN FOR NORMAL OPERATIONS

The operational thermohydraulic parameters used for the design of the DTs depend on several modes of operation for the draining process. The two main modes of operation are normal and safety. The safety mode for the emergency DTs corresponds to the draining process during a LOCA event in the VV. The normal mode for normal DTs encompasses several stages such as draining of PHTSs, draining of in-vessel components, draining of surplus water inventory during water baking, and draining derived from the drying operations. This section analyzes each of these modes of operation to determine the normal operational thermohydraulic parameters.

3.3.1 Normal Operation: Draining Only Primary Heat Transfer Systems

Draining operations for the PHTSs assume draining for maintenance and inspection during which the water will be drained by gravity. Figure 22 illustrates this process. To start the draining process, it is assumed that the water temperature for each PHTS will be lowered and the pressure reduced to slightly above atmospheric conditions.[12,13]

Thermohydraulic Parameters for the FW/BLK PHTS. The maintenance process is performed after a plasma operation has stopped. The inlet temperature of the coolant to the heat exchanger during plasma operations is 70°C (according to PCR 273) at a pressure less than 3.0 MPa.

Thermohydraulic Parameters for the DIV PHTS. The maintenance process is performed after a plasma operation has stopped. The inlet temperature of the coolant to the heat exchanger during plasma operations is 70°C (according to PCR 273) at a pressure of less than 3.0 MPa.

Thermohydraulic Parameters for the NBI PHTS. The maintenance process is performed after a plasma operation has stopped. The temperature during plasma operations is 90°C at a pressure of 2.0 MPa.

Thermohydraulic Parameters for the VV PHTS. The maintenance process is performed after a plasma operation has stopped. The temperature during plasma operations is 100°C at a pressure of 0.8 MPa.

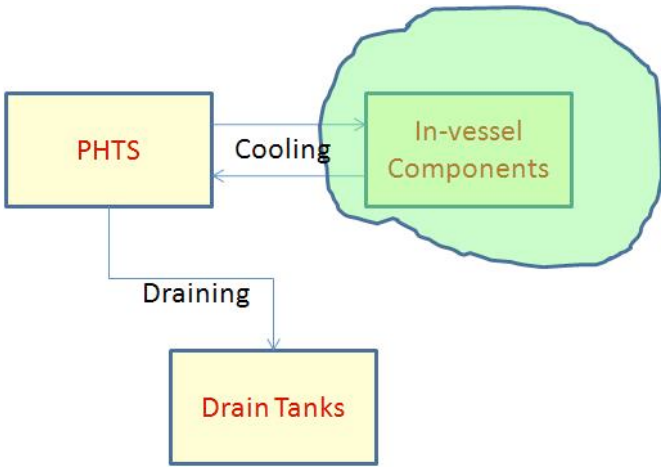


Fig. 22. Draining of a Primary Heat Transfer System isolated from the in-vessel component.

3.3.2 Normal Operation: Draining of Surplus Water Inventory During Water Baking

In preparation for water baking, there is water volume expansion during the heating process. This excess water goes to the Chemical and Volume Control System (CVCS) volume control tank, which has a water retention capacity of 10 m^3 and cannot absorb all the excess water (this water retention capacity may change due to AREVA's design of the CVCS in accordance with PCR 273). As illustrated in Fig. 23, this excess needs to be drained into the corresponding DT.

The VV will be baked at 200°C. Excess water due to volume expansion will be sent to the safety DTs. The VV PHTS will have a cooler for cooling this excess water.

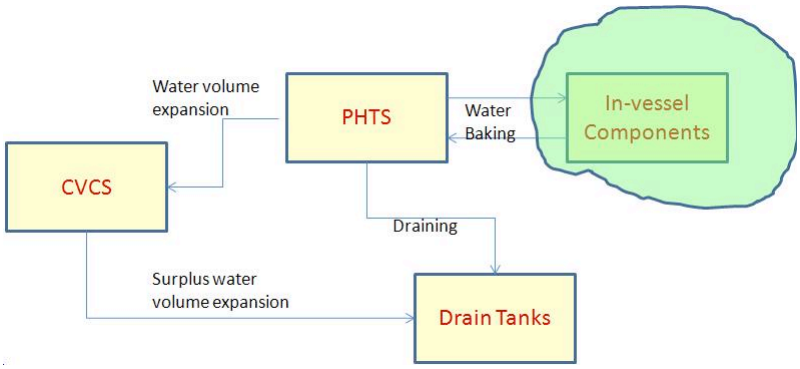


Fig. 23. Excess water from water baking being drained into the corresponding drain tank.

3.3.3 Normal Draining Operation: From Draining and Drying Operations

Design Description Document (DDD) 26 for the TCWS indicates that there are several operations to drain the in-vessel components and the PHTSs: (1) gravity drain, (2) forced drain, and (3) a sequence of drying stages. All these stages involve draining water to the DTs. Although the draining and drying operations are described in DDD-26, they will be briefly described in the following paragraphs to be comprehensive and to provide AREVA a better understanding of the draining and drying processes to facilitate development of optimized procedures.

Gravity Draining. The first step in draining a system is to perform a gravity drain in the PHTS and in-vessel components as illustrated in Fig. 24. The PHTS must cool the in-vessel component to 100°C before the valves to the respective DTs open.

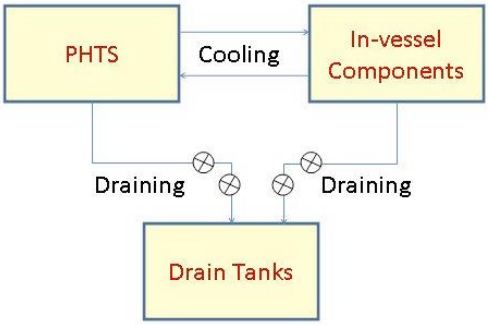


Fig. 24. Gravity drain from Blanket and Divertor Primary Heat Transfer Systems (PHTSs).

Forced Draining for the DIV Cassettes. Once the system has been gravity drained, fresh N_2 gas is charged with a charging compressor as illustrated in Fig. 25.

The compressor starts to circulate working gas to the in-vessel components. Cooler condenser 1 cools the hot working gas after the compressor. Return gas is recycled by the drain and mist separators, cooler condenser 2, and the filter, as illustrated in Fig. 26. The ejected water from the in-vessel components is collected to the DIV sump tank through the drain line connected with the main hot leg pipeline near the coolant collector. The water separated and condensed is drained to the BLK/DIV DTs.

The main parameter for the forced draining is the kinematic pressure difference required to push away the remaining water in the water channels, determined by the counter-current-flow-limitation (CCFL) criterion. The gas velocity that meets the CCFL criterion is inversely proportional to the square of the gas density. The gas density is proportional to pressure and is inversely proportional to the absolute temperature. Consequently, highly pressurized working gas with low temperature is preferable to reduce the CCFL velocity. The gas temperature is set around 40°C, the same temperature as the water in the in-vessel components. The highest gas pressure at the discharge side of the compressor is 4 MPa.

Under these conditions the water should drain at 40°C, and the pressure should be reduced to atmospheric conditions after the pressure reduction valves.

Forced Draining of the Blankets. The forced draining of the BLKs is similar to the DIV cassettes. The only difference is that three DIV cassettes are force drained at the same time and up to eight BLK modules are force drained at the same time. The temperature of the water is about 40°C and the pressure is about 3.8 MPa, which needs to be reduced to < 0.5 MPa. The water is collected at this temperature and the pressure reduced to atmospheric conditions after the pressure reduction valves.

Drying Operation: Heat Up Pressurization-Depressurization Mode. This is a drying operation phase that results in condensation of water that subsequently must be drained to the respective DT. This process is illustrated in Fig. 27. Working gas is circulated in the closed loop by the compressor and the two cooler condensers are bypassed. The working gas is heated by the compressor and the electrical heater. For pressure control during operations, additional charging of fresh gas from storage to the system and/or release of working gas from the system to the Normal Vent Detritiation System (N-VDS) buffer tank is

performed. The maximum pressure during this process is about 2.3 MPa and the temperature reaches 210°C. The water remains liquid at these conditions and is not drained until the system is depressurized.

Once the conditions of temperature and pressure are met, the system is depressurized by transferring the excess working gas from the system to the N-VDS, maintaining working temperature of the system constant. Condensers 1 and 2 condense water mist, which is in the working gas. The transferring gas is extracted from the system by the N-VDS at a rate of 100 m^3/h. A gas blower at the entrance of the N-VDS provides the driving force to the gas transfer. The depressurization mode is illustrated in Fig. 28.

The condensed water is subcooled to 50°C, and the pressure is reduced to meet atmospheric conditions.

3.3.4 Analysis of Thermohydraulic Conditions for the Normal Operations of Drain Tanks

Through the preliminary design process, AREVA will determine optimum thermohydraulic parameters and draining procedures using information in the conceptual design documented in DDD-26 as design input along with the results of other preliminary design studies.

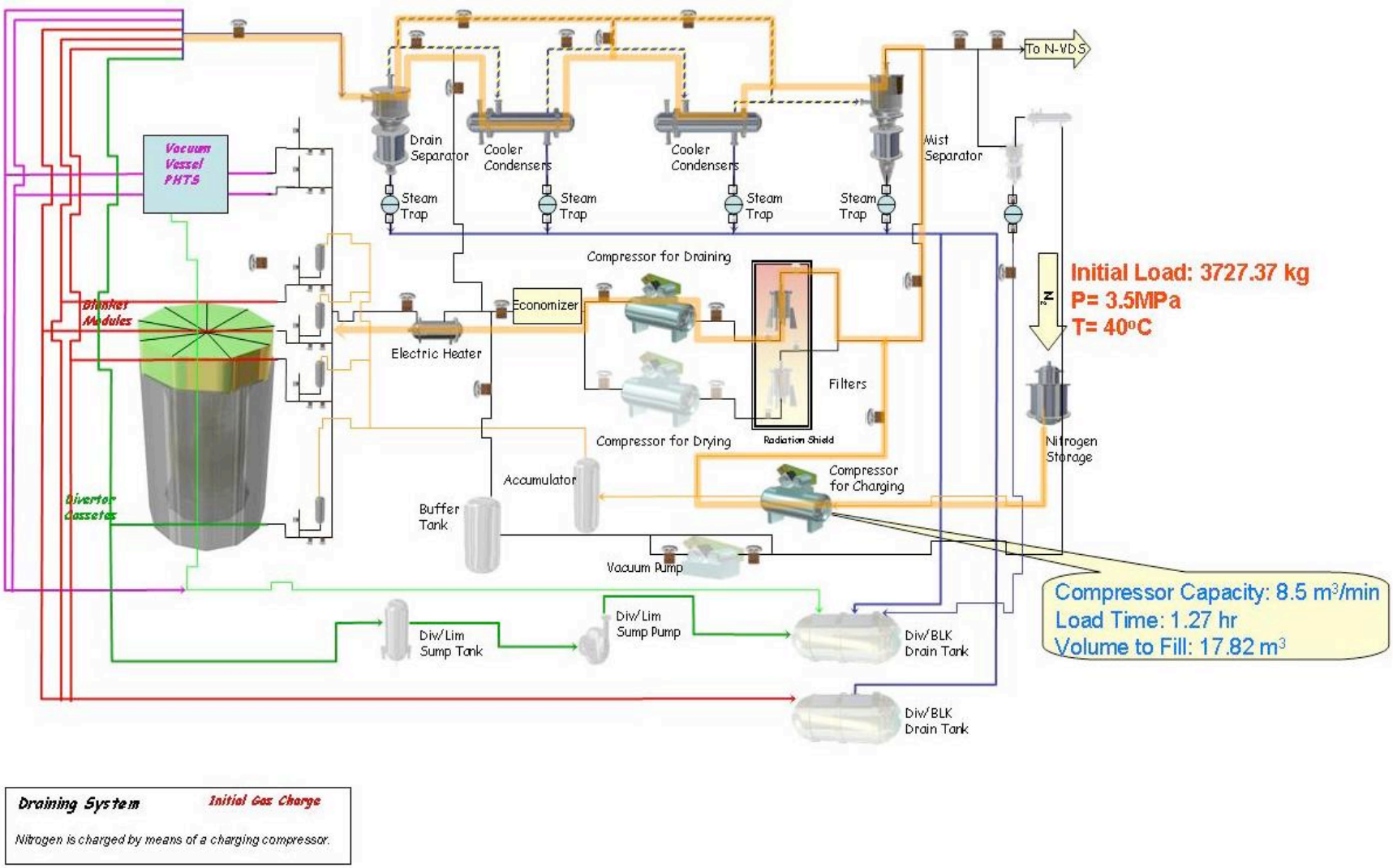


Fig. 25. Charging gas before forced draining.

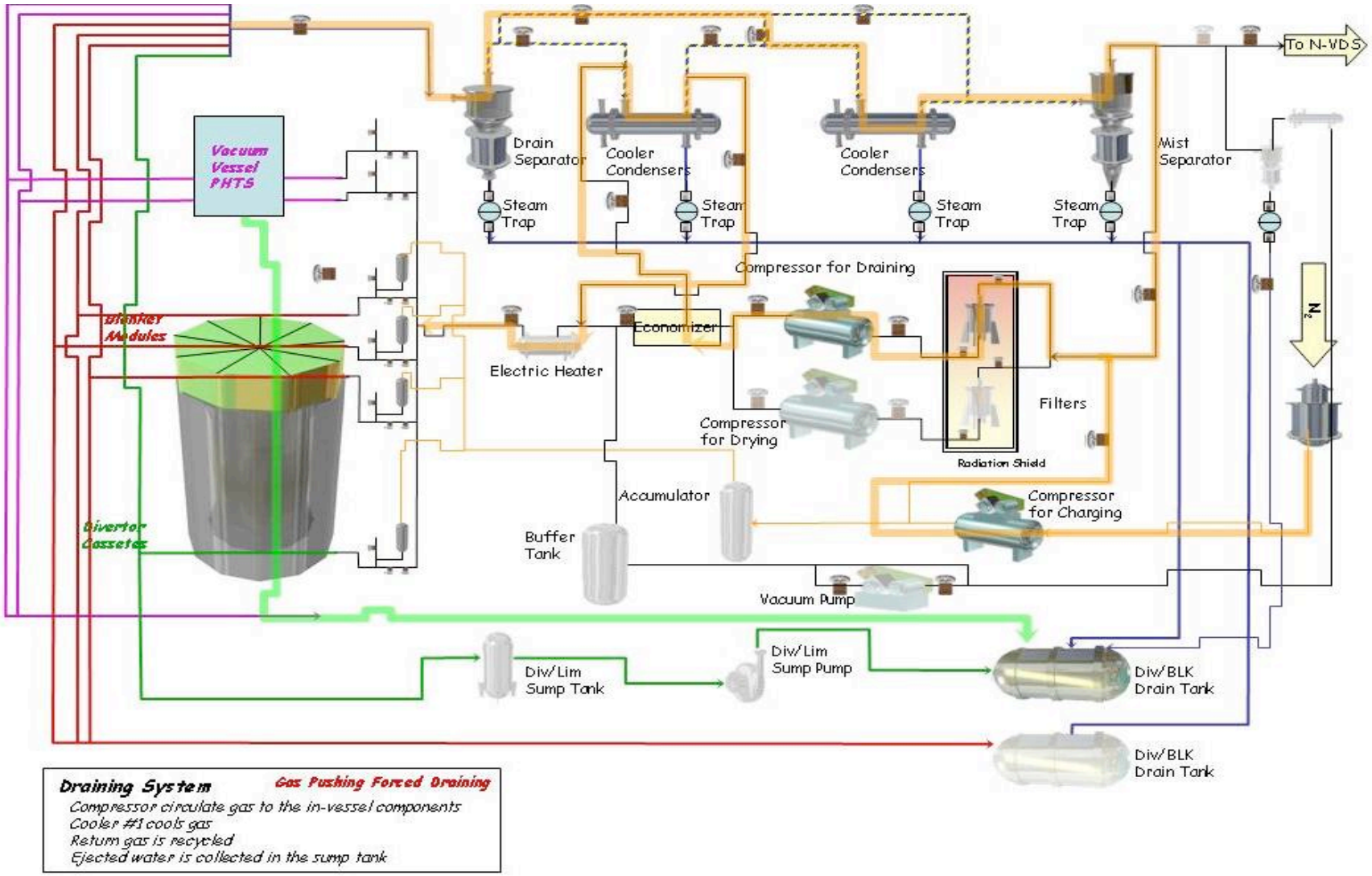


Fig. 26. Forced drain operation.

