UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, D.C. 20555-0001

June 11, 2003

MEMORANDUM TO: Maggalean W. Weston
Senior Staff Engineer
ACRS

FROM: Dana A. Powers
Chairman
Reactor Fuels Subcommittee
ACRS

SUBJECT: CERTIFICATION OF THE MINUTES OF THE MEETING OF THE ACRS SUBCOMMITTEE ON REACTOR FUELS, APRIL 21, 2003, ROCKVILLE, MD

I hereby certify that, to the best of my knowledge and belief, the minutes of the Reactor Fuels subcommittee meeting on the Mixed Oxide Fuel Fabrication Facility construction authorization request issued June 11, 2003, are an accurate record of the proceedings for that meeting.

Dana A. Powers 13\JUN\2003

Dana A. Powers, Chairman Date

UNITED STATES
NUCLEAR REGULATORY COMMISSION
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June 11, 2003

MEMORANDUM TO: Dana A. Powers
Chairman
Reactor Fuels Subcommittee
ACRS

FROM: Maggalean W. Weston
Senior Staff Engineer
ACRS

SUBJECT: WORKING COPY OF THE MINUTES OF THE ACRS SUBCOMMITTEE ON REACTOR FUELS, APRIL 21, 2003, ROCKVILLE, MD

A working copy of the minutes for the Reactor Fuels subcommittee meeting on the Mixed Oxide Fuel Fabrication Facility construction authorization request held on April 21, 2003, is attached for your review. Please provide me with any comments that you might have.

Attachment:
As Stated

Certified By Dr. Dana A. Powers
June 13, 2003

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
REACTOR FUELS SUBCOMMITTEE
MIXED OXIDE (MOX) FUEL FABRICATION FACILITY
ROOM T-2B3, 11545 ROCKVILLE PIKE
ROCKVILLE, MARYLAND
APRIL 21, 2003
MEETING MINUTES

INTRODUCTION

The ACRS subcommittee on Reactor Fuels held a meeting on April 21, 2003, with representatives of Duke Cogema Stone and Webster (DCS) and the NRC staff to discuss the Mixed Oxide (MOX) Fuel Fabrication Facility construction authorization request (CAR). The meeting was open to the public. Maggalean W. Weston was the cognizant ACRS staff engineer and designated federal official (DFO) for this meeting. The meeting was convened by the Reactor Fuels Subcommittee Chairman, Dr. Dana A. Powers, at 10:00 a.m. and adjourned at 6:47 p.m. on April 21, 2003.

Attendees

Attendees at the meeting included ACRS members and staff; NRC staff; members of the Advisory Committee on Nuclear Waste (ACNW); representatives of the Department of Energy (DOE), Duke Cogema Stone & Webster (DCS); and members of the public as follows:

ACRS-ACNW Members/Staff

D.A. Powers, Chairman	S.L. Rosen, Member	M.N. Levenson, ACNW
F.P. Ford, Member	W.J. Shack, Member	Michael T. Ryan, ACNW
T.S. Kress, Member	J.D. Sieber, Member	M.W. Weston, DFO

NRC Staff

David Brown, NMSS	Joel Klein, NMSS	Wilkins Smith, NMSS
Ivelisse Cabrera, NMSS	Joel Kramer, RES	Sharon Steele, NMSS
Joseph Glitter, NMSS	Alex Murray, NMSS	Christopher Tripp, NMSS
Herman Graves, RES	Andrew Persinko, NMSS	Bill Troskoski, NMSS
Tim Johnson, NMSS	Robert Pierson, NMSS	Rex Wescott, NMSS

DOE/DCS

David Alberstein, DOE	Stephen Kimura, DCS	Tom St Louis, DCS
Ken Ashe, DCS	Marc Klasky, DCS	Marc Vial, DCS
Jamie Johnson DOE	Larry Rosenbloom, DCS	Jean-Frances Weiss, DCS
Gary Kaplan, DCS	Don Silverman, DCS	

Members of the public were also in attendance at this meeting. A list of those attendees who registered is attached to the Office Copy of these minutes.

Presentations and Discussion

The presentations to the subcommittee and the related discussions are summarized below. The presentation slides and handouts used during the meeting are attached to the Office Copy of the minutes.

Chairman's Comments

Dana Powers, Subcommittee Chairman, convened the meeting. He noted the presence of Milton Levenson and Michael Ryan, members of the Advisory Committee on Nuclear Waste who will serve as members of the subcommittee. He stated that the purpose of the meeting was to discuss the MOX Fuel Fabrication Facility (MOX FFF) construction authorization request and the changes to the application for this facility. Committee members were encouraged to re-familiarize themselves with 10 CFR 70.61 A through F, 70.64 A and B, 7065, and 10 CFR 50.2 to understand the definitions, baseline design criteria, integrated safety analysis, and items relied upon for safety. D. Powers also indicated that he would be asking the speakers to explain the meanings of words like "unlikely, highly unlikely, credible, and incredible.

Industry and NRC Presentations

The DCS presentations were made by Ken Ashe, Mark Klasky, Larry Rosenbloom, Tom St. Louis and Steve Kimura. The NRC presentations were made by Andrew Persinko, Christopher Tripp, Timothy Johnson, William Troskoski, and Sharon Steele. The presentation continued with the following topics:

Introduction
- Criticality Safety
- Chemical Safety
- Fire
- Confinement Ventilation
- Closing Remarks

The main issues resulting from the subcommittee meeting were

- selection and scaling of airborne release fractions and respirable fractions from Mishima data base
- a clear statement of the fire protection design basis
- use of 'clean agent' fire suppressant and lacking of quenching fire
- design bases without results of ISA
- criticality in waste handling zone
- materials selection and corrosion

The major hazards at the facility are criticality and fires from kerosene, "red" oil, hydroxylamine nitroamine nitrate, sintering furnaces, zirconium metal, and waste handling facilities.

The safety strategies to be used at the facility are prevention and redundancy, nested ventilation zones, and HEPA filtration.

Subcommittee Comments

Introduction
Overview

K. Ashe provided some background information and discussed some of the changes to the program The construction authorization request (CAR) was originally submitted in February of 2001. The CAR was updated in October of 2002. A draft safety evaluation report (SER) was issued in April of 2002 and another based on the updated CAR in April 2003. Initially, it was intended that some material would go through the plutonium immobilization plant, but the plutonium immobilization facility was canceled. The changes to the facility to accommodate the alternate feedstock (material originally scheduled for immobilization) will involve some changes to the design. With the exception to some changes to the aqueous polishing line to remove some additional impurities and some powder pretreatment changes, there is minimal impact to the remainder of the facility. The facility change results in a delay in the schedule also. There were no major challenges associated with these changes. K. Ashe mentioned that initially there were 239 RAIs. Many of these have been resolved through various meetings and correspondence. There are 19 open items in the draft SER. It is hoped that they will be resolved soon. K. Ashe indicated that Dr. Bergman was available to answer any committee questions regarding HEPA filters, and Gary Kaplan was there to answer questions about the safety analysis and the safety assessment. The facility and system design is based on defense in depth practices.

Andrew Persinko, NMSS, provided background for the NRC. He indicated that DCS had submitted a revised Environmental Impact Report and the NRC has issued the draft Environmental Impact Statement for public comment. D. Persinko indicated that the pit disassembly and conversion facilities will be regulated by DOE, while the fuel facility would be regulated by NRC. 10 CFR Part 70.61 regulations will be used to as the basis for control of the area boundary as well as provisions for who is declared a member of the public (persons beyond the site or controlled area boundary) or a worker (a MOX facility worker within the restricted area in proximity to the facility.

Persinko provided information on the process for Committee re-familiarization. The first part of the process is aqueous polishing which consists of dissolution, purification, and conversion of plutonium oxide. The other part of the process is the fuel fabrication process which consists of blending of the oxide powders, fabrication of the pellets, and assembly of the rods and fuel. Part 70 allows for a two step approval process, construction and operation. The construction process is the subject of these reviews.

- D. Powers questioned the use of the term “unlikely” to refer to instances of occurrences of once per year. The response was that this issue will be looked at carefully in finalizing the SER.

- D. Powers asked if the staff had independently evaluated the licensee statement regarding release fractions and transport of materials. The response was that it was independent in the sense that the Mishima type release fractions and replicable fractions were looked at to get some assurance that the values were bounding.

Criticality Safety

Christopher Tripp discussed some of the more unique aspects of the MOX and plutonium facilities as opposed to uranium facilities. The plutonium chemistry and physical properties are more complex because of more valence states for plutonium which involve some criticality impacts. There is also a concern about the efficiency of solvent extraction because if you don't have the right valence state you can concentrate plutonium in the waste streams. This is a criticality concern because it eventually discharges an unsafe geometry. The main unique feature that is different from traditional fuel cycle facilities is the blending of the oxide powders. The blending is credited for criticality because it is important to ensure that the powders are dry, adequately milled, and homogenized to eliminate unwanted variations in plutonium assays. This is one of the important features to focus on. The open issue is validation of the design basis maximum k_{eff} limit. Tripp also talked about double contingency and ANSI Standards. Double contingency is similar to single failure criteria. It requires the occurrence of at least two unlikely independent process upsets before criticality is possible. The ANSI standards have to do with programmatic issues such as code validations, criticality limits, training requirements, etc.

- D. Powers asked if one complies with the double contingency requirement, is a criticality event likely to occur. The response was that it is highly unlikely, but not a guarantee that an event will not occur.

- P. Ford asked how limiting are the lack of availability of benchmarks for validation and how long it would take to resolve this. The response was that there may be other ways to deal with this by means of conservative calculations.

- M. Levenson asked is the staff has access to any classified information related to validation. The response was that the staff would look into it.

- J. Sieber asked about the reactivity of the feed stock. The response was that a set of bounding isotopes was developed for the process and they are characterized to assure that they are within 96 percent.

Chemical Safety (Red Oil and Hydroxylamine nitrate)

Mark Klasky, DCS, and William Troskoski, NMSS, discussed the approach to preventing tributyl phosphate degradation (TBP) or red oil phenomena. Red Oil is characterized as an organic-based material which can be formed by metal, nitric acid, and tributyl phosphate and a hydrocarbon diluent, with a material density of 1.1 to 1.5 g/cm^2, and with a different thermal decomposition temperature than the metal adduct. There are 50 years of experience that will prove very important in the formulation a comprehensive robust safety approach to preventing red oil events. They plan to do confirmatory research which might reveal more on red oil.

- P. Ford asked if there are any lessons learned from the processing experience at La Hague. The response was that they incorporated the lessons learned not only from La Hague, but also from DOE.

- P. Ford and S. Rosen expressed concern that rate limiting factors are not known at the design phase rather than later.

- P. Ford asked if hydrolysis is the rate limiting factor. The response was that a rate limit was not envisioned.

- P. Ford asked what were the things that will be monitored to provide information regarding an exothermic reaction. The response was temperature and from what point you're starting.

- P. Ford asked what assurances could be given that local conditions will not vary so much that you get in trouble even though bulk conditions are okay. The response was that right now assurances can not be given because that step will not be done until the ISA hazard analysis is done.

- P. Ford asked if the licensee had looked at the integrity of the proposed structural materials. The response was that from a regulatory point of view, they had not.

- J. Sieber asked what are the things that will be controlled to make the initiation temperature valid, and how are they going to do it. The response was the diluent and the resonance time of the TBP are controlled. Then, once you define how much mass you have, what the constituents are, and what the temperature is, you have bounded where you start and where it can end.

- T. Kress asked what equations are being used to determine the rate of evaporation. The response was that information has not been provided yet.

- M. Levenson asked what is the heat capacity of the total system evaporator plus its load of liquid if you have an incident when it is full of liquid compared to the amount of energy under discussion. The response was they have not done a formal count.

- M. Ryan asked if they had tried to optimize any of the chemical processes with regard to waste generation. The response was that they have done this by minimizing the quantity of waste by the selection of hydroxylamine.

- M. Ryan commented that the licensee should think about the end points of the waste and the chemical and radiological constituents and have an acceptable waste disposal. A responding comment was that the facility has the Savannah River site waste acceptance criteria which fits into the treatment and disposal scheme.

- D. Powers asked what was the least soluble azide in the system now. The response was silver azide.

- D. Powers asked if the licensee had thought about the possibility of accumulation of ammonium nitrate in the off gas treatment system. The response was no, but they will look into it.
- D. Powers asked if there were quantitative tools to look at the flow streams. The response was that there is a risk group that is considering a number of things such as fault tree analysis.

Fire Protection

Mr. Larry Rosenbloom, DCS and Ms. Sharon Steele, NMSS discussed the design of the fire protection system. They gave an overview of the program, talked about the fire hazard analysis, fire modeling, fire barriers, and what the fire safety strategy is. DCS's main strategy is to confine any fires that occur. They have also provided successive layers of protection at each area. The structures important to safety are protected by the exhaust systems that are provided for the gloveboxes and the process rooms. The C3/C4 confinement systems are suppose to remain operational during a fires, they are active redundant systems with redundant electrical trains that are separated at least 150 feet.

- D. Powers asked about defense-in-depth with regard to fire protection. The response was that the a fire hazard analysis is done and redundant IROFS are available elsewhere. The primary features of the facility are an automatic detection system, automatic and manual fire suppression, and means to confine the fire to its origin by structural barriers that segregate the fires.

- S. Rosen asked what clean agents are used for fire suppression. The response was a substitute for halon. And clean means environmentally.

- D. Powers asked if they considered seismically induced fires. The response was yes, and they concluded that the clean agent suppression systems address this.

- M. Levenson asked if the glass in the glovebox window were laminated safety glass or plain glass. The response was plain glass.

Containment Ventilation

Tom St. Louis and Steve Kimura, DCS and Tim Johnson, NMSS discussed the HVAC and the final filter units. The confinement barriers are designed to confine radioactive materials as close to the point of origin or use as possible. There are three confinement zones with differential pressures maintained between each zone. The HVAC system is capable of operating during a facility fire. The HEPA filter system is designed to protect the HEPA filter media from damage resulting from severe accident conditions , such as a fire. The HEPA filters are particulate removal systems . The filter media is made of a noncombustible glass fiber material and designed to filter greater than 99.9 percent of the most penetrating particle size, which is approximately .15 microns in size.

- S. Rosen wanted to know what is done about a fire that, after time, oxygen is provided and the fire starts burning again. The response was that to meet 10 CFR 61, the facility has been designed to contain the fire in the room of origin regardless of how long it takes.

The licensee has committed to do an analysis of flashing of hot gases in the system when the gases from the room combine with the other flows.

- D. Powers asked about the tornado effects on facilities. The response was that they have dual self closing tornado dampers in the exhaust system.

- W. Shack asked if the room with the highest soot load was one of the rooms evaluated for the operation of the final filters. The response was yes.

- T. Kress asked how do you test for bypass flow. The response was that an aerosol is injected upstream of the filter media and then measured downstream.

- D. Powers asked if there were worried about knock-along. The response was that the knock-along effect is inconsequential with regards to the total amount of material that could pass through two stages of HEPA materials.

- M. Levenson asked about the history of the filter media. The response was that it changes every year.

Further information regarding this meeting can be obtained by contacting the Designated Federal Official between 7:30 a.m. and 4:15 p.m. (ET). Persons planning to attend this meeting are urged to contact the above named individual at least two working days prior to the meeting to be advised of any potential changes in the agenda.

Dated: March 28, 2003.

Sher Bahadur,

Associate Director for Technical Support, ACRS/ACNW.

