DUKE COGEMA
STONE & WEBSTER

MOX Fuel Fabrication Facility
Design Basis Meeting

NRC/NMSS Staff

Duke Cogema Stone & Webster
04-05 January 2001

Agenda

- Introduction & MFFF Overview (Hastings) 30min
  - Agenda/Objectives/Introductions
  - Project Summary & MFFF Overview
  - Project Status & Schedule
- MFFF Process Description (St. Louis) 30-60 min
  - Aqueous Polishing
  - MOX Fuel Fabrication
- MFFF Site Description (McConaghy) 60-90 min
  - General
  - Natural Phenomena Hazards

Agenda (continued)

- Safety Assessment Overview (Kaplan) 60-90 min
  - Methodology Overview
  - Review of SA Results
- MFFF Design Bases Approach (Hennessey) 60-90 min
  - Design Basis Philosophy
  - Design Requirements Overview
  - Design Basis - Key Functional Categories
- MFFF Design Bases (All) 30 min
- Design Bases - Detail Discussion (Berry) 60-90 min
  - Principle SSCs & Design Basis Safety Functions
  - Design Basis Events or Conditions
  - Controlling Parameters

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Objectives

- Overview of pending Construction Authorization Request (CAR) submittal
  - Overview of format & content
  - Status
- Brief NRC Staff on design basis information to be included in the CAR
- Solicit NRC feedback

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DCS Participants

• Ed Brabazon	Deputy PM & Engineering Manager
• Peter Hastings	Licensing Manager
• Dick Berry	Facilities Design Manager
• Tom St. Louis	Mechanical Engineering Lead
• John McConaghy	Civil/Structural Engineering Lead
• Bill Hennessey	Nuclear Safety Engineering Lead
• Gary Kaplan	Nuclear Safety Eng. Assistant Lead
• Gary Bell	Electrical Engineering Lead

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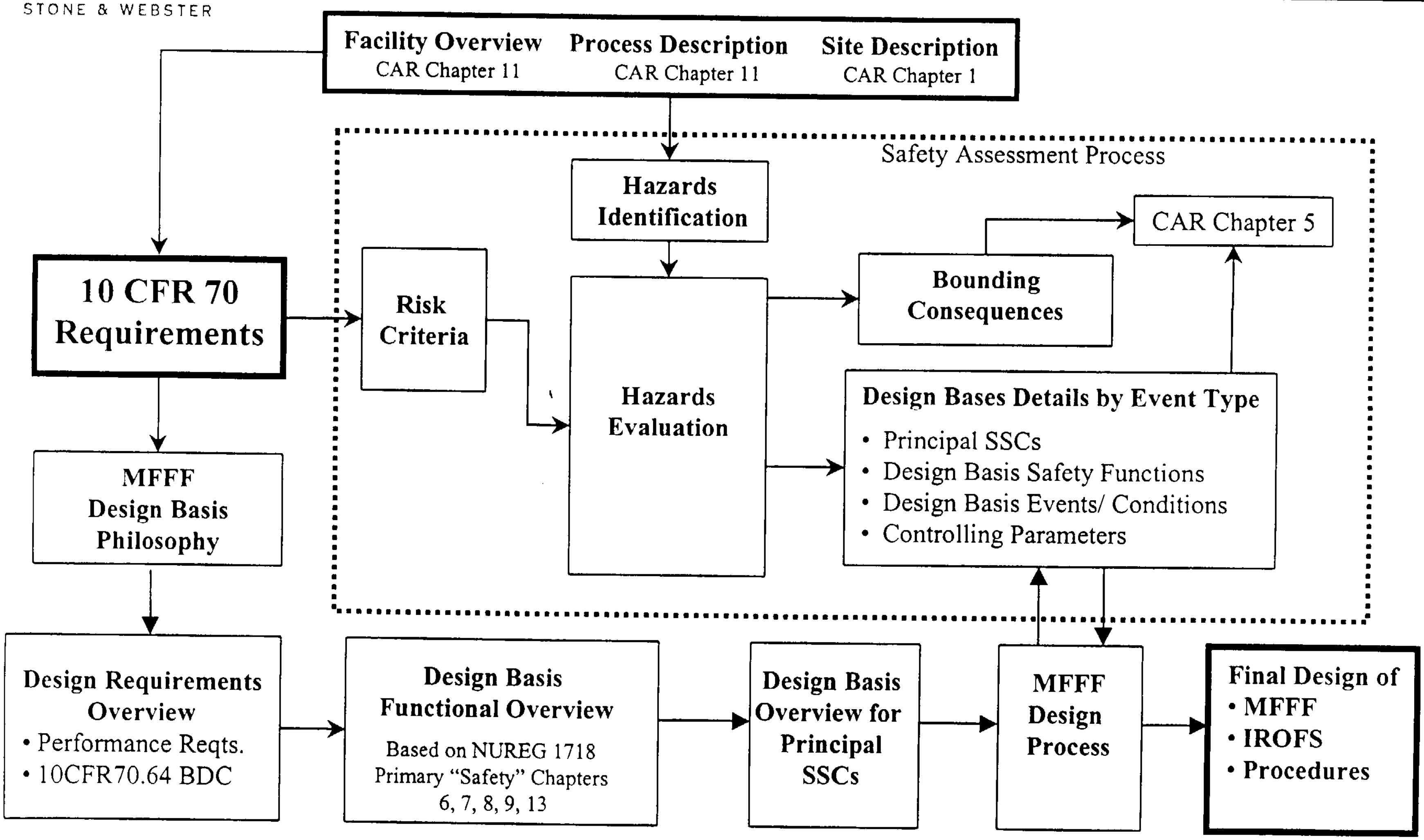
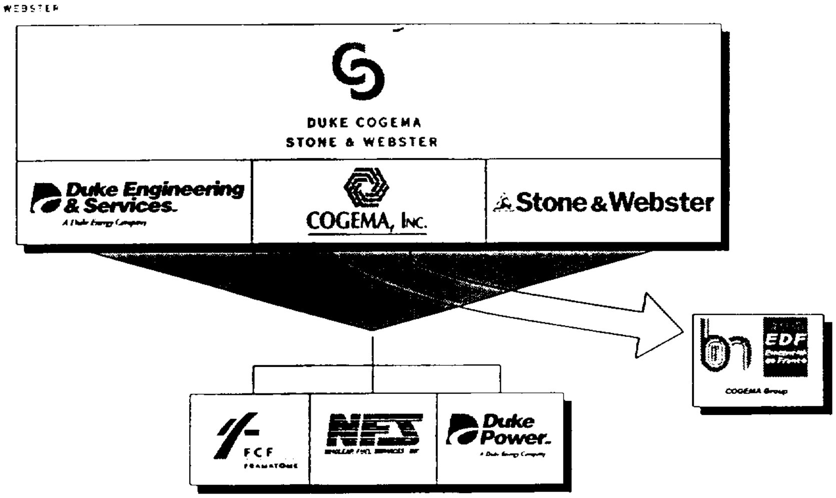
Presentation "Roadmap"



MOX Project Summary

- Duke Cogema Stone & Webster: private-sector consortium contracted by DOE
- Mission: convert plutonium to spent nuclear fuel
  - Design, license, construct, and operate a MOX fuel fabrication facility (MFFF) based on proven European technology of COGEMA and Belgonucleaire
  - Perform qualification program for MOX fuel lead assemblies
  - Design shipping containers for MOX fuel assemblies
  - Irradiate MOX fuel at commercial reactors

Project Summary (continued)



MFFF Schedule Overview

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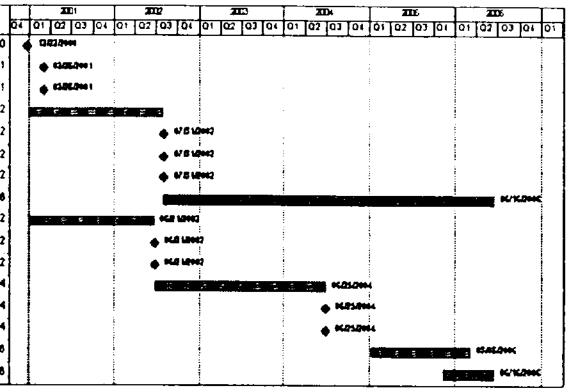
Task Name	Start	Finish
Environmental Report	Fri 12/22/00	Fri 12/22/00
Construction Authorization Request	Wed 02/28/01	Wed 02/28/01
Safety Assessment	Wed 02/28/01	Wed 02/28/01
NRC Staff Review	Wed 12/27/00	Wed 07/31/02
Final EIS & ROD	Wed 07/31/02	Wed 07/31/02
Final SER (Construction)	Wed 07/31/02	Wed 07/31/02
Construction Authorization	Wed 07/31/02	Wed 07/31/02
MFFF Construction & Testing	Wed 07/31/02	Fri 06/16/06
Final Design & LA Preparation	Mon 01/01/01	Fri 06/21/02
Possession & Use Application	Fri 06/21/02	Fri 06/21/02
ISA Summary	Fri 06/21/02	Fri 06/21/02
NRC Staff Review	Fri 06/21/02	Fri 06/25/04
Final SER (Possession and Use)	Fri 06/25/04	Fri 06/25/04
Issuance of License	Fri 06/25/04	Fri 06/25/04
Cold startup/testing	Mon 01/03/05	Wed 03/08/06
Hot startup/testing	Thu 11/10/05	Fri 06/16/06



- Three-year design schedule (Mar 99 - Jun 02)
- CAR submittal Feb 2001
- Application for possession and use mid-2002
- Construction start in mid-2002
- Plant startup in 2006
- First fuel delivery in 2007

MOX Fuel Fabrication Facility (MFFF)

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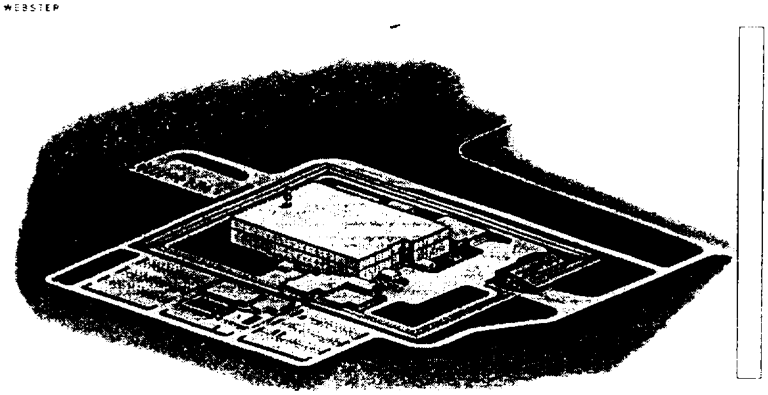

NRC Licensing Approach

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- MFFF licensing in accordance with 10 CFR 70, *Domestic Licensing of Special Nuclear Material* as revised Sep 2000
- NRC MOX Standard Review Plan (NUREG-1718) finalized August 2000
- Authorization to start construction and issuance of possession-and-use license are distinct steps
  - §§ 70.23(a)(7), 70.23(b) set requirements for construction authorization
  - §70.23(a)(8) sets requirements for possession and use (i.e., operation)

NRC Licensing Submittals

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- Construction Authorization Request includes information pursuant to 10 CFR §70.22(f):
  - Site description
  - Safety assessment of design bases of principal SSCs
- QA Program description (MOX Project QA Plan) submitted June 2000; pending are:
  - response to RAI
  - revision to reflect construction requirements
- Environmental Report submitted December 2000
- Application for possession and use of SNM
  - to be submitted upon completion of final design
  - includes ISA Summary
- Ongoing DCS-NRC technical exchanges

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MFFF Process Description

Tom St. Louis

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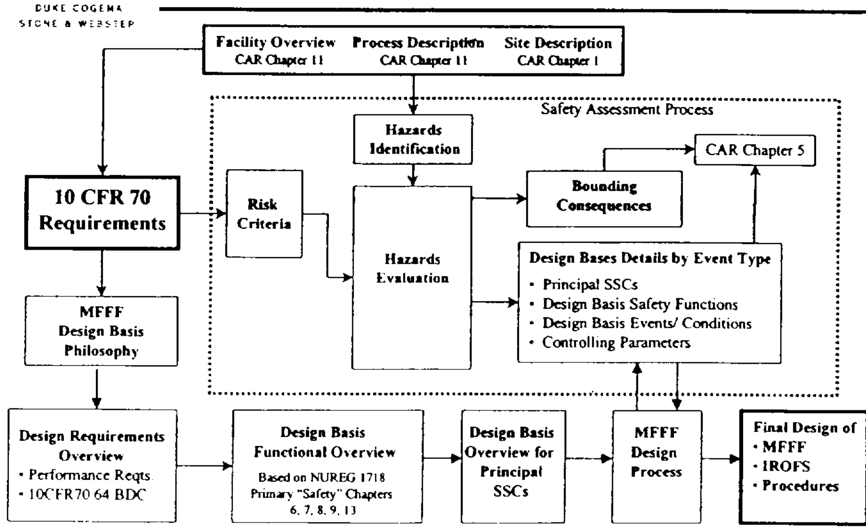
Presentation "Roadmap"