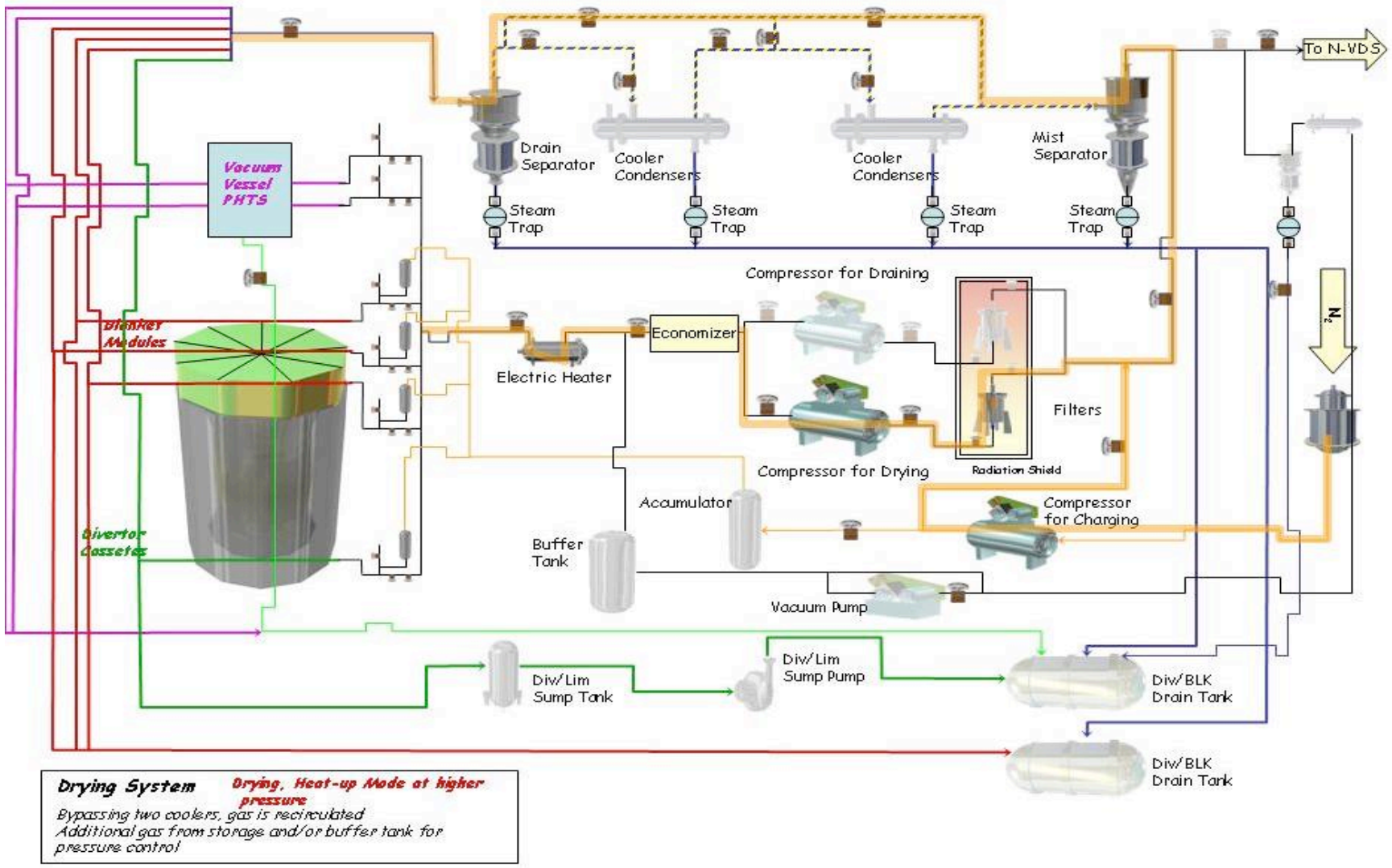


Fig. 27. Heat-up mode at higher pressure.

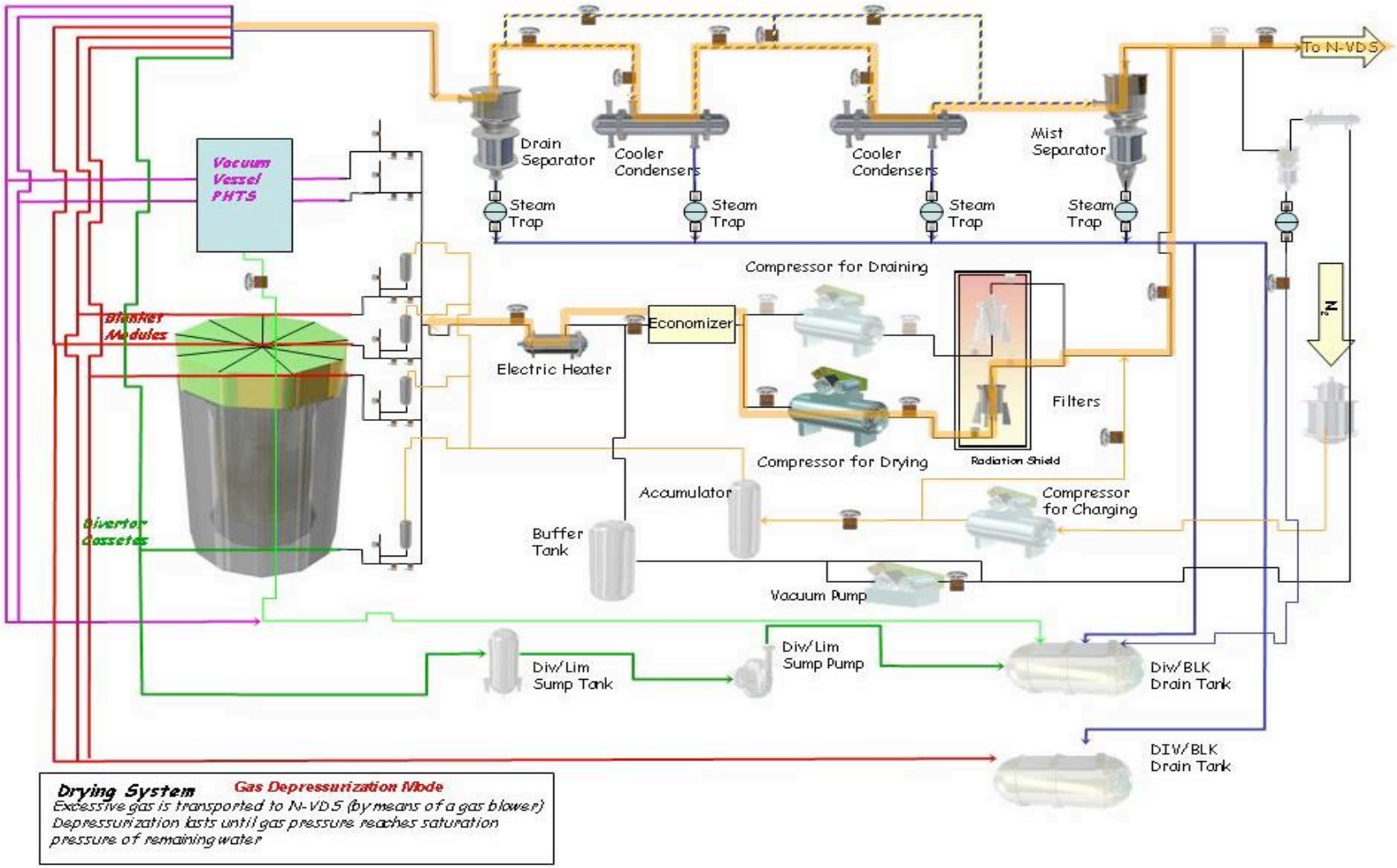


Fig. 28. Depressurization mode.

3.4 THERMOHYDRAULIC CONDITIONS FOR THE DRAIN TANK DESIGN FOR SAFETY OPERATIONS

Table 3 shows an extract of Table 1.4.1 from System Requirements Document (SRD) 26 that shows the reference events that would use the safety DTs. The safety DTs shall be

- designed to accept the contaminated water from the VV and from the VVPSS in case of in-vessel pipe breaks, as required
- capable of discharging the contaminated water to the Radwaste Building (Plant Breakdown Structure [PBS] 66) for processing
- designed to allow cleaning and decontamination before the plant restarts

Table 3. Extract of Table 1.4.1 from System Requirements Document 26

Event title	Category	Global design requirements	TCWS design requirements
Multiple FW/ BLK cooling water pipe break	Accident	VV safety assessment pressure limit 0.2 MPa; VV leak rate; VVPSS bleed-line set point 94 kPa; VVPSS rupture disk set-point 0.15 MPa; VV PHTS low flow safety mode	• Decay heat cooling capability of VV PHTS • Safety drain lines • Safety DTs
In-vessel FW pipe break	Incident	VV safety assessment pressure limit 0.2 MPa; VVPSS bleed-line set point 94 kPa; VVPSS drain valves open in 1 hour after the onset of the incident; Suppression Tank Venting System capability; VV PHTS low flow safety mode; N-VDS serves the port cells and TCWS vault	• Decay heat cooling capability of VV PHTS • Safety DTs

Calculations described in Sect. 2.2 indicate that the maximum pressure in the DTs is 80 kPa (0.080 MPa) and the maximum temperature is 94°C after a LOCA event and after the operators have decided to open the drain valves. The initial conditions of the safety DTs are 4 kPa and 30°C.

Results from the IO Safety Group indicated that the design temperature for the safety DTs is 94°C plus an uncertainty factor, determined according to sound engineering practices, to accommodate the uncertainties of the calculations. The design pressure was indicated as 0.9 MPa, again incorporating an overdesign factor to account for the uncertainties of the calculations and the DDD-26 indicated 1 MPa design pressure. Vacuum conditions on the DTs correspond to a 0.01 MPa according to DDD-26.

AREVA needs to consider that 1MPa design pressure (from N2 supply pressure) should not be used as a design basis. This issue should be addressed with the relief device and not a basis for design pressure for tanks. It is proposed to use maximum static head for design pressure. The N2 pressurization should be < 0.5 bars. N2 pressurization above 0.5 bars would indicate that the table to be used for the classification of these tanks is not the table for liquid group 2, but for gas group 2, making the drain tank become pressure Category IV instead of Category I.[14] In sum, the design pressure must consider that tank may be full of water, a N2 overpressure of 0.5 bar, plus the static head of water in pipes coming down from the Drying System and the pressure relief tank.

3.5 DRAIN TANK INTERFACES

The DTs interface with several systems (PBSs) within the Tokamak complex. There are external PBSs where the DTs send water; cooling water client PBSs that send water to the DTs; TCWS internal systems

that send to and receive water from the DTs; external systems that provide gas and demineralized water services to the DTs; and general external services such as electric, air, and sampling. Figure 29 illustrates the DT interfaces, and Appendix B shows some CATIA pictures of the DTs with a few interfaces.

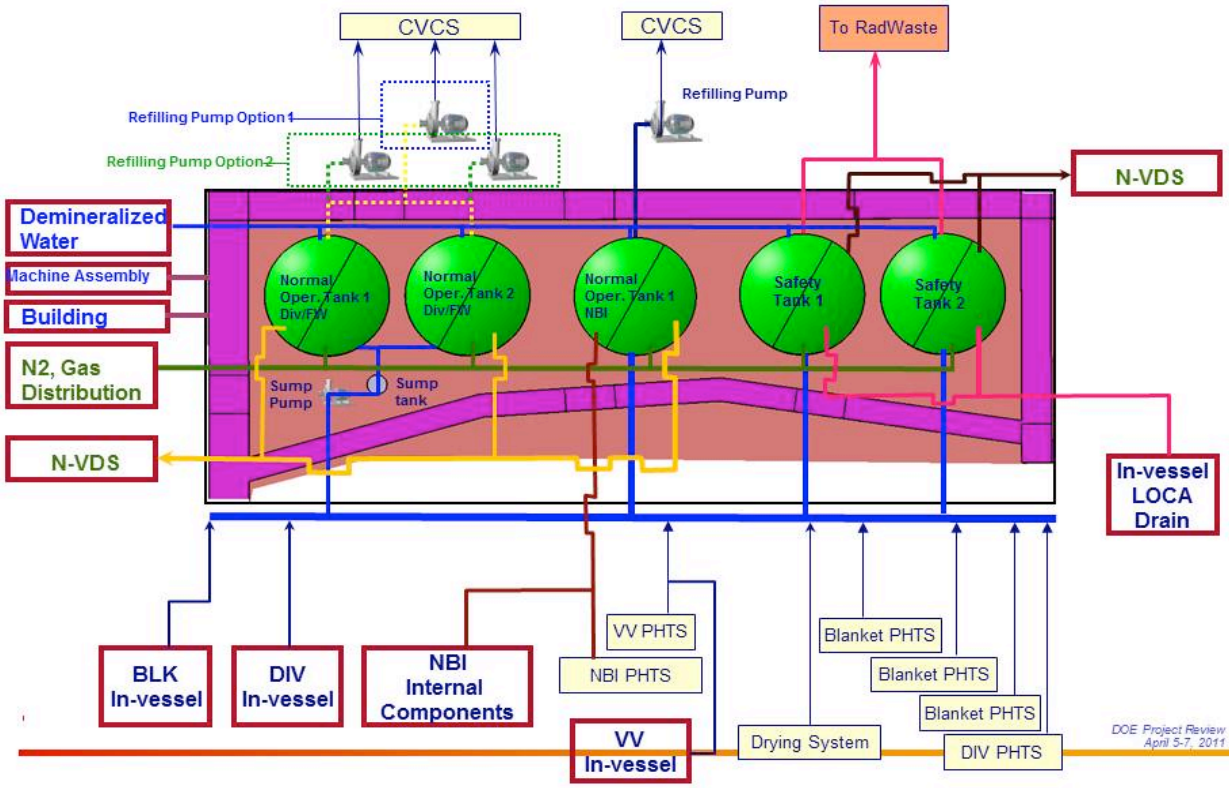


Fig. 29. Graphical representation of the drain tank interfaces.

3.5.1 Interfaces to the Drain Tanks

Normal Operations (Water to DTs). The interfaces that send water to the normal DTs are as follows

- FW/BLK PHTS
- DIV PHTS
- NBI PHTS
- VV PHTS
- Drying system
- FW/BLK in-vessel components
- VV components
- DIV in-vessel components
- NBI internal components
- Pressure relief tanks

Safety Operations (Water to DTs). The interfaces that send water to the safety DTs are as follows

- VV in-vessel components (LOCA emergency drain)
- VVPSS
- VV PHTS

3.5.2 Interfaces From the Drain Tanks

Normal Operations (Water from DTs). The interfaces that receive water from the normal operation DTs are as follows.

- CVCS (water from the BLK/DIV DTs through a refilling pump)
- CVCS (water from the NBI DT through a refilling pump)
- VV PHTS (water from safety DTs through a refilling pump)

Safety Operations (Water from DTs). The following interface receives radioactive liquid from the DTs: Radwaste (radioactive liquid waste from normal and safety tanks) (PBS 66).

Disposal Operations. The following inteface receives nonradioactive liquid from the DTs: Disposal (nonradioactive liquid waste from the normal and safety DTs, bypassing Radwaste).

3.5.3 General Interfaces

Several of the DT interfaces allow different purposes, as described below.

- **Demineralized water**. This water will come from the Gas and Liquid Distribution System to supply the needs for filling, refilling, and cleaning. The demineralized water connection point is to be provided at the safety DTs to facilitate decontamination of the tanks

- **Nitrogen distribution system.** Nitrogen is used to keep a gas blanket in the DTs.