[FR Doc. 03–8206 Filed 4–3–03; 8:45 am]

BILLING CODE 7590–01–P

NUCLEAR REGULATORY COMMISSION

Advisory Committee on Reactor Safeguards, Meeting of the ACRS Subcommittee on Materials and Metallurgy; Notice of Meeting

The ACRS Subcommittee on Materials and Metallurgy will hold a meeting on April 22–23, 2003, Commissioners' Conference Room O–1G16, 11555 Rockville Pike, Rockville, Maryland.

The entire meeting will be open to public attendance.

The agenda for the subject meeting shall be as follows:

Tuesday and Wednesday, April 22–23, 2003—8:30 a.m. until the conclusion of business

The purpose of this meeting is to review NRC inspection requirements and guidance, Wastage Research, and the Electric Power Research Institute Materials Reliability Program (EPRI/MRP) and industry efforts related to vessel head penetration cracking and reactor pressure vessel head degradation. The Subcommittee will hear presentations by and hold discussions with representatives of the NRC staff, the EPRI/MRP, and other interested persons regarding this matter. The Subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and actions, as appropriate, for deliberation by the full Committee.

Members of the public desiring to provide oral statements and/or written comments should notify the Designated Federal Official, Ms. Maggalean W. Weston (telephone 301/415–3151) five days prior to the meeting, if possible, so that appropriate arrangements can be made. Electronic recordings will be permitted.

Further information regarding this meeting can be obtained by contacting the Designated Federal Official between 8 a.m. and 5:30 p.m. (e.t.). Persons planning to attend this meeting are urged to contact the above named individual at least two working days prior to the meeting to be advised of any potential changes to the agenda.

Dated: March 28, 2003.

Sher Bahadur,

Associate Director for Technical Support, ACRS/ACNW.

[FR Doc. 03–8205 Filed 4–3–03; 8:45 am]

BILLING CODE 7590–01–P

NUCLEAR REGULATORY COMMISSION

Advisory Committee on Reactor Safeguards, Meeting of the Subcommittee on Reactor Fuels; Notice of Meeting

The ACRS Subcommittee on Reactor Fuels will hold a meeting on April 21, 2003, Room T–2B3, 11545 Rockville Pike, Rockville, Maryland.

The entire meeting will be open to public attendance.

The agenda for the subject meeting shall be as follows:

Monday, April 21, 2003—10 a.m. until the conclusion of business

The purpose of this meeting is to review the Duke Cogema Stone & Webster construction application request resubmittal for a mixed oxide (MOX) fuel fabrication facility. The Subcommittee will hear presentations by and hold discussions with representatives of the NRC staff, Duke Cogema Stone & Webster, and other interested persons regarding this matter. The Subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and actions, as appropriate, for deliberation by the full Committee.

Members of the public desiring to provide oral statements and/or written comments should notify the Designated Federal Official, Ms. Maggalean W. Weston (telephone 301/415–3151) five days prior to the meeting, if possible, so that appropriate arrangements can be made. Electronic recordings will be permitted.

Further information regarding this meeting can be obtained by contacting the Designated Federal Official between 8 a.m. and 5:30 p.m. (e.t.). Persons planning to attend this meeting are urged to contact the above named individual at least two working days prior to the meeting to be advised of any potential changes to the agenda.

Dated: March 28, 2003.

Sher Bahadur,

Associate Director for Technical Support, ACRS/ACNW.

[FR Doc. 03–8207 Filed 4–3–03; 8:45 am]

BILLING CODE 7590–01–P

NUCLEAR REGULATORY COMMISSION

Notice of Availability of Model Application Concerning Technical Specification Improvement To Modify Requirements Regarding Mode Change Limitations Using the Consolidated Line Item Improvement Process

AGENCY: Nuclear Regulatory Commission.

ACTION: Notice of availability.

SUMMARY: Notice is hereby given that the staff of the Nuclear Regulatory Commission (NRC) has prepared a model application relating to the modification of requirements regarding technical specifications (TS) mode change limitations. The purpose of this model is to permit the NRC to efficiently process amendments that propose to modify requirements for TS mode change limitations as generically approved by this notice. Licensees of nuclear power reactors to which the model applies could request amendments utilizing the model application.

DATES: The NRC staff issued a **Federal Register** Notice (67 FR 50475, August 2, 2002) which provided a model safety evaluation relating to modification of requirements regarding TS mode change limitations;[1] similarly, the NRC staff, herein provides a Model Application, including a revised model safety evaluation. The NRC staff can most efficiently consider applications based upon the Model Application, which reference the model safety evaluation, if the application is submitted within a year of this **Federal Register** Notice.

FOR FURTHER INFORMATION CONTACT: Robert Dennig, Mail Stop: O–12H4, Division of Regulatory Improvement Programs, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, DC 20555–0001, telephone 301–415–1161.

[1] [In conjunction with the proposed change, technical specifications (TS) requirements for a bases control program, consistent with the TS Bases Control Program described in Section 5.5 of the applicable vendor's standard TS (STS), shall be incorporated into the licensee's TS, if not already in the TS. Similarly, the STS requirements of SR 3.0.1 and associated bases shall be adopted by units that do not already contain them.]

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
REACTOR FUELS SUBCOMMITTEE
MIXED OXIDE (MOX) FUEL FABRICATION FACILITY (FFF)
ROOM T-2B3, 11545 ROCKVILLE PIKE
ROCKVILLE, MARYLAND
APRIL 21, 2003

-AGENDA-

SUBJECT	PRESENTER	TIME
Introductory Remarks Subcommittee Chair	D.A. Powers, ACRS	10:00-10;15 a.m.
Introductory Remarks	Andrew Persinko, NMSS Peter S. Hastings, DCS*	10:15-10:45 a.m.
Criticality Safety	Chris Tripp, NMSS	10:45-11:00 a.m.
Confinement Ventilation	DCS Tim Johnson, NMSS	11:00-11:45 a.m. 11:45-12:15 p.m.
	*****LUNCH*****	12:15-1:15 p.m.
Chemical Safety (Red Oil)	DCS William Troskoski, NMSS	1:15-2:00 p.m. 2:00-2:30 p.m.
Chemical Safety (Hydroxylamine nitrate)	DCS William Troskoski, NMSS	2:30-3:15 p.m. 3:15-3:45 p.m.
	*****BREAK*****	3:45-4:00 p.m.
Fire Protection	DCS Sharon Steele, NMSS	4:00-4:45 p.m. 4:45-5:15 p.m.
Closing Remarks	Andrew Persinko, NMSS Peter S. Hastings, DCS	5:15-5:45 p.m.
Discussion and Adjournment	D.A. Powers, ACRS	5:45-6:30 p.m.

*Duke Cogema Stone & Webster

Note: Presentation time should not exceed 50% of the total time allocated for a specific item. Number of copies of presentation materials to be provided to the ACRS - 35.

ACRS CONTACT: Maggalean W. Weston, mww@nrc.gov or (301) 415-3151.

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
SUBCOMMITTEE MEETING ON REACTOR FUELS

APRIL 21, 2003

ATTENDEES PLEASE SIGN IN BELOW
PLEASE PRINT

NAME	AFFILIATION
Ali Tabatabai	Link Technologies
Daniel Horner	McGraw-Hill
Jamie Johnson	Dept of Energy / NNSA
David Alberstein	DOE / NNSA NA-26
Jean-François Weiss	DCS
Don Silverman	Morgan Lewis / DCS
Ken Ashe	DCS
Stephen Kimura	DCS
Tom St. Louis	DCS
Gary Kaplan	DCS
Lary Rosenbloom	DCS
Marc Vial	DCS
Marc Vial	DCS

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
SUBCOMMITTEE MEETING ON REACTOR FUELS

APRIL 21, 2003

NRC STAFF PLEASE SIGN IN BELOW

PLEASE PRINT

NAME	NRC ORGANIZATION
TIM JOHNSON	NMSS
Joseph GITTER	NMSS
Joel Klein	NMSS
Andrew Persinko	NMSS
Sharon Steele	NMSS
Joel KRAMER	RES
David Brown	NMSS
Christopher S. Tripp	NMSS
Rex Wescott	NMSS
Bill Troskoski	NMSS
WILKINS SMITH	NMSS
ALEX MURRAY	NMSS.
Norma Garcia Santos	NMSS
Ivelisse M. Cabrera (Ivelisse Cabrera)	NMSS
Robert C. Pierson	NMSS
Herman GRAVES	RES

DUKE COGEMA STONE & WEBSTER

MOX Fuel Fabrication Facility (MFFF) Fire Protection

ACRS Subcommittee on Reactor Fuels Meeting
21 April 2003

DUKE COGEMA STONE & WEBSTER

Outline of the Presentation

- Overview of MFFF Fire Protection Design
- Overview of MFFF Fire Protection Program
- Fire Hazards Analysis
- Fire Modeling
- Robustness of Fire Barriers
- Fire Safety Summary
- Conclusion

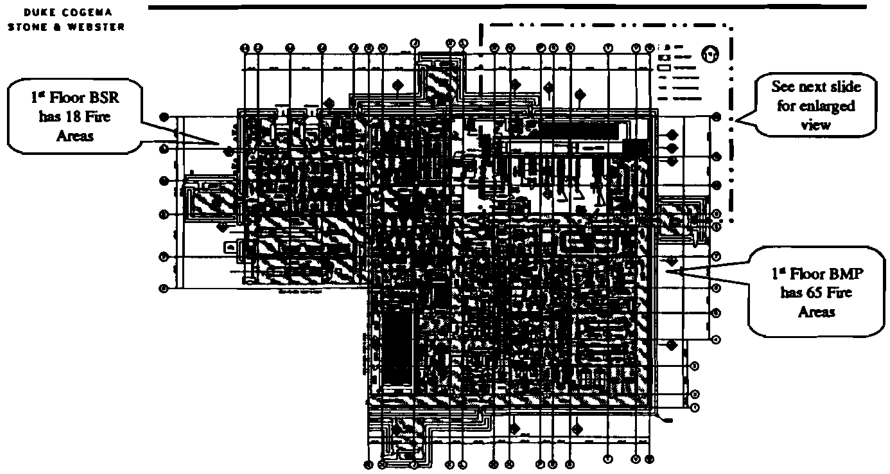
Overview of MFFF Fire Protection Design

DUKE COGEMA STONE & WEBSTER

- Fire safety design features at the MFFF:
  - Multiple fire areas with minimum of 2 hour rated fire barriers:
    - Hourly ratings based on ASTM E-119 definitions
    - Fire areas confine fire to its area of origin and prevent its spread
    - Fire-rated structural barriers segregate fire areas
    - Over 300 fire areas
  - Automatic fire detection systems
  - Automatic and manual fire suppression capabilities

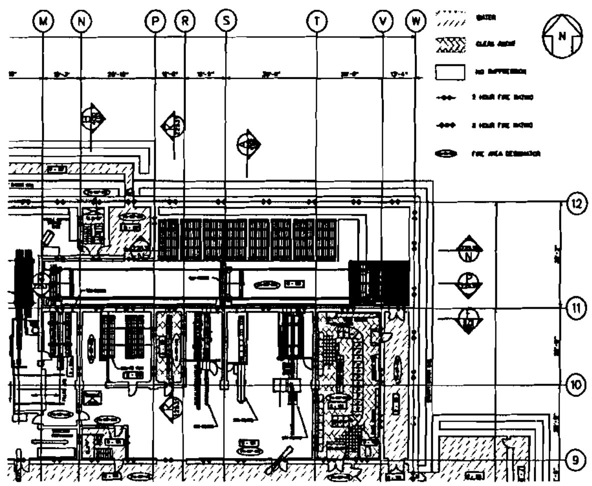
BMP First Floor Fire Areas

DUKE COGEMA STONE & WEBSTER



DUKE COGEMA
STONE & WEBSTER

BMP First Floor Fire Areas—Enlarged View



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Overview of MFFF Fire Protection Design

- Automatic fire detection systems throughout facility
- Fire detectors located in:
  - Gloveboxes
  - Rooms
  - Exhaust HVAC plenums of process cells

DUKE COGEMA STONE & WEBSTER

Overview of MFFF Fire Protection Design

- Fire suppression system types:
  - ➢ Carbon dioxide portable bottles - For manual suppression for glovebox internals
  - ➢ Clean agent – For automatic suppression of process rooms suppression and electrical/electronic rooms; protects majority of rooms.
  - ➢ Water-based – For life safety and for areas not containing radioactive materials, such as corridors and stairwells; automatic initiation. Manual standpipes in stairwells.
  - ➢ Portable fire extinguishers throughout.

DUKE COGEMA STONE & WEBSTER

Overview of MFFF Fire Protection Design

- Carbon dioxide systems:
  - ➢ For manual suppression of fires inside gloveboxes
  - ➢ Utilizes portable bottles that are modified carbon dioxide portable extinguishers
  - ➢ Bottles provided in vicinity of gloveboxes consistent with NFPA 10 travel requirements

DUKE COGEMA STONE & WEBSTER

Overview of MFFF Fire Protection Design

- Clean agent systems:
  - ➢In process areas and areas containing electrical/electronic equipment, including under raised floors
  - ➢Clean agent will be halogen-free
  - ➢Storage containers to be located in vicinity of protected areas; multiple storage container locations

DUKE COGEMA STONE & WEBSTER

Overview of MFFF Fire Protection Design

- Water-based systems:
  - ➢ Preaction inside process buildings for criticality safety
  - ➢ Not located in material areas
  - ➢ Alarm or valve failure and sprinkler head failure required for firewater to inadvertently flow
  - ➢ Dry standpipes in process buildings
  - ➢ Water to be provided by MFFF underground loop connected to SRS underground loop
  - ➢ Sized to handle largest demand plus 500 gpm hose streams

DUKE COGEMA STONE & WEBSTER

Overview of MFFF Fire Protection Program

- General employee training for fire protection includes:
  - Appropriate actions to take upon discovering a fire, including notification of control room personnel, attempt to extinguish the fire, actuation of local fire suppression systems
  - Actions upon hearing fire alarms
  - Administrative controls on the use of combustibles and ignition sources
  - Actions necessary in the event of a combustible liquid spill or gas release/leak
- The MFFF Fire Brigade provides on-site support for fire fighting activities. Fire brigade members are qualified per NFPA 600. Fire brigade team consists of fire brigade leader and fire brigade members.

DUKE COGEMA STONE & WEBSTER

Fire Hazards Analysis

- Purpose of the Fire Hazards Analysis (FHA):
  - "To document the specific fire hazards, the fire protection features proposed to control those hazards, and the overall adequacy of fire safety at the Mixed Oxide (MOX) Fuel Fabrication Facility (MFFF) based on current design information."

DUKE COGEMA STONE & WEBSTER

Fire Hazards Analysis

- Content of the MFFF FHA
  - Fire area determination
  - Fire safety with respect to HVAC and electrical design
  - Fire protection program
  - Firewater supply and manual fire fighting
  - Life safety analysis
  - Fire exposure analysis
  - Potential for fire spread between fire areas
  - Impact of natural phenomena hazards
  - Compensatory measures
  - Summary/conclusions (assessment to NUREG-1718, Appendix D)
  - Fire area analysis (for each fire area)

DUKE COGEMA STONE & WEBSTER

Fire Hazards Analysis

- Each fire area analysis within the FHA includes:
  - Description of rooms that comprise the fire area and their function(s)
  - Fire hazards and fire load within fire area
  - Ignition sources within fire area
  - Fire protection features within fire area, including passive fire protection features (e.g., fire barriers), fire detection and alarm systems, and fixed fire suppression systems and equipment
  - Identification and evaluation of principal SSCs (IROFS) located within fire area
  - Design-basis fire scenarios and consequences
  - Life safety (e.g., occupancy and egress routes)

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Fire Hazards Analysis

- Results and Conclusions of the FHA:
  - The MFFF fire safety design meets the applicable requirements or intent of the NFPA Standards and national building codes.
  - The potential fires are small and non-propagating.
  - In conclusion, fires contained to their fire area of origin.
  - To provide defense in depth to the fire barriers of fire areas containing dispersible radioactive materials, the fire detection system and the fire suppression system in these areas are designated as principal SSCs.

