



# DOE-ID Review of the Materials and Fuels Complex Documented Safety Analysis

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# Introduction

- ◆ **Background**
- ◆ **Review team**
- ◆ **Regulatory basis for review**
- ◆ **Review methodology**
- ◆ **Results**
- ◆ **Recommendations**
- ◆ **Lessons Learned**



## Background

- ◆ **The Materials and Fuels Complex (MFC) transitioned from DOE-CH to DOE-ID for management in October 2004.**
- ◆ **Battelle Energy Alliance (BEA) began management of MFC in February 2005.**
- ◆ **Former Argonne National Laboratory-West (ANL-W, now Materials and Fuels Complex) nuclear safety documents were reviewed by an independent group of nuclear safety professionals associated with BEA and DOE-ID (DOE-ID 2005).**
- ◆ **The reviews indicated that the state of ANL-W nuclear safety documentation did not fully satisfy the requirements of 10 CFR 830, Subpart B.**



## Background (cont)

- ◆ **May 2005, BEA submitted to DOE-ID an action plan to upgrade deficient DSA reports**
- ◆ **The total estimated cost for upgrades ~ \$11.8M**
- ◆ **Concern expressed by DOE-HQ regarding the validity of the estimate**
- ◆ **December 2006, DOE began a focused review of the current MFC safety basis documentation and controls**



# Review Team

- ◆ **Team Lead – Bob Boston, Reactor Technology Complex Team Lead**
- ◆ **Senior Technical Advisor – Tom Wichmann, STA Quality and Safety Division**
- ◆ **Nancy Buschman - Office of Nuclear Energy Laboratory Facilities Management, Program Manager MFC**
- ◆ **Jacquelyn Carrozza: DOE-ID, Quality and Safety Division, Nuclear Safety Specialist**



## **Review Team (cont)**

- ◆ **Jeff Perry: DOE-ID Programmatic Environmental Impact Statement, Program Manager**
- ◆ **Matt Hutmaker: Office of Nuclear Energy Facilities Management, Team Leader**
- ◆ **Kenn Kellar: Office of Nuclear Energy Facilities Management, Nuclear Engineer**
- ◆ **Christian Natoni: DOE-ID MFC, Facility Engineer**



## **Contractor Advisors**

- ◆ **Wray Landon: Director of INL Nuclear Technical Services**
- ◆ **Salvador Mascarenas: Project Manager for MFC SAR Upgrades Project**
- ◆ **Dr. Brad Schrader: INL Homeland and National Security Directorate, Vulnerability Assessment Analyst**



## Regulatory Basis

- ◆ **Nuclear Safety Management, 10CFR830, requires Documented Safety Analysis (DSA) reports and Technical Safety Requirements (TSRs) be prepared using a methodology approved by DOE or as set forth in Table 2 of Appendix A of Subpart B, *Safety Basis Requirements*.**



## Regulatory Basis (Cont)

- ◆ **DOE expects that contract provisions will be used to provide more detail on implementation of safety basis requirements such as preparing a documented safety analysis, developing technical safety requirements, and implementing a USQ process.**
- ◆ **DOE-ID has provided supplemental guidance to BEA which:**
  - elaborates on the hazard categorization process;
  - the identification of safety structures, systems and components (SSCs); and
  - the development of technical safety requirements for the mitigation and prevention of hazards for worker and public safety.



## Regulatory Basis (Cont)

- ◆ DOE-ID supplemental information also provides for implementation of a graded approach in nuclear safety document development.
- ◆ This allows BEA to select the controls and verifications to be applied to various items and activities consistent with their importance to safety, cost, schedule, and success of the program.
- ◆ Safety Class SSCs are those SSCs for which credit must be taken in the DSA, either preventive or mitigative, in order to meet the DOE-ID supplemental guidance EGs for the off-site public.
- ◆ The Safety Significant SSCs for worker safety can be limited to those which prevent or mitigate postulated abnormal events in the “anticipated” or “unlikely” frequency range which could result in consequences to on-site workers



# Review Methodology

- ◆ **Determine the upgrade priority for each HC 2 facility.**
- ◆ **For each facility, determine the accuracy and extent of the nuclear source term as described in the DSA.**
- ◆ **Evaluate the hazards list for completeness.**
- ◆ **Evaluate the hazards and accident analysis to ensure the major categories of design basis accidents have been adequately addressed.**
- ◆ **Determine the appropriate safety SSCs.**
- ◆ **Determine if there are adequate supporting TSRs.**