- **N-VDS.** Venting from the tanks is performed using the N-VDS system. Vacuum for safety DTs is performed using the N-VDS system.

- **Electric group**. The refilling pumps and sump tank pump interface with the electric group. There are instruments and controls that also interface with the electric group.

- **Air distribution system.** Air is used for instruments and controls.

Appendix B shows some of the interfaces with the DTs.

The tanks need to have a device to promote vacuum breaking to avoid tank collapse for a sudden vacuum on the tanks that may result from the tank being emptied.

Interfaces with other systems are formalized in interface control documents (ICDs) and interface sheets (ISs). The DT interfaces are included in the draft ICDs referenced in Table 4. This is a draft table that includes preliminary information about the DT interfaces. The ICDs referenced in this table represent a system level description of the interfaces, along with important interfacing agreements and agreed upon schedules between the interfacing systems. As evidenced in Table 4, these ICDs are mostly approved but will be revised and updated at a minimum at the end of the Preliminary and Final Design Phases of the project to account for any potential design changes. The ISs include the technical details associated with the interfaces. The initial drafts of these documents are currently in progress but have not yet been completed. Once completed, these approved documents will be needed for preliminary design. As with the ICDs, the ISs will also be revised and updated throughout the Preliminary and Final Design Phases of the project.

Table 4. Tokamak Cooling Water System drain tank interfaces

PBS system number	Drain interface (Yes/No)	Interface type	Interface location	Interface TCWS equipment ID	ICD document	ICD status	IS document	IS status	Notes
15VV	YES	Client	To be determined (TBD)	26DRFB-TA-0003	ICD 15-26	Approved	IS 15-26	Approved	Safety tank
15VV	YES	Client	TBD	26DRFB-TA-0001	ICD 15-26	Approved	IS 15-26	Approved	Normal tank
16	YES	Client	TBD	26DRFB-TA-0004	ICD 16-26	Approved	TBD	Not begun	Safety tank
16	YES	Client	TBD	26DRFB-TA-0002	ICD 16-26	Approved	TBD	Not begun	Normal tank
17	YES	Client	11-B2M Lower Pipe Chase Level B2M	26DRFB-TA-0003	ICD 17-26	Approved	TBD	Not begun	Safety tank
17	YES	Client	11-B2M Lower Pipe Chase Level B2M	26DRFB-TA-0002	ICD 17-26	Approved	TBD	Not begun	Normal tank
24VP	YES	Client	TBD	26DRFB-TA-0004	ICD 24VP-26	Approved	TBD	Not begun	Safety tank
26PH	YES	Client	11-L4 Crane Hall and TCWS Vault L4	26DRFB-TA-0001	N/A	Approved	TBD	Not begun	Normal tank
26PH	YES	Client	11-L4 Crane Hall and TCWS Vault L4	26DRFB-TA-0002	N/A	Approved	TBD	Not begun	Normal tank
26PH	YES	Client	11-L4 Crane Hall and TCWS Vault L4	26DRNB-TA-0001	N/A	Approved	TBD	Not begun	Normal tank
26CV	YES	Client	TBD	26DRFB-TA-0001	N/A	Approved	TBD	Not begun	Normal tank
26CV	YES	Client	TBD	26DRFB-TA-0002	N/A	Approved	TBD	Not begun	Normal tank

PBS system number	Drain interface (Yes/No)	Interface type	Interface location	Interface TCWS equipment ID	ICD document	ICD status	IS document	IS status	Notes
26CV	YES	Client	TBD	26DRNB-TA-0001	N/A	Approved	TBD	Not begun	Normal tank
26DY	YES	Client	Annex Vault	26DRFB-TA-0001	N/A	Approved	TBD	Not begun	Normal tank
26DY	YES	Client	Annex Vault	26DRFB-TA-0002	N/A	Approved	TBD	Not begun	Normal tank
26DY	YES	Client	Annex Vault	26DRNB-TA-0001	N/A	Approved	TBD	Not begun	Normal tank
31	YES	Server	Annex Vault	26DRFB-TA-0001	ICD 26-31	Approved	TBD	Not begun	Safety tank
32	YES	Server	Annex Vault	26DRFB-TA-0003	ICD 26-32	Approved	TBD	Not begun	Safety tank
32	YES	Server	Annex Vault	26DRFB-TA-0004	ICD 26-32	Approved	TBD	Not begun	Safety tank
32	YES	Server	Annex Vault	26DRFB-TA-0001	ICD 26-32	Approved	TBD	Not begun	Normal tank
32	YES	Server	Annex Vault	26DRFB-TA-0002	ICD 26-32	Approved	TBD	Not begun	Normal tank
32	YES	Server	Annex Vault	26DRNB-TA-0001	ICD 26-32	Approved	TBD	Not begun	Normal tank
43	YES	Server	11-B2 Basement Level B2	Multiple pumps/ motors	ICD 26-43	Approved	TBD	Not begun	TBD
53	YES	Client	TBD	26DRFB-TA-0001	ICD 53-26	Approved	TBD	Not begun	Normal tank
53	YES	Client	TBD	26DRFB-TA-0002	ICD 53-26	Approved	IS 26-53-001	Approved	Normal tank
53	YES	Client	TBD	26DRNB-TA-0001	ICD 53-26	Approved	IS 26-53-003	Approved	Normal tank
65-CA	YES	Server	Annex Vault	26DRFB-TA-0003	ICD 26-65CA	Approved	IS-65.CA-26. TC-001;-007	Signed	Safety tank
65-CA	YES	Server	Annex Vault	26DRFB-TA-0004	ICD 26-65CA	Approved	IS-65.CA-26. TC-001;-007	Signed	Safety tank
65-CA	YES	Server	Annex Vault	26DRFB-TA-0001	ICD 26-65CA	Approved	IS-65.CA-26. TC-001;-007	Signed	Normal tank
65-CA	YES	Server	Annex Vault	26DRFB-TA-0002	ICD 26-65CA	Approved	IS-65.CA-26. TC-001;-007	Signed	Normal tank
65-CA	YES	Server	Annex Vault	26DRNB-TA-0001	ICD 26-65CA	Approved	IS-65.CA-26. TC-001;-007	Signed	Normal tank
65-DW	YES	Server	Annex Vault	26DRFB-TA-0003	ICD 26-65DW	Approved	IS-65.DW-26. TC-001;-002	Signed	Safety tank

PBS system number	Drain interface (Yes/No)	Interface type	Interface location	Interface TCWS equipment ID	ICD document	ICD status	IS document	IS status	Notes
65-DW	YES	Server	Annex Vault	26DRFB-TA-0004	ICD 26-65DW	Approved	IS-65.DW-26. TC-001;-002	Signed	Safety tank
65-DW	YES	Server	Annex Vault	26DRFB-TA-0001	ICD 26-65DW	Approved	IS-65.DW-26. TC-001;-002	Signed	Normal tank
65-DW	YES	Server	Annex Vault	26DRFB-TA-0002	ICD 26-65DW	Approved	IS-65.DW-26. TC-001;-002	Signed	Normal tank
65-DW	YES	Server	Annex Vault	26DRNB-TA-0001	ICD 26-65DW	Approved	IS-65.DW-26. TC-001;-002	Signed	Normal tank
65-NG	YES	Server	Annex Vault	26DRFB-TA-0003	ICD 26-65NG	Approved	IS-65.NG-26. TC-001;-002	Signed	Safety tank
65-NG	YES	Server	Annex Vault	26DRFB-TA-0004	ICD 26-65NG	Approved	IS-65.NG-26. TC-001;-002	Signed	Safety tank
65-NG	YES	Server	Annex Vault	26DRFB-TA-0001	ICD 26-65NG	Approved	IS-65.NG-26. TC-001;-002	Signed	Normal tank
65-NG	YES	Server	Annex Vault	26DRFB-TA-0002	ICD 26-65NG	Approved	IS-65.NG-26. TC-001;-002	Signed	Normal tank
65-NG	YES	Server	Annex Vault	26DRNB-TA-0001	ICD 26-65NG	Approved	IS-65.NG-26. TC-001;-002	Signed	Normal tank
66	YES	Server	Annex Vault	26DRFB-TA-0003	ICD 26-66	Approved	TBD	Not begun	Safety tank
66	YES	Server	Annex Vault	26DRFB-TA-0004	ICD 26-66	Approved	TBD	Not begun	Safety tank

3.6 DRAIN TANK FLOODING CONDITIONS

Safety requirements for the DT area indicate that the tanks need to be enclosed in an area that allows flooding from the tanks including a 50% loss of the total capacity of the tanks.[15] Based on this information, the height of water under flooding conditions should be calculated by AREVA, and the refilling pumps and the sump tank pump should be located at a height above this level. Figure 30 indicates the use of space in the tank area, including the volume that can be used at the mezzanine.

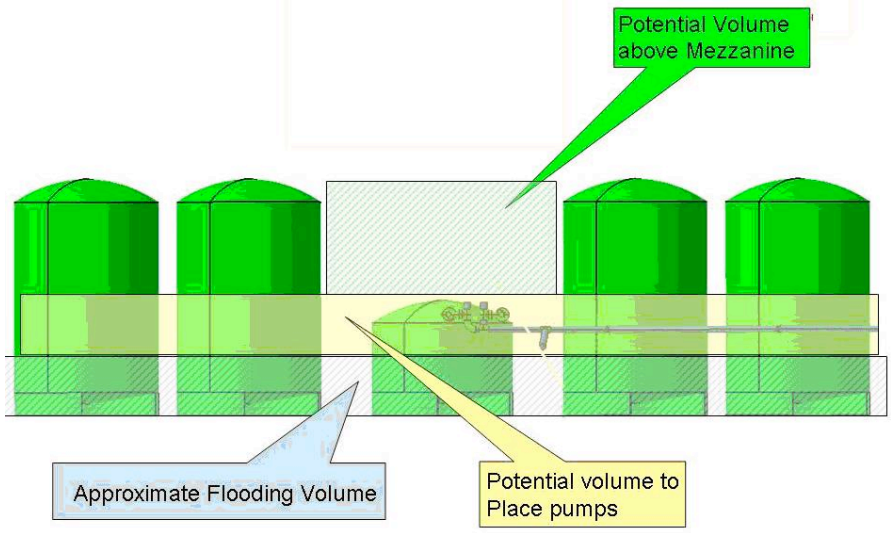


Fig. 30. Drain tank flooding conditions.

3.7 CLEANING PROVISIONS

The safety DTs can receive radioactively contaminated water from the VV chamber. Once this liquid waste is sent to the Radwaste Building (PBS 66), the empty tanks need to be washed with appropriate liquid, and this liquid waste must also be sent to the Radwaste Building. The DTs shall include features that will facilitate cleaning to allow the restart of the plant within 1 year of any such occurrence (Appendix A). Tanks should be designed to allow complete emptying without any accumulation of dust. If necessary, facility should be provided which allows the water content to be agitated in order to keep any solids suspended during discharging of the tank hold up water.[13]

3.8 DRAIN TANK CLASSIFICATION

In accordance with the French order dated December 12, 2005, concerning nuclear pressure equipment (ESPN or Nuclear Pressure Equipment Order 2005), the operator of a basic nuclear facility must compile a list of nuclear pressure equipment used in the facility.

This list and related justifications have been made available to the French nuclear regulatory body {currently L'Autorité de sûreté nucléaire (ASN)] for Preliminary Safety Report submission.[16]

Some current design changes indicate that both BLK and DIV will use copper; consequently, there is no need to have exclusive tanks to receive the respective waters. The tanks can be interconnected to receive water from both systems.

Clarification of the VV operations indicates that the VV will need to be drained only three times over the lifetime of the system. The first time corresponds to the initial joint field testing when the spent water can be directly disposed into the sewage after the testing is done. The second time is before the reactor enters the radioactive phase of operations when the field joints need to be tested again, and this water can also be disposed to the sewage system. The third time is after the lifetime of the reactor has ended, and this wastewater is radioactive and thus needs to be disposed into the radioactive wastewater system. The conclusion of this clarification indicates that the VV DTs are not needed for normal VV operations. If a LOCA scenario occurs, then no matter the origin of the water, it will constitute wastewater that can be collected in any of the safety tanks not requiring segregation. This is a good opportunity to homogenize the tank design and decrease the number of tanks.

The four original sump tanks (from version 2004) have been reduced to one sump tank that can collect liquid from normal operations of the DIV and FW/BLK.

As of date of Rev. 2 of this report, water volume calculations are different (231 m^3 rather than 270 m^3).

3.8.1 Normal Drain Tanks (Two Tanks)

3.8.1.1 Design Parameters

Size: diameter 6.25 m by 10.25 m
Volume: 270 m^3
Design pressure: 10 bars
Design temperature: <100°C
Coolant radioactivity concentration: 9.45 GBq/m^3 (FW/BLK loop, without N16&N17 contribution; refer to ITER_D_26GLXV v2.4)

3.8.1.2 ESPN and ESP Classification

The total radioactivity of the normal DTs will be 2,281.5 GBq (9.45 × 270 m^3 = 2,281.5). This value is above 370 GBq. That means the tank will fall into the N2 category as defined in ESPN.

For the Pressure Hazard classification, the normal DTs are classified as Category I. Figure 31 shows details.

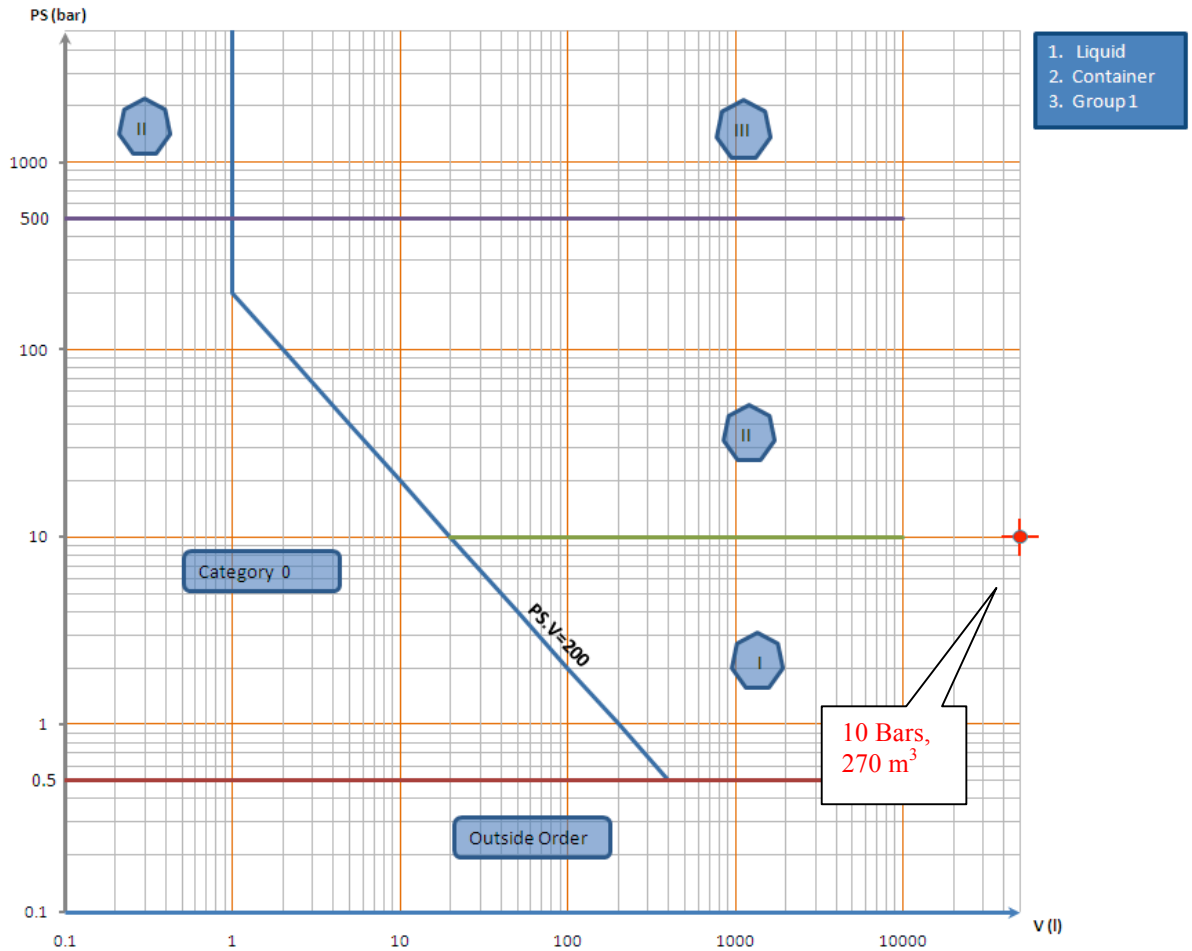


Fig. 31. Classification for normal drain tanks.