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Fire Modeling

- MFFF fire modeling applications:
  - Primarily utilized to examine the impact of fire-induced temperatures and heat fluxes on specific targets during key fire events
  - Secondarily utilized to demonstrate adequate safety margin with regard to fire severity in relation to ratings of fire-resistant barriers
  - Transient combustibles included in fire models
- Fire modeling codes utilized:
  - CFAST
  - FPEtool

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Robustness of Fire Barriers

- Structural elements in BMF, BEG, and UEF comprised of reinforced concrete are compliant with Type I (noncombustible construction) per NFPA 220-1995, "Standard on Types of Building Construction"
  - MOX Fuel Fabrication Building (BMF)
  - Emergency Generator Building (BEG)
  - Emergency Fuel Storage Vault (UEF)
- Structural elements in BMF, BEG, and UEF exceed minimum requirements for 3 hour barriers.

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Fire Safety Summary

- Key aspects of fire safety at the MFFF:
  - Multiple fire areas – 300+
  - Suppression and detection for rooms containing dispersible radioactive materials provide defense-in-depth to protect fire barriers
  - Prevention of fires in process cells (no ignition sources)
  - Control of combustibles
  - Control of ignition sources

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Fire Safety Summary

- Multiple fire areas:
  - ➤ Limits combustible loads to that contained in fire area plus transient loads
  - ➤ Limits extent of any individual fire to fire barrier boundaries
  - ➤ Limits MAR involved in fire
  - ➤ Effectiveness shown by –
    - Long history of fire safety
    - Analysis
    - Testing

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Fire Safety Summary

- Combustibles are limited by use of:
  - ➤ Noncombustible or nonflammable materials to the maximum reasonable extent for construction and furnishings
  - ➤ Thermally stabilized forms of pyrophoric materials (PuO_2, UO_2) or material in a form that is essentially noncombustible
  - ➤ Solvent and diluent in process buildings is used and handled within welded equipment and NFPA 30 compliant.
  - ➤ Fire retardant electrical insulation

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Fire Safety Summary

- Ignition sources are controlled by:
  - Restricting location of electrical equipment
  - Grounding of all equipment
  - Hot work permit system (for welding, grinding, flame-cutting, brazing, or soldering activities)

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Conclusion

- MFFF design has multiple layers of fire protection that meets the applicable regulatory requirements:
  - Low combustible loads
  - Control of ignition sources
  - Multiple fire areas
  - Fire detection systems
  - Fire suppression systems
  - Fire brigade
  - Fire prevention/protection training

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MOX Fuel Fabrication Facility (MFFF)
TBP Degradation and Red Oil Phenomena

ACRS Subcommittee on Reactor Fuels Meeting
21 April 2003

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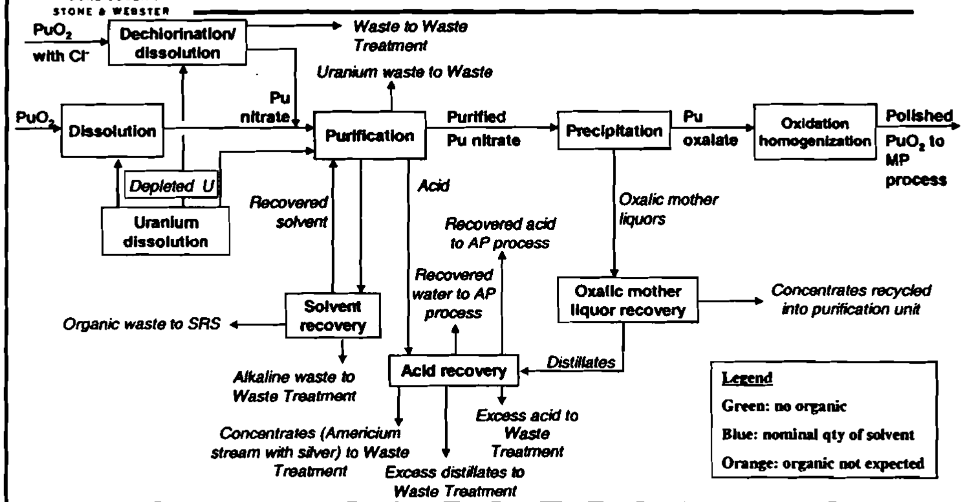
Content of the Presentation

- DCS Approach to Safety
- Operations with TBP Degradation Hazard
- Characteristics of Red Oil
- TBP Degradation
- Lessons Learned From Previous Events
- DCS Safety Strategy/Principal SSCs

DCS Approach to Safety

1. Development of a ***fundamental understanding of the system*** through:
   - an exhaustive review of the literature
   - a detailed investigation of the chemistry and physical phenomena of the system with the support of experts from national laboratories and universities
2. Incorporation of lessons learned from previous events
3. Confirmatory testing during the ISA to validate our analysis

Plutonium Polishing Process Overview



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Characteristics of Red Oil

- Characteristics of Red Oil:
  - ✓ Organic-based material which can be formed by metal, nitric acid, and TBP and a hydrocarbon diluent.
  - ✓ Dense material (1.1 to 1.5 g/cm^3)
  - ✓ Energetic material (with different thermal decomposition temperature than the metal adduct)
- Red Oil has been synthesized by:
  - Gordon et al. (Los Alamos National Laboratory)
  - Stieglitz et al. (Kernforschungszentrum Karlsruhe)
  - Wagner et al. (Hanford)
  - Wilbourn et al. (General Atomic)

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Techniques Used to Investigate Red Oil

- Red Oil synthesized by:
  - ➢ Reflux
  - ➢ Reflux/distillation
  - ➢ Closed pressurized vessel

Formation of "Red Oil" found when diluent contained large quantities of naphtalene

- Characterized by:
  - ➢ Nuclear Magnetic Resonance (^{1}H,^{13}C,^{31}P)
  - ➢ Infra-red spectroscopy
  - ➢ Gas Chromatography – Mass Spectroscopy
  - ➢ Elemental / Combustion analysis
- Main Results
  - ➢ ^{31}P NMR: δ for $UO_2(NO_3)$.2TBP @ 2.4ppm
  - ➢ Carbon (35-55%wt) and Nitrogen (1.5-5.0%wt) contents
  - ➢ Presence of Carboxylic Acid and Nitro/Nitrate/Nitrite group

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Results of Analysis of Red Oil

Differential Thermal Analysis (DTA)

❑ Broad exothermic between 130°C-250°C due to:

✓ Nitric acid reaction with TBP

✓ Partial pyrolysis of TBP

✓ Incipient calcination of $Th(NO_3)_4.2TBP$

// Thorium is used as a surrogate for plutonium

❑ Endothermic δ @ 300°C

✓ TBP pyrolysis - Butene

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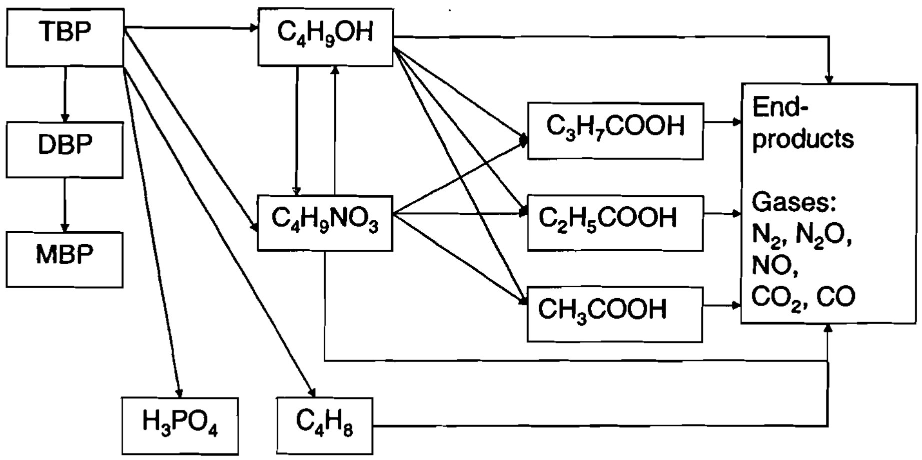
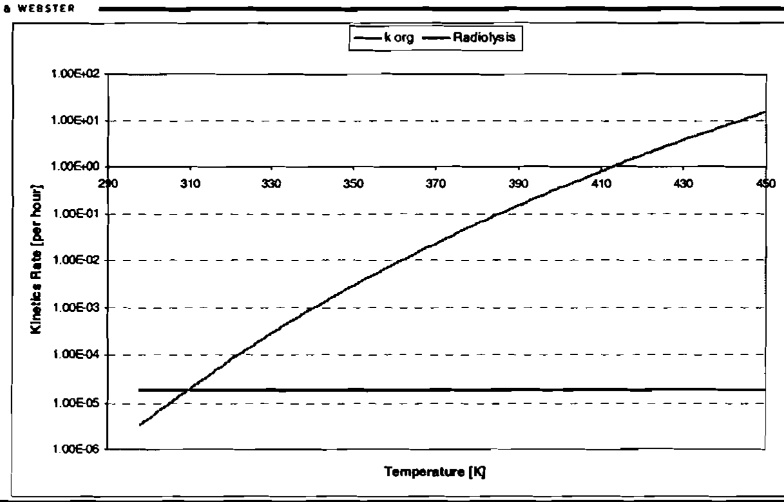
Influence of the Solvent

- The initiation temperature of the exothermic decomposition of the metal nitrate-TBP complex previously presented is altered by the oxidation of TBP products in nitric acid medium.
- Therefore, to understand this alteration of thermal decomposition of the metal nitrate-TBP complex, it is necessary to understand the phenomenon associated with TBP degradation in a nitric acid medium.

TBP Degradation



Hydrolysis and Radiolysis Effects



Influence of Temperature and Acidity on the Energy Production from Degraded Products

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TBP Degradation Product	$[HNO_3]$ (M)	Oxidation Onset Temp. (°C)	Exotherm Peak Temp (°C)	Measured Exotherm (cal/g) Organic
Butanol	15.8	35	52	102
	12.0	37	58	254
	10.0	60	68	254
	8.0	55	74	190
	6.0	75	86	34
Butyl Nitrate	15.8	52	78	176
	12.0	74	92	41
	10.0	85	94	6
	8.0	No Exotherm	No Exotherm	0

Limiting Quantity of Degradation Products

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$$\frac{dM_{TBP}(t)}{dt} = -k_1 M_{TBP}(t) - k_2 M_{TBP}(t)$$

$$\frac{dM_{D.O.}(t)}{dt} = k_1 M_{TBP}(t) + k_2 M_{TBP}(t) - M_{D.O.}(t)\exp(-k_3 t) - k_4 M_{D.O.}(t)$$

- M_{TBP} = mass of TBP as a function of time
- M_{DO} = mass of degraded organics as a function of time
- k_1 = hydrolysis rate constant
- k_2 = radiolysis rate constant
- k_3 = evaporation rate constant
- k_4 = oxidation rate for butyl nitrate

Mass & Heat Transfer

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Production terms

- Limit heating sources (<60° C except evaporator units; evaporators limited to steam temperature of 135° C)
- Heat from exothermic reactions

Removal terms

- Evaporation of water and other materials
- Heat transfer by conduction or convection to an aqueous phase
- Heat transfer to the vessel walls
- Heat transfer from endothermic reactions

Lessons Learned

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- 1953: Early events (SRS, Hanford) identified the importance of the properties of the diluent in determining safety and the necessity for redundant safety controls

  1975: Savannah River event identified the importance in limiting flammable gaseous products produced during TBP degradation reactions

  1993: Tomsk events identified the importance of long term degradation of solvent buildup and heat transfer mechanism

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MFFF Principal SSCs

- Diluent: branched chain hydrocarbon
- Venting: provide cooling mechanism to provide heat transfer and limit pressurization
- Steam temperature: limited at 135°C
- Limit exposure time to prevent degradation of chemical species and subsequent buildup of degraded organics

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Conclusions

- A fundamental understanding of the chemistry and physical mechanisms related to TBP degradation has been obtained
- Lessons learned from previous accidents have been utilized in formulating a safety strategy
- Principal SSCs and corresponding design bases have been identified
- Confirmatory testing has been identified

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MOX Fuel Fabrication Facility (MFFF) HVAC System Description

ACRS Subcommittee on Reactor Fuels Meeting
21 April 2003

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MFFF HVAC System Description

Outline

- Confinement Principals
- Application of Confinement Principals
- HVAC System Summaries
- HVAC Systems Operation During Fires

Confinement Principals

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- Multiple confinement system barriers
- Perform safety function effectively during normal & abnormal conditions
- Confine radioactive materials close to the point of origin
- Prevent uncontrolled release of radioactive materials
- Multiple zones: primary, secondary, tertiary
- Maintain pressure differentials between zones
- Capable of operation during a fire

Application of Confinement Principals

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- MFFF Confinement Zones

C1 - zero potential contamination.

