

KALIMER-600

Preliminary Structural Concept Design of KALIMER-600 Liquid Metal Reactor

150

600MWe

KALIMER - 600

Abstract

This paper describes the preliminary structural concept design for the mechanical system, structures and equipments of KALIMER-600, 600MWe pool type liquid metal reactor with sodium coolant. The key contents are new conceptual design for the mechanical structures, the reactor internal structures, reactor head and piping systems, reactor containment structures in points of economical improvement. The thermal protection devices of reactor vessel and the refueling system have been conceptually established.

1.

(510) ()

가

1992

92 9 94 7

[1].

1994 7 97 7

가 ,

[2].

1997 7 2000 3

1 KALIMER-150

[3].

2000 4 2002 3

2 1

KALIMER-150

[4,5].

2002 4 3

가 [6].

가 KALIMER-600

2.

KALIMER-600

600MWe , 40

60

2

. 1 2

2-loop IHTS .

, RV

가 ,

[6].

가 427°C

ASME-NH[7],

ASME-NB .

316SS ,

2.25Cr-1 Mo

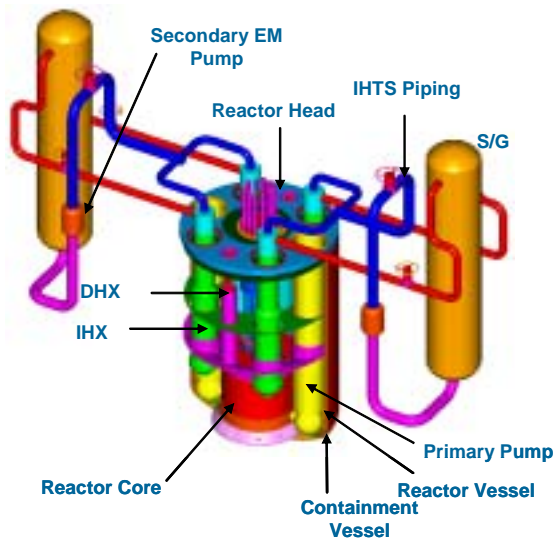
, Mod. 9Cr-1Mo 가 ASME

KALIMER-600

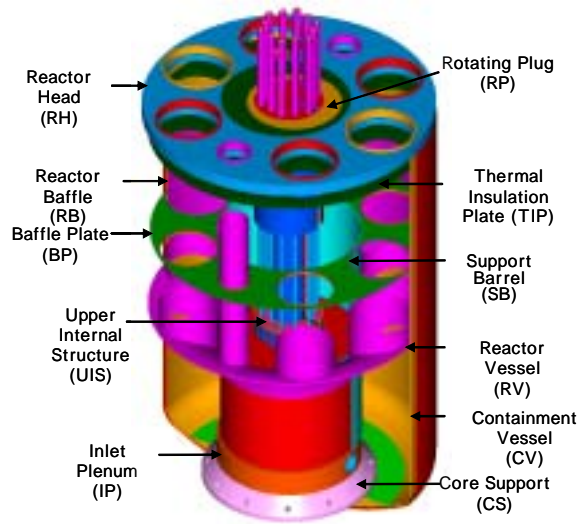
1 , KALIMER-150

2 . KALIMER-600 ,

11.4m 600MWe



1 KALIMER-600



2

1 KALIMER-600 KALIMER-150

| KALIMER-150 | | KALIMER-600 |
|--------------|-----------------------------|---------------|
| 150 | Capacity (MWe) | 600 |
| 570 | Rx Volume (m ³) | 1721 |
| 732 | Rx Weight(ton) | 2880 |
| 7.02 | RV Diameter(m) | 11.4 |
| 18.97 | RV Height (m) | 18.5 |
| 2 | Loop (EA) | 2 |
| 4 | IHX (EA) | 4 |
| 4 (Electric) | Primary Pump(EA) | 2(Mechanical) |
| 2 | SG (EA) | 2 |

