UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

October 3, 2003

MEMORANDUM TO: Alexander P. Murray
Senior Chemical Process Engineer
Division of Fuel Cycle Safety and Safeguards, NMSS

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

SUBJECT: NMSS DIRECTOR'S DECISION REGARDING YOUR DIFFERING PROFESSIONAL VIEW CONCERNING "MODELING CHEMICAL CONSEQUENCE EFFECTS FOR DETERMINING SAFETY REQUIREMENTS AT THE PROPOSED MIXED OXIDE FUEL FABRICATION FACILITY," DOCKET NUMBER: 070-03098" (NMSS-DPV-2002-03)

In a Memorandum dated December 19, 2002, you submitted for my consideration the subject Differing Professional View (DPV). Attachment 1 is a copy of your DPV.

Your DPV pertains to the Nuclear Regulatory Commission's (NRC) ongoing review of the 10 CFR Part 70 license application for construction and operation of a Mixed Oxide (MOX) fuel fabrication facility located on the Department of Energy (DOE) Savannah River site near Aiken, South Carolina. In your DPV, you express concerns about risks to the site workers, the public, and the environment related to potential hazardous releases. There is also mention of financial liability, which could result from potential accidents, and repercussions to the United States meeting its international obligations for plutonium disposition.

The specific safety concern expressed in your DPV is that chemical consequences to the MOX facility workers, public, and environment may be significantly understated if the NRC allows the use of the ARCON 96 automated scientific code and, therefore, safety measures may not be implemented. This relates to what (if any) controls are determined necessary (based on consideration of ARCON 96 results) for preventing and mitigating accidents involving chemical hazards. Your other concerns are generic in nature and pertain to NRC endorsement of automated scientific codes.

In your DPV, you requested that: "(1) the decision accepting the use of a less conservative code and parameters be over-turned; (2) NMSS establish a position on the use of codes, estimation techniques, and parameters that is consistent, peer-reviewed, conservative, provides adequate assurances of safety, and defensible [this could be a Branch Technical Position (from the Fuel Cycle Facilities Branch) or a separate guidance document (say, a NUREG document)]; and (3) NMSS address the fundamental problem of reconciliation of significantly different results from computer codes, models, and approaches listed in its guidance."

By memorandum dated December 23, 2002, I appointed an ad-hoc panel to review the merits of your DPV. The Panel members included the Panel Chairman, Charles Miller (NMSS), Stephen McGuire (NSIR), and Walter Schwink (NMSS). The DPV Panel completed its review and reported its findings and recommendations for my consideration. As discussed in the Panel's Report, some of your views were found to have merit. (Attachment 2 includes a copy of the Panel's report.) The following is a summary of the DPV Panel's review findings, recommendations concerning your DPV, and my decision on each position.

<u>DPV Position 1</u>

In your DPV, you request that "...the decision accepting the use of a less conservative code and parameters be over-turned."

The DPV Panel found that ARCON 96 code documentation indicates that the code is a suitable tool for analyzing potential chemical consequences for a MOX fabrication facility. Regulatory Guides and NUREGS documenting the NRC's development, endorsement, and acceptance of the ARCON 96 code clearly indicate the code is generally appropriate for modeling the generic phenomena involving dispersion of hazardous material releases. In this regard, the code is characterized as general in nature (i.e., models generic phenomena involving dispersion of hazardous material). Therefore, the DPV Panel recommends not granting your request to overturn the FCSS decision accepting the ARCON 96 code for modeling dispersion of hazardous material releases at the MOX facility.

However, the DPV Panel recommends that FCSS ensure that the MOX license application docketed information include the applicant's technical rationale demonstrating the reasonableness of the use of ARCON 96 results for MOX safety related decision-making and the Safety Evaluation documents the NRC staff's consideration of the applicant's code results and supporting rationale. The reasonableness of the MOX applicant's specific application of the ARCON 96 code and its results for safety related decision-making may involve consideration of the applicable and more important code modifications, assumptions, parameter values, algorithm option selection, diffusion coefficient adjustments, data input, data output, interpolations, and uncertainties. Both RG 1.194 and NUREG/CR-6331 provide generic guidance for application of the ARCON 96 code and its results for safety related decision-making. ***Therefore, I deny your request. However, I will request that FCSS ensure that sufficient information is docketed to demonstrate the reasonableness of the site specific application of the code for safety-related decision-making.***

<u>DPV Position 2</u>

In your DPV, you request that "NMSS establish a position on the use of codes, estimation techniques and parameters that is consistent, peer reviewed, conservative, provides adequate assurances of safety and defensible."

The DPV Panel notes that the results from automated scientific codes (i.e., analytical tools) are only one consideration in the regulatory process for determining adequate assurances of safety. Other elements of the regulatory process including defense in depth and robust requirements are also important for adequate assurances of safety. In this context, the Panel found that suitable documentation exists to guide NRC development, endorsement, and acceptance of automated scientific codes. Also, the Panel found that the ARCON 96 code is documented sufficiently for license reviewers to ascertain the suitability of the code for its specific application to conditions at the MOX facility. The DPV Panel recommends that your request be addressed by ensuring managers and staff involved with development, endorsement, use, or acceptance review of automated scientific codes are familiar with the relevant sections of Volume 2 of the NRC's Management Directives and NUREG/BR-0167, Software Quality Assurance.

Program and Guidelines pertaining to automated scientific codes used for safety related decision-making. Also, the DPV Panel recommends that a collaborative process involving agency stakeholders (e.g., NMSS, NRR, and RES) be established for coordinating Program Office needs for development and application of automated scientific codes that are suitable for use for NMSS and NRR applications. This will contribute to NMSS efforts for ensuring that licensing reviewers sufficiently understand codes, their specific applications, and results to determine their reasonableness for safety related decision making. To the extent practicable, other regulators (e.g., EPA, NOAA, OSHA, and DOE) and stakeholders should be informed about NRC development and application of generic scientific codes when appropriate. In this regard, a NRC public web page could be established to inform internal and external stakeholders about NRC code work. ***I will request that FCSS implement guidance to ensure managers and staff involved in the development, endorsement, use or acceptance of scientific codes are familiar with relevant sections of Volume 2 of the NRC's Management Directives and NUREG/BR-0167, Software Quality Assurance Program and Guidelines.***

<u>DPV Position 3</u>

You requested that "NMSS address the fundamental problem of reconciliation of significantly different results from computer code, models, and approaches listed in its guidance."

