Reference Data for RFI

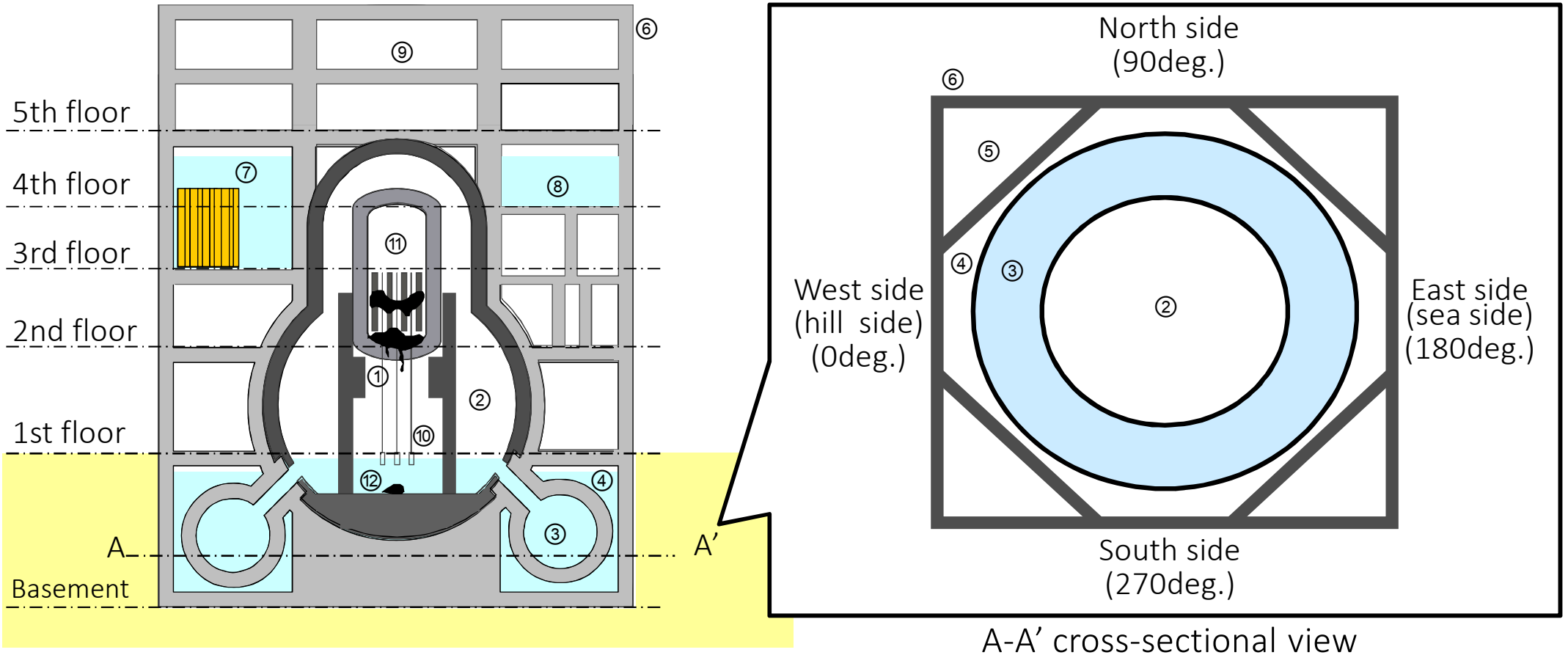
1. Reactor Building (B/B)
2. Primary Containment Vessel (PCV)
3. Reactor Pressure Vessel (RPV)

1. Reactor Building

No.	Item	Reference for
1-1	Name of Major Equipment and Areas in Reactor Building	All (Precondition)
1-2	Size of Reactor Building	All (Precondition)

1-1 Name of Major Equipment and Areas in Reactor Building

■ Name of major equipment and areas in the reactor building are shown below as a precondition.



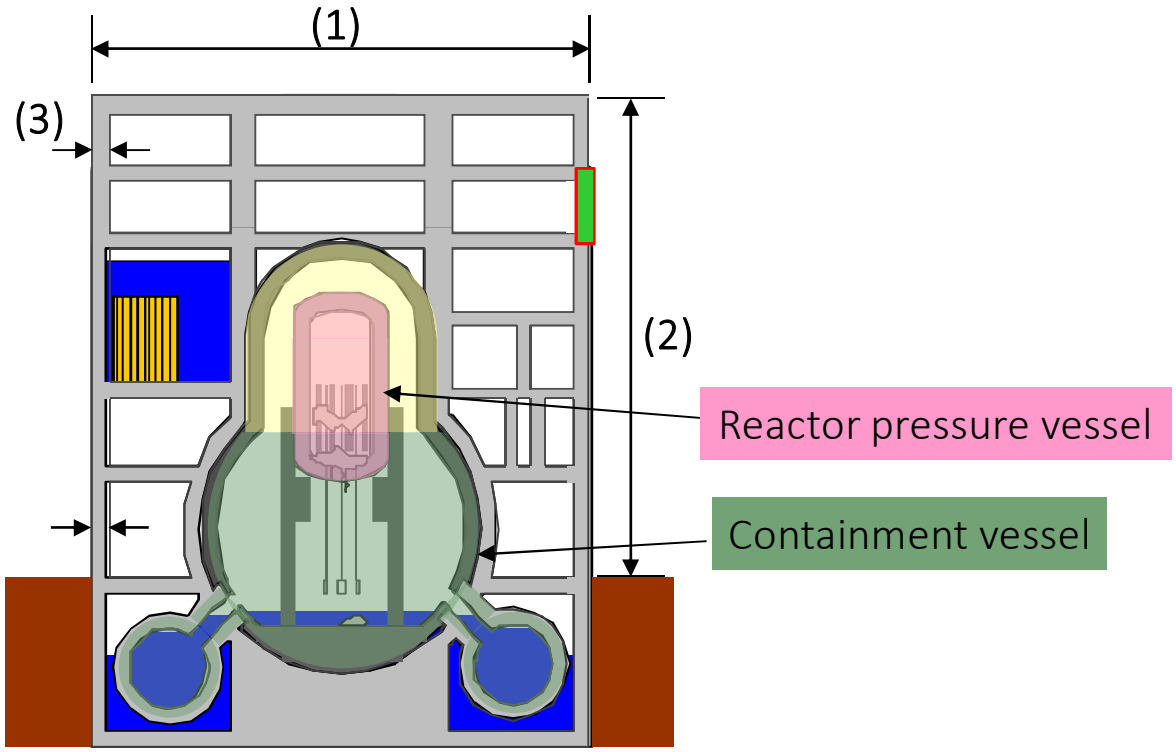
A-A' cross-sectional view

Name of major pieces of equipment

① Bottom of reactor pressure vessel
② Interior of primary containment vessel
③ Interior of pressure suppression chamber
④ Torus room
⑤ Triangular corner (square)
⑥ Reactor building
⑦ Spent fuel pool
⑧ Equipment storage pool
⑨ Refueling floor
⑩ Interior of pedestal
⑪ Interior of the reactor pressure vessel
⑫ Melted fuel debris

1-2 The Size of Reactor Building

■ Size of reactor building are shown below as a precondition.



