Current Status of Technology Development for

SF Transportation & Storage System

2013. 01. 30

Korea Radioactive Waste Management Corporation
Research & Development Office

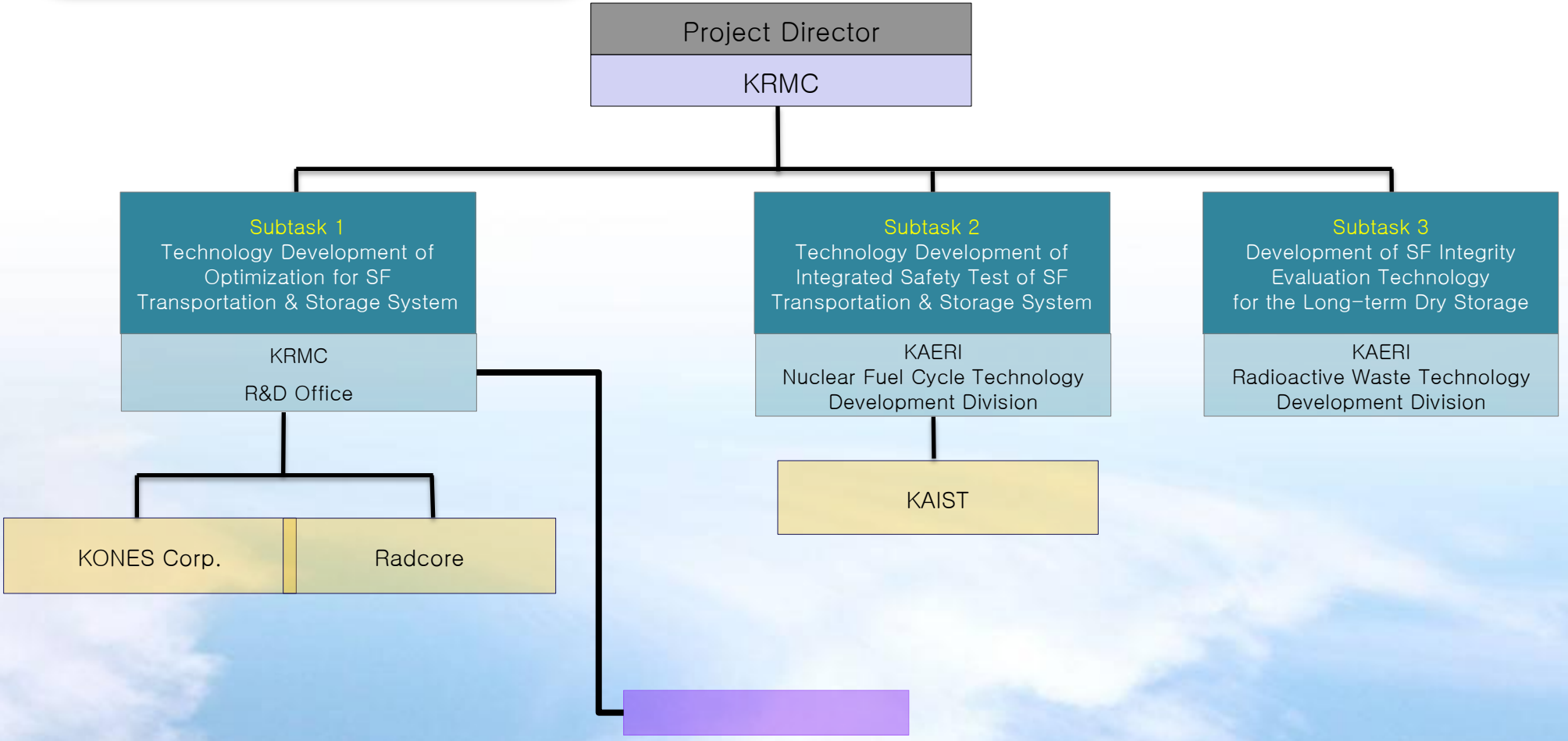
Contents

I. Project Overview

Goal	Technology Development of Optimization for Spent Nuclear Fuel Transportation & Storage System		
Period	June 2009 ~ May 2016 (84 months)	2nd Step Period	June 2011 ~ May 2014 (36 months)
Work Scope	- Safety Analysis for SNF Transportation & Storage System - Fabrication Technology Development of SNF Transportation & Storage Systems - Safety Test Model (Design/Fabrication/Test)		

