MEMORANDUM
FEBRUARY 24, 2003

TO: Martin J. Virgilio, Director
Office of Nuclear Material Safety and Safeguards

FROM: Alexander P. Murray, Senior Chemical Process Engineer
Special Projects Section
Special Projects and Inspection Branch
Division of Fuel Cycle Safety and Safeguards

SUBJECT: DIFFERING PROFESSIONAL VIEW ON CHEMICAL CONSEQUENCES AT THE PROPOSED MIXED OXIDE (MOX) FUEL FABRICATION FACILITY
DOCKET NUMBER: 070-03098

Attached is the subject Differing Professional View (DPV). In summary, the DPV discusses chemical consequences from potential chemical events that both staff and the applicant acknowledge might have significant or even fatal consequences for some facility and site workers, with a "not unlikely" likelihood, and some additional radiation exposure. The prevailing management/staff and applicant positions are that potentially applicable sections of the regulations (Part 70; specifically 70.64) do not apply and, thus, these are not regulated by the NRC. My conclusion is this is too simple an interpretation that contradicts the regulations, prior NRC precedence, Standard Review Plans (SRPs), and the "General Duty" clause of the AEA. Consequently, safety issues may not be adequately addressed at the proposed facility. In addition, the burden of proof has not been placed on the applicant.

I request that (1) the management/staff decision accepting the applicant's position on these chemical events be reversed; (2) the applicant is requested to submit a safety strategy for addressing these events; and (3) NMSS establish consistent guidance for addressing the potential consequences from chemical events and facility conditions affecting the safety of licensed material. This is particularly applicable when the potential consequences could be severe, a radiation safety effect cannot be dismissed, there are many uncertainties in plant design, and/or the chemicals are there explicitly for the processing of licensed radioactive materials. Such guidance could be in the form of a Branch Technical Position (from the Fuel Cycle Facilities Branch) or a separate guidance document (say, a NUREG document).

I request that the DPV panel allows me the opportunity to clarify my views and provide additional information on this complex and important subject, as discussed in NRC Handbook 10.159. Also, per Handbook 10.159, I propose Walt Schwink as a qualified individual who can serve on a review panel for this DPV. Finally, I will continue to monitor the emphasis on the schedule and the issue closure process.

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1. Summary:

Prevailing NMSS Staff/Management Position: On the MOX Construction Application Review (CAR), management and some staff members have accepted the applicant's position that chemical effects that are not from licensed radioactive materials are not regulated by the NRC, even if they could impact the safe handling of radioactive materials, cause additional radiation dose or uptake, and/or result in high consequences, including fatalities. This position is not formally documented, is not followed by the NRC Branch (NMSS/FCFB) that regulates chemical consequences at existing fuel cycle facilities, does not address all of the NRC regulations in Part 70, is not consistent with the "general duty" clauses in the Atomic Energy Act (AEA) and regulations, is not consistent with the NRC-OSHA Memorandum of Understanding (MOU) on the subject, is not consistent with NRC's role as the lead regulator at facilities it licenses, and does not meet the review and acceptance criteria in the MOX Standard Review Plan (SRP). Unless addressed, these risk levels would significantly exceed the NRC's targets. In addition, the burden of proof has not been placed on the applicant.

DPV Position: (1) The MOX CAR review should use an approach that fully addresses the requirements of its regulations, that follows its guidance and precedence, and that regulates chemical safety and facility conditions which impact the safe handling of radioactive materials. Thus, the NRC should require prevention or mitigation features to address these potential events and require management measures to ensure they are available and reliable. The NRC should also acknowledge and consider in its evaluations that the design approach of the proposed MOX facility with multiple barriers, cells, contamination and confinement zones, and security will impede facility evacuation and emergency response to chemical events. Therefore, a "see and flee" approach is unlikely to be acceptable. (2) The MOX approach on chemical safety and "facility conditions affecting the safe handling of licensed material" should be formally documented, say in a Branch Technical Position. (3) NMSS should have clear guidance on addressing chemical effects at other facilities it regulates and for future license applications and amendments, particularly when the chemical effects are severe (including potential fatalities) and the potential impact upon the safe handling of radioactive materials is real but difficult to quantify in terms of dose.