Reactor building

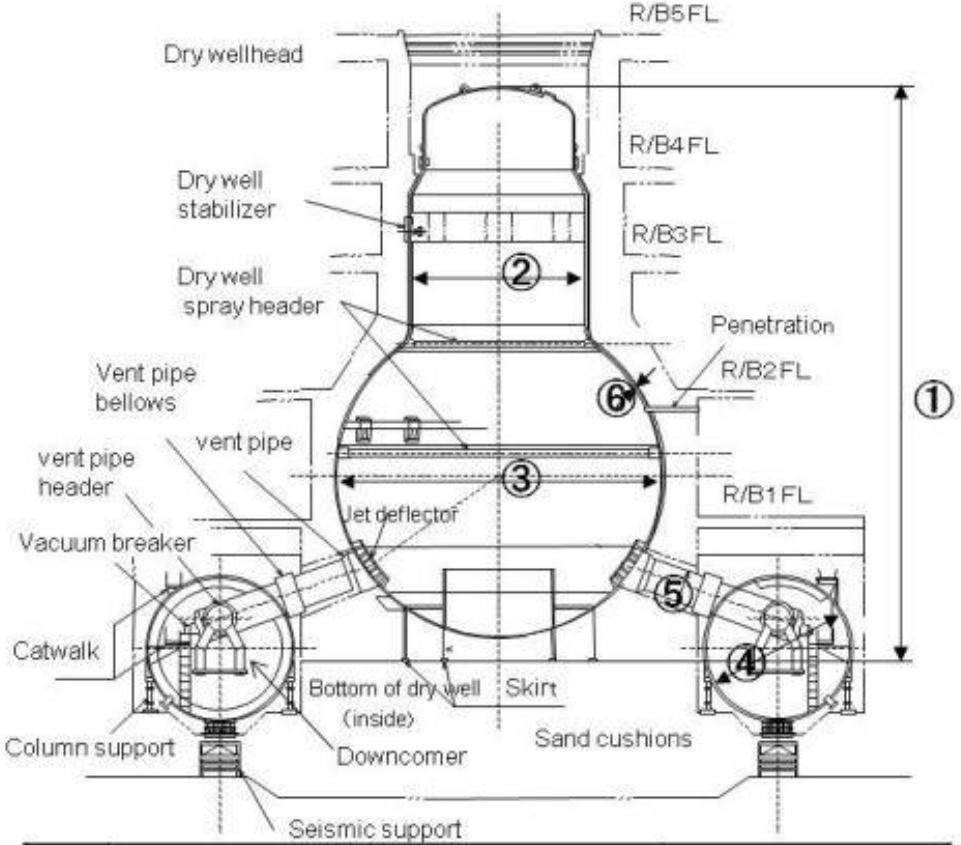
	Unit 1		Unit 2		Unit 3	
	Approx. dimensions	Material	Approx. dimensions	Material	Approx. dimensions	Material
(1)	approx.30m	Ferro-concrete	approx. 46m	Ferro-concrete	approx. 46m	Ferro-concrete
(2)	approx. 45m		approx. 46m		approx. 46m	
(3)	approx. 0.5 -1.5m		approx. 0.5 -1.5m		approx. 0.5 -1.5m	

2. Primary Containment Vessel

No.	Item	Reference for
2-1	Size and Structure of Primary Containment Vessel	All (Precondition)
2-2	Reactor Recirculation System	Access to RPV/PCV, Fuel deburis retrieval
2-3	Image of Internal Equipment of PCV	
2-4	Drywell Top (Primary Containment Vessel Upper Lid)	
2-5	Equipment Hatch and Staff Entrance	
2-6	Bottom part of PCV	

2-1 Size and Structure of Primary Containment Vessel

■ Size and structure of PCV are shown below as a precondition.



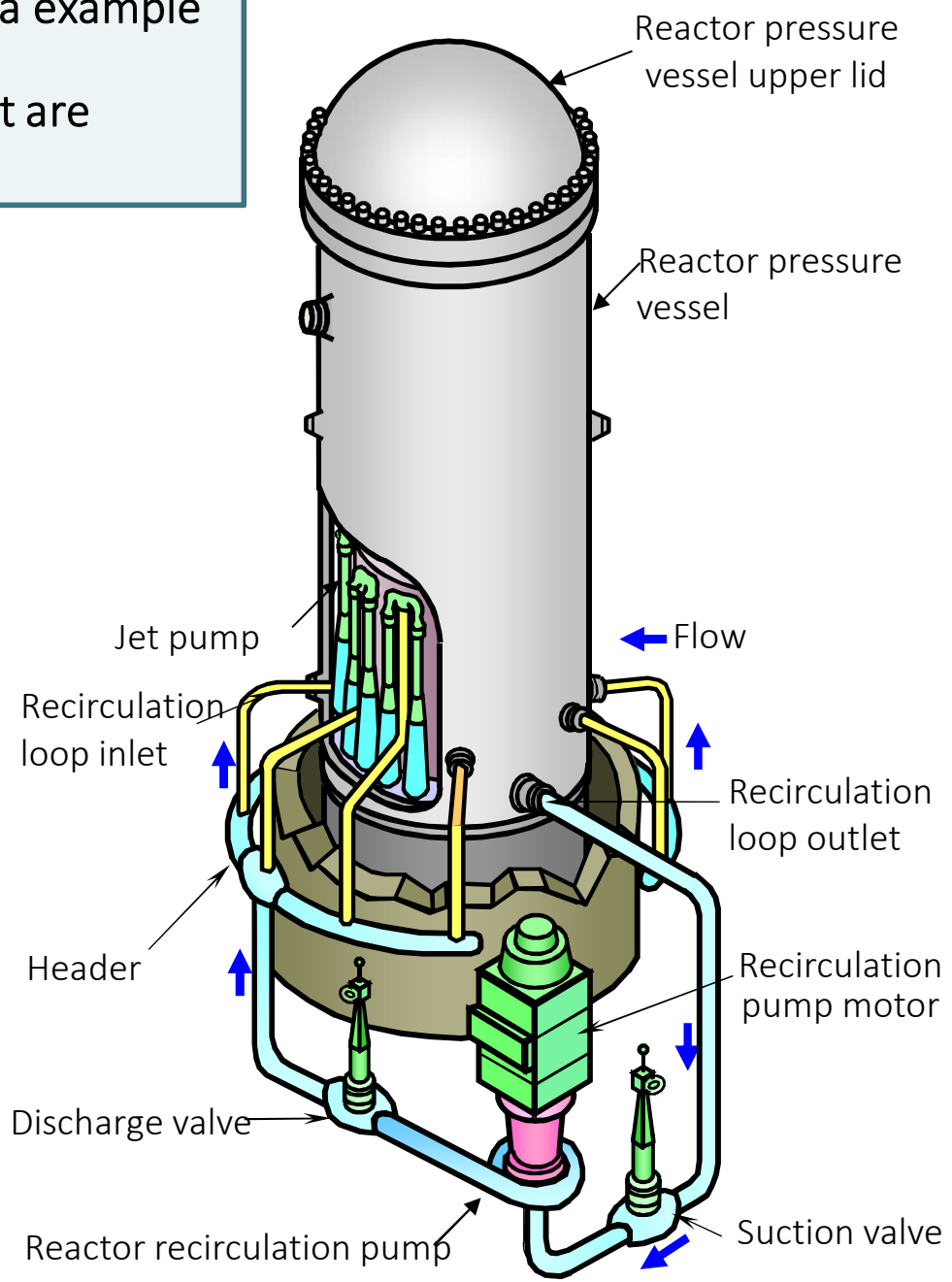
	Unit 1		Unit 2		Unit 3	
	Approx. dimensions	Material	Approx. dimensions	Material	Approx. dimensions	Material
①	32m	Carbon steel	34m	Carbon steel	34m	Carbon steel
②	10m		11m		11m	
③	18m		20m		20m	
④	8m		9m		9m	
⑤	2m		2m		2m	
⑥	min.15mm		17-34mm		17-34mm	