MFFF Overview, Process Description, Site Description



MFFF Process Description

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- MFFF Process Overview
- Aqueous Polishing Process
- MOX Fuel Fabrication Process

MOX Fuel Fabrication Facility Process Description

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- Based on COGEMA's MELOX and La Hague plants
  - MFFF is a 4th-generation design
  - Process design by COGEMA/Belgonucleaire team
  - Facility design and americanization of process design by DE&S/Stone & Webster team
- MFFF includes two fundamental processes:
  - Aqueous Polishing Process
  - MOX Fuel Fabrication Process

MFFF Major Processes Units

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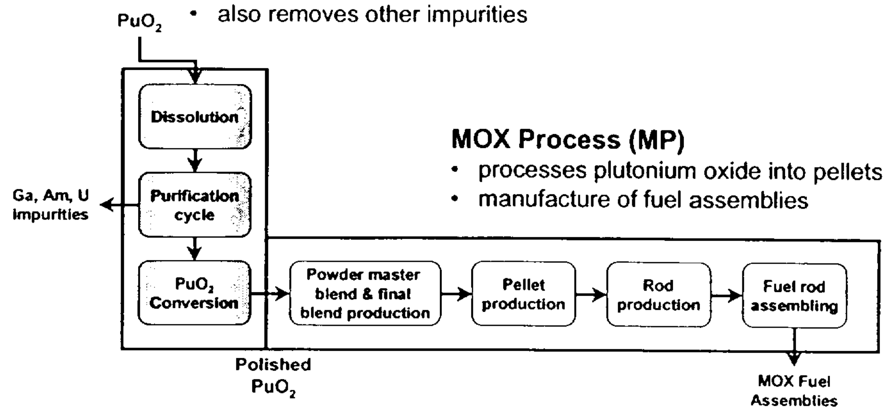
Aqueous Polishing (AP)
- primarily used to remove Ga
- also removes other impurities

MOX Process (MP)
- processes plutonium oxide into pellets
- manufacture of fuel assemblies



Aqueous Polishing Process

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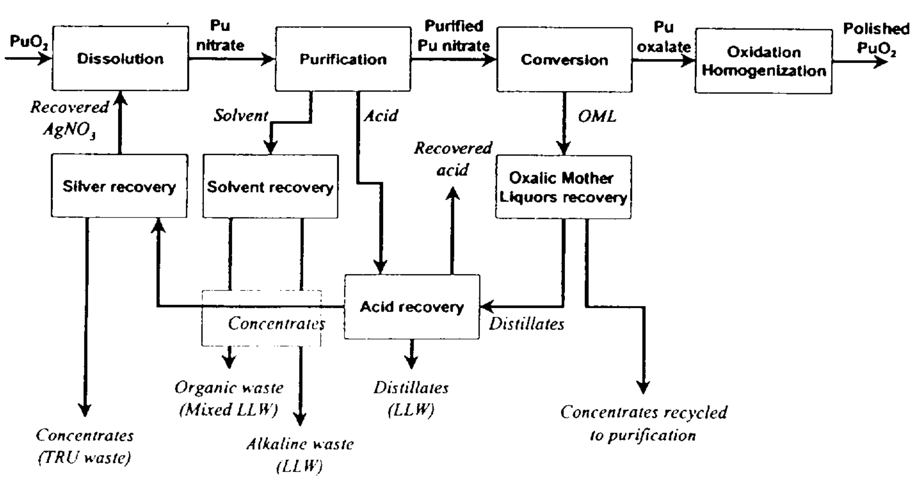

PuO_2 Dissolution by Electro-Generation Ag (II)

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- Dissolution step involves silver catalyzed dissolution and filtration
- Process very efficient
- Independent of PuO_2 powder characteristics
- PuO_2 powder is dissolved by electro-generated Ag (II) in a nitric acid solution

Pu Purification by Solvent Extraction

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- Purification step involves
  - Plutonium extraction in TBP
  - Solvent regeneration
  - Acid recovery
  - Silver recovery
- Selected Because
  - Yields very little Pu leakage
  - Has very high Gallium decontamination factor
- Plutonium extraction, impurities scrubbing and plutonium stripping performed in pulsed columns

Conversion into PuO_2 by Oxalate Calcination

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- Conversion process is a continuous oxalate conversion process
- Process selected since it yields a PuO_2 powder similar to that at Cogema MOX Fabrication Facilities
- Conversion to plutonium oxide includes several main operations
  - Precipitation
  - Filtration
  - Drying and calcination
  - Plutonium blending

MFFF Major Processes Units

DUKE COGEMA STONE & WEBSTER

Aqueous Polishing (AP)
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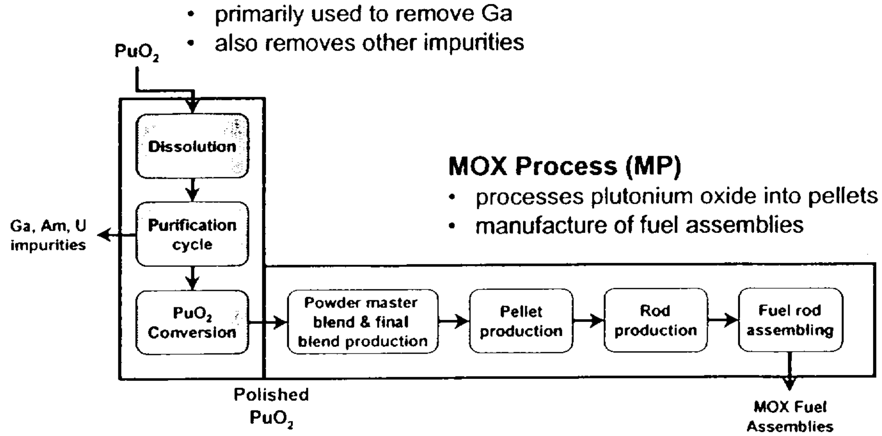

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MOX Process Major Steps

- Powder master blend and final blend production
  - Primary blending, ball milling, secondary blending, homogenization
- Pellets production
  - Pelletizing, sintering, grinding, sorting & inspection
- Rods production (cladding) and inspection
- Fuel rod assembly and inspection

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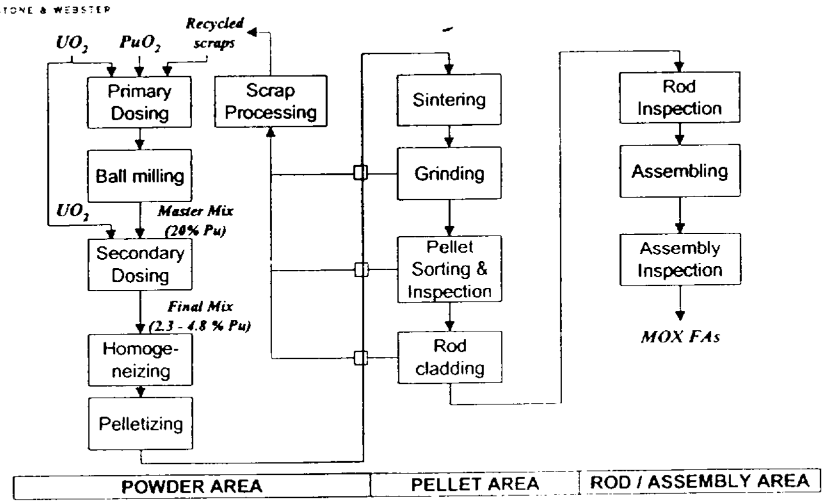
MOX Process



Powder Master Blend and Final Blend

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- Master blend with 20% plutonium content
  - Three different powders are blended

    PuO_2, UO_2, Recycled scraps of fuel pellets
  - Homogenized in rotary screw blender
  - Milled for particle size distribution with ball mill
- Final blend (the master blend and UO_2) with up to 6% plutonium content
  - Processing additives
  - Homogenized in rotary screw blender

Pellet Production

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- Powder is pelletized
- Sintered to form ceramic
- Dry centerless grinding machines grind the sintered pellets to the final diameter
- Pellet Inspection
  - for weight, length, diameter and other defects

Rod Production

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- Rods
  - Loaded with pellets/internals to adjusted pellet length
  - TIG welded
  - Helium pressurized
  - Decontaminated
- Rod inspection verifies
  - Helium tightness
  - Welding quality
  - Correct Pu Content
- Rods of required Pu content are manufactured in campaigns and stored for later fuel assembly manufacturing

Fuel Bundle Assembly

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- Mockup Loading
  - Receives rods from storage
  - Pre-assembly template places rods in desired configuration
- Fuel Assembly Fabrication
  - Loads assembly structure
  - Pulls fuel rods one complete row at a time
  - Installs assembly ends & crimps guide tubes
- Assembly Dry Cleaning
- Assembly Inspection
  - Length, verticality, external shape, foreign matter, insertion clearance (guide tubes), Pu content

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MFFF Site Description

John McConaghy

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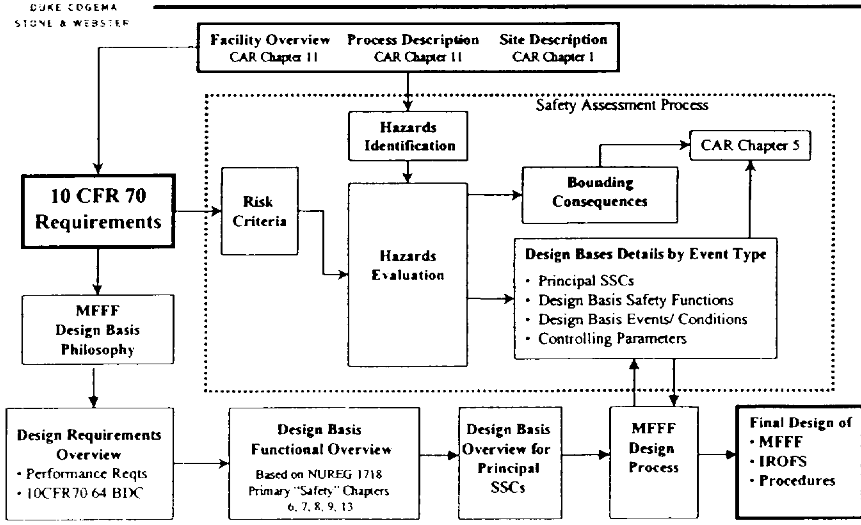
Presentation "Roadmap"

MFFF Overview, Process Description, Site Description



MFFF Site Description

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General

- Location
- Site Description

Natural Phenomena Hazards

- Selection
- Evaluation

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General Location and Site Description

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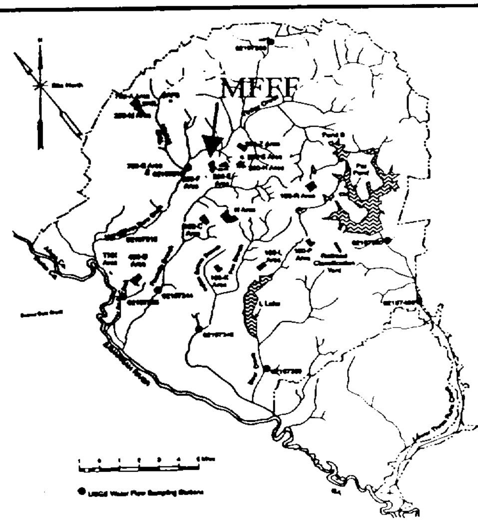

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General Location and Site Description

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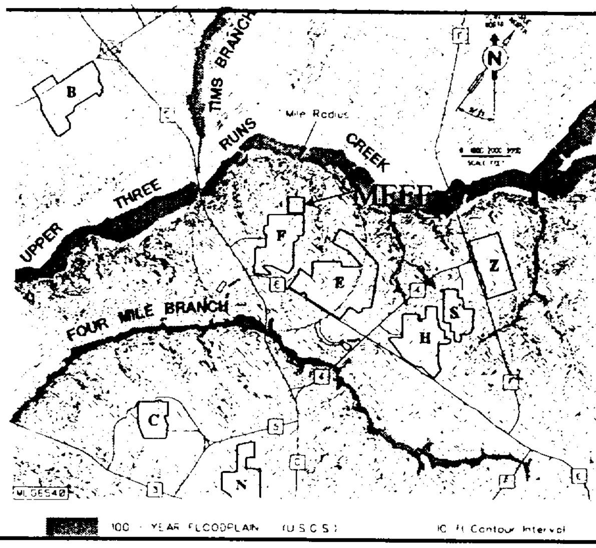

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General Location and Site Description: Savannah River F Area