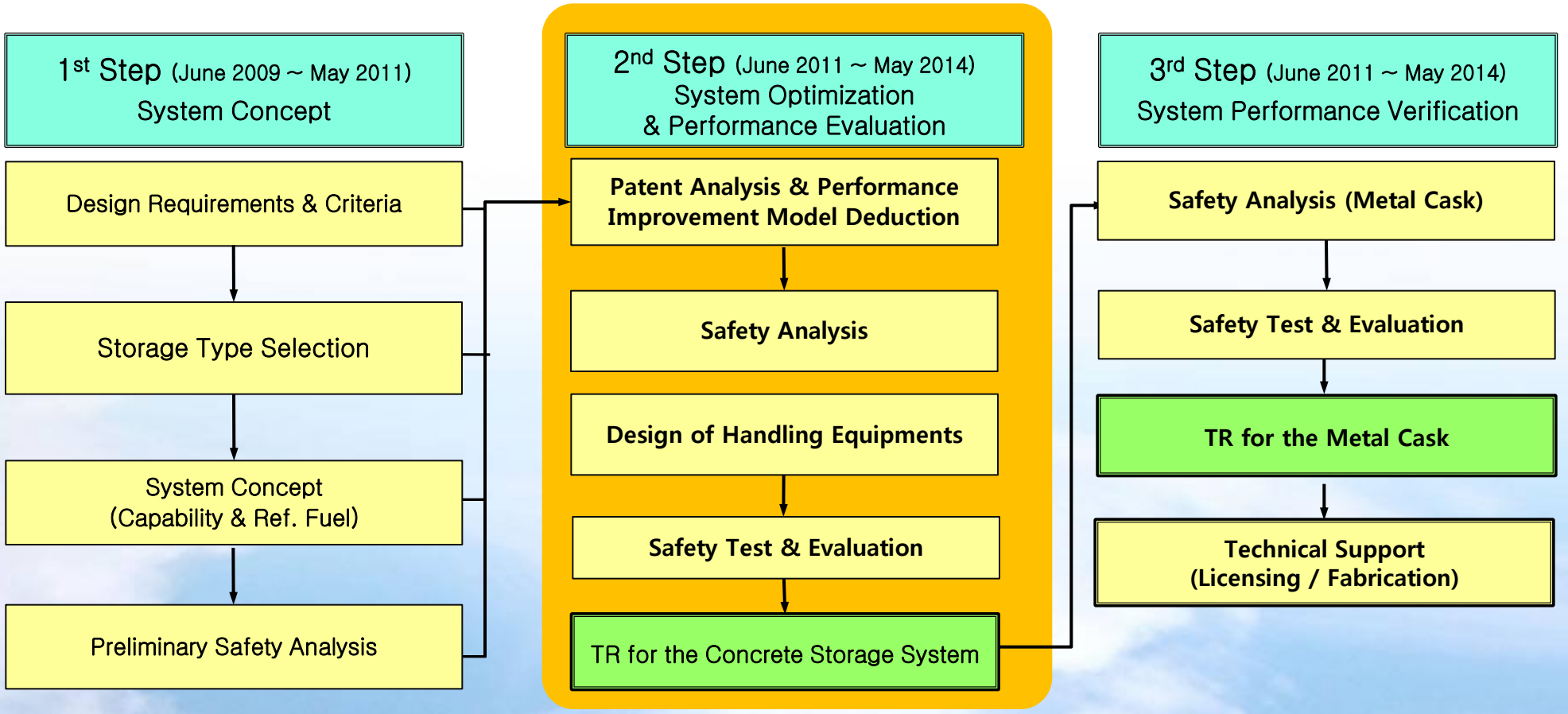
I. Project Overview

Organization



I. Project Overview

Development Work and Goal



II. Design Criteria

Codes and Standards

○ NSSC Notification No.2012-49, “Regulations on the Packaging and Transportation of Radioactive Materials”

