The design is such that if we find that there are changes in this correlation and we need to go to a more filter media area, the design can accommodate that.

We're doing moisture analysis to insure that what we said about dilution is true. And we're doing fault tree and single failure analysis of the systems to insure that such thing as global loss of facility power doesn't cause us to lose all the ventilation fans and other single failure type problems.

We're doing an HVAC transient disturbance analysis to make sure that we don't have small perturbations in the system flow causing reverse flow in other parts of the system and then causing operator exposure and dose.

And then we're looking at the effects of internal explosions.

All these analyses consider uncertainties. For the soot loading, we take the two largest soot generating fire events and lump them together. Even though those events occur in separate fire areas.

The same for the dilution error temperature analysis. We'll use the areas that generate the highest temperature air flow total heat content going to the HEPA filters in order to bound our dilution.

And as I said, we're having independent empirical verification of the filtration system performance by the soot loading experiments. And that will be completed for the ISA.

CHAIRMAN POWERS: Do you verify the fact that when you take a very hot gas, inject it with the rest of the gases that you're going to bring into the system that in fact it will mix? It won't get stratified fully?

MR. ST. LOUIS: We've committed to look at that phenomena as part of the ISA process.

CHAIRMAN POWERS: Good.

DR. LEVENSON: Is there any probability at all that sometime in the first teen years or so of operation you might want to change the diluent?

The context of my question is you're doing a fire analysis based on a specific material. You might want to think about whether you want to at this stage take a look at other possible diluents so that if you decide process wise you want to change it, you haven't locked yourself in on something. It would not take much effort right now to do the arithmetic.

MR. KIMURA: The diluent --

DR. LEVENSON: The total amount of soot, total quantity, that sort of thing.

MR. KIMURA: Yes. Where we handle mixed oxide power, we have nitrogen as the main diluent in the gloveboxes.

DR. LEVENSON: The diluent in the solvent extraction.

MR. ASHE: Excuse me. This is Ken Ashe.

Right now we've got a design that we're going to propose, and that's the one that we're going to go forward with. If we change something that significant, then obviously we'd have to go back to the staff with that. But I don't believe it's our intent at this point to change the diluent.

MR. KIMURA: All right. This slide just summarizes the filtration loading experiment program.

As I stated, that the filter design is based on previous studies that have been done. There is a lot of data on burning PMMA cribs. A crib is just a stack of combustible materials, like a stack of firewood. And the studies were done by Gaskill and Fenton, others at Lawrence Livermore in room sized combustion chambers. To characterize the burning of that type of soot, they burned wood, they burned other materials.

Ballinger up at Pacific Northwest characterized burning solvent on top of water. So different types of diluents and stuff, and different soots and combustibles generated different soots. Some were long-chain agglomerates, others were relative dry.

For PMMA Gaskill found that unless he added water to the stream, it was very hard for him to the HEPA filters to clog.

So what we're going to look at is we're going to look at how soot is distributed throughout the filter system. As I stated, our design basis to collect -- to filter out all the embers and brands at the roughing filter stage, collect most of the soot on the high-efficiency stainless stain prefilter and then have very little soot actually appear on the final HEPA filters.

We're going to look at the delta p change as soot is loaded up. And we're going to look at the flow rate through the system, make sure we're not going down to zero and clogging up our filter system. And then we're going to determine the ultimate soot loading capacity based on the characteristic soot that we're generating.

This is what we anticipate to be pretty

much our design for the HDE final filters. Stainless steel housing, bag in, bag out ports for each of the filter elements. Test ports, isolation valves so we can do our testing.

I've mentioned a lot of historical fires and other events that we used in order to evaluate our filter design -- do our filter design. The key lessons learned that came out, was to use noncombustible materials.

You have to some means to protect the final filter elements.

Dilution air is preferable over water sprays to protect them excessive temperatures.

The duct with several bends will attenuate any effects from rapid pressure excursions in order to keep fires from going from one fire zone to the other. There's fire isolation valves that allow us to isolate system or fire wrapping to keep the duct from causing secondly fires in other rooms.

And the building itself has multiple confinement zones, so that if the primary confinement, C4 area, starts to leak into C3, C3 will contain that leak. And if C3 leaks, C2 will contain that leak.

And finally, that we keep the contamination potential of the final HEPA filter element low. We don't allow material to build up.

The conclusion is that we think that we're protecting the HEPA filters from severe environmental conditions. We've accounted for various design basis events scenarios, included the uncertainties in the analyses that we conducted, that we have an historical basis for each of the elements that make up the HEPA filters, and that the combined total of all of these features make the MFFF final HEPA filter design very robust.

CHAIRMAN POWERS: Any questions of the speaker.

Thank you.

We'll move to Ms. McDonald.

MR. JOHNSON: My name is Tim Johnson, and I'm the principal reviewer for the ventilation system.

And what I'd like to -- if I can get this thing to move here. Is to talk about our ventilation system review.

Basically we're looking at the ability of the principal structures, systems and components to perform under various conditions during the required confinement. And in addition, we were also looking at defense-in-depth, and that's primarily redundancy of system components.

CHAIRMAN POWERS: In the redundancy, there's lot of redundancy that we see in this system, but not much diversity, it seems to me.

MR. JOHNSON: Well, I believe that if you look at the entire confinement system, there is diversity. And the diversities are in both the static and dynamic barriers that are part of the design. And by static barriers I'm talking about walls, gloveboxes and the dynamic systems are the actual ventilation systems that have active components with it.

In our review of the system, we basically have two open items, and I'd like to talk about each of those in a little bit more depth.

In our review of the proposed system we feel that the system can function under severe conditions. The question was what should be the allowable removal efficiency for particulates. And in our guidance we recommended that for severe conditions that credit be not taken for more than 95 to 99 percent removal of particulates under severe conditions. For example, such as a fire.

And what DCS is proposing is to have a release fraction of 10^{-4}, which is basically a 99.99 percent efficiency. And we recognize that there have been fires and filters that have -0 filter systems that have damaged HEPA filters. And we were very concerned about the uncertainties in that. And because of that we asked DCS for further justification on why they felt that 10^{-4} release fraction would be acceptable.

They provided some further information to us in February and 2 weeks ago. We're still considering that response, but we haven't made changes. Basically the information came in too late for us to make changes into the draft Safety Evaluation Report. So we're still carrying that as an open item while our review continues. But certainly what they've proposed is more robust than what they proposed originally in the Construction Authorization Request. So we feel we're moving int he right direction here.

MR. SHACK: What release fraction do they have to have?

MR. JOHNSON: I'm sorry?

MR. SHACK: What release fraction do they have to have?

MR. JOHNSON: At least 99 percent in a well designed system. And what they're proposing is that they retain 99 percent credit for each of the two HEPA filter banks. So basically they're saying that under severe conditions both HEPA filters will survive and be functioning. And by intent each HEPA filter, you know, should be well over 99.9 percent efficiency efficient. But, you know, with various aging effects, maybe problems in installation where there's additional bypass, in practice the NRC hasn't given full 99.97 percent efficiency for HEPA filters. And our regulatory guidance has been 99 percent.