C2 & PC - very low occasional contamination potential (RG 3.12 zone III)

C3 - low to moderate risk of contamination (RG 3.12 zone II)

C4 - containing radioactive material where permanent contamination is allowed (RG 3.12 zone I)

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Application of Confinement Principals

- Walls, glovebox, vessels, cladding
- Gasketed doors, penetration seals
- air locks
- HEPA filter at ventilation opening between C1,C2, C3 & C4 zones
- Relative pressure gradients between confinement zones C1 ➔ C2 ➔ PC

  C1 ➔ C2 ➔ C3a ➔ C3b ➔ C4
- Fully welded enclosures permitted in C2 & PC zones
- Two stages of HEPA in final filters prior to discharge to the atmosphere

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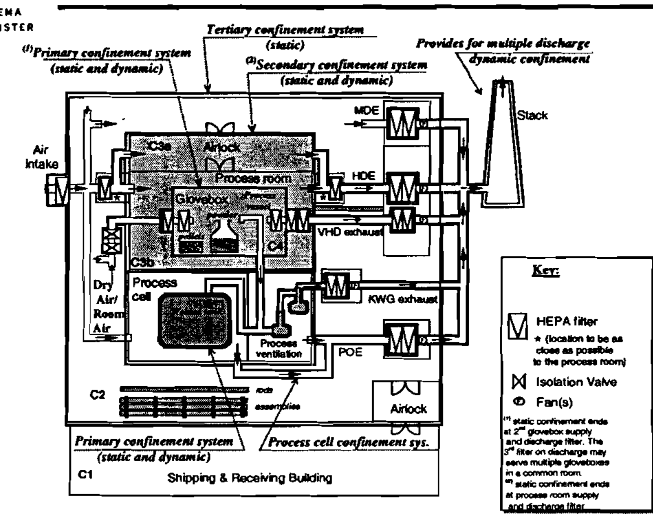
Simplified Schematic



Application of Confinement Principals

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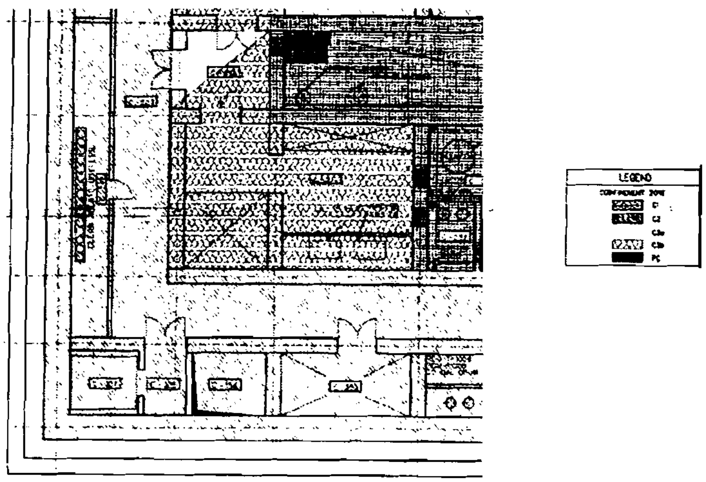

HVAC Systems

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- MFFF Confinement HVAC Systems
  - Supply Air system (HSA)
  - Medium Depression Exhaust System (MDE). Exhausts C2 zones. (RG 3.12 zone III)
  - Process Cell Exhaust System (POE). Exhausts PC zones (RG 3.12 zone III)
  - High Depression Exhaust System (HDE). Exhausts C3 zones. (RG 3.12 zone II)
  - Very High Depression Exhaust System (VHD). Exhausts C4 zones. (RG 3.12 zone I)

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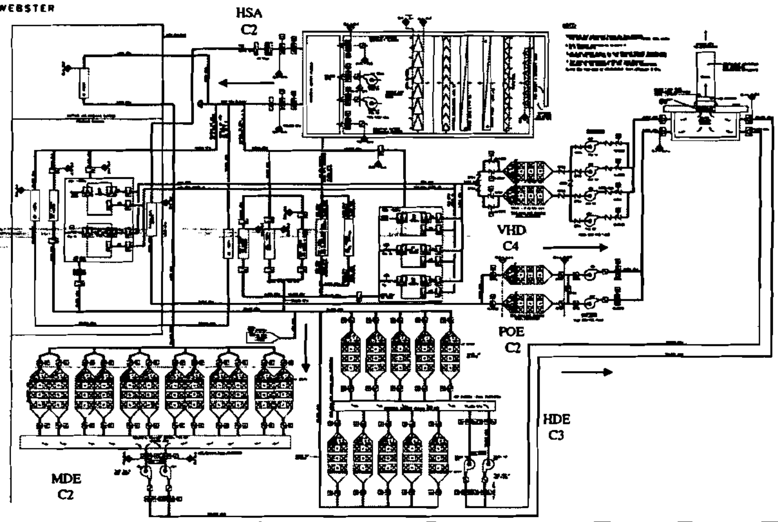
HVAC Systems Schematic Diagram



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MFFF HVAC System Description

Summary of Air Flows

- VHD System: 3500 CFM, 240 glove boxes and 61 flow circuits. Largest glovebox 118 cfm
- HDE System: 77,800 CFM, 194 rooms and 14 flow circuits (i.e., intermediate filters). Largest room 5,200 cfm.
- POE System: 9,000 CFM, 21 Process Cells and no intermediate filters. Largest room 2,350 cfm.
- MDE System: 100,900 CFM, 291 rooms and no intermediate filters. Largest room cfm 3,100 cfm.
- HSA System: 189,000 CFM, supplies air to 506 rooms.

MFFF HVAC System Description

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HSA Supply System

- Provides conditioned and ventilation air for environment control
- Provides a source of air for emergency cooling of the 3013 storage vault and other PSSC's.
- Incorporates controls to distribute and regulate the movement of air to each room.
- Seismic design (PSSC)

MFFF HVAC System Description

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MD Exhaust System

- Exhausts air from C2 confinement zone
- Maintains a negative pressure differential between the C2 confinement zone and atmosphere
- Filter contaminants from the exhaust air prior to discharge

MFFF HVAC System Description

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POE Exhaust System

- Exhausts air from the PC confinement zone
- Maintain a negative pressure differential between the process cell confinement zone and the C2 confinement zone.
- Filter contaminants from process cell exhaust air prior to discharge.
- Seismic Design

MFFF HVAC System Description

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HD Exhaust System

- Exhausts air from the C3 confinement zones
- Maintain a negative pressure differential between the C3 (process room) confinement zone and the C2 confinement zone
- Ventilates 3013 PuO_2 Storage and select PSSC equipment rooms during abnormal conditions.
- Provides intermediate filtration of the exhaust air
- Filter contaminants from the exhausted air prior to discharge
- Seismic Design
- Emergency Power

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MFFF HVAC System Description

Very High Depressurization Exhaust System

- Exhausts air from the C4 confinement zones
- Maintain a negative pressure differential between the C4 (glove box) and C3 (process room) confinement zones
- Provides intermediate filtration of the exhaust air
- Filter contaminants from the exhausted air prior to discharge
- Seismic design
- Uninterruptible Power Supply

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Operation During Fire

C3 Room Fire

- All Supply and exhaust fans remain in operation.
- Exhaust from involved room remains open.
- Clean agent is discharged to suppress fire
- Fire dampers in the involved room supply ducts are closed.
- HD Exhaust intermediate filters can be by-passed.
- Products of combustion are cooled by the flows from non-involved rooms.
- Final HEPA filters units are designed to handle soot generated by the design basis fire.
- Involved space(s) can be manually isolated from the exhaust system.
- C2 confinement zone provides buffer around C3 rooms.

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Operation During Fire

Glovebox Internal Fire

- All Supply and exhaust fans remain in operation.
- Glove box fire detectors sound alarm and operators respond with manual CO_2 suppression
- Glovebox exhaust maintained through out system.
- Products of combustion are cooled by the flows from non-involved gloveboxes.
- Final HEPA filters units are designed to handle soot generated.
- Involved glovboxe(s) can be isolated from the exhaust system.

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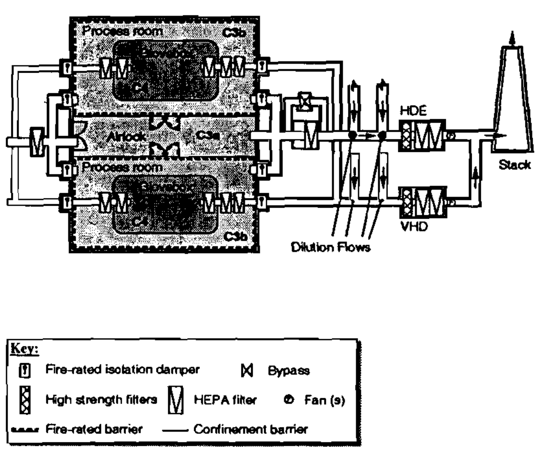
Simplified Schematic of Fire and Confinement Areas



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Conclusion

- HVAC Systems mitigate the release and dispersion of radioactive materials
- Remains Functional during abnormal events
- Includes a highly efficient filtration system
- Operates during abnormal events
- Meets the intent of RG 3.12

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MOX Fuel Fabrication Facility (MFFF) HEPA Filter Design Features to Mitigate Fire Effects

ACRS Subcommitte on Reactor Fuels Meeting
21 April 2003

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Purpose

- Present key MFFF design features that will protect HEPA filters from damage from severe environmental conditions during accident scenarios such as fire

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HEPA Filter Basics

- Particulate removal systems
- Testing ensures efficiency in service
- HEPA filter efficiency is the same across all stages
- Over 50 years of performance history
- MFFF HEPA filter design based on principles rooted in history
- Additional analyses being performed for the ISA will demonstrate that the final HEPA filters are protected

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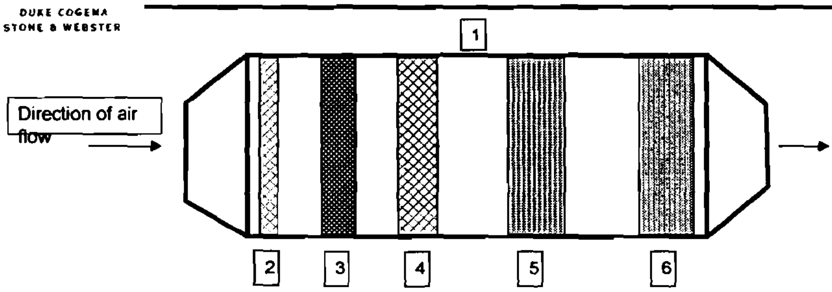
MFFF HEPA Filter Unit Schematic



1. All stainless steel filter housing (per ASME N 509)
2. Structurally strong roughing filter, all stainless steel with reinforced stainless steel wire mesh filter media (embers)
3. Structurally strong high efficiency prefilter, all stainless steel with reinforced stainless steel wire/glass fiber mesh media (soot)
4. Noncombustible prefilter (optional)
5. Nuclear grade HEPA filters (1st Stage)
6. Nuclear grade HEPA filters (2nd Stage)

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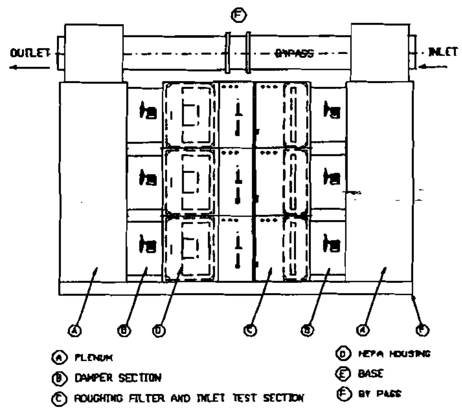
INTERMEDIATE HEPA FILTER BOX



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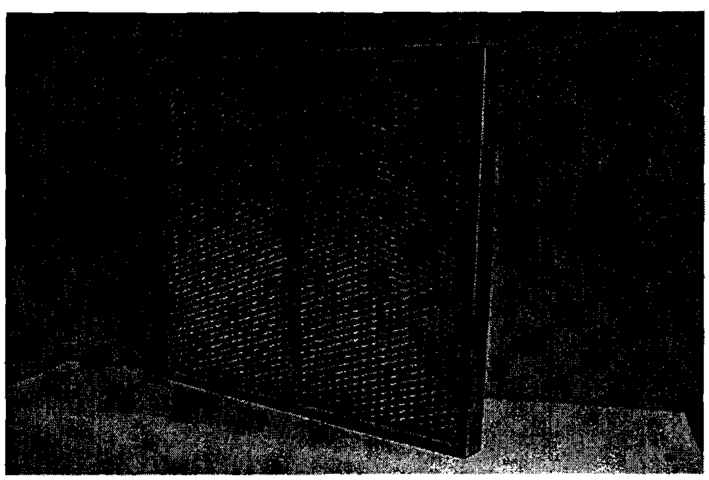
Stainless Steel Mesh Roughing Filter Element



Roughing Filter (Full-Size Prototype)

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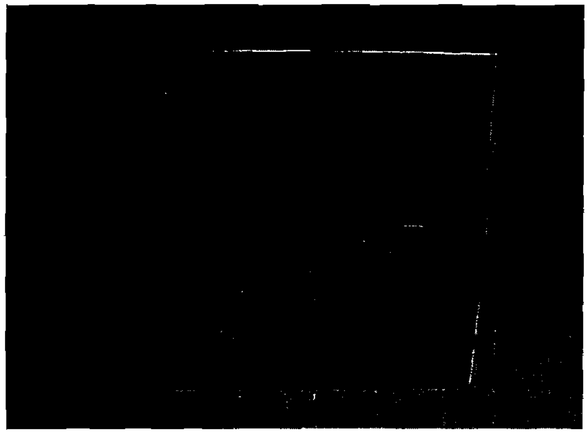
Stainless Steel/Glass Fiber Mesh Prefilter



Stainless Steel / Glass Fiber Prefilter
(Half-Size Prototype)

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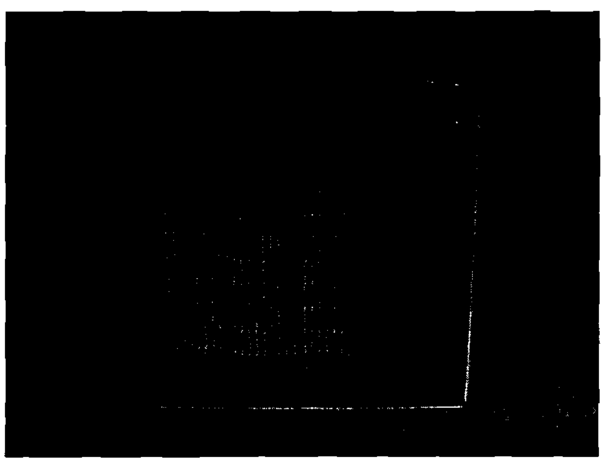
HEPA Filter Element



HEPA Filter (Half-Size Prototype)

Testing ensures efficiency in service

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- Manufacturer tests designs for efficiency, pressure drop, rough handling, pressure, moisture, heated air, pinhole leaks, and spot flame resistance
- All filters are tested for efficiency before shipment
- The MFFF performs insitu efficiency tests at installation, replacement and periodic intervals
- These tests ensure that installed HEPA filters work
  - Efficiency of > 99.9% for 0.2 μm at rated flow
  - Structurally withstand pressure drop > 10 inches H_2O
  - Withstand 700°F for 5 minutes

HEPA filter efficiency is the same across all stages

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- Tests and analyses indicate that filters in series do not lose efficiency: the second stage is just as efficient as the first stage
- Two HEPA filters in series have a combined efficiency of at least 99.9999% for most penetrating particles

Over 50 years of performance history

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- HEPA filter performance in nuclear service has been studied for more than 50 years
- Scientific studies, lessons learned, expert review panels, industrial/government standards organizations have all identifed factors that impact HEPA filter performance
- These factors fall within 3 categories
  - Short Term Physical Effects (Leaking, Clogging, Bursting)
    - Embers, Smoke/Soot, High Temperature, Mositure/Water, Airflow
  - Long Term Degradation Effects (Aging)
    - Chemicals, Moisture/Water, Radiation
  - Other Factors
    - Manufacturing Defects, Installation Errors, Inspection Errors

MFFF HEPA filter design based on principles rooted in history

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- Embers – mitigated by high strength roughing filter
- Soot – mitigated by high strength high efficiency prefilter
- High temperature – mitigated by noncombustible materials, high temperature materials and dilution air flow
- High moisture – mitigated by dilution air flow
- Entrained water – prevented by design features (i.e., no sprinklers, high strength high efficiency prefilter), dilution air flow

MFFF HEPA filter design based on principles rooted in history (continued)

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- High ΔP – prevented by combustible loading controls, fire detection/suppression features, high strength prefilter elements with DID monitoring for timely switchover to spare filter units
- Aging – mitigated by periodic inspection, testing and replacement
  - Chemical Exposure – also mitigated by process design features
  - Radiation Exposure – also prevented by facility design features
  - Moisture Exposure – also mitigated by facility design features

Summary of Analyses

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- Fire hazard analysis
- Fire severity modeling
- Soot loading analysis
- Dilution temperature analysis
- Moisture analysis
- Fault tree analysis
- Single failure analysis
- HVAC transient and disturbance analyses
- Internal explosion analysis

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Analyses Consider Uncertainties

