KAERI

Preliminary Study on the Repair and Transportation Methods of Spent Nuclear Fuel Assembly in KAERI





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Status of Spent Fuels in KAERI-PIEF

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Introduction

Background

- KAERI has transported the spent fuels from nuclear power plants (NPP) to the PIEF for the purpose of research and development since 1987, and the fuels currently in PIEF storage pool.
- Significant changes in social & political environment around KAERI
 - √ The National Assembly, local governments, and local residents are constantly raising concerns over the risk of spent fuels and radioactive wastes stored in KAERI.
 - ✓ Claim to return of SF & No additional transportation.
 - √ Transparent disclosure of test activities & inspections by citizen
- KAERI promised to return all spent fuels in PIEF to the Nuclear Power Plants from 2021
 - √ However, this can be changed according to the local public acceptance and government's decision.



'고준위폐기물' 반입 사전 논의 없었다

후해연료가 대랑 보관 중인 것이 알려지 원자리언이 사용후핵연료을 대전으 Z 등이기 전에 주민과 논의는 위념 보고 나 동보 정차조차 없었다는 부분에 집타 18일 원자력인에 따르면 원내에는 사

액인료 399개, 총 1966개가 현재 관리 중

원자력연은 1987년 4월부터 2013년 8 월까지 고리 • 한빛 • 한윤 등 원자리밥 전소에서 21차례에 걸쳐 페인료봉을 옮 첫 이송이 시작된 지 약 20여년 가까

이 지난지만 유성구만을 비우려 대전시 만들은 이러한 사실을 까맣게 모르고 있 은 "폐기점이 유성에 있는 위자리언에

없는지는 전혀 알지도 못했고, 자금도 터치에서 배기됐어 대체으로 되어오는 지 이유도 누구 하나 설명해주는 사람 없 용추핵인료인 패인료봉 1390개의 손상 지나 17일 유하고도 페인티되어 대한 의견을 공식적으로 내보였다.

이 사실을 주민에게 알리지 않고 쉬쉬한 건 명백한 기만했위"라며 "위자의 인진 관리에 대한 정부의 안양한 대처가 드러 난 것"이라고 밝혔다.

이에 대해 원자력인 관계자는 "페인 医额外 多级的 医皮肤 医皮肤 医皮肤 발해 성능과 안전성 연구를 진행하기 위 송해 왔다"고 설명했다.

또 미리 패언료봉의 이승에 대해 밝히 다 않은 이유에 대해 원자락인 관계자는 *쇼키 케이 아니카 규정상 텔어컨보이 이송 시간, 절차, 장소 등은 사전에 알리 지 않게 돼 있다"고 말했다 그러나 아직 주만들은 불안감을 감추

'대전시민은 무조건 안전하니 믿으리 원자력연구시설 측의 땅을 믿을 수 연고 그들이 내부하이고 자체적으로 6 다는 '안전 감증'도 신뢰할 수 없다"다 "대전의 시민사회단체와 주민 대표, 4 민족이 사람한 마찬 제화가들은 구성5 경증단을 통한 3차 경증이 필요하다"고

200L) 중재준위 폐기물과 고준의 폐기 설에 해당하는 액인료봉 1966개가 모두 대회에 되가 좋아 제이 등이나 시민들이 게 충격을 주고 있다"며 "대전 시민들음 위한 정부 차잎에서의 대책 마련이 시급 하다"고 주장했다.

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분위이 소요된 원으면 제되되다"가 되되어

다네에 검색 연구가입자 성들 건축 등을 위

용후 하면도 중 일부를 제외하고 모두 방 - 함께보관하고 있다. 중지로 단환하고, 관련 정보도 무렵하게 공 - 일부에서 제기하는 일부에서 제거하는 일반일 주장에 대하

원자력연구원, "대전 반입 사용 후 핵연료 발생지로 반환 추진"

한 환경 유명인데 나타하다 났다 유명인 병에 "면 BL 998 Red Will GL7985 @20201 구가 전혀 겠어다니 예정한 전혀 제외하고 항용 공개에 왔다"며 "과거 언론되도나 -PO ESCHORUS WICHO'S BUSIONS OF 변화과 변환 관련 내용 등 정확한 정보함

CODANI CRIBATO-"ARROR MONEY MINES



20# 핵망한소 100만 대한사업은등 등장 선안 및 대한 핵인한대적 축구 기자회간 등 대고 있다. 인합사

KAERI Research Institute

1 Introduction

Introduction to KAERI-PIEF

Post Irradiation Examination Facility(PIEF) at KAERI

Overview

History

Construction: 1981 ~ 1985
Test Operation: 1986 ~ 1990
Normal Operation: Since 1991
Budget: 17 million dollars

 Total floor space: 758m² (two stories above ground and three underground levels)