The second open item is one that Sharon talked about, and that's related to the soot loading. And when we try to duplicate their calculations that they submitted to us previously, we couldn't duplicate them. And we asked for additional information on that. And, again, more information was provided in February and April, and, again, we're still considering that, as Sharon mentioned.

If the soot loadings get too high, the HEPA filters could fail under pressure loading, under pressure drop loading.

CHAIRMAN POWERS: They have proposed a lot of experimental studies. And discussed the complexities of soot as far as of the shape. We know the agglomerate -- the primary particle sizes are probably right around the maximum penetrate in size, but the agglomerates tend to be long-chain ugly looking things. And then they're proposing these experiments to validate their models.

If you had thought about this issue, that we know that particles that are made up of agglomerates change their geometry in response to the relative humidity. We have a very dry system here with nitrogen as the purge as, and whatnot. The experiments will be done under some other circumstance. And are we likely to get data that's just not applicable here, or what's your thinking on this?

MR. JOHNSON: Well, you're right, there are uncertainties in here. And that's one of the reasons why the amount of credit that's given is well less than -- you know, a manufacturer's 99.97 percent efficient with .3 micron particles. And it's why they do a leak test on installation. And, again, the objective is to have no more than .05 percent bypass. But I don't expect those kind of changes to substantially make up a difference of two orders of magnitude in the overall efficiency.

So I think we're still conservative. And if you look at actual systems, HEPA filters are used in a number of plutonium systems in DOE. And they get pretty good performance out of them.

CHAIRMAN POWERS: When they install them correctly.

MR. JOHNSON: Yes, when you install them correctly and you don't have fires, like we've had at Rocky Flats.

DR. LEVENSON: Well, the fraction of the gas that might be coming from an inerted facility compared to room exhaust because of your mixing and blending system, you probably can't get very much of a change in the moisture content at the final filters. It'll be whatever is your incoming controlled humidity, won't it?

MR. JOHNSON: Well, the C4 system is your glovebox system. And that is going to have mostly inerted gas --

DR. LEVENSON: Yes. But what I'm saying is that --

MR. JOHNSON: And that's a separate system. So that'll probably stay pretty much the same. But the C3 and C2 systems, they use ambient air that is -- comes in from the supply.

DR. LEVENSON: But isn't the C4 system diluted with the others before it gets to the final filters?

MR. JOHNSON: Well, it's diluted by the C4 streams from different fire areas.

DR. LEVENSON: Okay. So there's not one set of final filters then?

MR. JOHNSON: There's one set of final filters, but it takes input from various gloveboxes and various fire --

DR. LEVENSON: No, no. What I mean is the implication that I got from before was that there was one set of final filters, and the dilution air came from the various areas, is that incorrect?

MR. JOHNSON: There are final filters separate for the C4 system. And separate ones for C3.

DR. LEVENSON: Okay. Each is -- okay.

MR. JOHNSON: And separate ones for C2.

DR. LEVENSON: Okay.

MR. JOHNSON: My only slide is a summary slide, and it basically just restates the two open items that we're carrying in the draft Safety Evaluation Report, and they are the HEPA filter removal efficiency credit and the soot loading. And, again, both of those areas are still under review. But, again, I believe we're going in the right direction with both of these from the responses that we've recently received from DCS.

Are there any other questions?

DR. KRESS: I'm sorry. Where did the standard review plan -- 99 percent credit come from?

MR. JOHNSON: Well, it's based on what has been used prior to that in Reg Guide 1.52 for engineered safety filter systems -- safety feature systems for reactors. That's the primary basis for it.

CHAIRMAN POWERS: It's been in the DOE evaluation for as long as I can remember.

MR. JOHNSON: Yes.

DR. KRESS: My basic question is where does it come from?

CHAIRMAN POWERS: I have no idea.

DR. LEVENSON: It's been around a long time. IT doesn't necessarily apply to systems --

MR. JOHNSON: We got a man with an answer here. Well, Dr. Bergman can fill us in on that.

DR. BERGMAN: As Tim pointed out, Bergman with DCS.

The 95 percent -- 99 percent came from Reg Guide 1.52 which has been, I think, talking with Roger Savadowski, he was kicking it around back amongst the first drafts, he and Humphrey Gilbert.

The issues of what efficiency. The DOE has regularly used under accident conditions credit of

99.9 percent for the first stage 99.8 percent, but that was based on best engineering judgments of a meeting held in Albuquerque in 1971.

The problem with --

CHAIRMAN POWERS: I hasten to point out I didn't attend.

PARTICIPANT: You weren't even born yet.

DR. BERGMAN: There's been a lot of work done since that time. And so if one were to convene the world's experts and establish what kind of credits you can get for it, we attempted to do that. And DOE almost came very close to issuing a DOE standard on this very subject, but there was a changing of the guard in headquarters and monies ran out, and consequently usually when money stops, work stops.

But we did manage to publish a paper. Myself, Mel First, Humphrey Gilbert and Wendell Anderson co-authored -- and Jack Jacox, co-authored a paper in which we reviewed all the available data and we compiled a series of efficiencies you can use for HEPA filters under various accident conditions.

And it's very clear if you meet the conditions, the environmental conditions and assault conditions for a HEPA filter, you can claim a variety of efficiencies.

For example, if you meet the temperature, pressure, moisture conditions, you can very readily claim 99.9 percent for each filter. DCS has chosen to be very conservative and 99 percent. But the idea is you can also find a condition where 80 percent is very questionable, even 50 percent is questionable. If you look at a filter that's been subjected to a tornado, you just see a great big hole where there used to be a HEPA filter.

So the idea, it's not a one cookie cutter, one size fits all. It's on a case-by-case basis. And this was really the bottom line of the whole consensus and analysis from -- in fact, my supervisor, you know, Wendell Anderson, Humphrey Gilbert, Mel First. And so that was our conclusion.

Thank you.

CHAIRMAN POWERS: Okay. We arrived to the point of closing comments. And I'm not sure whose going first here. I know Peter Hastings is not going. We're going to have to do something to Peter. He carries the heavy lifting next time, right.

MR. JOHNSON: I'll pass that along.

CHAIRMAN POWERS: Yes. So Drew is going to go first.

MR. PERSINKO: Yes. I just have a short

concluding remarks here.

I have on the screen a bargraph of where we were a year ago, what's happened in the middle and where we are today in terms of numbers of open items.

A year ago there were approximately 57 open items. That was in the draft Safety Evaluation Report published last April.

The number of items actually went up as we reviewed the revised Construction Authorization Request up to approximately 66.

Where we are today is that there are 19 open items. The revised draft Safety Evaluation Report will show 19 open items. Of those 19 items, 14 of those we are -- DCS will be providing information. And 5 of those are currently under review.

I'd also like to say of the 19 open items, we talked today about 6 of them in depth. When we met with you a year ago, we gave you the across the board view of all the open items. Today we picked 6, what we thought major ones, and discussed them with you in depth today.

So, you can see where we were a year ago, where we are today. Our plan is to continue to review the information and review the information that is provided by DCS, and most likely we'll be having additional meetings with the applicant.