- Factors that could affect HEPA filter performance are well known and have been quantified
- The systems and safety analysis use conservative values to bound these impacts
  - ➢ two ~~largest fire~~ events for both smoke
  - ➢ temperature challenges
- Independent empirical verification of filtration system performance by filter soot loading experiments is planned for the ISA

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MFFF Filtration System Soot Loading Experiments

- Filter design is based on previous empirical studies
- No specific data characterizes behavior of MFFF soot
- Filtration system soot loading experiments will determine behavior of soot in MFFF filtration system:
  - ➢ Distribution of soot through the filtration system
  - ➢ ΔP across each filter of the filtration system as a function of soot load
  - ➢ Change in flow rate as a function of soot load
  - ➢ Ultimate soot loading capacity of the filtration system

FINAL HEPA FILTER HOUSING

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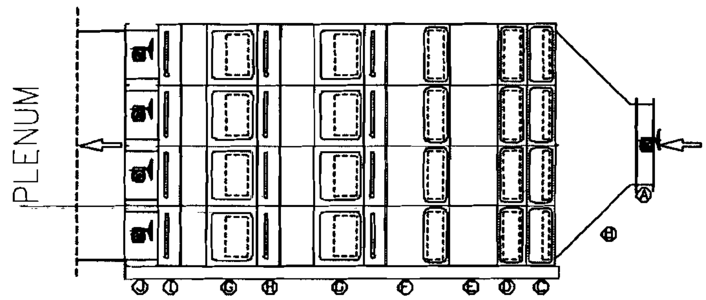

Application of Lessons Learned from Historical Fires

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- HVAC systems and filter elements are constructed of noncombustible materials
- HEPA filters have special features to protect the final HEPA filter elements
- Dilution air, not water sprays, protect the HEPA filters from excessive temperatures
- Ventilation duct attenuates rapid pressure excursions
- Fire isolation valves/fire wrapping provided for beyond design basis events
- MFFF process building designs provide multiple confinement layers
- Low potential contamination of final HEPA filters

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Conclusions

- The MFFF design prevents the final HEPA filters from exposure to severe environmental conditions
- The design basis event scenarios under which the filter design is being evaluated include and account for uncertainties in postulated events
- The design has a historical basis for each of the elements that make up the "HEPA Filter"
- These features make the MFFF Final HEPA filters robust

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MOX Fuel Fabrication Facility (MFFF) Hydroxylamine Nitrate (HAN)

ACRS Subcommittee on Reactor Fuels Meeting
21 April 2003

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Content of the Presentation

- Approach to Safety
- Use of HAN within the AP Process
- Properties of HAN
  - Back Extraction of Pu (IV) from Organic Phase
  - Reaction with nitric acid
  - Reaction with nitrous acid
  - Re-oxidation of Plutonium
- Use of Hydrazine
- DCS Safety Strategy

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DCS Approach to Safety

1. Development of a ***fundamental understanding of the system*** through:
   - an exhaustive review of the literature
   - a detailed investigation of the chemistry and physical phenomena of the system with the support of experts from national laboratories and universities
2. Incorporation of lessons learned from previous events
3. Confirmatory testing during the ISA to validate our analysis

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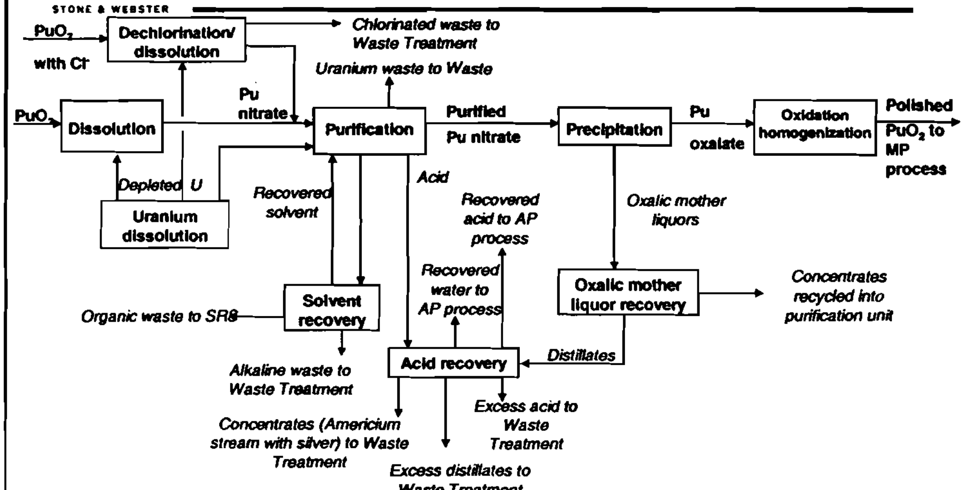
Plutonium Polishing Process Overview



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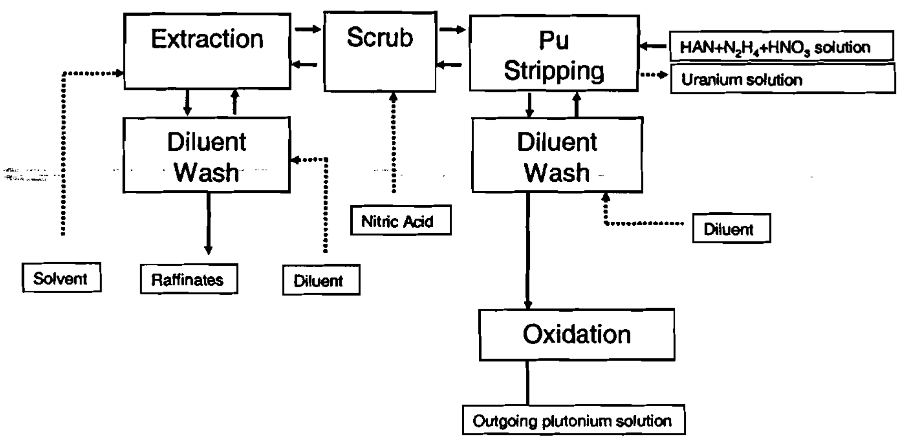
Simplified Purification Process



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Properties of Hydroxylamine (HAN)

- Soluble only in aqueous phase
- Extraction - Reduction of Plutonium [Pu(IV) →Pu(III)]
- Reactions with nitric acid and nitrous acid

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Extraction - Reduction of Plutonium

- Reduction of Pu(IV) to Pu(III) by HAN
- Two Reactions are possible:

$$2NH_3OH^+ + 4Pu^{4+} \rightarrow 4Pu^{3+} + N_2O + H_2O + 6H^+$$

$$2NH_3OH^+ + 2Pu^{4+} \rightarrow 2Pu^{3+} + N_2 + 2H_2O + 4H^+$$

- Preferred Reaction depends on the ratio R

$$R = \frac{[Pu(IV)]_0}{[NH_3OH^+]_0}$$

- R>1: reaction 1
- R<1: reaction 2

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Competitive Reactions involving HAN

- Reaction of HAN with Nitric Acid

$$HAN + HNO_3 \rightleftarrows 3HNO_2 + H_2O$$

- Reaction of HAN with Nitrous Acid

$$HAN + HNO_2 \rightleftarrows N_2O + 2H_2O$$

Reaction of HAN with Nitric Acid

DUKE COGEMA STONE & WEBSTER

$$H^+ + HNO_2 + NO_3^- \rightleftarrows N_2O_4 + H_2O$$

$$NH_2OH + N_2O_4 \rightarrow N_2O_3 + HNO + H_2O$$

$$N_2O_4 + HNO \rightarrow N_2O_3 + HNO_2$$

$$N_2O_3 + H_2O \rightarrow 2HNO_2$$

$$HAN + HNO_3 \rightleftarrows 3HNO_2 + H_2O$$

Kinetics of Decomposition of HAN

DUKE COGEMA STONE & WEBSTER

The rate law of decomposition of HAN by Nitric and Nitrous Acids can be derived by applying the steady state approximation to N_2O_4, HNO and N_2O_3:

$$\frac{d[HNO_2]}{dt} = [HNO_2][NH_3OH^+]\left(\frac{k_1[H^+][NO_3^-]}{\frac{k_{-1}}{k_2} + 2[NH_3OH^+]} - k_3\right)$$

DUKE COGEMA STONE & WEBSTER

Energetics of HAN Decomposition

- HAN autocatalytic oxidation is ***exothermic***.

$$4HAN \rightarrow 3N_2O + 7H_2O + 2HNO_3 \quad \Delta H = -49 kcal/mol$$

DUKE COGEMA STONE & WEBSTER

Plutonium Re-oxidation Mechanism

- The Re-Oxidation of Pu(III) has two main side effects
  - Re- produces Pu(IV) and therefore consumes HAN
  - Consumes Hydrazine
  - Autocatalyzes the production of Nitrous Acid

$$Pu^{3+} + N_2O_4 \rightarrow Pu^{4+} + NO_2 + NO_2^-$$

$$H^+ + NO_2^- \rightleftarrows HNO_2$$

$$2NO_2 \rightleftarrows N_2O_4$$

DUKE COGEMA STONE & WEBSTER

Use of Hydrazine

- Hydrazine scavenges nitrous acid which impedes the production of N_2O_4
- This scavenging consequently impedes
  - Plutonium re-oxidation
  - The auto-catalytic HAN/nitric acid reaction

DUKE COGEMA STONE & WEBSTER

Hydrazine is a more effective Nitrous Scavenging Agent than Hydroxylamine

Substrate	0.05 M [H^+]	0.5 M [H^+]	1.3 M [H^+]
HAN	0.15	2.1	9.6
Hydrazine	31	390	1820

Note: Rate constant are in $M^{-1}.s^{-1}$

Reactivity of Nitrous Acid Scavengers @25°C:

DUKE COGEMA STONE & WEBSTER

DCS Safety Strategy

- Hydrazine is an effective nitrous scavenging agent that will be utilized to demonstrate that the autocatalytic decomposition of HAN is precluded.
- PSSCs identified in CAR:
  - Chemical Safety Controls (e.g concentration of HAN, hydrazine)
  - Process Safety Controls (Temperature)
- Confirmatory testing will be performed during the ISA to further substantiate the minimum hydrazine necessary to preclude the auto-catalytic HAN reaction.

MIXED OXIDE FUEL FABRICATION FACILITY

ACRS PRESENTATION

April 21, 2003

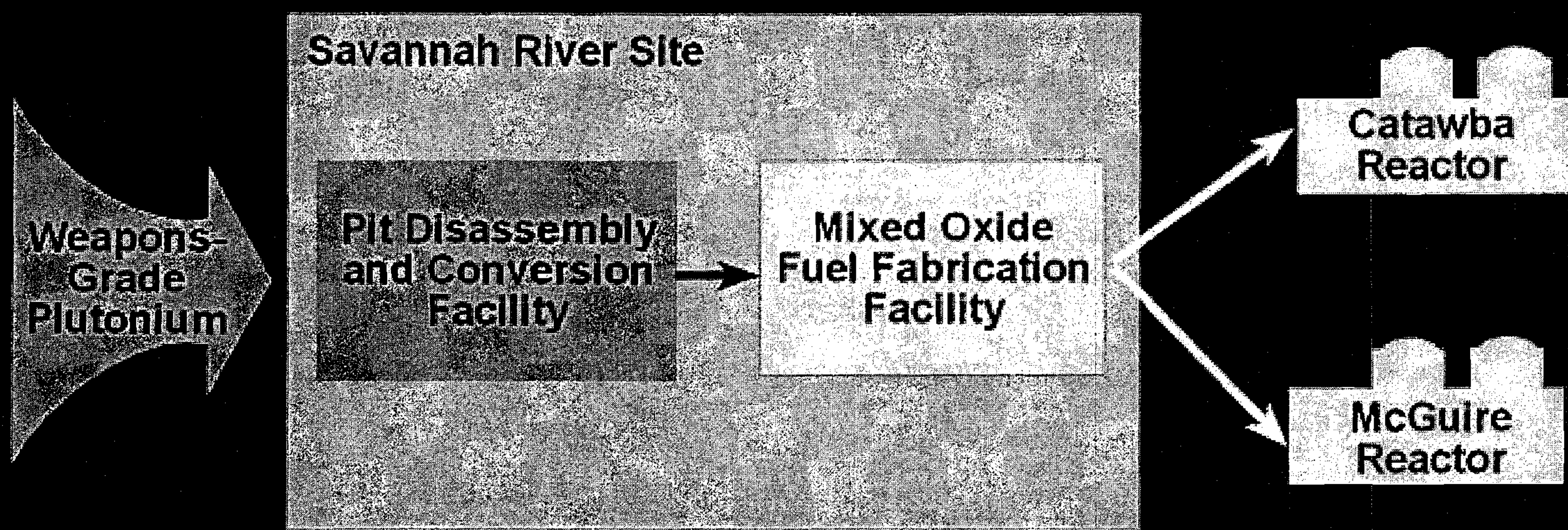
ACRS BRIEFING

Review of the Mixed Oxide Fuel Fabrication Facility
Construction Authorization Request

Introduction

Andrew Persinko, Sr. Project Manager
NMSS/FCSS/SPIB

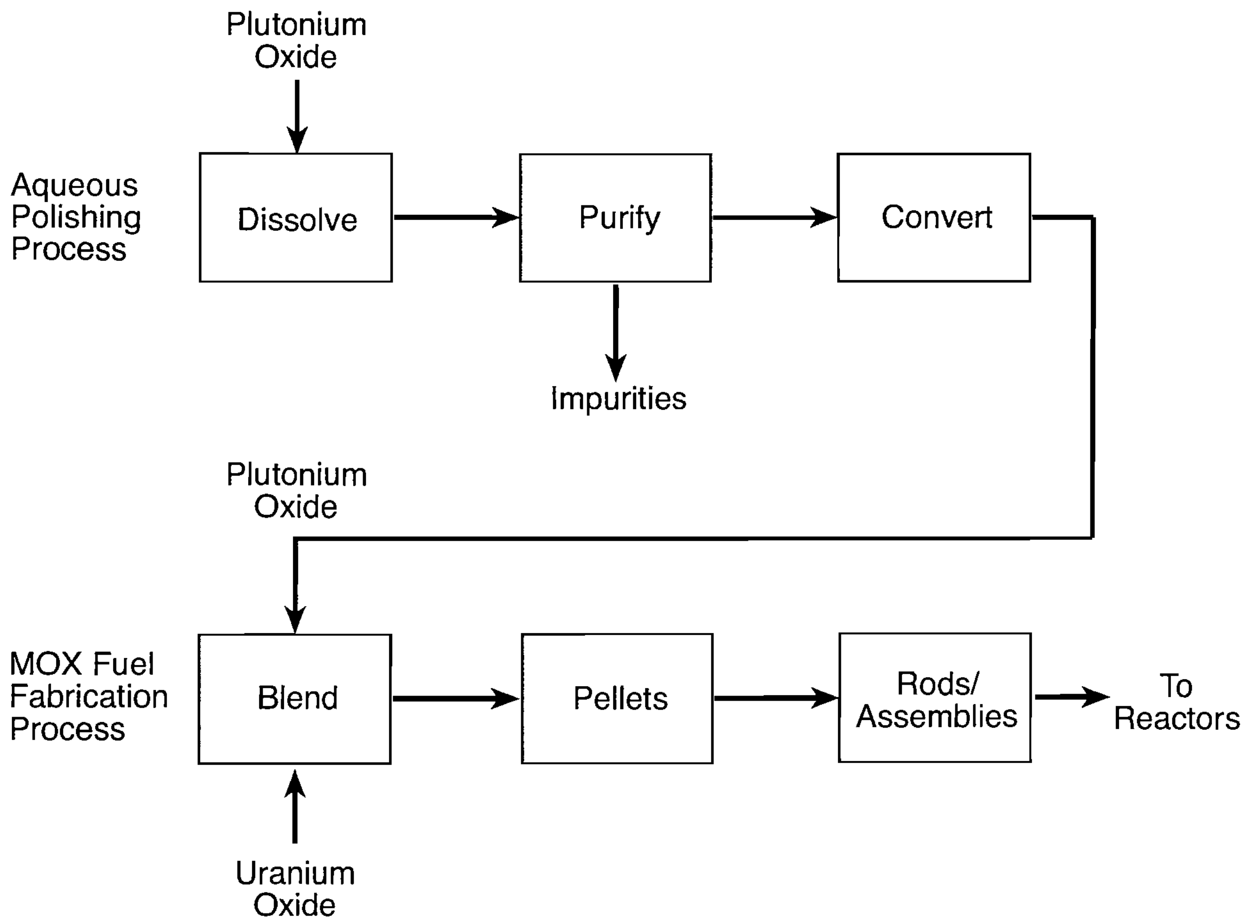
NRC Role in Regulating Mixed Oxide Fuel



Yellow = NRC regulated

Blue = DOE regulated

Mixed Oxide Fuel Fabrication Facility Process



Mixed Oxide Fuel Fabrication Facility

Licensing

- 2-step approval:
  - Construction
  - Operation/possession of special nuclear material
- Approvals to start construction plutonium facility
  - Design bases of principal structures, systems, and components (PSSCs)
  - Quality assurance program
  - Environmental impact statement
- Principal structures, systems, and components / Items relied on for safety

Construction

Design Bases

- 10 CFR 50.2 Definition:

"Design Bases means that information which identifies the specific functions to be performed by a structure, system, or component of a facility and the specific values or ranges of values chosen for controlling parameters as reference bounds for design..."