2 KALIMER-600

| | (m) | (m) | (tons) |
|---|---------|-------|--------|
| | 11.41 | 18 | 395 |
| | 11.76 | 18.35 | 158 |
| | 11.26 | 6.45 | 117 |
| | 5.81 | 11.5 | 67 |
| | 5.8-6.8 | 0.5 | 15 |
| | 2.8 | 10.2 | 67 |
| | 11.76 | 0.5 | 226 |
| | 2.4 | 7.9 | 30 |
| 1 | 2.4 | 17 | 110 |
| | 4.1 | 20.6 | 600 |

1)

가)

KALIMER-600

11.26m

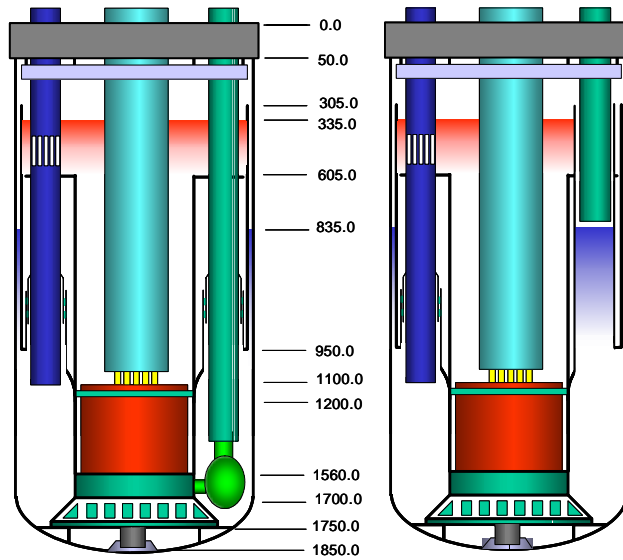
42°

/

3



3



4 KALIMER-600

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EFR[8]

1

가 가

가

4

KALIMER-600

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(Upper Internal Structure, UIS)

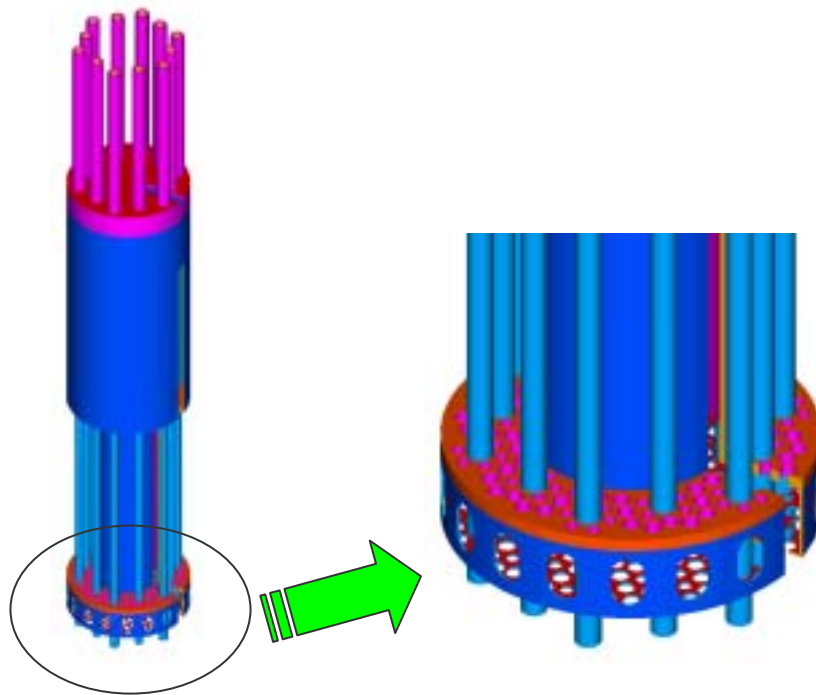
12

320cm

driver fuel

5

KALIMER-600



5 KALIMER-600

가 10.2m

, 2.8m 2

가

15.7cm,

KALIMER-600

551cm,

16.1cm

50cm

30cm 22.6 12
 3.5 . 3

3 (cm)