# Methodology - Prioritization

- ◆ DOE STD 1027-92 sum-of-ratios determined multiplied by the dose consequence of one REM at 100 meters
- ◆ This value was then multiplied by number of workers located at each facility providing the facility risk baseline in person-REM
- ◆ The baseline number was multiplied by the Nuclear Regulatory Commission (NRC 1995) mitigation value of \$3000/person REM to define the base facility rank.
- ◆ Each facility design basis accident dose consequence was evaluated in the same manner and compared to the baseline. The higher of the two numbers was used.
- ◆ Facility program funding was added to this basis as an indicator of mission and activity.
- ◆ Professional judgment was used as necessary to refine the ranking.



# Methodology - Prioritization

## Facility Prioritization and Risk Ranking

	1	2	3	4	5	6	7	8	9	10	11
Facility	Hazard categorizati on sum-of-ratios	No. of in-facility and co-located workers	Column 1 * column 2	Column 3 * \$3000	Highest design basis accident consequence (from the SAR)	Column 2 * column 5 * \$3000	Higher value of columns 4 and 6	Current program/ mission need (note 1)	Prof-essional judgment (note 1)	Ranking value (add column 7 & 8)	Comparative rank Number
	(rem)	(#)	(person-rem)	(\$)	(rem)	(\$)	(\$)	(\$)		(\$)	(#)
NRAD	0.983	10	9.83	2.95e4	.024	Note 1	2.95e4	805K	Note 4	8.4e5	7
HFEF	15.30	10	153	4.6e5	7.09	Note 1	4.6e5	9339K	Note 3	9.8e6	3
SSPSF	30	10	300	9e5	1.8e-4	Note 1	9e5	8200K	Note 4	8.7e6	4
ZPPR	1316	7	9122	2.8e7	10	Note 1	2.8e7	580K	Note 2	2.85e7	2
TREAT	1.65	20	33	9.9e4	18	1.1e6	1.1e6	718K	Note 4	1.8e6	6
RSWF	163	7	1.14e3	3.4e6	0.37	Note 1	3.4e6	1820K	Note 4	5.2e6	5
FCF	398	14	5572	1.7e7	0.11	Note 1	1.7e7	9060K	Note 2	2.6e7	1

Note 1—The resultant design basis accident value (\$) was clearly less than the hazard categorization value so not calculated.

Note 2—Ranking based on highest radiological inventory.

Note 3—Ranking based on high radiological inventory and significant programmatic funding.

Note 4—Ranking based on current and/or anticipated programmatic input plus overall radiological inventory.



# Methodology - Prioritization

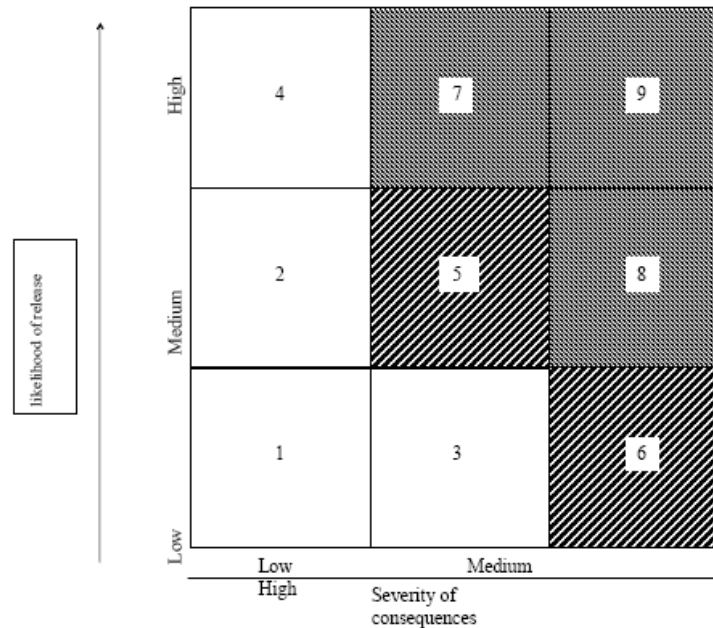
## Facility priority ranking:

1. **Fuel Conditioning Facility (FCF) and**
2. **Zero Power Physics Reactor (ZPPR)**
3. **Hot Fuel Examination Facility (HFEF)**
4. **Space and Security Power Systems Facility (SSPSF)**
5. **Radioactive Scrap Waste Facility (RSWF)**
6. **TREAT**
7. **NRAD**



# Methodology – Hazards Evaluation

- ◆ The review team developed a facility hazards evaluation table that was used to qualitatively determine the relative risk for the radiological hazards associated with each facility.