○ US 10CFR71, “Packaging and Transportation of Radioactive Material”

○ US 10CFR72, “Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste”

○ IAEA Safety standard Series No. TS-R-1, “Regulations for the Safe Transport of Radioactive Materials”

○ IAEA Safety Series No. 116, “Design of Spent Fuel Storage Facilities”

II. Design Criteria

Transport Cask (Normal & Accident Condition)

	Design Requirement	Reference
Normal Condition		
■ Environment Temperature (High/Low)	38℃/-40℃	NSSC Notification No.2012-49 10 CFR 71 IAEA SSS No. TS-R-1
■ Environment Pressure (High/Low)	140kPa/25kPa	
■ Free Drop	0.3m	
Accident Condition		
■ 9m Free Drop	Horizental/ Vertical/ Corner Drop	NSSC Notification No.2012-49 10 CFR 71 IAEA SSS No. TS-R-1
■ 1m Puncture	Upper/Lower/Side	
■ Fire	800℃/30min	
■ Submersion (200m in Water / time)	20kg/㎠/1hr	

II. Design Criteria

Storage Cask (Normal, abnormal & Accident Condition)

	Design Requirement	Reference
Normal Condition		
■ Environment Temperature	22℃	ANSI/ANS 57.9
■ Handling Load	115 % of its own weight	CMAA #70
Abnormal Condition		
■ Environment Temperature (High/Low)	-25℃/35℃	ANSI/ANS 57.9
■ Air Flow Blokage	50 %	-
■ Wind(Maximum)	45 m/s	
Accident Condition		
■ Environment Temperature	40 ℃	ANSI/ANS 57.9
■ Air Flow Blokage	100 %	10 CFR 72.128 (a)(4)
■ Falling/Overturn	(Assumption)	Reflecting Operation Condition
■ Fire Condition	(800℃ / Assumption)	10 CFR72.122(c)
■ Earthquake(Horizental/Vertical)	0.3g / 0.2g	RG 1.60, 1.61

III. System Concept

Design Basis Fuel Selection

○ Design Basis Fuel

Items	Characteristics
• Spent Nuclear Fuel	CE 16×16 & WH 17×17
• Initial Enrichment	4.5wt%
• Maximum Burnup	45,000MWD/MTU
• Minimum Cooling Period	10 YRS

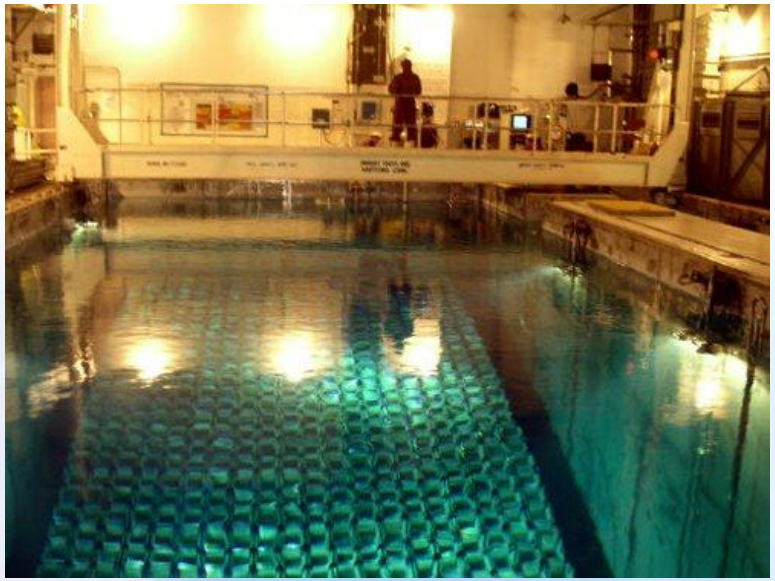
○ The Characteristics of SF(2008.12)