10 CFR 70.61 Performance Requirements

	Highly Unlikely	Unlikely	Not unlikely
High Consequence Publ Dose > 25 rem Worker Dose > 100 rem	Acceptable	Not Acceptable	Not Acceptable
Medium Consequence Publ Dose 5 - 25 rem Worker Dose 25 -100 rem Env releases > 5000 Tbl 2	Acceptable	Acceptable	Not Acceptable
Low Consequence Publ Dose < 5 rem Worker Dose < 25 rem	Acceptable	Acceptable	Acceptable

Schedule

Major Milestones

- Issued draft Safety Evaluation Report (SER) for construction 4/30/02
- Received revised Environmental Report 7/11/02
- Received revised Construction Authorization Request 10/31/02

Schedule

Major Milestones

- Issued draft Environmental Impact Statement (EIS) for public comment 2/28/03
- Issue revised draft SER for construction 4/03
- Issue final EIS 8/03
- Issue final SER and construction licensing decision 9/03

ACRS BRIEFING

Nuclear Criticality Safety Review for the MOX Fuel Fabrication Facility Construction Authorization Request

Christopher S. Tripp, Senior Nuclear Process Engineer (Criticality)
NMSS/FCSS/SPIB

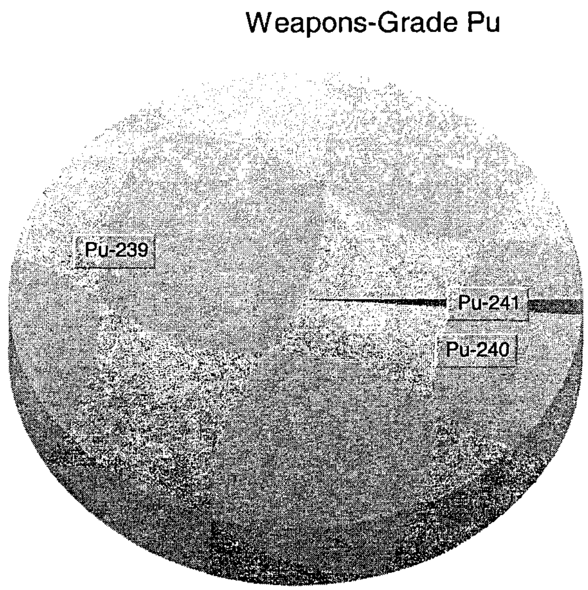
April 21, 2003

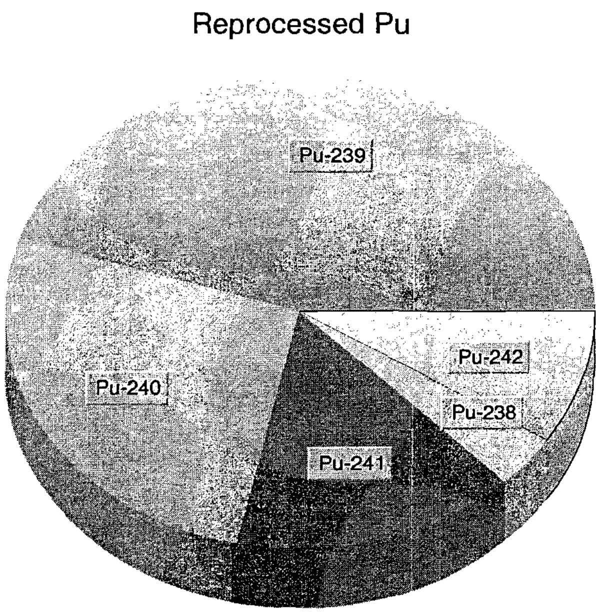
MFFF *vs.* Licensed Part 70 Facilities

- Pu characteristics *vs.* U:
  - Complex chemical and physical properties
  - Isotopics:
    - $^{240}Pu/Pu$
    - $^{241}Pu/Pu$
    - $^{235}U/U$
    - Pu/(U+Pu)
  - Generally smaller critical mass/limits than LEU, HEU, SNF
- Dry "Downblending":
  - Oxide powders downblended in large geometry tanks.
  - Downstream processes credit isotopics.
  - Homogenization important for criticality safety.

Comparison of Pu Isotopes

Comparison is for Highest Impurity MFFF Feed *vs.* Typical SNF (w/ Pu Recycle)





Current NCS Issues

- Code validation:
  - Few critical benchmarks for:
    - Limited Pu/MOX benchmarks across range of important parameters.
    - Few Pu/MOX benchmarks with required absorbers.

- Subcritical Margin/Code Validation: 70.61(d)
  - ABNORMAL: k_{eff} + bias + uncertainty $\leq$ 0.95 Design Basis
  - NORMAL: Normal margin => k_{eff} sensitivity Non-Design Basis
    - System-dependent/variable
    - Parameters or k_{eff}
  - Few benchmarks for code validation => special tools required

Code Validation

- 5 different Areas of Applicability (AOAs):
  - Pu nitrate solutions large benchmarks - over 100 >
  - MOX pellets, rods, and assemblies
  - PuO_2 powder
  - MOX powder } not well benchmarked.
  - Pu compound solutions oxalates pu chloride

- Received VR (validation report) January 2003.
  - Meeting ~~January~~ March 2003: parametric range required by AOAs to be reevaluated.
  - NRC will acquire new version of SCALE code May, 2003 => resolve open questions on benchmark applicability.
  - Dual (CAR preferred) vs. Single-parameter control.
    how do you initiate double contingency

Area of applicability too broadly defined?

Conclusions

- One main open issues remaining for NCS => setting design basis k-effective limits.

  Issue going to > 5%
  - Validation across all AOAs.
  - Normal case subcritical margin.
  - Adherence to dual-parameter approach.

- Identified early as main technical challenge for NCS.
- Staff reviewing validation reports => design basis k_{eff} limits.

  NRC Neutronics code
- SCALE-5 code being pursued to answer benchmark questions.

  few data to validate some aspects of code.
- DCS reevaluating. On schedule for closure by September 2003.

ACRS BRIEFING

Tributyl-Phosphate (TBP) -Nitrate
(Red-Oil) Review for the Mixed Oxide Fuel
Fabrication Facility Construction
Authorization Request

William Troskosi, Sr. Chemical Eng.
NMSS/FCSS/SPIB

April 21, 2003

Introduction

- TBP - Nitrate reactions - highly exothermic chemical reactions similar to many runaway reactions found in the Chemical Process Industry (CPI).
- Regulatory Safety Concern - rapid evolution of heat and non-condensable gases can breach process equipment containing licensed material.
- Staff review - first principals as outlined by applicant and in the literature (including DOE).
- Staff considered known industry events and the CPI approach to similar runaway reactions (Process Hazard Analysis)

First Principals

Fuel - Oxygen - Heat Triangle

- TBP with limited degradation products -DBP, MBP and quantities of butanol and/or butyl nitrate.
- HNO_3 and related oxidizers - assumed to saturate the organic phase.
- Prevent TBP with limited degradation products from reaching the 137°C initiation temperature via evaporative cooling (confirmatory measurements to be performed).

Applicant's PSSCs

Safety Strategy - heat removal greater than heat generation.

- Chemical Safety System - Diluent properties (based on experiments) not susceptible to nitration or radiolysis.
- Process Safety Control Subsystem :
  - Residence time limits on organics (oxidizing agents and high radiation fields).
  - Solution temperature (organics) is within analyzed safety limits (heat transfer calculations).
- Offgas System:
  - Heat removal via evaporative cooling through venting is 1.2 x [heat generation + heat input].
  - Venting to prevent over-pressurization consistent with experiments (e.g. 8×10^{-3} mm^2/g)

Industry Events

Unexpected presence of organics and adequacy of PHA

- TNX 1953 - 80 lbs of TBP in a 78% UN concentrated aqueous solution with T > 130°C and a 50-100 psi backpressure due to partially plugged plates.
- A-Line Denitrator 1975 - 30 gal TBP with metal adducts that accumulated > 1 year; aqueous phase specific gravity change lighter than organic phase; organic transfer to evaporator, then denitrator (~225°C?); pyrolysis @ 150°C
- Tomsk-7 - 1,500 l concentrated nitric acid added to 500 l degraded organic solvent; organic layer @ 80-100°C; presence of more reactive organics

Applicant Confirmatory Experiments

- Diluent - foaming
- Impurities - metal ion affect on initiation temperature and heat generation
- Residence Time - concentration limits for heat generation
- Reaction Kinetics - for heat generation rate

Staff Review

Construction Authorization Phase - design bases of PSSCs provide reasonable assurance against consequences of potential accidents

- Applicant identified PSSCs to address red-oil event initiators and phenomena
- Staff review is considering how "highly unlikely" can be achieved; values and ranges of values for functions; and safety margins.
- Assure Defense-in-Depth
- ISA - HAZOP Analysis and What-if/Checklist to be performed.

ACRS BRIEFING

Hydroxylamine Nitrate (HAN) Review for the Mixed Oxide Fuel Fabrication Facility Construction Authorization Request

William Troskosi, Sr. Chemical Eng.
NMSS/FCSS/SPIB

April 21, 2003

Introduction

- HAN - Nitric Acid Solutions - susceptible to spontaneous autocatalytic reactions
- Regulatory Concern - reactions can explode if in a constrained volume, breaching process equipment containing licensed material.
- Staff Review - first principals as outlined in by Applicant and in the literature (including DOE).
- Staff considered known industry events and the CPI approach to similar runaway chemical reactions (Process Hazard Analysis)

First Principals

Fuel - Oxygen - Heat Triangle

- HAN Concentration (NH_2OH)
- HNO_3 Concentration (and related HNO_2 concentration) -HAN reacts autocatalytically with nitrous acid, which is always present in nitric acid solutions, generating more than is consumed.
- Temperature - decomposition temperature is a function several known reaction conditions (nitric acid - HAN ratio, iron concentration - a catalyst)

Applicant's PSSCs

Safety Strategy - use hydrazine to scavenge nitrous acid before N_2O_4, the main intermediate of the autocatalytic reaction can form.

PSSCs were developed for three process vessel groups:

- HAN and hydrazine nitrate w/o NOx addition
- HAN and no hydrazine nitrate
- HAN and hydrazine nitrate with NOx addition

PSSCs

HAN and hydrazine nitrate w/o NOx addition and
HAN and no hydrazine nitrate

- Process Safety Control Subsystem (PSCS) - limit temperature of solutions containing HAN within safety limits.
- Chemical Safety Control (CSC) - control and maintain nitric acid, metal impurities and HAN concentrations to within safety limits

PSSCs

HAN and hydrazine nitrate with NOx addition

- CSC - control concentrations of HAN, hydrazine nitrate, and hydrazoic acid to within safety limits.
- Offgas Treatment System - provide process vessel gas exhaust path.
- PSCS - control oxidation column flow rate

Industry Events

Inadvertent concentration through heating or natural evaporation; addition of concentrated nitric acid; presence of catalysts (Fe).

- Hanford 1987 - added strong nitric acid to HAN heel
- SRS 1972 - S/U temperature over concentrated HAN and nitric acid by a factor of 10.
- SRS 1978 - makeup nitric acid added to "empty" tank heel.
- SRS 1980 - inadvertent heating for several days; leaking coil
- Hanford 1989 - HAN/hydrazine isolated for ~ 1 year
- SRS 1996 - proximity to external heat source.

DOE Approach

DOE/EH-0555 Technical Report

- Instability Index correlated nitric acid -HAN ratio, nitric acid molarity and iron molarity to temperature.
- The applicant has reviewed the approach and determined that it had limited application.
- The index did not account for affects of plutonium (Catalysis and radiolysis), impurities such as iron, and low hydroxylamine concentrations.

Applicant's Safety Strategy Approach

- Use of hydrazine to scavenge nitrous acid
- DCS still evaluating use of hydrazine as well as other means such as a direct HAN approach.

Staff Review

- Pending submittal of additional information by the applicant to support the selected approach.