- A steel pressure vessel, of which the upper part is cylindrical and the lower part is of a spherical flask shape.
- A bolt-on, machinery carry-in entrance and a double-door doorway for the staff are installed in the spherical part.
- The top of the dry well consists of a semi-ellipsoidal head (dry wellhead), and it is structured to be fastened with bolts and double-sealed with gaskets for attachment.
- While the exterior of the dry well is fenced with ferro-concrete for shielding and to prevent it from being deformed excessively with jet force, a gap of about 5cm is installed between the dry well and the concrete except in the embedded concrete part of the foundation of the dry well.
- Stabilizers are installed in the cylindrical part of the dry well (at 8 spots) to connect the dry well with the neighboring concrete structure and support horizontal force in the event of earthquake. The stabilizer is of a structure that supports horizontal force effectively without restraining thermal expansion.
- The jet deflector protects the vent pipe against the jet force associated with the rupture of primary system piping.

2-2 Reactor Recirculation System

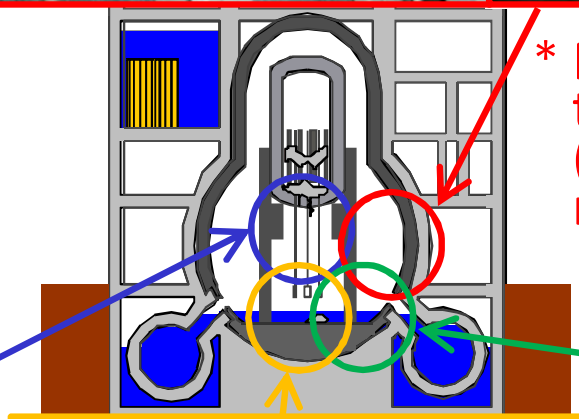
- Image of reactor recirculation system is shown below as a example of internal PCV equipment.
- Except for reactor recirculation system , many equipment are installed in PCV, which make accessing into PCV difficult

- Part of the reactor coolant is brought out of the pressure vessel with the reactor recirculation pump through the downcomer located inside the reactor pressure vessel.
- The coolant coming out of the recirculation pump passes through the exterior riser pipe and then enters again into the reactor pressure vessel, and further passes through the interior riser pipe to serve as driving water for individual jet pumps.
- The water in the downcomer is sucked with this jet pump driving water, and the driving water and driven water (suction flow) come together out of the jet pump and are fed into the core to cool the reactor.
- The reactor recirculation pump is of a centrifugal and variable speed type, equipped with a shaft seal of a mechanical seal type.



2-3 Image of Internal Equipment of PCV

- Many equipment are installed in PCV, which make accessing into PCV difficult

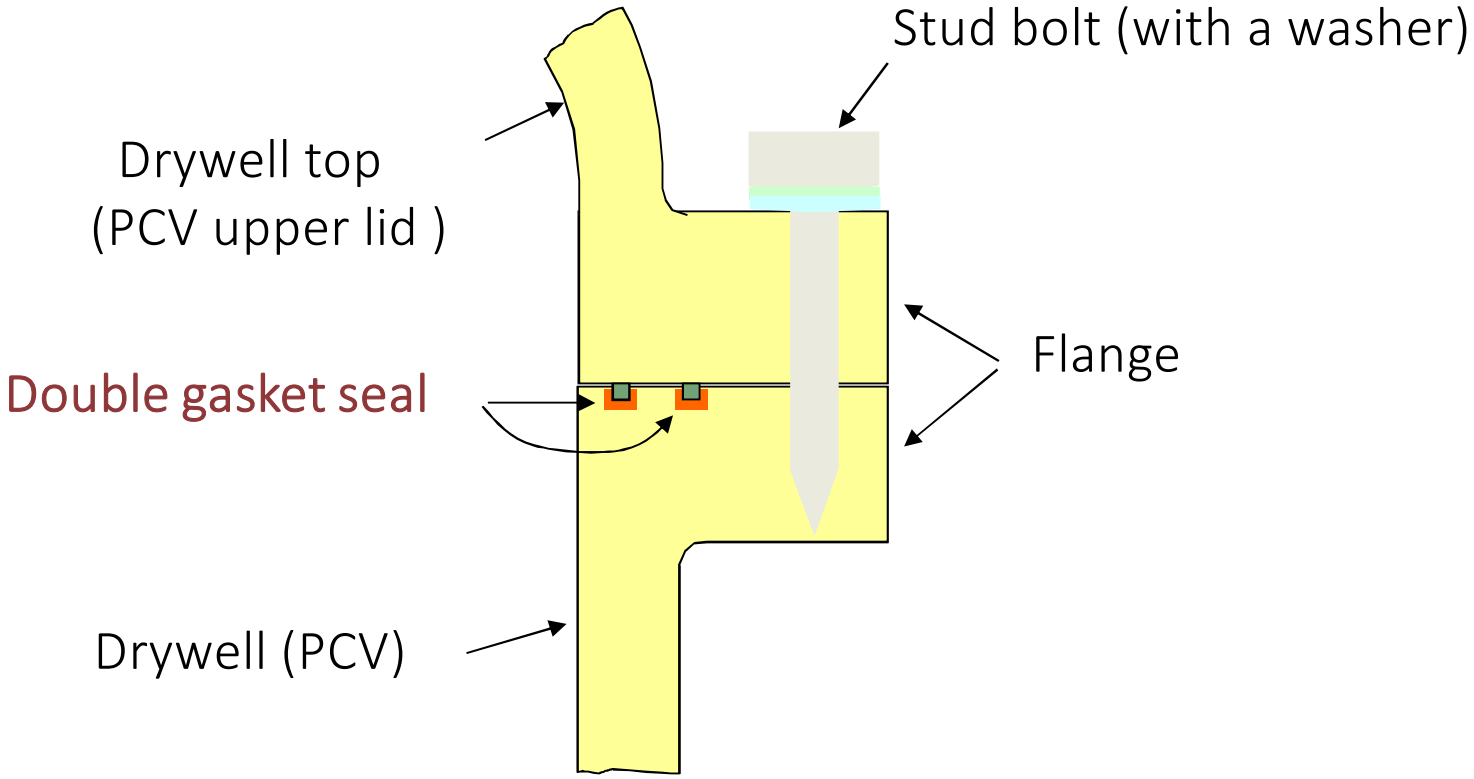


* Photos are taken at Unit 5 (Just for reference)

2-4 Drywell Top (Primary Containment Vessel Upper Lid)

- Image of drywell top is shown below as a reference to accessing from lateral side of PCV/RPV.

- Drywell top (upper lid of the PCV) is a semi ellipsoidal head (drywell head).
- It is bolted on with double gasket seal for mounting.