The DPV Panel is of the view that different results are possible when applying different automated scientific codes to the same phenomena (e.g., dispersion of hazardous material release). This is due in part to the codes being based upon different conceptual models and incorporating different assumptions and parameters. Rather than reconcile these differences, the Panel concluded that it is more important to determine which code is appropriate (i.e., reasonable) for the intended use (e.g., providing site specific condition input for consideration in safety related decision-making). In this regard, the license reviewer needs to understand what about the code, its application, and its results are most important for safety related decision-making. Comporting with application specific conditions and safety related importance, this may include the code's intended versus actual use, technical basis, assumptions, parameters, conceptual models, algorithms, coefficients, data inputs and outputs, interpolations, interpretations, uncertainties. A variety of avenues can be used for reviewers to acquire code knowledge, skills, and experience, e.g., reading code documentation, seminars, colloquiums, classroom training, self study/practice, discussions with code developers and users, and participation in code development and endorsement. The license applicant using a code for license specific application should provide justification concerning the suitability of the code (i.e., specific application of the code and its results for safety related decision-making) for consideration by the license reviewer. The DPV Panel recommends that NMSS ensure that license reviewers using or reviewing codes and their license specific application results, understand the code's suitability for its specific use. The reviewers understanding should be sufficient enough to determine what code is appropriate (more reasonable) for its intended use, its site specific application, and its results. ***I will request that FCSS issues guidance to ensure that staff have sufficient understanding of relevant automated scientific codes to determine which code is appropriate (i.e., reasonable) for the intended use.***

<u>Other Considerations</u>

You view your DPV and its resolution as important safety related information that should be available for consideration by internal and external stakeholders in the on-going MOX licensing activities. In this regard, you have requested in writing that your DPV and its resolution be made available to the ACRS, ASLB, and the public. The DPV Panel recommends that copies of your DPV, the Panel's Report, and the NMSS Director's Decision for resolving the DPV be made available to the ACRS, ASLB, and the public (e.g., ADAMS, NRC MOX web page).

Summary:

I have considered your DPV documentation and the DPV Panel's Report and find that some of your views have merit. I agree with the Panel's recommendations for addressing your views. Also, I grant your request for making your DPV and its resolution publicly available for consideration by internal and external stakeholders in the on-going MOX licensing activities. By separate memorandum, I requested that the Director, Division of Fuel Cycle Safety and Safeguards (FCSS) take action to implement my decision articulated above. A copy of the memorandum will be provided to you.

Thank you for your concern for safety and participating in the Differing Professional View (DPV) process. An open and thorough dialogue about how we carry out our regulatory programs is essential for maintaining the effectiveness of these programs.

Attachments:

1. DIFFERING PROFESSIONAL VIEW ON MODELING CHEMICAL CONSEQUENCE EFFECTS FOR DETERMINING SAFETY REQUIREMENTS AT THE PROPOSED MIXED OXIDE FUEL FABRICATION FACILITY, DOCKET NUMBER: 070-03098 (NMSS-DPV-2002-03)

2. DPV PANEL REPORT: REVIEW OF DIFFERING PROFESSIONAL VIEW ON "MODELING CHEMICAL CONSEQUENCE EFFECTS FOR DETERMINING SAFETY REQUIREMENTS AT THE PROPOSED MIXED OXIDE FUEL FABRICATION FACILITY," DOCKET NUMBER: 070-03098 (NMSS-DPV-2002-03)

cc: R. Pierson

MEMORANDUM
DECEMBER 19, 2002

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

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

SUBJECT: DIFFERING PROFESSIONAL VIEW ON MODELING CHEMICAL CONSEQUENCE EFFECTS FOR DETERMINING SAFETY REQUIREMENTS AT THE PROPOSED MIXED OXIDE (MOX) FUEL FABRICATION FACILITY
DOCKET NUMBER: 070-03098

I apologize for bringing the subject up but this issue has not been adequately reviewed by the MOX management and staff before a conclusion was made. Attached is the subject Differing Professional View (DPV). In summary, the DPV discusses the applicant's use of a code and parameters that do not necessarily meet the "conservative" criteria of the MOX Standard Review Plan nor the standard approach used by the NRC (in the Fuel Cycle Facilities Branch) for existing fuel cycle licensees. The applicant's approach also does not necessarily follow approaches, models, and other guidance for chemical consequence modeling used by the Environmental Protection Agency (EPA). Consequently, safety issues may not be adequately addressed at the proposed facility and appropriate safety measures implemented.

I request that (1) the decision accepting the use of a less conservative code and parameters be over-turned; (2) NMSS establishes a position on the use of codes, estimation techniques, and parameters that is consistent, peer-reviewed, conservative, provides adequate assurances of safety, and defensible [this could be a Branch Technical Position (from the Fuel Cycle Facilities Branch) or a separate guidance document (say, a NUREG document)]; and (3) NMSS addresses the fundamental problem of reconciliation of significantly different results from computer codes, models, and approaches listed in its guidance.

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 Management Directive (MD) 10.159. Also, per MD 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.

Attachment 1

DIFFERING PROFESSIONAL VIEW ON MODELING CHEMICAL CONSEQUENCE EFFECTS FOR DETERMINING SAFETY REQUIREMENTS AT THE PROPOSED MIXED OXIDE (MOX) FUEL FABRICATION FACILITY DOCKET NUMBER: 070-03098

1. Summary:

Prevailing NMSS Staff/Management Position: This is dichotomous. For the MOX construction application review, MOX management with some support from staff has decided to allow the use of one code (ARCON96) which incorporates additional parameters for dispersion, and, hence, reduces estimated chemical concentrations and consequences. The reduction effect is primarily due to one parameter - plume meander. This approach 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 uncertainty concerns in NRC guidance, does not meet the "conservatism" acceptance criteria in the MOX Standard Review Plan (SRP), and is not generally followed by the EPA in its chemical consequence evaluations. NMSS/FCFB and the EPA generally use codes and approaches that result in more conservative (higher) chemical concentrations and consequences.

DPV Position: (1) The MOX Team should use an approach that produces more conservative chemical consequence results and is consistent with NMSS/FCFB and EPA practice. (2) This should be formally documented, say in a Branch Technical Position. (3) NMSS should have a formal approach for reconciling codes and methodologies that produce significantly different estimates of consequences. The DPV notes that other applicable applicant documents have not been reviewed prior to the decision to use the ARCON96 code. Hence, the decision is also premature.

Significance: Without the DPV, chemical consequences to the facility worker, the site worker, the public, and the environment may be significantly under-estimated and approaches for adequate safety measures - and safety controls - may not be implemented. Thus, without safety controls, 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, could be substantial. There would also be significant financial liabilities from actual injuries, 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.

Note: These concerns apply to chemical events and consequences normally regulated by the NRC. These are hazardous chemical effects of radioactive materials, hazardous chemicals produced from radioactive materials, and hazardous chemicals affecting the safe handling of licensed radioactive material.

2. Overview of Documents and Activities

2.1 Construction Application Request (CAR - DCS-NRC-000038) - February 2001:

The applicant submitted the CAR on February 21, 2001. The CAR indicates chemical effects to the public, site worker, and facility worker would be low, using the 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.