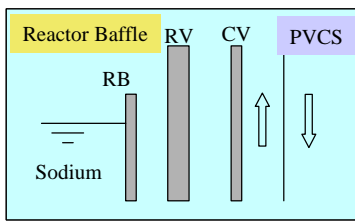
| | | | |
|--|-----|-----|-----|
| | | | |
| | 280 | 150 | 280 |
| | 2.5 | 5.0 | 2.5 |
| | 510 | 450 | 60 |

2) RV

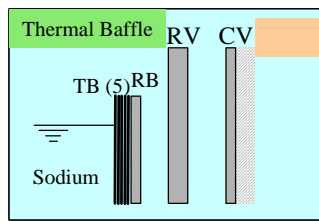
510
 (RV) 가
 . KALIMER-600 RV 가 6 가
 thermal baffle 가

(ACS, Ari Cooling System) RV , RV

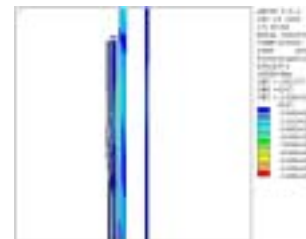
가 . Thermal baffle
 가 thermal baffle . Thermal
 baffle 2mm , 10mm . Thermal baffle 1 , 3 , 5
 24°C, 31°C, 35°C가
 thermal baffle
 RV 가
 RV [9].



RV Air Cooling



Thermal Baffle



Thermal Baffle

6 RV

3)

가) IHX
 (IHX) 1

. IHX

IHX 2 ,
 IHX , IHX

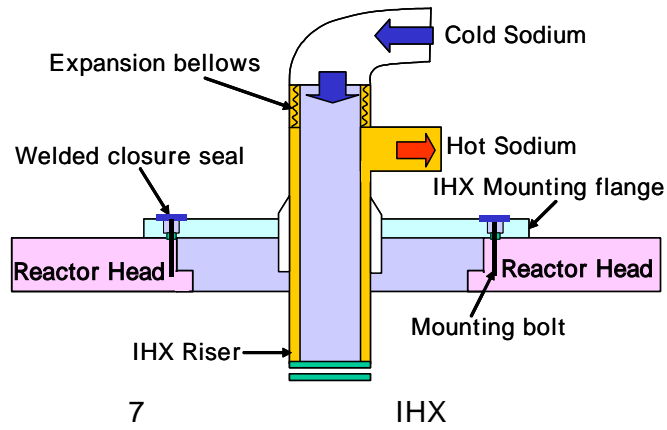
IHTS

(expansion bellows)

sealing

7

IHX



7

IHX

(insulation plate)

(insulation box)