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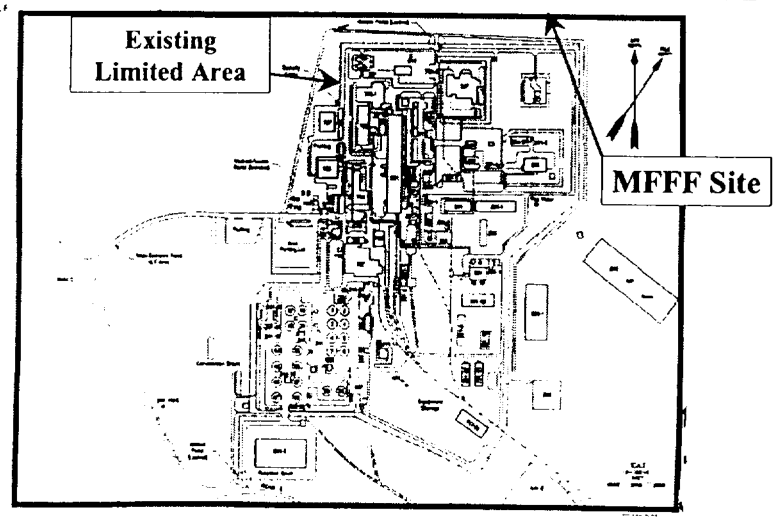

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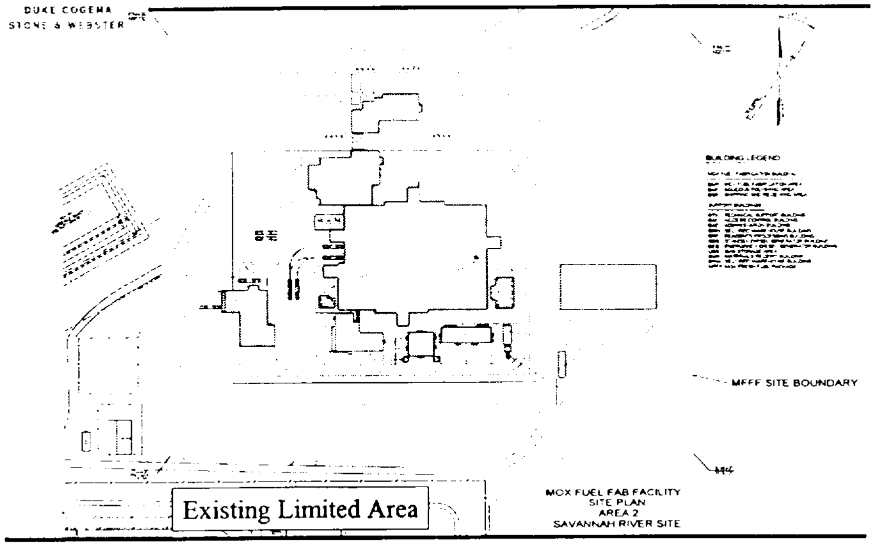
General Location and Site Description



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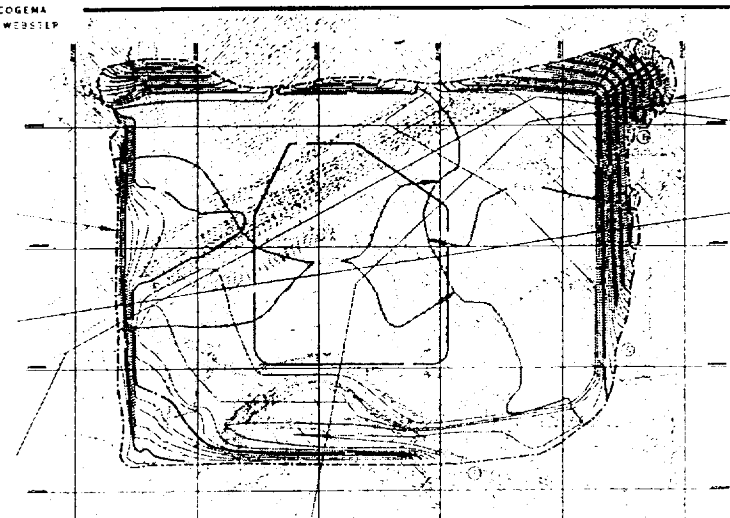
Site Grading Concept



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MFFF Site Description

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General

- Location
- Site Description

Natural Phenomena Hazards

- Selection
- Evaluation

Representative NPH Screened Out

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- Avalanche
- Coastal Erosion
- Dam Failure
- Glacial Erosion
- Glaciation
- High Tides
- Landslides
- Meteorite Impact
- Sedimentation
- Seiche
- Static Fracturing
- Stream Erosion
- Tsunami
- Volcanic Eruption
- Volcanic Ash Fall
- Wave Action

NPH Not Screened Out

- Extreme Winds
- Range Fire
- Flooding
- Ice and Snow
- Lightning
- Liquefaction
- Rain
- Earthquake
- Subsidence
- Temperature Extreme
- Tornado Winds
- Tornado Missiles

External Man-Made Event Screening

Events Screened Out:

- Pipeline Accidents
- Retaining Structure Failure
- Industrial Accidents (Fire, Hazardous Releases, Missiles)
- Military Facility Accidents
- SRS Facility Accidents
- Release of hazardous substances (transportation accident)
- Damage to safety-related structures (transportation accident)

Events Retained:

- Loss of Offsite Power
- External Fire

Overall Approach to NPH Design

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- NPH are considered event initiators
- Design must ensure that all potentially high consequence events are highly unlikely
- For some NPH (e.g., winds, earthquake), facility design margins against physical loads is considered in selecting design basis NPH
- For other NPH (e.g., rising water), more unlikely design basis NPH is selected because margin is not easily demonstrated

NPH Technical Bases

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- Savannah River site contractor (WSRC) provides site-specific NPH magnitudes and properties
- WSRC is qualified supplier under DCS QA program
- Information based on existing risk-informed methodology

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Precipitation and Flooding

- Little margin can be provided in the design process for such events.
- Select a highly unlikely recurrence frequency to ensure design achieves desired safety goal.

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Precipitation Criteria

- Rainfall
  - Annual Hazard Exceedance Probability $1 \times 10^{-5}\ yr^{-1}$
  - Accumulation:
    - 3.9 in/15 min
    - 7.4 in/hr
    - 14.1 in/3 hr
    - 16.7 in/6 hr
    - 22.7 in/24 hr
- Snow and Ice Criteria
  - 100-year accumulation is 0.67 in (ice) and 5 psf (snow)
  - 10 psf snow and ice load assumed in design of SSCs
  - Greater accumulation bounded by other live loads

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Flood Criteria

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- 1.0E-5 Recurrence frequency
- Design basis flood level 207.9 ft. above MSL
- Water level due to Probable Maximum Precipitation 224.5 ft. above MSL
- Yard elevation approximately 270 ft.
- Therefore, flood is not a design driver for MFFF

Structural Seismic Design Criteria

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- Seismic Categories
  - SC 1 Normal, severe, and all extreme loads
  - SC 2 Normal, severe, and extreme loads limited to DE
  - CS Normal, severe, and extreme loads limited to UBC seismic loads
- Seismic Code Criteria
  - SC 1 ACI 349 & N690
  - SC 2 ACI 349 & N690 vs ACI 318 / AISC
  - CS UBC

Structural Design (cont.)

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Buildings	Abbreviations	Seismic Category
• MOX Fuel Fabrication Building	BMF	SC 1
- MOX Processing Area	BMP	SC 1
- Aqueous Polishing Area	BAP	SC 1
- Shipping & Receiving Area	BSR	SC 1
• Emergency Diesel Generator Building	BEG	SC 1
• Safe Haven Buildings	BSH	SC 2
• Reagents Processing Building	BRP	CS
• Standby Diesel Generator Building	BSG	CS
• Access Control Building	BAC	CS
• Administration Building	BAD	CS
• Secured Warehouse Building	BSW	CS
• Technical Support Building	BTS	CS
• Material Receipt Building	BMR	CS
Facilities, Structures and Areas		
• Gas Storage Facility	UGS	CS
• Switchyard	ESW	CS
• Main Access	WMA	CS
• Service Access	WSA	CS
• Vehicle Access Portal	WVA	CS
• HVAC Chiller Pads	VCX,Y, or Z	CS

Seismic NPH Design Basis

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- July 2000 NRC meeting
  - DCS proposed event-tree assessment to demonstrate that high consequence events are highly unlikely
  - Focus on confinement functions
  - Proposed 2,000-year design earthquake
- After further consideration, DCS is implementing more conservative, deterministic approach

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Development of Seismic NPH Design Basis

- Seismic spectra typically used at SRS site
  - based on DOE categories PC-3 and PC-4 for moderate and high hazard facilities, respectively
  - Current PGA for PC-3 is 0.16g
  - Current PGA for PC-4 is 0.23g
- Spectra, hazard curves, and return periods on following slides

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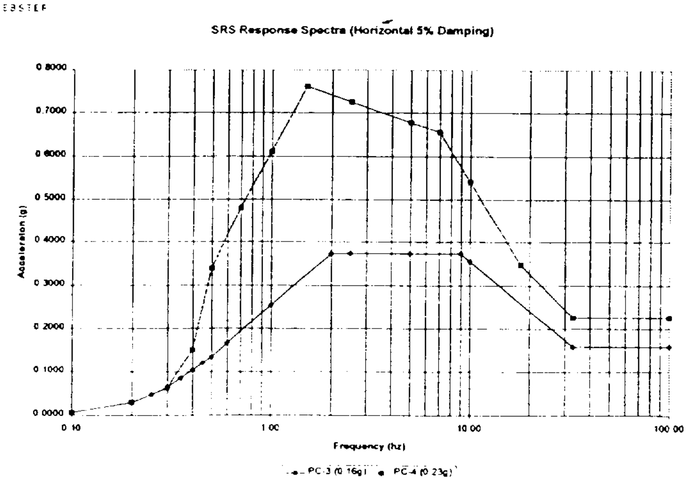
SRS PC-3 and PC-4 Response Spectra



SRS Seismic Hazards

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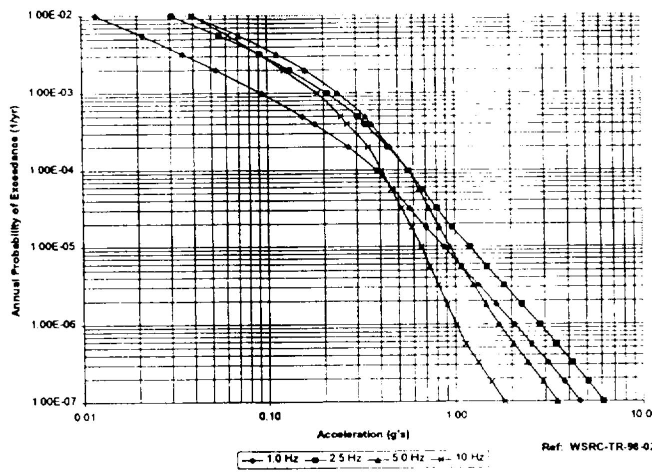
SRS Soil Surface Seismic Hazard Curves



Ref: WSRC-TR-98-0263 Rev 0

Return Period for PC-3 and PC-4 Accelerations

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PC-3 Spectrum (0.16g)		
Frequency	Acceleration	Return Period
1.0 Hz	0.250 g	4,000 years
2.5 Hz	0.375 g	3,300 years
5.0 Hz	0.375 g	2,700 years
10.0 Hz	0.360 g	5,600 years

PC-4 Spectrum (0.23g)		
Frequency	Acceleration	Return Period
1.0 Hz	0.610 g	37,000 years
2.5 Hz	0.730 g	23,000 years
5.0 Hz	0.680 g	22,000 years
10.0 Hz	0.540 g	36,000 years

Selection of MFFF Design Earthquake

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- Select a criterion between PC-3 and PC-4 levels
  - Achieves desired safety performance on deterministic basis
  - Consistent with NRC precedent
- For reference, consider a PC-3 spectrum increased in magnitude by 20%
- Also consider RG-1.60 horizontal spectrum scaled to 0.2g PGA
- Evaluate return period of accelerations

Selection of MFFF Design Earthquake

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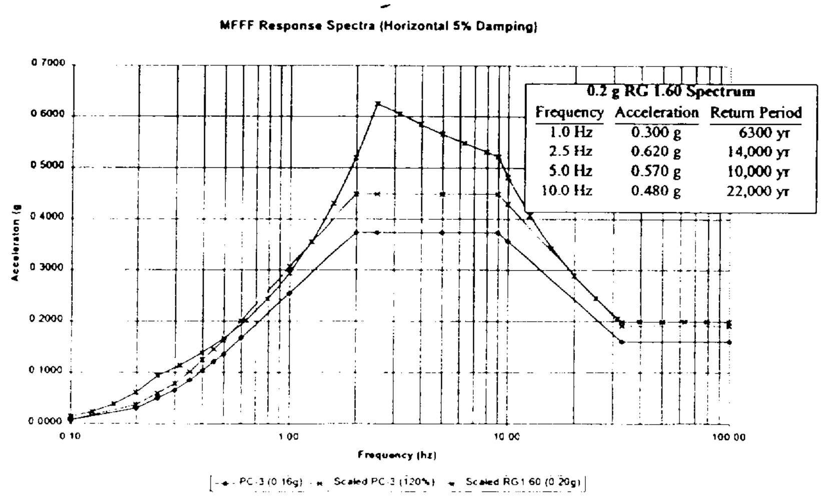

Selection of MFFF Design Earthquake

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- Select 0.2g RG-1.60 horizontal spectrum
- These accelerations can be characterized as a 10,000-year surface event
- Vertical component is calculated by scaling the corresponding horizontal component by two-thirds throughout the entire frequency range
- Vertical component value is currently under evaluation.
- Design Earthquake spectra are shown on the following slide.