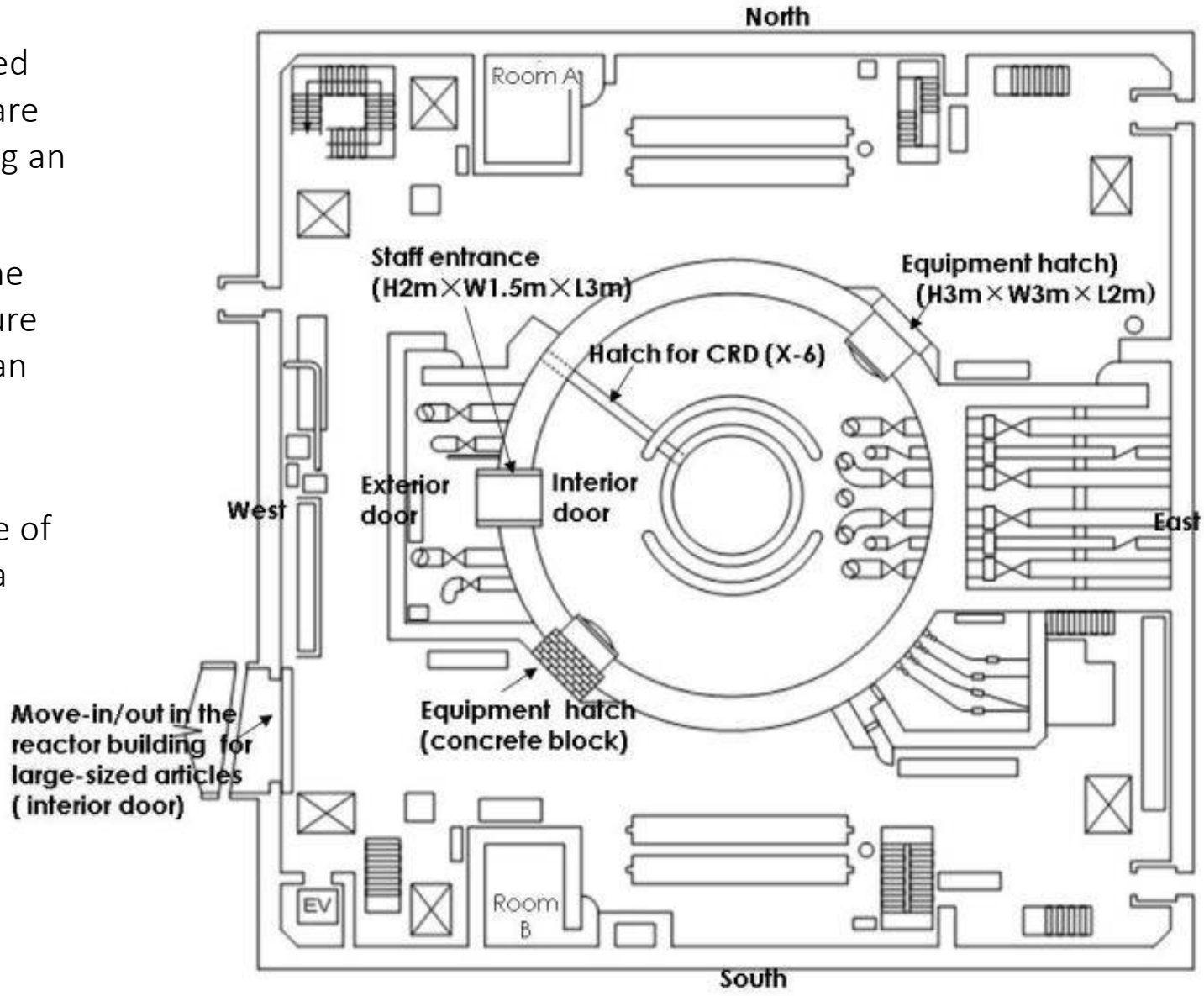


2-5 Equipment Hatch and Staff Entrance

■ Image of equipment Hatch and Staff Entrance are shown below as a reference to accessing from lateral side of PCV/RPV.

- The equipment hatches are installed symmetrically at two spots . They are opened for such purposes including an inspection of the equipment.
- The staff entrance is installed at one spot. It is made of a double structure consisting of an interior door and an exterior door.
- The move-in/out for large-sized articles is installed on the west side of the reactor building. It is made of a double structure consisting of an interior door and an exterior door.

* Dimensions represent approximate values.

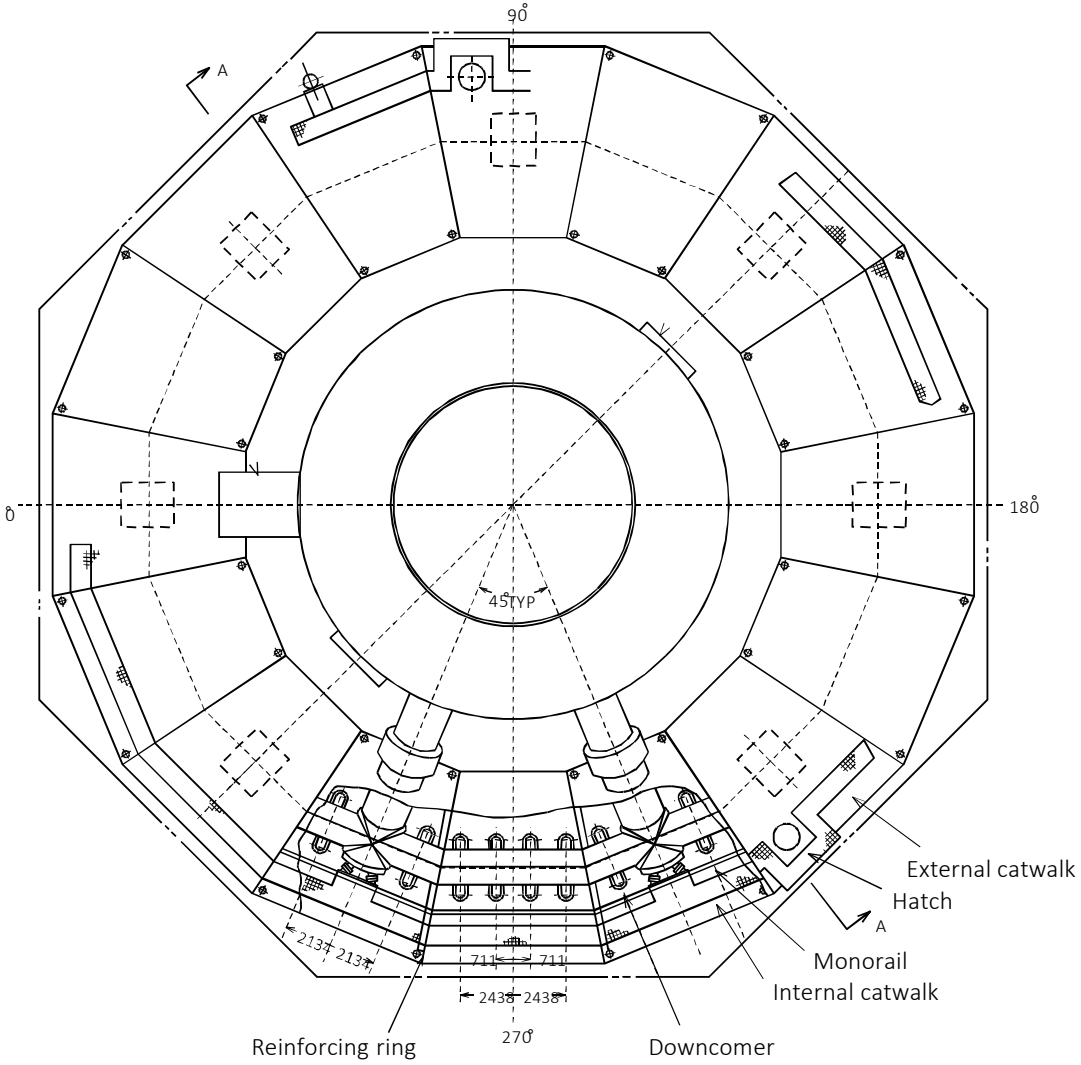


2-6 Bottom part of PCV

■ Bottom part of PCV is shown below as a reference for accessing from bottom side of PCV/RPV.

