November 8, 2000

MEMORANDUM TO: Ledyard B. Marsh, Chief
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Office of Nuclear Reactor Regulation

FROM: Alexander Adams, Jr., Senior Project Manager ***/RA/***
Events Assessment, Generic Communications and
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Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

SUBJECT: 2000 INTERNATIONAL MEETING ON REDUCED ENRICHMENT FOR RESEARCH AND TEST REACTORS

On October 1 - 6, 2000, I attended the 2000 International Meeting on Reduced Enrichment for Research and Test Reactors (RERTR) in Las Vegas, Nevada. Over 200 persons attended with over 50 papers presented (the attachment contains a list of the papers presented, copies of papers are available except as noted). Papers of interest to NRC were given in the areas of advanced low enriched uranium (LEU) fuels development, conversion of reactors to LEU fuel and the development of LEU targets for the production of Molybdenum-99 (Mo-99) for nuclear medicine.

The RERTR program has been working on the development of very high density LEU fuels for a number of years that would allow high power and high performance non-power reactors (NPRs) to convert from high enriched uranium (HEU) to LEU. No suitable LEU fuel currently exists for these reactors. After screening many fuel forms, it appears that uranium-molybdenum (U-Mo) aluminum dispersion fuel holds promise. Micro-plates of 6.0 and 8.0 gm/cm^3 uranium have been irradiated to high burn ups with acceptable fission gas behavior. An unexpected result from the micro-plate test irradiation program has been the discovery that the aluminum matrix (which is suppose to contain fission gases and limit fuel swelling) of the dispersion fuel has been consumed in the high burn up micro-plates without any indication of unacceptable fission gas retention. This led to the decision to irradiate several mini-plates of U-Mo metal foil that allows very high (15 g/cm^3) uranium densities. Along with the metal foil plates, mini-plates of various U-Mo dispersion fuels are currently being irradiated and irradiation of a full U-Mo dispersion fuel element will begin soon.

The United States policy on the return of US origin NPR fuel is having a direct impact on fuel development. The US will accept until May 2009, US origin fuel that was irradiated up to May 2006. After May 2009, no fuel will be allowed into the US from overseas. COGEMA of France, the only remaining NPR fuel reprocessor outside the US, has determined that the existing NPR LEU silicide fuel is not compatible with their reprocessing chemistry. This makes silicide fuel unusable in foreign NPRs after May 2006. Therefore, the RERTR program is developing low

density U-Mo fuel as a replacement for silicide fuel in addition to the high density fuel for reactors that could not convert because the existing silicide fuel does not contain sufficient uranium.

The RERTR program schedule is to have low density U-Mo fuel qualified by 2003 and high density fuel qualified by 2006. The RERTR program wants to interest an NRC licensed reactor into using low density U-Mo fuel. This would require an NRC generic review of the fuel similar to that done in the late 1980s for the current silicide fuel. The RERTR program hopes that a licensing request for the new fuel from a NRC licensee could occur early in FY 2004. This would involve a major review by NRC and consideration should be given to placing this review into the budget planning process. It is not clear what DOE's position will be on continuing to supply silicide LEU fuel to US NPRs once the U-Mo fuel is licensed.

While not directly affecting any NRC NPR licensees, significant progress appears to have been made in the development of LEU Mo-99 targets for nuclear medicine. Test targets have been irradiated and Mo-99 successfully recovered. It was very interesting to note that papers were presented by some Mo-99 producers about the economic challenges that converting to LEU targets would present. The tone was reminiscent of the difficulties faced to convert reactors to LEU at the start of the RERTR program. Issues such as modification of chemical processes, waste generation, and FDA or other medical approval of the resulting drugs were discussed as financial barriers to conversion. The RERTR program will be drafting a document in the next few months for signature by the Mo-99 producers as to the desirability of the goal of conversion of targets to LEU.

Many efforts continue around the world to convert reactors to LEU. A paper was given by the Rhode Island Atomic Energy Commission staff about the success of their conversion from HEU to LEU. They were complimentary of the NRC review process.

The next RERTR meeting is scheduled for October 2001, in Indonesia. Continued NRC attendance at these meetings is important given the increasing probability that the RERTR program will be successful in the development of U-Mo fuel and the NRC will be asked to perform a safety review of the fuel.

