

Refurbishing ACPF for Pyroprocessing Technology Development at KAERI



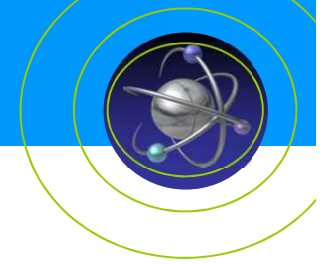
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Contents



I. Background

II. Overview of PRIDE

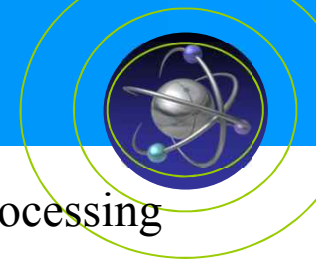
- *PRIDE: PyRoprocess Integrated inactive DEMonstration facility*

III. Refurbishment of ACPF

- *ACPF: Advanced spent fuel Conditioning Process Facility*

IV. Summary

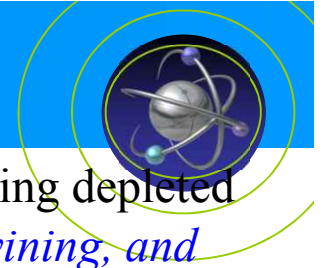
I. Background



- ◆ The Korea Atomic Energy Research Institute (KAERI) has been developing pyroprocessing technology, which is considered one of the promising fuel cycle options in Korea.
 - *Spent fuel management policy in Korea will be established based on open discussions and public consensus considering R&D activities and results on various nuclear fuel cycle options.*
- ◆ Pyroprocessing is an electrochemical recycling technology to recover valuable resources (U, TRU, etc.) from spent fuels in molten salt media at 500~650°C.
 - *Consists of head-end, electrolytic reduction, electro-refining, electro-winning, and waste salt treatment*
- ◆ Each of these processes using simulated fuel has been independently studied at the lab-scale at KAERI.
- ◆ KAERI constructed a mock-up facility, called **PRIDE** (**PyR**o**process** **I**ntegrated inactive **D**emonstration facility) in 2012.
 - *To demonstrate an engineering-scale integrated pyroprocessing experiments of all the five processes using depleted uranium or surrogates*
- ◆ As of 2015, KAERI has been refurbishing **ACPF** (**A**dvanced spent fuel **C**onditioning **P**rocess **F**acility) constructed in 2005.
 - *To demonstrate a lab-scale electrolytic reduction process of pyroprocessing using spent nuclear fuel in an argon atmosphere*

II. Overview of PRIDE

Outline



- ◆ Inactive test facility for verifying a full spectrum of pyroprocessing technology using depleted uranium or surrogate - *head-end, electrolytic reduction, electro-refining, electro-winning, and waste salt treatment processes*
- ◆ Design completion: early 2009
- ◆ Construction completion: late 2012
 - Constructed by refurbishing the aged ADU (Ammonium Di-Uranate) conversion facility located at the KAERI site
- ◆ Layout
 - Three-story building: an air cell on 1st floor and an argon cell through 2nd/3rd floors
 - Argon cell: 40.3 x 4.8 x 6.4 (LxWxH)m with 6-mm-thick SS walls and a 10-mm-thick SS floor, and a total volume of 1,240 m³
- ◆ Operating conditions of argon cell
 - Temperature/Pressure: 25 to 40 °C / -50 to 20 mmH₂O
 - Impurity levels of oxygen and moisture: below 50 ppm



[Aged ADU conversion facility]