Pressure suppression chamber

- The pressure suppression chamber is installed on top of the ferro-concrete foundation of the reactor building and supported with the earthquake-resistant supports and the column supports.
- Its shape is a doughnut-like torus. It contains about 3000m^3 of water inside. This torus consists of 16 diagonally cut pieces of circular cylinder connected together and assembled.
- The vent pipe header, downcomer, etc. are contained inside the pressure suppression chamber and in addition, the vacuum breakers, a catwalk for inspection and maintenance, etc. are also installed.
- A catwalk for inspection and maintenance and a bolt-on hatch with double gasket seal for internal inspection are installed outside the pressure suppression chamber.



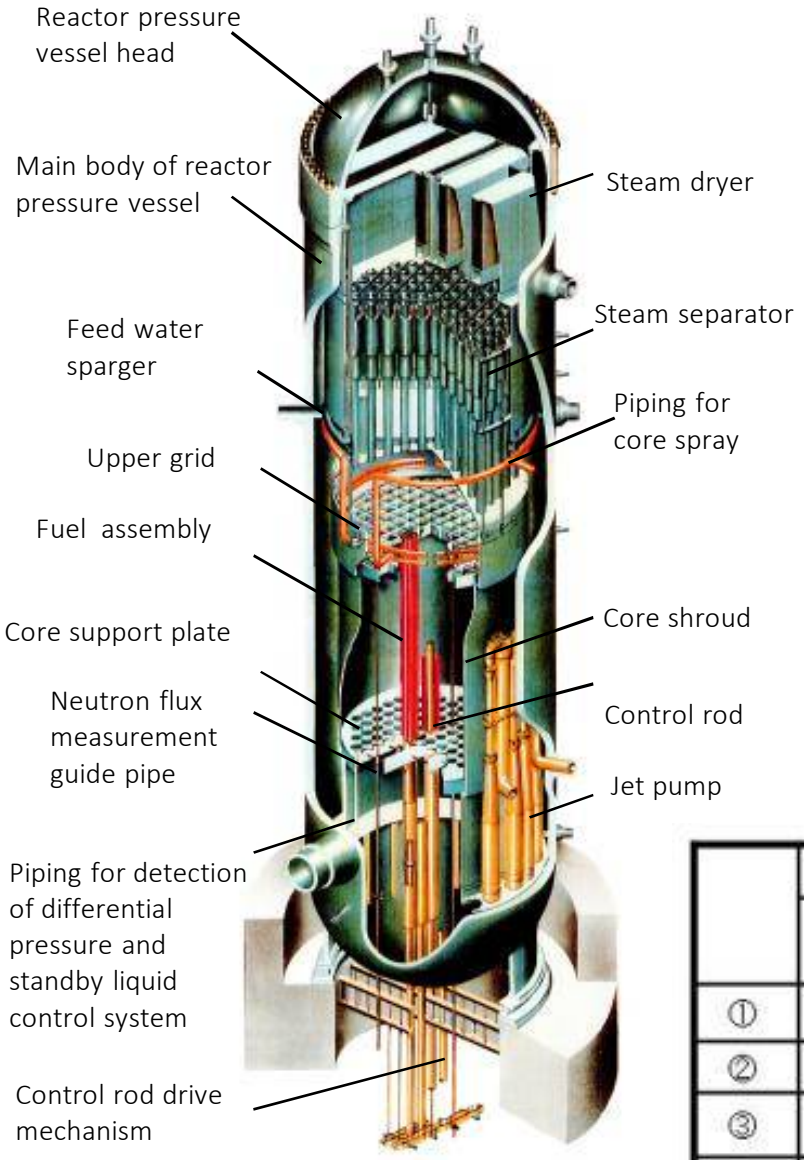
Cross-section of S/C

3. Reactor Pressure Vessel

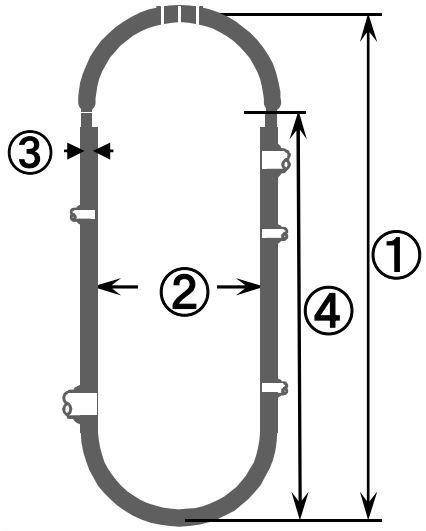
No.	Item	Reference for
3-1	Reactor Pressure Vessel	Access to RPV/PCV, Fuel debris retrieval
3-2	Description of Core Internals	
3-3	Reactor Pressure Vessel and Major Nozzles	
3-4	Reactor Pressure Vessel Support Structure	Access to RPV
3-5	Piping for Detection of Leak from the Reactor Pressure Vessel Flange	
3-6	Control Rod Drive Housing	

3-1 Reactor Pressure Vessel

■ The size and structure of RPV are shown below.



- A welded structure consisting of a perpendicular cylindrical section and a hemisphere shell section.
- Stainless steel lining is welded on the internal wall of the cylindrical section and the lower refractive spherical shell. The cladding is about 3mm in thickness. The head has no stainless cladding.
- The head is fastened with stud bolts and nuts using a stud bolt tensioner.