# Methodology – Hazards Evaluation

- ◆ Hazards risk ranked as a six, seven, eight, or nine generally require Technical Safety Requirements (TSRs), including specific administrative controls, or safety SSCs as mitigation.
- ◆ The radiological consequences from the accident analysis summaries were compared to the current Documented Safety Analysis, the MFC Hazard Assessment Document (EHA-70), and other DSAs and technical reports with similar hazards, conditions, and phenomena.
- ◆ The existing and review team proposed mitigations for these events were included in the analysis.
- ◆ A Technical Safety Requirements and a Design Feature comparison table was used to assess the adequacy of the existing control set and design features.



### FCF Hazards Evaluation

Hazard	Cause	Mitigation	Consequence	Frequency	Ranking	Comment
Radioactive material release	Dropped driver fuel assembly in Air-cell	Ventilation system remains intact	L	A	4	Analyzed in FCF DSA  Consequence – EHA-70  Frequency – Appendix A F0000-0018-AK  Clad is damaged (20 of 61 pins breached. 100% noble gases, EHA-70)
	Waste can drop in Air-cell	Waste can is sealed prior to transfer.  Ventilation system is in operation.	L	U	2	Analyzed in FCF DSA



### TSR Design Feature Comparison

<b>Design Basis Event</b>	<b>FCF DSA F0000-018-AK</b>	<b>MFC DSA Review Results</b>
NPH – Air-cell criticality caused by greater than design basis earthquake, stack damage, ground level release	None identified	Cell shield walls, fuel storage racks.
NPH – Argon Cell criticality caused by excessive fissile material	None identified	Cell shield walls, Cathode Processor
Radiological – Argon Cell manipulator seal failure	None identified	Manipulator seals



MFC PISA Issues	MFC DSA Review
PISA issue on the lack of analysis for facility worker consequences	Failure of the DSA to evaluate worker radiological dose consequences in the existing FCF DSA: With one exception, there was no evaluation of worker dose consequences.
PISA issue on the use of mitigated accident analysis	Mitigated accident analysis was used in the existing FCF DSA to determine active and passive safety SSCs and TSR level controls: Mitigated accident analysis was used. However, the control set may not be appreciably changed by re-analysis.
PISA issue on how material at risk versus facility inventory was calculated and facility hazard categorization conducted in accordance with the DOE standard	The FCF material at risk/hazard categorization may be questionable: The HC is adequate for FCF. However, the MAR for some of the design basis accident scenarios did not include actinides or transuranics. While the DSA discussed the isotope of concern being Cs-137 or Kr-85 and did not anticipate the contribution of transuranics to the worker or public dose, the current control set may be adequate.



# General Recommendations

- ◆ **INL must maintain rigorous conduct of operations, integrated safety management, training, and self-assessment programs.**
- ◆ **DOE-ID must maintain rigorous assessment and oversight of nuclear programs.**
- ◆ **There must be continued compliance with 10CFR830 Subpart B USQ regulatory requirements.**
- ◆ **Develop a long-term risk based plan to ensure that MFC DSAs conform to the requirements of 10CFR830 Subpart B. The priorities established in this report and the follow on Phase II review provide a basis for the risk based plan.**



# Recommendations

- ◆ **In-facility worker dose consequences should be evaluated for all nuclear facilities and analysis should evaluate the adequacy of existing protective measures.**
- ◆ **A limited subset of the CHCS controls should be elevated to the TSRs so that DOE approval (DOE risk acceptance) is obtained. Extensive re-analyses of criticality hazards should not be required.**
- ◆ **Active and passive safety SSCs should be identified, and appropriately incorporated into the DSA/TSRs in accordance with DOE guidance.**



# Recommendations

## ◆ The MFC DSA upgrades should be separated as follows:

- DSAs should be upgraded to include evaluations of in-facility worker dose and the subsequent TSR level controls (if any) that result from these evaluations. Where DSA references exist, it should be assumed by BEA and DOE that they are adequate.
- When DSA references can not be found to support the accident analysis and the ability of SSCs to carry out their function, these situations should be addressed as a focused design basis reconstitution (DBR). No assumption should be made that there exists a PISA due to lack of reference documentation.
- If a question arises regarding the current facility activities or a new activity that is to be performed in the facility and DSA reference(s) do not exist to support the activity, a justification for continued operation or a change to the DSA should be submitted to DOE.