Significance: If the prevailing management position is not reversed, chemical safety risks for the facility worker, the site worker, the public, and the environment that affect the safe handling of licensed radiative materials may not be identified and approaches for adequate safety measures (i.e., to reach acceptable risk levels) may not be implemented. Major injuries and/or fatalities could result to workers and the public from a potential event that the applicant assumes is "not

unlikely." Environmental cleanup from commingled chemical and radioactive contamination, and ensuing fires initiated by the chemicals, could be substantial. There would also be significant financial liabilities from actual injuries and deaths, insurance payments, likely litigation, repairs, and lost operations. There could also be international repercussions due to the agreements involved in plutonium disposition. This would negatively impact the NRC strategic goals of maintaining safety, improving regulatory effectiveness, and increasing public confidence. The potential news impact of such an event would be extremely critical of the NRC and could result in increased Congressional oversight.

2. The NRC, Chemical Safety, and the Regulations:

The NRC is the lead regulatory agency at its licensee facilities. The NRC regulates three main categories of chemical safety at its licensees: hazardous chemical effects from radioactive materials (e.g., for MOX, the chemical toxicity of depleted uranium), hazardous chemical effects from chemicals produced from radioactive materials (e.g., for MOX, nitric acid fumes from nitrate solutions or nitrogen tetraoxide releases via the oxidation column), and chemical hazards that affect the safe handling of radioactive materials (this is sometimes referred to as facility conditions affecting the safe handling of licensed radiative materials). In general, the NRC does not strictly regulate only chemical hazards. The NRC and OSHA have a Memorandum of Understanding (MOU) that outlines these regulatory responsibilities. However, for some facilities, the principal hazard is due to chemicals that are there only for radioactive materials processing and are indistinguishable from chemicals released from processing radioactive materials. Thus, in some cases and to address security concerns, the NRC has proposed interim compensatory measures (ICMs) for these chemicals and facilities.

For the proposed MOX facility, the principal governing regulation is 10 CFR Part 70 which also reiterates the chemical hazards regulated by the NRC: 70.61(b)(4), 70.61(c)(4), 70.62(c), and 70.64(a)(5) outline the three categories of chemical hazards the NRC currently regulates, simply put as:

Category 1: chemical hazards that are caused by the radioactive material,

Category 2: chemical hazards from chemicals released by radioactive materials, and

Category 3: chemical hazards that affect the safe handling of radioactive materials (essentially facility conditions in 70.64(a)(5)).

Chapter 8 of the MOX Standard Review Plan (SRP - NUREG-1718) also reiterates these three categories of chemical safety regulated by the NRC.

Part 70.62(c) (iii) further elaborates that the ISA (Integrated Safety Analysis) should identify facility hazards that could affect the safety of licensed materials and thus present an increased radiological risk. Finally, the chemical protection baseline design criterion in 70.64(a)(5) specifies that the design "must provide for adequate protection against *chemical risks produced from licensed material, facility conditions which might affect the safety of licensed material,* and

hazardous chemicals produced from licensed material." Note that a specific dose level is not specified for either the chemical or radiological effect in facility hazards and facility conditions.

Part 70 also contains a general safety statement:

70.23(b): "The Commission will approve construction of the principal structures, systems, and components of a plutonium processing and fuel fabrication plant ... when the Commission has determined that the design bases of the principal structures, systems, and components, and the quality assurance program, provide reasonable assurance of protection against natural phenomena and the consequences of potential accidents."

Note that this general statement has no restriction on potential chemical accidents; if such chemical accidents are possible, have high consequences, and present undue risk, then the applicant is required to provide reasonable assurance of protection against the consequences of such potential accidents.

In addition, the Atomic Energy Act (AEA) also contains general clauses "... to protect the health and safety of the public" (Section 2, paragraphs (d) and (e)). Section 161(b) states in part, "... to protect health or to minimize danger to life or property." Section 182(a) contains a similar statement.

Thus, the NRC regulates the three categories of chemical safety and, if there is sufficient risk from high consequence chemical accidents, the NRC also has the regulatory authority from the "general duty" clauses. In the review of the MOX application, the prevailing management/staff position does not appear to adequately consider the third category of chemical safety regulated by the NRC (i.e., chemical hazards affecting the safe handling of radioactive materials) nor the requirements of the general duty clauses. As elaborated upon below, there are potential events that can result in multiple incapacitations and fatalities with a "not unlikely" likelihood that the applicant has determined are unregulated. However, these events would appear to be in the third category of chemical safety regulated by the NRC and the general duty clauses and, thus, should be regulated by the NRC to provide for adequate protection and safety.

