RAS 11212

February 24, 2006

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

DOCKETED
USNRC

February 24, 2006 (4:12pm)

OFFICE OF SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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| In the Matter of: | ) | |
| | ) | Docket No. 70-3103-ML |
| Louisiana Energy Services, L.P. | ) | |
| | ) | ASLBP No. 04-826-01-ML |
| (National Enrichment Facility) | ) | |

# APPLICANT'S PREFILED TESTIMONY IN MANDATORY HEARING CONCERNING MATTERS RELATED TO NUCLEAR CRITICALITY (SAFETY MATTER NOS. 5 - 8 AND OCTOBER HEARING QUESTIONS 6.b, 6.e, 6.f, and 6.g)

## I. WITNESS AND PROCEDURAL BACKGROUND

**Q1.** Please state your name, occupation, and by whom you are employed.

**A1.** My name is Rod M. Krich ("RMK"). I am Vice President of Licensing, Safety, and Nuclear Engineering for Louisiana Energy Services, L.P. ("LES"), the license applicant in this matter. LES is seeking authorization from the U.S. Nuclear Regulatory Commission ("NRC") to construct and operate a gas centrifuge uranium enrichment facility -- designated the National Enrichment Facility ("NEF") -- in Lea County, New Mexico. I am presently "on loan" to LES from Exelon Nuclear, where I am Vice President, Licensing Projects, and lead Exelon Nuclear's licensing activities relative to future generation ventures.

My name is Daniel G. Green ("DGG"). I am a Senior Consulting Engineer with EXCEL Services Corporation, which is headquartered in Rockville, Maryland.



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My name Allan J. Brown ("AJB"). I am the Design and Licensing Consultant for Urenco (Capenhurst) Ltd., as well as the Urenco Assistant Project Manager with respect to the National Enrichment Facility project (also referred to as the "LES-2" project).

My name is Barbara Y. Hubbard ("BYH"). I am employed as a Supervisory/Advisory Engineer with Framatome ANP in Marlborough, Massachusetts.

My name is David M. Pepe ("DMP"). I am employed as a Principal Engineer with Framatome ANP in Marlborough, Massachusetts.

**Q2.** Please describe your responsibilities relative to the NEF project.

**A2.** (RMK) As Vice President of Licensing, Safety, and Nuclear Engineering for LES, I have the overall responsibility for licensing and engineering matters related to the NEF project. In this capacity, I oversaw preparation and submittal of the NEF license application, as well as the engineering design of the facility processes and safety systems. As a result, I am very familiar with the NEF license application, and NRC requirements and guidance related to the contents of such an application. This includes familiarity those portions of the NEF Safety Analysis Report ("SAR") and the NEF Integrated Safety Analysis ("ISA") that relate to nuclear criticality.

(DGG) As an engineering and regulatory consultant to LES, I supported the development, review, and submittal of the NEF license application. In this capacity, I helped to ensure that the application complied with the applicable guidance set forth in NUREG-1520, "Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility." Subsequent to the submittal of the NEF application, I have had a lead role in responding to NRC Staff Requests for Additional ("RAIs") on various aspects of the licensing submittal, and in preparing and/or reviewing any necessary revisions to the application. I also am a member of the

ISA team, and thus am familiar with those portions of the ISA and SAR relating to nuclear criticality.

(AJB) As Urenco Assistant Project Manager for the NEF project, I serve as the core technology/design manager for the project. Urenco is the originator of the gas centrifuge enrichment technology and general plant design to be utilized by LES. I am responsible for overseeing all non-architectural/engineering design work that will be done to support the NEF. Among other things, this work includes preparing the reference design for the NEF, providing technical assistance and consultation relative to the NEF during the design and early operational phases of the facility, and conducting technical reviews of design activities to ensure that the NEF design is consistent with the Urenco reference design information. I also am a member of the ISA team for the NEF project.

(BYH) As Supervisor of the Nuclear and Radiation Engineering group at Framatome ANP, I have supervise nuclear and radiological analysis work performed for variety of customers, including LES. Since 2004, I have been closely involved in the criticality analyses for the proposed NEF and, in that capacity, have served as a member of the NEF ISA team. I also am one of the preparers of the MONK 8A Validation and Verification report discussed herein.

(DMP) As a Principal Engineer at Framatome ANP, I have provided technical and engineering support with respect to various aspects of the NEF license application. I am the ISA Manager and a member of the ISA team. In this capacity, I contributed extensively to the preparation of the NEF ISA.

**Q3.** Please summarize your educational and professional qualifications.

**A3.** (RMK) I hold a B.S. degree in mechanical engineering from the New Jersey Institute of Technology and an M.S. in nuclear engineering from the University of Illinois. I have over 30 years of experience in the nuclear energy industry covering engineering, licensing, and regulatory matters. This experience encompasses the design, licensing, and operation of nuclear facilities. A full statement of my professional qualifications is attached hereto.

(DGG) I hold B.S. and M.S. degrees in nuclear engineering from Kansas State University. I have approximately 25 years of experience in engineering, licensing, and regulatory matters involving the nuclear energy industry. I have been a consulting engineer with EXCEL Services Corporation since 1991, and provided consulting services to a large number of utilities. Prior to 1991, I was employed principally as a licensing engineer at Florida Power Corporation and Kansas Gas and Electric Company. A full statement of my professional qualifications is attached hereto.

(AJB) I hold a B.S. degree (with Honors) from the University of Liverpool, where I also undertook several years of graduate research in nuclear structure physics. I have 30 years of commercial experience relating to the enrichment of uranium by the gas centrifuge process. I was employed with BNFL from 1975 to 1991. During my tenure at BNFL, I held a number of positions relating to centrifuge plant design and operations management. From 1989 to 1991, I served as Design Liaison Officer for the LES1 (Claiborne Enrichment Center) project. Since 1991, I have been employed with Urenco, where I have also held a number of key design-related positions, including my current position as Design and Licensing Consultant. Also, from 1991 to 1995, I served as Decommissioning Manager for the first green field decommissioning of pilot and commercial demonstration gas centrifuge plants at Urenco's Capenhurst, U.K. site. A full statement of my professional qualifications is attached hereto.

(BYH) I hold B.S. and M.S. degrees in nuclear engineering from the Georgia Institute of Technology and the University of Massachusetts (Lowell), respectively. I have 25 years of experience as a nuclear engineer and a reactor physicist. This experience includes core reload licensing analysis, core management report and core follow analysis, neutronics benchmarking for BWR and PWR reactors, and spent-fuel-related criticality analyses. A full statement of my professional qualifications is attached hereto.

(DMP) I hold a B.S. degree in nuclear engineering from Rensselaer Polytechnic Institute. I have 29 years of experience in the nuclear engineering field. This experience includes application of the ISA methodology; application of the EPRI RI-ISI methodology; preparation of safety and engineering analyses for nuclear steam supply systems and various secondary systems; and fire protection, Appendix R and plant start-up engineering.

**Q4.** What is the purpose of your testimony?

**A4.** (RMK, DGG, AJB, BYH, DMP) We are providing this testimony on behalf of LES in accordance with the Licensing Board's Memorandum and Order (Memorializing Board Questions/Areas of Concern for Mandatory Hearing) of January 30, 2006 ("January 30th Order"), and Memorandum and Order (Administrative Matters Relative to Mandatory Hearing) of February 8, 2006 ("February 8th Order"). In those issuances, the Board "memorialized" a series of questions or "areas of concern" upon which the Board has required presentations from LES and/or the NRC Staff in the context of the mandatory hearing in this proceeding. This testimony is intended to respond specifically to the safety questions set forth in paragraphs 5 through 8 of the Board's January 30th Order (under Section I.A), and in paragraphs 6.b, 6.e, 6.f, and 6.g of Attachment A to the Board's February 8th Order. The matters identified by the Board in the foregoing paragraphs pertain to LES's criticality calculations and the Staff's review

thereof. These matters fall into four categories or topical areas: (1) the relationship between Items Relied on for Safety ("IROFS") and the nuclear criticality safety analyses selected for verification in the MONK 8A Validation and Verification report; (2) the significance of the hydrogen to uranium ("H/U") (*i.e.*, moderation) ratio ranges associated with the benchmark criticality experiments used to validate the MONK 8A code (including the impact of varying H/U ratios on computational bias); (3) the manner in which the "no hydrogen moderation" case was treated in validating the MONK 8A code; and (4) the probability of significant water vapor intrusion affecting criticality safety at the NEF. The expert testimony provided below is organized consistent with these four areas of concern.

**Q5.** Please briefly describe your understanding of the findings to be made by the Board relative to the Staff's safety review of the license application.

**A5.** (RMK, DGG, AJB, BYH, DMP) As we understand it, the Board is required to conduct a "sufficiency" review of uncontested issues. According to the Commission, the Board should confirm that the NRC Staff "has performed an adequate review and made findings with reasonable support in logic and fact." In doing so, the Board is to decide whether the overall safety record is sufficient to support license issuance. Accordingly, this testimony is intended to facilitate the Board's review by presenting the additional technical information and discussion requested by the Board relative to the nuclear criticality-related matters identified above.

## II. RESPONSE TO BOARD QUESTIONS

### A. Relationship Between IROFS and Nuclear Criticality Calculations

**Q6.** Please describe the Board's inquiry relative to the relationship that exists between IROFS and the MONK 8A criticality calculations.

**A6.** (RMK, DGG, AJB, BYH, DMP) In safety question 7 of its January 30th Order, the Board stated as follows:

> 7. The staff is requested to correlate the IROFS discussed in the SER with the cases listed in Table 7-3 of the report. Are all IROFS adequately represented in the table?

During the February 6, 2006 prehearing telephone conference with the parties, the Board expressed its desire to understand how the criticality calculations in the MONK 8A Validation and Verification report relate to the IROFS in Table 7-3 of that report. The Board explained, by way of example, that it sought an explanation of the connection between the IROFs relating to depleted uranium hexafluoride ("$DUF_6$") cylinders, and the calculations done for such cylinders. The Board also requested a discussion of the "technical basis" for SER Table 5.3-1 (SER at 5-14), which sets forth safety criteria (*i.e.*, parameter, critical value, safe value, and safety factor) for uniform aqueous solutions of enriched $UO_2F_2$.

**Q7.** Please describe the purpose of the MONK 8A Validation and Verification Report, Revision 2 (Feb. 16, 2006) (LES Exh. 127-M).

**A7.** (RMK, DGG, BYH, DMP) LES contractor AREVA (Framatome ANP) prepared the referenced report to validate the MONK 8A Monte Carlo computer code, and to use the validated MONK 8A code to verify the criticality calculations performed by Urenco for the proposed NEF. The MONK 8A code package is the computational code that was used for the NEF criticality analyses. The validation and verification methodologies used by AREVA are described

in detail in the report itself. *See* LES Exh. 127-M. In short, the criticality code *validation* methodology involved four steps: (1) identification of general NEF design applications; (2) selection of applicable benchmark experiments for the area of applicability ("AOA") of interest; (3) modeling and calculation of $k_{eff}$ values of selected critical benchmark experiments; and (4) statistical analysis of the results to determine computational bias and the Upper Safety Limit ("USL"). The *verification* methodology involved (1) comparing AREVA's benchmark to the benchmark results to those published by the vendor of the MONK 8A code (Serco); (2) assessing the repeatability and reliability of the code by running one the validation cases at different dates and times; and (3) repeating a subset of the MONK 8A criticality analysis cases run by Urenco.

**Q8.** With respect to the Board's question, please explain the "correlation" between the IROFS discussed in the SER with the cases listed in Table 7-3 of the MONK 8A Validation and Verification report.

**A8.** (RMK, DGG, AJB, BYH, DMP) As discussed in Section 7 of Revision 2 of the MONK 8A Validation and Verification report, Urenco ran an extensive set of MONK 8A criticality calculations in support of its existing enrichment facilities and the proposed NEF. *See* LES Exh. 127-M at 37. In other words, the NEF design and criticality analyses necessary to support that design were completed *before* LES filed its NEF license application with the NRC. (This stands in contrast to those cases where applicants perform code validation and verification prior to completing facility design and criticality analyses.) In developing Chapter 5 of the SAR (LES Exh. 128-M), LES recognized that a validation and verification effort would be necessary to comply with NRC requirements. That effort is reflected in the MONK 8A Verification and Validation report.

Of particular importance here, after it completed validation of the MONK 8A computer code used for the NEF, LES contractor AREVA (Framatome ANP) selected 30 representative *Urenco-run cases* from the NEF nuclear criticality safety ("NCS") supporting analyses. These cases are presented in Table 7-3 of Revision 2 of the MONK 8A Validation and Verification report (for purposes of step 3 of the *verification* methodology described above). *See* LES Exh. 127-M at 40. The use of these Urenco-run cases was intended to verify that similar results are achieved for the validated MONK 8A computer code maintained and utilized by AREVA for the NEF. Notwithstanding their use in the code verification process, because the 30 cases are drawn from the NEF NCS supporting analyses, their primary purpose is to support nuclear criticality safety at the NEF and, as a result, the criticality accident sequences or the designation of safe-by-design component parameter values for the NEF ISA. This is why a direct relationship does in fact exist between IROFS discussed in the SER and the cases listed in Table 7-3 of the MONK 8A Validation and Verification report

Each of the thirty cases listed in Table 7-3 of Revision 2 of the MONK 8A Validation and Verification report are addressed in SAR Table 5.1-1 (cases 1 through 6) and ISA Summary Sections 3.4 and 3.5 (cases 7 through 30). *See* LES Exh. 128-M (SAR Chapter 5, Revision 8 (Feb. 2006)); Staff Exh. 58-M (NEF ISA Summary). For example, cases 1 through 6 of Table 7-3 are criticality calculations performed to determine the maximum value of a parameter to yield $k_{eff} = 1$. These criticality analyses were then repeated to determine the maximum value of the parameter to yield a $k_{eff} = 0.95$. NEF SAR Table 5.1-1, Safe Values for Uniform Aqueous Solution of Enriched $UO_2F_2$, shows the resulting parameter critical and safe limits for 5.0 $^{w}/_{o}$ and 6.0 $^{w}/_{o}$ enrichments. (Note that NRC SER Table 5.3-1 is equivalent to NEF SAR Table 5.1-1, except that NRC SER Table 5.3-1 does not include the critical or safe values

for 5.0 $^{w}/_{o}$ enrichment.) NEF SAR Table 5.1-2, Safety Criteria for Buildings/Systems/Components, lists the safe criteria of SAR Table 5.1-1 that are used as control parameters to prevent criticality. *See* LES Exh. 128-M.

In accordance with the Board's request, the relationship between *all* criticality IROFS and the associated parameter safe values/safety criteria/NCS supporting analyses is provided in LES Exhibit 129-M (Table 1, "Relationship Between Criticality IROFS and Parameter Safe Values/Safety Criteria/Nuclear Criticality Safety Supporting Analyses"). Each criticality IROFS is listed with a brief IROFS description, its related control parameter and associated reference, and comments, as required, to further explain the IROFS relationship to the parameter safe value, safety criteria, or NCS supporting analyses.

**Q9.** You mentioned earlier the designation of safe-by-design component parameter values. Please explain the significance of passive safe-by-design components in the context of the Board's question regarding IROFS.

**A9.** (RMK, DGG, BYH, DMP) The passive safe-by-design components are those components which, by their physical size or arrangement, have been shown to have a $k_{eff} < 0.95$. The passive safe-by-design components are listed in ISA Summary Tables 3.7-6 through 3.7-21. *See* Staff Exh. 58-M. In regard to the Board's question, because safe-by-design components are considered items that may *affect* IROFS (*see* ISA Summary Table 3.7-2, page 64 of 64), they are considered to lie within the boundary of criticality IROFS. As such, the safe-by-design components are treated as if they were IROFS for purposes of establishing quality levels for components and configuration management requirements. The relationship between passive safe-by-design components and parameter safe values/NCS supporting analyses therefore is

provided in LES Exhibit 130-M (Table 2, "Relationship Between Passive Safe-By-Design Components and Parameter Safe Values/Nuclear Criticality Safety Supporting Analyses").

We also note that the definition of passive safe-by-design components encompasses two different categories of components. The first category includes those components that are safe-by-volume, safe-by-diameter or safe-by-slab thickness. A set of generic conservative criticality calculations has determined the maximum volume, diameter, or slab thickness (*i.e.*, safe value in NEF SAR Table 5.1-1 for 6.0 $^{w}/_{o}$ enrichment) that would result in a $k_{eff} < 0.95$. A component in this category has a volume, diameter or slab thickness that is less than the associated safe value resulting from the generic conservative criticality calculations and therefore the $k_{eff}$ associated with this component is $< 0.95$. The components in the second category require a more detailed criticality analysis (*i.e.*, a criticality analysis of the physical arrangement of the component's design configuration) to show that $k_{eff}$ is $< 0.95$. In the second category of components, the design configuration is not bounded by the results of the generic conservative criticality calculations for maximum volume, diameter, or slab thickness that would result in a $k_{eff} < 0.95$. Examples of components in this second category are the product pumps that have volumes greater than the safe-by-volume value, but are shown by specific criticality analysis to have a $k_{eff} < 0.95$.

**B. <u>Issues Relating to the Range of H/U Ratios Used to Validate the MONK 8A Computer Code</u>**

**Q10.** Please describe the nature of the Board's inquiries into the H/U ratio ranges evaluated by LES/AREVA in validating the MONK 8A computer code for the NEF.

**A.10.** (RMK, DGG, BYH, DMP) Paragraphs 5 and 6 of the Board's January 30th Order seek additional explanation regarding the range of H/U ratios evaluated in the MONK 8A

Validation and Verification Report. More specifically, paragraphs 5 and 6 contain the following inquires:

> 5. From Table 7-3 of the Monk 8 Verification/Validation report, revision 1, the Board sees that the criticality calculations for the items relied on for safety (IROFS) concerning pipe works involve hydrogen to uranium (H/U) ratios from 12 to 14. How does the staff compute the bias allowance for these cases, given the spreads indicated in Figure 6.3 of that report? Is the number in the Safety Evaluation Report (SER) correct?
>
> 6. How does the staff justify acceptance of IROFS for depleted uranium hexafluoride ($DUF_6$) mixtures with no hydrogen (except in the reflector) when, according to the second full paragraph in section 6.1 (page 29) of the report, the H/U ratio varied between 0.102 to 1378 in the calculations used for verification?

Paragraphs 5 and 6 encompass earlier inquires made by the Board during the October 27, 2005 hearing. *See* February 8th Order, Attach. A at ¶¶ 8.e-8.f.

**Q11.** In paragraph 5 above, the Board references Revision 1 of the MONK 8A Validation and Verification report. *See* LES Exh. 126-M. Revision 1 of the report was recently revised. MONK 8A Validation and Verification report, Revision 2 (LES Exh. 127-M), which was submitted to the NRC on February 16, 2005, now represents the current version of the report. Did the recent revisions to the report include any changes to the range of H/U ratios considered by AREVA in connection with its code validation effort? If so, please explain the significance of those changes.

**A11.** (RMK, DGG, BYH, DMP) Yes. Revision 2 of the MONK 8A Validation and Verification report reflects the incorporation of additional benchmark critical experiments to better cover the AOA range of the validation, as well as the deletion of benchmark critical experiments involving High Enriched Uranium ("HEU"). As a result of these changes, the $H/U_{total}$ (H/U) ratio range evaluated in the NCS supporting analyses for the NEF is more fully

covered. The H/U ratio for the cases in MONK 8A Validation and Verification Table 7-3 (and the NEF NCS supporting analyses) is the $H/U_{total}$ ratio and ranges from 1 to 32. *See* LES Exh. 127-M at 40. The benchmark critical experiments used in Revision 2 of the MONK 8A Validation and Verification report have H/U ratios that range from 0.787 to 103. Thus, in regard to Board question 6, the H/U ratios no longer range from 0.103 to 1378, as they did in Revision 1 of the MONK 8A Validation and Verification report. With the new benchmark critical experiments added, and the benchmark critical experiments involving HEU removed from the validation, the H/U ratio range of the benchmark critical experiments also more closely reflects the NEF-specific H/U ratio range. As a result of these changes, the calculated USLs previously reported have been revised. *See* LES Exh. 127-M at 28, 41.

**Q13.** Please explain how you have addressed the issue raised by the Board in question 5 above regarding the computation of bias allowance for the H/U ratios considered.

**A13.** (RMK, DGG, BYH, DMP) Consistent with NUREG/CR-6698 "Guide for Validation of Nuclear Criticality Safety Calculational Methodology" (Jan. 2001) (LES Exh. 131-M), no additional bias allowance is required for the $UF_6$ Product Pipework cases (*i.e.*, beyond that calculated for the applicable USL), because the H/U ratio range of 12 to 14 for these cases is within the range of H/U ratios of the benchmark critical experiments provided in Revision 2 of the MONK 8A Validation and Verification report. Notwithstanding, to address the impact of extension of the AOA for an H/U ratio of 0 (*i.e.*, no moderation), Figure 6.3 of Revision 2 of the MONK 8A Validation and Verification report was reviewed. Figure 6.3 provides the trend for the entire range of H/U ratios, with an intercept of 1.00375 and a slope of –4.024E-05 [$k_{eff}$/(H/U)]. *See* LES Exh. 127-M at 31. Because the bias slope is negative (*i.e.*, $k_{eff}$ goes up as H/U ratio goes down), and the extrapolation is small (from 0.787 to 0), NUREG/CR-6698

permits the extension of the AOA to an H/U ratio of 0 (*i.e.*, no moderation) with no penalty. *See* LES Exh. 131-M.

Additionally, to address the impact of the ranges of H/U ratios from the benchmark critical experiments used in the validation on the resulting bias, a set of hypothetical USLs were calculated for select ranges of H/U ratios, and then compared to the USL results presented in Revision 2 of the MONK 8A Validation and Verification report. The USLs were calculated using the methods described in Revision 2 of MONK 8A Validation and Verification report. *See* LES Exh. 127-M at 7-8. The change in bias or bias allowance (*i.e.*, ΔBias) was determined by subtracting the USL calculated for the different ranges of H/U ratios from the USL determined in the MONK 8A Validation and Verification report. The USLs and the resulting ΔBias values are as follows:

| Minimum H/U Ratio | Maximum H/U Ratio | Average $k_{calc}$ ($k_{bar}$) | Number of Cases | Pooled Variance (Sp) | One Sided Lower Tolerance Factor (U) | USL | ΔBias = $USL_{V\&V}$ -$USL_{range}$ |
|---|---|---|---|---|---|---|---|
| 0.787 | 102.613 | 1.0009 | 93 | .0041 | 2.065 | .9415 | n/a |
| 0.787 | 5.32 | 1.0025 | 40 | .0073 | 2.126 | .9345 | 0.0070 |
| 5.32 | 37.3 | 1.0041 | 11 | .0054 | 2.815 | .9348 | 0.0067 |
| 37.3 | 102.613 | 1.0005 | 42 | .0033 | 2.092 | .9431 | -0.0016 |

**Q14.** Please summarize the key results associated with your analysis of the impact of the H/U ratio ranges on computational bias.

**A14.** (RMK, DGG, BYH, DMP) The first result presented in the above table is from Revision 2 of MONK 8A Validation and Verification report (*i.e.*, $USL_{V\&V}$). The USL selected from the report is for the H/U ratio range of 0.787 to 102.613 and is 0.9415. For the H/U ratio

range of 0.787 to 5.32, the calculated USL is 0.9345. The resulting ΔBias is 0.0070. For the H/U ratio range of 5.32 to 37.3, the calculated USL is 0.9348. The resulting ΔBias is 0.0067. Finally, for the H/U ratio range of 37.3 to 102.613, the calculated USL is 0.9431. The resulting ΔBias is -0.0016.

**Q15.** Based on the above results, can you provide any observations?

**A15.** Yes. The change in bias varied substantially with changes in the range of H/U ratios. These variances could be attributed to the following: (1) the large experimental uncertainties reflected in some of the groupings of benchmark cases for the varied ranges; (2) the small number of cases represented in some of the groupings of benchmark cases for the varied ranges (particularly in the grouping for the H/U ratio range of 5.32 to 37.3), and the lack of sufficient applicable benchmark cases in certain H/U ratio ranges.

In a critical system, the primary purpose of the moderator is to slow the high energy neutrons born of fission down to thermal energies at which they have a higher probability of causing a $^{235}U$ atom to fission. The Mean Log Energy of Neutrons Causing Fission ("LMENCF") is a reasonable single-value indicator of the neutron spectrum. LMENCF is plotted against H/U ratio for the validation cases and the NEF NCS support analyses cases in **Figure 1** ("Mean Log Energy of Neutron Causing Fission versus H/U Ratio") below. Although there is some scatter, **Figure 1** shows a strong correlation between LMENCF and H/U ratio. The neutron spectrum is affected by other parameters, such as leakage or parasitic absorption, which are not accounted for in the H/U ratio. These factors are the reason for the scatter.

There are some gaps in the H/U ratios in the validation cases that may contribute to the calculated change in bias associated with variance of H/U ratio ranges. Given that the spectrum is primarily controlled by the H/U ratio, the impact of the variance of H/U ratio ranges

on the MONK 8A validation for NEF (*i.e.*, change in bias) can be answered by looking at how well the neutron energy spectrum is covered by the validation cases.

**Figure 1 and Figure 2** ("Validation and NCS Support Analysis Cases k-effective vs Mean Log Energy of Neutrons Causing Fission") below show that the LMENCF for the NEF NCS support analyses cases cover a region of the plot that has some gaps in the validation cases. However, the NEF NCS support analyses cases all fall in an energy region below 1 eV. Neutron cross sections in this energy region vary very little with energy, and are usually well characterized by 1/v behavior. Given the well-behaved cross sections in this energy region, there is no reason to expect a change in bias due to a relatively small change in neutron spectrum. As a result, considering the strong correlation between H/U ratio and neutron energy spectrum, it is expected that the true impact (given sufficient applicable benchmark critical data) of the variance of H/U ratio ranges, for the ranges covered by the NEF NCS support calculation cases, should be insignificant.

**Figure 1 Mean Log Energy of Neutron Causing Fission versus H/U Ratio**

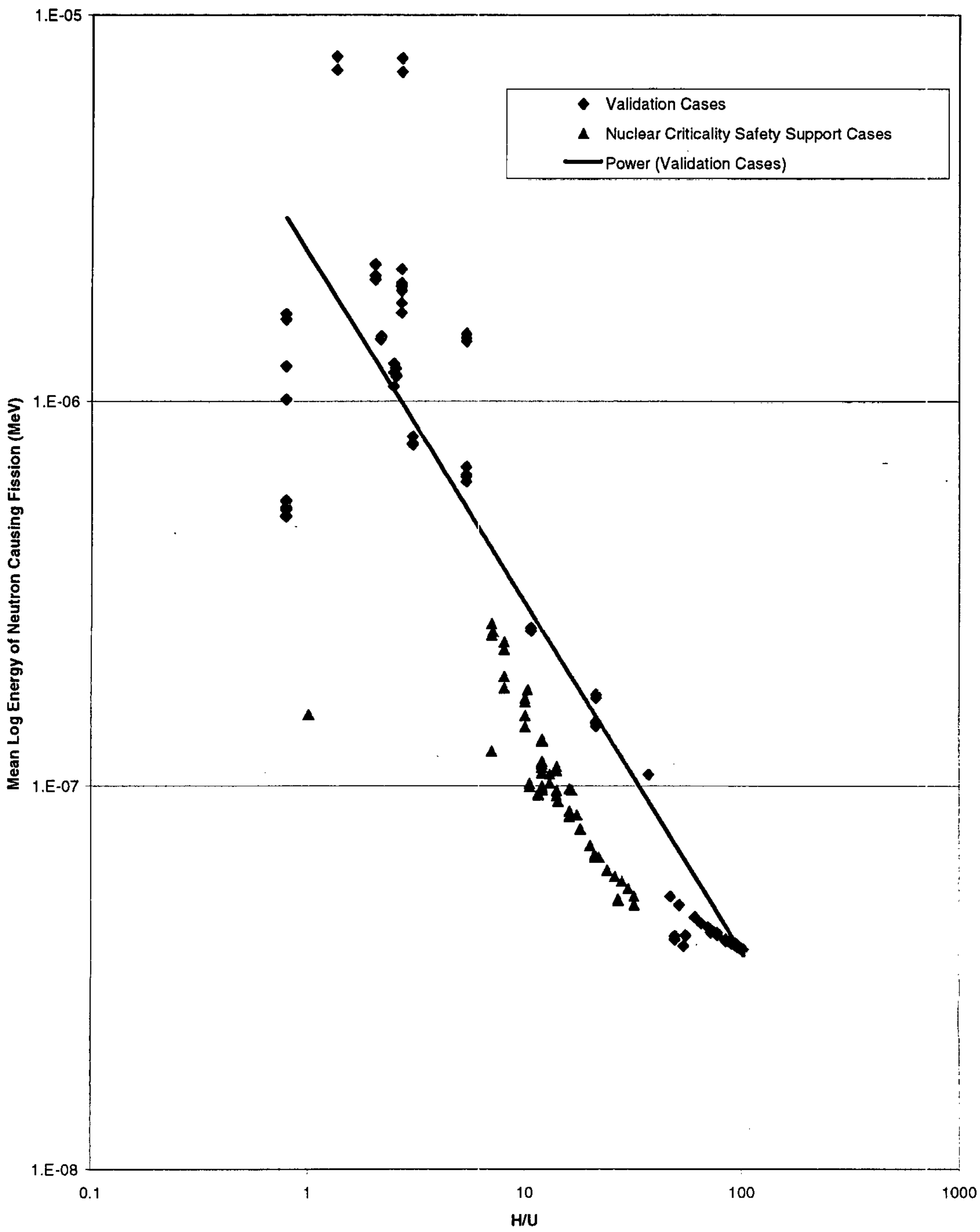
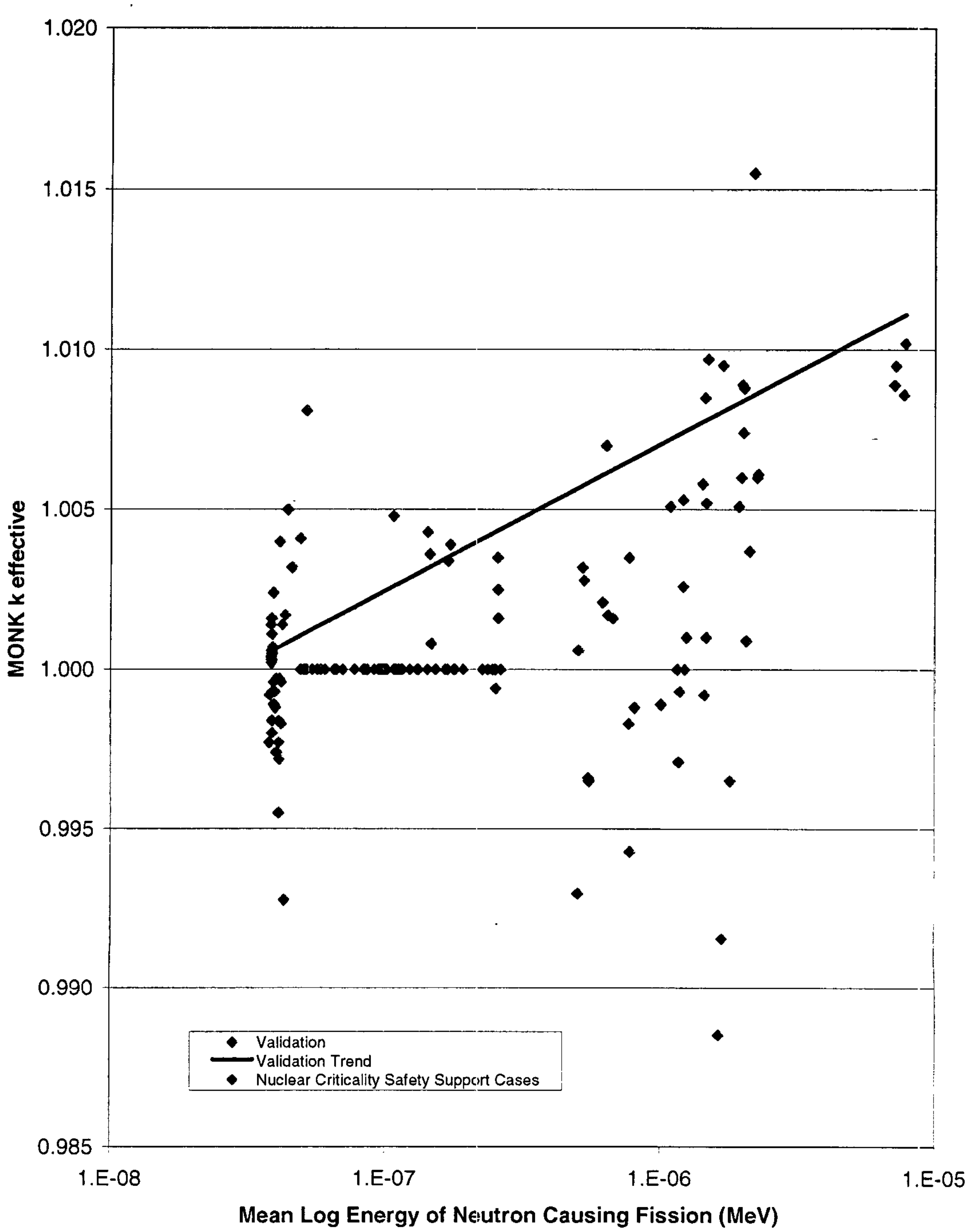


**Figure 2 Validation and NCS Support Analysis Cases k-effective vs Mean Log Energy of Neutrons Causing Fission**




Note: NCS support analysis cases have k-effective artificially set to 1.0 to show range of LMENCF only.

## C. Treatment of the "No Hydrogen Moderation" Case in the MONK 8A Computer Code Validation

**Q16.** Please describe the issues raised by the Board with respect to LES's/AREVA's treatment of the no hydrogen moderation scenario (*i.e.*, H/U ratio equals zero).

**A16.** In paragraph 8 of its January 30th Order, the Board posed the following questions to LES:

> 8. The Board requests that LES provide information regarding the following three matters:
>
> (a) Which case in Table 7-3 of the MONK 8 report corresponds to no hydrogen moderation, *i.e.*, $DUF_6$ only?
>
> (b) Which critical experiments were analyzed to validate the code for such cases?
>
> (c) In performing such validation work, how were the unresolved resonances treated?

**Q17.** With respect to subparagraph 8(a), do any of the cases in Table 7-3 of the MONK 8A Validation and Verification report (Revision 2) correspond to "no hydrogen moderation?" If not, please explain why such a case is not included in Table 7-3.

**A17.** (RMK, DGG, BYH, DMP) None of the cases in Table 7-3 of the MONK 8A Validation and Verification report correspond to no hydrogen moderation. This reflects the fact that, at the low enrichment limits established for the NEF, sufficient enriched uranic material cannot be accumulated to achieve criticality without moderation. Calculations performed by Framatome ANP for LES have demonstrated that $k_{eff}$ for enriched uranic material at 6.0 $^{w}/_{o}$ enrichment, with no moderation (H/U ratio=0), and with reflection, is less than 0.77.

**Q18.** With regard to the Board's question in paragraph 8(b), what critical experiments were analyzed to validate the code for low hydrogen moderation cases?

**A18.** (RMK, DGG, BYH, DMP) The lowest H/U ratio for the cases shown in Table 7-3 of the MONK 8A Validation and Verification report is Case 28 "TSB Chemistry Laboratory 1S bottles in a 25x25 array with water flooding 1.5 cm spacing." That case has an H/U ratio of 1. An H/U ratio of 1 was selected because the maximum permitted H/U ratio for a 30B product cylinder is unity. The 1S sample bottles are used in the process of sampling the product's purity. The $k_{eff}$ calculated for this case is 0.6549. As discussed above, the MONK 8A Validation and Verification Report has been revised, and, as a result, the H/U ratio range of the benchmark critical experiments more closely reflects the NEF-specific H/U ratio range. In particular, the MONK 8A validation now includes benchmark critical experiments at H/U ratios of 0.787, 2 and 3. This range of H/U ratios adequately covers the H/U ratio of Case 28 in Table 7-3 of the MONK 8A Validation and Verification report.

**Q19.** Paragraph 8(c) of the Board's January 30th Order presents a question that the Board originally posed in October. Specifically, in discussing unmoderated cores, the Board inquired as to how the MONK 8A code treats "unresolved resonances," *i.e.*, the inherent randomness of unresolved JEF2.2 cross-sections. Please explain how the MONK 8A code addresses this situation.

**A19.** (BYH) To resolve this Board question, we consulted with Serco, the vendor of the MONK code. As the Board recognized, the source of nuclear data used in the MONK code is the JEF2.2 evaluated nuclear data library. We confirmed that Serco Assurance has validated the JEF2.2 library, in combination with the MONK code, and demonstrated that it gives results that are comparable to other data libraries. JEF2.2 gives statistical resonance parameters in the unresolved range that have a coarser energy mesh than is required by the MONK code. The form of the data library used by MONK is the continuous energy database. In this database, the

data is stored in a fine energy mesh (13193 groups). Therefore, the data for JEF2.2 need to be processed for use in the MONK code calculations.

**Q20.** Please describe how the JEF2.2 data are processed for use in the MONK code calculations.

**A20.** (BYH) The NJOY code is used for the processing of the data in the unresolved resonance range. The modules of the NJOY code that are used to process data, in the unresolved resonance range, used by the MONK code are described below:

- The RECONR module calculates the smoothed infinite dilute cross sections at the energies where unresolved parameters are given.
- The BROADR module Doppler broadens these infinite dilute data to required temperatures but keeps the cross section on the same energy grid.
- The UNRESR module group averages the infinite dilute cross sections to give data in the energy bins required by MONK. The energy bins required by MONK are much narrower than the statistical parameter grid given in modern nuclear data evaluations. UNRESR calculates the cross sections for the fine energy groups required by MONK from the cross sections of the coarser energy groups in NJOY.
- The UNRESR module also calculates the cross section at the user defined background. In MONK, 10 barns for U-238 is used for the background, for all other isotopes a background cross section of 100 barns is used. In the unresolved resonance range, there are 1/1024 lethargy width groups from 72eV up to 10KeV covering the unresolved resonances in U-235 and Pu-239 and 1/128 lethargy width groups from 10Kev to 14MeV covering the unresolved range of U-238.

After NJOY processes the data using the above modules, the cross sections in each of the new groups in the unresolved region are collected into pairs. The cross sections in each of the original energy groups are modified so that the cross section in each paired group is reproduced exactly at infinite dilution and at 10 barns for U-238. One member of the pair of cross sections is randomly allocated to the lowest energy. The other member of the cross section pair goes to the higher energy group. This process creates a set of cross sections for each energy

group used by MONK in the unresolved resonance range. These are the only cross sections used in the MONK code for the unresolved resonance range. All levels of shielding from thick samples to thin samples to dilute mixtures are covered by this scheme.

Finally, the results of this process are output into a cross section library called dice96j2v5.dat. This cross section data library is used by MONK 8A. The dice96j2v5.dat cross section data library was validated as part of the overall validation documented in the MONK 8A Validation and Verification report.

### D. Probability of Significant Water Vapor Intrusion With Respect to Criticality Safety

**Q21.** In October 2005, the Board requested a more detailed, preferably quantitative, discussion of the probability of significant water vapor intrusion with respect to criticality safety. Accordingly, please discuss the likelihood of such an event occurring at the NEF.

**A21.** (RMK, DGG, AJB, BYH, DMP) The NEF will be designed and constructed to preclude the occurrence of such an event. Due to the high vacuum requirements for the normal operation of the gas centrifuges of the Separations Plant, air in-leakage -- and, as a result, water vapor intrusion -- into the process systems is controlled to very low levels, such that the condition of significant water vapor intrusion constitutes an abnormal condition. In addition, excessive air in-leakage (and any resulting water vapor intrusion) would result in a loss of vacuum, which, in turn, would cause the affected centrifuges to abruptly stop. Therefore, the buildup of mass of moderated breakdown material in the associated process system components, such that the components become filled with sufficient mass of moderated enriched uranic material for criticality, is precluded.

**Q22.** The Board suggested the possible preparation of a "fault-tree diagram" to address its question. Have you prepared such a diagram?

**A22.** (RMK, DGG, AJB, BYH, DMP) No. However, we believe that the following discussion is fully responsive to the Board's question. With respect to criticality safety, water vapor intrusion potentially impacts only those portions of the Separations Plant in which enriched uranium is present, *i.e.*, the centrifuges of the cascades, the product pipework, product cylinders, product pumps, product $UF_6$ cold traps, and the associated product vacuum pump/chemical trap sets. Therefore, it is possible to discuss in greater detail the potential impact of significant water vapor intrusion -- *assuming* it were to occur -- on criticality safety relative to each of those components.

**Q23.** Please describe the potential impact of significant water vapor intrusion on criticality safety with respect to *facility centrifuges.*

**A23.** (RMK, DGG, AJB, BYH, DMP) The individual centrifuges are safe-by-favorable geometry. The only potential for a criticality incident in a centrifuge cascade is by gross uranium accumulation in failed centrifuges. To achieve criticality in a cascade would require an array of failed centrifuges to be substantially filled with enriched uranic breakdown product (as $UO_2F_2 \cdot 3.5H_2O$). The extreme conditions required to obtain the necessary uranic accumulation for criticality by this mechanism could never credibly occur in practice.

Specifically, the cascade criticality occurrence would require that: (1) a large number of centrifuge machines fail in a specific geometric grouping within the cascade; (2) this specific grouping must be positioned at the product end of the cascade; (3) contrary to established processes, this specific grouping of failed centrifuge machines is not recognized; (4) every centrifuge machine within the group develops atmospheric in-leakage; (5) those in-leakages are not detected over an extremely extended period of time; (6) loss of product material from the process system occurs due to the in-leakages (*i.e.*, due to the accumulation of $UF_6$

breakdown materials in the failed centrifuge machines); and (7) the loss of material is not detected during the implementation of the material control and accountability procedures/requirements. Conservatively assigning the probability of $10^{-1}$ for each of the above events (in the chain of events required for criticality) supports the conclusion that this scenario is not credible. As such, significant water vapor intrusion does not have an impact on the criticality safety of centrifuges.

**Q23.** Please describe the potential impact of significant water vapor intrusion on criticality safety with respect to *product pipework.*

**A23.** (RMK, DGG, AJB, BYH, DMP) Product pipework in the Separations Building varies in size up to a maximum nominal diameter of 150 mm (5.9 in). As such, individual product pipework is safe-by-favorable geometry. Criticality calculations have been performed for generic arrays of pipe intersections that are assumed to be filled entirely with uranyl fluoride/water mixture at optimum moderation at 6.0 $^{w}/_{o}$ enrichment. Subcriticality has been demonstrated for each of these arrays. Parallel pipe runs containing product material either fit within the criticality safe-by-favorable geometry value for cylinder diameter, or have been explicitly modeled assuming optimum moderation at 6.0% enrichment and demonstrated to be subcritical. Accordingly, significant water vapor intrusion does not have an impact on criticality safety of the product pipework.

**Q24.** Please describe the potential impact of significant water vapor intrusion on criticality safety with respect to *product pumps.*

**A24.** (RMK, DGG, AJB, BYH, DMP) The product pump combination unit consists of two Leybold pumps, models WS2000 series and WS500 series, positioned in a fixed frame. The WS500 series pump internal free volume is safe-by-favorable geometry. Although the WS2000

series pump internal free volume exceeds the safe-by-favorable geometry volume, the WS2000 series pump internal free volume is far from the optimum. Therefore, the WS2000 pump was modeled in detail based on drawings supplied by the manufacturer. Criticality calculations have been performed for the WS2000 pump, which is assumed to be filled with uranyl fluoride/water mixture at optimum moderation at 6.0 $^{w}/_{o}$ enrichment and have demonstrated that subcriticality is maintained. In addition, criticality calculations were performed for this product pump combination unit (*i.e.*, the WS500 and WS2000 series pump) using an enrichment of 6.0 $^{w}/_{o}$ and optimum moderation and have demonstrated that subcriticality is maintained. Therefore, significant water vapor intrusion does not have an impact on criticality safety of the product pumps.

**Q25.** Please describe the potential impact of significant water vapor intrusion on criticality safety with respect to *product cylinders*.

**A25.** (RMK, DGG, AJB, BYH, DMP) Criticality safety of Type 48Y and 30B product cylinders depends on the control of moderator content. Criticality safety is achieved by ensuring that hydrogen present in Type 48Y product cylinders and hydrogen present in Type 30B product cylinders is less than the applicable safety criteria limits specified in SAR Table 5.1-2, Safety Criteria for Buildings/Systems/Components. *See* LES Exh. 128-M. The moderation within product cylinders is controlled by a series of plant operating features. These features include checks that the product cylinder is clean and empty prior to filling (*i.e.*, performance of the IROFS16a required independent verifications, prior to introducing product into a cylinder, that no visible oil is present and that cylinder vapor pressure is within required limits). Also, the moderator ($H_2O$, HF) entering the product cylinder is monitored during the time the product cylinder is connected to the plant $UF_6$ systems (i.e., performance of the IROFS16c and

IROFS16d required periodic independent verifications of associated cylinder venting to limit addition of moderator). Cylinder venting is required to remove any light gases (air and HF) present in the cylinder, which has originated from the process system, to allow the cylinder to be filled. Excessive venting operations are indicative of abnormal process system air in-leakage. In the event that the total vent count limit (which is based on the moderator limits of the applicable safety criteria specified in SAR Table 5.1-2) is exceeded (*i.e.*, the IROFS acceptance criteria not met), then venting of the associated cylinder and the product cylinder filling process shall be immediately stopped. Accordingly, significant water vapor intrusion does not have an impact on criticality safety of the product cylinders.

**Q26.** Please describe the potential impact of significant water vapor intrusion on criticality safety with respect to *Product $UF_6$ Cold Traps.*

**A26.** (RMK, DGG, AJB, BYH, DMP) The individual product $UF_6$ cold traps are safe-by-favorable geometry. The cold trap and the standby cold trap are separated from each other by center-to-center separation of 110 cm (43.3 in). Therefore, calculations were performed on the pair of cold traps. These calculations assumed an enrichment of 6.0 $^{w}/_{o}$ and a maximum credible H/U ratio of 7 and have demonstrated subcriticality is maintained. As such, significant water vapor intrusion does not have an impact on criticality safety of the product $UF_6$ cold traps.

**Q27.** Please describe the potential impact of significant water vapor intrusion on criticality safety with respect to *Product Vacuum Pump/Chemical Trap Sets.*

**A27.** (RMK, DGG, AJB, BYH, DMP) The product vacuum pumps and chemical trap set components are individually safe-by-favorable geometry. Calculations have been performed for the combination of components of the associated product vacuum pump/chemical trap sets and the nearby standby product vacuum pump/chemical trap set. These calculations assume an

enrichment of 6.0 $^{w}/_{o}$ and that components are filled with uranyl fluoride/water with no restriction on water content. The calculations have demonstrated that subcriticality is maintained. Therefore, significant water vapor intrusion does not have an impact on criticality safety of the product vacuum pump/chemical trap sets.

**Q28.** Does this conclude your testimony?

**A28.** Yes.

# RESUME

**Rod M. Krich**
**6395 Twin Oaks Lane**
**Lisle, IL 60532**
**(H) 630 428 1967**
**(W) 630 657-2813**

## EDUCATION

MS Nuclear Engineering - University of Illinois - 1973
BS Mechanical Engineering~ New Jersey Institute of Technology— 1972

## EXPERIENCE

**1998 to Present**

Exelon (formerly Com Ed)

Vice President, Licensing Projects for Exelon Nuclear, with the overall responsibility for leading Exelon Nuclear's licensing activities on future generation ventures, predominantly leading the licensing effort for a U.S. gas centrifuge enrichment plant. In addition, I have been assisting with the Yucca Mountain project licensing effort and served as the lead on strategic licensing issues with the responsibility of working with the Nuclear Regulatory Commission and the Nuclear Energy Institute on the development of a new approach to licensing new reactors.

Vice President-Regulatory Services responsible for interface with the NRC and State regulatory agencies, and regulatory programs. This responsibility covers all 12 ComEd nuclear units and the Nuclear Generation Group headquarters. With respect to regulatory programs, responsibilities include programs such as the change evaluation process (i.e., 10 CFR *50.59,* "Changes, tests and experiments), the operability determination process, and the Updated Final Safety Analysis revision process). In this capacity, I was responsible for improving the relationship with the regulatory agencies such that, taken together with improved plant performance, the special scrutiny applied to the ComEd operating plants will be replaced with the normal oversight process. The Regulatory Services organization consists of a group located at the Nuclear Generation Group headquarters and a Regulatory Assurance group at each plant that has a matrix reporting relationship to the Vice President-Regulatory Services.

**1994 to 1998**

Carolina Power & Light Company

As Chief Engineer from November 1996 to April 1998, 1 was head ofthe Chief Section oftlie Nuclear Engineering Department. In this capacity, I was responsible for maintaining the plant design bases and developing, maintaining and enforcing the engineering processes procedures. In addition to the corporate Chief Section, the Design Control groups at each of the nuclear plant sites reported to me starting in February 1997.

As Manager - Regulatory Affairs at the H. B. Robinson Steam Electric Plant, Unit No. 2 (Westinghouse PWR) from February 1994 to November 1996, the managers of Licensing/Regulatory Programs, Emergency Preparedness, and Corrective Action/Operating Experience Program organizations reported to me. As such, I was responsible for all interface and licensing activities involving the NRC headquarters and regional office, environmental regulatory agencies, and the Institute of Nuclear Power Operations. My responsibilities also included implementation of the Emergency Preparedness program, and administration of the Corrective Action and Operating Experience programs. After assuming my position in Carolina Power &

Light Company, I was instrumental in revising and upgrading the I OCFR5O.59 safety evaluation program, and was responsible for its implementation at the plant site. My group was also responsible for leading the team that prepared the NRC submittal containing the conversion to the improved Technical Specifications.

1988 to 1994

Philadelphia Electric Company

As Manager - Limerick Licensing Branch at the Nuclear Group Headquarters, responsible for all licensing activities for the two unit Limerick Generating Station (General Electric BWR) conducted with the NRC headquarters and all enforcement issues involving NRC Region I, including completion of the final tasks leading to issuance of the Unit 2 Operating License. Special projects included assisting in the development of the Design Baseline Document program, obtaining NRC approval for an Emergency Operations Facility common to two sites, preparation of the Technical Specification changes to extend the plant refueling cycle to 24 months and to allow plant operation at uprated power, and obtaining NRC approval of a change to the Limerick Operating Licenses to accept and use the spent fuel from the Shoreham plant. I was also responsible for the development and implementation of the IOCFR5O.59 safety evaluation process used throughout the nuclear organization, development of the initial Updated Final Safety Analysis Report for Limerick Generating Station, and served as the Company's Primary Representative to the BWR Owners' Group.

1986 to 1988

Virginia Power Company

As the Senior Staff Engineer in the Safety Evaluation and Control section, my activities involved responding to both routine and special licensing issues pertaining to North Anna Power Station (Westinghouse PWR). My duties ranged from preparing Technical Specification interpretations and change requests, exemption requests, and coordinating responses to NRC inspection reports, to developing presentations for NRC enforcement conferences and coordinating licensing activities associated with long-term issues such as ATWS and equipment qualification. I was also the Company representative to the utility group formed to address the station blackout issue, and was particularly involved in developing an acceptable method by which utilities can address equipment operability during station blackout conditions.

1981 to 1986

Consumers Power Company

During my employment with Consumers Power Company, I worked at the General Office in the Nuclear Licensing Department and the Company's Palisades Plant (Combustion Engineering PWR). While in the Nuclear Licensing Department, I held the position of Plant Licensing Engineer for the Big Rock Point Plant (General Electric BWR), Section Head - Special Projects Section, and Section Head - Licensing Projects and Generic Issues Section. My responsibilities while in these positions included managing the initial and continuing Palisades Plant FSAR update effort, developing and operating a computerized commitment tracking system, managing the licensing activities supporting the expansion of the Palisades Plant spent fuel storage capacity, and coordinating activities associated with various generic issues such as fire protection and seismic qualification of equipment. As the administrative point of contact for INPO, I coordinated the Company's efforts in responding to plant and corporate INPO evaluations. At the Palisades Plant, I was head of the Plant Licensing Department. My responsibilities primarily entailed managing the on-site licensing activities, including preparation of Licensee Event Reports and responses to

inspection reports, interfacing with NRC resident and regional inspectors, and serving as chairman of the on-site safety review committee. I also administered the on-site corrective action system and managed the on-site program for the review and implementation of industry operating experience.

1974 to 1981 General Atomic Company

My positions while at the General Atomic Company were principally concerned with fuel performance development efforts for the High Temperature Gas-Cooled Reactor (HTGR). Specific responsibilities included two assignments to the French Atomic Energy Commission laboratories at Saclay and Grenoble (France) for the purpose of coordinating a cooperative test program. I was also assigned as a consultant to the Bechtel Corporation, Los Angeles Power Division, and worked in the Nuclear Group of the Alvin M. Vogtle Nuclear Project for Georgia Power.

## RELATED EXPERIENCE

University of Illinois

As a graduate research assistant, I assisted in both the experimental and analytical phases of a NASA-funded program in the study and modeling of far-field noise generated by near-field turbulence in jets.

## PUBLICATIONS

General Atomic Company

"CPL-2 Analysis: Fission Product Release, Plateout and Liftoff."

University of Illinois

"Prediction of Far-Field Sound Power Level for Jet Flows from Flow Field Pressure Model," paper 75-440 in the AIAA Journal, co-authored by Jones, Weber, Hammersley, Planchon, Krich, McDowell, and Northranandan.

## MEMBERSHIPS

American Nuclear Society
Pi Tau Sigma -Mechanical Engineers 1-Honorary Fraternity
American Association for the Advancement of Science

## REFERENCES

Furnished upon request

DANIEL G. GREEN
2726 Edgewood Drive
Cedar Falls, Iowa 50613
(319) 277-3182

**EDUCATION:**

Master of Science in Nuclear Engineering, Kansas State University, August 1981.

Bachelor of Science in Nuclear Engineering, Kansas State University, May 1980.

**RELATED EXPERIENCE:**

EXCEL Services Corporation, Louisiana Energy Services (01/04-Present)

Senior Consulting Engineer: Supported the licensing effort for the construction and operation of the National Enrichment Facility, a gaseous centrifuge enrichment plant proposed to be located in Lea County, New Mexico. This involved supporting NRC review meetings and teleconferences, developing responses to NRC Requests for Additional Information regarding the licensing submittal, and revising the licensing submittal, as necessary. Responsibilities during this time also included serving as a member of the Integrated Safety Analysis team and supporting the development and implementation of the Configuration Management program.

EXCEL Services Corporation, Louisiana Energy Services (08/03-12/03)

Senior Consulting Engineer: Supported development and submittal of the Louisiana Energy Services License Application for the construction and operation of the National Enrichment Facility, a gaseous centrifuge enrichment plant proposed to be located in Lea County, New Mexico. This included ensuring applicable regulatory requirements were addressed.

EXCEL Services Corporation, International Access Corporation (IAC) (7/03)

Senior Consulting Engineer: Perfomed an evaluation of the impact of the new Reactor Oversight Process (ROP) on regulatory burden for the US nuclear industry. The evaluation examined the impact on the US nuclear industry as a whole, as well as the impact on individual US nuclear industry licensees using case studies that show the decreasing or increasing regulatory burden when plant performance trends show improvement or decline, using the new ROP. Research for the evaluation was conducted using NRC public domain resources, Nuclear Energy Institute and US nuclear industry input, and insights from US nuclear plant licensees. Interviews of US nuclear plant licensees were also conducted.

EXCEL Services Corporation, Entergy - Indian Point 2 (6/03)

Senior Consulting Engineer: Performed an independent assessment of the submitted Indian Point 2 (IP2) Improved Technical Specifications (ITS) to ensure that the final product was ready for implementation. The focus of the assessment was to perform both a limited "horizontal" review (i.e., looking at the IP2 ITS and Bases in an integrated fashion to ensure overall consistency), and a limited "vertical" review (i.e., looking in some detail at specific IP2 Technical Specifications and Bases, including the associated ITS Conversion Package, which are known in the industry to be especially complex and/or important to safety to ensure that the requisite unity of design/licensing bases are preserved). The results of the assessment were documented in a report provided to Entergy.

EXCEL Services Corporation, American Electric Power (AEP) - DC Cook (5/03)

Senior Consulting Engineer: Assisted in the development of the DC Cook Units 1 and 2 Improved Technical Specifications/24 Month Operating Cycle initial draft submittal of the Instrumentation section. The submittal utilized NUREG-1431, Revision 2, as the standard. This involved development of plant specific Technical Specifications, Bases, technical justifications, 10CFR50.92 evaluations, and comparison documents.

EXCEL Services Corporation, Omaha Public Power District (OPPD) - Fort Calhoun Station (4/03)

Senior Consulting Engineer: Developed a root cause analysis evaluation associated with the Fort Calhoun Station practice of establishing Allowed Outage Times for systems not included in the Technical Specifications that support the operability of systems in Technical Specifications.

EXCEL Services Corporation, Omaha Public Power District (OPPD) - Fort Calhoun Station (3/03)

Senior Consulting Engineer: Performed an assessment of the benefits of options and disadvantages and advantages of upgrading the Fort Calhoun Station (FCS) current Technical Specifications (CTS). The resulting report discussed the options for upgrading FCS CTS, including the option of full conversion to Revision 2 of the Improved Standard Technical Specifications for Combustion Engineering Plants. For each of the options examined, the report provided the estimated cost, advantages, disadvantages, plant impacts, and interface requirements with other planned FCS major projects.

EXCEL Services Corporation, Australian Nuclear Science and Technology Organisation (ANSTO) (2/03)

Senior Consulting Engineer: Developed update for ANSTO Replacement Research Reactor (RRR) Safety Analysis Report Chapter 13, "Conduct of Operations. This included providing updates to address the proposed RRR Organizational Structure, Training Program, Review and Audit Functions, Operating Procedures and Instructions, and Maintenance, Testing and Inspection.

EXCEL Services Corporation, Exelon (1/03)

Senior Consulting Engineer: Performed an independent review of the Louisiana Energy Services License Application for the construction and operation of a gaseous centrifuge enrichment plant. The review included ensuring compliance with the guidance of NUREG-1520, "Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility."

EXCEL Services Corporation, Australian Nuclear Science and Technology Organisation (ANSTO) (12/02)

Senior Consulting Engineer: Developed a Maintenance and Testing Program Bases Document for the currently under construction ANSTO Replacement Research Reactor (RRR). The program is based on the requirements of 10 CFR 50.65, "Requirements for Monitoring the Effectiveness of Maintenance of Nuclear Power Plants," and the associated implementation guidance.

EXCEL Services Corporation, First Energy Nuclear Operating Company - Davis Besse (11/02)

Senior Consulting Engineer: Supported reconstitution of the Davis Besse Licensing Basis to support restart. This involved research and review of both generic and plant-specific licensing correspondence and documentation of the current licensing basis for the plant.

EXCEL Services Corporation, Wolf Creek Nuclear Operating Company (10/02)

Senior Consulting Engineer: Supported development of on-line training courses for the License Amendment Requests, the Introduction to Technical Specifications and the Use and Application of Technical Specifications courses of the United Services Alliance Regulatory Affairs and Qualification Initiative.

EXCEL Services Corporation, First Energy Nuclear Operating Company - Perry (9/02)

Senior Consulting Engineer: Supported development of training materials for the Licensing Basis Introduction and Miscellaneous Licensing Basis Change Processes courses of the United Services Alliance Regulatory Affairs and Qualification Initiative.

EXCEL Services Corporation, Australian Nuclear Science and Technology Organisation (ANSTO) (11/01-8/02)

Senior Consulting Engineer: Developed Operating Limits and Conditions (OLCs) and Bases for the currently under construction ANSTO Replacement Research Reactor (RRR). The OLCs and Bases were developed using the format and concepts from the U.S. Improved Standard Technical Specifications. This required review of RRR Preliminary Safety Analysis Report and plant specific application of the U.S. Technical Specification criteria to the RRR design and safety analysis. Supported resolution of discrepancies identified during development of the Bases. Supported resolution of comments generated during ANSTO internal reviews.

EXCEL Services Corporation, Vermont Yankee Nuclear Power Corporation (11/01-7/02)

Senior Consulting Engineer: Provided an independent assessment of the Vermont Yankee Nuclear Power Station Technical Specifications and Bases. Identified inconsistent requirements, non-conservative requirements and recommended enhancements. Working with the Operations Department, prioritized recommendations from the assessment and began development and processing of License Amendment requests to adopt the changes from the recommendations.

EXCEL Services Corporation, Nebraska Public Power District (NPPD) (10/00-9/01)

Senior Consulting Engineer: Assisted in day-to-day licensing activities for Cooper Nuclear Station (CNS). This involved performing reviews for License Amendment Requests, 10 CFR 50.59 Safety Evaluations, Operability Evaluations, and other changes to licensing basis documents. Supported the development of the presentations for the following NRC/NPPD meetings: a Cooper Nuclear Station Performance Status Meeting and a Regulatory Conference concerning Equipment Qualification Non-conformances. Participated in the development of training materials for the United Services Alliance Regulatory Affairs Training and Qualification Initiative. Also participated on the CNS Condition Review Team for the Significant Condition Report related to weaknesses in the Determination and Documentation of Equipment Operability.

EXCEL Services Corporation, Commonwealth Edison Company (8/99-9/00)

Senior Consulting Engineer: Served as project lead licensing engineer responsible for technical oversight and review of the Improved Technical Specifications/24 Month Operating Cycle submittal for the Commonwealth Edison Company Boiling Water Reactors (BWRs). The submittal utilized NUREG-1433, Revision 1, and NUREG-1434, Revision 1, as the standards. This involved review of plant specific application of the Technical Specification criteria, Technical Specifications, Bases, technical justifications, 10CFR50.92 evaluations, and comparison documents. Supported resolution of discrepancies between current Technical Specifications and safety analyses identified during development of the Bases. Supported resolution of comments generated during Commonwealth Edison Company internal reviews. Also, served as the project lead licensing engineer responsible for licensing of the Improved Technical Specifications/24 Month Operating Cycle submittal for Commonwealth Edison Company BWRs. This involved supporting NRC review meetings, developing responses to NRC comments and questions regarding the submittal, and revising the submittal, as necessary. Responsibilities during this time also included developing the Technical Requirements Manuals for the BWRs.

EXCEL Services Corporation, Commonwealth Edison Company (7/98-7/99)

Acting Director, Licensing and Compliance - Byron/Braidwood Stations: Provided governance in developing strategies, positions, and responses for federal regulatory programs and issues. Responsible for development and maintenance of policies that support Byron/Braidwood and Corporate Nuclear Generation Group needs while complying with regulations. Planned, directed and provided oversight of the corporate staff. Served as the primary contact with NRR and was responsible for ensuring that NRR requests are satisfied in a timely and quality manner. Other responsibilities included ensuring that the NRR Project Managers were kept informed of significant regulatory issues at Byron/Braidwood and that issues with NRR were addressed in a professional and business-like manner. Also served as the primary contact between Regulatory Services and the Byron and Braidwood Regulatory Assurance Managers.

EXCEL Services Corporation, Nebraska Public Power District, Cooper Nuclear Station (11/97-7/98)

Senior Consulting Engineer: Assisted in the licensing of the Improved Technical Specifications submittal for Cooper Nuclear Station. This involved supporting NRC review meetings, developing responses to NRC comments and questions regarding the submittal, and revising the submittal, as necessary.

EXCEL Services Corporation, Baltimore Gas & Electric Company, Calvert Cliffs Nuclear Plant Units 1 and 2 (6/97-7/97)

> Senior Consulting Engineer: Assisted in the licensing of the Improved Technical Specifications submittal for Calvert Cliffs Nuclear Plant Units 1 and 2. This involved developing responses to NRC comments and questions regarding the submittal and revising the submittal, as necessary.

EXCEL Services Corporation, Carolina Power and Light Company, Robinson Steam Electric Plant Unit 2 (3/97-8/97)

> Senior Consulting Engineer: Assisted in the licensing of the Improved Technical Specifications submittal for Robinson Steam Electric Plant Unit 2. This involved developing responses to NRC comments and questions regarding the submittal and revising the submittal, as necessary. Responsibilities during this time also included developing the Technical Requirements Manual and the associated 10CFR50.59 safety evaluations.

EXCEL Services Corporation, Nebraska Public Power District, Cooper Nuclear Station (2/97-3/97)

> Senior Consulting Engineer: Performed an integrated review of the complete Cooper Nuclear Station Improved Technical Specifications submittal to ensure that the final product was ready for submittal to the NRC. The review included ensuring that all changes were appropriately addressed, that the submittal met the NEI guidance for Improved Technical Specifications submittals, and that lessons learned from other Improved Technical Specifications projects were incorporated.

EXCEL Services Corporation, Commonwealth Edison Company, Byron Station Units 1 and 2 and Braidwood Station Units 1 and 2 (11/96-12/96)

> Senior Consulting Engineer: Performed an integrated review of the complete Byron/Braidwood Improved Technical Specifications submittal to ensure that the final product was ready for submittal to the NRC. The review included ensuring that all changes were appropriately addressed, that the submittal met the NEI guidance for Improved Technical Specifications submittals, and that lessons learned from other Improved Technical Specifications projects were incorporated.

EXCEL Services Corporation, Carolina Power and Light Company, Robinson Steam Electric Plant Unit 2 (8/96)

> Senior Consulting Engineer: Performed an integrated review of the complete Robinson Steam Electric Plant Unit 2 Improved Technical Specifications submittal to ensure that the final product was ready for submittal to the NRC. The review included ensuring that all changes were appropriately addressed, that the submittal met the NEI guidance for Improved Technical Specifications submittals, and that lessons learned from other Improved Technical Specifications projects were incorporated.

EXCEL Services Corporation, Carolina Power and Light Company, Brunswick Nuclear Plant Units 1 and 2 (11/95-7/98)

Senior Consulting Engineer: Served as project lead engineer responsible for development and aiding in the coordination of the Improved Technical Specifications/24 Month Operating Cycle submittal for Brunswick Nuclear Plant Units 1 and 2. The plant specific submittal utilized NUREG-1433, Revision 1, as the BWR/4 Standard. This involved development of plant specific application of the Technical Specification criteria, Technical Specifications, Bases, technical justifications, 10CFR50.92 evaluations, and comparison documents. Supported resolution of discrepancies between current Technical Specifications and safety analyses identified during development of the Bases. Supported resolution of comments generated during Carolina Power and Light Company internal reviews. Also, served as the project lead engineer responsible for licensing of the Improved Technical Specifications/24 Month Operating Cycle submittal for Brunswick Nuclear Plant Units 1 and 2. This involved supporting NRC review meetings, developing responses to NRC comments and questions regarding the submittal, and revising the submittal, as necessary. Responsibilities during this time also included developing the Technical Requirements Manual, revising to Offsite Dose Calculation Manual, and developing the associated 10CFR50.59 safety evaluations.

EXCEL Services Corporation, PECO Energy Company, Peach Bottom Atomic Power Station Units 2 and 3 (10/95-10/96)

Senior Consulting Engineer: Served as project manager responsible for licensing of the Improved Technical Specifications submittal for Peach Bottom Atomic Power Station Units 2 and 3. This involved supporting NRC review meetings and developing responses to NRC comments and questions regarding the submittal. Also, served as project manager responsible for the development of the programs necessary to implement the Peach Bottom Atomic Power Station Units 2 and 3 Improved Technical Specifications. This involved revising and updating the Technical Requirements Manual, Offsite Dose Calculation Manual, UFSAR, Design Basis Documents, and the QA Program and also included development of 10CFR50.59 evaluations and 10CFR50.54(a) evaluations, as applicable. This effort also included development of matrices to implement the Safety Function Development Program.

EXCEL Services Corporation, Philadelphia Electric Company, Peach Bottom Atomic Power Station Units 2 and 3 (5/93-9/95)

Senior Consulting Engineer: Served as lead engineer responsible for development and aiding the coordination of the Improved Technical Specifications submittal for Peach Bottom Atomic Power Station Units 2 and 3. The plant specific submittal utilized NUREG-1433 as the BWR/4 Standard. This involved development of plant specific application of the Technical Specification criteria, Technical Specifications, Bases, technical justifications, 10CFR50.92 evaluations, 10CFR50.59 evaluations, and comparison documents. Supported resolution of discrepancies between current Technical Specifications and safety analyses identified during development of the Bases. Supported resolution of comments generated during Philadelphia Electric Company internal reviews.

EXCEL Services Corporation, Commonwealth Edison Company, Zion Nuclear Power Station Units 1 and 2 (3/91-4/93)

Consulting Engineer: Responsible for development of license amendment requests needed for Unit 1 and 2 refueling outages. This included supporting licensing of the microprocessor based Westinghouse Eagle 21 Process Protection System replacement, safety analyses upgrade for Westinghouse Vantage 5 fuel, and Setpoint Methodology upgrades. Supported resolution of discrepancies between current plant design and procedures and the safety analyses identified during the development of these license amendment requests. Also, supported daily licensing activities including development and submittal of Temporary Waivers of Compliance, UFSAR updates, and numerous short-term Technical Specification improvement license amendment requests. Served as lead engineer responsible for development of the Zion Station Units 1 and 2 Improved Technical Specifications initial draft submittal. This involved development of plant specific application of the Technical Specification criteria, Technical Specifications, Bases, technical justifications, 10CFR50.92 evaluations, and comparison documents.

EXCEL Services Corporation, Washington Public Power Supply System, WNP-2 (3/90-3/91)

Consulting Engineer: Responsible for development and aiding the coordination of the draft Improved Technical Specifications submittal for WNP-2. The plant specific submittal utilized the NUMARC/NRC negotiated BWR Standards. This involved development of plant specific application of the Technical Specification criteria, Technical Specifications, Bases, technical justifications, 10 CFR 50.92 evaluation, and comparison documents. Supported resolution of discrepancies between WNP-2 current Technical Specifications and safety analyses identified during development of the Bases.

Impell Corporation, Systems Engineering Department (11/89-2/90)

Lead Senior Engineer: Served as lead engineer on projects which involved preparation of FSAR change requests and 10CFR50.59 safety evaluations for the North Anna and Surry plants, the Turkey Point plant, and the Calvert Cliffs Nuclear Power Plant. The purpose of these projects was to correct FSAR discrepancies and inaccuracies discovered during FSAR verification and design basis documentation efforts.

Florida Power Corporation, Nuclear Department (8/84-11/89)

Licensing Engineer: Responsible for activities related to maintenance of the operating license for Crystal River Unit 3. The activities included the development and coordination of Technical Specification change requests, and implementation of a Technical Specification Interpretation program. Also participated in the Atomic Industrial Forum Subcommittee on Technical Specification Improvements and was Vice Chairman of the Babcock & Wilcox Owners Group Technical Specification Committee. Responsible for the development and coordination of the Technical Specification Improvement Program for Crystal River Unit 3 (lead plant for the Babcock & Wilcox Owners Group) from initiation through submittal to the NRC. Coordinated licensing resolution of design problems including the Emergency Diesel Generator overload concerns. Responsible for the initiation and development of the nuclear industry Snubber Utility Group.

Kansas Gas & Electric Company, Nuclear Department (5/81-8/84)

Licensing Engineer: Responsible for facilitating activities related to obtaining the Wolf Creek Generating Station operating license in addition to interfacing with the NRC. These activities included the development and coordination of technical reports and documents as well as responses to NRC concerns. Also responsible for licensing issues related to seismology and plant Technical Specifications. Coordinated licensing resolution of design and construction deficiencies.

Kansas State University, Nuclear Engineering Department (5/80-5/81)

Thesis Research: Involved in designing an iodine collection system. Research procedure included the use of neutron activation analysis to determine amount of iodine in a resin bed.

Kansas State University, Nuclear Engineering Department (6/79-9/79)

Research Assistant: Assisted with radiation shielding project. Responsible for collecting and reducing data on the effects of shielding, source-strength, wall thickness, and angle, in order to determine penetration through ducts.

Curriculum Vitae for Allan James Brown

2 Burland Road
Bailey's Reach
Halewood
Merseyside, L26 9YS
United Kingdom

**Employment Experience:**

| Period | Company | Position Held |
|---|---|---|
| 1972 – 1975 | University of Liverpool | Research Student Nuclear Structure Physics |
| 1975 – 1980 | BNFL | Shift Manager Gas Centrifuge Pilot Plant and First Gas Centrifuge Commercial Demonstration Plant<br>▪ Responsible for managing one shift comprising shift supervisor and seven shift operators<br>▪ Responsible for yearly operating budget of £600,000 |
| 1980 – 1982 | BNFL | Day Operations Manager Gas Centrifuge Commercial Demonstration Plant<br>▪ Responsible for management of five shift teams, comprising shift supervisor and seven shift operators per shift and responsible for day to day operation of the plant<br>▪ Responsible for yearly operating budget of £3.16 million |
| 1982 – 1985 | BNFL | Design Liaison Officer for second generation plant, Commissioning Manager and subsequently Operations Manager<br>▪ In design liaison role working individually, in Commissioning Manager and Operations Manager roles responsible for five shift teams of shift supervisor and seven shift operators per shift and responsible for five professionals during commissioning and for two professionals during operation<br>▪ Responsible for yearly operating budget of £3.2 million |
| 1985 – 1988 | BNFL | Commissioning Manager for all Capenhurst Centrifuge Plants<br>▪ Responsible for five shift teams comprising shift supervisor and five shift operators per shift and responsible for three professionals<br>▪ Responsible for yearly operating budget of £2.2 million |

| Period | Company | Position Held |
|---|---|---|
| 1988 – 1989 | BNFL | Quality Assurance Manager for British Nuclear Fuels Capenhurst<br>▪ As Quality Assurance Manager responsible for a section of five Quality Engineers and Auditors and for a quality control section of one professional, a supervisor and six technicians<br>▪ Responsible for yearly operating budget of £1.4 million |
| 1989 – 1991 | BNFL | Design Liaison Officer for LES1<br>▪ Working individually as the LES1 Design Liaison Officer<br>▪ Responsible for yearly operating budget of £130,000 |
| 1991 – 1995 | Urenco (Capenhurst) Ltd (Urenco (Capenhurst) Ltd formed 1993) | Decommissioning Manager for first green field decommissioning of pilot and commercial demonstration gas centrifuge plants<br>▪ As Decommissioning Manager responsible for a core decommissioning management team of three professional engineers and for the management of decommissioning contracts<br>▪ Responsible for yearly operating budget of £370,000 plus £6 million of contracts spread over 3 years |
| 1995 – 1998 | Urenco (Capenhurst) Ltd | Commissioning Manager for latest generation gas centrifuge plant at Capenhurst<br>▪ Responsible for a commissioning team of five professional engineers and for 1998 five shift teams comprising shift supervisor and eight shift operators per shift<br>▪ Responsible for operating budget of £600,000 and for a budget of £2.9 million in 1998 |
| 1998 – 2003 | Urenco (Capenhurst) Ltd | Urenco Projects Department Design Manager, with particular involvement in the LES2 project.<br>▪ Design Manager for all plant design work within the Urenco Plant Design and Projects office<br>▪ Responsible for management of the core design and engineering team within Urenco Projects Department of some 40 professional engineers working in a multi-project matrix environment<br>▪ Responsible for operating budget of £3.5 million per year servicing projects spending £100 million per year |

| Period | Company | Position Held |
| --- | --- | --- |
| 2003 – today | Urenco (Capenhurst) Ltd | Design and Licensing Consultant and Assistant Project Manager LES2 Project.<br>▪ At the time of writing responsible for three professional engineers in the UK<br>▪ Responsible for an operating budget of £450,000 |

**Education**

- Sir William Turners Grammar School
  O Levels 1967 in Maths, Physics, Chemistry, English, French, Biology, Geography, History.
- Sir William Turners Grammar School
  A Levels 1969 in Physics, Maths, Chemistry
- The University of Liverpool
  Degree of Bachelor of Science with Honours 1972
- The University of Liverpool
  Research student Nuclear Structure Physics 1972 to 1975

**BARBARA Y. HUBBARD**
**FRAMATOME ANP**

**Classification: Supervisor** **Years of Experience: 25**

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## SUMMARY

Ms. Hubbard is an experienced nuclear engineer and reactor physicist. She has held several engineering, project management and supervisory positions. She has worked on reload 14 reloads cores performing the reload licensing analysis, core management report and core follow analysis. In addition, she has participated in the neutronics benchmarking of three BWRs and one PWR reactors. Ms. Hubbard has also performed criticality analysis for Spent Fuel Pools as well as New Fuel Vaults. Since 2004 she has been involved with the Criticality Analyses for the National Enrichment Facility and, in that capacity, serves as a member of the National Enrichment Facility ISA team. She is also currently involved in the neutronics analysis of the Next Generation Nuclear Plant.

## EDUCATION/TRAINING

MS, Energy Engineering (Nuclear Option), University of Massachusetts, Lowell, Mass., 1991
BS, Nuclear Engineering, Georgia Institute of Technology, 1980
Modern Nodal Methods for Analyzing LWRs, Massachusetts Institute of Technology, 1987
Leadership Center Participant, Framatome ANP, 2003-2004
Bentley Management Training, Yankee Atomic, 1996
Quality Service Every Time, Yankee Atomic, 1993
Supervisory Development Training, 1991
Station Nuclear Engineer's Refresher Course, General Electric Company, 1990
Skills of Utility Management, The Electric Council of New England, 1992
Communicating Under Pressure, Communications Counsel of America, 1982

## PROFESSIONAL AFFILIATIONS/CERTIFICATIONS

American Nuclear Society (ANS), Member
Sigma XI, The Scientific Research Society, Associate Member

## EXPERIENCE

*Supervisor/Advisory Engineer* 1/2003- present
**Framatome ANP**

Serves as Supervisor of the Nuclear and Radiation Engineering group. This technical management position involves supervising work in Nuclear Analysis and Radiological Analysis for various customers.

Selected to participate in the Leadership Center Development Program. As a member of the Optimization Task Force, lead a team to investigate the issues associated with working remotely. Currently involved in performing the neutronics analysis for the Very High Temperature Reactor (Next Generation Nuclear Plant). Also currently involved with the Criticality Analyses for the National Enrichment Facility and, in that capacity, serves as a member of the National Enrichment Facility ISA team. Performed criticality analysis for a New Fuel Vault and a Spent Fuel Pool. Served as primary reviewer for the National Enrichment Facility Integrated Safety Analysis Consequence Assessments for Airborne Releases Calculation.

***Supervisor, Reactor and Systems Analysis*** 11/98- 12/2002
**Duke Engineering & Services**

Served as the Supervisor of the Reactor and Systems Analysis. This technical management position involved supervising work in Reactor Physics and Thermal Hydraulics for various plants.

Participated in the modeling and benchmarking of the CASMO-4/MICROBURN2 core model against Dresden plant data. This project, which was performed in Marlborough, was performed for Framatome ANP- Richland using the Richland HP UNIX environment.

Participated in the modeling and benchmarking of the CASMO-3/SIMULATE-3 core model against Sequoyah Unit 2 plant data. This project, which was performed in Marlborough, was part of the TXU program to qualify the TXU methods to model Westinghouse IFBA designs.

***Engineer*** 12/97-11/98
**Duke Engineering & Services**

Served as the Vermont Yankee Cycle 20 Reload Coordinator. This project management position involved managing the nuclear engineering work scope, and writing the Engineering Design Change Request (EDCR) for the Cycle 20 reload.

***Senior Nuclear Engineer*** 1994-1997
**Yankee Atomic Electric Company**

Supervised the CASMO-3/SIMULATE-3 model development and benchmark of Vermont Yankee Cycles 9-18. Also, authored a YAEC report that presented the CASMO-3/SIMULATE-3 development and benchmark. Provided independent design review for the CASMO-3/ SIMULATE-3 model of the Monticello Nuclear Power Station. Verified various analyses and provided independent review for the Monticello Cycle 18 reload. Verified the cross-section development for the Prairie Island Nuclear Plant. Reviewed several of the Vermont Yankee Cycle 19 reload analysis calculations. Supervised the optimization of the General Electric (GE) Cycle 11 reload core design of the Pilgrim Nuclear Power Station.

***Senior Engineer*** 1990-1994
**Yankee Atomic Electric Company**

Supervised the CASMO-3/SIMULATE-3 model development and benchmarking of Pilgrim Station. Also performed a core optimization and spectral shift study for Pilgrim. Provided independent design review of the CASMO-3/SIMULATE-3 model of Confrentes for IBERDROLA, S.A.

Served as the Cognizant Engineer for the reactor physics portion of the Vermont Yankee Cycle 16 and 17 reloads. Duties included directing and reviewing the analyses to assure technical accuracy and timely delivery of the reload. Performed several studies for the Vermont Yankee Nuclear Power Station (VYNPS), including an end of full power life sensitivity study to determine a change in thermal limits associated with a standard operational window; a sensitivity study to determine the impact of a time varying axial power shape on the reload transients; and a power uprate study to determine the effect on the licensing limits. Provided input and benchmarking assistance on VYNPS' on-line shutdown margin code, ShuffleWorks. Also provided physics data for the VYNPS loss of coolant accident (LOCA) methods submittal.

*Nuclear Engineer* 1987-1990
**Yankee Atomic Electric Company**

Provided analytical and technical support to VYNPS. Supported the development and benchmarking of the CASMO-3/SIMULATE-3 model for the lead plant licensing submittal. This included several sensitivity studies to determine the adequacy of the thermal-hydraulics model and fuel temperatures used in SIMULATE-3, and to match the neutron spectrum between CASMO-3 and MICBURN-3. Served as Cognizant Engineer for the reactor physics portion of the Vermont Yankee Cycle 15 reload. Also served as Acting Reload Coordinator for three months where responsibilities included developing the schedule to assure inter-group transfers and reporting monthly progress to management. Also, performed reload physics analysis on VYNPS Cycle 14, and provided independent review of the WNP-2 reactor physics model review for the Washington Public Power Supply System.

*Engineer* 1984-1987
**Yankee Atomic Electric Company**

Provided analytical and technical support to the Maine Yankee Nuclear Power Station (MYNPS). Performed reload physics analyses on Vermont Yankee Cycle 13 and Maine Yankee Cycles 9 and 10. Helped develop a program to automate the Maine Yankee core follow data.

*Engineer* 1980-1984
**Westinghouse Electric Corporation**

Performed reload physics analyses for three Westinghouse plants for a total of five different cores. Interfaced between Westinghouse and the utility on a dual licensing effort for two plants that were developing their own models. Assisted with the development of procedures to be used when modeling a reactor with part length burnable poisons. These procedures covered the setup of three-dimensional nodal models and three-dimensional INCORE models. Also, coordinated

an information exchange program between Westinghouse and Mitsubishi Heavy Industries of Japan.

*Co-op Student* 1977-1979
**U.S. Nuclear Regulatory Commission**

Provided technical support for the Region II Office of Inspection and Enforcement. Supported the development of a computer program to calculate containment leak rate, and supported the inspection effort for the containment leak rate test for two boiling water reactors (BWRs) and two pressurized water reactors (PWRs).

**PUBLICATIONS/PAPERS**

"CASMO-3/SIMULATE-3 Analysis of GE10/GE11 Fuel," co-authors G. Lam and B. Hagemeier, Proceedings of the ANS Topical Meeting: Advances in Nuclear Fuel Management II, TR-107728 Vol. 2, March 23-26, 1997.

VY EOFPL Sensitivity Study for the Revised BWR Licensing Methodology, co-author J. D. Robichaud, et al., YAEC-1822, October 1991.

"MICBURN-3/CASMO-3/SIMULATE-3 Sensitivity Studies for Vermont Yankee," co-author J. Pappas, et al., CASMO Users Group Meeting, Miami, Fla., February 1989.

"CASMO-3/SIMULATE-3 Model Development for Vermont Yankee," co-author J. Pappas, et. al., CASMO Users Group Meeting, Miami, Fla., February 1989.

MICBURN-3/CASMO-3/TABLES-3/SIMULATE-3 Benchmarking of Vermont Yankee Cycles 9 through 13, co-author R. A. Woehlke, et al., YAEC-1683-A, March 1989.

"CASMO-3/SIMULATE-3 Benchmarking Against Vermont Yankee," co-author D.J. Morin, et. al., ANS Transactions, Vol. 60, TANSAO 60, 582, 1989.

Contributing author on numerous other in-house publications including six Core Performance Analysis Reports (CPARs) and four Core Management Reports in support of the licensing and operation of Vermont Yankee; and one CPAR, two Design Reports and three Cycle Summary Reports in support of Maine Yankee.

**DAVID M. PEPE**
**FRAMATOME ANP**

**Title/Position: Principal Engineer** **Years of Experience: 29**

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## SUMMARY

Mr. Pepe has more than 29 years of expertise in the nuclear field. He has experience in Integrated Safety Assessment (ISA) methodology, application of the EPRI RI-ISI methodology, preparing safety analysis for the Department of Energy, D.O.E., Hanford Tank Waste Remediation System (TWRS), nuclear steam supply systems (NSSS); secondary systems; and heating, ventilating and air conditioning (HVAC) systems engineering. He also possesses experience in fire protection, Appendix R and plant start-up engineering. Mr. Pepe has conducted engineering reviews for the Seabrook, Maine Yankee, Calvert Cliffs, St. Lucie Unit 2, Millstone Unit 2 and Vermont Yankee nuclear power stations, as well as for General Electric's (GE's) simplified boiling water reactor (SBWR). He also played a lead role in establishing and maintaining Seabrook Station's 10CFR50 Appendix R fire analysis requirements. In addition, Mr. Pepe participated in start-up testing activities and provided support for Seabrook Station probabilistic risk assessments (PRAs).

## EDUCATION/TRAINING

BS, Nuclear Engineering, Rensselaer Polytechnic Institute, 1976
The Engineer as Manager, Worcester Polytechnic Institute (WPI), 1986
Heating, Ventilation and Air Conditioning (HVAC), Center for Professional Advancement, 1981
Health Physics Training Program, Brookhaven National Laboratory (BNL), 1976
Integrated Safety Analysis Leader Training, 2002, by Process Safety Institute

## PROFESSIONAL AFFILIATIONS/CERTIFICATIONS

Intern Engineer, N.Y.
ANSI N45.2.6 and ANSI 3.1 Test and Start-up Engineer Certification, 1978

## EXPERIENCE

*Principal Engineer*
**Framatome ANP** 5/02-Present

Experience in Integrated Safety Assessment (ISA) methodology for the identification and evaluation of facility hazards and accident sequences. Currently applying this methodology to the National Enrichment Facility (NEF), a gaseous centrifuge enrichment plant. Supported the licensing effort for the design, construction and operation for NEF. This involved supporting NRC review meetings and teleconferences, developing

responses to NRC Requests for Additional Information regarding the licensing submittal and revising the licensing submittal. Responsibilities during this time also included serving as the ISA team scribe, ISA screener and reviewer of draft 10 CFR 70.72 screens forms.

**Duke Engineering & Services**

Supported the application of the EPRI RI-ISI methodology to the following plants: Pilgrim, Seabrook, Perry, Calvert Cliffs, South Texas Project, Units 1 and 2, Comanche Peak, Units 1 and 2, Diablo Canyon, Units 1 and 2, Callaway, Wolf Creek, Brunswick, Units 1 and 2, Fermi, Point Beach, Units 1 and 2, Kewaunee, