PRE-OPERATION TESTS OF A PYROPROCESS INTEGRATED INACTIVE DEMONSTRATION FACILITY

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PRIDE (PyRoprocess Integrated inactive Demonstration facility)

**Pyroprocessing**  Handling active metal and deliquescence molten salts materials

*An inert atmosphere environment is required*

- Leak tightness to minimize air ingress into the argon cell / Prevent air ingress when transfer material into the cell
- Negative pressure control for a safety reason
- Closed argon re-circulation system
- Remote operation and maintenance

- The PRIDE has been developed to fulfill these requirements
- The impurity (oxygen and moisture) level of the inert cell is controlled below 50ppm

*Performance evaluation is in progress.*
OVERVIEW OF PRIDE
Overview of PRIDE

• Purpose
  – To evaluate performance (cold-run) and scale-up issues of full-spectrum pyroprocessing technology

• Construction and Operation Plans
  – Design: 2007 ~ 2008 (2 years), Construction: 2009 ~ 2011 (3 years)
  – Operations: 2012 ~

• Main Features
  – Pyroprocess test & demonstration with depleted uranium or surrogate up to engineering scale
  – Argon gas-filled cell for pyroprocessing work (impurity level below 50ppm)
  – full remote operation and maintenance concepts
  – Argon cell size: 40m(L) × 4.8m(W) × 6.4m(H), about 1200 m³
Overall Layout of PRIDE

2nd Floor

Oxide reducer
OR cathode processor
Electrorefiner
Salt distiller
Salt transfer
Electrowinner
Residual Actinide Removal
Cd distiller
Oxidative precipitator
Crystallizer

1st Floor

Solidification equip.
U-chlorinator
U ingot casting furnace
Kiln-type voloxidizer
• 10 main equipment for 4 pyroprocesses
  – Installation of 14 process equipment has been completed in the Ar cell.
Cell Equipment of PRIDE Ar Cell

- **Crane handling hoist**: 3 ton, 1.15 m/min, remotely maintained by Crane handling hoist.

- **In-cell Crane**: 3 ton, 1.15 m/min, remotely maintained by Crane handling hoist.

- **BDSM & MSM**
  - 34 Cell lights
  - 17 Windows
  - 34 MSMs (master)

- **Small & Large equipment Transfer Lock System**
  - 0.9x0.3x0.25 m, Interlocked control
  - 2.6x2.3 m, Interlocked control

- **2 Gravity Tubes**
  - φ0.13x0.32 m, Interlocked control

- **Operation area**
  - BDSM (master)
  - 34 MSMS (master)
All equipments have been designed to be remotely operable and maintainable.
Utility systems of PRIDE Facility

- PRIDE Utility system for control of cell operation conditions
  - Argon supply system, cooling system, purification system, relief system
  - Concentration of impurity: oxygen < 50 ppm, moisture < 50 ppm
  - Cell temperature: 25~40 ℃
  - Cell pressure: -50 ~ -30 mmAq

- Sensor system for monitoring the cell states
  - Concentration of oxygen and moisture, off-gas (chlorine)
  - Pressure in the cell
  - Cell temperature: 153 points in the cell
Leak test
Ar charging
Investigation of effects of LTL

PRE-OPERATION TESTS OF PRIDE
Pre-operation Test: Leak Test

- Measurement of leakage rate (ingress rate)
  - Pressure decay method
  - According to ANSI/ANS 56.8

- Computation of ingress rate of the air weight
  - -125 mmAq initially
  - 4 hours for stabilization

- Measurement for 2 days
  - Cell pressure
  - 154 temperature line sensors

- Estimation by the least squares
  - 95% upper confidence level

0.14% wt./day
Pre-operation Test: Ar Charging

- **Sweep-through purge**
  - Oxygen & moisture concentration are monitored at 9 points

- **Three steps for gas exchange**
  - Step I: Ar charging into circulation pipes (red box)
  - Step II: Ar charging into the cell up to 200 ppm
    - Slightly positive pressure
    - From filter boxes on the floor of the cell
    - About 0.1 kgf/cm²
  - Step III: Using purification system
Pre-operation Test: Ar Charging

Result of Step I and II (The step III result is not shown here)
Pre-operation Test: Effects of LTL

Operation of LTL: Transfer of equipment/materials into/out of the cell
Pre-operation Test: Investigation of Effects of LTL

- LTL: Large equipment transfer lock system
  - Volume of LTL chamber: 12.1 m³
  - Predicted increase of oxygen concentration by LTL open without purge: 2095 ppm
    → Purge of LTL chamber is required

- Determination of the number of purge
  - Vacuum pump to 200 torr
  - 5 purges are required

\[ y_j = y_0 \left( \frac{P_L}{P_H} \right)^j \]

<table>
<thead>
<tr>
<th></th>
<th>without purging</th>
<th>after purge</th>
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<tbody>
<tr>
<td>Estimated increased O₂ concentration (ppm)</td>
<td>2095</td>
<td>39 (3 purges)</td>
</tr>
<tr>
<td>Measured increased O₂ concentration (ppm)</td>
<td>1431</td>
<td>5 (5 purges)</td>
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</tbody>
</table>
Conclusions

• Development of PRIDE facility is completed in 2012
  – Provided with large Ar cell and utilities
  – Provided with 17 windows, each window with 2 MSMs
  – Provided with one large and small transfer lock, two gravity tube, one 3-ton over-head crane, one 1 ton hoist, and one BDSM in cell

• Pre-operational tests are going on to evaluate performances
  – Operational and functional test of operation equipment and utility systems
  – Leakage test of Ar cell and auxiliary systems
  – Ar charging and purification
  – Performances of cooling systems during equipment operation

• PRIDE will be used for testing integrity of unit process, adaptability of remote operation, safegaurdability, etc.
  – Ready for salt test
THANK YOU FOR YOUR ATTENTION