3. Overview of Chemical Consequence Documents and Events:

3.1 MOX Construction Application Request (CAR - DCS-NRC-000038):

The applicant submitted the CAR on February 21, 2001. The CAR approach has hazardous chemicals in three main areas and activities: the MOX fuel fabrication area of substantial construction (includes the main contaminated processing areas, with gloveboxes and cells), an immediately adjacent reagents building of simple construction, and chemical deliveries by vehicles. In addition, there is a separate gas storage area that could present an aphyxiation concern. No safety controls for chemical effects are identified apart from the air supply to the Emergency Control Room. The CAR indicates chemical effects to the public, site worker, and facility worker would be low, using the DOE TEEL consequence limits (pages 8-13 and 8-14). D class stability, a 4.5 m/sec wind speed, a rural terrain, and a leak from the largest container were assumed. In addition, the applicant stated on page 8-14 that principal structures, systems,

and components (PSSCs) defined for radiological events may be applicable to process units where chemicals mix with radiological material.

3.2 Argonne National Laboratory (ANL) Analyses on the Original Environmental Report - Late 2001:

ANL started evaluating chemical consequence effects from potential chemical releases in late 2001, starting with information supplied by the applicant's Environmental Report. ANL independently decided to use the ALOHA code for estimation of consequences after separately evaluating chemical release and evaporation rates. The ALOHA code is maintained and updated by NOAA and is funded by the EPA; the EPA routinely uses ALOHA for estimating consequences from chemical releases. ANL used F Class meteorology and a wind speed of 1.5 m/sec, as recommended by the EPA (40 CFR 68.22) for the minimum, worst case scenario. The results from using ALOHA showed significant chemical consequences beyond 100 meters for several chemicals, and estimates for nitrogen tetraoxide and hydrazine had the potential to exceed limits at the Savannah River Site (SRS) boundary some 5 miles away. Estimated concentrations for nitrogen tetraoxide indicate fatalities could result. ANL deferred additional work on the chemical consequence modeling until later in 2002 pending receipt of a Revised Environmental Report from the applicant that incorporated changes to the program made by the applicant (and DOE) in February 2002.

3.3 NRC Staff Analyses in the DSER - April 2002:

The staff had to address the apparent contradiction of the CAR analyses, which indicated no chemical concerns, and the preliminary ANL results, which indicated significant chemical consequences. The staff conducted several parametric analyses using the ALOHA code and obtained similar results to ANL; i.e., indicating the potential for significant chemical consequences. The results are summarized in Section 8 of the staff's Draft Safety Evaluation Report (DSER, NRC, April 2002) and in Table 1 here.

Table 1: Preliminary Analysis of Potential Chemical Impacts - Ambient Temperatures (using TEELs as guidelines; staff does not accept the use of TEELs)

Chemical	Exposure at 100 m, mg/m3	TEEL-1 mg/m3	TEEL-2 mg/m3	TEEL-3 mg/m3	Maximum Distance to TEEL Level, m		
					TEEL-1	TEEL-2	TEEL-3
N_2O_4	140,000	15	15	75	8,000	8,000	4,000
HNO_3	250	2.5	12.5	50	1,800	700	300
HAN	350	10	25	125	600	400	200
$N_2H_4.H_2O$	35	0.006	0.04	0.04	>10,000	5,000	5,000

TEEL = Temporary Emergency Exposure Level (from DOE)

Note that the values at 100 m exceed the values for TEEL-3s by a wide margin. Thus, significant, high consequence chemical effects would be anticipated and the workers would not be able to adequately evacuate. For at least two chemicals (nitrogen oxides [N2O4] and nitric acid [HNO3]), the exposure levels would be so high that fatalities would likely result in and around the facility. The staff does not accept the use of TEEL values for chemical consequence limits due to multiple TEEL changes in the past two years, NIOSH and EPA requirements and guidance for using lower values, and the NRC use of lower values for chemical consequence categorization for other fuel cycle facilities. The NRC would likely use values lower than Immediately Dangerous to Life and Health (IDLH) limits; for example, these might be in the 10-15 mg/m3 range for N2O4 and 8-10 mg/m3 range for nitric acid. The use of lower, more reasonable consequence levels of concern results in receptors at even greater distances being potentially impacted and in a larger area of high consequence effects around the facility. The staff identified controls for chemical safety as part of open item CS-5.

3.4 Staff In-Office Review of Applicant Document - August 2002:

The staff reviewed documents during the August 2002 In-Office Review. In one of the documents, chemical consequences are analyzed. Table 2 summarizes the results for the site worker. The Table 2 results indicate high consequences which was acknowledged in the document. Table 3 shows the results as a function of distance. The applicant had concluded that nitrogen tetraoxide and hydrazine could exceed the numerical value of the TEEL-2 limit at the SRS boundary (about 5 miles - 8 km - away), the assumed location for the public receptor. This is essentially consistent with the prior analyses by ANL and the staff. Again, potential releases from nitrogen tetraoxide result in such high estimated concentrations that they would likely result in fatalities.