ACRS BRIEFING

Fire Protection Review of the Mixed Oxide Fuel Fabrication Facility Construction Authorization Request

Sharon Steele, Fire Protection Engineer
NMSS/FCSS/SPIB

April 21, 2003

Fire Protection Issues

Status of open issues identified in the April 2002 draft Safety Evaluation Report (SER)

- Closed:
  - Glovebox window material
  - Facility wide system
- Open:
  - Fire Barriers
  - Soot loading analysis

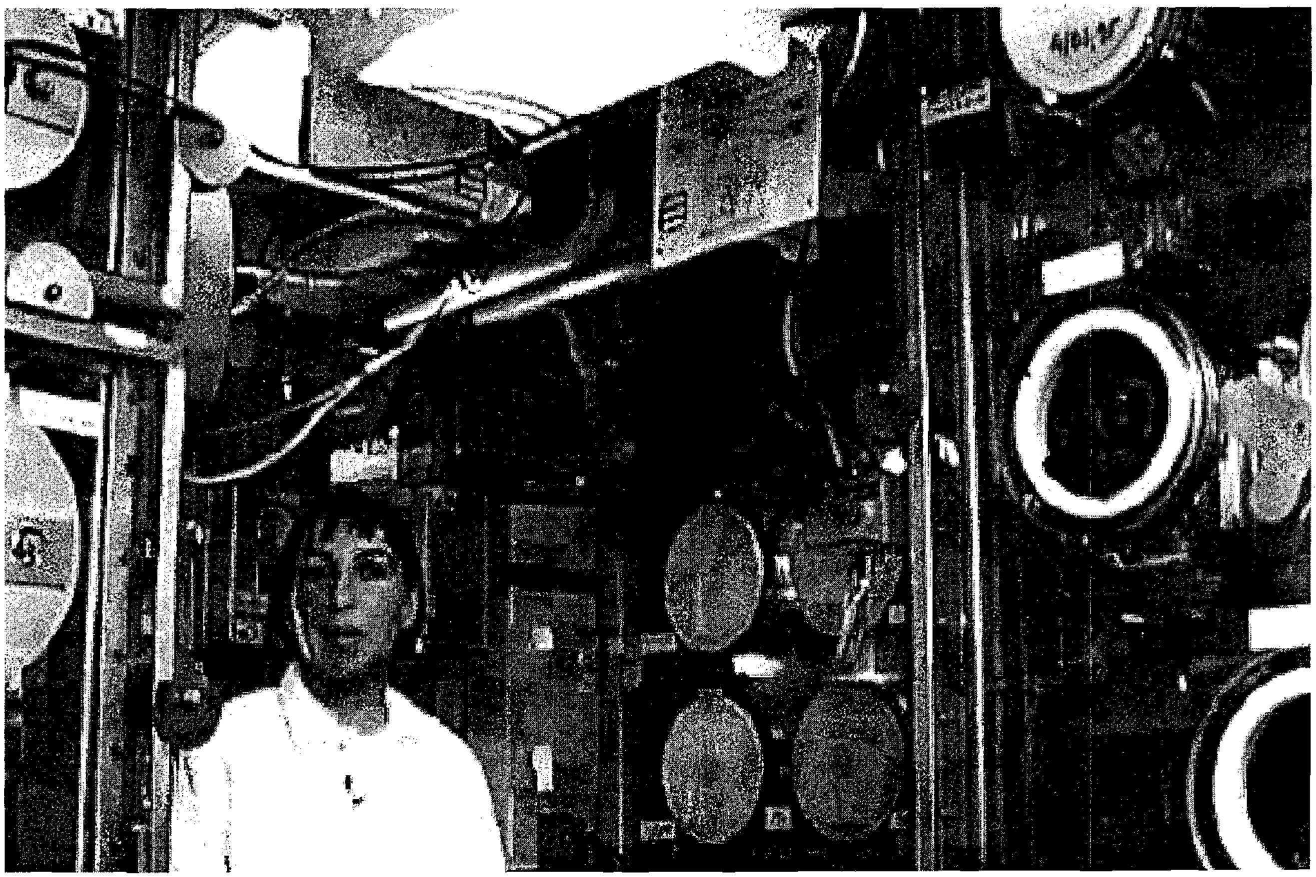
Closed: Design basis criteria for glovebox window

- National Fire Protection Association -NFPA 801, "Standards for Fire Protection for Facilities Handling Radioactive Material"
  - "*The glovebox and window shall be of non-combustible construction*"
- Polycarbonate glovebox windows - to reduce seismic vulnerability and overall risk.

MOX Polycarbonate Report:

- superior seismic inertia and deflection properties compared to glass
- superior fire properties compared to other plastics

Typical Glovebox Installation



Closed: Design basis criteria for glovebox window

- NRC requested the design basis criteria (to assure stated mechanical, fire and seismic properties were bounding)
- Additional fire protection features:
  - automatic detection and suppression (PSSC)
  - manual CO_2 glovebox injection
  - inert atmospheres
  - combustible loading controls (PSSC)

PSSC - Principal Structures, Systems and Components

Closed: Design basis criteria for glovebox window

- Fire Hazard Analysis will account for polycarbonate
- Integrated Safety Analysis will evaluate:
  - Whether range of properties are bounding for expected use/conditions
  - Normal operating conditions such as material creep due to temperature & aging
- NRC considers polycarbonate to be a candidate material

Closed: Propagation of Hot Gas through Facility Wide Systems

- Pneumatic pipe automatic transfer system carries material throughout the facility
  - Convenience cans, sample vials
  - Between gloveboxes (across process atmospheres)
- Hot gases from a fire could be transported across fire area boundaries

Closed: Propagation of Hot Gas through Facility Wide Systems

- Double wall piping
- Combustible loading control -PSSC
- Integrated Safety Analysis will evaluate:
  - Impact of hot gas transport in the pneumatic transfer tubes
  - Isolation valves as IROFS where needed
- High confidence that design is acceptable

Open: Fire barriers

- Insufficient margin of safety
- Fire barriers are rated a minimum of two hours per ASTM E-119 standard time-temperature curve
- Equal Area Hypothesis method - relates fire severity to fire barrier rating
- Fire modeling - demonstrated that the duration of fires was less than barrier rating (with slow growth fire assumptions)

Open: Fire barriers

- Construction authorization:
  - Applicant will evaluate fire scenarios where temperatures could exceed the ASTM E-119 curve (using rapid growth fire assumptions)
  - Fire barriers could withstand thermal shock due to rapid fire development

- Integrated Safety Analysis:
  - fire barrier performance under credible fire conditions (including flashover)
  - account for potential barrier failure

Open: Soot loading analysis

- Process room and glovebox exhaust systems remain operational during a fire
- Protection of final HEPA filters provided by air stream dilution, spark arrester and pre-filter
- Insufficient justification that the final HEPA filters could perform their safety function under fire/soot conditions:
  - No soot analysis for the glovebox exhaust system
  - Process room exhaust appeared to have inadequate capacity to remove the expected soot loading.

Open: Soot loading analysis

- Revision of final filtration analysis
- Applicant provided additional information - February and April (not incorporated in the revised draft SER)
- Soot loading will be experimentally verified

Conclusion

- Technical meetings on open items
- Additional information to address open issues before the final SER

ACRS BRIEFING

Confinement Ventilation Review of the Mixed Oxide Fuel Fabrication Facility Construction Authorization Request

Tim Johnson, Sr. Mechanical Eng.
NMSS/FCSS/SPIB

April 21, 2003

Ventilation and Confinement Systems

- Design Basis Objectives
  - Principal structures, systems, and components (PSSCs) of confinement systems must perform safety functions under conditions requiring confinement
  - Systems must exhibit defense-in-depth Redundance of system components

Proposed Confinement System

- Confinement and ventilation systems are important in minimizing release and dispersal of radioactive material.

- Release of radioactive materials minimized by:
  - Static Barriers (e.g., gloveboxes, process cells)
  - Dynamic Barriers (Ventilation systems)

HEPA Filter Removal Efficiency

- DCS is proposing to use a 10^{-4} release fraction in its accident analyses
- Because of past experiences where fire damage has occured in filtration systems, and due to uncertainties in fire analyses, NRC staff asked for further justification of proposed removal efficiency
- DCS provided further justification on February 18, 2003, and April 10, 2003. Staff is considering April response to questions.

Soot Loading Analysis

- NRC staff unable to verify HEPA filter Soot Loading calculation under fire accident conditions;
- If HEPA filters can rupture under excessive loading conditions;
- DCS provided further justification on February 18, 2003, and April 10, 2003. Staff is considering April response to questions.

Open Items

- How much credit should be given for HEPA filter particulate removal efficiency?
- Under fire conditions, will HEPA filters undergo excessive soot loading conditions?

ACRS BRIEFING

Confinement Ventilation Review of the Mixed Oxide Fuel Fabrication Facility Construction Authorization Request

Tim Johnson, Sr. Mechanical Eng.
NMSS/FCSS/SPIB

April 21, 2003

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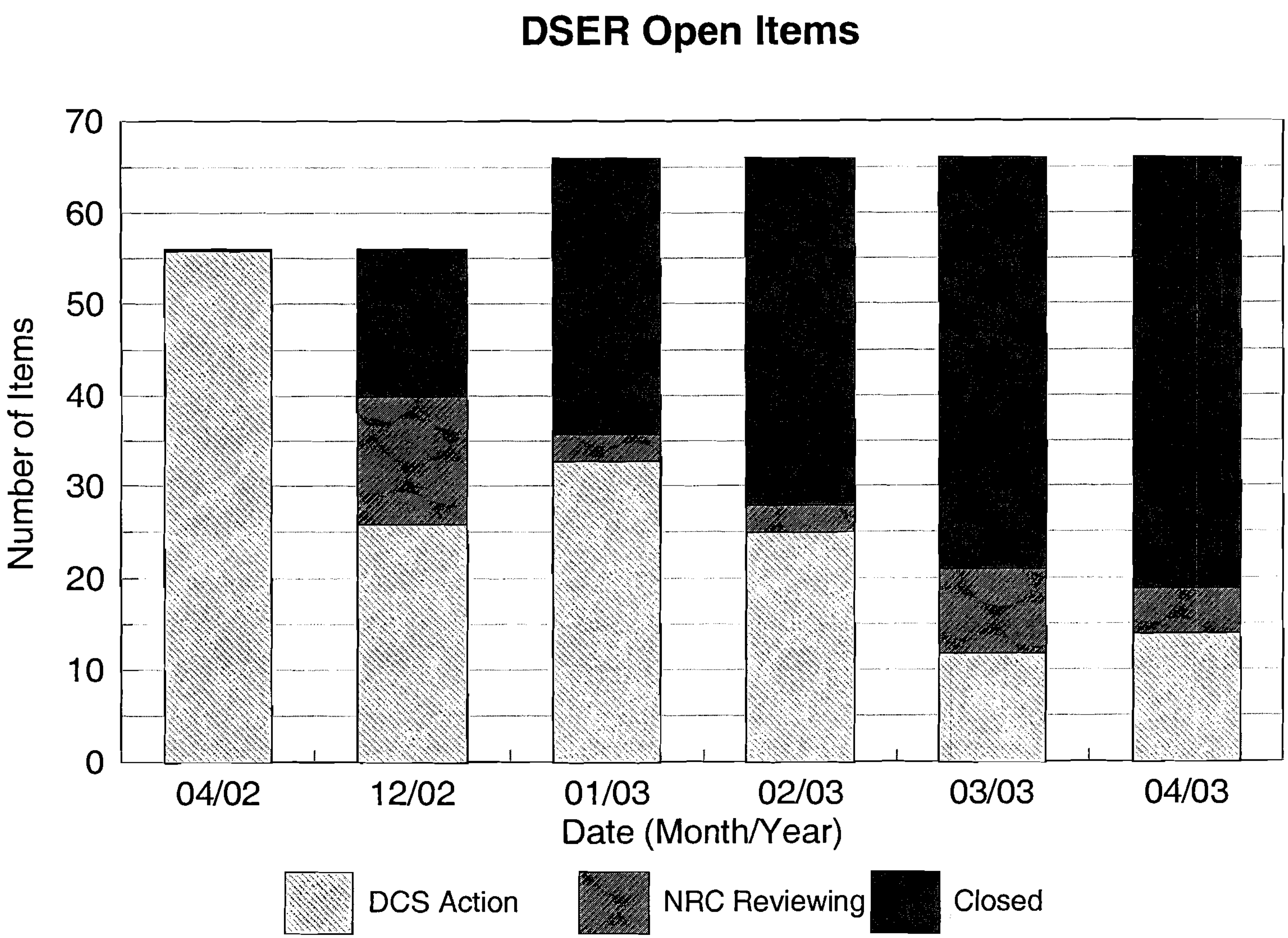
ACRS BRIEIFING

Review of the Mixed Oxide Fuel Fabrication Facility
Construction Authorization Request

Closing Remarks

Andrew Persinko, Sr. Project Manager
NMSS/FCSS/SPIB

Closing Remarks



RETURN "ASAP" TO BJWHITE (T-2A8)

HOTEL RESERVATIONS FOR ACRS MEMBERS/CONSULTANTS

Barbara Jo White, Program Assistant (415-7130)

ACRS MEETING INFORMATION

1. The following meeting has been scheduled:

REACTOR FUELS

Date: APRIL 21, 2003 Site Visit:-------------

2. A closed session will___ will not___ be required to discuss classified information. (If such a session is to be held, I have discussed with Jenny M. Gallo the security clearance of consultants asked to attend any such closed sessions.)

3. The list of ACRS members and consultants to attend and hotel reservations made for them is correct as indicated below:

	NAME	RESERVATIONS MADE AT	ARRIVE	DEPART
(1)	POWERS	RESIDENCE INN	4/20	4/21
(2)	FORD	RESIDENCE INN	4/21	4/23
(3)	KRESS	RESIDENCE INN	4/20	4/23
(4)	RANSOM	RESIDENCE INN	4/20	4/23
(5)	ROSEN	RESIDENCE INN	4/20	4/23
(6)	RYAN	RESIDENCE INN	4/20	4/23
(7)	SHACK	RESIDENCE INN	4/20	4/23
(8)	SIEBER	RAMADA INN	4/20	4/23
(9)	WALLIS	RESIDENCE INN	4/20	4/23

(Barbara Jo White will be notified by a brief note of changes to item 3)

5. A memorandum presenting the outcome of my conflict-of-interest review of members and consultants asked to attend the above meeting or site visit has been, or is being prepared in accordance with ACRS procedures.

______________ Date

______________________________ Signature

NRC FORM 587 (1-2003) U.S. NUCLEAR REGULATORY COMMISSION

REQUEST FOR COURT REPORTING SERVICE

WORK ORDER NUMBER	NRC
DATE OF REQUEST	04/01/2003
TIME OF REQUEST	1:00pm
DOCKET NUMBER(S)	
REQUESTING OFFICE	ACRS
REQUESTER	BARBARA JO WHITE BJW
NAME AND TYPE OF PROCEEDING	REACTOR FUELS SUBCOMMITTEE
LOCATION OF PROCEEDING	ROOM T-2B3, 11545 ROCKVILLE PIKE, ROCKVILLE, MD
CONTACT(S) AND TELEPHONE NUMBER(S)	BARBARA JO WHITE (301-415-7130), E-MAIL: BJW2@NRC.GOV
CHAIRMAN / MEMBERS	N/A
DATE(S) OF PROCEEDING	MONDAY, APRIL 21, 2003
TIME(S) OF PROCEEDING (FROM - TO)	10:00 A.M. UNTIL 5:00 P.M.