가

Plate type

3.0cm

5

2.5cm

Box type

10cm

Box type

가

65cm

45cm

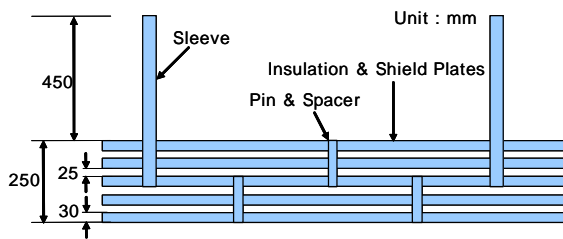
가

plate type

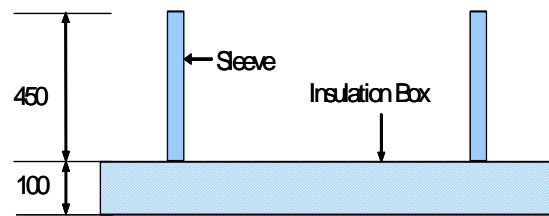
가

box type

8 plate type box type



(a) Plate Type



(b) Box Type

8 KALIMER-600

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가

KALIMER-600

3-

2-

가

가

,

2-

2-

7

IHX가 2 , DHX

가 1

8

1.20m가

40cm

2-

2.4m

1

IHX

가

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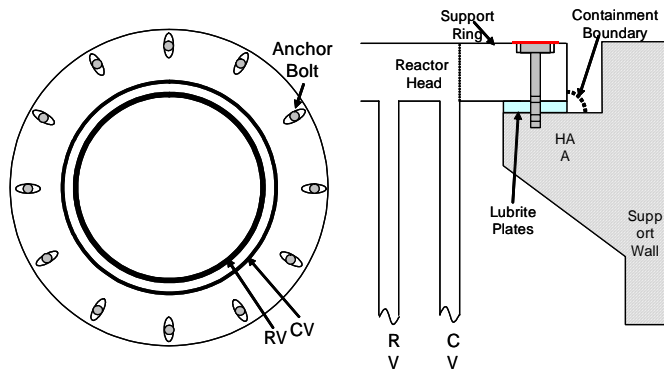
KALIMER-600

가

KALIMER-600

가

9



9

가 130

1.02cm

가

가

500SP가

500SP

100MPa, 30MPa

2880

0.95m²

20cm,

25cm

20

28.3Mpa

4)

(Intermediate Heat Transport System, IHTS)

(SG)

(510)

4

| Reactor | Power (MWe) | Material | Outer Diameter (mm) | Thickness (mm) |
|---------------------------|-------------|-------------|---------------------|----------------|
| Super - Phenix 2 (France) | 1440 | 316 | 760 | - |
| SNR 2 (Germany) | 1497 | 304 | 800 | - |
| DFBR (Japan) | 660 | 304 | 711 | 12.7 |
| CDFR (UK) | 1500 | 316 | 864 | 10 |
| BN - 1600 (Russia) | 1600 | 18Cr - 9Ni | 820 | 13 |
| EFR | 1580 | 18Cr - 13Ni | 711 | 11 |
| ALMR (USA) | 303 | 316 | 711 | 13 |

KALIMER - 600 IHTS

82cm

56cm

1.5 가

IHTS

Tee

316 SS

12Cr

5

12Cr

316 SS

5

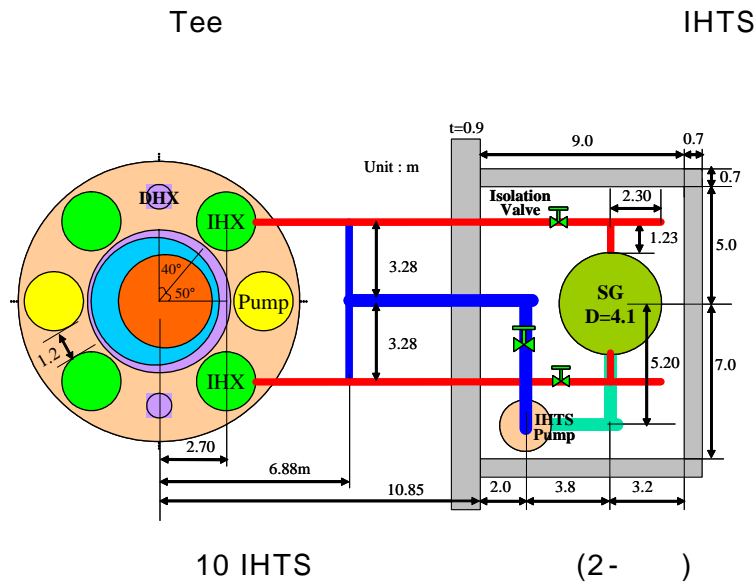
| Materials | Su (MPa) | Sy (MPa) | Sm (MPa) | Thermal Expansion (1/) | Thermal Conduction (W/mk) |
|---------------|----------|----------|----------|-------------------------|---------------------------|
| | 550 | 550 | 550 | 550 | 550 |
| 12Cr | 403 | 333 | 132 | 11.35 | 32.3 |
| 316 | 378 | 105 | 95 | 18.33 | 21.75 |
| Mod.9Cr - 1Mo | 348 | 287 | 116 | 12.35 | 28.8 |

IHTS

SWR(Sodium Water Reaction)

IHX SG 가 7m , hot leg cold leg
 가 7m IHX-SG
 10.26m , 7.95m
 10 2- IHTS
 8 1.20m, 가 IHX , IHX
 6.58m가 118m . IHX

[10].