Attachment: Papers Presented at the
2000 RERTR Conference

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PAPERS PRESENTED AT THE 2000 RERTR CONFERENCE

1. **A. Travelli (USA)**
   Status and Progress of the RERTR Program in the Year 2000

2. ***T.P. Mustin*, M. Clapper, J.E. Reilly (USA)**
   A Continuing Success - The U.S. Research Reactor Spent Nuclear Fuel Acceptance Program

3. **J. Minguet and A. Ballagny (France)**
   Technological Irradiation Reactors and RJH Progress Status

4. **N. Arkhangelsky (Russia)**
   ***Twenty Years of RERTR in Russia: Past, Present and Future* (copy of paper not available)**

5. **K. Kanda, Y. Nakagome, K. Kaieda, H. Takahashi, and K. Shimizu (Japan)**
   Status of RERTR in Japan

6. **P. Adelfang, L. Alvarez, N. Boero, R. Calabrese, M. De La Fuente, P. Echenique, M. Markiewicz, E. Pasqualini, A. Pérez, A. Piazza, G. Ruggirello, and H. Taboada (Argentina)**
   RERTR Activities in Argentina

7. **J. S. Guidez, A. Gevers (European Communities), F.J. Wijtsma, P.J.M. Thijssen, J.A. Hendriks (Netherlands)**
   Status in 2000 of the High Flux Reactor Fuel Cycle

8. **W. Stumpf, A. Vernaak, and G. Ball (South Africa)**
   The Conversion to LEU of a Mo-99 Commercially Producing Reactor: SAFARI of South Africa

9. **G. Malkoske (Canada)**
   A Conversion Development Program to LEU Targets for Medical Isotope Production in the Maple Facilities

Attachment

10. **C. Conner, J. Sedlet, T.C. Wiencek, D.J. McGann, G.L. Hofman, G.F. Vandegrift, and J.L. Snelgrove (USA)**
    Production of Mo-99 from LEU Targets—Acid Side Processing

11. **T.M. Donlevy, P.J. Anderson, G. Storr, G. Yeoh, D. Beattie, M. Deura, D. Wassink, B. Braddock, and Chant (Australia) Presented by K.W. Horlock**
    Low Enrichment Mo-99 Targets Development Program at ANSTO

12. **G.F. Vandegrift, C. Conner (USA), Y. Koma (Japan), H. Cols (Argentina), S. Aase, M. Peter, D. Walker, R.A. Leonard, and J.L. Snelgrove (USA)**
    Production of Mo-99 From LEU Targets—Base Side Processing

13. **C. Kohut, M. De La Fuente, P. Echenique, and P. Adelfang (Argentina_**
    Targets of Development of Low Enrichment for the Production of ^{99}Mo Fission

14. **H.J. Cols, P. Cristini, and A.C. Manzini (Argentina)**
    Mo-99 From Low Enriched Uranium

15. **I. Konovalov (Russia)**
    Fundamental Properties of Fuel - Determining its Behavior Under Irradiation

16. **J. Rest, (USA)**
    A Theoretical Model for the Irradiation-Enhanced Interaction Between Al and Uranium-Alloy Fuels

17. **J. Rest (USA) and H. Taboada, (Argentina)**
    Fast Dart: A New Friendly and Quick Version of Dart Code

18. **G. Hofman, M.K. Myer (USA), and J.M. Park (Korea)**
    Observations on the Irradiation Behavior of U-Mo Allow Dispersion Fuel

19. **B. Pace, and G. Gale (USA)**
U-Mo Fuel Development at BWX Technologies Inc.

20. **H. Vacelet, A. Languille, J.L. Guilles, E. Leborgne, and, J.M. Mamy (France)**
Status as of October 2000 of U-Mo Development Program

21. **M. Meyer, G.L. Hofman, J.L. Snelgrove, C.R. Clark, S.L. Hayes, and R.V. Strain (USA)**
***Irradiation Behavior of U-Mo Dispersion Fuel: Fuel Performance Data From RERTR*-3 (copy of paper not available)**

22. **D.F. Sears and N. Wang (Canada)**
Research Reactor Fuel Development at AECL

23. **S.L. Hayes, M.K. Meyer, C.R. Clark, and T.C. Wiencek (USA)**
Irradiation Testing of Intermediate and High Density U-Mo Alloy Dispersion Fuels to High Burnup

24. **C.K. Kim, H.J. Ryu, Y.S. Lee, H.R. Kim, and K.H. Lee (Korea)**
Fabrication of Atomized U-Mo Dispersion Rod Type for Irradiation Test Related to the Qualification

25. **M. Solonin, A. Vatulin, Y. Stetskiy, Y. Trifonov, and B. Rogozkin (Russia)**
Development of the Method of High Density Fuel Comminution by Hydride-Dehydride Processing

26. **S. Balart (Argentina)**
U-Mo Alloy Powder Obtained by a Hydride-Dehydride Process

27. **S.H. Lee, and J.C. Kim (Korea)**
An Investigation on Thermo-Physical Properties of U-Mo Dispersion Fuel Meats

28. **T. Wiencek, and I.G. Prokofiev (USA)**
Low-Enriched Uranium-Molybdenum Fuel Plate Development

29. **K.H. Kim, S.J. Oh, J.S. Lee, Ho-Jin, J.M. Park, and C.K. Kim (Korea)**
An Investigation on the Fuel/Matrix Reaction Behaviors of Atomized U-Mo/Al Dispersion Fuels Prepared by Centrifugal Atomization

30. **M. Solonin, A. Vatulin, Y. Stetsky, I Dobrikova, E. Ryanzantsev, P. Egorenkov, and V. Nassanov (Russia)**
Preparation for In-Pile Tests of a LEU New Type Fuel Element