CHAIRMAN POWERS: Well, it's not with the applicant, but the meetings with us, that's the question I want to pose here.

Our obligation, of course, this is something the Commission has explicitly asked to report on to them. But my question is in engineering judgment or administrative judgment issue here, is that as we resolve these and the point where you say, yes, we're happy with everything, do we need to do it in a Subcommittee format before we go to the full committee or can we go directly to the full committee given that I will do my best to educate the full committee prior to you getting there?

MR. PERSINKO: I would think you could go straight to the full committee. I think you could.

CHAIRMAN POWERS: I'm going to ask you guys the same question.

MR. ASHE: This is Ken Ashe.

We believe that we've given you a lot of information today. And if you look at our Construction Authorization Request and the draft SER, you should get a very good picture of where we are.

We also believe that as we go forward with the staff working with the staff, they should be able to keep you abreast of where we stand so you can go to the full committee.

CHAIRMAN POWERS: Right now my prejudice is given that the resolution of the outstanding issues does not elicit controversy. In fact, forget a resolution. That everybody's happy. That we'll go straight to the committee on this rather than having another Subcommittee.

Now, of course, if -- rises in there or things need a bigger discussion, we're perfectly willing to have another Subcommittee meeting. But that's the strategy I would like to pursue is that -- the plan will be success oriented in our planning and will adjust it if need be.

MR. PERSINKO: Okay.

CHAIRMAN POWERS: Good. Any other questions?

MR. PERSINKO: No. That concludes my statements here.

CHAIRMAN POWERS: Nobody wants to ask any questions?

MR. PERSINKO: What I do want to say is staff is very interested in any comments the Subcommittee would have regarding what we have been doing and what we presented, especially if you have areas where you think we need to do something different. Because we are planning to issue a final SER in September. And we would like to -- if there's any corrections we need to do, we want to do them now.

CHAIRMAN POWERS: Yes. Let me comment on a couple of things.

First of all, let me comment that all of your staff presentations were excellent today. Enjoyed them very much.

On the SER, it is a very comprehensive document, and that's good. It is rather well written with respect to providing enough background. I don't think one can read it, just pick it up and say now I know everything about this facility without reading any of the ancillary documents or the Construction Authorization Request or something like that. But as a document for reading, it is quite readable.

What I will comment is that about half the time you come down and you tell what the applicant has written. You tell me something about your analysis and then you draw a conclusion. The other half of the time you tell me what the applicant has done and you say we looked at this and it's fine. That's not very helpful.

The former approach where you tell me

something about what you guys did more than we looked at this, but give some rational for your coming to the judgment that things are okay, those are great. And the more you can do that, the better -- the more satisfactory the document is.

and you're about 50/50 as far as I can tell in there. And it is not a scientific proof that I think people are looking for. It is some indication of what a pain you went through in arriving at your conclusion. It can usually be handled in a sentence or two.

That was my view of the SER. I certainly invite comments from the rest of the Committee on their examination of it.

Jack, do you have a point to make?

MR. SIEBER: Well, no. I'm just prepared to agree with you. I also do agree that it's a likely document, very comprehensive. And it would be good on a CD ROM.

CHAIRMAN POWERS: Yes. There's no question that the staff has done a very thorough job in examining this from the SER. And like I say, it is -- it's very good at getting the appropriate amount of background, the appropriate amount of description of the system. And often times it does a fine job in explaining the rational for the conclusion you did. But there are those occasions where you're pretty abrupt. I forget what the exact phraseology used. It's another one you could easily fabricate an acronym, I think.

But as you go back through it. Of course, there are enormous number of typographical things, as you would expect from any draft and whatnot like that. But quite frankly, they don't detract from the document very much because it's really -- when I first downloaded it I said "Oh, my God, this is going to be pain." And it wasn't. I rather enjoyed reading it. Thank you.

MR. PERSINKO: Well, let me say, the first goal you set, the first example your set is our goal. We wanted to be like that all the time. And it'll continue to our goal so that we explain the analyses. For those areas we're not, we'll take a harder look at.

We also are trying not to repeat the CAR in the application.

CHAIRMAN POWERS: That's right. That's right.

MR. PERSINKO: A short summary. And if you want to read more, you can read the CAR.

CHAIRMAN POWERS: And I think that's what I'm telling you, is you've succeeded in that one. You were not -- it was very evident you were trying not to repeat the CAR, but to give enough background so that you kind of knew what the issue was. And I think you succeeded in that.

MR. PERSINKO: Thank you.

Is there any other comments, please let us know.

DR. FORD: Yes, I've got a point to that. Materials issues, I remain concerned about the materials issues. I've seen too many chemical process plants fail terribly, catastrophically because of the assumption that, for instance in this case, 300 L-series stainless steel will be all right. It's a highly oxidizing environment with chloride, you will undoubtedly get pitting. I wouldn't be at all surprised if you get transgranular stress corrosion cracking. So I really do urge someone to look at that.

MR. PERSINKO: Let me say, we are. But keep in mind, this is also a design basis information at this point. And I think one of the PSSCs is a corrosion control program and the details of that will be established at the possession and use phase. So there will be more information at the possession and use phase.

MR. ASHE: I want to add one thing regarding the materials of construction. I think within our Safety Analysis we have made a point of putting the equipment with process cells and consequently, the radiological consequences or chemical consequences as well are below those requirements of 70.61. So from a pure safety aspect, I think we've accommodated the materials of construction. That is not to say that we can't have leaks. We have provisions to account for leaks. But from a safety perspective within the AP process, I think we have accounted for that --

DR. FORD: You not only have safety issues, but public perception. And also your finances.

CHAIRMAN POWERS: Any other -- Steve?

MR. ROSEN: I just want to quickly summarize a couple of technical points that were made today.

CHAIRMAN POWERS: We'll be going around later.

MR. ROSEN: Oh, we will.

CHAIRMAN POWERS: This is just -- yes. We're going to -- and the plan I have is once these closing comments, we'll take a little break, then we'll come back and we're going to go around and discuss --

MR. ROSEN: Okay.

CHAIRMAN POWERS: You have a closing comment you want to make? How much you enjoyed being in front of us? What a delightful way it is to spend a Monday after Easter? All those things I want to hear, yes.

MR. ASHE: This is Ken Ashe.

We did enjoy ourselves today. And it was wonderful to be here the day after Easter.

CHAIRMAN POWERS: Tell me he doesn't learn quick.

MR. ASHE: We would like to thank you for the opportunity to provide you some of the technical information associated with our program. And, hopefully, we did impart a confidence in our abilities to go forward with this project.

CHAIRMAN POWERS: You've definitely convinced you know more about HEPA filters than I do, if that's what you're looking for.

MR. ASHE: Yes. Thank you.

And that's all.

CHAIRMAN POWERS: Okay. My plan is let's

take a 12 minute break, Jack. And we will come back.

And what I want to do is just summarize some technical points, but more important discuss -- or just as important, discuss what kinds of things we want to say to the full committee in our briefing at the main meeting.