MFFF Design Earthquake Spectrum

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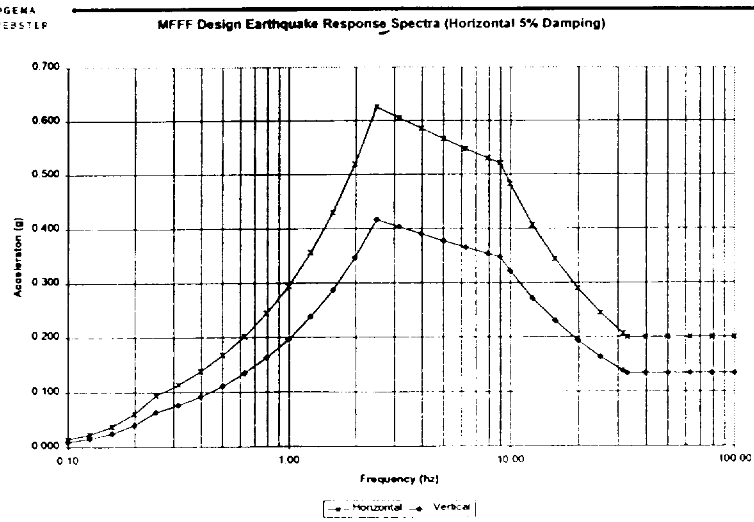

Demonstrate Margin

- Evaluations show that designing for the selected DE spectrum will ensure that failure of individual components due to seismic event is highly unlikely

Demonstrate Margin (cont)

- Methodology:
  - Given site seismic hazard curves and design spectrum
  - Consider representative Principal SSCs
    - Gross building structure, primary and secondary confinements
    - Ventilation systems and backup power
  - Estimate conditional failure probability relations (probability of failure given seismic acceleration)
  - Perform numerical summation through all earthquakes
  - Sum probability of EQ times the probability of failure given EQ

Demonstrate Margin (cont)

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- Results:
  - Probability of failure of any individual Principal SSCs due to seismic loading is less than 1.0 E-05
  - This achieves "highly unlikely" goal.

Evaluation of Subsurface Conditions

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- For evaluation of liquefaction and dynamic settlements, bedrock motions selected for consistency with PGA for DE (i.e., 0.2 g surface PGA)
- Bedrock motions based on the PC-3 uniform hazard bedrock spectrum are scaled so that amplification through site soil profile results in 0.2g PGA

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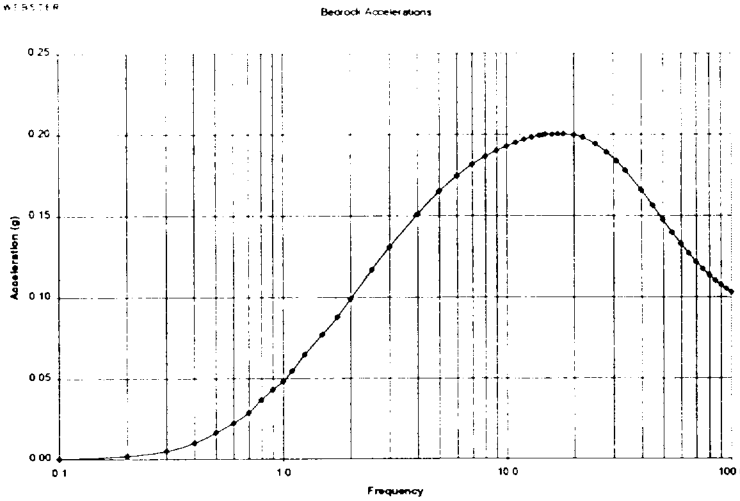
SRS PC-3 Bedrock Spectrum



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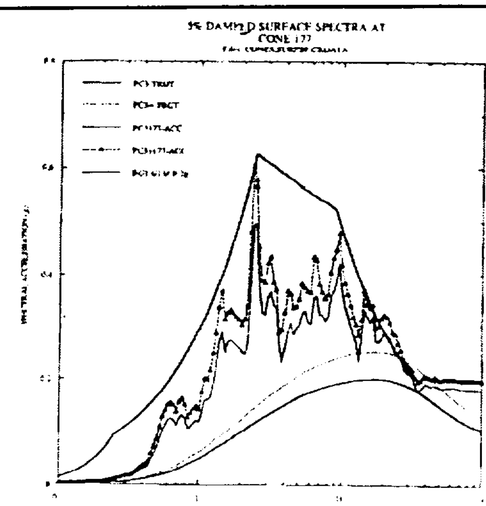
Scaling of Bedrock Motions (Preliminary)



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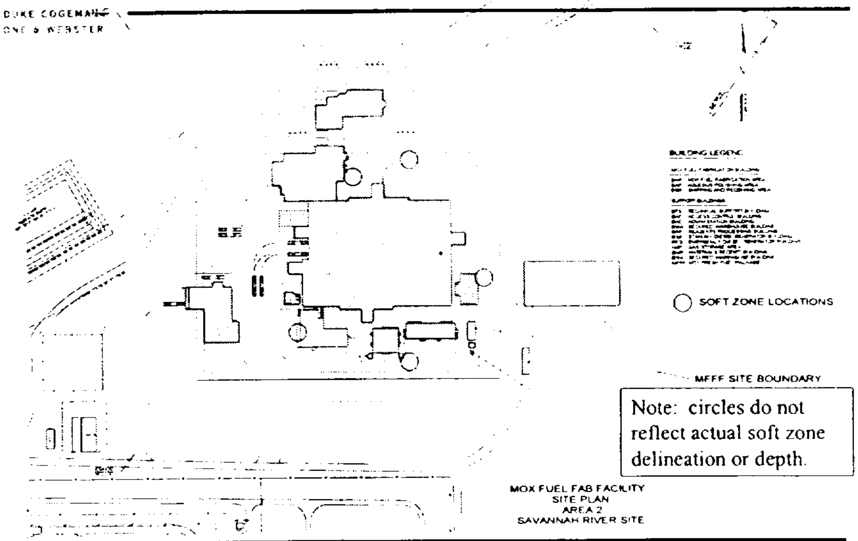
Identified Soft Zone Locations



Note: circles do not reflect actual soft zone delineation or depth.

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Soft Zones (cont.)

- Analyses are planned to assess whether soft zones in the vicinity of Seismic Category I buildings have the potential to collapse and adversely affect adjacent buildings.
- First technical approach is to demonstrate that soft zones <u>do not</u> collapse at the design earthquake.
- If this cannot be demonstrated, will evaluate necessity for additional reinforcement of building structures.

Liquefaction Potential

- Past analyses for SRS have shown acceptable factors of safety for liquefaction at PC-3 levels.
- WSRC has conducted study of potential for liquefaction at MFFF site.
- Preliminary results support decisions about design earthquake level
- DCS will perform engineering liquefaction analyses to demonstrate acceptability (FS>1.1) at the selected design earthquake.

Wind/Tornado Criteria

- Straight Wind
  - $1X10^{-4}$ annual hazard exceedance probability
  - 130 mph
  - Small 2 x 4 timber missile, 15 lbs @ 50 mph < 50 ft altitude
- Tornado
  - $2x10^{-6}$ annual hazard exceedance probability
  - 240 mph 3-sec tornado speed
  - 150 psf atmospheric pressure change (APC) at 55 psf/sec
  - Missiles
    - 2x4 timber plank 15 lb @ 150 mph (horizontal); max height 200 ft; 100 mph (vertical)
    - 3 in diameter standard steel pipe, 75 lb @ 75 mph (horizontal); max height 100 ft; 50 mph (vertical)
    - 3000 lb automobile @ 25 mph rolls and tumbles

Temperature Extremes

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- 107° F Maximum Outside Recorded Temperature
- -3° F Minumum Outside Recorded Temperature

Month	Average Daily Temperature, °F [a] Maximum	Average Daily Temperature, °F [a] Minimum	Month	Extreme Temperature, °F [b] Maximum (Yr)	Extreme Temperature, °F [b] Minimum (Yr)
January	55.9	36.0	45.8	86 (1975)	-3 (1985)
February	60.0	38.3	49.1	86 (1989)	10 (1996)
March	68.6	45.4	57.0	91 (1974)	11 (1980)
April	77.1	52.5	64.8	99 (1986)	29 (1983)
May	83.5	60.7	72.1	102 (1963)	38 (1989)
June	89.6	68.0	78.8	105 (1985)	48 (1984)
July	92.1	71.5	81.7	107 (1986)	56 (1963)
August	90.1	69.6	80.3	107 (1983)	56 (1986)
September	85.4	65.6	75.4	104 (1990)	41 (1967)
October	76.6	54.6	65.6	96 (1986)	28 (1976)
November	67.0	45.2	56.2	89 (1974)	18 (1970)
December	59.3	39.1	49.1	82 (1984)	5 (1962)
Annual	75.5	54.0	64.7	107 (1986)	-3 (1985)

[a] Period of record: 1967-1996.
[b] Period of record: 1961-1996.

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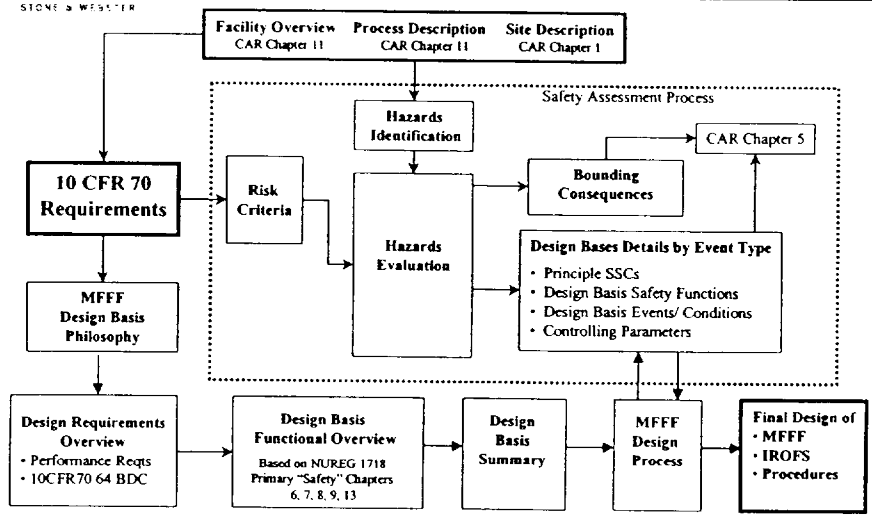
Safety Assessment Overview

Gary Kaplan

Presentation "Roadmap"

Safety Assessment Overview



SA Overview

- ISA and SA Introduction
- SA Contents
- SA Methodology
- SA Results

ISA and SA Introduction

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- 10CFR70 (and NUREG 1718) requires preparation of an ISA with the LA, and the SA with the CA
- 10CFR70 defines an ISA as a systematic analysis to identify plant and external hazards, potential accident sequences, the associated frequency and consequence, and the associated items relied on for safety (IROFS)
- Safety assessment of design bases is first step of ISA process

SA vs ISA Major Purpose

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- SA
  - Identify hazards and events associated with MFFF design and operations
  - Identify principal SSCs required to mitigate or prevent these events, and identify their design bases
  - Describe principal SSCs capability through general commitment to codes, standards, and preliminary design
- ISA
  - Demonstrate IROFS are capable of meeting design bases through detailed analysis
  - Demonstrate IROFS are sufficiently reliable and available to perform their intended safety function

SA and ISA Relationship Example

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- SA
  - Hazard - earthquake
  - Unmitigated Event - Earthquake causes damage to MOX process building, which damages glovebox, resulting in a release
  - Principal SSC - MOX process building
  - Design Bases - withstand design earthquake and not damage internal SSCs, X g
  - Description - proposed codes and standards, design methods, general facility design
- ISA
  - demonstrate building withstands design earthquake of X g through detailed structural analysis

Major SA Contents

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- Process Safety Information
- Risk Criteria
- Methodology
- Hazard Identification
- Hazard Evaluation and Preliminary Accident Analysis
- Principal SSCs and Design Bases
- Mitigated Consequences

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Process Safety Information

- Radioactive and Hazardous Material List
- Site Description
  - NPH and associated magnitudes
  - applicable external man made hazards
- Facility, Process, System Descriptions
  - Facility descriptions, functions, layout
  - Process and systems descriptions, functions, major equipment descriptions, system interfaces, control concepts