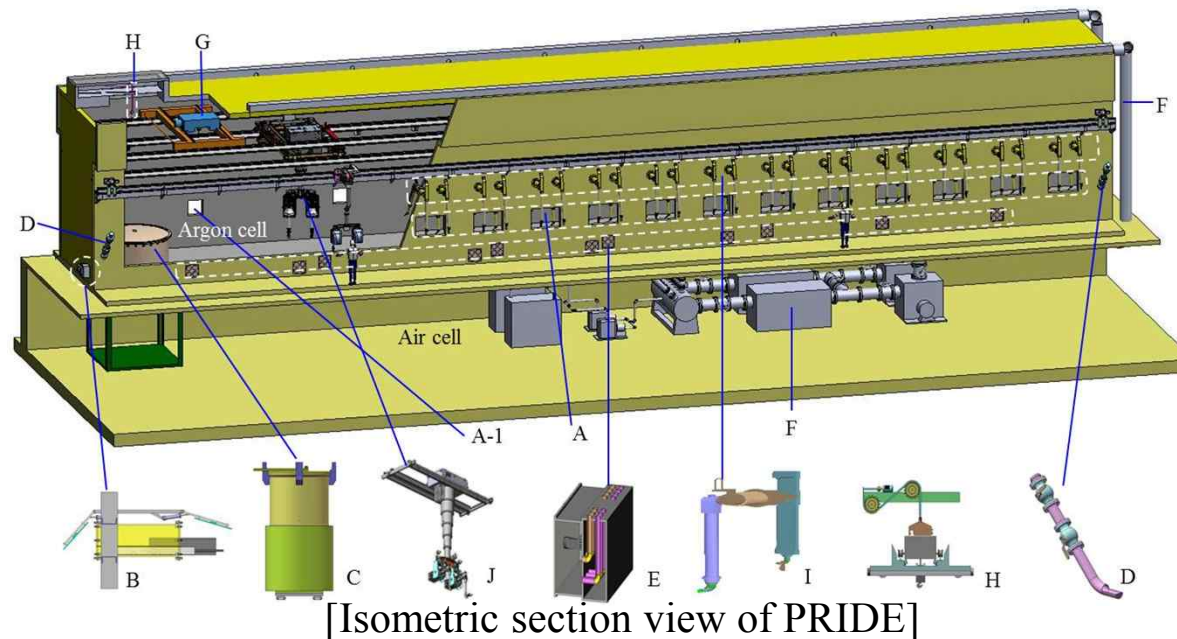
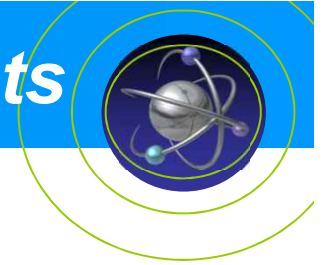
Refurbished



[PRIDE constructed]

II. Overview of PRIDE

Components



[Isometric section view of PRIDE]

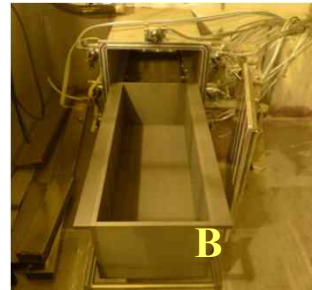
- ◆ Cell equipment (A-F)
 - Windows (17 front, A, 5 rear, A-1), Small transfer lock (B), Large transfer lock (C), Gravity tube (D)
 - Feed-throughs (E), Argon utility system (F)
- ◆ Remote handling systems (G-J)
 - Crane (G), Blister (H), Master-slave manipulators (I), Bridge-transported Dual arm Servo-Manipulators (J)
- ◆ In-cell monitoring systems: not shown
 - Cameras (12), O₂ concentration analysers (9), Moisture analysers (9), Pressure sensors (3), Temperature sensors (3), Temperature line sensors (111 points on the walls, 26 points on the outside floor, 16 points on the outside ceiling)

II. Overview of PRIDE

Components



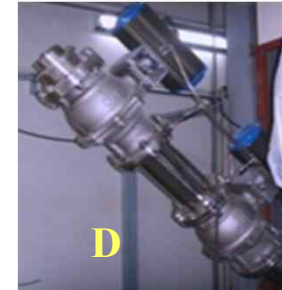
Small/Large TLS closed



Small TLS opened
[0.9x0.3x0.25 (LxWxH) m]



Large TLS opened
[ϕ 2.6x2.3 m]