Table 2: Applicant's Results for the Site Worker (the 100 meter receptor)

Compound	Release Rate, kg/hr	Concentration at 100 meters
N2H4*H2O, 35% 477 liters, 47.7 m2 pool	1.487	0.136 mg/m3 (TEEL-3 = 0.02)
HNO3 609 liters, 60.9 m2 pool	5.806	0.266 ppm (TEEL-3 = 20)
N2O4 908 liters, 90.8 m2 pool	2,442	280 mg/m3 (TEEL-3 = 36)
UO2, drum emptying 200 kg	0.120	0.014 mg/m3 (TEEL-3 = 10)
UO2, fire event 37,500 kg	2.25	0.258 mg/m3 (TEEL-3 = 10)

Table 3: Applicant's ALOHA Results as a Function of Distance for Several Chemicals

N2H4*H2O, 35%, 477 liters, TEEL-3 = 0.02 mg/m3

Distance, miles	ALOHA Value	Extrapolation Fit
0.0621 (100 meters)	8.67 mg/m3	7.718 mg/m3
0.1242	2.24	2.248
0.25	0.592	0.647
0.5	0.167	0.189
1	0.0517	0.055
1.5	0.0276	0.027
2	0.0182	0.016

[Staff notes that the power fit is trending below the ALOHA results for 1.5 and 2 mile distances and will likely underestimate the ALOHA prediction at the SRS boundary.]

HNO3, 13.6 N, 609 liters, TEEL-3 = 20 ppm

Distance, miles	ALOHA Value	Extrapolation Fit
0.0621 (100 meters)	26.9 ppm	23.947 ppm
0.1242	6.95	6.972
0.25	1.83	2.007
0.5	0.517	0.584
1	0.16	0.170
1.5	0.0856	0.083
2	0.06	0.05

[Staff notes that the power fit is trending below the ALOHA results for 1.5 and 2 mile distances and will likely underestimate the ALOHA prediction at the SRS boundary.]

N2O4, 100%, 908 liters, TEEL-3 = 36 mg/m3

Distance, miles	ALOHA Value	Extrapolation Fit
0.0621 (100 meters)	29,100 mg/m3	25,944.5 mg/m3
0.1242	7,520	7,552.5
0.25	1,990	2,173.6
0.5	560	632.7
1	173	184.2
1.5	92.7	89.5
2	60.9	53.6

[Staff notes that the power fit is trending below the ALOHA results for 1.5 and 2 mile distances and will likely underestimate the ALOHA prediction at the SRS boundary.]

3.5 Argonne National Laboratory (ANL) Analyses on the Revised Environmental Report - Ongoing:

ANL resumed work on chemical consequence analysis with the receipt of the Revised Environmental Report from the applicant. Again, they have independently accepted and used the ALOHA code for analyses and have concluded there is the potential for significant chemical consequences to the site worker from several chemicals and to the public from at least one chemical (hydrazine). Their results are essentially the same as in their previous activities (see Section 3.2, previously). ANL has been given direction by NRC Management (of the MOX program) to use a less conservative code and estimation techniques. However, estimated concentrations from potential nitrogen tetraoxide releases are still very high and would likely result in fatalities regardless of the computer model used.

3.6 Revised Construction Application Request (RCAR) - October 2002:

Sections 5.5.2.10 and 8.4 of the RCAR summarizes the chemical accident consequences. The applicant has assessed a "not unlikely" likelihood for chemical releases. The analysis is stated to follow the guidance found in NUREG/CR-6410. The calculations for the site worker are based upon an F stability class using 95% meteorology from 10 years of historic data, and arrived at an air speed of 2.2 m/sec (i.e., different again from the CAR and previous analyses). The chi/q is calculated by the ARCON96 code applied at 100 meters; this value is 6.1E-4 sec/m3 (page 5.4-16). The calculations for the public are based upon a distance of 5 miles (8 km) using the MACCS2 code; the calculated chi/q is 3.7E-6 sec/m3 (page 5.4-15). The use of ALOHA for the 5 mile receptor is also mentioned.

The applicant has identified a uranium dioxide release from a fire event as requiring controls under Part 70; this event is regulated by the NRC because the chemical hazards arise from a radioactive material. This is representative of the first category of chemical safety regulated by the NRC. The applicant has proposed controls to provide adequate assurances of safety.