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Risk Criteria from 10CFR70

CONSEQUENCE \ LIKELIHOOD	1 Highly Unlikely	2 Unlikely	3 Not Unlikely
High 3	3 acceptable risk	6 unacceptable risk	9 unacceptable risk
Intermediate 2	2 acceptable risk	4 acceptable risk	6 unacceptable risk
Low 1	1 acceptable risk	2 acceptable risk	3 acceptable risk

Consequence Categories from 10CFR70

Consequence Category	Workers	Offsite Public	Environment
3: High (H)	TEDE > 1 Sv (100 rem) > AEGL3, ERPG3	TEDE > 0.25 Sv (25 rem) >30 mg soluble U intake >AEGL2, ERPG2	
2: Intermediate (I)	0.25 Sv < TEDE ≤ 1 Sv (25 rem < TEDE ≤ 100 rem) > AEGL2, ERPG2 but < AEGL3, ERPG3	0.05 Sv < TEDE ≤ 0.25 Sv (5 rem < TEDE ≤ 25 rem) > AEGL1, ERPG1 but < AEGL2, ERPG2	radioactive release > 5000 x (Table 2 in Attachment B of 10 CFR Part 20)
1: Low (L)	Events of lesser radiological and chemical exposures to workers than those above in this column	Events of lesser radiological and chemical exposures to the public than those above in this column	Radioactive releases producing effects less than those specified above in this column

Frequency Definitions

- Not Unlikely – Event may occur during the lifetime of the facility
- Unlikely – Credible event not expected to occur during the lifetime of the facility
- Highly Unlikely - Event originally classified as Not Unlikely or Unlikely to which sufficient principal SSCs (or IROFS) are applied to further reduce the associated likelihood to an acceptable level
- Credible – Events that are not Incredible
- Not Credible/Incredible – Natural Phenomena or External Man-Made Events with an extremely low initiating frequency

SA And ISA Method Overview

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- Systematic, comprehensive analysis
- Iterative process to demonstrate performance criteria of 10CFR70 are met
- Start with simple techniques to evaluate and screen events
- Use progressively more sophisticated analysis as necessary

Summary of SA Methodology

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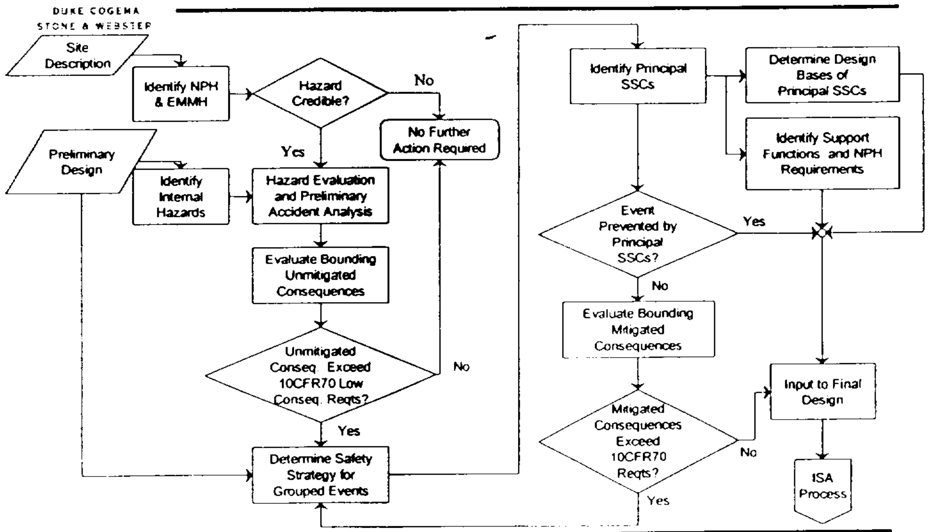
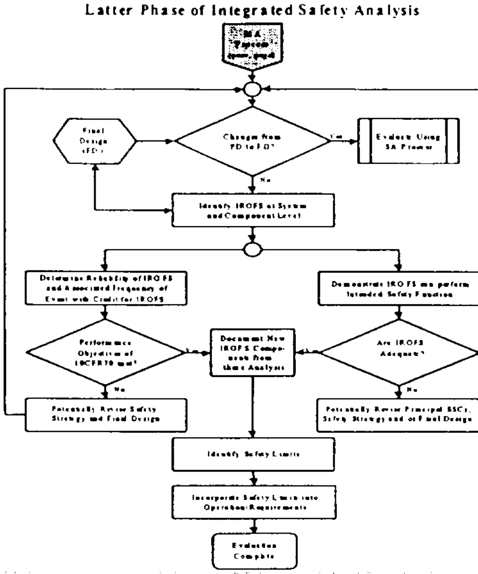


Latter Phase of Integrated Safety Analysis



Hazard Identification (con't)

- Sample Hazard ID Sheet

Aqueous Polishing

SYM: KDA | PuO2 Decanning | Sort Number: 1

Hazardous Materials

- [ ] Corrosive chemicals
- [ ] Toxic Chemicals
- [ ] Alkali Metals
- [ ] Hydroxylamine Nitrate
- [ ] Nitric Acid
- [ ] Hydrazine
- [ ] Other Oxidizers

Other

Ionizing Radiation Sources

- [x] Fissile Material
- [x] Radioactive Material
- [ ] Radiography Equipment
- [ ] Radioactive Sources

Other

Explosive Materials

- [ ] Explosive gases
- [ ] Explosive chemicals
- [ ] Incompatible Chemicals - Explosive Incompatibilit
- [x] Radioactive/Hydrogenous (Radiolysis)

Other

Flammable/ Combustibles

- [ ] Flammable Gases
- [ ] Hydrogen
- [ ] Solvents
- [x] Other Combustibles
- [ ] Pyrophoric Materials
- [ ] Flammable Liquids
- [ ] Methane
- [ ] Propane
- [ ] Oxygen

Other

Thermal Sources

- [ ] Incompatible Chemicals - Thermal Release
- [ ] Furnaces
- [ ] Grinders
- [ ] Welding Equipment
- [ ] Cryogenic
- [ ] Electrical Heating Resistor
- [ ] Evaporators/Boilers
- [ ] Lasers
- [ ] Bunsen burners
- [ ] Microwave
- [ ] Heater
- [x] Electrical Equipment
- [ ] Heating Plates
- [ ] Radioactive Decay Heat
- [ ] Electric Arc
- [ ] Electrolyzers
- [ ] Other Process Equipment
- [ ] Solar

Other

Gravitational

- [ ] Cranes/Hoists
- [x] Human efforts
- [ ] Lifts
- [ ] Suspended objects

Other

Kinetic Energy Sources

- [x] Elevators
- [ ] Fork Lifts
- [x] Presses
- [ ] Crane Loads in Motion
- [ ] Impacter
- [ ] Shears
- [ ] Carts
- [ ] Power-driving Tools
- [x] Conveyors
- [ ] Air Ejector/Air Lift/Air Jet
- [ ] Steam Ejector
- [ ] Dollies

Other

Pressure Sources

- [ ] Autoclaves
- [ ] Pressure Vessels
- [ ] Gas Receivers
- [ ] Steam Header and Steam Lines
- [ ] Gas Bottles

Other

Rotational / Friction

- [x] Belts
- [x] Gears
- [ ] Exhausters
- [ ] Centrifuges
- [x] Power Rotating Tools
- [ ] Fans
- [x] Bearings
- [x] Motors

Other: Cutting wheel

Confinement Type

- [ ] AP vessels, tanks and piping
- [x] Glove Box
- [x] Containers inside Gloveboxes
- [x] Containers outside Gloveboxes
- [ ] Rods/ Assemblies
- [x] HVAC
- [x] HEPA Filters
- [ ] Off-gas Process Confinement
- [x] Pneumatic transfer tubes

Other

Utilities

- [ ] Process Water Supply
- [x] Compressed Air
- [x] Process Gas Lines
- [x] Pneumatic Pipe Vacuum Transfer System
- [x] Radiation Air Monitoring System
- [ ] Reagents Supply Lines
- [ ] Steam/Condensate Lines
- [ ] Contaminated Drains

Other

Hazard Evaluation and Preliminary Accident Analysis

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Event Type Workshop Event #	Event Description Specific Location Mode Hazard Source	Causes	Bounding Risk With No Controls
Internal Fire MFFF Gloveboxes GB-1	A fire involving glovebox combustibles (e.g., electrical equipment, transient combustibles, flammable liquids, HEPA filter) results in a breach of the Glovebox and the dispersal of radiological materials Specific Location AP-Acid recovery AP-Solvent recovery AP-PuO2 Decanning AP-PuO2 Canning AP-Silver recovery AP-Precipitation-Filtration-Oxidation AP-Homogenization-Sampling AP-Dissolution AP-Purification cycle AP-Sampling AP-Oxalic mother liquors recovery Receiving Workshop Powder Workshop Pellet Workshop Cladding and Rod Control Workshop Miscellaneous Areas (Laboratories) Waste Handling Mode: All Hazard Sources Radiological Material (maximum inventory in a fire area)	1 Combustibles and electrical short 2 Combustion of waste from exposure to chemicals 3 Ignition of flammable liquid (e.g. isopropanol used in rod cleaning) 3 Maintenance activities 4 Combustibles and unknown ignition source	Likelihood Not Unlikely Consequence Worker H Site H Public I Risk Level Worker [illegible] Site [illegible] Public [illegible]

Unmitigated Consequence Analysis

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- Bounding, conservative evaluation with no credit for SSCs
- Site worker and public - quantitative calculations
  - Bounding values for MAR, ARF, RF, Breathing Rate, X/Q
- MFFF worker - qualitative estimates
  - rapid or catastrophic failures involving PuO_2 powder are assumed to result in a high dose
- Intermediate or High Consequence Events are Required to be Prevented or Mitigated

Principal SSCs

- The set of design features along with administrative controls implemented to meet performance requirements of 10CFR70.61
- For each principal SSC, the following is provided:
  - Identification of SSC or administrative control
  - Design Basis including safety function and controlling parameter
  - Required support systems
  - NPH requirements
  - General Description

Principal SSC Example

- Unmitigated Event - Crane failure damages glovebox
- Principal SSC - C3 Confinement System
- Design Bases
  - Provide filtration to mitigate dispersions from C3 areas
  - X% particulate removal efficiency
- Support Systems - Emergency AC and DC Power, Safety I&C, HDE, EG Building Ventilation, Stack Exhaust, EG Fuel Oil and Exhaust

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Principal SSC Example (con't)

- NPH Requirements - C3 confinement system must be operable following credible NPH
- C3 Confinement System Description includes:
  - system description
  - major component listing
  - single line drawing of system
  - control concepts
  - applicable codes and standards

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Bounding Mitigated Consequences

Bounding Event	Site Worker TEDE (rem)	Public TEDE (rem)
Loss of Confinement	8.7×10^{-2}	7.8×10^{-4}
Internal Fire	8.7×10^{-2}	7.8×10^{-4}
Load Handling	7.5×10^{-2}	6.7×10^{-4}
Criticality*	1.5	1.2×10^{-2}
Explosion*	3.1×10^{-1}	2.7×10^{-3}

* Consequences provided even though event is highly unlikely

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Mitigated Event Frequencies

- No explicit frequency analysis provided in SA
- Intermediate and High consequence events assumed to be highly unlikely with application of Principal SSCs
- Standard nuclear deterministic design practices provide confidence in SSC reliability and availability
- Demonstration of likelihood provided in ISA

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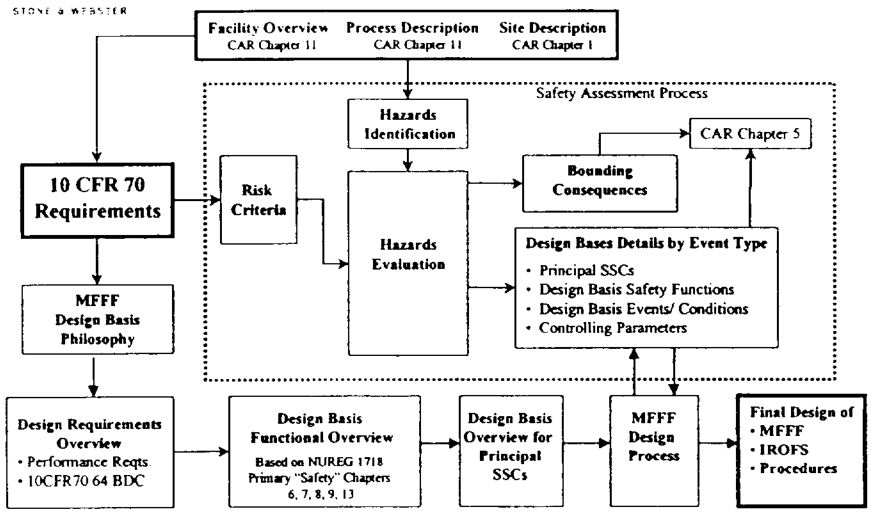
MFFF Design Bases Approach