31. **K.A. Konoplev, A.S. Zakharov, YuP. Sajkov, R.G. Pikulik and L.V. Teodaradze (Russia)**
LEU WWR-M2 Fuel Assemblies Burnable Test

32. **E.P. Ryazantsev, P.M. Egorenkov, V.A. Nassonov, A.V. Taliev, A.D. Gerstle, A.A. Kazpukhin, V.M. Chernyshov, B.S. Yuldashev, T.B. Ashzapov, and A.A. Dosimbaev (Russia)**
Testing of the IRT-4M Type FA with LEU UO_2-Al Fuel in the WWR-CM Reactor

33. **J.C. Chavez, M. Barrera, O. Jimenez, J. Lisboa, and J. Marin (Chile)**
LEU Fuel Fabrication Program for the RECH-1 Reactor, Status Report

34. **M. Yagi, S. Wada, Y. Murayama, and M. Takeuchi (Japan)**
Characteristic Tests of Silicide Fuel Core in JRR-3M

35. **J.E. Thomas, D.W. Bickley, and E. Ray Conatser (USA)**
Pre-Shipment Preparations at the Savannah River Site — WRSC's Technical Basis to Support DOE's Approval to Ship

36. **B.K. Chambers, and M. Clapper (USA)**
Package Licensing in Support of the U.S. DOE Foreign Research Reactor Spent Nuclear Fuel Acceptance Program

37. **G. Harbonnier, F. Obadia, and C. Anne (France)**
New CERCA Transport Container

38. **O. Novara, J. LaFeuente (Argentina), W.S. Large, T. Andes, and C. Messick (USA)**
Inspection Experience with RA-3 Spent Nuclear Fuel Assemblies at CNEA's Central Storage Facility

39. **J.R. Maiorino, and R. Frajndilich (Brazil)**
The Operational and Logistic Experience on Transportation of Brazilian Spent Fuel to USA

40. **N.A. Hanan, J.R. Deen, and J.E. Matos (USA)**
Neutronic Feasibility Studies for LEU conversion of the HFR Petten Reactor

41. **R. Pond, N.A. Hanan, J.E. Matos (USA), and G. Ball (South Africa)**
A Neutronic Feasibility Study for LEU Conversion of the SAFARI-I Reactor

42. **M.M. Bretscher, J.R. Deen, N.A. Hanan, and J.E. Matos (USA)**
Neutronic Feasibility Studies Using U-Mo Dispersion Fuel (9 Wt%Mo, 5.0 gU/cm^3) for LEU Conversion of the MARIA (Poland), IR-8 (Russia), and WWR-SM (Uzbekistan) Research Reactors

43. **A.Olson (USA)**
Status of REBUS Fuel Management Software Development for RERTR Applications

44. **K. Andrzejewski and T. Kulikowska (Poland)**
Reactivity Effect of Interchanging Positions of Poisoned Beryllium Blocks in the MARIA Reactor

45. **J. Ernest (Czech Republic)**
Preliminary Calculations to Initiating LVR-15 HEU-LEU Conversion Study for Czech Research reactor LVR-15
(copy of paper not available)

46. **Y.V. Petrov, A.N. Erykalov, and M.S. Onegin (Russia)**
A Neutronic Feasibility Study for LEU Conversion of the WWR-M Reactor at Gatchina

47. **R. Nabbi and J. Wolters (Germany)**
Optimum Fuel Management for the German Research Reactor Using MCNP

48. **B.G. Susanto (Indonesia)**
Plant Safety Review From Mass Critical Accident

49. **T.N. Tehan (USA)**
The Rhode Island Nuclear Science Center Conversion from HEU to LEU Fuel and Efforts to Upgrade from 2 MW to 5 MW

50. **S.C. Mo, R.S. Smith, J.E. Matos, T.N. Tehan, and M.J. Davis (USA)**
Modification of the Rhode Island Nuclear Science Center LEU Core to Increase Fluxes for Boron Neutron Capture Therapy Study

51. **A.M. Lerner, M.R. Madariaga, R. Waldman (Argentina)**
Safety Analysis of an Irradiation Device for ^{99}Mo Production in RA-3 Reactor

52. **T. Zagar, M. Ravnik (Slovenia)**
Fuel Element Burnup Determination in HEU-LEU Mixed TRIGA Research Reactor Core

53. **K. Haas, C.-O. Fischer, and H. Krohn (Germany)**
HEU/LEU Conversion of BERII Successfully Finished

54. **K. Horlock (Australia)**
ANSTO's Replacement Research Reactor **(copy of paper not available)**

55. A. Gläser, C. Pistner, and W. Liebert (Germany)
FRM-II Conversion Revisited

56. H.J. Roegler (Germany)
Nuclear Liability and Research Reactor Fuel, A Plant-Supplier's View

Not presented but handed out to some attendees

Kuperman, A., Leventhal, P., (Nuclear Control Institute), Forging Consensus to Phase Out HEU for Medical Isotope Production: A Proposed Path Forward