6 KALIMER-600
 1721m³ , 1301m³
 2883

6 KALIMER-600

| Items | Outer Dia. (cm) | Thickness (cm) | Weight (ton) | Material | Remark (cm) |
|--|-----------------------------|----------------|--------------|--------------|--|
| Containment Vessel | 1176.0 | 2.5 | 158.22 | 2(1/4)Cr-1Mo | Partial-spherical bottom head |
| Reactor Vessel | 1141.0 | 5.0 | 395.96 | 316SS | Gap between RV and CV=15.0 |
| Reactor Baffle | 1126.0 | 2.5 | 117.77 | 316SS | Gap between RB and RV=2.5 |
| Support Barrel | 581.0 | 5.0 | 67.40 | 316SS | Gap between SB and IHX=20.0 |
| Inlet Plenum | 581.0 | 15.0 | 100.37 | 316SS | Upper Grid Plate T=10.0 Lower Grid Plate T=15.0 |
| Baffle Plate | 1111.0 | 2.5 | 7.93 | 316SS | Circular Disk Type |
| Core Support | 581.0(top) 681.0(bottom) | 15.0 | 15.25 | 316SS | Skirt Type, Height=85.0 |
| Core | 551.0 | - | - | - | Gap between core and SB=10 |
| Reactor Head | 1176.0 | 50.0 | 225.74 | 316SS | Circular Disk Type |
| Rotating Plug | 520.0 | - | 77.95 | 316SS | 2-Rotating Plugs |
| UIS | 280.0 | - | 67.18 | 316SS | - |
| Insulation Plates | 1131.0 | 3.0×5 | 66.64 | 316SS | Plate(3.0cm)×5EA |
| * Outer Dia. of IHX (4EA) = 240 cm * Outer Dia. of Primary Pump (2EA) = 240 cm * Outer Dia. of DHX Support Barrel = 100 cm * Density(316 SS) = 7800 kg/m ³ | | | | | |

5)

가)

KALIMER-600

2001

31

(5)

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(13)

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가

(23)

23

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KALIMER-150

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LOCA,

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KALIMER-600

11

[11].

1.0E-6/R

가

24

가

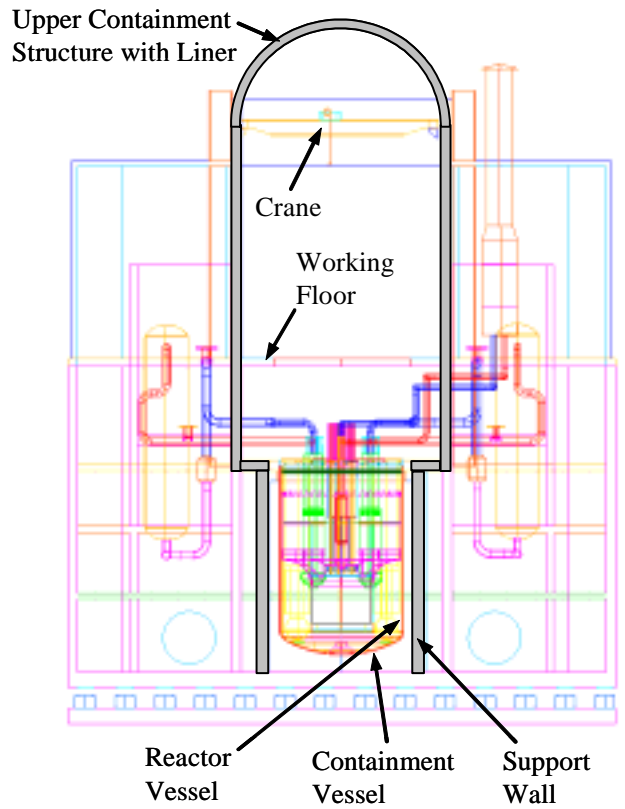
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ACS(Air Cooling

System)



11 KALIMER - 600

6)

가)

A-Frame type .