Dick Berry

Presentation "Roadmap"

Design Bases Discussion



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MFFF Design Bases Approach

- **Design Basis Philosophy**
- **Design Requirements Overview**
  - Baseline Design Criteria
- **Design Basis - Key Functional Categories**
  - Criticality
  - Fire Protection
  - Chemical Safety
  - Radiological Safety/Radiological Protection
  - Safeguards and Security

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Design Basis Philosophy

- **10 CFR 70 Requirements**
  - Public health and safety
  - Worker protection
  - Radiological and chemical exposure thresholds and probabilities
  - Criticality prevention
- **Two fundamental safety functions to be provided**
  - Criticality: prevent criticality under normal and credible abnormal conditions, including application of double contingency principle (discussed in detail later)
  - Confinement: maintains continuous confinement during and following all internal and external design basis events (discussed in detail below)

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Design Basis Philosophy

- **Confinement Barriers**
  - Primary Confinement - Immediately around radioactive material
  - Secondary Confinement - Provided around primary confinement areas
  - Tertiary Confinement - Buffer between primary and secondary confinement of radioactive materials and the environment

Design Basis Philosophy

Confinement Barriers (AP)

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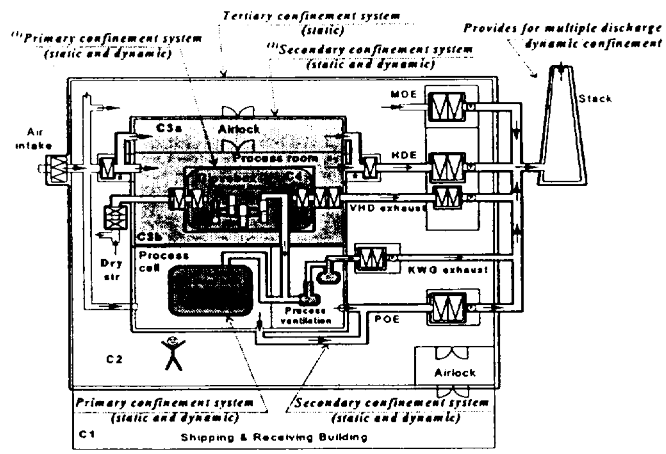

Aqueous Polishing static and dynamic confinement systems

Design Basis Philosophy

Confinement Barriers (MP)

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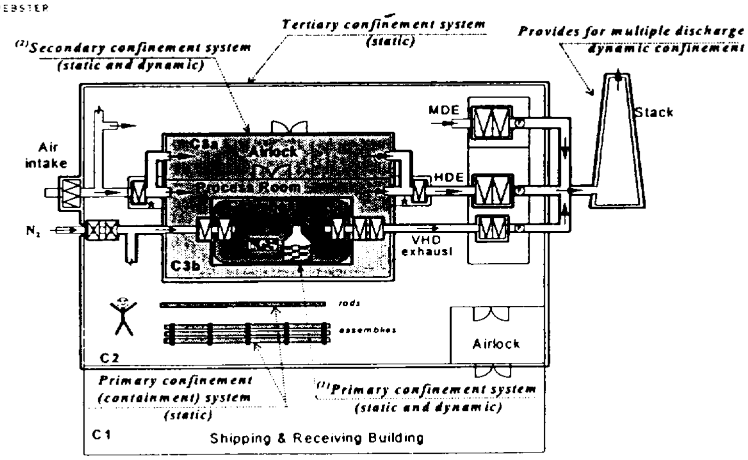

MOX Process static and dynamic confinement systems

Design Requirements Overview

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- Design Performance Requirements (10CFR70.61)
- Baseline Design Criteria [10CFR70.64a]
  - Apply 10 Baseline Design Criteria
  - Applicable to IROFS
- Defense-in-Depth Practices [10CFR70.64b]
  - Provide Successive Levels of Protection
  - Prefer Engineered Controls Over Administrative Controls
- Plus Features that Reduce Challenges to IROFS (non IROFS)

Baseline Design Criteria [10CFR70.64a]

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- Quality Standards and Records
- Natural Phenomena Hazards
- Fire Protection
- Environmental and Dynamic Effects
- Chemical Protection
- Emergency Capability
- Utility Services
- Inspection, Testing and Maintenance
- Criticality Control
- Instrumentation and Controls

Baseline Design Criteria (Continued)

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- Quality Standards and Records
  - Implemented Through MOX Project Quality Assurance Plan (MPQAP) and QA Procedures
  - MPQAP Based on:
    - 10CFR50, Appendix B
    - ASME NQA-1-1994 (as revised by ASME NQA-1a-1995 Addenda)
    - NRC Regulatory Guide 1.28, Revision 3

Baseline Design Criteria (Continued)

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- Natural Phenomena Hazards
  - Implemented Through Design Criteria Documents that Reflect ISA Results and Site-Related Design Criteria
  - Based on Selected Site Location
  - Screening Process Identifies Specific Hazards
  - Technical Criteria Based on Historical and Actual Conditions
  - Rigorous Seismic and Soils Analyses

Baseline Design Criteria (Continued)

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- Fire Protection
  - Implemented Through Fire Protection and Electrical Design Criteria
- FHA Performed in Conjunction with ISA to Identify Specific Hazards Including Explosions and to Identify IROFS
  - Small Fire Areas Limit Fire Size and Spread
  - Material Disbursement Mitigated by Confinement Systems Consequences
  - Design Also Incorporates Detection and Suppression Systems

Baseline Design Criteria (Continued)

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- Environmental and Dynamic Effects
  - Implemented Through Seismic and Electrical Design Criteria Along With an Environmental Qualification Program as Appropriate
  - Design Considers Normal Operations, Testing, Maintenance and Postulated Accident Conditions

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Baseline Design Criteria (Continued)

- Chemical Protection
  - Implemented Through ISA, MOX Process and Aqueous Polishing (AP) Design Criteria
  - Primary Focus is AP Chemical Processes
  - Offgas, Ventilation and Confinement Systems are Primary Mitigation Features
  - Gaseous Release, Explosion, and Fire are Potential Sources of Hazards
- Preventative measures will be discussed later

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Baseline Design Criteria (Continued)

- Emergency Capability
  - Implemented Through Emergency Planning Design Criteria and Site WTA, including integration with SRS emergency plan
  - Emergency On-site MFFF Evacuation Plans and Utilization of Existing On-site Facilities and Services Coordinated Through WTA Facilitate Use of Available Offsite Services
  - Safe Havens Provide Provisions for Personnel Protection While Controlling Potential Material Loss

Baseline Design Criteria (Continued)

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- Utility Services
  - Implemented Through ISA, HVAC, Utility, and Electrical Design Criteria and Site WTA's
  - Continuous Operation of IROFS Where Appropriate
  - Two Off-site Power Supplies
  - Standby Diesel Generators
  - Emergency Diesel Generators
  - Un-interruptible Power Supplies

Baseline Design Criteria (Continued)

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- Inspection, Testing and Maintenance
  - Programmatic
    - Identified Through Design Review Process, QA Program and per Vendor Recommendations
    - Implemented Through Design Procurement Specifications and Operations and Maintenance Manual
    - Incorporates La Hague inspection and testing experience
  - Examples:
    - Glovebox Design Maximizes the Placement of Prime Movers External to Glovebox
    - Glovebox Design Based on Large Window Surfaces and Multi-glove Ports to Facilitate Accessibility for Inspection and Maintenance

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Baseline Design Criteria (Continued)

- Criticality Control
  - Implemented Through Nuclear Criticality Safety Design Criteria
  - Design Ensures Criticality Events Are Highly Unlikely
  - Double Contingency Principle Applied
  - Control Mode Hierarchy Established
  - Nuclear Criticality Safety Evaluations Performed

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Baseline Design Criteria (Continued)

- Instrumentation and Controls
  - Implemented Through Instrumentation and Controls Design Criteria and Operations and Maintenance Manuals
  - Design Provides for Monitoring and Controlling IROFS
  - Independent and Redundant Controls for IROFS
  - Automated Digital Process Controls Utilized
    - IROFS (i.e. fail safe) as appropriate
    - Limits dose and human error
    - Enhances product quality
    - Reliability and predictability ensured

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MFFF Design Basis

Key Functional Categories

Bill Hennessey

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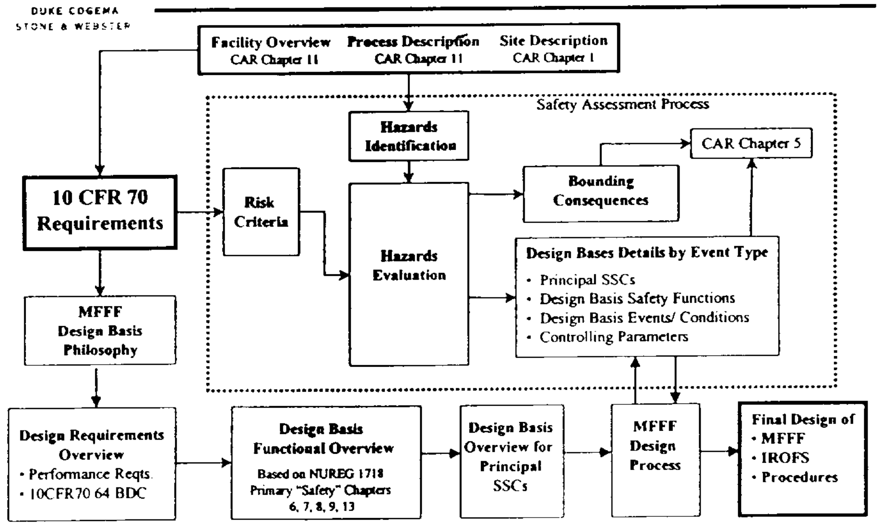
Presentation "Roadmap"

Design Bases Discussion



MFFF Design Basis

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Key Functional Categories

- Nuclear Criticality Safety (SRP Section 6)
- Fire Protection (SRP Section 7)
- Chemical Safety (SRP Section 8)
- Radiological Safety and Protection (SRP Sections 5 and 9)
- Safeguards and Security (SRP Section 13)

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Nuclear Criticality Safety

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- **Design Requirements Overview**
  - Criticality Events are Prevented
  - Double Contingency Principle Applied
  - Fissile Medium Clearly Identified
  - Criticality Control Modes Selected
  - Appropriate Criticality Benchmark Experiments will be Employed for each Type of Physical Situation
  - Criticality Monitoring Systems Included

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Nuclear Criticality Safety

Criticality Control Mode Selection

Primary Modes	Secondary Modes
Geometry Control	Density
Moderator Control	Process Variables
Mass Control	Isotopics
Concentration Control	Reflection
Neutron Absorption	Interaction
	Volume
	Heterogeneity

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Nuclear Criticality Safety

Criticality Monitoring

- CAAS installed in areas containing high SNM quantities per 10CFR70.24
- Coverage provided by two sets of detectors per Regulatory Guide 3.71
- Sensitivity requirements based on 10CFR70.24
- Design criteria based on ANSI/ANS-8.3
- Controlled under MPQAP and QA Procedures

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Nuclear Criticality Safety

Key Design Basis Events/Conditions

- Material Storage
- Material Handling / Processing
- Equipment Malfunction
- Operator Procedural Error
- External Events

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Fire Protection

Design Requirements Overview

- Any potential fire is constrained to fire area
- Incorporate fire prevention measures in the MFFF
- Include design features to mitigate consequences of internal fire events
- Ventilation system that prevents release of nuclear materials during fire events
- Incorporate monitoring systems for early and reliable fire detection
- Fixed and mobile fire suppression systems
- Fire fighting team, equipment and training

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Fire Protection

Fire Area Design Requirements

- Fire Area Purpose
  - Separation and spread prevention
- Fire Area Boundary Design
  - Presence of combustible and nuclear materials
  - Location of IROFS
  - Location of detection/suppression systems
  - Fire Barriers
- Ventilation System
  - High Temperature Fire Dampers At Area and Glovebox Inlet and Exhaust
  - Air Stream Dilution Before Filters

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Fire Protection

Key Design Basis Events/Conditions

- Material Storage Area Fire
- Equipment Failure Leading to Fire
- Electrical Overload Fire
- Fire Detection System Failure
- Fire Duration

Chemical Safety

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Design Requirements Overview

- Chemicals used in AP for Purification (dissolution, purification, precipitation) & Recovery (sovents, acids, silver)
  - solids: silver nitrate, manganese nitrate
  - liquids: nitric acid, hydrogen peroxide, tributyl phosphate, oxalic acid, sodium carbonate, hydrazine, dodecane, hydroxylamine nitrate, sodium hydroxide
  - gases: dinitrogen tetroxide
- Chemicals used in MP for pellet production and lubricant
  - azodicarbamide (poreformer) and zinc stearate
- Most chemicals stored and mixed in reagents building (BRP) and piped to AP
  - no licensed material in BRP
- Off-gas system: treats, filters, releases chemical vapors