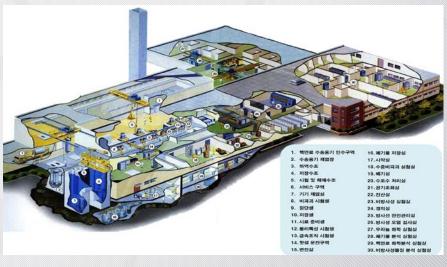
Function

- In-core Performance and Integrity Evaluation of Nuclear Fuels
- PIEs of PWR Fuel in Pool and Hot Cells
- PIEs for Research/Development in the field of Nuclear Materials & Fuels in Domestic Companies and Foreign Institutes

Main Facility

- 3 Pools: Unloading Transportation Cask, Storage of Nuclear Fuels, Pool Side Inspection and Dismantling of Fuel Assembly
- 6 Hot Cells: 4 Concrete Cells (Wall Thickness 85 cm),
 2 Lead Cells (Wall Thickness 15 cm)
- Hot Laboratory: Mechanical Test of Irradiated Cladding and Irradiated Spacer Grid





1 Introduction

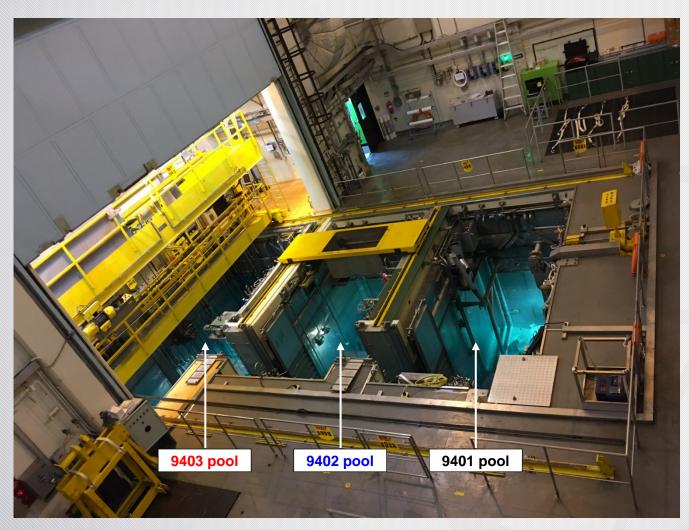
Introduction to KAERI-PIEF



- Visual Inspection (storage pool)
- Specimen preparations, Non-destructive examinations, Dimension measurements (Hot cell)
- Mechanical tests for cladding (compressive / fatigue / creep tests), Hydrogen analysis, Delayed hydride cracking
- Microstructure / Composition analyses for fuels using SEM, EDS, EBSD, WDS (Hot lab)



PIEF storage pool



- No.1 pool (9401)
- Cask unloading
- 6.5x3.0x15.5 (m)
- No.2 pool (9402)
- Storage of Spent Fuels
- 6.5x3.0x10.0 (m)
- No.3 pool (9403)
- Dismantling & Inspection
- 7.5x3.9x15.5 (m)

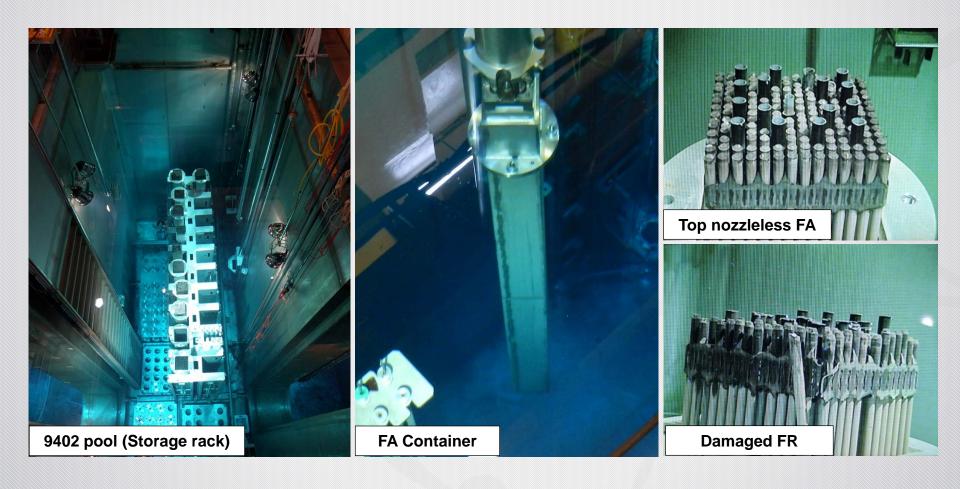


9401 pool - Cask unloading



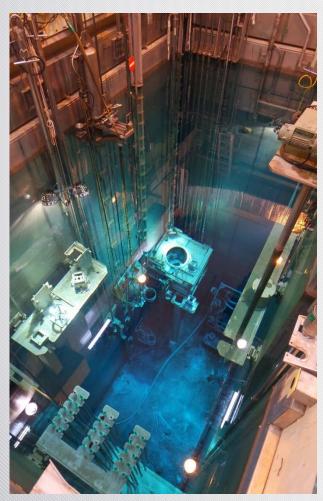


9402 pool - Storage of Fuel Assembly and Fuel Basket





9403 pool - Dismantling & Inspection









Information of Spent Fuels(SFs)