To conclude, the normal DTs are classified as Nuclear Level N2, Pressure Category I.

3.8.2 Safety Drain Tanks (Two Tanks)

3.8.2.1 Design Parameters

Size: Diameter 6.25 m by 10.25 m (TBD)
Volume: 270 m^3
Design pressure: 10 bars
Design temperature: <100°C
Coolant radioactivity concentration: >9.45 GBq/m^3

3.8.2.2 ESPN and ESP Classification

The total radioactivity of the safety DTs will be more than 2,112.5 GBq (9.45 × 270 m^3 = 2,281.5). This value is above 370 GBq. That means the tank will fall into the N2 category as defined in ESPN.

For the Pressure Hazard classification, the safety DTs are classified as Category I. Figure 32 shows details.

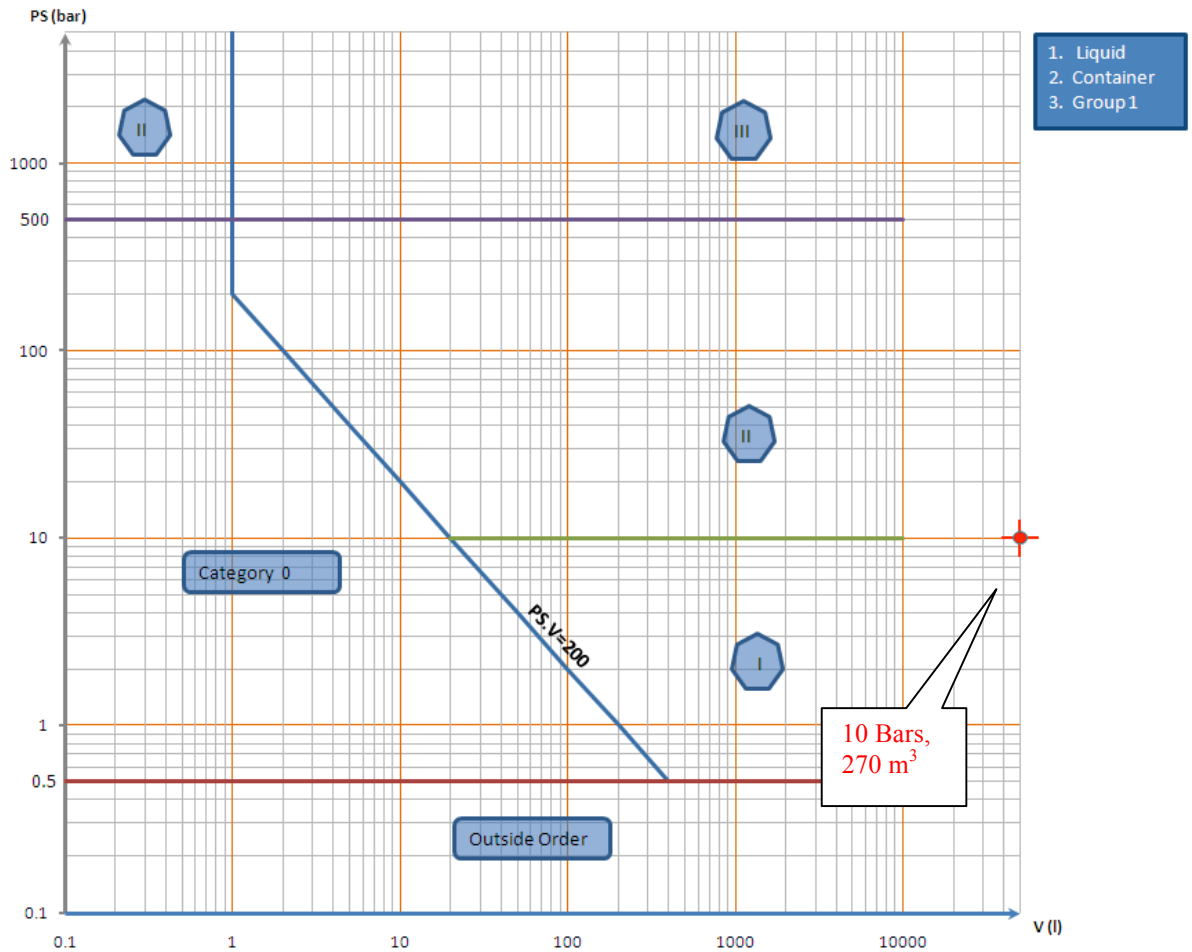


Fig. 32. Classification for the safety drain tanks.

To conclude, the safety DTs are classified as Nuclear Level N2, Pressure Category I.

3.8.3 Neutral Beam Injector Drain Tanks (One Tank)

3.8.3.1 Design Parameters

Size: Diameter 6.1 m by 5 m (TBD)
Volume: 120 m^3
Design pressure: 10 bars
Design temperature: <100°C
Coolant radioactivity concentration: 1.86 GBq/m^3 (NBI loop, without N16&N17 contribution; refer to ITER_D_26GLXV v2.4)

3.8.2.2 ESPN and ESP Classification

The total radioactivity of the NBI DT will be 223.2 GBq (1.86 × 120 m^3 = 223.2). This value is between 370 MBq and 370 GBq. That means the tank will fall into the N3 category as defined in ESPN.

For the Pressure Hazard classification, the NBI DT is classified as Category 0. Figure 33 shows details.

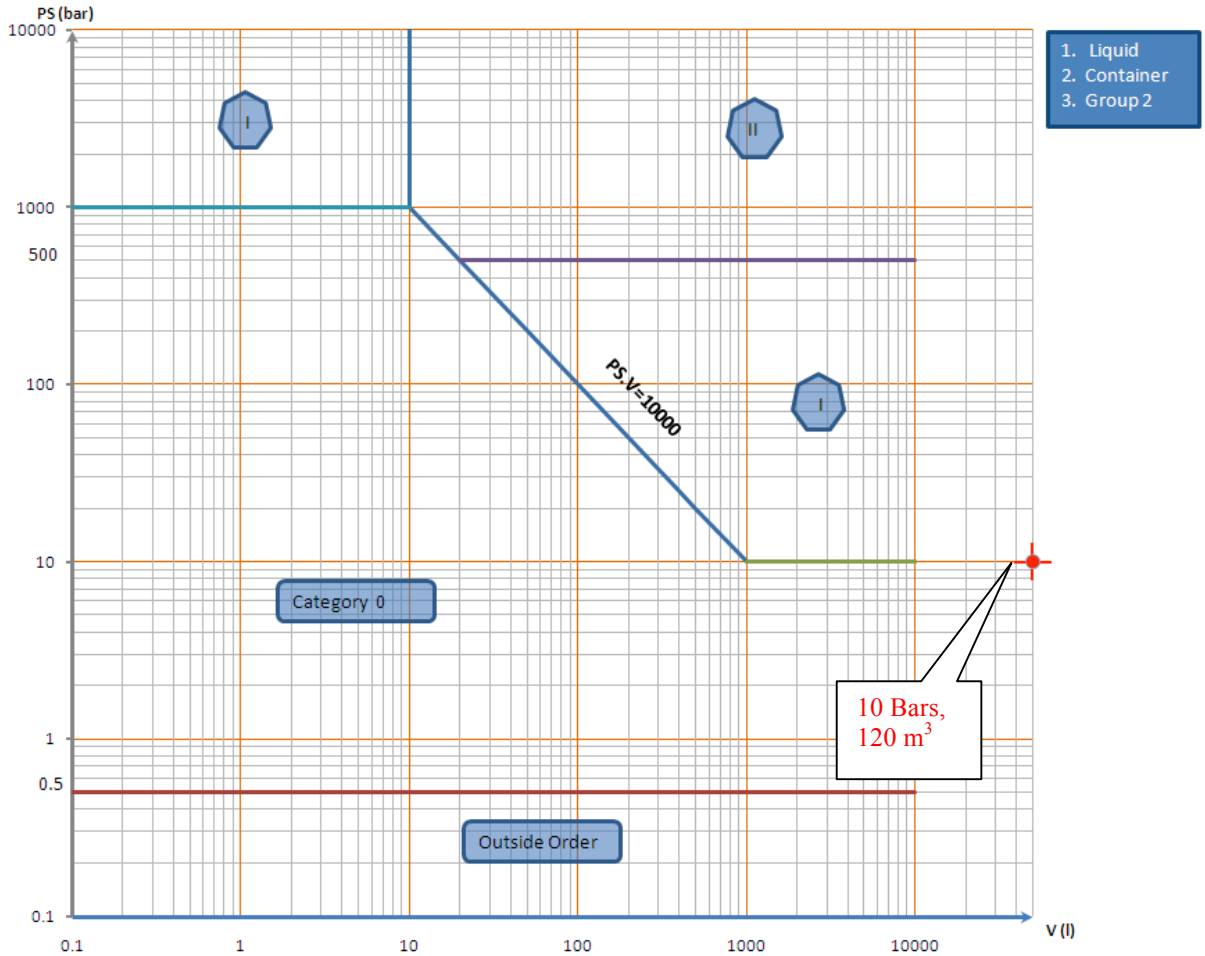


Fig. 33. Classification for the NBI drain tank.

To conclude, the NBI DT is classified as Nuclear Level N3, Pressure Category 0.

3.8.4 Sump Tank (One Tank)

The total radioactivity of the sump DT will be 37.8 GBq (9.45 × 4 m^3 = 37.8). This value is between 370 MBq and 370 GBq. That means the tank will fall into the N3 category as defined in ESPN.

For the Pressure Hazard classification, the sump DT is classified as Category 0. Figure 34 shows details.

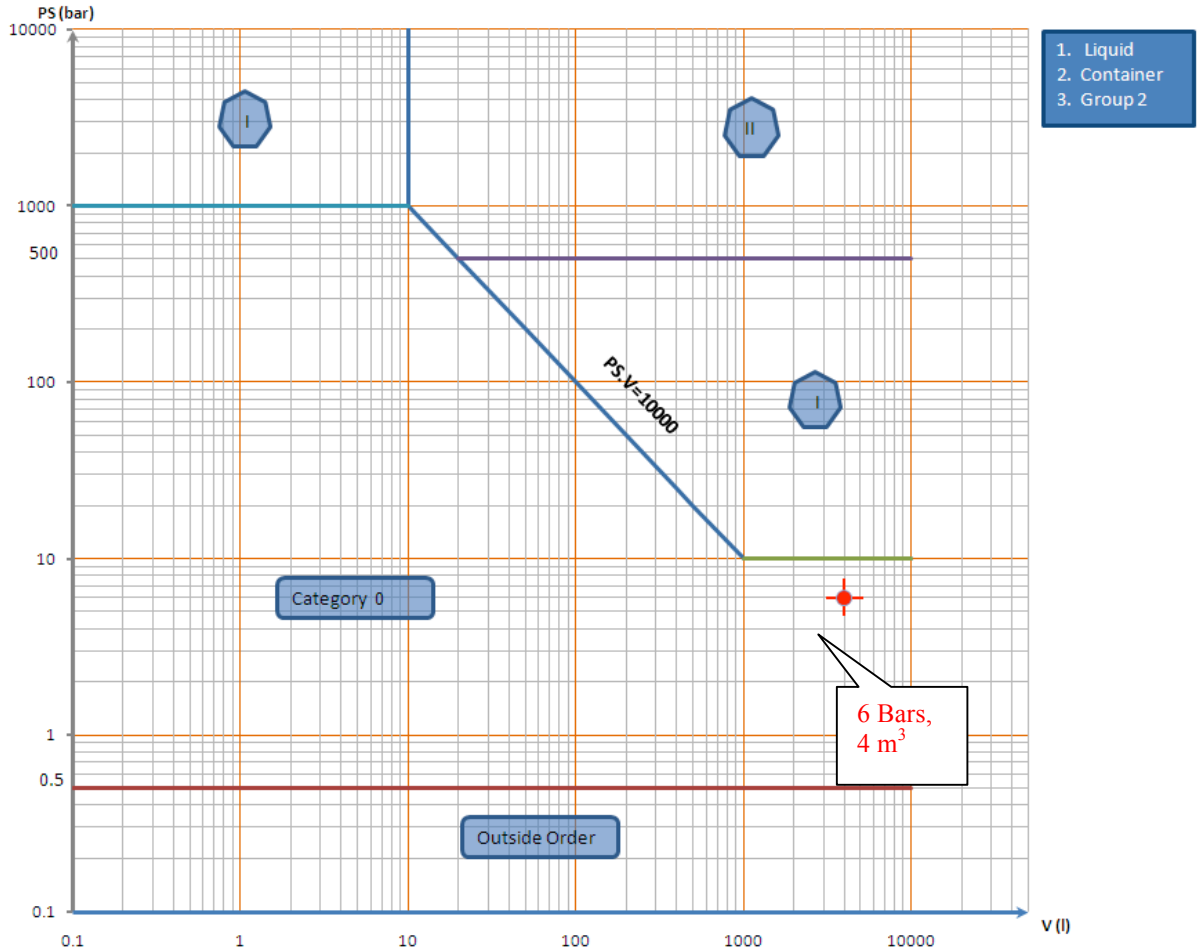


Fig. 34. Classification of the sump tank.

To conclude, the sump DT is classified as Nuclear Level N3, Pressure Category 0. Table 5 summarizes the classification of all tanks.

Table 5. Tokamak Cooling Water System—Draining and Refilling System

PBS	Equipment and description	Fluid	ESPN Nuclear Level	ESPN Pressure Category	Comments
26	**DT** Vertical	Pressurized water, ESP: liquid, Group 2	N2	I	2 tanks
26	**Safety DT** Vertical	Pressurized water, ESP: liquid, Group 2	N2	I	2 tanks
26	**NBI DT** Vertical	Pressurized water, ESP: liquid, Group 2	N3	0	1 tank
26	**Sump Tank** Vertical	Pressurized water, ESP: liquid, Group 2	N3	0	1 tank

3.8.5 Rational for the Classification of the Fluid

The rationale for the classification of the fluids comes from a communication between Thierry Jourdan, QA Engineer Tritium, IO Quality Assurance Division, and Vladimir Barabash, Senior Technical Officer, IO System Analysis and Standard Section.[14] The email confirms that according to French Decree 99-1046 and an ESPN order dated December 12, 2005, the fluids which must be classified as dangerous fluids (group 1) are

- explosive
- highly inflammable
- easily inflammable
- inflammable (when the maximum acceptable temperature is greater than the flash point)
- very toxic
- toxic
- combustive

The other fluids must be classified as group 2 fluids (nondangerous).

Therefore, water with radioactivity is considered a group 2 fluid, (nondangerous), whatever the level of radioactivity.

Nevertheless, if a piece of equipment which contains water with radioactivity is N2, the fluid is group 2, but for the classification of this equipment, the charts for dangerous fluid (group 1) shall be used [*articles 4 a) and b) of the ESPN order and Chapter 2.3, Table A of ASN guide 8, version 1, of March 31, 2009*].

Even though there are no official references, Table A of Chapter 2.3 of ASN guide 8 (version 1 of March 31, 2009) shows for level N3 several tables apply that are related to fluid group 1 and 2. If a fluid group 2 which contains radioactivity should be considered as fluid group 1, this table would not be necessary.

3.9 DRAIN TANK REQUIREMENTS FROM SYSTEM REQUIREMENTS DOCUMENT 26

DTs are instrumented to deliver tank level information and activate a high level alarm, both locally and in the control room.