# Recommendations

- ◆ **DOE-ID should review TREAT activities to ensure they are supported by the current DOE approved safety basis. (Current activities are only storage and training. The TREAT SAR written for and operating Rx).**
- ◆ **There appears to be vulnerabilities in the current DSAs regarding the ability of safety SSCs to carryout their function (specifically in regards to seismic qualifications and quality level). Where questions arise in this area, a graded approach should be used to qualify safety SSCs. Seismic qualification due to application of new standards should be treated as a DSA update.**
- ◆ **BEA should develop a plan to include the implementation of new standards (i.e. Natural Phenomenon Hazards [NPH]).**
- ◆ **The results of the Phase I and Phase II should be considered to re-evaluate the cost, scope, and schedule for the MFC upgrade plan NS-18308.**



# Lessons Learned

- ◆ **The Team members should be familiar with the facility description and accident analysis sections of the SAR/DSA prior to commencing the review.**
- ◆ **A tour of the facility should be conducted prior to review.**
- ◆ **The team should include operations or DOE Facility Representatives or contractor facility expertise**
- ◆ **The team should include personnel expertly familiar with 10CFR830 Subpart B.**
- ◆ **The team should include a subject matter expert that can perform real-time computer analysis of airborne radiological dispersion to derive worker and public dose consequences.**



## Lessons Learned

- ◆ **Prior to the review team members should gather appropriate references from other documented safety analyses. The references should be of facilities with similar source terms and physical conditions.**
- ◆ **Team size need only be four people. Each team should have a facility specific expert, a nuclear safety specialist, an airborne radiological dispersion SME, and a Senior Technical Advisor.**



## Lessons Learned

- ◆ **One of the team members should review the facility ORPS summary prior to convening the team.**
- ◆ **To adequately prioritize the DSA update and/or safety analysis upgrade, program and mission data (program funding, commitments to DOE corporate, the state, or other Federal agencies, customer agreements [work for others]) should be readily available to the team.**



# Conclusion

- ◆ **The review team concluded that no near-term vulnerabilities or imminent nuclear safety risks were identified in the MFC DSAs.**
- ◆ **Failure to upgrade these DSAs represents a significant vulnerability for the Department because of the difficulty in accurately conducting the Unreviewed Safety Question (USQ) process.**
- ◆ **Implementation of the recommendations contained within the Phase I and II reports can occur in a cost effective manner. The contractor should revise plan NS-18308 to show cost, scope, and schedule for achieving conformance with DOE-STD-3009.**



## Conclusion

- ◆ **DOE-ID and INL must maintain rigorous oversight and self-assessment of nuclear programs.**
- ◆ **The INL should develop a long-term risk based plan to ensure that MFC DSAs conform to the requirements of 10CFR830 Subpart B. The priorities and vulnerabilities established in the MFC DSA review provide a basis for the risk based plan.**



# Conclusion

- ◆ **Application of the USQ process to safety basis documents which do not comply with safe harbor provisions of the rule could lead to inadequate decisions by DOE on facility operations.**
- ◆ **As the Federal oversight for the safety of Idaho National Laboratory nuclear facilities, DOE-ID has an obligation to ensure that DSAs provide the appropriate level of protection to facility workers, the public and the environment.**
- ◆ **This obligation to safety must be risk informed so that overly conservative limits are not placed on facility operations.**