MR. ROSEN: And some of the technical points I would hope the applicant would listen to so that those could be included at the main meeting.

CHAIRMAN POWERS: You don't think he took notes while you were debating him?

MR. ROSEN: Well, someone should be possibly -- I was hoping responsive to those points. But we can talk about it.

CHAIRMAN POWERS: Yes. Okay. We will recess for 12 minutes.

(Whereupon, the hearing was concluded at 6:47 p.m.)

CERTIFICATE

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission in the matter of:

Name of Proceeding: Advisory Committee on Reactor Safety Reactor Fuels Subcommittee

Docket Number: n/a

Location: Rockville, MD

were held as herein appears, and that this is the original transcript thereof for the file of the United States Nuclear Regulatory Commission taken by me and, thereafter reduced to typewriting by me or under the direction of the court reporting company, and that the transcript is a true and accurate record of the foregoing proceedings.

Rebecca Davis
Official Reporter
Neal R. Gross & Co., Inc.

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

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

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

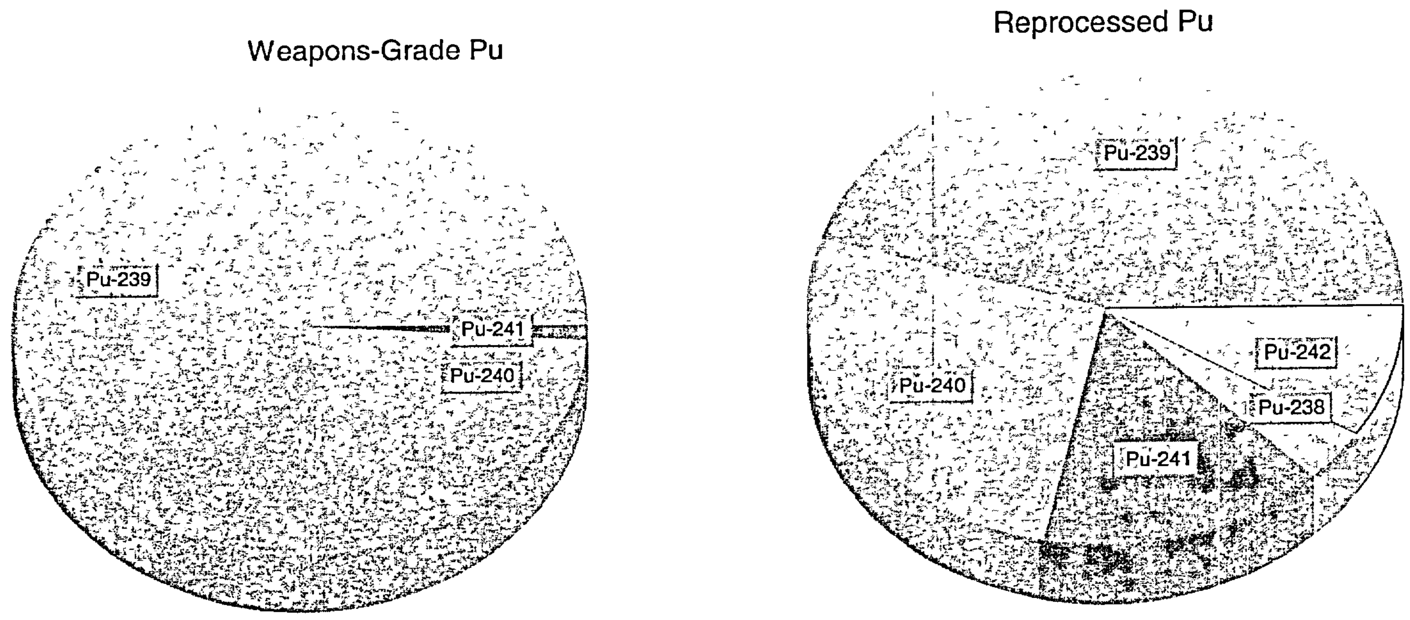
April 21, 2003

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:
  - 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
  - MOX pellets, rods, and assemblies
  - PuO_2 powder
  - MOX powder
  - Pu compound solutions

- Received VR January 2003.
  - Meeting January 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 vs. Single-parameter control.

Conclusions

- One main open issues remaining for NCS => setting design basis k-effective limits.
  - 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.
- SCALE-5 code being pursued to answer benchmark questions.
- DCS reevaluating. On schedule for closure by September 2003.

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

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?

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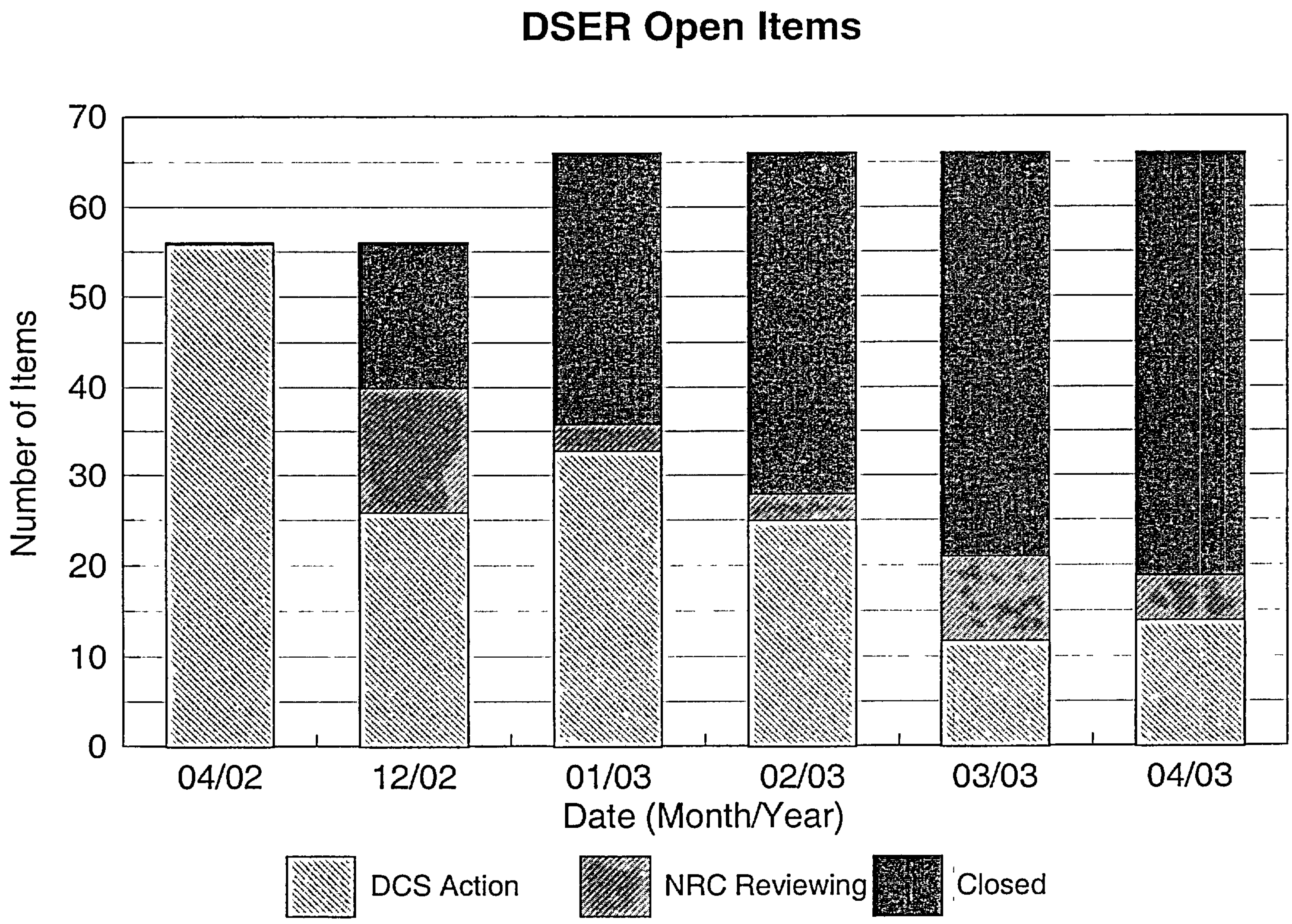
ACRS BRIEIFING