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Chemical Safety

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Design Requirements Overview

Chemical Material Risks:

- Fire hazard: solvents, diluents, hydrogen/oxygen
- Explosion hazard: gases, 'red oil', hydrafoic acid
- Corrosion
- Toxicity

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Chemical Safety

Key Design Basis Events/Conditions

- Process Operations, Upset
- Process Equipment I&C Malfunction
- Material Handling or Storage Error
- Chemical Interaction
- Off-Gas System Failure

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Radiological Safety/ Radiological Protection

Design Requirements Overview

- Primary MFFF hazard is Pu ~~ingestion~~ inhalation
- MFFF design prevents plutonium migration and dispersal from process equipment, glove boxes, and final product
- Primary features are static barriers and ventilation systems
- Primary and secondary confinement principles applied
- Continuous activity detection and personnel monitoring systems used

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Radiological Safety/ Radiological Protection

Design Requirements Overview

- Secondary MFFF hazard is external exposure
- External exposure hazards addressed separately from Pu exposure through industry standard practices:
  - exposure time and distance limitation
  - biological shielding as necessary
  - equipment maintainability
  - exposure level monitoring
  - COGEMA facility experience

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Radiological Safety/ Radiological Protection

Confinement Systems:

- The first (primary) confinement system comprises glove box systems and vessels, tanks and piping for aqueous polishing, and the very high depressurization exhaust system
- The second (secondary) confinement system comprises rooms and associated ventilation exhaust systems that filter any potential release of hazardous material from the primary confinement

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Radiological Safety/ Radiological Protection

Key Design Basis Events/Conditions

- Shielding Design
- Rad Zone Maps/HP Surveys
- Ventilation System Failure
- Material Handling Accident
- Normal MOX Process Malfunction

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Safeguards and Security

- **Information not intended for public disclosure pursuant to 10CFR2.790**

- Information to be discussed in separate closed session

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Design Basis Overview for Principal SSCs

All

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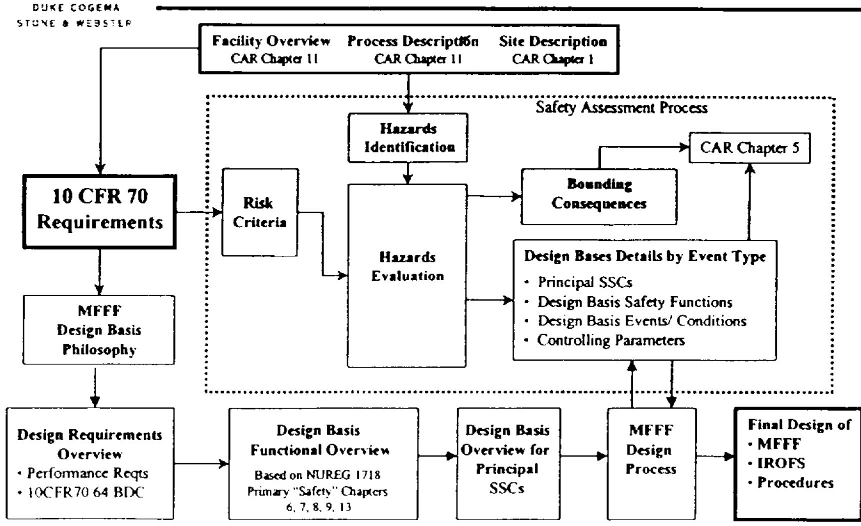
DUKE COGEMA STONE & WEBSTER

Presentation "Roadmap"

Design Bases Discussion



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Design Basis Overview for Principal SSCs

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Principal SSC Categories

- Civil/Structural
- Electrical
- Mechanical
- Radiological Safety and Criticality
- Environmental
- Human Factors

Design Basis Overview for Principal Civil/Structural SSCs

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- Principal SSCs
  - MFFF Buildings and Structures
  - EDG Building
  - Missile Barriers
- Design Basis Functional Requirements
  - Protect SSCs from loads associated with NPH events
  - Protect EDG components from NPH events

Electrical Distribution System

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Description of SSC's

- Two normal sources of power
- Source of Standby power
- 2 Redundant and Independent Emergency Electrical Systems
  - Emergency Diesel Engine Driven Generators
  - Emergency Switchgear, 4160V and 480V Switchgear
  - 120V UPS

Electrical Distribution System

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Basis of Design

- Provide highly reliable source of power to IROFS
- Power available under all natural phenomena conditions
- Independent and redundant power sources for IROFS

Design Basis Overview for Principal Mechanical SSCs

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- Principal SSCs/Functional Requirements
  - C4 Confinement System
    - Maintain Negative Pressure for small breach
  - C3 Confinement System
    - ~~Prevent~~ Mitigate all releases from C4 and C3 areas
  - Fire Barriers
    - Contain fire within fire area
  - Isolation Function for Support Systems

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Design Basis Overview for Principal Nuclear Safety & Criticality SSCs

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- Principal SSCs
  - Confinement Systems
  - Criticality control systems
- Design Basis Functional Requirements
  - Minimize exposure and prevent criticality events
  - Details covered elsewhere

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Design Basis Overview for Principal Environmental Protection SSCs

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- Principal SSCs
  - C4 Confinement Systems
- Design Basis Functional Requirements
  - Limit releases to prevent public exposures above allowable limits
  - Environment Environmental release criteria [§70.61(c)(3)]
  - stated in terms of intermediate consequence events
  - effluent releases exceeding 5000 times Table 2 values of 10 CFR 20 App B must be made at least unlikely

Design Basis Overview for Principal Environmental Protection SSCs (contd.)

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- Safety analyses calculate 24-hour average effluent concentration for all postulated releases
  - some postulated unmitigated events exceed environmental criterion but not intermediate public exposure criterion
  - in all cases, unmitigated site worker exposure is more limiting than the environmental effluent concentration
- Conclusion
  - SSCs required for site worker criterion prevent/ mitigate environmental release to below the limit
  - no SSCs identified as required uniquely to prevent/ mitigate environmental release

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Design Basis Overview for Human Factors Engineering

- IEEE-~~1012~~ 1023 and NUREG 0700 Guidelines Used
- Replication of Existing Facilities
  - Allocation of functions
  - Organization of plant information
  - Staffing
  - Input to preliminary design
- HFE During Detailed Design
  - Task descriptions developed
  - HFE criteria applied as part of "Americanization" tasks
  - Formal HFE review of the detailed design conducted prior to design completion

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MFFF Design Detail Discussion

Dick Berry

MFFF Design Bases Discussion

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Design Basis - Detail Discussion

- Principle SSCs
- Design Basis Safety Functions
- Design Basis Events/Conditions
- Controlling Parameters

Presentation "Roadmap"

Design Bases Discussion

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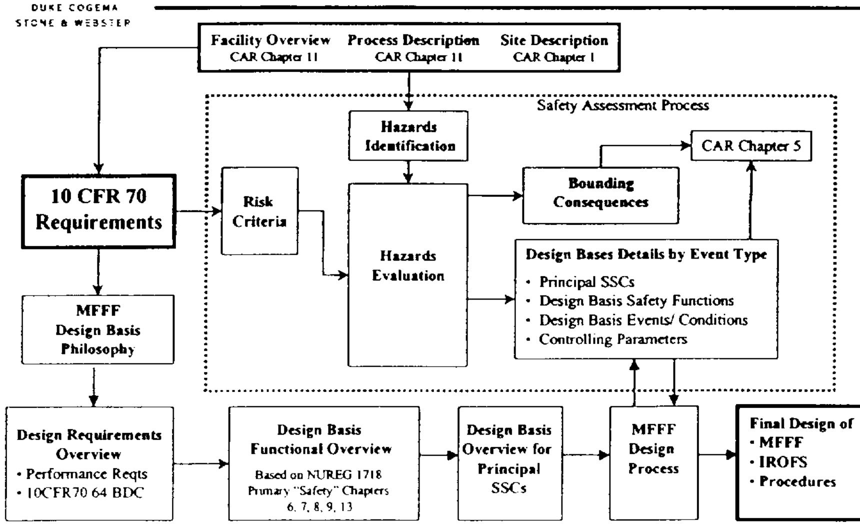

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Design Basis Event Categorization

Event Types:

- Internal Fire Events
- Internal Explosion Events
- Loss of Confinement/Dispersion Events
- Criticality Events
- Direct Radiation Exposure Events
- Natural Phenomenon
- Man Made External Events
- Load Drop Events
- Chemical Release Events

Design Basis Detail Discussion

Design Basis Event Type :

Internal Fire Events

Event Type Description:

The design basis fire is a conservative determination of the most severe fire which could credibly occur within each fire area. The design basis fire is contained within the designed fire area by the installed fire barrier systems. No credit is taken for the availability or operation of fire suppression, detection, and inert glovebox systems or for the action of the fire brigade to prevent the spread of the fire.

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Design Basis Detail Discussion

Design Basis Event Type: **Internal Fire Events**

Principle SSCs (Key Examples)	Design Bases Safety Function	Design Basis Event or Condition	Controlling Parameters
MFFF Structure	MFFF is designed with multiple fire areas to limit the size of a fire within the facility and to ensure all smoke is filtered	Credible Internal Fire Event	Defined fire areas based on location of safety SSCs and availability/inventory of combustible materials
C3 Confinement Ventilation System	Filter potentially contaminated smoke	Credible fire occurring in area containing material at risk	10E-2 to 10E-4 Filter effectiveness for each design basis fire Redundant C3 exhaust powered from emergency bus
Fire Barrier System – Barrier Walls	Prevent the spread of fires from established fire areas	Credible fire occurring in area containing material at risk	Bounding fire event duration based on maximum available combustibles (2 – 3 hr fire rating)
Fire Barrier System – Fire Dampers (supply air to room)	Restrict the release of degrading chemicals released by or resulting from a fire event to assure effectiveness of mitigating confinement filters	Credible fire occurring in area containing material at risk	Manually or automatically closed based on detection
Fire Barrier System – Fire Dampers (room exhaust)	1.Remain open to support operation of C3 confinement 2. Capable of being manually closed	Credible fire occurring in area containing material at risk	High differential pressure across final filters High exhaust temperature
Worker Training and procedures	Ensure compliance with fire protection program regarding material storage, plant modifications, and maintenance of fire barriers	Credible fire occurring in area containing material at risk	Administratively controlled maximum quantities and locations for combustibles
3013 Canister	Prevent radiological release from stored Pu Oxide powder areas to workers or public during the design basis fire	Credible fire occurring in area containing material at risk	Combustible loading to ensure fire rating of 3013 canister is not exceeded

Design Basis Detail Discussion

Design Bases Event Type :

Internal Explosion Events

Event Type Description:

Internal explosion events within the MFFF are a hazard due to the presence of potentially explosive mixtures and over-pressurization events. Such events are prevented. To reduce the risk associated with this event group, a mitigation safety strategy is adopted.

Design Basis Detail Discussion

Design Basis Event Type: **Explosion Events**

Principle SSCs (Key Examples)	Design Bases Safety Function	Design Basis Event or Condition	Controlling Parameters
Hydrogen Mixture Preparation Controls	Ensure non-explosive mixture of hydrogen is introduced into the process	Hydrogen Explosions	Hydrogen-Argon ratio
Hydrogen Mixture Composition Monitoring	Ensure potential changes to the composition of the hydrogen are detected prior to exceeding limits	Hydrogen Explosions	Hydrogen content
Process Safe Shutdown Controls	Ensure the flow of hydrogen is terminated prior to the attainment of explosive conditions	Hydrogen Explosions	Hydrogen content
AP Process Off-Gas System	Provide passive exhaust path to ensure explosive build-up of hydrogen does not occur	Radiolysis Induced Explosions	Hydrogen generation rate
Dilution Air System	Provide sufficient air-flow to dilute the dydrogen produced by radiolysis such that an explosive conditions do not occur	Radiolysis Induced Explosions	Hydrogen generation rate
Waste Containers	Ensure hydrogen buildup in excess of limits does not occur	Radiolysis Induced Explosions	Hydrogen generation rate
Process Safe Shutdown Controls	Shutdown process prior to exceeding temperature or concentration limits	Hydrazine/Hydrazoic Acid Explosion	Temperature, Concentration

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Design Basis Detail Discussion