Gravity Tube



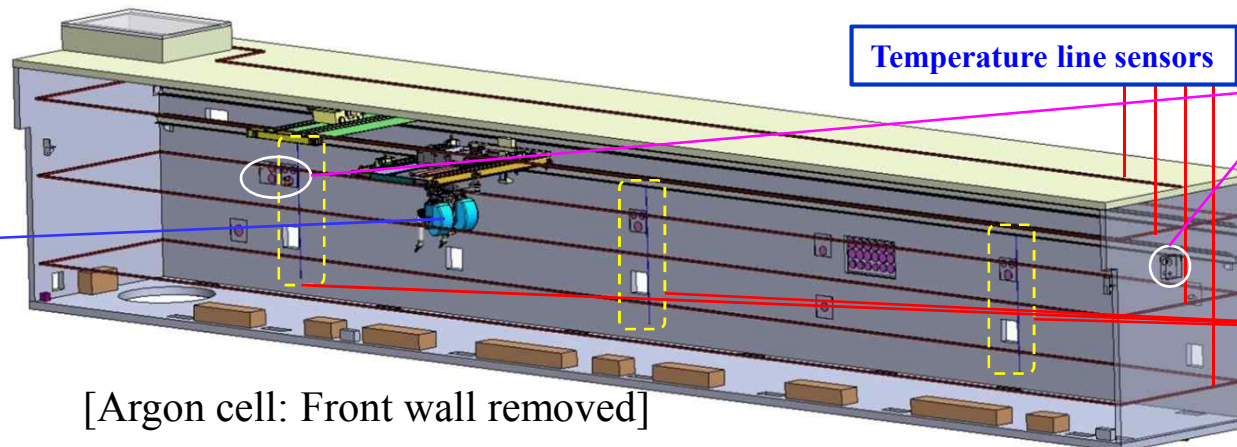
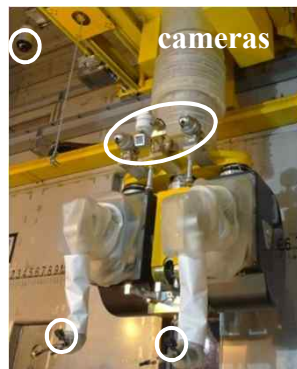
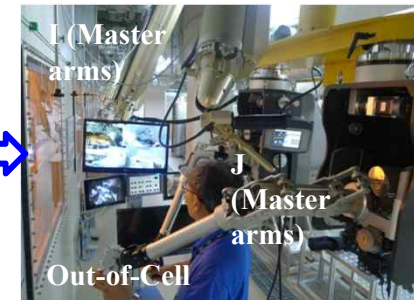
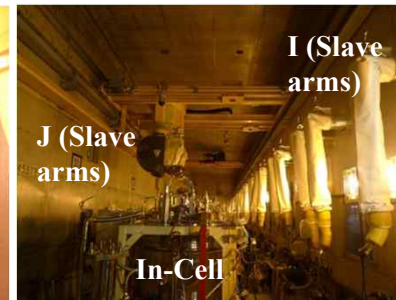
Feed-throughs



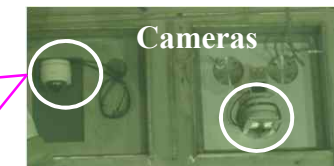
Argon utility system



In-cell lamp

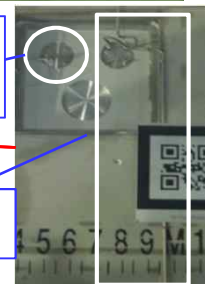


[Argon cell: Front wall removed]