Review of the Mixed Oxide Fuel Fabrication Facility
Construction Authorization Request

Closing Remarks

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

Closing Remarks



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

ACRS Subcommittee on Reactor Fuels Meeting
21 April 2003

DUKE COGEMA STONE & WEBSTER

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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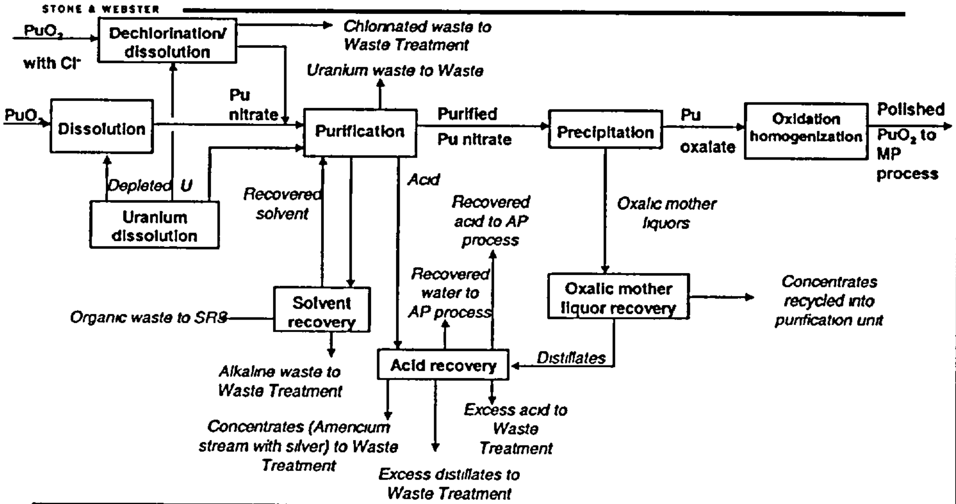
Plutonium Polishing Process Overview



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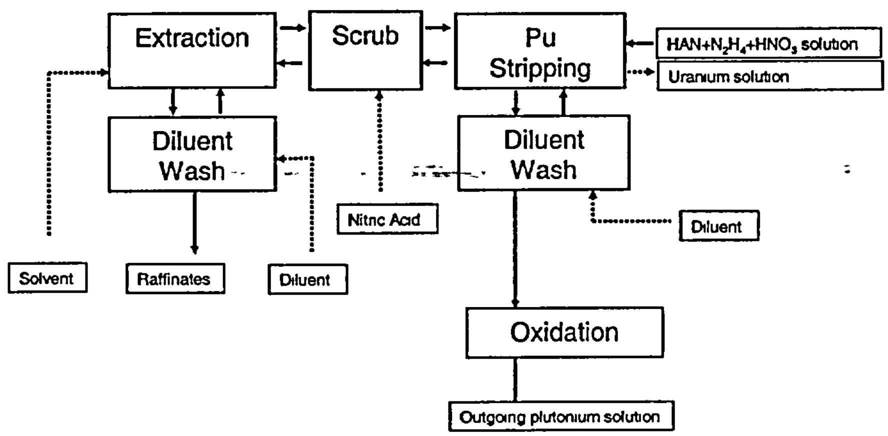
Simplified Purification Process



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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

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

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

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

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

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

$$N_2O_3 + H_2O \rightarrow 2HNO_2$$

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

Kinetics of Decomposition of HAN

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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:

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

Energetics of HAN Decomposition

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

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

Plutonium Re-oxidation Mechanism

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- 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

$$Pu^{3+} + N_2O_4 \rightarrow Pu^{4+} + NO_2 + NO_2^-$$
$$H^+ + NO_2^- \rightleftarrows HNO_2$$
$$2NO_2 \rightleftarrows N_2O_4$$

Use of Hydrazine

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- 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

Hydrazine is a more effective Nitrous Scavenging Agent than Hydroxylamine

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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:

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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.

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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

DUKE COGEMA STONE & WEBSTER

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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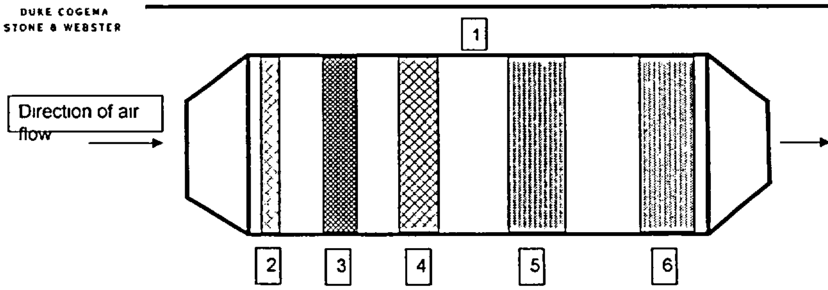
MFFF HEPA Filter Unit Schematic



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 (1^{st} Stage)
6 Nuclear grade HEPA filters (2^{nd} Stage)

INTERMEDIATE HEPA FILTER BOX

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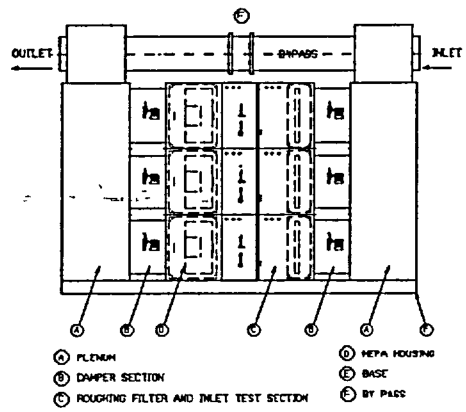