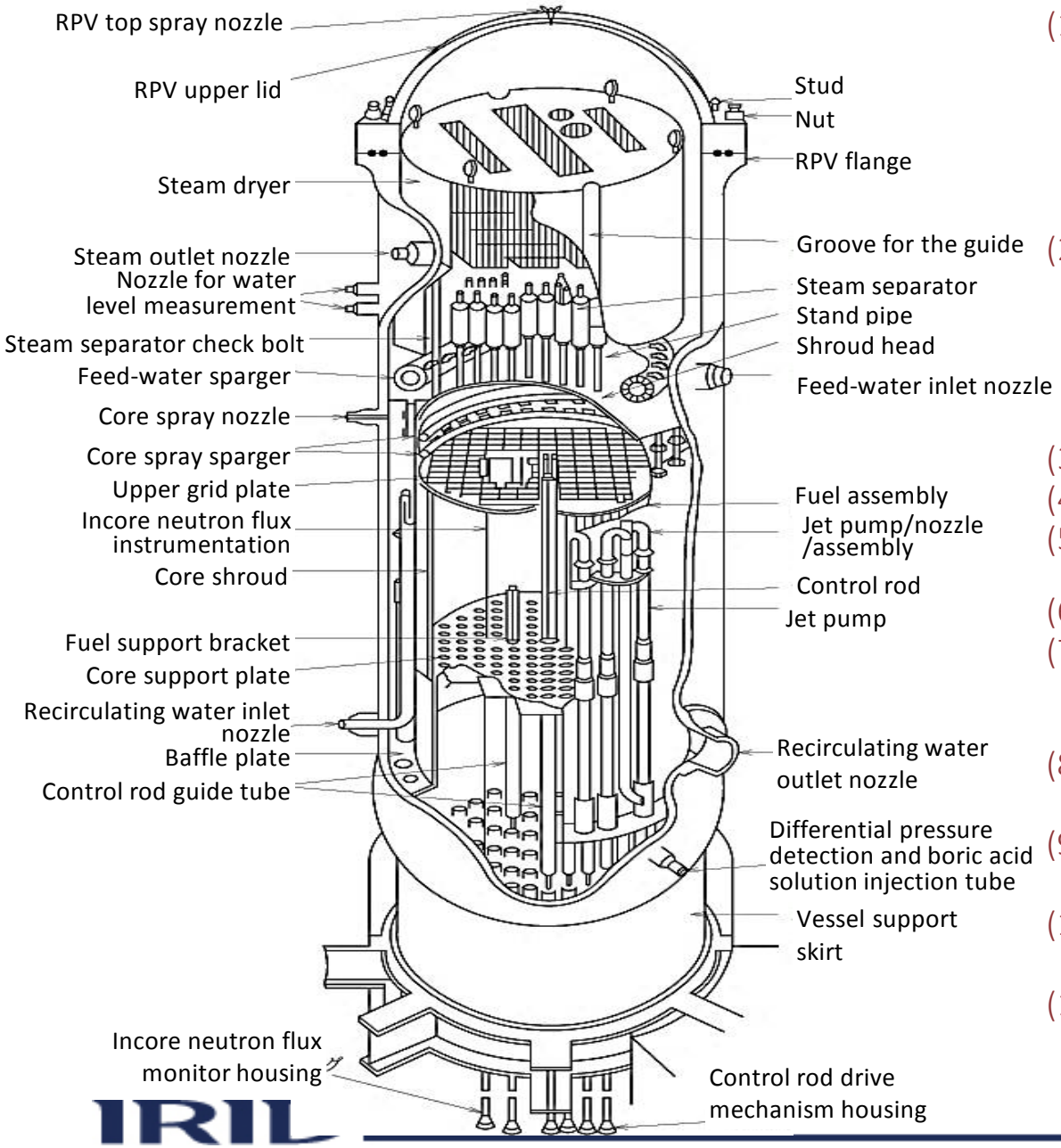


Size of RPV

	Unit 1		Unit 2		Unit 3	
	Approx. dimensions	Material	Approx. dimensions	Material	Approx. dimensions	Material
①	ca. 19m	Carbon steel (with stainless steel lining)	ca. 21m	Carbon steel (with stainless steel lining)	ca. 21m	Carbon steel (with stainless steel lining)
②	ca. 4.8m		ca. 5.5m		ca. 5.5m	
③	ca. 16cm		14cm		14cm	
④	ca. 16.5m		ca. 18.4m		ca. 18.4m	

3-2 Description of Core Internals

■ Name and structure of core internals are shown below.



(1) Core shroud

Outside diameter of the upper shroud: about 4.8m;

Outside diameter of the middle section of the shroud: about 4.5m

Wall thickness in the central part: about 4cm; mass: about 34 tons

(2) Shroud head

Thickness of the head: about 5cm; number of air-water separator s: 151; outside diameter of the air-water separator: about 34cm; inside diameter of the stand pipe : about 15cm; outside diameter of the stand pipe: about 17cm; total mass : about 42 tons

(3) Core support plate: mass: about 5 tons

(4) Upper grid plate: mass: about 5 tons

(5) Fuel support: number of peripheral type: 12; number of central type: 137

(6) Control rod guide tube: number: 137

(7) Jet pump: number: 20

Diameter of the throat: about 17cm ; total mass: about 10 tons

(8) Feed-water sparger : number: 4

Outside diameter: about 14cm; wall thickness : Sch. 40

(9) Core spray sparger

Diameter: about 10cm; number of spray nozzle: 344

(10) RPV top spray nozzle

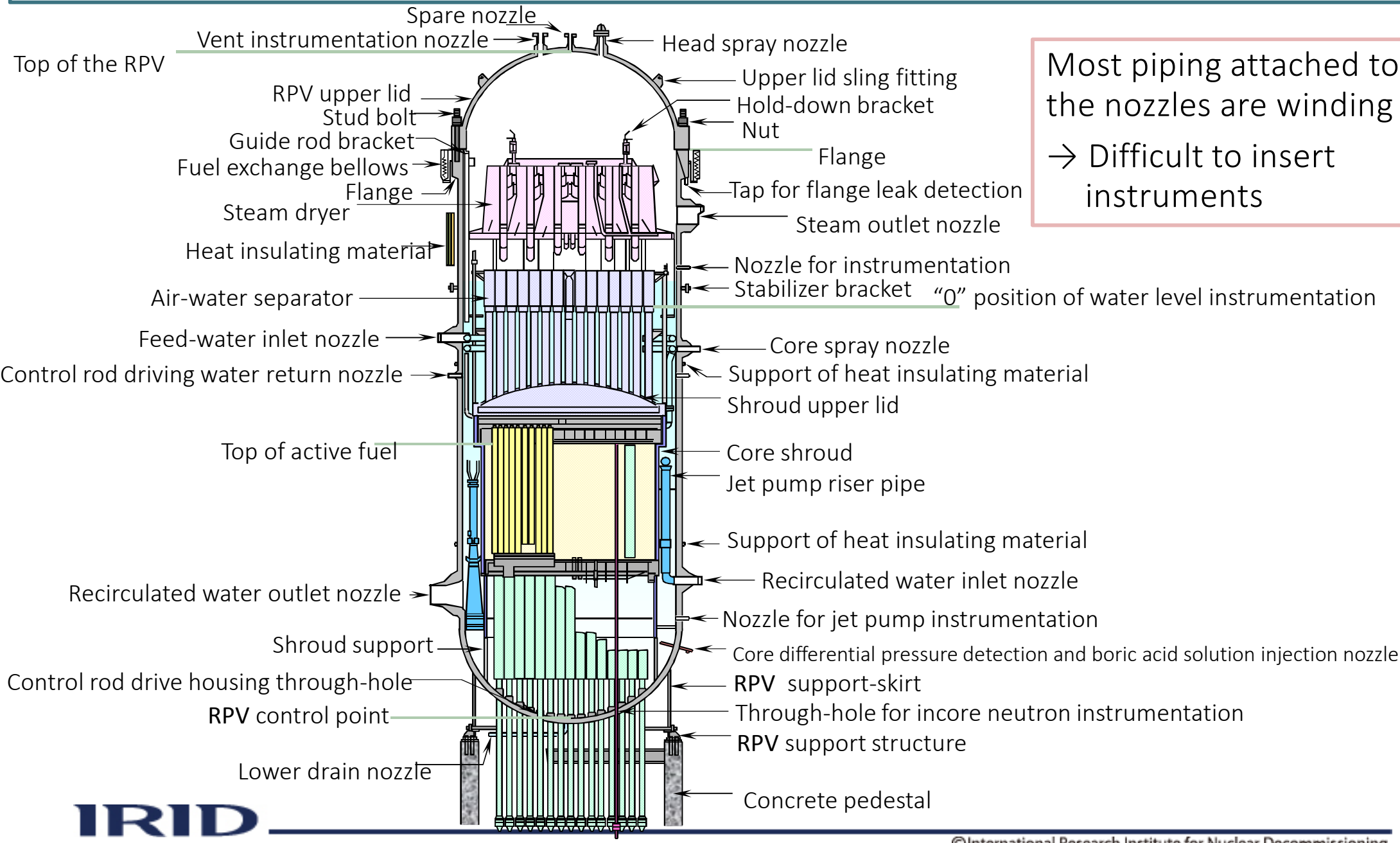
Outside diameter of pipe: about 6cm; wall thickness: Sch. 40

(11) Pipe for core differential pressure detection and injection of boric acid solution

Inner pipe (boric acid solution): about 2,5cm; outer pipe: about 5cm

3-3 Reactor Pressure Vessel and Major Nozzles

■ The name and rough position of nozzles on RPV are shown below.