**Questions?**



# Regulatory Basis – supplemental slide

- ◆ **DOE G 424.1-2, *Implementation Guide For Use in Developing Documented Safety Analyses To Meet Subpart B Of 10CFR830.***
- ◆ **DOE G 423.1-1, *Implementation Guide For Use In Developing Technical Safety Requirements.***
- ◆ **DOE O 420.1B, *Facility Safety.***
- ◆ **DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports.***
- ◆ **DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports.***
- ◆ **DOE-STD 3007-93, *Guidelines for Preparing Criticality Safety Evaluations at Department of Energy Non-Reactor Nuclear Facilities.***
- ◆ **DOE-STD-1186-2004, *Specific Administrative Controls.***
- ◆ **Letter from Michael L. Adams to Ms. Lisa A. Sehlke, Subject: Contract No. DE-AC07-05ID14517–Nuclear Safety Rule Supplemental Information (OS-QSD-05-121), dated October 11, 2005 (DOE 2005a).**



# Fuel Conditioning Facility Description

- ◆ **The Fuel Conditioning Facility (FCF) is a hot cell facility.**
- ◆ **The current mission of the facility is research and development of the electro metallurgical treatment technology for the remote conditioning of spent metallic Experimental Breeder Reactor II (EBR-II) driver- and blanket-fuel assemblies.**
- ◆ **The major features of the hot cell facility are:**
  - wash stations,
  - an air-atmosphere cell
  - an argon-atmosphere cell and
  - a hot repair facility,



# Fuel Conditioning Facility Results

- ◆ **The source term/hazard categorization was found to be adequate.**
- ◆ **There are no near term vulnerabilities or imminent nuclear safety risks not identified in the FCF SAR.**
- ◆ **Under previous analysis the ventilation system should have been considered a safety significant SSC. However, reliance on the Safety Exhaust System (SES) may be an unnecessary programmatic risk.**



# Fuel Conditioning Facility Results

- ◆ **It was assumed that the seismic design basis for performance category 3 conditions was adequate (new response spectra generated in 2006). Previously portions of FCF were seismically qualified. The new information may impact the ability of the FCF to meet PC3 seismic design criteria.**
- ◆ **Criticality safety has been mitigated in the “Criticality Hazards Control Statement” (CHCS). However, the CHCS is not carried forward into the FCF SAR/TSR and may be overly cumbersome.**



## **FCF Recommendations for Conformance to 10CFR830 Subpart B**

- ◆ In-facility worker dose consequences should be evaluated.**
- ◆ Appropriate criticality controls should be carried forward into the SAR/TSR.**
- ◆ TSR controls should conform to DOE G 423.1-1.**
- ◆ Important non-active safety SSCs should be designated as passive SSCs in the FCF SAR/TSR.**
- ◆ The seismic robustness of FCF SSCs must be reconfirmed based on current site specific response spectra.**



# Zero Power Physics Reactor Description

- ◆ **The ZPPR is a split-table-type critical facility designed to model power breeder systems.**
- ◆ **In 1992, the ZPPR reactor was placed into non-operational standby. All fissile, moderator, reflector, and other reactor materials have been removed from the core.**
- ◆ **Current activities are limited to passive storage activities including, non-fissile ZPPR core materials, reactor equipment, experimental apparatus, and structural mockup materials.**
- ◆ **A corrugated steel panel covers the building.**



# Zero Power Physics Reactor Results

- ◆ **The source term/hazard categorization was found to be adequate.**
- ◆ **In-facility worker dose consequences have not been evaluated.**
- ◆ **Not all hazards have been discussed (e.g. wildland fires and flooding scenarios) or analyzed.**
- ◆ **There are unsupported controls in the current SAR\TSR.**
- ◆ **There are several SSCs that should be considered as passive design features in the TSR including the “bird cages,” the ZPPR building, and concrete storage bins.**



# Zero Power Physics Reactor Results

- ◆ **The review identified several facility systems that could be considered as safety significant or defense-in-depth SSCs in the TSR.**
- ◆ **The ZPPR DSA analyzed criticality controls in the facility “Criticality Hazards Control Statements.” Appropriate criticality controls were not further elevated into TSR controls**



## **ZPPR Recommendations for Conformance to 10CFR830 Subpart B**

- ◆ **In-facility worker dose consequences should be evaluated**
- ◆ **Appropriate criticality controls should be carried forward into the DSA/TSR**
- ◆ **TSR controls should conform to DOE G 423.1-1**
- ◆ **Important active and passive safety significant or defense-in-depth SSCs should be identified in the ZPPR DSA/TSR. Active SSCs identified include CAS, Mound Area Ventilation, Load/Fume Hood, and Radiation Area Monitoring system. Passive SSCs identified include “bird cages,” the ZPPR building, and concrete vault storage bins.**