Stainless Steel Mesh Roughing Filter Element

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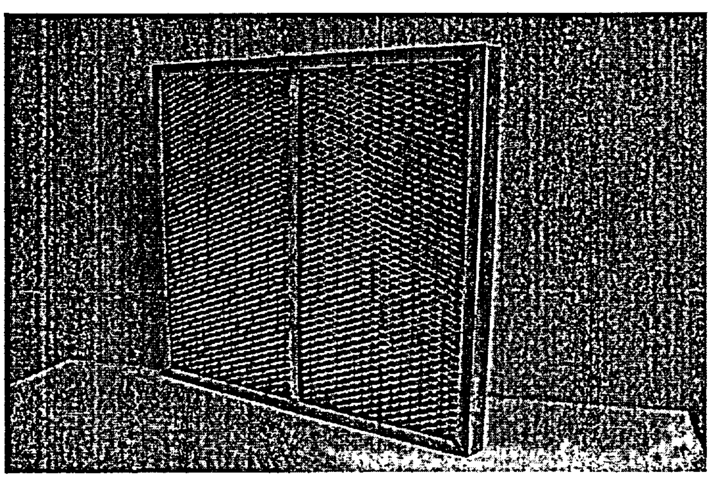

Roughing Filter (Full-Size Prototype)

Stainless Steel/Glass Fiber Mesh Prefilter

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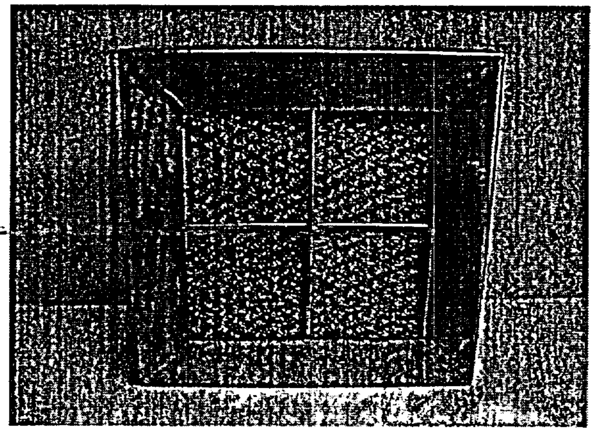

Stainless Steel / Glass Fiber Prefilter
(Half-Size Prototype)

HEPA Filter Element

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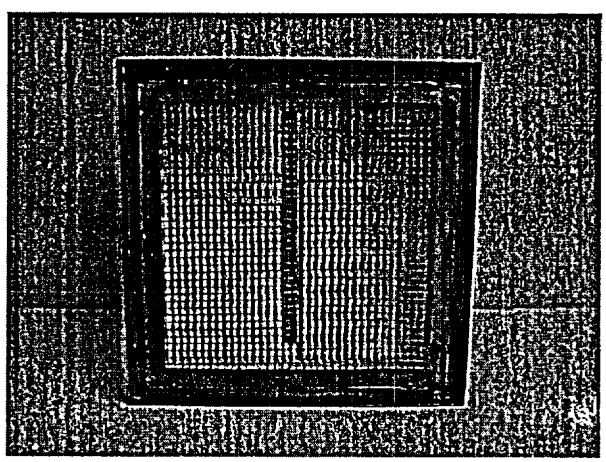

HEPA Filter (Half-Size Prototype)

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Testing ensures efficiency in service

- 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

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HEPA filter efficiency is the same across all stages

- 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 – mitgated 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

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

- 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

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Summary of Analyses

- 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

Analyses Consider Uncertainties

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- 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

MFFF Filtration System Soot Loading Experiments

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- 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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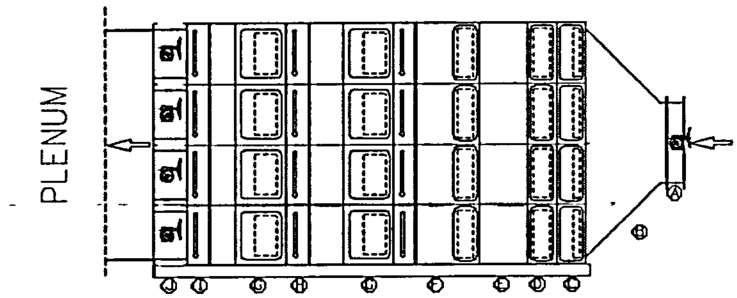

- (A) ISOLATION DAMPER
- (B) TRANSITION
- (C) ROUGHING FILTER
- (D) HIGH EFFICIENCY PRE FILTER
- (E) PLENUM SECTION
- (F) INLET TEST SECTION
- (G) HEPA FILTER SECTION
- (H) COMBINATION TEST SECTION
- (I) OUTLET TEST SECTION
- (J) DAMPER SECTION

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)
TBP Degradation and Red Oil Phenomena

ACRS Subcommittee on Reactor Fuels Meeting
21 April 2003

DUKE COGEMA
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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
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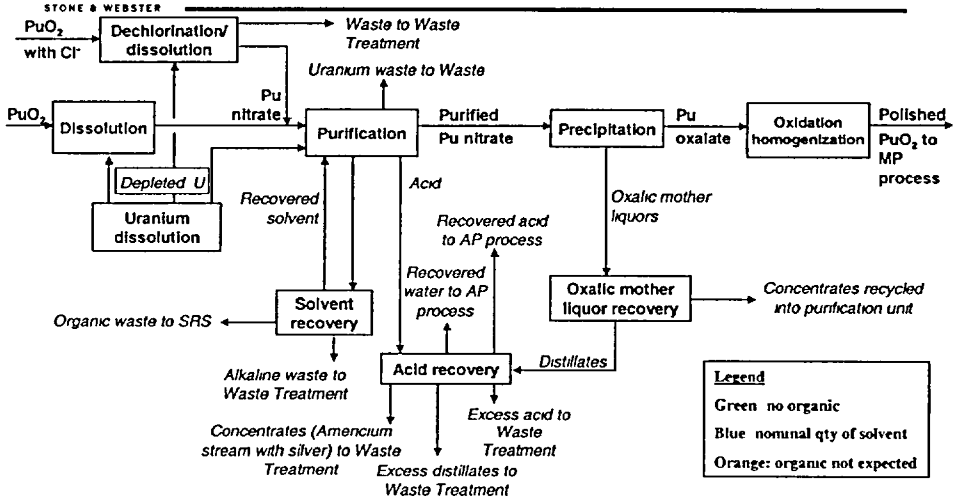
Plutonium Polishing Process Overview



Characteristics of Red Oil

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- 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)

Techniques Used to Investigate Red Oil

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- 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 (^1H, ^{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.