Enrichment and Burnup	WH Type	CE Type	Sum
· Enrichment < 4.0 wt% · Burnup < 45GWD/MTU	64.0% (5,073 Bundles)	61.8% (1,972 Bundles)	63.3% (7,045 Bundles)
· Enrichment < 4.5 wt% · Burnup < 45GWD/MTU	85.4% (6,765 Bundles)	84.6% (2,700 Bundles)	85.1% (9,465 Bundles)
· Enrichment < 4.5 wt% · Burnup < 50GWD/MTU	98.9% (7,831 Bundles)	95.9% (3,070 Bundles)	98.0% (10,901 Bundles)
· Enrichment < 4.5 wt% · Burnup < 55GWD/MTU	99.8% (7,908 Bundles)	99.7% (3,189 Bundles)	99.8% (11,097 Bundles)

III. System Concept

Interim Storage of Spent Nuclear Fuel

[Wet Storage]



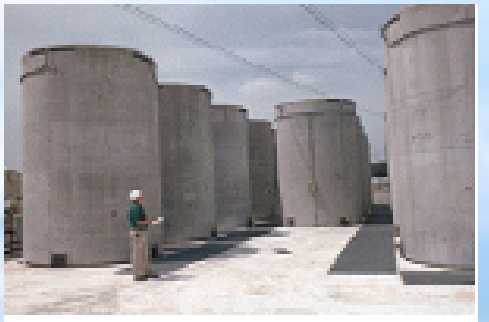
[Dry Storage]

Vault

Module

Metal Cask

Concrete Cask



III. System Concept

Conceptual Dwg. of F Transportation / Storage System

IV. System Safety Evaluation

System Optimization & Preliminary Safety Analysis

Goals	Items	2011							2012				
		6	7	8	9	10	11	12	1	2	3	4	5
System Optimization/ Safety Analysis													
	– Analysis of Optimization Items for each Design Element	■	■	■									
	– Performance Evaluation and Analysis for Materials, Shapes and Specifications of the Items				■	■	■	■					
	– Preliminary Safety Analysis of Improved System								■	■	■	■	
Domestic Model Derivation													
	– Patent Analysis				■	■	■	■	■	■	■		
	– Derivation of Domestic Model of Dual-purpose & Concrete Cask										■	■	■

IV. System Safety Evaluation

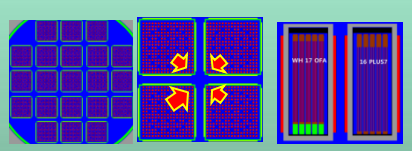
Preliminary Safety Analysis

➢ Purpose of Assessment

- ✓ An preliminary safety evaluation is performed on criticality/shielding/heat/structural of conservative conditions for improved models derived through optimization of systems
- ✓ Results on evaluations are applied to preparing detailed drawings and manufacturability evaluations

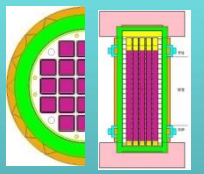
Criticality Evaluation

– Normal transport, 100% flooding, bias condition



Shielding Evaluation

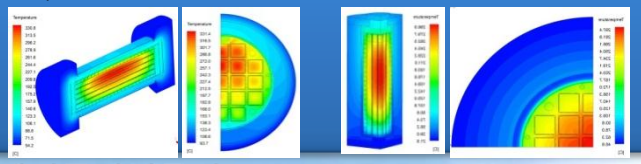
– Normal transport, dose evaluation at surface of cask body and at 2m separation site



System Detail drawings & design data

Heat Transfer Evaluation

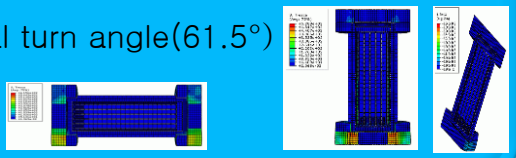
– Normal transport, maximum decay heat, ambient temperature 22~38C°