Status of SFs in PIEF	
Туре	Location
1 Intact Fuel Assembly	FA basket (storage rack)
7 Damaged FA (without top nozzle)	FA basket (storage rack)
Intact and damaged Fuel Rods	FR basket (storage rack)
Rod fragments / mounted specimen	Rod Cut Container(RCC)

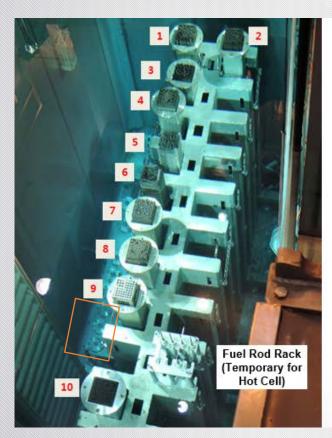
~ 1700 fuel rods received from Nuclear Power Plant (stored in the storage pool)

Characteristics of fuel rods

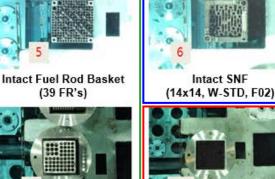
- ✓ Max. diameter of spent fuel rod : ≤ 10.7 mm
- ✓ Max. length of spent fuel rod : ≤ 4094.5 mm
- ✓ Max. enrichment of U-235 : assumed less than 5 wt%
- ✓ Max. discharge pin burn-up: assumed less than 60 GWd/tU
- ✓ Min. cooling time: assumed longer than 6 months



Fuel Storage Rack







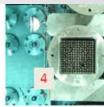




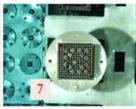
SNF w/o Top nozzle (14x14, W-STD, A39)



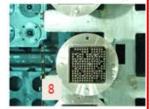
SNF w/o Top nozzle (16x16, KOFA, J44)



SNF w/o Top nozzle (14x14, W-STD, J14)



SNF w/o Top nozzle (14x14, W-STD, A17)



SNF w/o Top nozzle (14x14, W-STD, G23)



SNF w/o Top nozzle (17x17, V5H, K23)



Rod Cut Containers for fragment/specimen

1 intact FA

7 damaged FAs

2 Fuel Rod Baskets

Rod Cut Containers



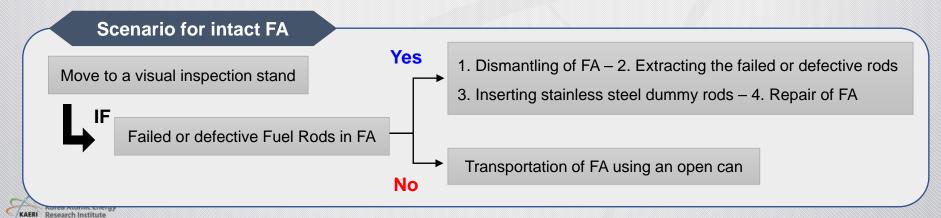
Intact Spent Fuel Assembly

- 1 Intact Spent Fuel Assembly
 - ✓ The safe handling of intact FA can be achieved without an additional task because of the top nozzle.
 - ✓ The transportation of intact FA using an open can will be adopted if there are no failed or defective fuel rods.

*WH STD 14 x 14 fuel assembly type (Kori Unit 1)







Damaged Spent Fuel Assembly

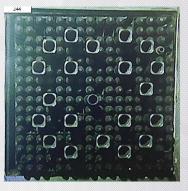
- 7 Damaged Spent Fuel Assemblies without top nozzle
 - ✓ The top nozzle was removed to extract the fuel rods for the purpose of research in PIEF
 - ✓ The repair of top nozzle is the first step to achieve the handling of FAs in the pool.