The SRD does not contain any specific requirements about normal operation DTs. The requirements for safety DTs were described in Sect. 3.4.

3.10 CHEMICAL COMPOSITION OF DRAIN WATER

3.10.1 Normal Operations

Water drained into the DTs will have radioactive components. Table 6 gives the current reference radioactivity concentration values for the ITER components and cooling loops.[17]

Table 6. Coolant activation concentration for various ITER components and cooling systems

Source of radioactivity	VV	FW/BLK	DIV	NB
		GBq/m^3		
Tritium (T)—diffusion from plasma chamber	36	1,800	1,800	1,800
T—from borated steel (= to content)	40	–	–	
^{14}C (= content)	1.0E–02	1.0	1.0	1.0E–02
Activated corrosion products (ACP) solute + cruds	6.65E–2	6.65	4.84	4.84E–2
Activity of coolant due to ^{16}N isotopes[a]	5.62E+3	3.0E+6	1.85E+6	4.0E+3
Activity of coolant due to ^{17}N isotopes[b]	1.69	1.7E+3	0.66E+3	4.0
Total fluid radioactivity concentration:				
T/1000 + ^{14}C + ACP + ^{17}N + (^{16}N)/1000[b]	**7.46E+0**	**4.71E+03**	**2.52E+03**	**9.86E+0**

[a]This concentration is the maximum value of the fluid in the corresponding component.
[b]It is assumed that the coefficient of 1/1,000 is applied for activity of ^{16}N. Activity of ^{17}N isotope is included without reduction coefficient.

3.10.2 Safety Drain Operations

The functional requirements of the safety DTs are shown in Appendix A. The requirement of the activity of water collected in the tank is as follows: water collected in the safety DTs from TCWS could have maximum fluid radioactivity concentration of 6.65 GBq/m^3 due to activated corrosion products (ACP) and 1.8E+03 GBq/m^3 due to tritium. During a LOCA event, 330m^3 of water, which will contain heavily activated dusts and tritium codeposited in the dust, is expected to be collected in the tanks.

The dust transferred during a LOCA event in the expected 330m^3 water collected in the tanks will have beryllium, tungsten, and tritium codeposited in the dust. The total inventory of in-vessel heavily activated dusts is not expected to exceed 1,000 kg. The total mobilized tritium inventory in VV is 1,000 g. About 221 kg of dust, 28 kg of ACP, and 20 g of tritium will be transported in the safety DTs in case of a LOCA.

3.11 DESIGN CODE AND MATERIALS OF CONSTRUCTION

The DTs are assumed to be manufactured in stainless steel 304L. The DTs, which are considered pressure equipment for the TCWS, shall be designed and constructed in accordance with the codes and standards as established in the *Codes and Standards for ITER Mechanical Components*.[18]

Stainless steel 316 can also be used to construct the DTs. However, the use of this material can only be recommended where there is a clear cost advantage due to the market price of the metal.

3.12 SEISMIC ANALYSIS

IO has performed seismic analysis of the B2 level where the DTs will be located.[19] It is important that AREVA analyzes this report and is familiar with its contents. It is already uploaded in the "Information Only" area of the US ITER SharePoint, but an extract of its salient points follows.

3.12.1 The Level B2 Spectrum Locations

The Level B2 spectrum locations are shown in Fig. 35.

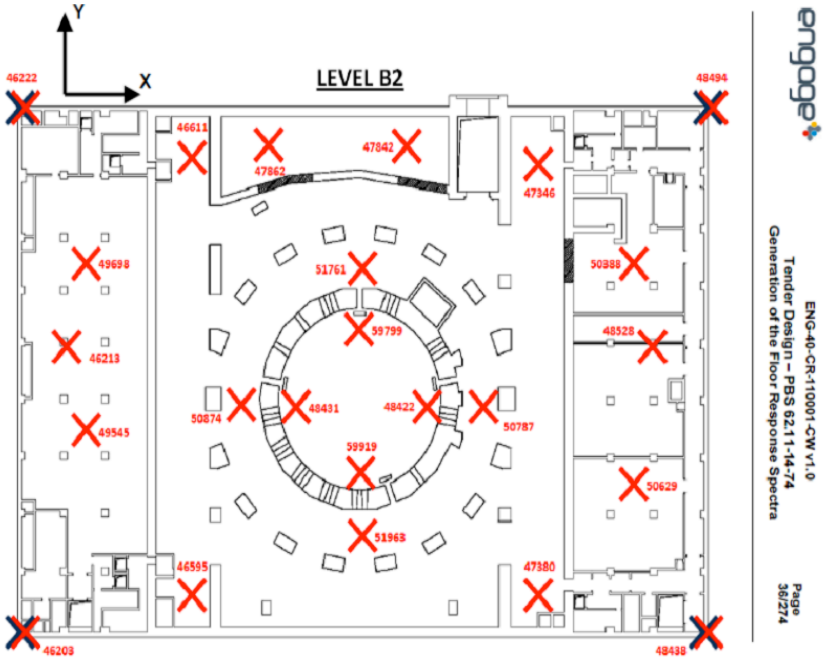


Fig. 35. Level B2 spectrum locations.

The relevant spectra for the seismic analysis of the DTs correspond to locations 47862, 47842, 46222, 48494, 46203, and 48438. From the locations on the two adjacent corners of the DT area on the B2 level we have the X and Y (Figs. 36–39) from where the seismic analysis for the DTs should select the highest value from the two X and Y direction spectra. Spectra for locations 47862 and 47842 within the DT area have the floor response for direction Z (Figs. 40 and 41). There is no response in the X and Y directions because it is assumed to be an isolated pad.

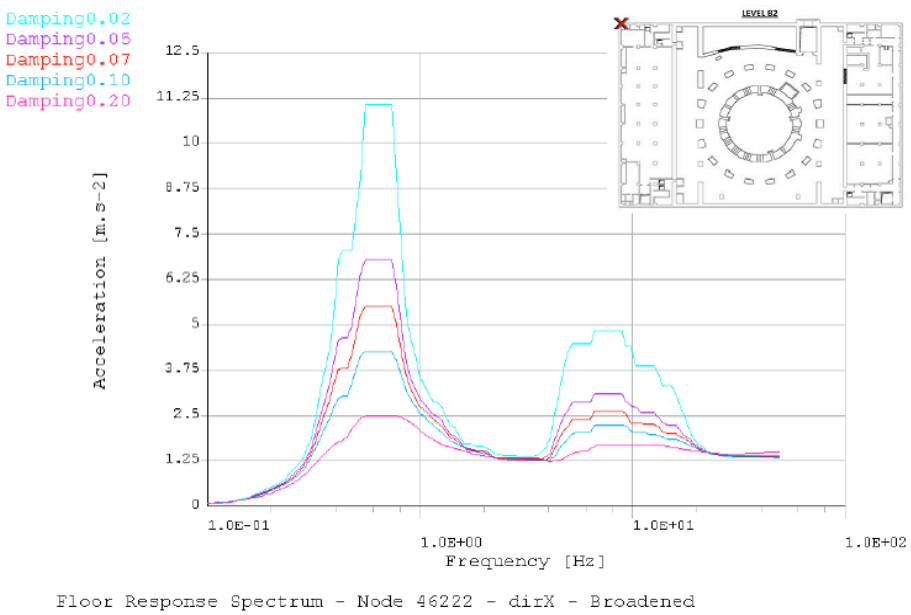


Fig. 36. Floor response spectra (Node 46222), direction X broadened.

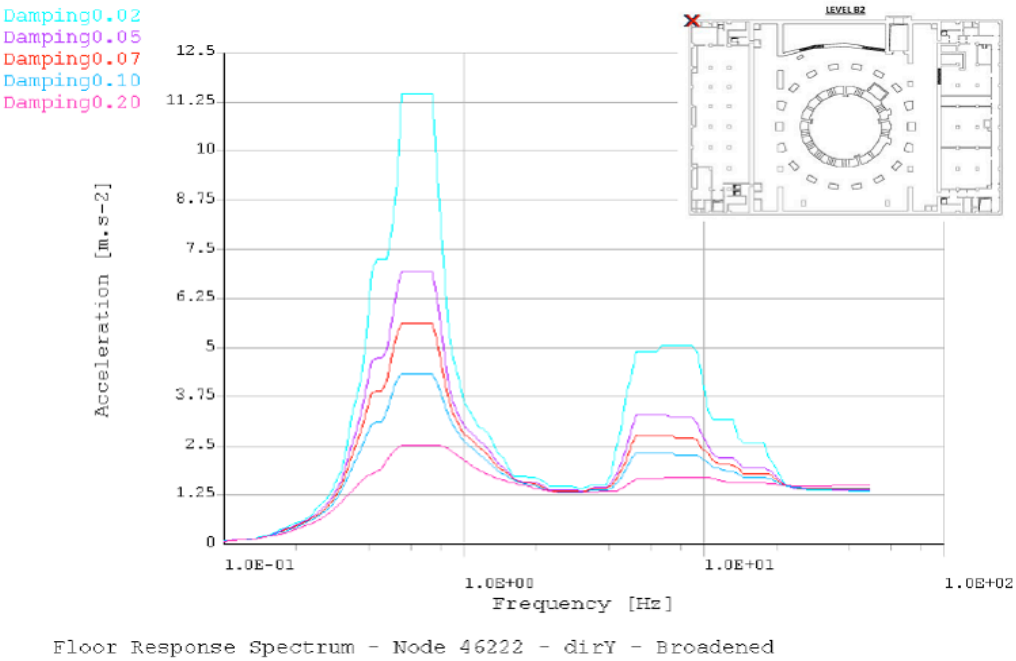


Fig. 37. Floor response spectra (Node 46222), direction Y broadened.

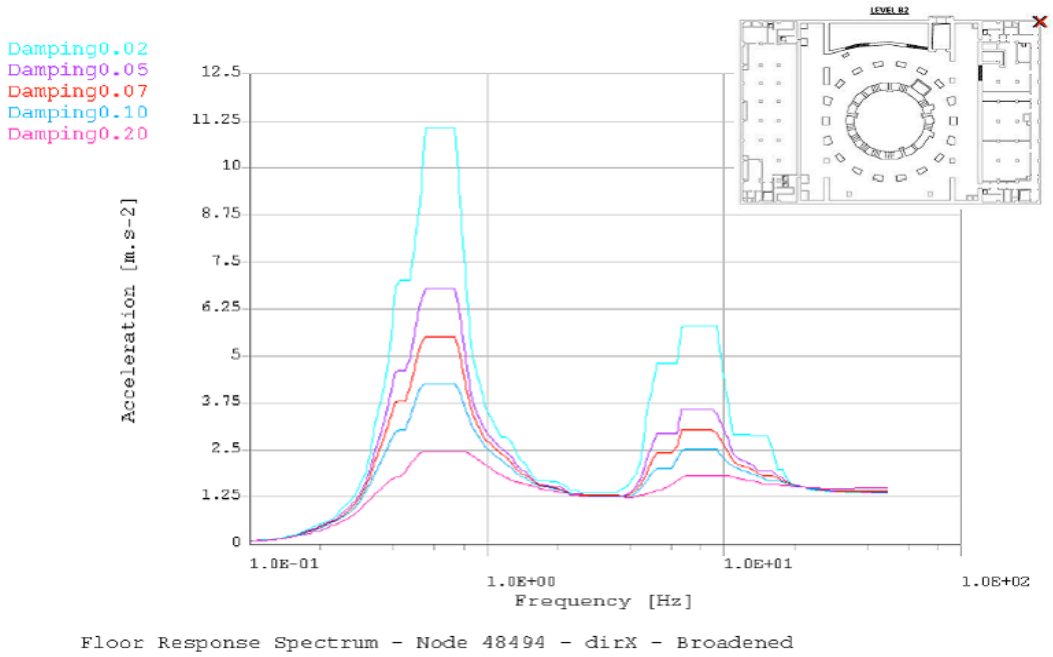


Fig. 38. Floor response spectra (Node 48494), direction X broadened.

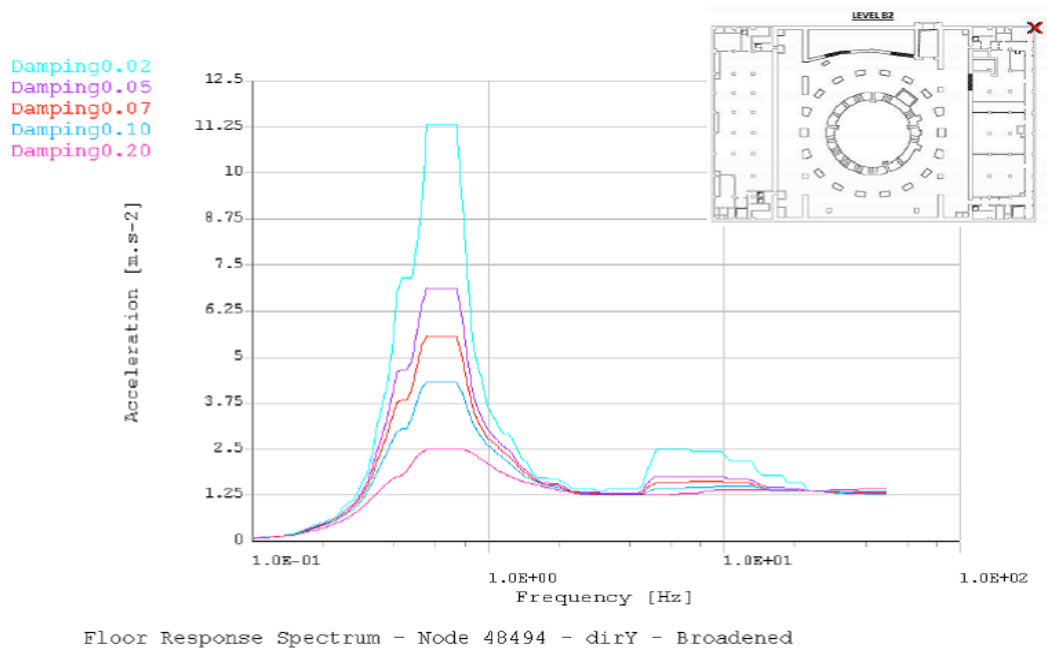


Fig. 39. Floor response spectra (Node 48494), direction Y broadened.

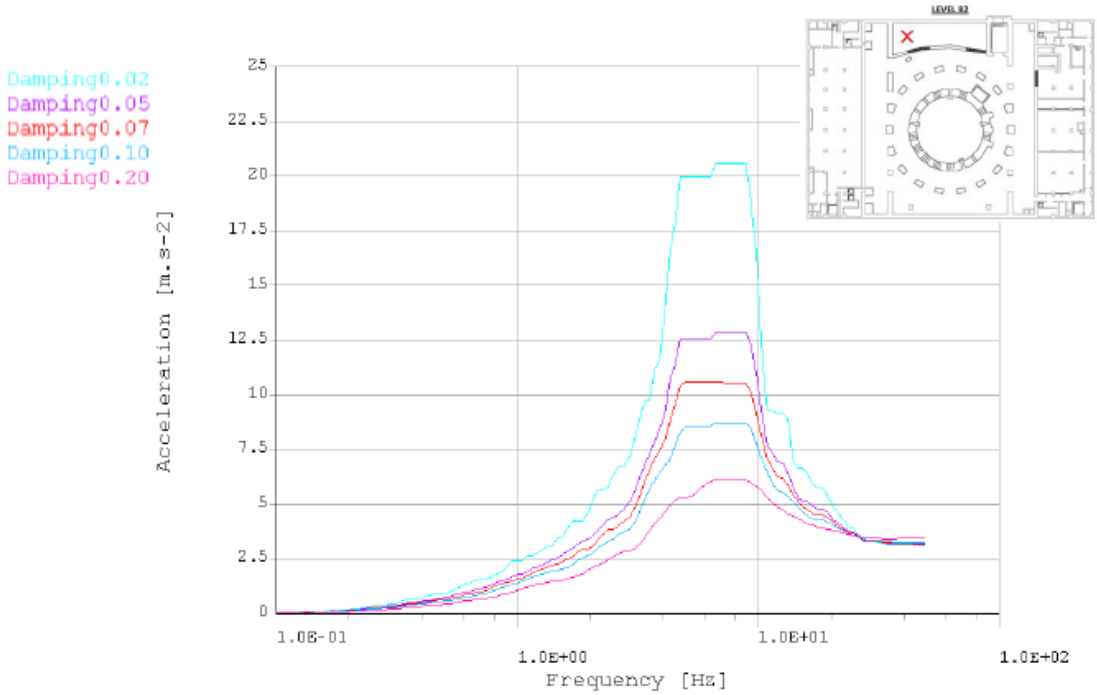


Fig. 40. Floor response spectra (Node 47862), direction Z broadened.