In the applicant's response to a request for additional information (RAI Response 113), the applicant describes plans for chemical consequence modeling using ALOHA for the public (at 5 miles/8 km), with a wind speed of 1.2 m/sec and F stability class, based upon 95% meteorology at the Savannah River Site (SRS). The applicant intended to extrapolate the results out to the site boundary since ALOHA limits the execution time to one hour, which corresponds to about 2.68 miles with a 1.2 m/sec wind speed. For the site worker, the applicant intended to use a 95% chi/q value derived from the ARCON96 code, applied at 100 meters; this value is 4.13E-4 sec/m3 and is approximately a factor of 100 lower than what would be estimated using a "classic" Murphy-Campe calculation. The wind speed was calculated as 1.2 m/sec based upon analyses of 10 years of historical data, at the 95% percentile limit (i.e., lower wind speed and more stability/less dispersion only occur 5% of the time). The applicant states ARCON96 is more applicable because it accounts for building wake and plume meander effects. The applicant intended to use another code for the control room worker, based upon the guidance in R.G.1.78 (June 1974). No results were provided in the RAI response.

2.2 Recent SRS Usage - 1998:

SRS had previously provided recommendations for DOE facility safety analyses for chemicals (WSRC-MS-98-00899). This identified the following dispersion factors (chi/q) used in their analysis:

	F Class, 1 m/sec wind speed	D Class, 4.5 m/sec wind speed
100 meters:	chi/q = 0.024 [s/m3]	0.0014
300 meters:	chi/q = 0.0005 [s/m3]	0.0002

Note that both F and D class dispersion factors at 100 meters are significantly larger than the 100 meter value used by the applicant.

2.3 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; 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 site boundary. 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.

2.4 NRC Staff Analyses in the DSER - April 2002:

The staff had to address the apparent contradiction of the CAR analyses indicating no chemical concerns and the preliminary ANL results indicating 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

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 guidance for using lower values, and the NRC use of lower values for chemical consequence categorization for other fuel cycle facilities. The use of lower, more reasonable consequence levels of concern results in receptors at even greater distances being potentially impacted.

2.5 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 and this 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 TEEL-2 limit at the SRS boundary (about 5 miles - 8 km - away), the assumed location for the public receptor.

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

Compound	Release Rate, kg/hr	Concentration at 100 meters
$N_2H_4 \cdot H_2O$, 35% 477 liters, 47.7 m2 pool	1.487	0.136 mg/m3 (TEEL-3 = 0.02)
HNO_3 609 liters, 60.9 m2 pool	5.806	0.266 ppm (TEEL-3 = 20)
N_2O_4 908 liters, 90.8 m2 pool	2,442	280 mg/m3 (TEEL-3 = 36)
UO_2, drum emptying 200 kg	0.120	0.014 mg/m3 (TEEL-3 = 10)
UO_2, 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.]

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

ANL has 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 (Item 2.3). ANL may be given direction by MOX Management to use the less conservative code and approaches.

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

Section 8.4 of the RCAR summarizes the chemical accident consequences. 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; 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.

2.8 NMSS Accident Analysis Guidance - March 1998:

Guidance on estimating consequences is provided in NUREG/CR-6410, "Nuclear Fuel Cycle Facility Accident Analysis Handbook." The Gaussian Model used by ALOHA and other codes is discussed on page 5-6 et seq. ALOHA is listed as a code on page 5-80, in a discussion on EPA guidance on applying refined dispersion models. Page 5-21 et seq discusses building wake effects; ARCON96 is not explicitly mentioned but there is a reference to a revised model developed that incorporates plume meander and may be the precursor to ARCON96. This guidance mentions many models and makes no recommendations or endorsements. On page 5-80, it mentions EPA work that shows "good" models generally perform within a factor of 2 or so based upon chemical release tests. On page 5-81 et seq, model uncertainties are discussed; factors of 3-10 are mentioned.

2.9 Regulatory Guide on Control Room Habitability - December 2001:

The NRC has published Regulatory Guide 1.78, "Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release," Revision 1, dated December 2001. This mentions the use of the HABIT code for evaluating hazardous chemical concentrations, which is briefly described as a Gaussian plume or puff dispersion model that allows longitudinal, lateral, and vertical dispersions. The model also allows for the effects of wakes and for additional dispersion when the distance between the release point and the control room is small (small is not defined). The report states other dispersion models with similar capabilities may be used - ARCON96 is listed as an example. There is no endorsement. ALOHA or other models from NUREG/CR-6410 are not mentioned. Model selection criteria are not discussed.

2.10 MOX Standard Review Plan (SRP - NUREG-1718) - August 2000:

NUREG-1718 is the MOX SRP entitled, "Standard Review Plan for the Review of an Application for a Mixed Oxide (MOX) Fuel Fabrication Facility," dated August 2000. On page 8.0-6, paragraph C under the acceptance criteria for "Estimated Concentrations" states, "The applicant provides evidence that the techniques, assumptions, and models used are appropriate for the application and they lead to a conservative estimate of potential consequences. Paragraph A further down the same page similarly states "... and the assumed data input leads to a conservative estimate of potential consequences." Clearly, the applicant's use of ARCON96 and the MOX program acceptance of it are not leading to a conservative estimate.

2.11 Fuel Cycle SRP (NUREG-1520) - March 2002:

NUREG-1520 is the fuel cycle SRP entitled, "Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility," dated March 2002. On page 6-4, paragraph 5 of the acceptance criteria uses a similar phrase "... a conservative estimate of potential consequences."

2.12 "Atmospheric Relative Concentrations in Building Wakes," NUREG/CR-6331 (May 1997):

This report documents the ARCON96 computer code developed for potential use in control room habitability assessments. Figure 27 on page 44 shows a comparison of the classic Murphy-Campe and ARCON96 diffusion models as a function of wind speed for conditions that existed during diffusion experiments at seven reactor sites. At low wind speeds (below about 4.5-5 m/sec), there is a divergence between the models, with ARCON96 generally predicting lower chi/q values (i.e., this would predict lower concentration and consequence estimates). In addition, there is considerable spread in the data comparisons. At 2.2 m/sec, the spread goes from about 0.8 (higher concentrations with ARCON96) to about 12 (lower concentrations with ARCON96); the mode is around 2-3.