Structure Evaluation

– 9m vertical, horizontal, corner drop

• – overturning critical turn angle(61.5°)



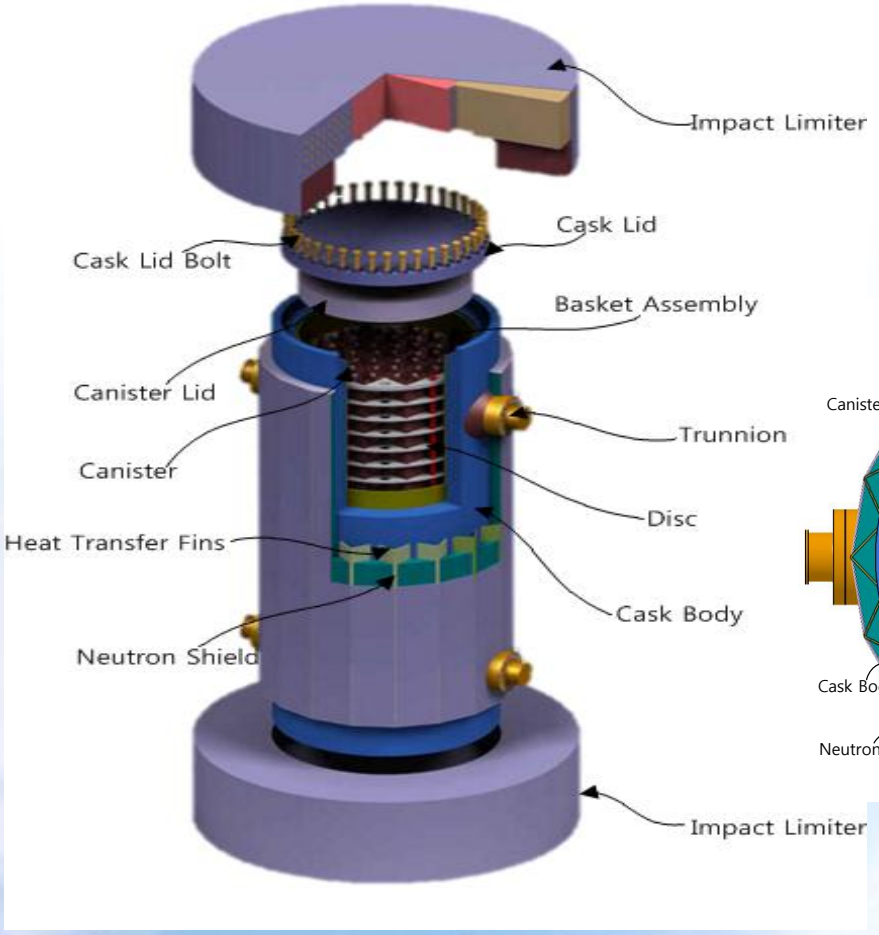
IV. System Safety Evaluation

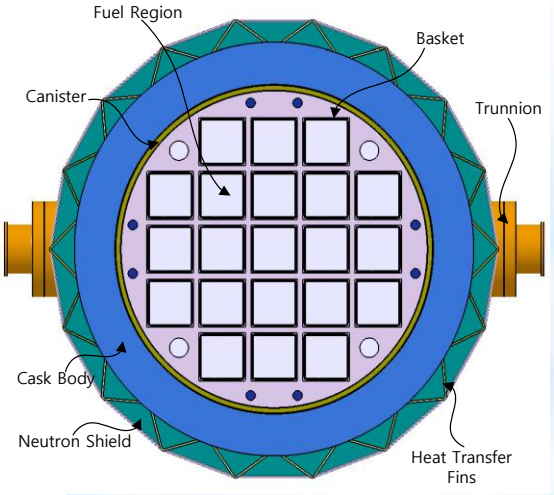
Dual-purpose Metal Cask

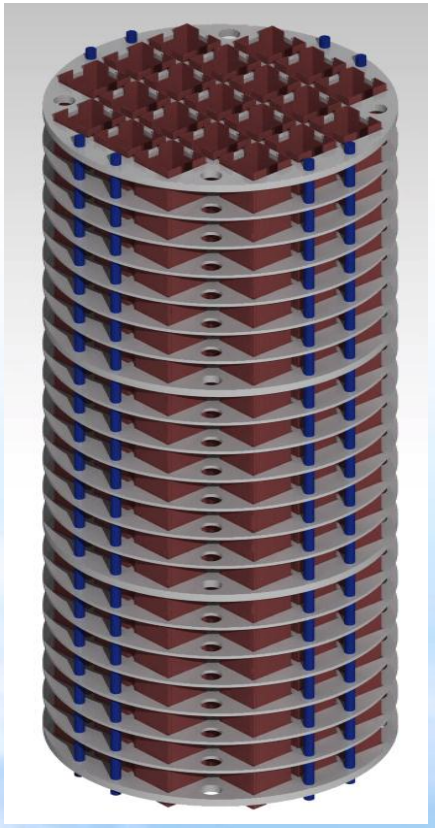
Items	Design features
Storage capacity	- 21 PWR F/A(WH & CE)
Dimension	- Cask Body: O.D. 2,216 mm x 5,285 mm L - Canister : O.D. 1,686 mm x 4,880 mm L
Total weight	- Storage Cask : 105 ton (with Loaded Canister) - Canister : 33 ton (with Loaded Fuel)
Material	- Cask Body : Carbon Steel - Canister : Stainless Steel, BORAL(B_4C + Al) or METAMIC
Cooling	- Natural Cooling (Canister : Inert Gas)