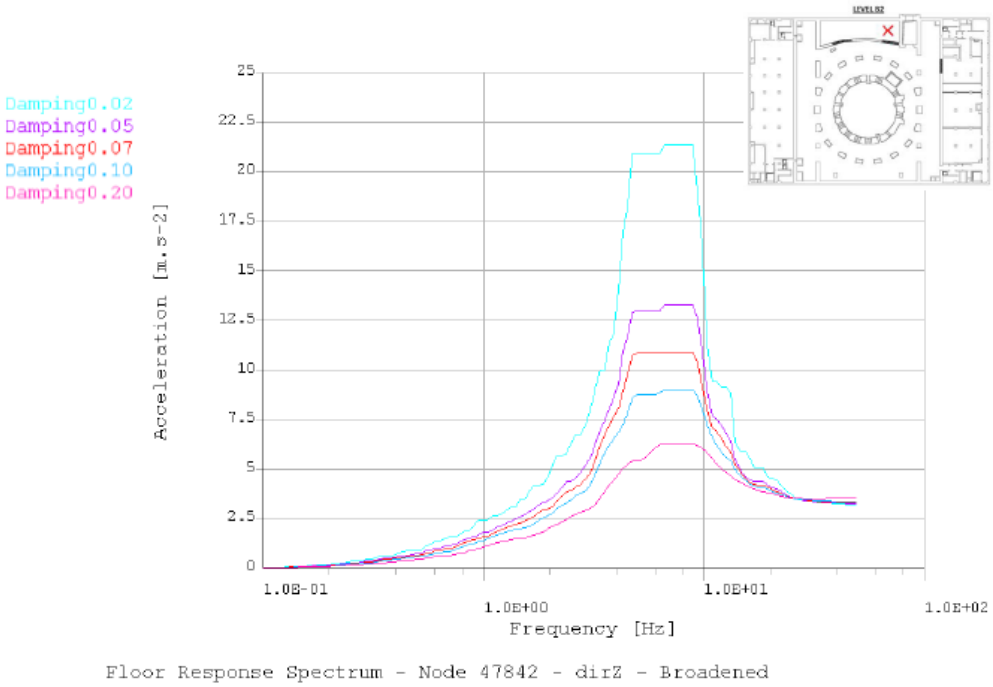


Fig. 41. Floor response spectra (Node 47842), direction Z broadened.

3.12.2 Seismic Design and Classification

The seismic design of equipment is based on functional safety requirements in the event of an earthquake for operational or maintenance states, conditions following an accident, or other abnormal facility states.[20] These requirements concern the following points:

- maximum displacement (e.g., interaction between VV and toroidal field coils)
- integrity of geometric characteristics and degree of permanent deformation
- leakage
- operating capability of mechanical or electrical equipment (valves, pumps, circuits, etc.) of systems to perform a safety function
- adequacy of shielding

Components and structures are classified to facilitate the design process. The seismic classification principle is based on the safety objective and functional requirements in the event of an earthquake. The seismic classes defined are as follows.

- SC1 (SF)—Seismic class one-SF: Structural stability and required functional seismic safety performance maintained in the event of an earthquake. The respect of this level of requirement guarantees the level of safety as throughout the normal operation of the equipment. Nevertheless, taking into account seismic load characteristics, fatigue is not taken into account.
- SC1 (S)—Seismic class one-S: Structural stability maintained in the event of an earthquake (i.e., no rupture of piping, no collapse of structures or equipment, limited plastic strain, limited concrete cracking, structural support functions maintained). With this level of requirement, it is possible that a small level of deformation could occur. Consequently, it could be necessary to inspect equipment before reusing it.
- SC2—Seismic class two: Nondamage to safety important components (SIC); absence of damage to SIC for buildings and structures housing and protecting SIC or to buildings that can potentially damage such structures in the event of collapse; no other requirements regarding structural or functional performance in the event of an earthquake.
- NSC—Nonseismic category. No seismic requirements for safety.

A modified extract of the table with seismic classifications for the DT area is shown in Table 7. The DT area is being classified as SC1.

Table 7. Extract of Annex 1 in ITER_D_2DRVPEv.1.1 (modified)

PBS	System	Preliminary assessment of consequences	Subsystems/ components	SC1	SC2	NSC	Comments and additional indication about safety requirements during and following SSE earthquake
2.6	TCWS	• Piping remains intact • Plasma heat load terminated	VV PHTS	No leakage			Structural stability maintained with loads and displacements within limits to prevent damage or deformation of cooling passages that could lead to a flow blockage. Loads, strains, deformation below limits to ensure no rupture
		• Piping remains intact • Plasma/NB heat load terminated • Interruption of coolant circulation circuit may occur due to loss of off-site power	FW/BLKT PHTS DIV/LIM PHTS NB PHTS	No leakage			Loads, strains, deformation below limits to ensure no rupture
		• Coolant discharge into Relief Tank if any short-time pressure rise • Minor increase in leakage may occur (e.g., from fittings)—no TCWS vault pressure increase	Coolant discharge system into Relief Tank	Function			Loads, strains, deformation below limits to ensure no rupture. I&C for detection and operation functional
		• Piping remains intact • Minor increase in leakage may occur (e.g., from fittings)	• CVCS • Draining & Refilling System • Drying System	No leakage			Loads, strains, deformation below limits to ensure no rupture

PBS	System	Preliminary assessment of consequences	Subsystems/ components	SC1	SC2	NSC	Comments and additional indication about safety requirements during and following SSE earthquake
		• Failures may occur, but no flooding leading to damage to SIC	• Component cooling water • Chilled water system (non-SIC) • Heat rejection system			X	Assess consequential damage (pipe whip, flooding etc.) and design to prevent damage to SIC.

3.12.3 Seismic Loads

Seismic load excitation corresponds to the specific selected site (Cadarache) for the ITER construction. The ground acceleration can be both in the horizontal and in the vertical direction and typically has a special content, which leads to some level of support reaction of load amplification. The severity of seismic events is defined according to the service level (SL-1 and SL-2). For the components, which are classified in seismic class 1 and 2 (SC-1, SC-2), two levels (SL-1 and SL-2) of ground motion are considered (from LS_222QGL, Sect. 5). These load conditions are combined with other load conditions.

A SL-2 (also called SSE – Safe Shutdown Earthquake) is a category IV event and corresponds to the seismic level required by French nuclear practice (RFS 2001/01). It shall be demonstrated that all safety functions are maintained during and after the event. For ITER site, the design earthquake is the Safe Shutdown Earthquake which is defined by two spectra by enveloping of SMS and PALEO spectra.

A SL-1 (also called OBE – Operating Basis Earthquake) is a category II event and corresponds to an event with a probability in the order of 10^{-2} per year and represents an investment protection earthquake level (following the Nuclear Pressure Equipment regulation it corresponds to a foreseeable event). The equipment and all components which belong to SIC have to be designed to restart and operate after an SL-1 event without special maintenance or test. SL-1 seismic level is defined as ¼ of SL-2. Unless a specific SL-1 analysis is performed, seismic response to an SL-1 event may be obtained by dividing the results from SL-2 by a factor 3. A factor 3 is used instead of 4 because the damping is lower for SL-1 events.

A seismic event is, in many cases, the most demanding loading condition, in particular for the supports and interface structures which must be sized for high strength and often also for high stiffness. ITER components are classified into seismic classes based on the safety importance and investment protection criteria.

Based on the related ITER documents, seismic qualification has to be done for TCWS equipment and piping design to ensure SIC functions during or after an earthquake. The collapse, falling, dislodgement or any other spatial response of a SIC or non-SIC component as a result of an earthquake shall not jeopardize the function of other SIC components providing a safety function. Damage to components that are non-SIC should not lead to failure of SIC components. Equipment and piping that are SIC and SR

should remain intact to keep its function during and after seismic events. Minor increase in leakage may occur from fittings, for example, but no TCWS vault pressure increase and no flooding occurs.

The combinations of loads from earthquake with other loading events are considered in the design of components and structures (ITER_D_3YGYH7) . The equipment seismically designed for a SL-2 earthquake could have to face foreshocks or aftershocks, which are about the level of a so-called SMHV (Séisme Maximum Historiquement Vraisemblable: Maximum conceivable historic earthquake), defined in the Fundamental Safety rule, "Basic safety rule RFS 2001-01: Determination of earthquake risk for surface nuclear facilities."

The seismic and concurrent loads applied by the pipe at equipment and component nozzles shall be qualified as part of the seismic design. The movements of nozzle caused by seismic events also need to be taken into account. For position retention, it is usually sufficient to show that the piping loads on equipment and components will not cause rupture. For leak tightness, the stress shall be maintained within yield or shown not to cause fatigue ruptures.

For operability, the piping loads shall be kept within operability limits established by detailed analysis, testing, or similarity to seismically qualified equipment or components. Components with unsupported extended structure, such as valves with heavy motor operators, shall be evaluated to insure that the extended structure does not fail during a seismic event. For components with unsupported extended structures like long stem valve for example, a natural frequency check shall be performed and shall be greater than 33 Hz. When the natural frequency is less than 33 Hz, the component extended structure shall be stiffened as recommended by the component manufacturer.

3.13 DRAIN TANK TEMPORARY STORAGE

The IO CCS Building Group has advised that to date it or Fusion for Energy (F4E), an IO architecture-engineering company, has not documented any special requirements for temporary storage on site. However, at this stage IO would suggest that any weathering or protection required to preserve the integrity of the tanks should be put in place by the U.S. Domestic Agency (DA). Stability issues with regard to wind loads while stored on site need to be considered. If necessary, recommendations made or temporary measures included by U.S. DA-US ITER should suggest the proper and unique protection methods required to preserve the integrity of the DTs, both during transportation and during possible temporary storage at the ITER site.[21]

Based on this information AREVA should consider suggesting appropriate protection for the tanks while being transported and stored on site when no special IO temporary storage measures are in place.

4. GENERAL COMMENTS

In the course of writing this report, several meetings and conference calls have occurred for clarifying the input information for the design basis of the DTs. Appendix C includes a table with questions asked by AREVA and answers given by US ITER. These answers reflect a compilation of responses from US ITER and IO.

IO has prepared the document *Functional Requirements for the Safety Drain Tanks* that has been fully approved by IO. This document answers many of the questions asked by AREVA with respect to the functional requirements of the safety DTs and has been included as Appendix A for AREVA's benefit. As this is an approved document, it also constitutes a design input document for the DT design.

5. REFERENCES

1. Final Report Phase 1, Washington Group; Final Report for Task 3 Cooling Water System Optimization Study, Tractebel.
2. "RELAP5 Model of the Vacuum Vessel Primary Heat Transfer System," J. Carbajo, G. Yoder, and S. Kim, US ITER 12103-TD0062-R00, May 2010.
3. "Modifications to the VV PHTS RELAP5 Model" (Draft), J. Carbajo, US ITER 12103-TD0004-R00, August 2010.
4. "Influence of the drain tank geometry and location on the water drainage in case of multiple FW/BLK in-vessel pipe break," Leonid Topilski, ITER-D_34T2C9 v 1.0, August 25, 2010.
5. Leonid Topilski, email to Giovanni Dell'Orco, 2009.
6. Trip report, 26 August–5 September 2009, Cadarache, France, Jan Berry, and Juan Ferrada.
7. Email from Giovanni Dell'Orco to Juliano Rigoni, January 4, 2010.
8. Compliance of some ASME Codes and Standards with French ESP and ESPN regulations for ITER project. ITER_D_3E5HKQ v1.0.
9. Preliminary Safety Report (RPrS) version 2.0, Mar 25, 2010. Volume 1: Description of Facility and its Environments, 3ZR2NC v1.0, Chapter 6.1 Systems of the Tokamak, Sect. 12.3.4: Filling and Drainage Systems.
10. Presentation from William Ring sent to Juan J. Ferrada on Feb 8, 2011. "Drain Tanks Installation through lift shaft by Mobile Crane from North side of Tokamak Building," ITER Organization. Draft issue for comments.
11. Email between Giovanni Dell'Orco, Bill Rain, and US ITER group, June 11 2011.
12. "System description of the draining drying and refilling systems for PHTS loops, Tractebel, TIERSDI-4NG-3400-03," 2001.
13. Preliminary input temperature of 50°C has been considered in the past, but it has to be <=100°C with operational margin to be determined during preliminary design by AREVA.
14. Email between Thierry Jourdan, QA Engineer Tritium, Quality Assurance Division, ITER Organization and Vladimir Barabash, Senior Technical Officer, System Analysis and Standard Section of ITER Organization, October 4, 2010.
15. ITER_D_24D8R5 v1.0 – Order –December 31, 1999, amended 01/2006 design of INB and hazard on environment EN.
16. List of ITER Nuclear Pressure Equipment, ITER_D_34MZKE, January 18, 2010.
17. Fluid Radioactivity Concentration for the ITER Tokamak Cooling Water System, ITER_D_26GLXV v2.4, January 4, 2010.
18. *Codes and Standards for ITER Mechanical Components* (ITER_D_ 25EW4K).
19. *Tender Design—TOKAMAK Complex, PBS 62.11, PBS 62.14 AND PBS 62.74, Generation of the Floor Response Spectra,* ENG-40-CR-110001-CW v 1.0, ITER Organization, ENGAGE, 9/10/2010.
20. ITER Seismic Nuclear Safety Approach, ITER_D_2DRVPEv.1.1, September 18, 2008.
21. Email from William Ring (from IO CCS Building) to Jan Berry, September 30, 2010, eDOCS 6022.
22. Email between Giovanni Dell'Orco and Leonid Topilski from the Safety Group, May 20, 2011.

APPENDIX A.
FUNCTIONAL REQUIREMENTS FOR THE SAFETY DRAIN TANKS

APPENDIX A. FUNCTIONAL REQUIREMENTS FOR THE SAFETY DRAIN TANKS

Abstract

This document specifies the functional requirements of the Safety Drain Tanks of the ITER Tokamak Cooling Water System.

	External Number: ITER_D_3YG3ZL	Date: 3rd November 2010
	Name	**Affiliation**
Author	G. Babulal	CEP-PED-CWS
Reviewers	G. Dell'Orco	CEP-PED-CWS
	W. Curd	CEP-PED-CWS
	P. Cortes	CIE-NSE-SAA
	J.Elbez-Uzan	CIE-NSE-SDI
	N. Taylor	CIE-NSE
	D. Stout	CEP-PED
Approver	Y. H. Kim	CEP

Revisions

Version number	Date	Chapter	Scope of the revision
v1.1	5-11-2010	7,8	The chapters "References" and "Abbreviations" were renumbered
v1.2	19-11-2010	3,4,5.5,5.16	Comments of the reviewers were incorporated.

Table of Contents

Abstract A-3
Revisions A-3
1. INTRODUCTION A-5
2. OBJECTIVE A-5
3. SCOPE A-5
4. ZONING CLASSIFICATION OF DRAIN TANK AREA A-6
5. FUNCTIONAL REQUIREMENTS OF SAFETY DRAIN TANKS A-6
6. INSTALLATION REQUIREMENTS A-8
7. REFERENCES A-8
8. ABBREVIATIONS A-9

1. INTRODUCTION

Draining and Refilling System (DRS) of Tokamak Cooling Water System (TCWS) has total five drain tanks to serve functions during normal operation and safety accidents. Out of these, three drain tanks are designated for normal operation and are used for the storage of coolant during maintenance and inspection, excess coolant from the PHTSs owing to water volume expansion during baking, and residual coolant from forced draining and drying.[4] Two drain tanks are designated as Safety Drain Tanks (SDT) for safety operation to store the inventory of water resulting from the design basis loss of coolant accident of the PHTS that results in a leak into the vacuum vessel (VV).[2,4,8] These tanks could also be used to drain water from VV PHTS based on operational requirements and the status of the tanks.[4]

During the preliminary design of the Drain tanks, US ITER has raised some queries with regard to the design requirements of safety drain tanks that are needed to answer the questions of Architect Engineers AREVA, who is engaged in the TCWS preliminary design. A meeting was held with US ITER, ITER Safety Section and Cooling Water Section to discuss these issues. Based on the decision taken during the meeting, this document is prepared to indicate the functional requirements for safety drain tanks in order to facilitate the design.