Most piping attached to the nozzles are winding

→ Difficult to insert instruments

3-4 Reactor Pressure Vessel Support Structure

Name and structure of RPV supports are shown below.

1. Pressure vessel stabilizer

(1) The pressure vessel stabilizer connects the vessel with the shield wall in a manner to allow the vessel to expand in the radial and axial directions of the upper part of the vessel and at the same time to limit vibration in the horizontal direction so as to withstand earthquake and jet reaction force.

(2) Eight stabilizer brackets are attached to RPV. The individual stabilizers consist of a gusset plate located at the upper surface of the shield wall, a clevis (u-shaped fastening device) to be connected to the stabilizer bracket with a pin, and a spring coupling rod.

(3) Two stabilizers are attached to each bracket to add tensile force in the opposite direction.

(4) Initial load is added with the tensioner.

2. RPV support structure

(1) Setup of RPV support structure

(a) Concrete pedestal

(b) Anchor bolt

(c) Sole plate

(d) Ring girder

(e) RPV support-skirt

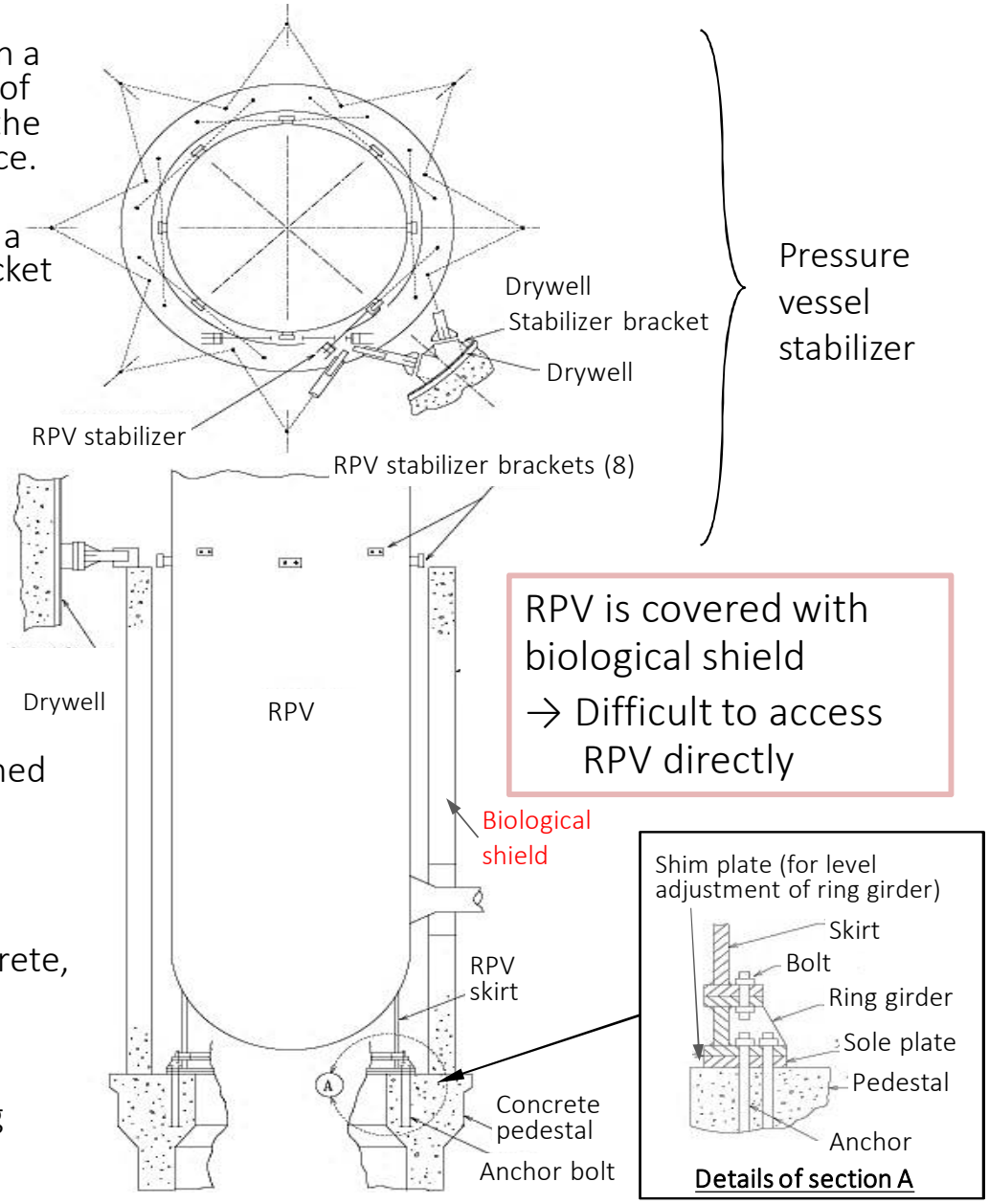
(2) The location of the pressure vessel support structure shall be determined in between RPV support-skirt and the concrete pedestal and it shall be firmly fixed.

(3) The concrete pedestal shall be constructed as an integral part of the foundation of the building, in which steel anchor bolts are embedded.

(4) The sole plate shall be installed horizontally on the top surface of concrete, and the ring girder shall be placed atop.

(5) RPV support-skirt shall be placed on top of the ring girder and bolted together.

(6) Adjusting shim plates shall be inserted between the sole plate and ring girder to make the ring girder level

