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Status of the TRIGA Shipments to the INEEL from Europe

Presenter

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INEEL European Pre-Assessment

- Italy
  - Italian National Agency for New Technology, Energy and the Environment (ENEA), Rome
  - University of Pavia, Applied Nuclear Energy Laboratory [Universita di Pavia, Laboratoria Energia Nuclearie Applicata (LENA)], Pavia

- Romania
  - Institute for Nuclear Research (ICN), Pitesti

- Slovenia
  - Institute Jozef Stefan (IJS), Ljubljana

- Germany
  - Medical University of Hannover [Medizinische Hochshule Hannover (MHH)], Hannover
  - Institut Fur Kernchemie (IFK), Mainz
  - German Cancer Research Center [Deutsches Krebsforschungszentrum (DKFZ)], Heidelberg

INEEL European Pre-Assessment

Reactor:**ENEA, Rome, Italy**
Began Operations: began operations in 1959
Power: operated at 100 kW until 1968.converted into a 1 MW reactor
Uses: produce medical isotopes, neutron activation analysis, neutron radiography, and neutron diffractionation
TRIGA Fuel:

Total/Type/Enrichment:273 low enriched uranium (LEU) TRIGA fuel rods. There are 106 stainless steel rods in the reactor, 20 stainless steel fresh fuel rods in storage, and the remaining are stored in pits)

Spent:147 SNF rods (23 stainless steel stored in pits, 59 stainless steel stored in racks in the pool, and 65 aluminum rods

Future: They are anticipating making major electrical and mechanical upgrades of the facility and believe the reactor could operate for an additional 20 years. The ENEA wants to participate in a 1999 shipment, assuming the IU-04 shipping cask is available. They would keep the remaining SNF at the reactor until the end of the acceptance period for the program when more SNF is available. ENEA estimates generating one (1) SNF rod each year.

INEEL European Pre-Assessment

Reactor: **LENA,**University of Pavia**, Pavia, Rome**
Began Operations:1965
Power:250 kW
Uses: neutron activation analysis (NAA), boron neutron capture therapy (BNCT), and production of some medical isotopes. The NAA is used for carbon dating objects. The BNCT is focused on treating liver cancer
TRIGA Fuel:

Total/Type/Enrichment: 90 LEU TRIGA fuel rods 28 stainless steel and 53 aluminum
Spent:nine (9) damaged SNF rods

Future: LENA would like to operate the reactor an additional 5 to 7 years, however, 10 to 15 new TRIGA rods would be needed to extend the life of the core. Additional funding is being sought to procure the fuel. Until the funding issue is resolved, LENA does not know if they will participate in a 1999 shipment.

INEEL European Pre-Assessment

Reactor:**ICN, Pitesti**, **Romania**
Began Operations:1979
Power: two TRIGA reactors, a 14 MW Steady-State and an Annular Core Pulsing Reactor (ACPR)ACPR can be operated at a steady state mode of 500 kW or less and up to 20,000 MW in pulse mode.
Uses: in-core irradiation of experimental CANDU fuel, radioisotope production, and other scientific and technical applications.
TRIGA Fuel:

Total/Type/Enrichment:14 MW reactor was originally designed to run with 93% enriched 153 fuel elements which are 19.7% enriched 54 Incoloy TRIGA fuel clusters, 35 containing highly enriched uranium (HEU), at 93% enrichment, and 19 LEU. Each cluster consists of 25 fuel pins

Spent:11 spent HEU fuel clusters

Future:This conversion will be completed before May 2006, assuming replacement LEU clusters are available by 2001. ICN plans to ship a total of at least 40 fuel clusters, including all 35 HEU clusters, to the U.S. under the FRR SNF program.

INEEL European Pre-Assessment

Reactor: **IJS, Ljubljana, Slovenia**
Began Operations:1966 refurbished from 1991 to 1992
Power:250 kW
Uses:radioisotope production, neutron activation analysis, neutron scattering, neutron radiography, and other scientific and technical applications
TRIGA Fuel:

Total/Type/Enrichment: 313 TRIGA fuel rods, including 26 HEU FLIP (70% enriched) and 287 LEU 67 rods are aluminum clad and 246 rods are stainless steel clad

Spent:218 SNF rods

Future:adding new instrumentation and new control panels. With this refurbishment, IJS estimates that the life of the reactor has been extended 10-20 years. They want to [participate in a 1999 shipment

INEEL European Pre-Assessment

Reactor:**MHH,** Medical University of **Hannover Germany**
Began Operations: 1973
Power:250 kW
Uses: Shut down December 1996
TRIGA Fuel:

Total/Type/Enrichment:fuel rods, including 71 aluminum and five (5) stainless steel rods
Spent: 76 spent LEU TRIGA

Future: Ship in 1999; decomission the reactor

INEEL European Pre-Assessment

Reactor:**IFK, Mainz**, Germany
Began Operations: began operation in 1965
Power:100 kW TRIGA Mark II pulse reactor; could operate at 300 kW when licensed
Uses: fundamental research in short lived isotopes, chemical behavior of the heaviest elements, neutron activation analysis, and training
TRIGA Fuel:

Total/Type/Enrichment: 85 LEU TRIGA fuel rods 73 rods, including 58 aluminum, 13 stainless steel, two (2) instrumented [one (1) stainless steel and one (1) aluminum]. There are five (5) fresh stainless steel clad fuel rods, one (1) slightly irradiated stainless steel clad element, and two (2) additional elements with thermocouples [one (1) stainless steel and one (1) aluminum]. There are four (4) aluminum SNF rods

Spent: 4 Al clad

Future: refurbishment in 1995. They estimate there is enough fuel to operate the reactor for up to 25 years. Will not participate in 1999 shipment

INEEL European Pre-Assessment

Reactor: **DKFZ, Heidelberg, Germany**
Began Operations:1966 and operated until 1977.
Power: modified 250 kW TRIGA Mark III.
Uses: production of radionuclides for medical research and for neutron activation analysis.
TRIGA Fuel:

Total/Type/Enrichment:142 LEU TRIGA fuel rods, including 65 aluminum rods, 68 stainless steel rods, and 9 fuel follower control rods with stainless steel cladding.

Spent: 11 spent or warped fuel rods, and one (1) fuel follower control rod.

Future:interested in shipping their fuel in early 2000.

Conclusions

- 1999 shipment from 4 European countries, involving 4 research reactors. The research reactors and countries are ENEA of Italy, ICN of Romania, IJS of Slovenia, and MHH of Germany.

Unique Challenges

- first shipment to the INEEL from the east coast of the United States
- Need to identify a transportation route and working with the states, tribes and local governments to ensure that adequate public safety and security planning is done and followed
- first shipment to INEEL involving both high-income and less-than-high-income countries in one shipment. There is an opportunity to save a significant amount of money for both DOE and the high-income countries by cooperating and coordinating the shipments together.
- First shipment to INEEL of mixed TRIGA SNF and more than one shipping cask type. This shipment will include a mixture of LEU, HEU, aluminum clad, stainless steel clad, and Incoloy clad rods. INEEL will need to prepare the safety documentation, procedures, and make equipment and facility modifications necessary to handle the different fuel and cask types.