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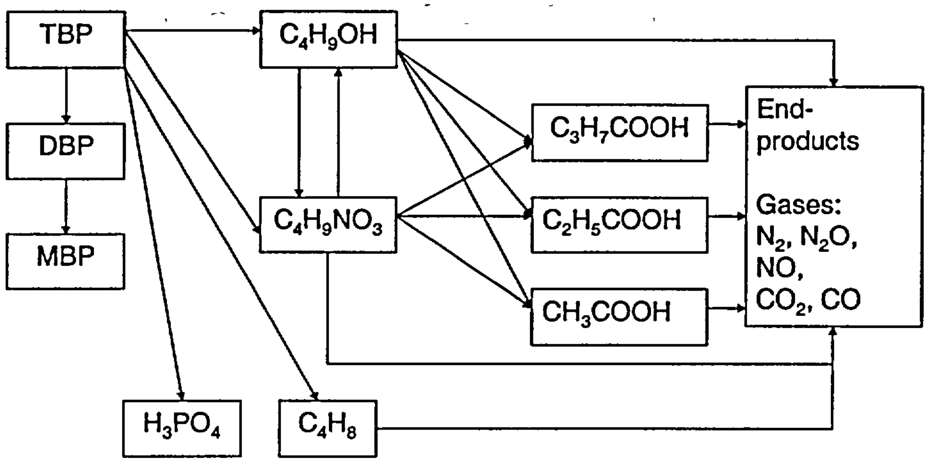
TBP Degradation



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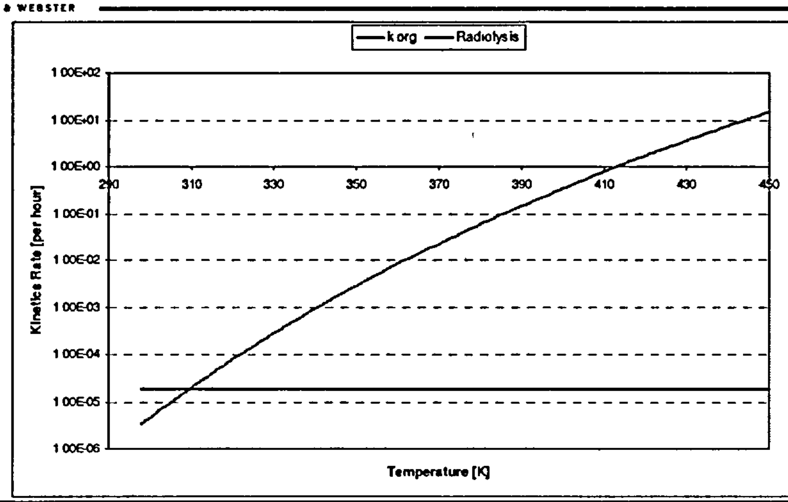
Hydrolysis and Radiolysis Effects



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

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

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Limiting Quantity of Degradation Products