2.13 Comparison of ALOHA and Applicant (ARCON96 and MACCS2) Results:

At a distance of 100 meters, with a wind speed of 2.2 m/sec and F class stability, and a 2,000 kg/hr release (approximates the nitrogen tetraoxide situation with a cylinder rupture and release at 20 C):

Applicant (ARCON96): 340 mg/m3 ALOHA: (rural) 13,000 mg/m3, ratio = 40
(Urban) 2,710 mg/m3, ratio = 8

For the facility and site worker receptors, typical levels of concern might be in the 10-40 mg/m3 range (i.e., OSHA and IDLH limits, respectively). Note that such values are clearly exceeded by both modeling approaches but the ALOHA results imply potentially prompt incapacitations and/or fatalities. The ALOHA code does not explicitly output a chi/q value. However, the relative value is inferred by the ratios. Note that the ratio of 40 is above the upper range of ARCON96 ratios and the ratio of 8 is above the mode of Figure 27 in the ARCON96 report (Paragraph 2.12 on the previous page). Thus, the ratios and the numerical values imply ARCON96 is not providing conservative results. Essentially all of the differences are due to one parameter - plume meander.

At the site boundary of approximately 5 miles (essentially the public at the site boundary):

Applicant (MACCS2): 2.1 mg/m3 ALOHA: (rural) 9 mg/m3, ratio = 5

Using the OSHA limit of 9 mg/m3, the ALOHA code indicates potential effects to the public while the applicant's approach does not. Execution of ALOHA with the urban roughness factor indicates the 9 mg/m3 limit would not be exceeded beyond about 1.6 miles. Again, the ratios and the numerical values imply ARCON96 is not providing conservative results.

As an additional indication of non-conservative predictions by the ARCON96 code, the staff ran ALOHA at 4.5 m/sec, Class D stability, and rural conditions. At 100 meters, the result is 882 mg/m3; with urban effects, the concentration becomes 358 mg/m3 (approximately equal to the ARCON96 result with 2.2 m/sec and Class F stability: the evaporation rate was held constant). By comparison to Figure 27, ALOHA and ARCON96 should predict approximately the same value at 4.5 m/sec. Thus, this implies the ARCON96 code results cited by the applicant and accepted by the MOX program are not conservative.

The use of ARCON96 for releases of other chemicals, such as nitric acid and hydrazine, may not identify any consequences requiring safety controls while ALOHA would predict conditions requiring safety controls. Clearly, a defendable rationale is needed for code selection.

3. Staff Discussions:

The staff has had two meetings on the subject of chemical consequence modeling. Both of these meetings and the MOX program decision that use of the ARCON96 code was acceptable (11/25/2002) occurred before the staff had finished its review of the RCAR and before the staff has had the opportunity to conduct another in-office review of chemical consequence calculations. MOX management appeared to act in an arbitrary and capricious manner. It appeared that management had already discussed the issue before the meetings and made a decision, without consideration and discussion of the conservative requirement in the MOX SRP, limitations of ARCON96 and the single parameter effect, the ARCON96 report figure implications, inherent modeling uncertainties (see accident guidance), and FCFB (and EPA) use of ALOHA. FCFB was represented at these meetings and discussed their use of ALOHA, ALOHA's use by the EPA and others, and EPA's viewpoint on reduction parameters like plume meander (it was stated that EPA considered these to be "too manipulative" and not conservative). The issues were not addressed.

The existence of many codes producing different results raises the fundamental question of what to do when codes and assumptions give significantly different results? At the NRC, the staff is required to have adequate assurances of safety and an adequate safety margin. The clear precedence for chemical consequence modeling in NRC/NMSS/FCFB, the CPI (Chemical Process Industries), and the EPA is to use a conservative model/approach like that in ALOHA. As noted in Section 2, ANL also selected ALOHA for chemical consequence modeling for the EIS, and the applicant used ALOHA in the original CAR for modeling releases of gases and vapors. The applicant has also used ALOHA in the revised CAR for concentration estimates at the SRS site boundary. Thus, without an adequate basis, the Agency (and the applicant) gives the appearance of arbitrarily selecting a code. Such an approach seems closer to risk based regulation and does not appear to meet the intent of NRC's risk-informed, performance based (RIPB) regulation and the (revised) Part 70. It would seem that a conservative chemical consequence modeling approach like ALOHA should be used for the EIS analysis and the revised CAR (RCAR) in order to have consistency with precedence, to have reasonable conservatism, to provide adequate safety margins, and to have a defensible position.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

September 30, 2003

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

FROM: Charles Miller, Chairman Charles J. Miller
Differing Professional View Panel

SUBJECT: DPV PANEL REPORT: REVIEW OF "DIFFERING PROFESSIONAL VIEW ON MODELING CHEMICAL CONSEQUENCE EFFECTS FOR DETERMINING SAFETY REQUIREMENTS AT THE PROPOSED MIXED OXIDE FUEL FABRICATION FACILITY," DOCKET NUMBER: 070-03098 NMSS-DPV-2002-03

In your December 23, 2002, memorandum regarding the titled subject, you appointed an ad-hoc panel to review the merits of a differing professional view (DPV) submitted by Mr. Alex Murray, an NRC senior chemical safety reviewer. (A copy of Mr. Murray's DPV was attached to the memorandum.) Panel members included Panel Chairman Charles Miller (NMSS), Stephen McGuire (NSIR), and Walter Schwink (NMSS). The Panel has completed its review of the DPV and reports in the attached DPV Panel Report, its findings and recommendations for your consideration. As described in the Report, some of Mr. Murray's views were found to have merit.

Mr. Murray's DPV pertains to the NRC's ongoing review of the 10 CFR Part 70 license application for construction and operation of a Mixed Oxide (MOX) fuel fabrication facility located on the DOE Savannah River site near Aiken, South Carolina. The DPV concerns risks to the site workers, public, and environment related to potential hazardous releases. There is mention of financial liability, which could result from potential accidents, and repercussions on the U.S. meeting its international obligations for plutonium disposition.

Mr. Murray's specific safety concern is that chemical consequences to the MOX facility workers, public, and environment may be significantly understated if NRC allows the use of the ARCON 96 automated scientific code and therefore, safety measures may not be implemented. His concerns are related to what (if any) controls are determined necessary (based on consideration of ARCON 96 results) for preventing and mitigating accidents involving chemical hazards. His other concerns are generic in nature and pertain to NRC endorsement of automated scientific codes.

The DPV Panel's review, findings, and recommendations concerning Mr. Murray's DPV are detailed in the attached report. The Panel's findings and recommendations are summarized below.

DPV Position 1

Mr. Murray requests that "...the decision accepting the use of a less conservative code and parameters be over-turned."

The DPV Panel found that ARCON 96 code documentation indicates the code is a suitable tool for analyzing potential chemical consequences for a MOX fabrication facility. Regulatory Guides and NUREGS documenting the NRC's development, endorsement, and acceptance of the ARCON 96 code clearly indicate the code is generally appropriate for modeling the generic phenomena involving dispersion of hazardous material releases. In this regard, the code is characterized as general in nature, (i.e., models generic phenomena involving dispersion of hazardous material). Therefore, the DPV Panel recommends not granting Mr. Murray's request, to overturn the FCSS decision accepting the ARCON 96 code for modeling dispersion of hazardous material releases at the MOX facility.