2. OBJECTIVE

The objective of this document is to provide relevant information to US ITER in order to facilitate their Architect Engineers to design the Safety Drain Tanks meeting all functional requirements. The design of the Safety Drain Tanks should meet the requirements indicated in this document in addition to the requirements specified in the relevant baseline documents like SRD, DDD, PR, etc.

3. SCOPE

The scope of the document is to specify the requirements of the Safety Drain Tanks that are to be considered during its design. The requirements that need to be defined are as follows:

- Identify the factors that impact the design of Safety Drain Tanks
- Quantity of dust transferred after LOCA inside VV to the Safety Drain tanks
- Quantity of activated corrosion products (ACP) and Tritium content of water collected inside the Safety Drain Tank.
- Impact of the contaminated water on the zoning, in particular radiological, ventilation and waste zoning of the area.
- Level of residual contamination of the Drain Tanks after cleaning
- Cleaning features that are to be incorporated in the Safety Drain Tanks for decontaminating the tanks after discharging the contaminated water collected during an in-vessel leak.
- Features in the tank for discharging the contaminated water.

4. ZONING CLASSIFICATION OF DRAIN TANK AREA

The safety drain tanks are located in the Tokamak Building room number 11-B2-01 and 11-B1-01. The RPrS provides the zoning classification of the drain tank room.

During operating mode (plasma phase), Tokamak building is classified as an orange zone (dose rate < 100 mSv/h) and access is not allowed.

During shutdown phase, the area is classified as Yellow zone (Dose equivalent rate < 2 mSv/h) and as a C2 zone with regard to the ventilation zoning (permanent contamination in the room < 1 DAC, < 80 DAC for accidents). The room is permanently served by HVAC systems and on a stand-by mode by detritiation systems.[7,11]

The waste zoning of this room is a nuclear waste zone and the beryllium zone corresponds to a non-beryllium zone.

During maintenance, physical measures (such as interlocks, wearing of protective clothing, etc.) and/or administrative measures (warning signs, sound messages, etc.) will be set up to restrict access to rooms that have a dose rate higher than the green zone limit or a atmospheric contamination greater than 1 DAC.

5. FUNCTIONAL REQUIREMENTS OF SAFETY DRAIN TANKS

5.1 **Purpose of Safety Drain Tanks:** To store the inventory of water ensuing from the design basis loss of coolant accident that results in a leak into the vacuum vessel (VV). The contaminated water collected in these tanks following an in-vessel water leak shall be sent to Radwaste facility for further processing and disposal.

These tanks could also be used to store water from VV PHTS based on operational requirements and the status of the tanks.[4]

5.2 **Number of Safety drain tanks:** Two.[4]

5.3 **Location:** B2 level of Tokamak building.[10]

5.4 **Net height available in the area for installing the tanks:** 10.6 m.[12]

5.5 **Minimum volume to be accommodated by the 2 tanks:** 330 m^3 (as per safety analysis by ITER Nuclear Safety Division) + 30% excess capacity to accommodate for uncertainties of the calculation and free space.[6] But to homogenize the size of these tanks with that of the normal drain tanks of FW/BLK and DIV PHTS (2 tanks, each of 270 m^3), the construction volume of safety drain tanks should be 540 m^3 (2 tanks, each of 270 m^3 volume).

5.6 **Classification under nuclear pressure equipment:** ESPN category N2.[9]

5.7 **Normal operating pressure**: 10 kPa (abs).[4]

5.8 **Maximum pressure inside the tank due to design basis accident:** 80 kPa (abs).[6]

5.9 **Design pressure taking account of worst operational scenarios:** 1 MPa.[9]

5.10 **Venting provision:** The tank should have provision at its top to give connection to Normal Vent Detritiation System (NVDS).

5.11 **Maximum operating temperature:** 94°C.[6]

5.12 **Activity of water collected in the tank:** Water collected in the SDTs from TCWS could have maximum fluid radioactivity concentration[13] of 6.65 GBq/m^3 due to ACP and 1.8E+03 GBq/m^3 due to Tritium. During LOCA event, 330 m^3 of water is expected to be collected in the tanks, which will contain heavily activated dusts and Tritium co-deposited in the dust.

5.13 **Quantity of dust transferred during LOCA:** During LOCA event, the expected 330 m^3 water collected in the tanks will have heavily activated dusts (such as Beryllium, Tungsten) and Tritium co-deposited in the dust. Total inventory of in-vessel heavily activated dusts is expected not to exceed 1000 kg.[11] The total mobilized tritium inventory in VV is 1000 grams.[2] About 221 kg of dust, 28 kg of ACP and 20g of tritium will be transported in the SDTs in case of a LOCA.[2, 6]

5.14 **Inlet and outlet connections:** The tank should have provision for inlet at suitable locations. Outlet nozzle should be at the bottom most elevation to facilitate complete emptying of the tank. The bottom of the tank should be shaped such that the entire water, dust and other particulates collected in the tank can be discharged fully and permit decontamination of the tank.

5.15 **Provision for sampling:** There should be provision for grab sampling of water collected in the tank without spillage in the area. The sampling line can be located at the discharge line of the tank.

5.16 **Provision for decontamination:** There should be suitable provision to decontaminate the tanks. Provision for decontamination such as built-in jet nozzles or any other suitable technique should be provided to enable removal of solids and residues from the tank wall surfaces by using high-pressure water jetting.[5] The surface finish of these tanks and the design of their internals should facilitate to minimize difficulty of decontamination.

During collection of grab samples, while discharging the contaminated water from the tank, at the time of doing maintenance on the equipment related to the drain tank and during decontamination operation, there could be chances of spread of contamination in the tank room. Adequate health physics procedures will be sufficient to deal with such cases.

The decontamination provision for the SDTs should be sufficient enough to meet zoning regulation of the area and complete emptying of the tank without leaving any solid or liquid contaminants that can violate limiting values of the zoning.

5.17 **Special features for discharging the water:** Tanks should be designed to allow complete emptying without any accumulation of dust. If necessary, facility should be provided which allows the water content to be agitated in order to keep any solids suspended during discharging of the tank hold up water.[5]

5.18 **Instrumentation:** Measuring and monitoring instrumentation for level, temperature, pressure and radiation field should be provided on the SDTs. Instrumentation sensors should be installed in such a way that there should not be any connection to the bottom of the tank and any equipment

positioned inside the tank should not cause dead zones or accumulation of deposits. Care should be taken that electrical cables are installed in sealed, corrosion resistant protection ducts that can be easily decontaminated.[5]

5.19 **Inspection:** There should be provision for internal and external inspection of the tanks. Provision for remote inspection and measurement of radiation fields should be considered. Manholes of suitable size should be provided at the lower and upper side of the tank with leak proof sealing.

5.20 **Impact of the contaminated water on the radiation zoning of the area:** Since the water collected in the safety drain tanks during LOCA event will have ACPs, tritium, heavily activated dusts and Tritium co-deposited in the dust, which will contribute to the increase in the radiation field of the area around the tanks and could exceed the zoning limits. Suitable temporary shielding provisions as per ALARA principle, if necessary, could be arranged before draining the contaminated water to SDTs. Complete discharging of the collected drains and decontamination can normalize breaches in the zoning limits.

6. INSTALLATION REQUIREMENTS

6.1 The design of the safety drain tank should consider the installation requirements. Tank design should consider the use of air pads and temporary brackets to attach air pads for the installation purpose.

6.2 There shall be sufficient space at the top of the tanks to provide vent connection.

6.3 There should be accessibility to the top of the tanks using in built ladder for carrying out inspection and maintenance activities.

7. REFERENCES

1. Accident Analysis Report (AAR) Volume I - Event Identification and Selection (ITER_D_2DPVGT v1.4)
2. Accident Analysis Report (AAR) Volume II - Reference Event Analysis (ITER_D_2DJFX3 v4.10)
3. ITER_D_2823A2 v2.1 - SRD-26-PH, -CV, -DR, -DY (TCWS) from DOORS
4. ITER Tokamak Cooling Water System (TCWS) Design Description Document (DDD)(ITER_D_2V3L3R v1.1)
5. IAEA Technical Reports Series No. 401
6. Influence of the drain tank geometry and location on the water drainage in case of multiple FW/BLK in-vessel pipe break (ITER_D_34T2C9 v1.0)
7. Rooms Hazards Environmental Conditions Excel Data (ITER_D_2W9MDE v1.0)
8. Project Requirements (PR)(ITER_D_27ZRW8 v4.6)
9. Modification of TCWS ESPN Classification (ITER_D_35TFL4 v1.0)
10. Tokamak Complex Radiological Zoning Mode 1 and Mode 2 - B2 and B2M (ITER_D_3QQSNU v1.0)
11. Tokamak Complex Radiological Zoning Mode 1 and Mode 2 - B1 (ITER_D_3QFG4D v1.0)
12. Tokamak Building - N-S Elevation Drawing (ITER_D_29NALR v1.1 - 621100-CCS-QXD-01)
13. Fluid Radioactivity Concentration for the ITER Tokamak Cooling Water System (ITER_D_26GLXV v2.4)
14. Email message from Thierry Jourdan to Glen Cowart (QA ITER IO), April 21, 2011

8. ABBREVIATIONS

ACPs	Activated Corrosion Products
ALARA	As Low As Reasonably Achievable
DAC	Derived Air Concentration
DDD	Design Description Document
DRS	Draining and Refilling System
ESPN	Equipements Sous Pression Nucleaires
LOCA	Loss of Cooling Accident
NVDS	Normal Vent Detritiation System
PR	Project Requirements Document
PHTS	TCWS Primary Heat Transfer Systems
SDT	Safety Drain Tank
SRD	System Requirements Document
TCWS	Tokamak Cooling Water System
VV	Vacuum Vessel

APPENDIX B.
INTERFACES WITH THE DRAIN TANKS

APPENDIX B. INTERFACES WITH THE DRAIN TANKS

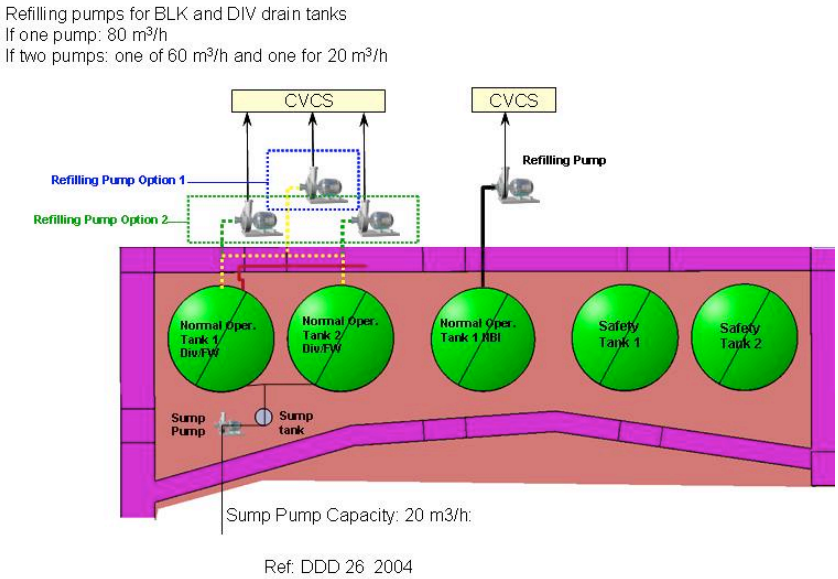


Fig. B.1. Refilling pump interfaces.

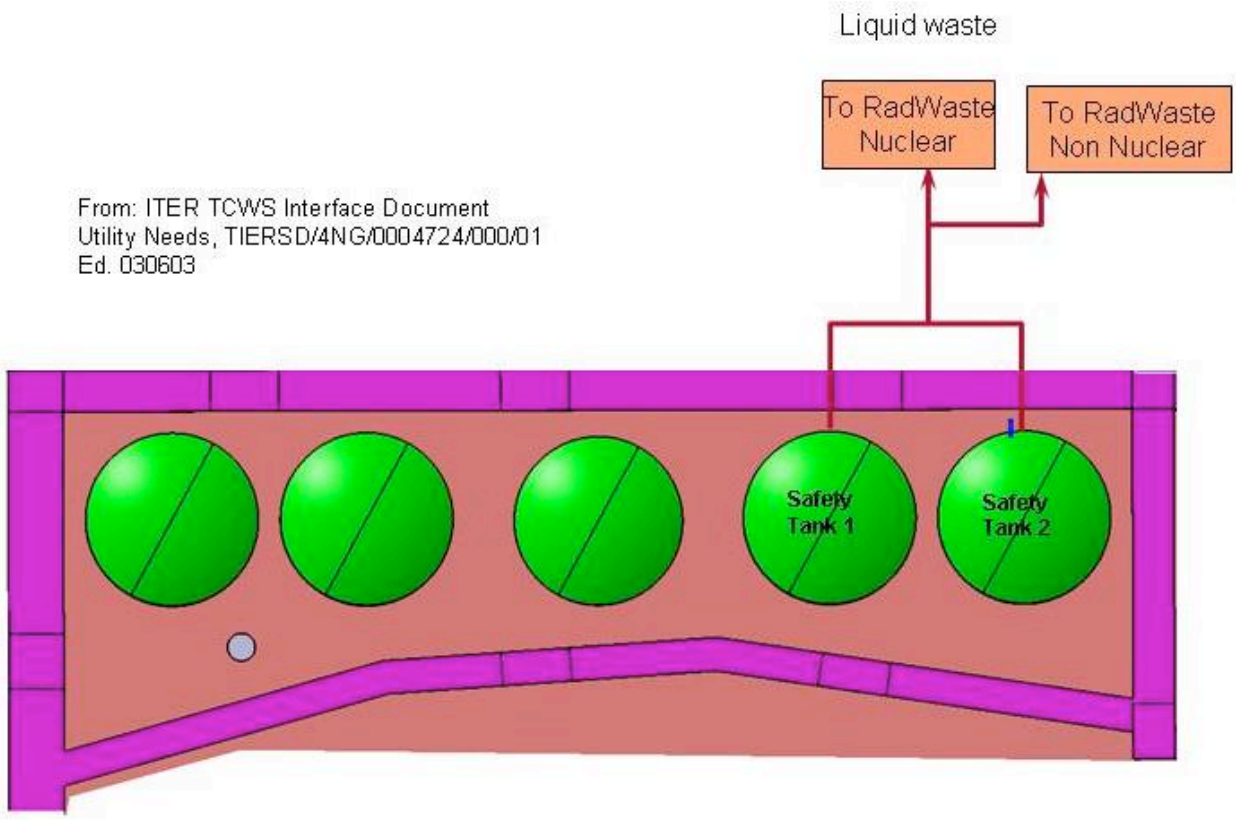
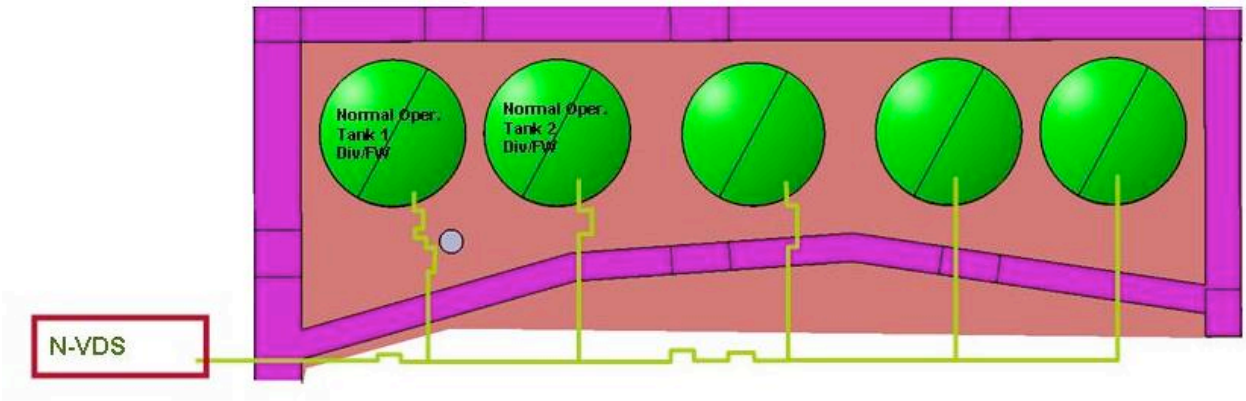
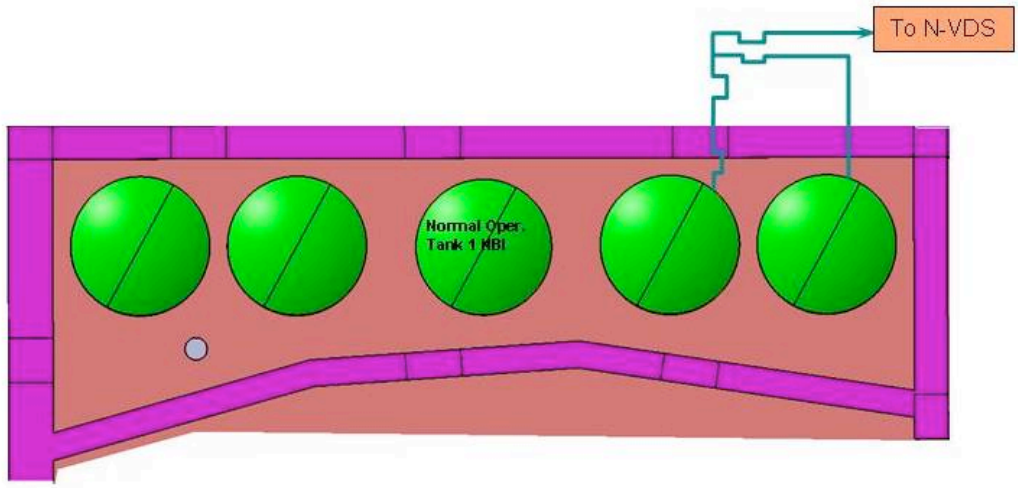