Pressure/
Temp.
sensors

O₂/Moisture
sensors

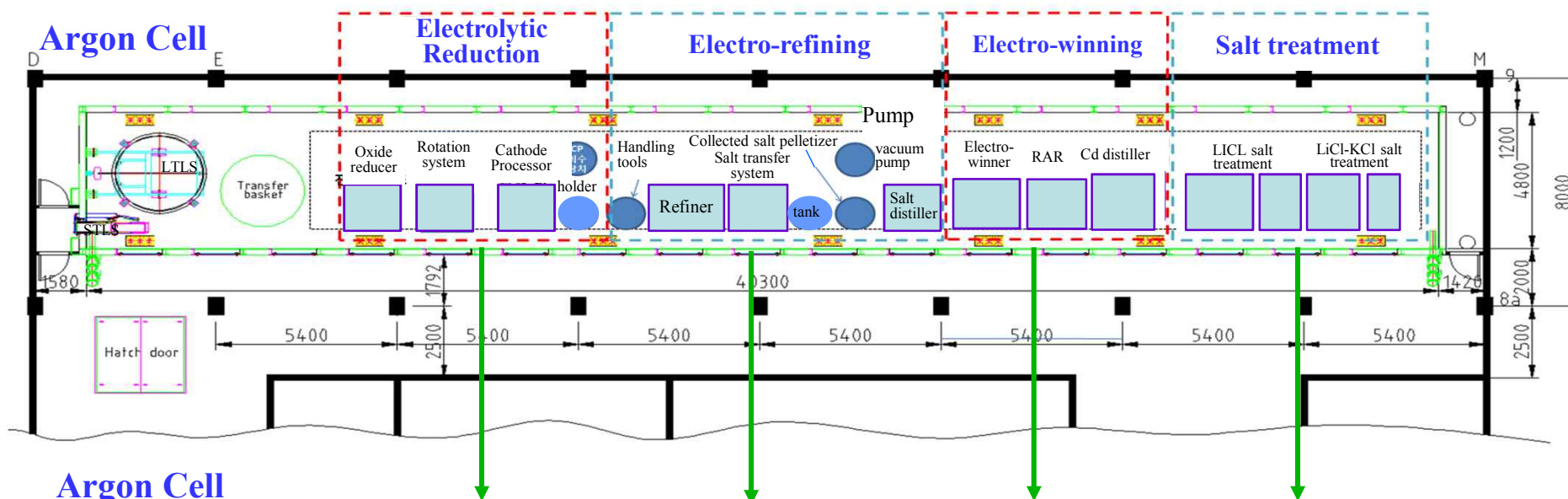


II. Overview of PRIDE

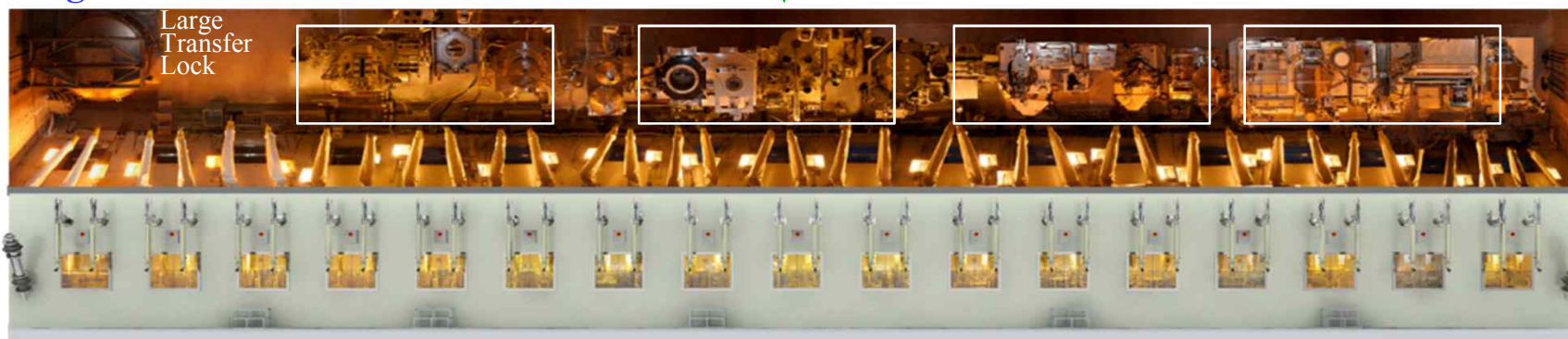
Arrangement

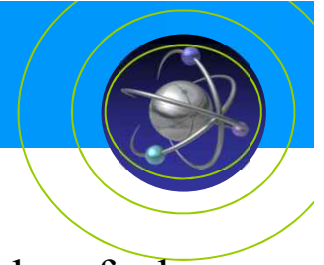


- ◆ Four Major Processes
- ◆ Processing equipment installed in the argon cell: Thirteen major equipment and auxiliary devices