However, the DPV Panel recommends that FCSS ensure that the MOX license application docketed information include the applicant's technical rationale demonstrating the reasonableness of the use of ARCON 96 results for MOX safety related decision-making and the Safety Evaluation documents the NRC staff's consideration of the applicant's code results and supporting rationale. The reasonableness of the MOX applicant's specific application of the ARCON 96 code and its results for safety related decision-making may involve consideration of the applicable and more important code modifications, assumptions, parameter values, algorithm option selection, diffusion coefficient adjustments, data input, data output, interpolations, and uncertainties. Both RG 1.194 and NUREG/CR-6331 provide generic guidance for application of the ARCON 96 code and its results for safety related decision-making.

DPV Position 2

Mr. Murray requests that "NMSS establish a position on the use of codes, estimation techniques and parameters that is consistent, peer reviewed, conservative, provides adequate assurances of safety and defensible."

The DPV Panel notes that results from automated scientific codes (i.e., analytical tools) are only one consideration in the regulatory process for determining adequate assurances of safety. Other elements of the regulatory process including defense in depth and robust requirements are also important for adequate assurances of safety. In this context, the Panel found that suitable documentation exists to guide NRC development, endorsement, and acceptance of automated scientific codes. Also, the Panel found that the ARCON 96 code is documented sufficiently for license reviewers to ascertain the suitability of the code for its specific application to conditions at the MOX facility. The DPV Panel recommends that Mr. Murray's request (DPV Position 2) be addressed by ensuring managers and staff involved with development, endorsement, use, or acceptance review of automated scientific codes are familiar with relevant sections of Volume 2 of the NRC's Management Directives and NUREG/BR-0167, Software Quality Assurance Program and Guidelines pertaining to automated scientific codes used for safety related decision-making. Also, the DPV Panel recommends that a collaborative process involving agency stakeholders (e.g., NMSS, NRR, and RES) be established for coordinating Program Office needs for development and application of automated scientific codes that are suitable for use for NMSS and NRR applications. This will contribute to NMSS efforts for ensuring licensing reviewers sufficiently understand codes, their specific applications, and results to determine their reasonableness for safety related decision making. To the extent practicable, other regulators (e.g., EPA, NOAA, OSHA, and DOE) and stakeholders should be informed about NRC development and application of generic scientific codes when appropriate. In this regard, a NRC public web page could be established to inform internal and external stakeholders about NRC code work.

DPV Position 3

Mr. Murray requests that "NMSS address the fundamental problem of reconciliation of significantly different results from computer code, models, and approaches listed in its guidance."

The DPV Panel is of the view that different results are possible when applying different automated scientific codes to the same phenomena (e.g., dispersion of hazardous material release). This is due in part to the codes being based upon different conceptual models and incorporating different assumptions and parameters. Rather than reconcile these differences, the Panel concluded that it is more important to determine which code is appropriate (i.e., reasonable) for the intended use, e.g., providing site specific condition input for consideration in safety related decision-making. In this regard, the license reviewer needs to understand what about the code, its application, and its results are most important for safety related decision-making. Comporting with application specific conditions and safety related importance, this may include the code's intended versus actual use, technical basis, assumptions, parameters, conceptual models, algorithms, coefficients, data inputs and outputs, interpolations, interpretations, uncertainties. A variety of means can be used for reviewers to acquire code knowledge, skills, and experience, e.g., reading code documentation, seminars, colloquiums, classroom training, self study/practice, discussions with code developers and users, and participation in code development and endorsement. The license applicant using a code for license specific application should provide justification concerning the suitability of the code (i.e., specific application of the code and its results for safety related decision-making) for consideration by the license reviewer. The DPV Panel recommends that NMSS ensure that license reviewers using or reviewing codes and their license specific application results understand the code's suitability for its specific use. Their understanding should be sufficient for reviewers to determine what code is appropriate (i.e., reasonable) for its intended use, its site specific application, and its results.

Other Considerations

Mr. Murray views his DPV and its resolution as important safety related information that should be available for consideration by internal and external stakeholders in the on-going MOX licensing activities. In this regard, he has requested in writing that his DPV and its resolution be made available to the ACRS, ASLB, the and public. The DPV Panel recommends that copies of Mr. Murray's DPV, the Panel's Report, and the NMSS Director's Decision for resolving the DPV be made available to the ACRS, ASLB, and the public (e.g., ADAMS, NRC MOX web page).

Attachment:

REPORT OF THE AD-HOC PANEL CONVENED TO REVIEW A DIFFERING PROFESSIONAL VIEW ON "MODELING CHEMICAL CONSEQUENCE EFFECTS FOR DETERMINING SAFETY REQUIREMENTS AT THE PROPOSED MIXED OXIDE FUEL FABRICATION FACILITY," DOCKET NUMBER: 070-03098 (NMSS-DPV-2002-03).

REPORT OF THE AD-HOC PANEL CONVENED TO REVIEW A DIFFERING PROFESSIONAL VIEW ON "MODELING CHEMICAL CONSEQUENCE EFFECTS FOR DETERMINING SAFETY REQUIREMENTS AT THE PROPOSED MIXED OXIDE FUEL FABRICATION FACILITY DOCKET NUMBER: 070-03098"

(NMSS-DPV-2002-03, submitted by Alex Murray)

Charles L. Miller

Charles Miller, Chairman

Stephen A. McGuire

Stephen McGuire, Member

Walter Schwink

Walter Schwink, Member

Attachment

Date: September 30, 2003

Purpose

In a memorandum dated December 23, 2002, the Director of the Office of Nuclear Material Safety and Safeguards appointed an ad-hoc panel to review the merits of a differing professional view (DPV) submitted by Mr. Alex Murray, a senior chemical safety reviewer in the Division of Fuel Cycle Safety and Safeguards (FCSS). (A copy of Mr. Murray's DPV was attached to the memorandum.) Panel members included Panel Chairman Charles Miller (NMSS), Stephen McGuire (NSIR), and Walter Schwink (NMSS). The purpose of the review by the Ad-Hoc Panel was to determine the merits of Mr. Murray's differing professional view (DPV), and make recommendations to the NMSS Director for resolving any issues of merit. NRC Management Directive (MD) 101.59, "Differing Professional Views or Opinions" provides guidance for review of DPVs.

Background

Mr. Murray's DPV pertains to the NRC's ongoing review of the 10 CFR Part 70 license application for construction and operation of a Mixed Oxide (MOX) fuel fabrication facility located on the Department of Energy (DOE) Savannah River site near Aiken South, Carolina. Regulatory oversight of the site is shared between DOE, EPA, OSHA, State and Local governments, and NRC (when MOX fabrication is licensed). NRC regulation of MOX related hazardous chemicals is limited to those chemicals that could degrade or fail engineered and human performance relied on for radiological safety or safeguards, chemicals co-mingled with radioactive material, and chemicals released from uranium bearing compounds. NRC's regulatory jurisdiction is described in a Memorandum dated March 10, 2003, from R. Pierson to C. Paperiello with the subject: "REGULATORY AUTHORITY OVER CHEMICAL HAZARDS AT FUEL CYCLE FACILITIES."