Fig. B.2. Radioactive waste interfaces.



From: ITER TCWS Interface Document
Utility Needs, TIERSD/4NG/0004724/000/01
Ed. 030603

Fig. B.3. Normal Vent Detritiation System (N-VDS) interfaces.



From: ITER TCWS Interface Document
Utility Needs, TIERSD/4NG/0004724/000/01
Ed. 030603

Fig. B.4. Vacuum interfaces.

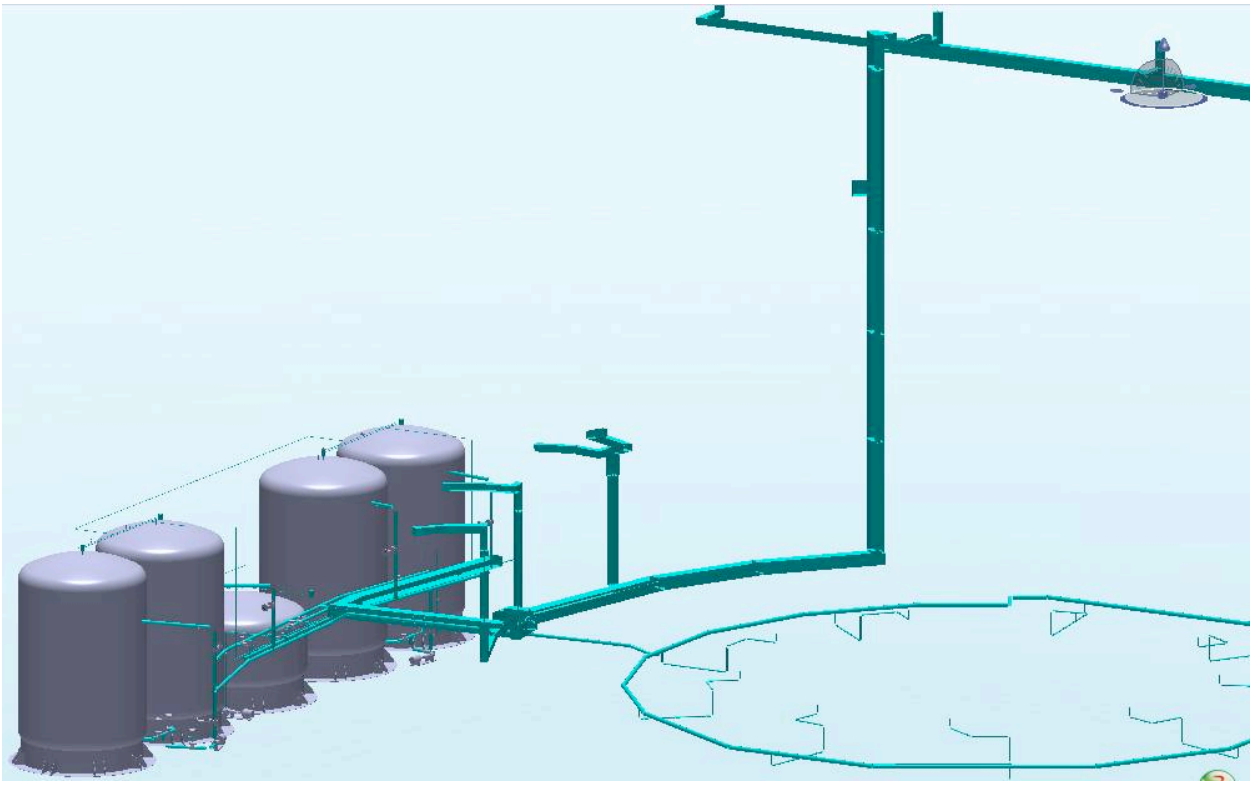


Fig. B.5. Computer-graphics-aided three-dimensional interactive application representation of the drain tanks and some of their interfaces.

APPENDIX C.
QUESTIONS ASKED BY AREVA ON INFORMATION FOR THE DESIGN BASIS OF THE DRAIN TANKS

APPENDIX C. QUESTIONS ASKED BY AREVA ON INFORMATION FOR THE DESIGN BASIS OF THE DRAIN TANKS

	Issue/Question	Reason	Comment	Response by US ITER
1	3 drain tanks vs 5.	Design codes for both safety and nonsafety are the same. Redundancy may not be required.	US ITER will discuss with IO.	Redundancy is not the appropriate criteria to select the number of tanks. The total net volume to be stored has to be equivalent to the overall inventory of the water in the concerned PHTS (plus a small margin for uncertainties). The volume of the safety tanks is calculated as the volume to be drained after LOCA event inside the VV (plus margin for uncertainties). The number of both normal and emergency tanks is related to the design criteria and available footprint and height (volume) in the DT room. Based on this IO opinion we should have 5 drain tanks. In addition, Areva needs to consider the different functions of the safety and normal DTs. Having safety and normal DTs is not because of redundancy but because of different chemistry of water in the safety and normal DTs. We need to segregate those two waters. The water in the safety DT will be discharged to the Radwaste while the water in normal DT will be reused to fill PHTSs.
2	Super heated conditions into drain tanks.	Based on design temp and pressure, the conditions are in super heat conditions. May involve two phase flows.	Volumes are based on subcooled liquid. Actual liquid volume maybe higher. Dynamic loading conditions.	The water temperature for the drainage condition of the safety drain tanks is the most stringent (<100°C). The safety drain tanks are normally linked to the N-VDS under vacuum pressure of about 90 kPa absolute. Therefore the pressure in the tanks needs to be determined using transient analysis taking into account both discharge and evaporation rate. US ITER could also use the same design condition for the normal drain tanks. This means that the water could be discharged at a max temperature of 100°C during normal operation. Different scenario of discharge needs to be justified by US ITER. Based on this IO opinion there is a need to run a transient analysis to indeed analyze AREVA's question. Topilski from IO already performed a transient analysis and determined subcooled conditions for the safety tanks. AREVA should check this matter by performing a transient analysis if doubt persists.
3	Normalize use of the words "drain tanks" and "safety drain tanks."		US ITER task.	US ITER will do this in the report.
4	"Expected volume" change to "working volume."		US ITER task.	US ITER will do this in the report.

	Issue/Question	Reason	Comment	Response by US ITER
5	Can sump tank for DIV be used for VV?	Defer to later date as it doesn't impact the specs.		IO would like to consider only one sump tank of 4 m^3 connected to the Drying system. During the gravity drain of the VV there is the risk of not sufficient height from the bottom of the Lower Pipe Chase to the level in the DT to permit a full drainage. Therefore we could link this drainage line to the same sump tank by using an isolation valve. In conclusion, we will have one sump tank that can be used for both DIV and VV draining procedures. Certainly, after each procedure the sump tank needs to be washed.
6	Forms for concrete floor in drain tank area.	Option one for tanks to be installed before the floor above may not be feasible due to forms required for construction of concrete floor above.	IO question.	TCWS IO's opinion is that to permit the pouring of the floor above, temporary frames need to be used that will interfere with the DTs. This means that this option will be refused from the assembly group. This is one question that we will ask from the construction people by email, and we will have a meeting with them when we go to France in October.
7	Mezzanine location changes from center to sides.		IO question.	The central location has been selected to minimize the connection to the Lower Pipe Chase (this is important for the proposed horizontal shaft to link the DT room to the UPC at the ceiling of the B2 level). If the mezzanine is on the one side of the DT room there is a higher available surface but this not so important. This is IO's opinion and we will perform the design with this in mind. The mezzanine is considered at the center of the space.
8	Embedded bolts for tanks interference with air pallets.		IO question.	We will discuss this issue with the IO Construction and Assembly group. There has been a suggestion of using screw anchor bolts that needs to be considered by the Construction and Assembly group. US ITER will send emails to the Construction and Assembly group. US ITER will add this issue for discussion with the construction group when we go France in October.
9	Seismic requirement inputs (check with Hedrick).	Confirm with Hedrick that the document is most accurate and updated. If not available, inform Juan.		US ITER will provide what we think is the most appropriate and recent seismic analysis that involves level B2. It will be posted in SharePoint at the same time that AREVA receives this spreadsheet.

	Issue/Question	Reason	Comment	Response by US ITER
10	Why does the VVPSS drain to drain tanks instead of Radwaste?	How does draining from VVPSS work?	IO question.	ITER IO CWS has refused the storage of the VVPSS drainage into the TCWS DTs. The drainage line from the VVPSS could be merged with the TCWS drainage line to have a unique connection to the Radwaste. In conclusion, it is the opinion of the TCWS IO group that we will not have an interface with the VVPSS. This will be finally determined when the interface sheet is finally approved. However, the SRD 26 (v 2.1), Sect. 2.2 will be modified to say: "Safety drain tanks shall include features that will facilitate cleaning to allow the restart of the plant within 1 year of such occurrence." After the wastewater has been processed, the water collected in the VVPSS may be discharged to the safety drain tanks following the in-vessel leak; however, the piping connection between the VVPSS and the TCWS safety drain tank shall be provided by the VVPSS. This aspect is still in discussion.
11	Design pressure scenario discussions.	1MPa design pressure (from N2 supply pressure) should not be used as a design basis. This issue should be addressed with the relief device and not a basis for design pressure for tanks. AFS proposes to use maximum static head for design pressure.		In general ITER IO would agree adding some uncertainty factor due current unknowns of operations. The N2 pressurization should be < 0.5 bars. N2 pressurization above 0.5 bars would indicate that the table to be used for the classification of these tanks is not the table for liquid group 2, but for gas group 2, making the drain tank become pressure Cat. IV instead of Cat I. The external pressure on the drain tank area has been considered to be close to 200 kPa. This value has resulted from a LOCA event in the VV PHTS.[22]
12	FMEA effect on relief valves (Tim Dodson).	Informed Tim Dodson and his team to start work on FMEA for drain tanks early.		Informed Tim Dodson and his team to start work on FMEA for drain tanks early.
13	NBI connection to drying system—mistake on slide?	US ITER to review Figure 11 for services to tanks.		This will be fixed in the document by US ITER.
14	Minimum design metal temperature.	US ITER (Juan) to provide.		At B2 level (−11.6 m below the ground level), the minimum design temperature has been established at 12°C. US ITER will provide a list of environmental variables and their values at the same time this spreadsheet is delivered.
15	Electrical grounding for drain tanks.	How many grounding lugs will be required for each tank.	IO question.	It is not established yet. We need to uniform this according to the indications from the electrical section. I presume that could be at least two. However, there will be a workshop on TCWS I&C during October where this question will be definitively answered.

	Issue/Question	Reason	Comment	Response by US ITER
16	I&C.	Need to confirm control safety and date acquisition redundancy.		This is a question that should be discussed during the TCWS I&C workshop in October. From our point of view 2/3 logic for safety monitoring and 1/2 for normal gauging. So we have to determine what to be monitored. Level gauge is safety according to RPrS. But P&T monitoring, we have not seen these requirements described anywhere.
17	Tank contamination levels for wash down for all tanks.	Required to know for radiological and cleanliness associated with drain tanks for tank design.	IO question.	This issue needs to be discussed with IO Safety Section to assess the ORE during maintenance due to the residual radionuclides in the DTs. US ITER's opinion is that the basis for this range of concentrations should come from contaminated tank from solutions with concentrations from Table 6 on the report on *Drain Tank Information for Developing Design Basis of the Preliminary Design*. Once the liquid with this concentration abandons the tank and the tank is washed then the residuals constitute the lower range of contamination. However, IO TCWS opinion is that we need to talk to Safety. We will do that.
18	Surface finish of tank ID vs required decon.	Same as item 17.		We suggest using the best industrial practices. AREVA should suggest methodologies. US ITER should participate in the evaluation.
19	Update "drain tank classification table."	Need to reconcile Table 5 with Fan Li's table.	IO question.	Drain tank classification table is being sent to ITER IO for their approval. We hope to update this information in report *Drain Tank Information for Developing Design Basis of the Preliminary Design* as soon as we get the approval from IO.
20	Personnel protection requirement near tanks-shielding, insulation?	Coordinate with HFE engineer. Operational issues and French safety standards.	IO question.	This issue needs to be discussed with IO Safety Section to assess the ORE during maintenance due to the residual radionuclides in the DTs. We also need to have access to RPrS. We are planning to discuss this issue with the Safety people in our visit to Cadarache in October.
21	20 years or 30 years for corrosion allowance?	Operational conditions after decommission associated with corrosion allowance built in the tank design.	IO question.	The drain tanks will have to be designed for 40 years. After 20 years of operation, liquids will be stored in drain tanks for decommissioning the plant. This number is being given by IO and reflects these thoughts.
22	Passivation treatment on SS surface.	Do we need passivation treatment?	Andrei's question.	AREVA should make recommendations, and US ITER should make decisions based on value engineering principles.
24	Allow the use of 304L and 316L.	This will give vendors flexibility associated with material costs.	US ITER SS experts.	US ITER agrees with this principle.
25	What is the cleaning medium for compatibility with the metal?	Operation pressure for demin. system (relate to item 17).		We are getting this information from IO. It is demineralized water.
26	Name plate standards size location?		IO question.	This information is not yet available. IO TCWS suggests that the best option could be in the cylindrical shell at 1.8 m from the floor level to be better readable. However, AREVA should supply best practice for this kind of tanks.

	Issue/Question	Reason	Comment	Response by US ITER
27	Transmitters 2 out of 3 requirements for safety related tanks?		Kofi's question.	This is a question that should be discussed during the TCWS I&C workshop in October. DDD specifies 2/3 logic for safety monitoring and 1/2 for normal gauging.