*Examples of damaged fuel assemblies without the top nozzle









Scenario for damaged FA IF there are failed or defective rods 1st top nozzle repair Move to a visual inspection stand Dismantling of FA

Extracting the failed or defective rods

Inserting stainless steel dummy rods

2nd top nozzle repair Transportation of FA using the open can



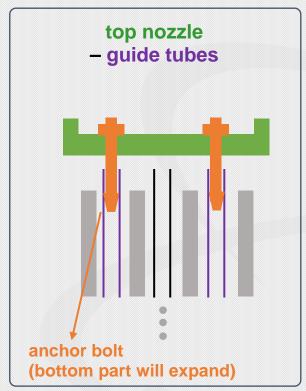
Damaged Spent Fuel Assembly

Possible solutions for the top nozzle restoration

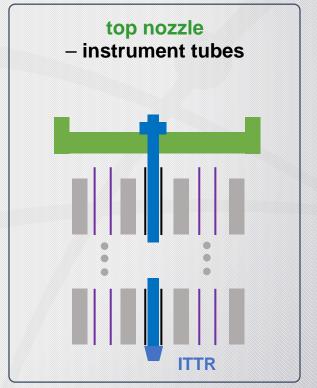
(1) Welding

top nozzle guide or instrument tubes dummy top nozzle fuel rods guide tube instrument tube

(2) Anchor bolt



(3) Instrument Tube Tie Rod, ITTR



: if these methods are not applicable,

the fuel rod containers (ex. Quiver) will be used after extracting all fuel rods.

Intact and Damaged Fuel Rods

- Fuel Rod Basket in the storage rack
 - ✓ Intact and damaged fuel rods are stored in the fuel rod baskets, respectively
 - ✓ Some fuel rods are stored in a storage rack in pool #3

FRs(Intact) in Basket

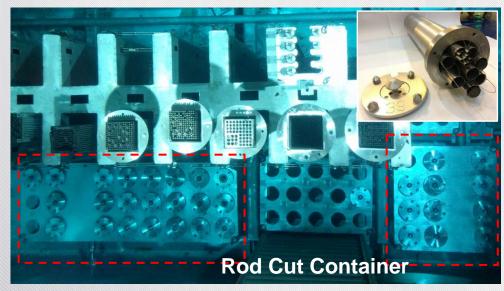


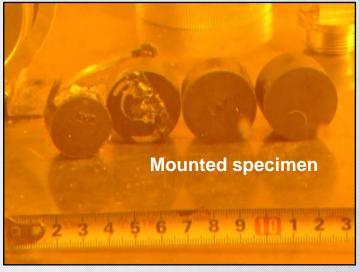


Fragments / Specimens

- Rod Cut Container(RCC) and specimen cask
 - ✓ Fragments and mounted specimens are stored in the RCC and specimen cask
 - ✓ The length of fragment: less than 45 mm
 - ✓ The size of **mounted specimen** will be reduced through a coring process (Diameter \leq 20 mm)

Fragments / Specimens



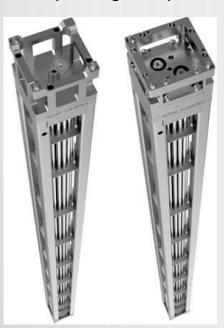




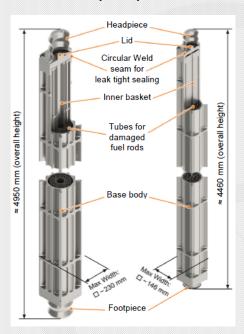
Fuel Rods and Fragments/Specimens

- Possible solutions for transportation of fuel rods and fragments/specimens
 - ✓ Following commercial spent fuel containers can be adopted.

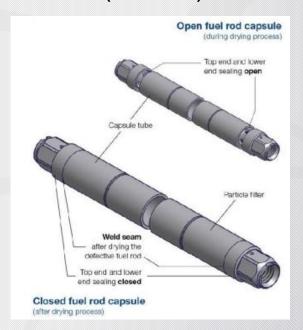
Quiver System (Westinghouse)



Integrated Quiver (GNS)



Opened/closed fuel rod capsules (Framatome)



< References for image >

- [1] Westinghouse Quiver Digital Handout, http://www.westinghousenuclear.com/
- [2] GNS IQ integrated Quiver System. http://www.gns.de/language=en/29870/quiver-iq
- [3] Matthew French, David Nixon, Roger Thetford, Mark Cowper, "Packaging of Damaged Spent Fuel", Amec Foster Wheeler, 204895-UA00, 2016.



3 Summary and Future Works

Conclusion

- Status of spent fuels in KAERI-PIEF has been introduced.
- KAERI-PIEF has been performed the preliminary study with Korea Hydro & Nuclear Power (KHNP) and nuclear power companies.
- To achieve the safe transportation and long-term storage of spent fuels in the NPP storage pool or interim storage site, it is essential to determine the optimum solutions based on the conditions of FAs, fuel rods, and fragments/specimens.
- KAERI will determine the optimum repair and canning solutions for FAs, fuel rods and fragments/specimens stored in PIEF.





감사합니다

Thank you for attention