The DPV concerns risks to the site workers, public, and environment related to potential hazardous releases. There is mention of financial liability, which could result from potential accidents, and repercussions on the U.S. meeting its international obligations for plutonium disposition. Mr. Murray's specific safety concern is that chemical consequences to the MOX facility workers, public, and environment may be significantly understated if NRC allows the use of the ARCON 96 automated scientific code and therefore, safety measures may not be implemented. His concerns are related to what (if any) controls are determined necessary (based on consideration of ARCON 96 results) for preventing and mitigating accidents involving chemical hazards. His other concerns are generic in nature and pertain to NRC endorsement of automated scientific codes.

In the docketed MOX application, the applicant addresses hazardous material (nuclear and chemical) safety related risks to the workers, public, and environment. The NRC's regulatory jurisdiction for hazardous chemicals is limited to those that are: in direct contact with nuclear material, part of a nuclear material bearing compound, released from a nuclear material bearing compound, or likely to fail engineered or human performance relied on for nuclear material safety or safeguards. Other chemicals are not under NRC jurisdiction and are regulated by other federal, state, and local government agencies. MOX site specific hazardous chemical related release scenarios, dispersions, and consequences are analyzed by the MOX applicant to determine what (if any) preventive and/or mitigative controls (engineered and human performance) are needed to control risks to acceptable levels in a accordance with regulatory performance) are needed to control risks to acceptable levels in a accordance with regulatory requirements. In determining consequences of potential releases of hazardous chemicals regulated by the NRC, the MOX applicant used the ARCON 96 automated general scientific code as a tool to evaluate the potential hazardous chemical release dispersion to MOX site areas, structures, systems, equipment, and workers relied on for nuclear material safety and safeguards.

The MOX application briefly describes the ARCON 96 code and references NUREG/CR-6331, "Atmospheric Relative Concentrations in Building Wakes." NUREG/CR-6331 documents NRC's development, endorsement, acceptance, and user guidance for the the ARCON 96 code to model dispersion of hazardous releases. The MOX applicant has not provided sufficient justification for the appropriateness of MOX specific application of the code for modeling dispersion of potential hazardous releases at the MOX site. According to FCSS management and staff interviewed by the Panel the applicant's use of the ARCON 96 code is based on previous NRC development, endorsement, and acceptance of the code for modeling dispersion of hazardous releases at reactor sites. They are of the view that the ARCON 96 code is a generic code (tool) for evaluating generic phenomena involving the dispersion of potential hazardous material releases.

Mr. Murray's safety concern (differing view) results from FCSS acceptance of results from MOX specific application of the ARCON 96 code without a docketed applicant justification (i.e., explanation of why the general code reasonably models dispersion of hazardous material releases at the MOX site (e.g., MOX site specific code modifications, assumptions, parameter values, algorithm options, diffusion coefficient adjustments, data input, data output interpretations)) supporting the appropriateness of the general code for MOX site specific modeling of the dispersion of potential hazardous chemical releases. Specifically, he is concerned, that In the absence of such justification, the applicant's use of the ARCON 96 code (results) will result in significant understatement of MOX safety related risks considered in deciding what (if any) controls are necessary for preventing and mitigating accidents involving chemical hazards. In this regard, Mr. Murray requests that "the decision accepting the use of a less conservative code and parameters be over-turned." Mr. Murray's request is referred to and addressed by the DPV Panel as DPV Position 1.

Another concern expressed in Mr. Murray's DPV is the lack of a collaborative process (involving internal and external stakeholders) for agency development, endorsement, and acceptanceof automated scientific codes. In this regard, Mr. Murray requests that "NMSS establish a position on the use of codes, estimation techniques, and parameters that is consistent, peer-reviewed, conservative, provides adequate assurances of safety, and defensible [this could be a Branch Technical Position (from the Fuel Cycle Facilities Branch) or a separate guidance document (say, a NUREG document)]." Mr. Murray's request is referred to and addressed by the DPV Panel as DPV Position 2.

In discussions with the DPV Panel, Mr. Murray offered that he is concerned about what he considers are risk significant differences in results from various generic automated scientific codes (e.g., ARCON 96, ALOHA) used to model dispersion of the same or similar hazardous material. As an example, he offered the difference in results from the generic ARCON 96 code and ALOHA using MOX applicant data. He noted that differences in results among codes are noted in NUREG/CR-6410, Nuclear Fuel Cycle Facility Accident Analysis Handbook. He offered that regulatory guidance is not provided for NRC reviewer and license applicant reconciliation of these differences. In this regard, Mr. Murray requests that "NMSS address the fundamental problem of reconciliation of significantly different results from computer codes, models, and approaches listed in its guidance." Mr. Murray's request is referred to and addressed by the DPV Panel as DPV Position 3.

Discussion

The DPV Panel focused its review on Mr. Murray's requested actions, i.e., DPV Positions 1, 2, and 3. In addition to reading the DPV, the MOX application, and other documents deemed relevant, the Panel met with Mr. Murray (at his request) to clarify his views and provide additional information. As suggested by Mr. Murray, the Panel also met with the MOX Project Manager (PM), the PM's supervisor, and another MOX chemical safety reviewer in FCSS, who accepted ARCON 96 results. In addition, Panel members discussed with NRR staff, their development, acceptance, endorsement, and use of generic automated scientific codes (e.g., ARCON 96) for modeling the dispersion of hazardous releases.

Mr. Murray is of the view that FCSS should not accept the results from MOX specific application of the ARCON 96 code without a docketed applicant explanation of why the code is a reasonable tool for modeling dispersion of potential hazardous material releases at the MOX site. For example, the explanation should address MOX site specific code modifications, assumptions, parameter values, algorithm options selection, diffusion coefficient adjustments, data input and data output. Specifically, he is concerned, that In the absence of such explanation, the applicant's use of the ARCON 96 code (results) will result in significant understatement of MOX safety related risks considered in deciding what (if any) controls are necessary for preventing and mitigating accidents involving chemical hazards. His view is based on running the ALOHA code (EPA and NRC accepted code) and comparing the results with those from the ARCON 96 code. He offered that although he is not familiar with the ARCON 96 code and has not run the code, the comparison of results between the codes shows that the ARCON 96 code results from the applicant are significantly different than the results from the ALOHA code. Details of the comparison supporting Mr. Murray's views are included in his DPV submittal. Albeit Mr. Murray offered differences among the results from the codes, he did not offer any technical reasons that the use of the ARCON 96 code was not appropriate as used by the applicant for modeling potential hazardous material releases at the MOX site.