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

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

- 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

MIXED OXIDE FUEL FABRICATION FACILITY

ACRS PRESENTATION

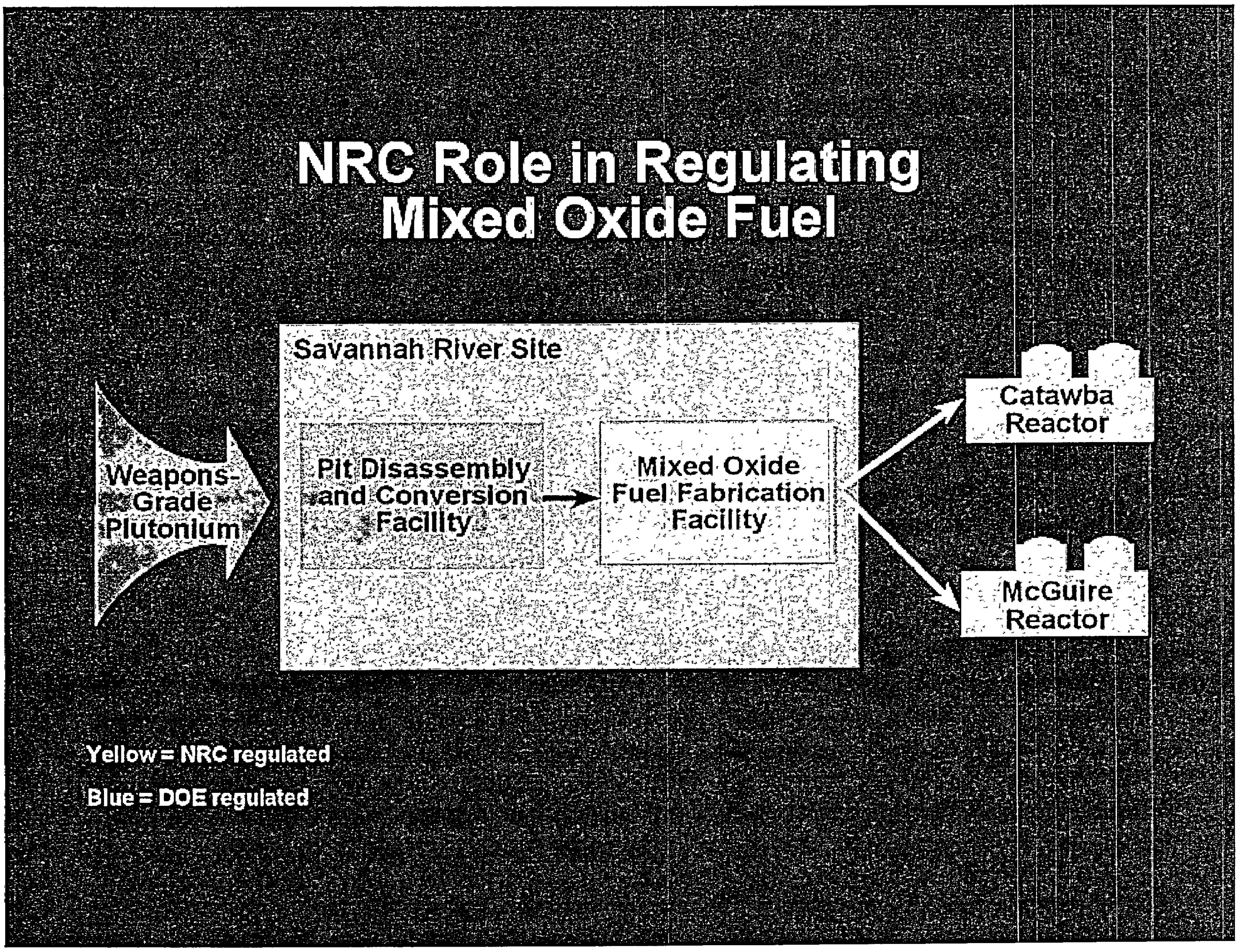
April 21, 2003

ACRS BRIEFING

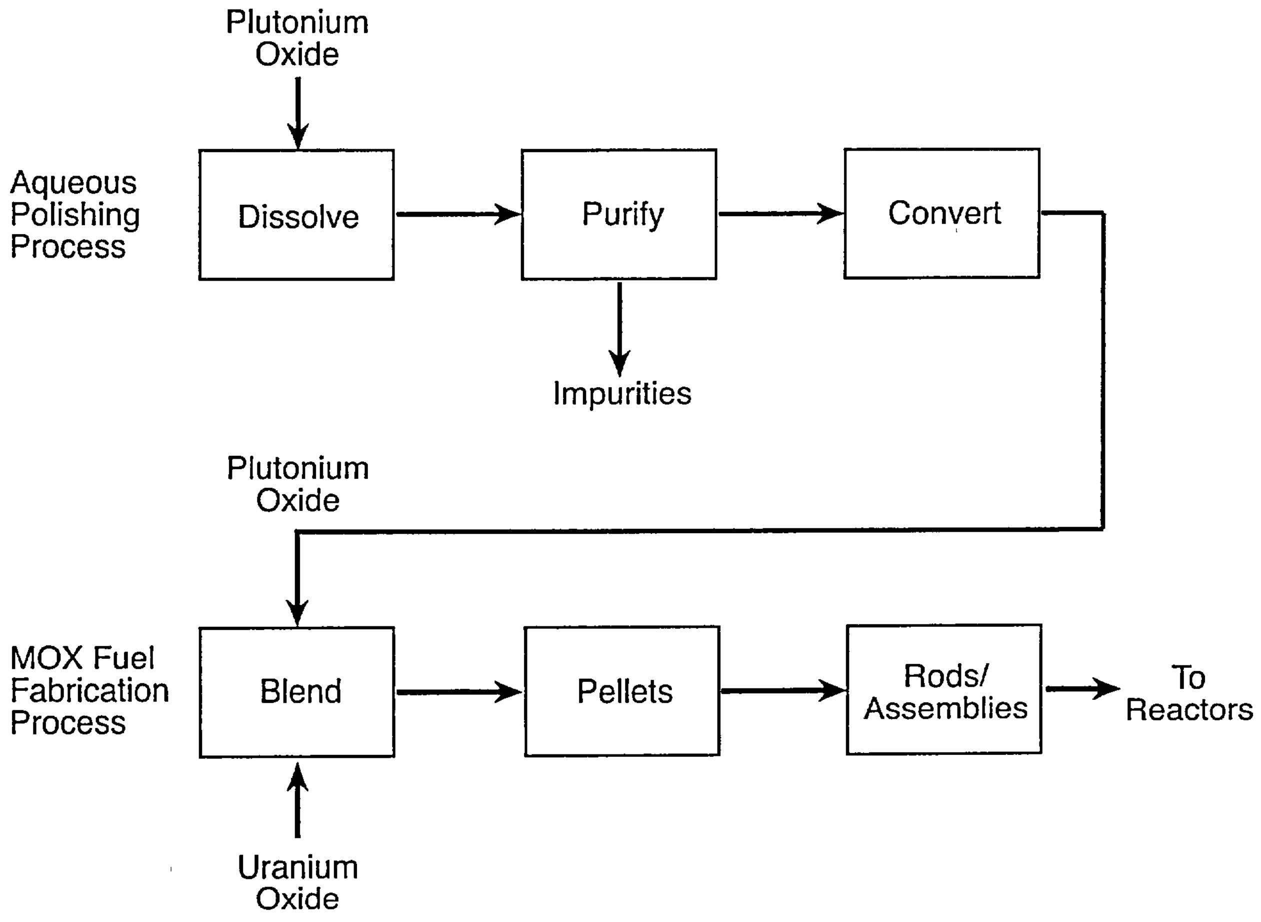
Review of the Mixed Oxide Fuel Fabrication Facility
Construction Authorization Request

Introduction

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


NRC Role in Regulating Mixed Oxide Fuel
Savannah River Site
Weapons-Grade Plutonium
Pit Disassembly and Conversion Facility
Mixed Oxide Fuel Fabrication Facility
Catawba Reactor
McGuire Reactor
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

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

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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

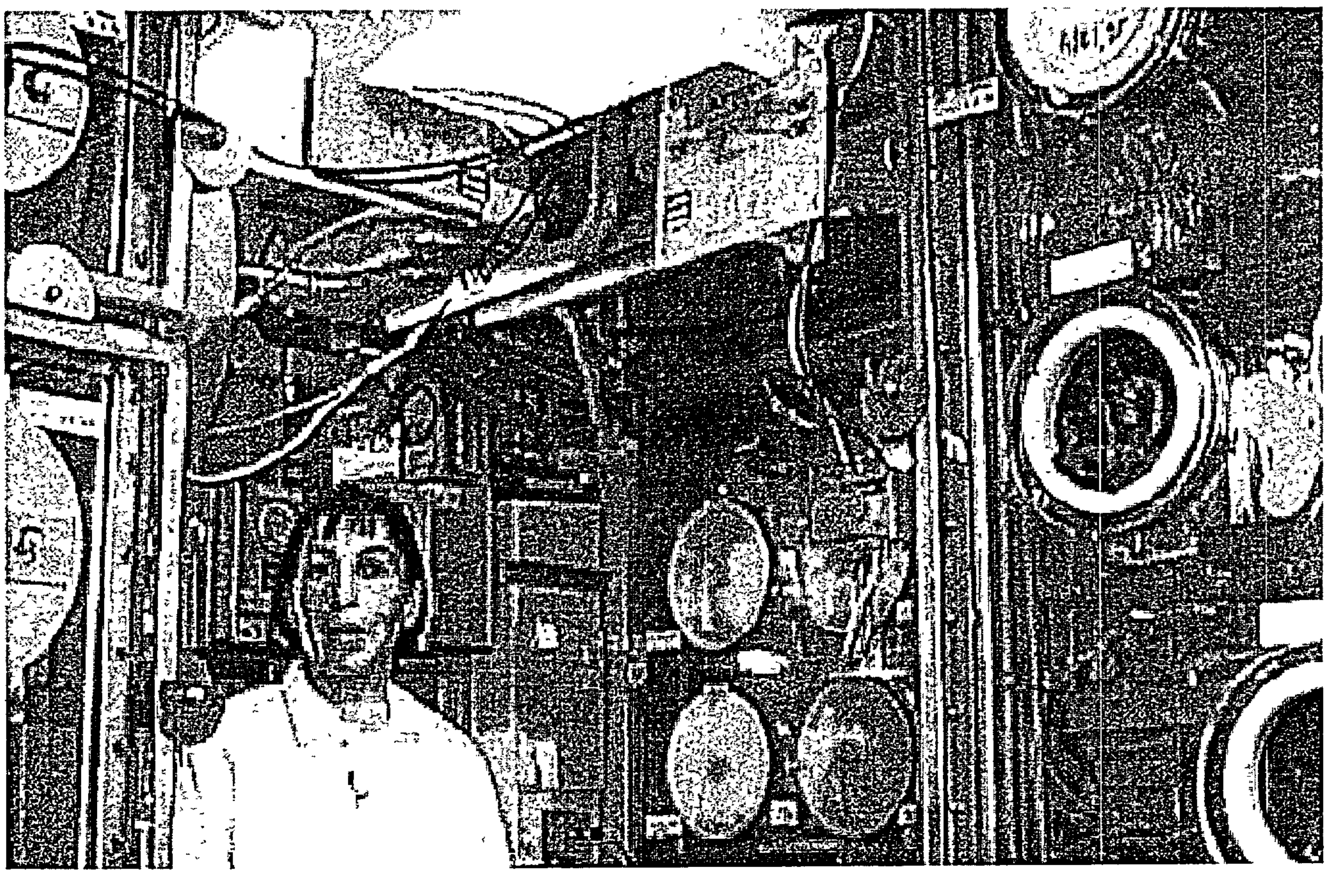
Closed: Design basis criteria for glovebox window

- 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
- 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