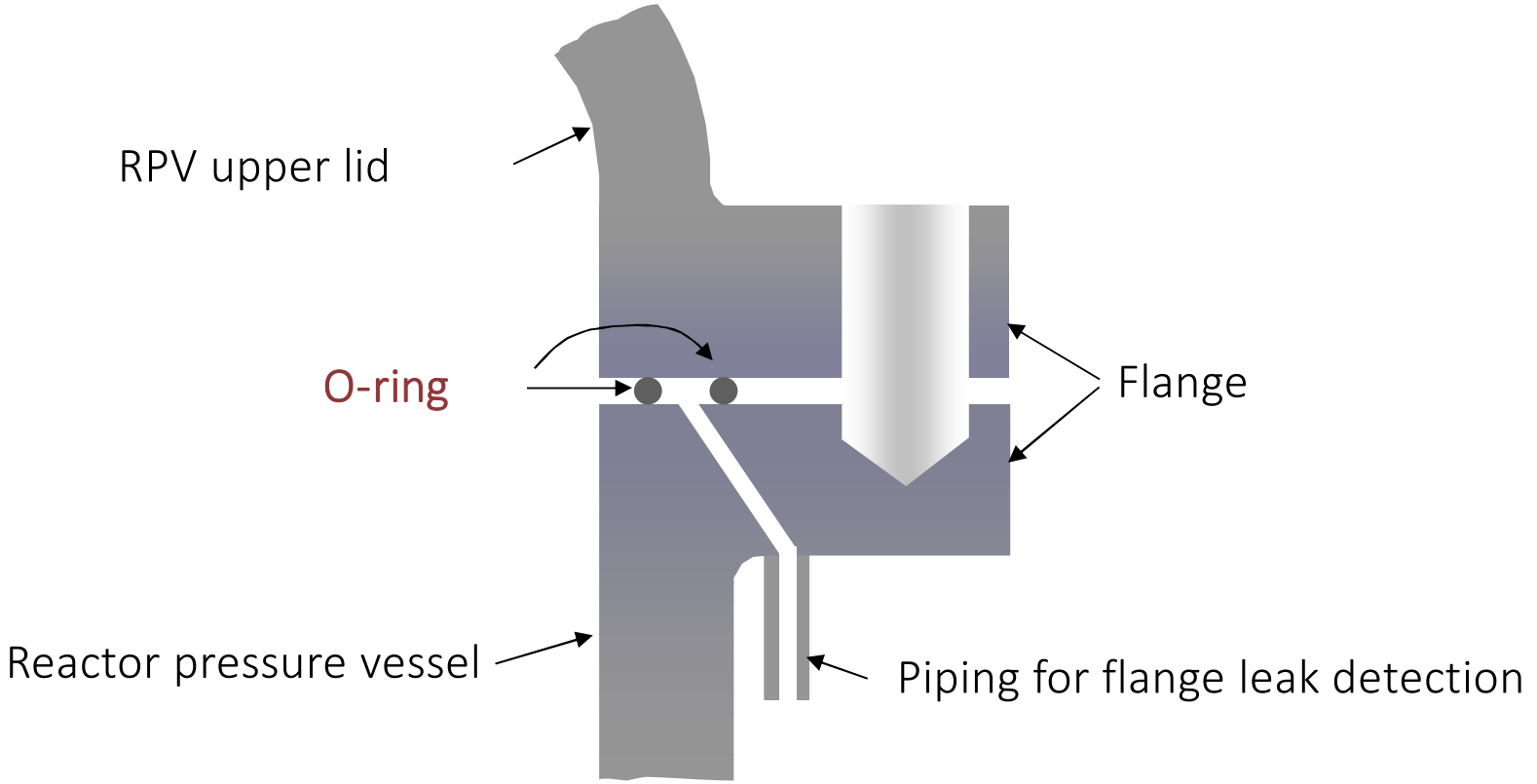


RPV is covered with biological shield
→ Difficult to access RPV directly

3-5 Piping for Detection of Leak from the Reactor Pressure Vessel Flange

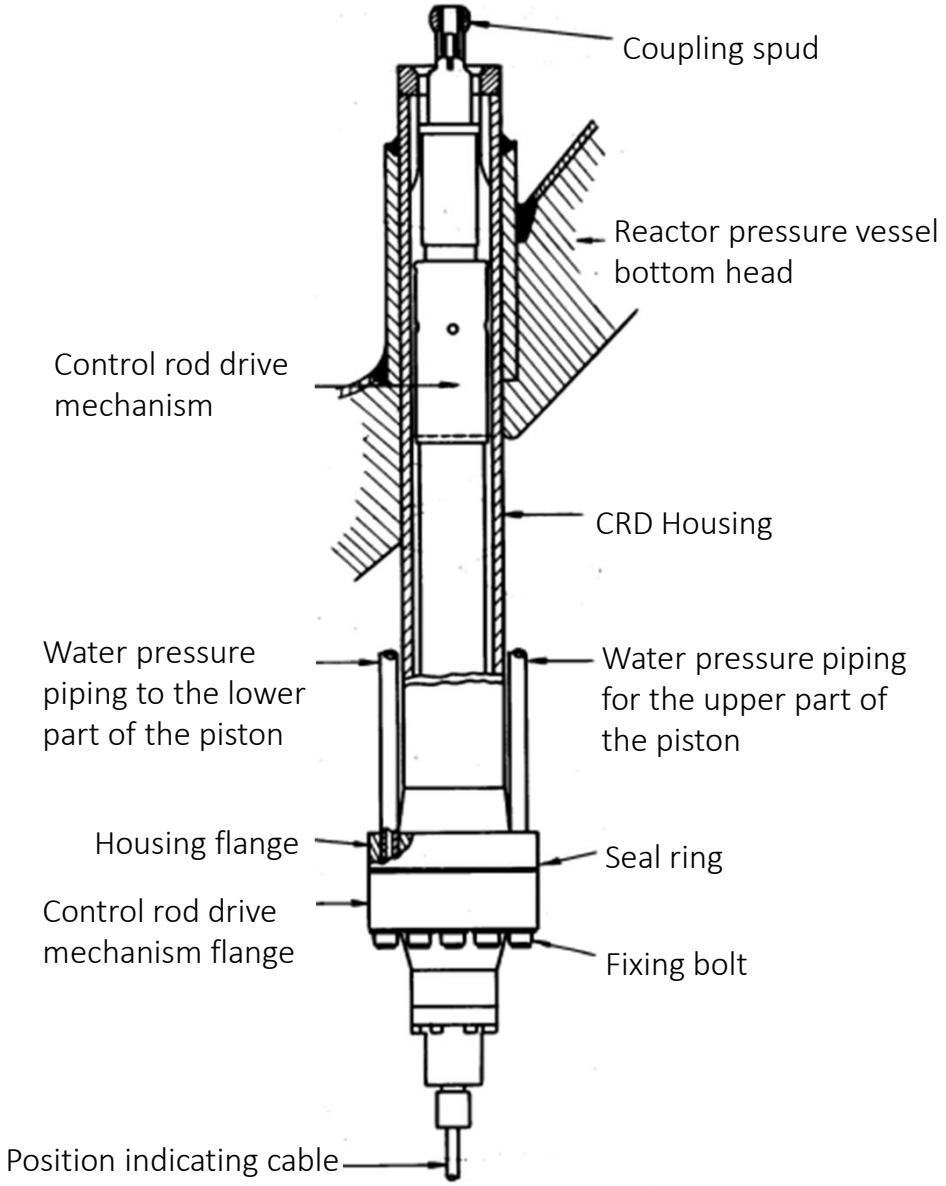
- The structure of RPV flange is shown below to consider accessing and fuel debris retrieval from top side of RPV.

- Flange leak detection piping is installed for detection of steam leak from the flange part of RPV during the operation of the reactor.
- The flange part of RPV is sealed with double O-rings and the detection piping is connected in between.



3-6 Control Rod Drive Housing

- The structure of CRD drive housing is shown below to consider accessing and fuel debris retrieval from bottom side of RPV.



(1) The control rod drive housing is attached to the bottom head of RPV.

(2) The load of control rod, guide tube, fuel support and fuel is applied to the vessel bottom head through this housing.

Major Information Sources

1. METI HP for Fukushima restoration (METI HP)
http://www.meti.go.jp/english/earthquake/nuclear/decommissioning/index.html

2. Mid and Long-term Roadmap and Planning for R&D (METI HP)
http://www.meti.go.jp/english/press/2013/0627_01.html
http://www.meti.go.jp/english/press/2013/pdf/0627_01.pdf

3. International Symposium on March in 2012 organized by METI (METI HP)
http://www.meti.go.jp/english/earthquake/nuclear/decommissioning/20120315_01.html

4.Information regarding to accidental Analysis results (TEPCO HP, etc)
http://www.tepco.co.jp/en/nu/fukushima-np/images/handouts_120312_04-e.pdf
https://fdada.info/