As explained to the DPV Panel by NRC's MOX licensing Project Manager (PM), the PM determined that the ARCON 96 code and its results were acceptable for MOX safety related decision-making, e.g., determining what chemical hazard controls are needed. He offered that Mr. Murray's differing views were considered in determining the acceptability of the generic ARCON 96 code and its results for safety related decision-making. The PM noted that his determination resulted from discussions and meetings with FCSS licensing reviewers and the MOX license applicant.

In discussions with the PM's Section Chief, the Panel was told that he was aware of differing staff views on the acceptability of the generic ARCON 96 code but, did not disagree with the PM's determination that the code and its results were acceptable. In discussions with a MOX license reviewer, the Panel was told that he agreed with acceptance of the generic ARCON 96 code based on his independent testing of the generic ARCON 96 code algorithms (math equations) and considering site conditions during which hazardous chemical releases could occur. In his view, the ARCON 96 code and its results offered reasonable conservatism and therefore are acceptable for MOX site specific safety related decision-making.

No reasons were offered to the DPV Panel concerning why MOX site specific results from the ARCON 96 code are not reasonable for safety related decision-making. Conversely, no explanation was offered to the Panel concerning why MOX site specific code results are reasonable for safety related decision-making.

DPV Position 1:

Mr. Murray requests that "...the decision accepting the use of a less conservative code and parameters be over-turned."

Mr. Murray noted that NUREG-1718, Standard Review Plan for Review of an Application for a Mixed Oxide (MOX) Fuel Fabrication Facility (SRP) characterizes hazardous chemical dispersion modeling as highly uncertain and therefore warrants conservatism, which he believes is lacking in the ARCON 96 code results. In this regard, he noted that a conservative estimate of potential consequences is called for in NUREG-1520, Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility. Mr. Murray supports his views about ARCON 96 with technical rationale in his DPV submittal which includes a detailed comparison of MOX site specific results from ARCON96 and ALOHA. Mr. Murray did not offer reasons why ARCON 96 results are not reasonable or why ALOHA results are reasonable. The results included concentrations and comporting doses involving the following hazardous chemicals: N_2H_4, HNO_3, HAN, $N_2H_4H_2O$, N_2O_4, and UO_2. Mr. Murray's concern is that the ARCON 96 code results will cause no or inadequate controls ("items relied on for safety") to be identified for prevention and mitigation of severe consequences involving potential releases of hazardous chemicals. He told the Panel that a NRC acceptable docketed applicant explanation is needed to document why the ARCON 96 code reasonably models dispersion of potential hazardous material releases at the MOX site. The explanation should address MOX site specific code modifications, assumptions, parameter values, algorithm options, diffusion coefficient adjustments, data input, data output and uncertainties.

Mr. Murray offered that he is not knowledgeable about NRC development, endorsement, and acceptance of the ARCON 96 code. He noted that the applicant has not provided for NRC review, an explanation for why the MOX site specific code results are reasonable. In this regard, he believes that the applicant should be required to submit such information for NRC review before accepting the code results for MOX safety related decision-making.

Mr. Murray did not offer any technical reasons supporting his view that use of the ARCON 96 code results was not appropriate for MOX applicant safety related decision-making.

<u>DPV Panel Findings and Recommendations:</u>

The Panel found that NRC had developed and endorsed the general ARCON 96 code, which is a tool, for evaluating hazardous material dispersion at nuclear power plants. The code is general in nature and reasonably models generic phenomena (i.e., dispersion of hazardous material) and, therefore, is generically applicable to any site including fuel cycle facilities. The reasonableness of site specific application of the code including its results (e.g., at the MOX site) requires explanation and acceptance of site specific code modifications, assumptions, parameter values, algorithm option selection, diffusion coefficient adjustments, data input, data output, interpolations, and uncertainties. Documentation indicates that the ARCON 96 code has evolved from continuing research, experience, and industry and NRC staff views. In the 1980s, the NRC sponsored studies to evaluate the existing (e.g., Murphy-Campe) models against experimental testing in the environment and in wind tunnels and to develop alternative approaches. The results of these studies were published in 1988 in NUREG/CR-5055, "Atmospheric Diffusion for Control Room Habitability Assessments." The results indicated that the existing dispersion models (including those currently used in ALOHA) overestimated concentrations during low wind speed conditions and in the vicinity of buildings.

The reason that concentrations were overestimated during low wind speeds was that the dispersion parameters used for estimating the spread of the plume were based on experiments done during relatively high wind speed conditions. When wind speeds are high, normally there is little variability in wind direction. During low wind speed conditions, wind direction is much more variable. The variability in wind direction has the effect of spreading the plume and lowering concentrations. The reason that concentrations were overestimated near buildings is that the building causes turbulence that expands the size of the plume in the building's wake. ARCON 96 was designed to correct for both the low wind speed and building wake effects. The correction is often called the "building wake effect," but in fact, the correction accounts for both the low wind speed effect and building wake effect. At low wind speeds, the low wind speed correction is the dominant correction. The developers of the ALOHA code have recently recognized that ALOHA overestimates concentrations at low speeds, and they are now planning to incorporate the low wind speed correction into future versions of ALOHA.

NUREG/CR-5055 presented a statistical diffusion algorithm (automated scientific code) that made significantly more accurate predictions in building wakes. This was peer reviewed in 1994 by a formal panel comprised of recognized atmospheric dispersion experts including representatives from NOAA, EPA, DOE, NRC, and industry. The code was revised in response to this peer review and included in a code referred to as the ARCON 95 code. Stakeholder (public, industry, and regulators) comments on the code resulted in modifications made to the code and its re-issuance as the generic ARCON 96 code. The code is described as including improved low wind speed and building wake dispersion algorithms for assessment of ground level, building vent, elevated, and diffuse source release modes; use of hour-by-hour meteorological observations; sector averaging; and directional dependence of dispersion conditions. This results in a more reasonable model of dispersion with less uncertainty, which requires less conservatism than other codes.

NRC REGULATORY GUIDE 1.194, ATMOSPHERIC RELATIVE CONCENTRATIONS FOR CONTROL ROOM RADIOLOGICAL HABITABILITY ASSESSMENTS AT NUCLEAR POWER PLANTS, endorses the generic ARCON 96 code with guidance for its site/facility specific use and acceptance. The REG GUIDE (RG) notes that ARCON 96 results may show significantly less hazardous material concentrations and therefore less potential dose than would be shown using results from other codes (e.g., ALOHA). The generic ARCON 96 code also is endorsed in NRC REGULATORY GUIDE 1.78, EVALUATING THE HABITABILITY OF A NUCLEAR POWER PLANT CONTROL ROOM DURING A POSTULATED HAZARDOUS CHEMICAL RELEASE. Guidance for use of the generic ARCON 96 code is provided in NUREG/CR-6331, Atmospheric Relative Concentration in Building Wakes. Use of the ARCON 96 code in nuclear power reactor licensing actions has survived challenges by internal and external stakeholders (e.g., ACRS, ATOMIC SAFETY AND LICENSING BOARD (ALSB NO. 99-762-02-LA)), the Nuclear Regulatory Commission, UNITED STATES COURT OF APPEALS FOR THE DISTRICT OF COLUMBIA (CASE Nos. 01-1073 & 01-1246).