The applicant has identified two events involving hazardous chemicals produced from radioactive materials. One involves a chlorine release and the other involves a release of nitrogen tetraoxide via the oxidation column. These are representative of the second category of chemical safety regulated by the NRC. The applicant has proposed controls to provide adequate assurances of safety; for nitrogen tetraoxide, these controls limit the release rate to under 44 kg/hr so that TEEL-2 limits (15 mg/m3) are not exceeded for the 100 meter receptor.

The applicant has stated that the only safety functions to meet the 70.61 performance requirements for operators are in the Emergency Control Room (ECR). Consequently, the ECR air conditioning system is designated as a safety control to maintain habitable conditions during an event, such as a release of hazardous chemicals. No other controls are identified for chemical safety or for meeting 70.62 and 70.64(a)(5) requirements for chemical safety. The applicant has not identified any other safety effects from a chemical release. The applicant has identified ten administrative controls with some twenty-seven safety functions for radiological safety that occur outside of the control room.

3.7 Public Meeting with the Applicant - December 2002

The NRC held a public meeting with the applicant. One of the subjects discussed was plant conditions affecting radiological safety (i.e., the third category of chemical safety regulated by the NRC) as part of open item CS-5. The applicant stated that the administrative controls identified as PSSCs were permissive in nature (i.e., not associated with an ongoing activity) or the activity would fail safe. The applicant stated that the performance requirements of Part 70.61 would not be exceeded. However, the applicant also stated that, during a chemical release or event, there could be worker radiation exposures incurred that were below Part 70.61 levels (i.e., 100 rem for a high consequence event and 25 rem for an intermediate consequence event) and that severe health effects or death could occur due to the chemical exposure. The applicant stated these were not regulated. In essence, the applicant implied the third category of chemical hazards regulated by the NRC was not applicable to their facility. Such statements do not provide the adequate assurance of safety mentioned in the acceptance criteria in the MOX standard review plan nor do they meet the regulations.

4. Staff Discussions:

MOX management and some staff accepted the applicant's assertion that, outside of the operators in the control room (ECR), no operator actions were required to meet the radiological performance requirements of Part 70.61, even though there could be radiological dose increases and severe health effects or death from the chemical exposures. No burden of proof was required of the applicant. This has not been formally documented nor has NRC upper-management been informed of the decision or its potential policy implications.

Some staff members have acquiesced: they do not believe the applicant can sufficiently automate the plant so that operator actions for safety are not required outside of the control room yet they are willing to accept the assertion for the construction permit stage and make the point during the possession and use license application. However, this implies it should be considered as a safety issue now or the NRC could be placed in the unpleasant position of requiring future changes in a constructed facility. In addition, it overlooks the "facility condition" requirements of the regulations (70.64(a)(5)) and NRC precedence.

Other staff members (including myself) find it preposterous that the NRC would accept the applicant's position given that serious injury or death could result with a "not unlikely" likelihood, a radiation dose increase is likely to occur, and that such releases would be unregulated. The applicant has not justified its assertion and provided reasonable assurance - the MOX SRP criterion - that radiological safety is not impacted by major chemical releases. In addition, the general duty clauses would give the NRC the authority over these chemical releases because of the potentially severe consequences they would produce.

I note that the Reagents Building (BRP) contains hydrazine solution, nitric acid, and N2O4, in multi-hundred gallon quantities (each). These can provide significant releases via spills or container failures, and, in the case of N2O4, a pressurized release. There are no special/safety

controls for releases of these chemicals and the building does not contain safety features to prevent/mitigate their release. The applicant identified such releases as "not unlikely" but stated they were not regulated by the NRC.

The applicant has included a control for potential N_2O_4 releases via the plutonium oxidation column. The control would keep releases below 44 kg/hr in order to keep the concentration to the 100 meter receptor below 15 mg/m3, based upon the applicant's calculations. However, a release due to failure or puncture of the N_2O_4 storage containers could result in release rates of 1,000 to 2,000 kg/hr, or more (based upon analyses by the applicant, ANL, and the NRC). Clearly this would exceed chemical concentration levels around the facility and at least up to the 100 meter receptor, affect plant conditions, and likely result in fatalities. There is also an obvious contradiction in the applicant's position that the NRC would regulate the smaller release but not the larger one.

A similar situation exists for nitric acid.

Hydrazine releases could have effects extending out for miles.

There may be 3-5 other chemicals that need to be screened and could impact facility conditions affecting the safe handling of radioactive materials.