Argon Cell



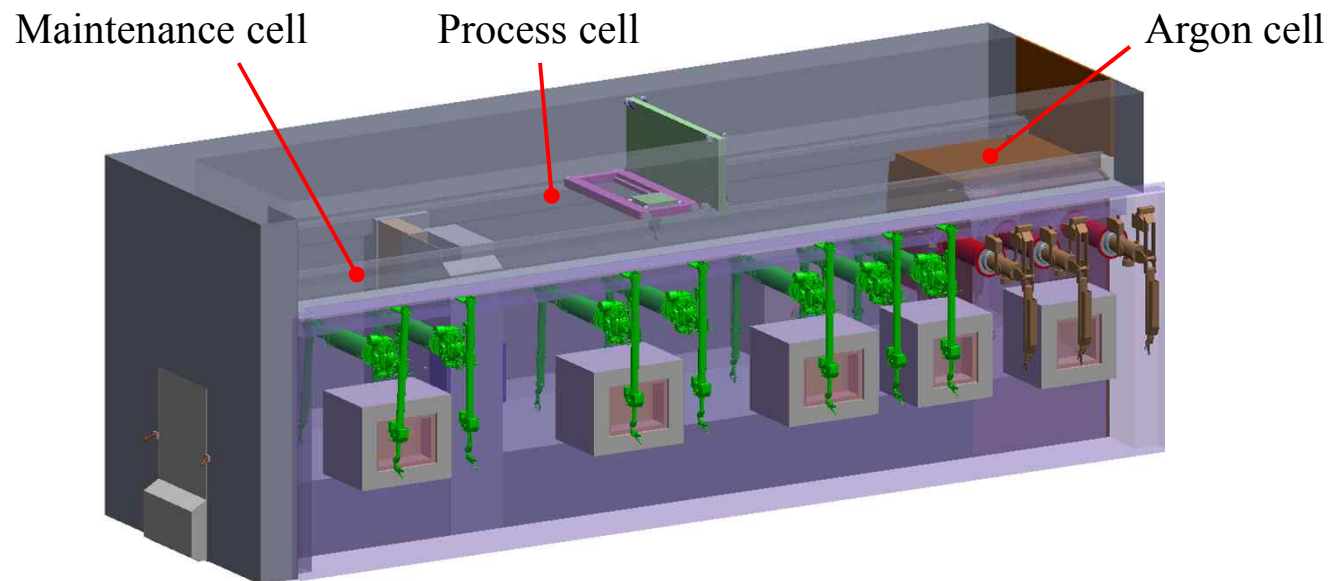


- ◆ ACPF: Advanced spent fuel Conditioning Process Facility
- ◆ Test facility for verifying a **lab-scale electrolytic reduction process** using spent nuclear fuel in an **air atmosphere** – a conditioning process to convert oxide form into metallic form of spent fuel and to isolate high heat-load fission products from spent fuel separately.
- ◆ Location: Basement of IMEF (Irradiated Material Examination Facility) at KAERI
- ◆ Construction completion: 2005
- ◆ Layout
 - Configuration: 11.0 x 2.0 x 4.3 (LxWxH)m with a wall thickness of 0.9 m
 - Maintenance cell and process cell with an air atmosphere
 - Five shielding windows, ten master-slave manipulators, one overhead crane, one gate crane



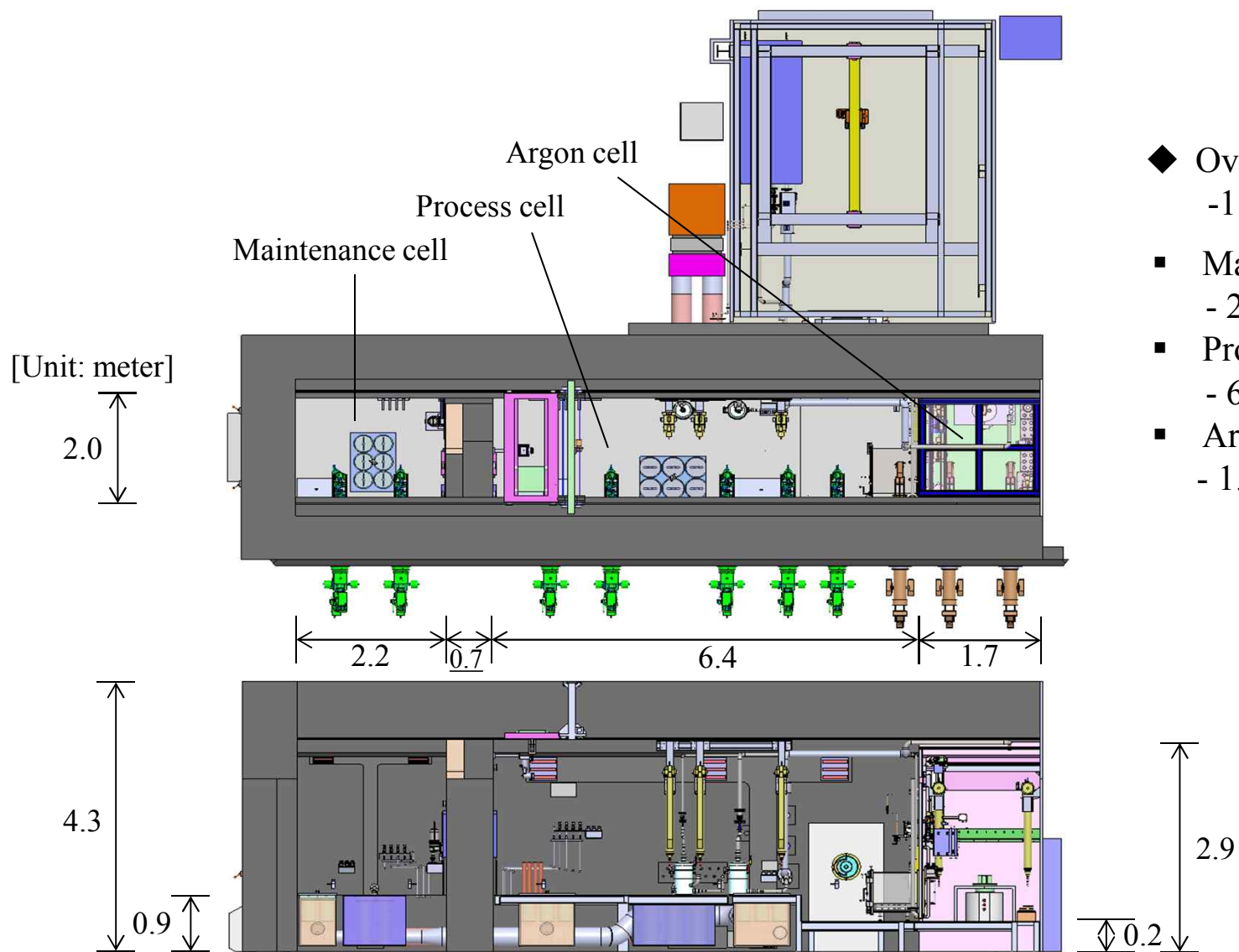
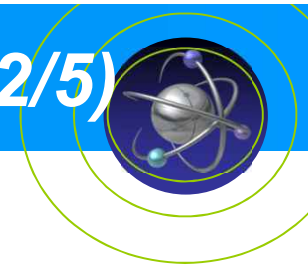


