November 1, 1996

MEMORANDUM TO: David B. Matthews, Chief
Generic Issues and Environmental
Projects Branch
Division of Reactor Program Management
Office of Nuclear Reactor Regulation

FROM: Egan Y. Wang, Reactor System Engineer Egan Y. Wang/for
Generic Issues and Environmental
Projects Branch
Division of Reactor Program Management
Office of Nuclear Reactor Regulation

SUBJECT: MEETING SUMMARY OF OCTOBER 23, 1996, REGARDING THE REQUIREMENTS NEEDED TO LICENSE A RELOAD CONTAINING MIXED OXIDE FUEL.

On October 23, 1996, representatives of Siemens Power Corporation (SPC) met with representatives of the Nuclear Regulatory Commission (NRC). The purpose of this meeting was to provide an opportunity for SPC representatives to review the requirements needed to license a reactor core reload containing mixed oxide (MOX) fuel. SPC representatives provided an introduction and a brief description on utility activities regarding MOX. SPC representatives also presented SPC's response to Department of Energy MOX plans. In addition, SPC representatives indicated that SPC had evaluated U.S. codes & methods that would be used to perform reload calculations and determined that a relatively small number of reload modifications are required. A portion of the meeting involved presentation of proprietary information. Attachment 1 provides a list of meeting attendees. Attachment 2 is the non-proprietary version of the presentation material.

Attachments: As stated

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

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cc:

Mr. H. D. Curet, Manager
Product Licensing
Siemens Power Corporation
2101 Horn Rapids Road
P. O. Box 130
Richland, WA 99352-0130

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A. Thadani
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E. Jordan
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H. Richines

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NRC/SIEMENS POWER CORPORATION MEETING
ON MIXED OXIDE FUEL
LIST OF ATTENDEES
Oct 23, 1996

NAME	ORGANIZATION
Burns, J. P.	WPPSS
Heiks, R. L.	Siemens
Garner, N. L.	Siemens
Garber, D. E.	Siemens
Copeland, R.	Siemens
Collins, T. E.	NRC/NRR
Kavanagh, K.	NRC/NRR
Richines, H.	NRC/NRR
Wang, Egan	NRC/NRR

ATTACHMENT 1

NRC Meeting on Licensing MOX Reloads

Siemens Power Corporation

October 23, 1996

Attachment 2

Agenda

- Introduction/Utility Activity--J. Burn WPPSS
- SPC Response to DOE MOX Plans
- Siemens Experience with MOX Fuel
- Review of US Codes and Methods
- Reactor Licensing Issues
- Summary/Conclusions

Goal: Review License Needs for Reload Fuel and Reactors and Identify Issues Not Addressed

- SPC has reviewed US codes and methods needed to support MOX
- Relatively small number of reload modifications are required
- Limited number of reactor issues to be resolved

DOE May Issue Contract to Dispose of Weapons Grade Pu by Burning it in Commercial Reactors

- Have estimated 50 MT of weapons grade plutonium to dispose
- One alternative is to fabricate into mixed oxide fuel for use in commercial reactors
- Contract would require the fabrication and use of MOX fuel

Siemens Has Experience in Fabricating MOX

- Previously provided MOX in US to Big Rock Point and R. E. Ginna reactors
- Developed Hanau facility in Germany for MOX fabrication
  - Initial facility provided 35 MThm/yr
  - Upgraded facility to provide 120 MThm/yr (not operated due to change in licensing policy of state)

European Experience is Technical Basis for Fabrication and Use of MOX

- Siemens inserting reloads of ATRIUM-10 MOX fuel in Gundremmingen starting in 1997
- Working with consortium of US BWR licensees to supply similar ATRIUM-10 designs in US
- Note: Gadolinia to be used in only UO_2 rods

Reload Licensing Requires Approved Design Codes, Methods, and Criteria

- SPC is reviewing currently approved methodology and criteria for applicability

- Review focused on Chapters 4 and 15 of SRP

Design Methods Review

- Mechanical design
  - RODEX2--Fuel performance code, gives FGR, pellet densification/swelling, cladding strain, cladding oxidation, etc. as function of exposure
  - RAMPEX--Cladding stress during transients
  - Generic BWR design criteria

- Thermal hydraulic design
  - XCOBRA--Steady state thermal hydraulic analysis
  - ANFB--Critical power correlation
  - Safety limit methodology

Design Methods Review (Continued)

- Non-LOCA transient
  - COTRANSA2--System response code
  - XCOBRA-T--Transient fuel thermal hydraulic code
  - STAIF--Frequency domain code to determine susceptibility to power instabilities

- LOCA--EXEM BWR evaluation model
  - RELAX--System response code, hot channel code
  - FLEX--Time to reflood
  - HUXY--Fuel rod heatup

Design Methods Review (Continued)

- Neutronic design
  - CASMO-3G--Cross section code
  - MICROBURN-B--Core simulator

MOX Fuel Changes in the Neutronic Kinetics Have to be Incorporated in the Transient Analyses

- Control rod worths decreased
- Lower delayed neutron fraction and shorter prompt neutron lifetime
- Void fraction reactivity is more negative

BWR Transients and Accidents Have Only Small Impact from MOX Fuel

- CRDA is limiting reactivity transient
  - Reduced control rod worth, increased temperature and void reactivity feedback tend to compensate for the smaller delayed neutron fraction
  - Net impact is not significantly changed
- Pressurization transients affected by void reactivity and increases ΔCPR which will require slightly higher operating limit
- DNB controlled by heat flux
  - LHGR limits set to provide similar peak heat fluxes
  - Geometry unchanged from standard fuel

Stability and Shutdown Margin Concerns are Helped by ATRIUM-10 Design

- Because of smaller rod worth, MOX fuel has less shutdown margin than UO_2. Central water canister provides additional hot to cold reactivity change which improves shutdown margin.

- The more negative void reactivity feedback is mitigated by part length rods in ATRIUM-10. Thus the design compensate for any stability changes from the MOX fuel.

LOCA Response Not Significantly Changed by MOX

- SPC will use EXEM BWR LOCA model
- Impact of MOX on neutronics not significant in LOCA event
- Geometry and system response unchanged

Reduction in Boron Worth Will Require SLCS Analysis

- Current SLCS boron levels must be assessed to assure sufficient shutdown

- If not, either the boron level can be increased or enriched boron used

MOX Impact on Reactor Licensing is Limited

- Three major issues based on DOE sponsored evaluations
  - New fuel storage
  - Spent fuel storage
  - Security
- Reactor systems not changed by the use of MOX

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