IV. System Safety Evaluation

Dual purpose Metal Cask







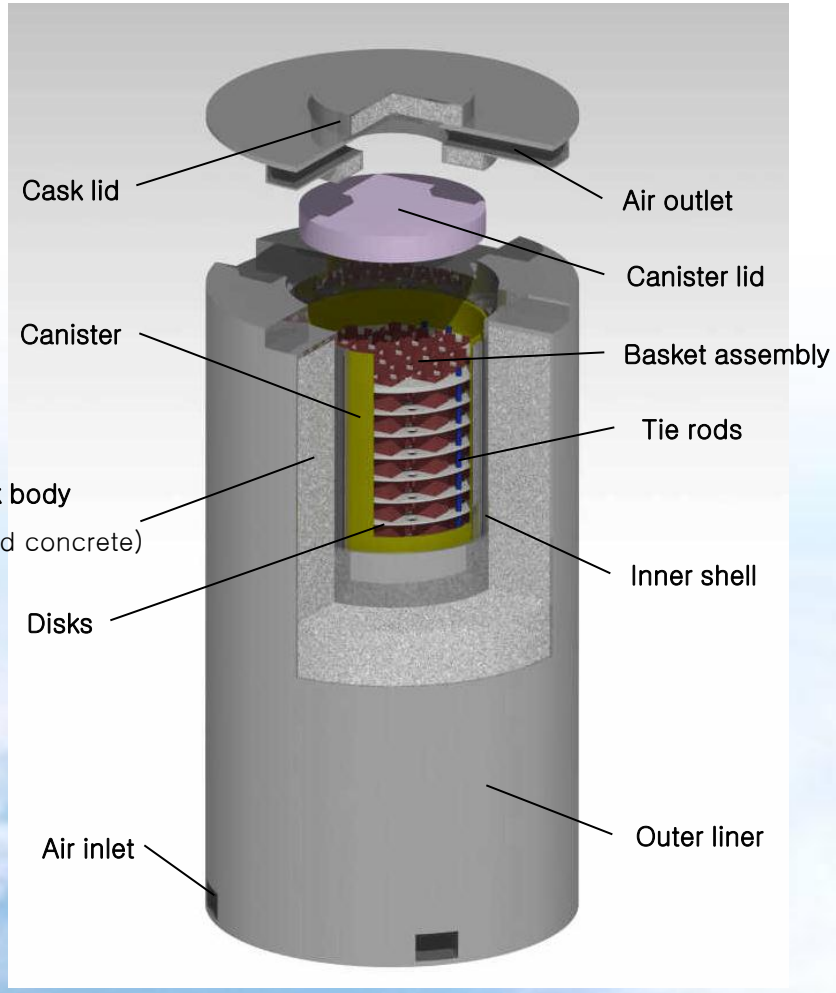
IV. System Safety Evaluation

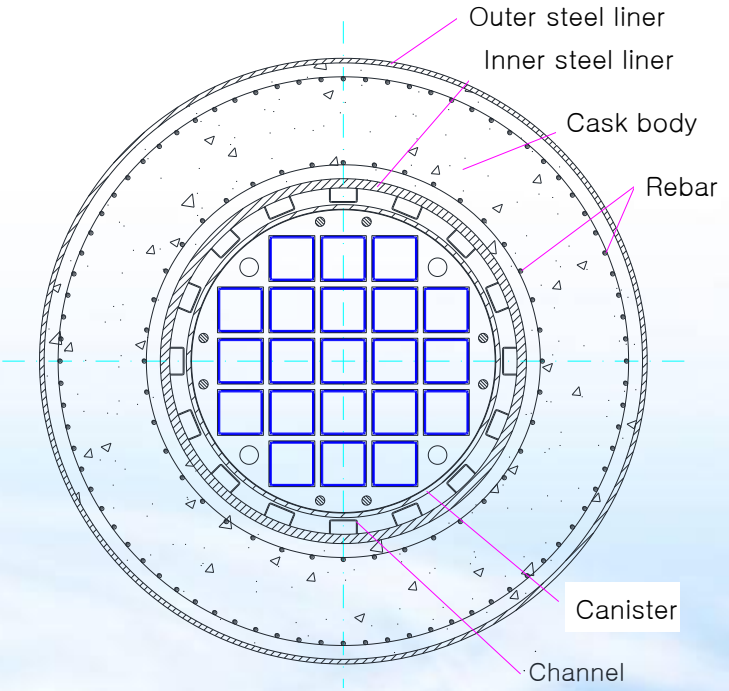
Concrete storage cask

Items	Design features
Storage capacity	- 21 PWR F/A(WH & CE)
Dimension	- Cask Body: O.D. 3,266 mm x 6,030 mm L - Canister : O.D. 1,686 mm x 4,880 mm L
Total weight	- Storage Cask : 144 ton (with Loaded Canister) - Canister : 33 ton (with Loaded Fuel)
Material	- Cask Body : Concrete, Carbon Steel Lining - Canister : Stainless Steel, BORAL(B_4C + Al) or METAMIC
Cooling	-Natural Cooling : Air Circulation System (4 Air Inlet and Outlet) (Canister : Inert Gas / Helium)

IV. System Safety Evaluation

Concrete storage cask





IV. System Safety Evaluation

System safety evaluation

Goal	Items	2012							2013				
		6	7	8	9	10	11	12	1	2	3	4	5
Metal cask (transport condition)	Criticality/Shielding Evaluation												
	Heat Transfer Safety Evaluation												
	Structural Safety Evaluation (Including Handling Equipment)												
Metal cask (storage condition)	Criticality/Shielding Evaluation												
	Heat Transfer Safety Evaluation												
	Structural Safety Evaluation												
Concrete system	Criticality/Shielding Design Safety Evaluation												
	Heat Transfer Safety Evaluation												
	Structural Safety Evaluation (Transfer Cask, Handling Equipment)												
Manufacturability Evaluation/ Mockup	Evaluations for Metal Cask Manufacturability Evaluation Items												
	Manufacturing Process Development For Concrete Cask												
	Manufacturing Test Models for Safety												