. MDP (Modular Double Pool)

. A-Frame type

가

. Phenix, Superphenix

SAFR(Sodium Advanced Fast Reactor) .

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가 가

, 가

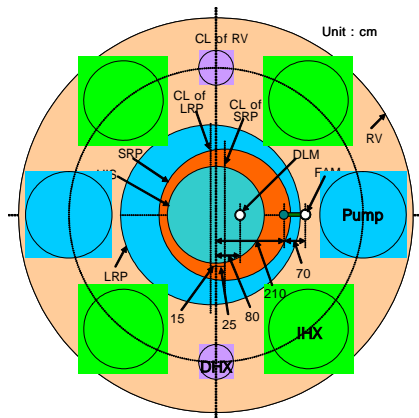
Offset arm ,

Pantograph arm .

7

| | 용량(MWe), 배관수 | 노심직경 (m) | LRP OD (m) |
|-------------|-----------------|----------|----------------------------|
| KALIMER-150 | 150 (2) | 3.44 | 2.74 w/ IVTM |
| KALIMER-600 | 600 (2) | 5.51 | 4.0 w/IV TM or 5.2 /3.8 |
| EFR | 1490(6) | 8.2 | 7.2 |
| SuperPhenix | 1440 (4x2) | 8.0 | 11.2/6.5 |
| PFBR | 500 (2x2) | 4.96 | 6.93/4.68 |
| LMFBR | 1000 | 5.4 | 8.69 |
| ALMR | 330 (2) | 4.08 | 3.7 w/IV TM |

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 KALIMER-600 4.71m 5.5m 가 , 가
 . 2 KALIMER-150 가 ,

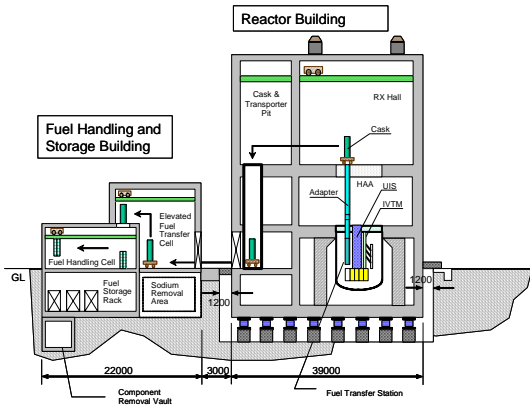


12 2

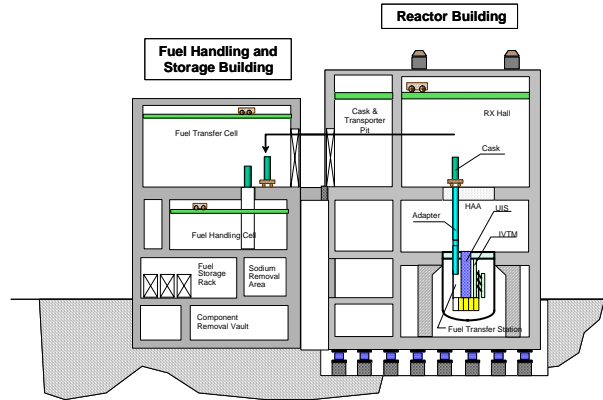
12 2 5.2m 3.8m 2
 . KALIMER-600

4m , 가 1.82m
 [12].

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13



14 KALIMER-600

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13

KALIMER-150

14

가

3.

KALIMER-600

가

가

가

5

KALIMER-600

가

KALIMER-150

가

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