- ◆ To demonstrate a lab-scale electrolytic reduction process of pyroprocessing using spent nuclear fuel in an **argon atmosphere**
- ◆ Refurbishing periods: 2012 through 2016
- ◆ Scope of refurbishment
 - Construction of an **additional argon cell** inside of the ACPF process cell with an air atmosphere
 - Isolation room, in-cell structure, remote handling systems, cell equipment or devices, etc.



III. ACPF

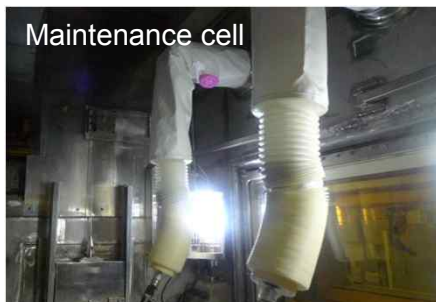
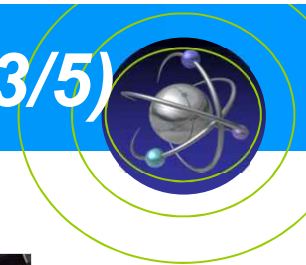
Refurbishment(2/5)



- ◆ Overall cell configuration
- 11.0x2.0x4.3 (LxWxH)
- Maintenance cell
- 2.2x2.0x3.4 (LxWxH)
- Process cell
- 6.4x2.0x3.4 (LxWxH)
- Argon cell
- 1.7x2.0x2.7 (LxWxH)

III. ACPF

Refurbishment(3/5)