Design Basis Event Type: **Explosion Events (contd.)**

Principle SSCs (Key Examples)	Design Bases Safety Function	Design Basis Event or Condition	Controlling Parameters
Temperature Controls	Ensure temperature conditions conducive to a hydrazine/hydrazoic acid explosion are not reached	Hydrazine/Hydrazoic Acid Explosion	Temperature
Concentration Control	Ensure hydrazine and hydrazoic acid concentrations are controlled to within safety limits	Hydrazine/Hydrazoic Acid Explosion	Concentration
Concentration Control	Ensure concentrations of hydrogen peroxide do not exceed 75 weight percent	Hydrogen Peroxide Explosion	Hydrogen peroxide concentration
Temperature Controls	Ensure temperature conditions conducive to an explosion are not reached	Hydrogen Peroxide Explosion	Hydrogen peroxide temperature
Process Safe Shutdown Controls	Shutdown process prior to exceeding concentration or temperature limits	Hydrogen Peroxide Explosion	Hydrogen peroxide concentration and temperature
Concentration Controls	Ensure concentrations of ammonia, nitric acid, and oxidizing agents do not accumulate in appreciable quantities	Solvent Explosions	Reagent Concentration
Process Safe Shutdown Controls	Shutdown process prior to exfeeding concentration or temperature limits	Solvent Explosions	Concentration and temperature

Design Basis Detail Discussion

Design Bases Event Type :

Loss of Confinement/Dispersion Events

Event Type Description:

The design basis for the confinement system is to maintain continuous confinement of nuclear material during all normal, upset and accident contitions. The following are design basis requirements for the MFFF confinement system:

1. **Except for material contained in fuel assemblies, sealed fuel rods and DOE Standard 3013 welded containers, the confinement design will normally consist of Primary, Secondary and Teritary Confinement.**
2. **The Primary annd Secondary Confinement Systems are classified as Quality Level 1, Items Relied Upon For Safety. They are qualified to operate during Design Basis Events.**
3. **The Primary and Secondary Confinement Systems are seismically qualified, redundant (active components), independent and are powered form emergency power supply.**
4. **Gloveboxes are designed to maintian a face velocity of 125 fpm through an opening equal to two 8 inch diameter gloveports or a single bagout port.**

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Design Basis Detail Discussion

Design Basis Event Type: **Loss of Confinement/Dispersion Events**

Principle SSCs (Key Examples)	Design Bases Safety Function	Design Basis Event or Condition	Controlling Parameters
Primary, secondary and tertiary (C4,C3,C2) confinement systems	Maintain releases within allowable limits during normal operations.	Normal Operations	Maintain -1.4 in. WG glovebox pressure relative to room. For C3 rooms, maintain -0.72 in. WG relative to atmosphere. For C2 areas, maintain 0.32 in. WG.
MFFF Building Structure	Protect the Primary and secondary confinement system from Natural Phemonema Hazards and External Events	Earthquakes, Tornado, TornadoMissiles, release form other facilities	Design of MFFF structure C3 and C4 systems for design earthquake. Design of MFFF Structure for the effects of a Tornado
Glovebox pressure controls	Maintain glovebox pressure within design limits	Over or under pressure	1. Glovebox vacuum breakers open at -4.0 in WG 2. Glovebox dump valves open at –0.8 in. WG.
C3 Confinement System	Provide filtration to mitigate dispersions	Any release from C4	C3 Normal operations
Process Temperature Controls	Shutdown process (electrolyzer) prior to exceeding a temperature limit	Malfunction of the temperature controller	High temperature limit for the electrolyzer.
C4 Confinement	Maintain negative glovebox pressure through a design bases breach	Two 8" glove ports or a bagout port opening	Maintain 125 fps across opening
Power to C3 and C4 Confinement Systems	Provide backup power supply if normal power is lost	Loss of normal power coincident with a NP hazards (earthquake, tornado, etc.)	1. C4 is powers from UPS which is charged by Emergency Diesels. 2. C3 is powers from Emergency Diesels.

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Design Bases Event Type Review

Design Bases Event Type :

Criticality Events

Event Type Description:

As required by 10CFR 70.61 (d), the facility is designed to preclude any criticality accident. This is achieved by implementing the double contingency principle.

Specific techniques include:

- Preventive measures taken in normal operations
- Corrective action to avoid reaching maximum permissible conditions in the event of a malfunction
- Measures taken with regard to other hazards to preclude criticality in any design situation (fire, earthquake, flooding, etc.).

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Design Basis Detail Discussion

Design Basis Event Type: **Criticality Events**

Principle SSCs (Key Examples)	Design Bases Safety Function	Design Basis Event or Condition	Controlling Parameters
Mass Measurement Instrumentation	Maintain mass within acceptable limits under all conditions	Criticality - All modes of Operation	1. Mass limit per unit 2. Direct weighing and/or mass balances
SSCs used to limit moderation	Limit moderation within acceptable limits under all conditions	Criticality - All modes of Operation	1. Exclusion of fluids from process rooms unless necessary for process 2. Control of organic products to powder 3. Maintaining a double barrier between fissile material and moderator
Geometry safe equipment SSCs	Maintain geometry within acceptable limits under all credible loads and process conditions	Criticality - All modes of Operation	1. Equipment dimensions accounting for possible deformation due to earthquake, corrosion, etc. 2. Critically safe leak collection for chemical process vessels 3. Mechanical design of containers to avoid mix-ups
SSCs used to limit and detect concentration	Maintain fissile material concentration within acceptable limits under all conditions	Criticality - All modes of Operation	PUO2 concentration and interlocks
Neutron Absorbers	Used in conjunction with geometry control to meet acceptable dimensional limits	Criticality - All modes of Operation	1. Dimensions and material composition 2. Protection against high temperatures, siesmic designs 3. Surveillance during operations

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Design Basis Detail Discussion

Design Basis Event Type :

Direct Radiation Exposure Events

Event Type Description:

- The dose equivalents received by plant personnel will meet 10CFR 20 requirements
- The design goal for the facility is to limit worker's whole body dose equivalent to less than 0.5 rem/year (10% of the 10CFR 20 requirement).
- Weapons grade Pu in the MFFF will result in lower exposures than MELOX which uses reactor grade Pu
- No specific principal SSCs have been identified for this event. All external exposures are controlled through the application of a radiation protection program, which is designed to limit all exposures to personnel during normal, off-normal, and accident conditions. Accordingly, no specific design basis events have been selected.

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Design Basis Detail Discussion

Design Basis Event Type: **Direct Radiation Exposure Events**

Principle SSCs (Key Examples)	Design Bases Safety Function	Design Basis Event or Condition	Controlling Parameters
Radiological Protection Program	Prevent operator from receiving unacceptable dose consequences	Direct Radiation Exposure - All modes of Operation	N/A
Controlled access to high or very high radiation areas	Meet 10CFR part 20 requirements	Abnormal maintenanceDirect Radiation Exposure - All modes of Operation	1. Locked entrance 2. Controlled maintenance activity

Design Basis Detail Discussion

Design Bases Event Type :

Natural Phenomena Events

Event Type Description:

Extreme natural phenomena events including earthquakes, extreme winds, floods and tornado missiles are included in the design of items relied upon for safety where applicable. Loss of normal power is assumed to occur.

Design Basis Detail Discussion

Design Basis Event Type: **Natural Phenomena Events**

Principle SSCs (Key Examples)	Design Bases Safety Function	Design Basis Event or Condition	Controlling Parameters
MFFF Building and Emergency Diesel Building	Protect SSCs from the effects of NPH	Credible NPH conditions	1. Design 2. Earthquake 3. Design Tornado 4. Design Tornado missiles
Tornado Dampers	Protect C4 and C3 confinement from differential pressure effects	Tornado induced pressure gradient	DP of 150 psf at 55 psf/sec
Seismic Detectors	• Trips normal and standby power during seismic event • Isolates gas and liquid supply to building	Design Earthquake	1. Seismic detector setpoints 2. Redundant isolation valves 3. Emergency power
C-4 and C-3 Confinement Systems	System shall remain operational during and following seismic events	Design Basis Earthquake coincident with a loss of off-site power.	SSCs qualifies for design earthquake.
C4 and C3 Confinement Systems	Remain operational during and following extreme winds	Design basis tornado, atmospheric pressure change	SSCs qualified for three second wind speed: 240mph
SSC required to meet double conti ngency principle for criticality prevention	Prevent ciriticality during NPH conditions	Design Earthquake or Design Floods coincident with a loss of normal power.	1. SSCs are enviornmentally qualified and seismically designed. 2. Probable Maximum Flood: 224.5ft MSL Lite Grade: 270ft MSL (approx) 3. Loss of normal power to the Normal process results in a safe condition.

Design Basis Detail Discussion

Design Basis Event Type :

Man Made External Events

Event Type Description:

- Man-made external events include hazards (e.g., explosions, fires, hazardous releases, missiles, loss of offsite power, etc.) that arise from:
  - Failure of nearby retaining structures
  - Operation of nearby pipelines or facilities (e.g., public, private, government, industrial, chemical, nuclear, military, etc.)
  - Operation of transportation vehicles (e.g., cars, trucks, trains, aircraft, barges, ships, etc.)
- These events and associated postulated hazards have been screened and only loss of offsite power and fires have the potential to affect MFFF operations. During external fires it is assumed that loss of offsite power occurs.

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Design Basis Detail Discussion

Design Basis Event Type: **Man Made External Events**

Principle SSCs (Key Examples)	Design Bases Safety Function	Design Basis Event or Condition	Controlling Parameters
• MOX Fuel Fabrication Building Structure • Emergency Generator Building Structure	• Withstand effects of the design basis external fire • Provide protection for internal IROFS SSCs from the effects of heat, fire and smoke	Design Basis External Fire	1. IROFS structures and associated penetration fire barriers qualified for exposure to postulated environmental conditions 2. Isolation capability of ventilation normal and emergency air supplies
MFFF Ventilation Systems	Ensure habitable conditions for facility operators	Design Basis External Fire	1. Continuous operation of ventilation C3 and C4 exhaust confinement systems 2. Isolation capability of ventilation normal and emergency air supplies 3. Separate charcoal filtered air supply for emergency control rooms
• Emergency Diesel Generators • Un-interruptible Power Supply	IROFS SSCs and associated support systems are provided backup or auxiliary power to assure they are capable of performing their safety function	Loss of Offsite Power	1. Isolation from normal electrical system 2. Automatic start 3. 7 day diesel fuel oil storage capacity 4. 1 hour battery capacity for fans (charged from emergency generators)

Design Basis Detail Discussion

Design Bases Event Type :

Load Drop Events

Event Type Description:

The Design Basis load Handling Events are a conservative determination of the most sever possible load handling accidents which could occur as a result of equipment malfunctions.

Risks related to load handling arise from:

- **Possible damage to loads or targets containing nuclear materials, resulting in a risk of criticality or dispersal of radioactive material,**
- **Possible damage to equipment providing safety functions.**

Handling operations taken into account in the analysis include those necessary for the operations of plant facilities (e.g. transfer of sintering boats, baskets, pellet trays, fuel assemblies) and for maintenance and special interventions.

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Design Basis Detail Discussion

Design Basis Event Type: **Load Drop Events**

Principle SSCs (Key Examples)	Design Bases Safety Function	Design Basis Event or Condition	Controlling Parameters
C4 Confinement System	Maintaining Glovebox integrity for design basis impacts	Design Basis drop event	Maintain confinement integrity for design basis impacts
Load Handling Controls	Prevent impacts to the glovebox that exceed design basis	Design Basis Drop Event	Maintain confinement integrity for design basis impacts
3013 Containers	Maintain integrity following a design basis drop	Container drop during normal handling	Lift height - qualifies for 30 foot drop
C3 Confinement Systems	Filter releases into the C-3 areas	Breach in C4 system caused by load drop event	Operation of the C3 system

Design Bases Event Type Review

Design Bases Event Type :

Chemical Release Events

Event Type Description:

Chemical hazards at the MFFF exist as a result of the storage and active use of chemicals that may cause toxic releases, explosions, fires and corrosion events potentially involving radioactive material.

Unmitigated causes considered for chemical events that result in the release of a toxic chemical at the MFFF buildings include:

- Mechanical failure of a vessel, tank, or pipe containing pure chemicals
- Over temperature or pressurization of a vessel, tank, or pipe containing pure chemicals
- Corrosion failure of a vessel, tank, or pipe containing pure chemicals
- Failure of a ventilation system that scavenges potentially toxic chemicals from vessels
- Incorrect chemical addition resulting in a chemical reaction
- Drop of a container containing a hazardous chemical
- Impact of natural phenomena hazards (NPH) on the Reagents Preparation Building (BRP)

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Design Basis Detail Discussion

Design Basis Event Type: **Chemical Release**

Principle SSCs (Key Examples)	Design Bases Safety Function	Design Basis Event or Condition	Controlling Parameters
Process safe shutdown/Isolation Controls	Shutdown process prior to exceeding concentration or temperature limits	AP/MP Building Chemical Fire/Explosion	Temperature set point
MFFF Ventilation systems	Ensure habitable conditions for operators Ensure principal SSCs are not adversely affected by toxic chemicals	Internal Chemical Leak or Spill Events Chemical Release External to AP/MP Building	TEEL Limits
Separate supply air intakes with charcoal filters for emergency control rooms	Ensure habitability in Emergency Control Rooms	External Chemical Release Jeopardizes Normal Operation and Operations Control Rooms	Separate Control Intakes with Charcoal Filters

Latter Phase of Integrated Safety Analysis