The DPV Panel found that ARCON 96 code documentation indicates the code is a suitable tool for analyzing potential chemical consequences for a MOX fabrication facility. Regulatory Guides and NUREGS documenting the NRC's development, endorsement, and acceptance of the ARCON 96 code clearly indicate the code is generally appropriate for modeling the generic phenomena involving dispersion of hazardous material releases. In this regard, the code is characterized as general in nature, i.e., models generic phenomena involving dispersion of hazardous material. FCSS licensing reviewers for chemical safety could learn more about the ARCON 96 code (including its technical basis/conservatism) from the aforementioned NRC documents and through collaborative discussions with NRC staff cognizant for the code. Therefore, the DPV Panel recommends not granting Mr. Murray's request, to overturn the FCSS decision accepting the ARCON 96 code for modeling dispersion of hazardous material releases at the MOX facility.

However, the DPV Panel recommends that FCSS ensure that the MOX license application docketed information include the applicant's technical rationale demonstrating the reasonableness of the use of ARCON 96 results for MOX safety related decision-making and the Safety Evaluation documents the NRC staff's consideration of the applicant's code results and supporting rationale. The reasonableness of the MOX applicant's specific application of the ARCON 96 code and its results for safety related decision-making may involve consideration of the applicable and more important code modifications, assumptions, parameter values, algorithm option selection, diffusion coefficient adjustments, data input, data output, interpolations, and uncertainties. Both RG 1.194 and NUREG/CR-6331 provide generic guidance for application of the ARCON 96 code and its results for safety related decision-making.

DPV Position 2:

Mr. Murray requests that "NMSS establish a position on the use of codes, estimation techniques and parameters that is consistent, peer reviewed, conservative, provides adequate assurances of safety and defensible."

DPV Panel Findings and Recommendations:

In discussions with various managers and staff, the DPV Panel found that the ARCON 96 code was not developed and endorsed in collaboration with FCSS staff responsible for chemical safety reviews. The code is a tool that was developed for nuclear power plant safety related decision-making. This accounts for why FCSS chemical safety reviewers are not familiar with the technical basis for NRR development, endorsement, and acceptance of the code.

Various managers and staff involved with codes offered that they were not aware of NUREG/BR-0167, Software Quality Assurance Program and Guidelines, for scientific code development consistent with Volume 2 of NRC MDs. Except for code validation dictated by the intended use of a code, a "value added warranting costs" rationale was offered by various staff experienced in code development for not following such guidance (e.g., validation and verification, for all codes developed by the NRC for safety related decision-making (e.g., risks involved with code results did not warrant time and effort for code validation and verification)).

The DPV Panel notes that results from automated scientific codes (i.e., analytical tools) are only one consideration in the regulatory process for determining adequate assurances of safety. Other elements of the regulatory process including defense in depth and robust requirements are also important for adequate assurances of safety. In this context, the Panel found that suitable documentation exists to guide NRC development, endorsement, and acceptance of automated scientific codes. Also, the Panel found that the ARCON 96 code is documented sufficient for license reviewers to ascertain the suitability of the code for its specific application to conditions at the MOX facility. The DPV Panel recommends that Mr. Murray's request (DPV Position 2) be addressed by ensuring managers and staff involved with development, endorsement, use, or acceptance review of automated scientific codes are familiar with relevant sections of Volume 2 of the NRC's Management Directives and NUREG/BR-0167, Software Quality Assurance Program and Guidelines pertaining to automated scientific codes used for safety related decision-making. Also, the DPV Panel recommends that a collaborative process involving agency stakeholders (e.g., NMSS, NRR, and RES) be established for coordinating Program Office needs for development and application of automated scientific codes that are suitable for use for NMSS and NRR applications. This will contribute to NMSS efforts for ensuring licensing reviewers sufficiently understand codes, their specific applications, and results to determine their reasonableness for safety related decision making. To the extent practicable, other regulators (e.g., EPA, NOAA, OSHA, and DOE) and stakeholders should be informed about NRC development and application of generic scientific codes when appropriate. In this regard, a NRC public web page could be established to inform internal and external stakeholders about NRC code work.

DPV Position 3:

Mr. Murray requests that "NMSS address the fundamental problem of reconciliation of significantly different results from computer code, models, and approaches listed in its guidance."

<u>DPV Panel Findings and Recommendations:</u>

The DPV Panel is of the view that different results are possible when applying different automated scientific codes to the same phenomena (e.g., dispersion of hazardous material release). This is due in part to the codes being based upon different conceptual models and incorporating different assumptions and parameters. Rather than reconcile these differences, the Panel concluded that it is more important to determine which code is appropriate (i.e., reasonable) for the intended use (e.g., providing site specific condition input for consideration in safety related decision-making). In this regard, the license reviewer needs to understand what about the code, its application, and its results are most important for safety related decision-making. Comporting with application specific conditions and safety related importance, this may include the code's intended versus actual use, technical basis, assumptions, parameters, conceptual models, algorithms, coefficients, data inputs and outputs, interpolations, interpretations, uncertainties. A variety of means can be used for reviewers to acquire code knowledge, skills, and experience, e.g., reading code documentation, seminars, colloquiums, classroom training, self study/practice, discussions with code developers and users, and participation in code development and endorsement. The license applicant using a code for license specific application should provide justification concerning the suitability of the code (i.e., specific application of the code and its results for safety related decision-making) for consideration by the license reviewer. The DPV Panel recommends that NMSS ensure that license reviewers using or reviewing codes and their license specific application results understand the code's suitability for its specific use. Their understanding should be sufficient for reviewers to determine what code is appropriate (i.e., reasonable) for its intended use, its site specific application, and its results.

Other Considerations:

Mr. Murray views his DPV and its resolution as important safety related information that should be available for consideration by internal and external stakeholders in the on-going MOX licensing activities. In this regard, he has requested in writing that his DPV and its resolution be made available to the ACRS, ASLB, and the public. The DPV Panel recommends that copies of Mr. Murray's DPV, the Panel's Report, and the NMSS Director's Decision for resolving the DPV be made available to the ACRS, ASLB, and the public (e.g., ADAMS, NRC MOX web page).