ADDITIONAL INFORMATION

MAGGALEAN W. WESTON, DFO, ACRS STAFF ENGINEER @ THE MEETING
3-COPIES OF HANDOUTS SHOULD BE GIVEN TO COURT ERPORTER (1-ORIGINAL + 1-COPY + 1-WORKING)

TRANSCRIPTS

- [x] ORIGINAL
- [x] COPIES 1 + Handouts
- [x] E-MAIL
- [ ] NOTARY REQUESTED
- [ ] DO NOT BIND EXHIBITS
- [ ] PROVIDE PC FLOPPY DISKETTE
- [x] BEGIN PAGINATION ON 1
- [ ] AUTHORIZED SALE TO: ____ NAME
- [ ] LAST DAY: ____
- [ ] AUTHORIZED FOR SALE
- [ ] NOT AUTHORIZED FOR SALE
- [ ] L - CLEARED
- [ ] Q - CLEARED

DELIVERY

- [ ] DAILY
- [ ] 3-DAY
- [x] 7-DAY

FUNDING

- [x] REACTOR
- [ ] MATERIALS
- [ ] HLW
- [ ] NON-HLW
- [ ] MGMT & SUPPORT

DELIVER TO

- [x] ASLBP - CALL 415-7408/7550 11545 ROCKVILLE PIKE 3RD FLOOR, T-3 F25 ROCKVILLE, MARYLAND
- [ ] MARKED IN A SEALED ADDRESSEE ONLY ENVELOPE WITH TAPES AND/OR NOTES FOR: ____
- [ ] SECY 11555 ROCKVILLE PIKE LOBBY - CALL 415-1969 ROCKVILLE, MARYLAND

THIS SECTION FOR ASLBP USE ONLY

PREPARED BY (Print)	DATE	REQUEST GIVEN TO REPORTING COMPANY		CONFIRMATION
NAME: TITLE:		DATE:	TIME:	

BY PROJECT OFFICERS:

NAME	DATE	NAME	DATE

TRANSMITTAL BY CONTRACTOR

TRANSCRIPT PAGES	COPIES	RECEIVED BY	
DISK	TAPES AND NOTES	DATE	TIME

Figure 1.1-1 MOX Fuel Fabrication Facility Controlled Area Boundary

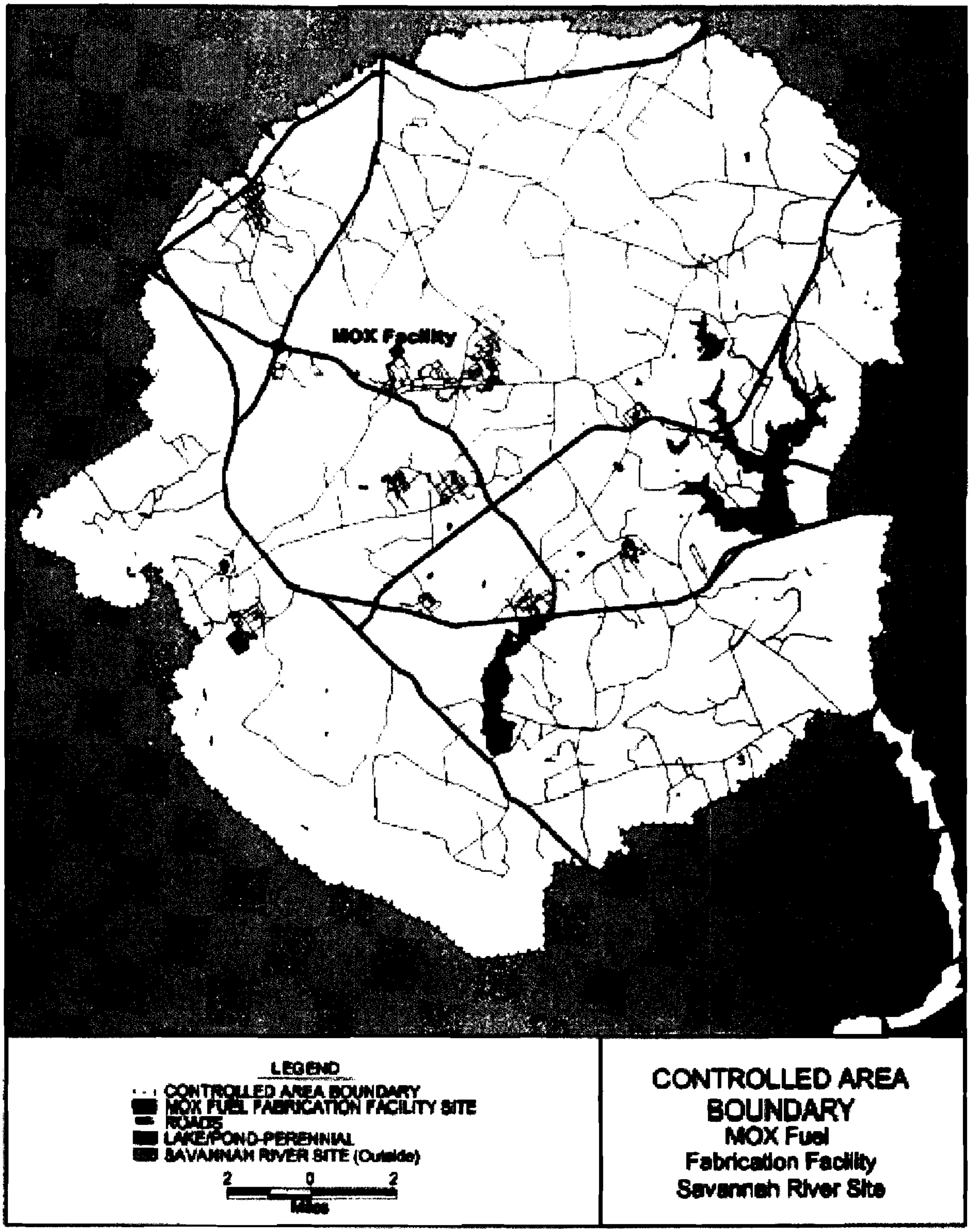
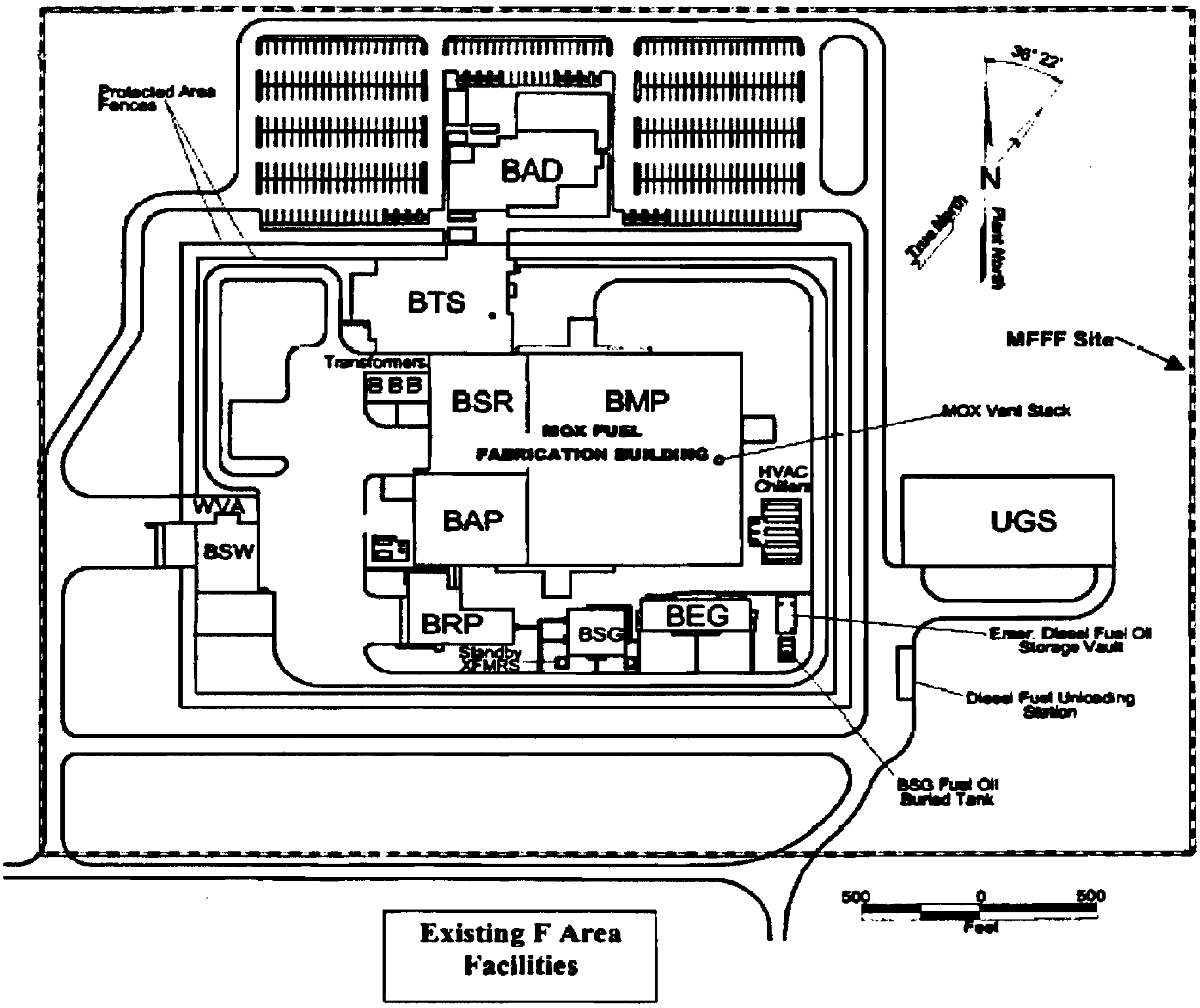


Figure 1.1-2, MFFF Site Layout and the Main Buildings



BUILDING LEGEND

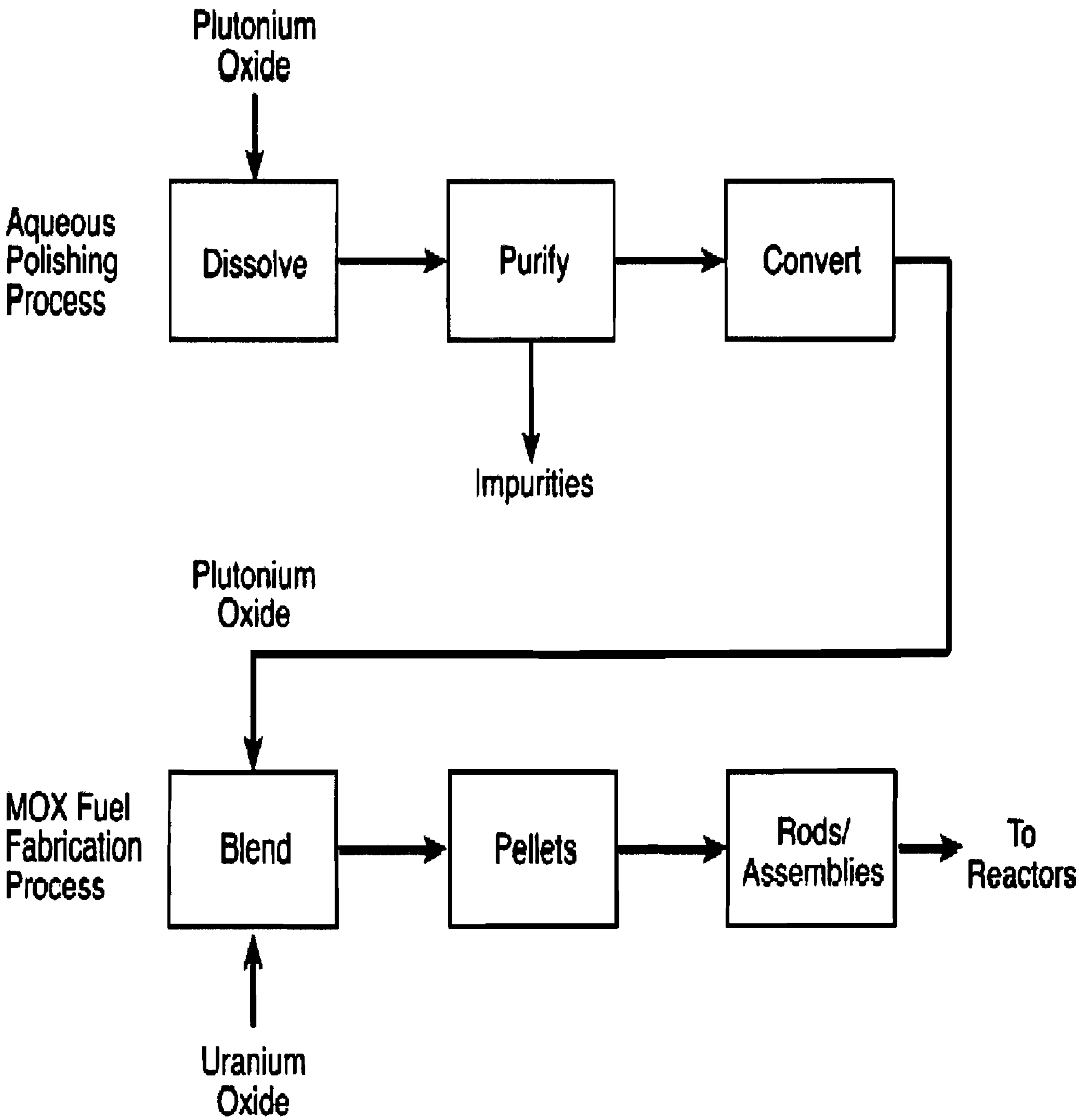
MOX FUEL FABRICATION BUILDING (BMF)

BMP- MOX Processing Area
BAP- Aqueous Polishing Area
BSR- Shipping and Receiving Area

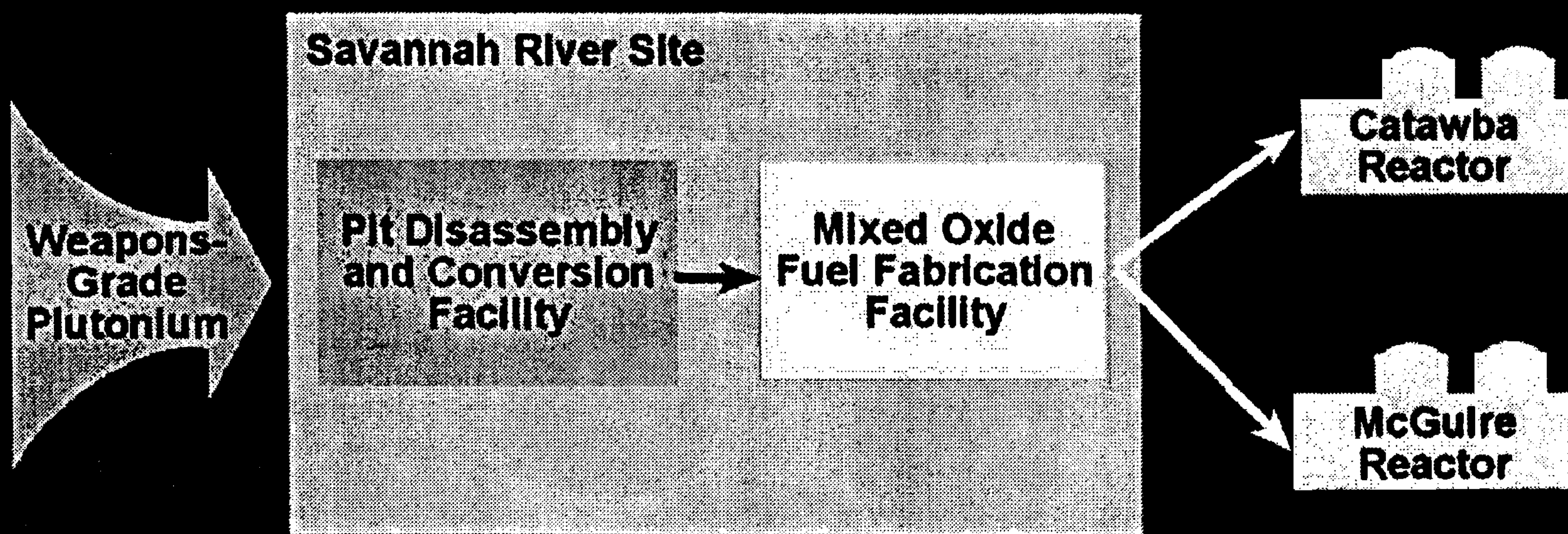
SUPPORT BUILDINGS

BTS- Technical Support Building
BSW- Secured Warehouse Building
BSG- Standby Diesel Generator Building
UGS Gas Storage Area
BAD- Administration Building
BRP- Reagents Processing Building
BEG- Emergency Diesel Generator Building
WVA- Vehicle Access Portal

Figure 1.1-3, Overview of AP and MP Process



NRC Role in Regulating Mixed Oxide Fuel



Flow of material at SRS