Maintenance cell



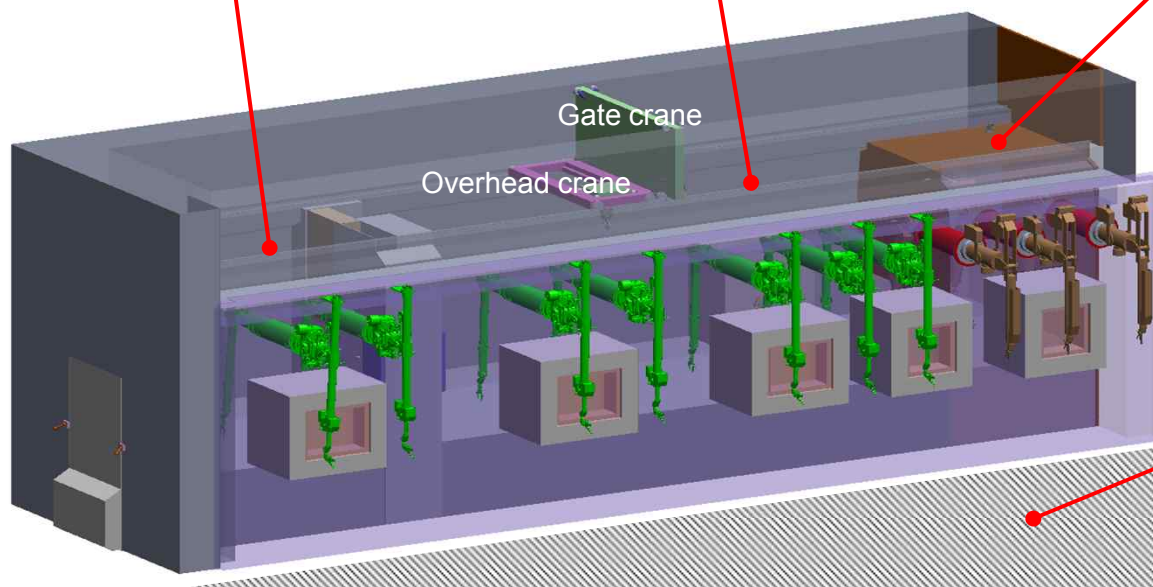
Process cell

MSMs



Argon cell

Spare
Slave arms



Gate crane

Overhead crane

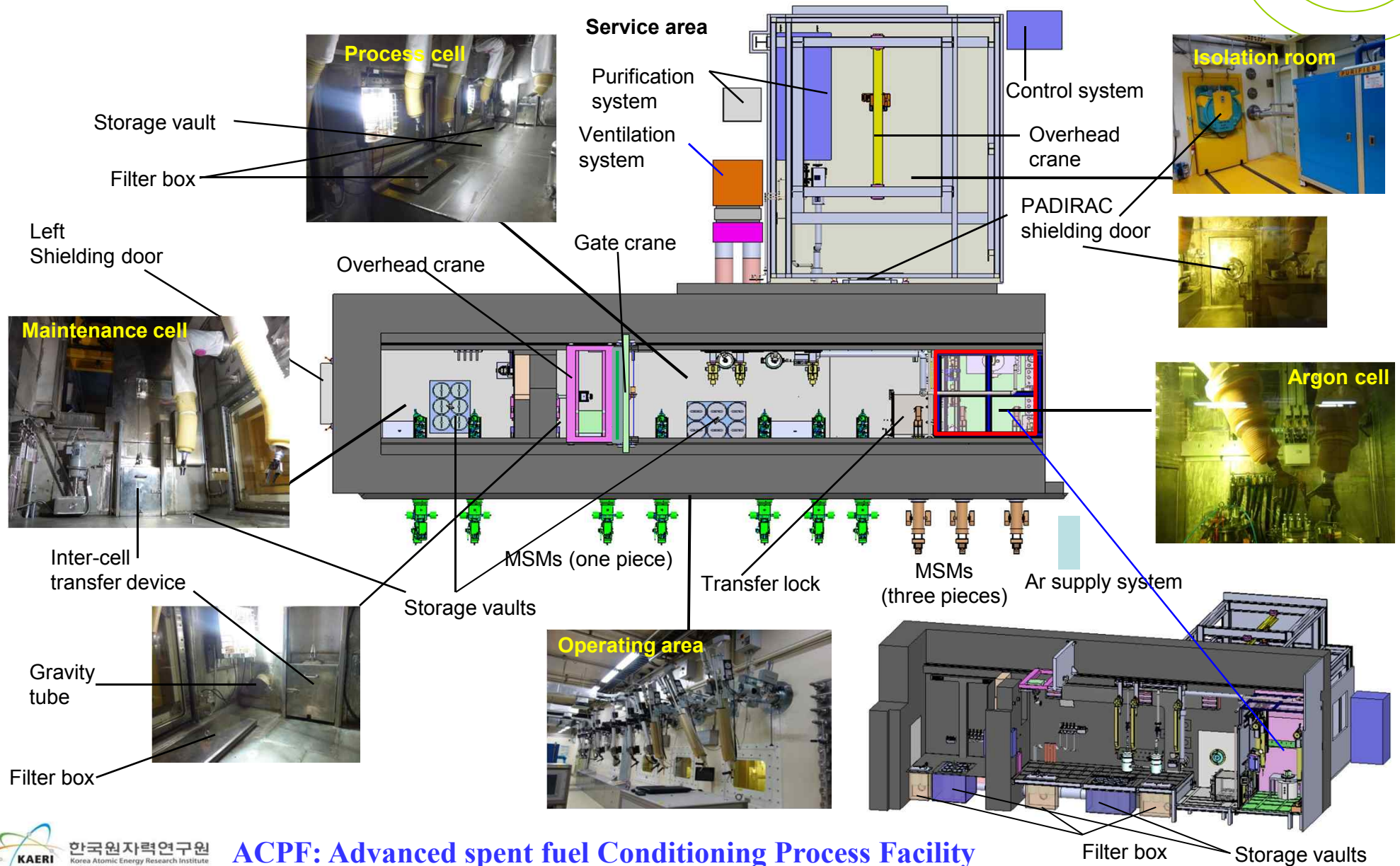


Ar supply
system

Operating area

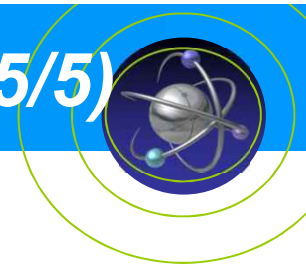
III. ACPF

Refurbishment(4/5)



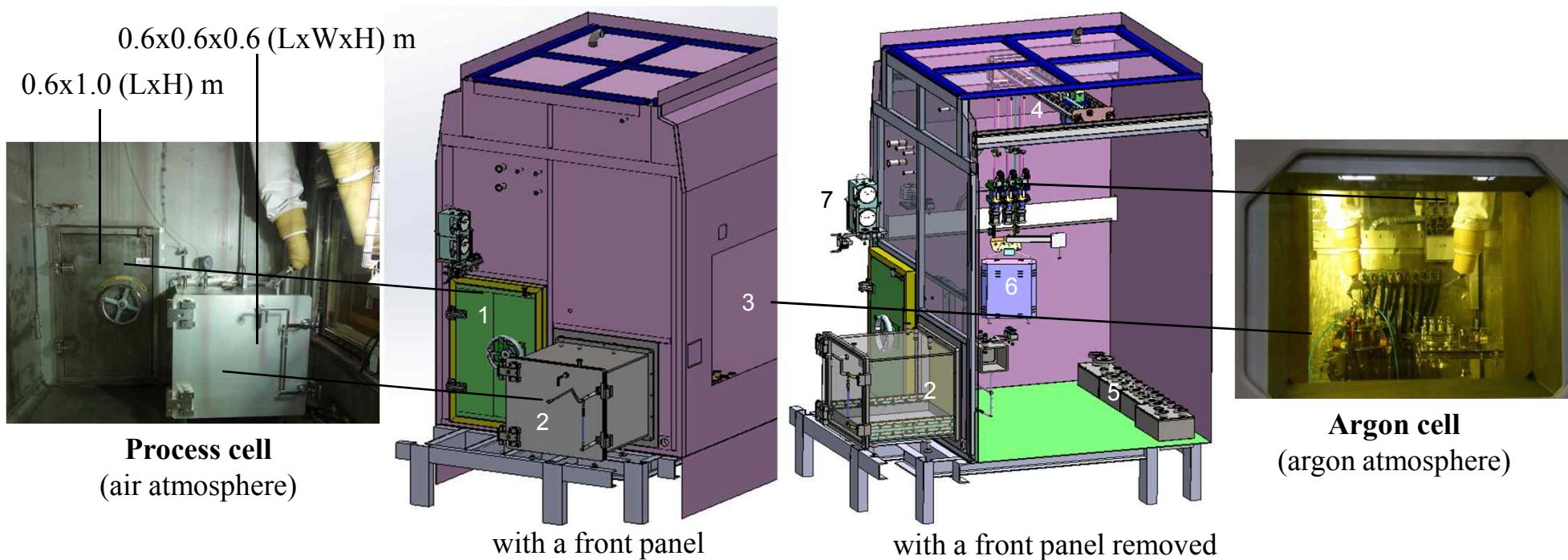
III. ACPF

Refurbishment(5/5)



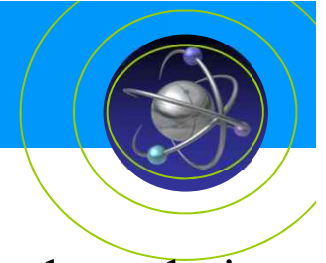
◆ Operating conditions of argon cell

- Temperature/Pressure: $< 38\text{ }^{\circ}\text{C}$ / -37 to -27 mmH₂O
- Impurity levels of oxygen and moisture: below 1 ppm



- 1: Entrance door, 2: Transfer lock (max. transferring capacity of 100-kg), 3: Shielding window,
4: Crane (150-kg), 5: Feed-throughs, 6: Cell light (one 250W metal halide lamp, one 100W three-wave lamp),
7: Temperature/pressure sensors

IV. Summary



- ◆ KAERI has been refurbishing ACPF constructed in 2005 to demonstrate an electrolytic reduction process of pyroprocessing using spent nuclear fuel in an argon atmosphere.
- ◆ An additional argon cell was constructed inside of the process cell.
 - The gas-tightness test of the argon cell was completed meeting all the facility design requirements.
- ◆ The relevant cell equipment, devices, tools and utilities necessary for the refurbished hot-cells have been refurbished or newly fabricated from remote operation and maintenance viewpoints.
- ◆ Blank tests and remote handling tests of the refurbished ACPF hot-cells are being conducted partially and will be completed by early next year.
- ◆ Processing equipment installation in the argon cell and salt tests will be followed.
- ◆ Experiments on an electrolytic reduction process using spent nuclear fuel in the argon cell are not scheduled yet.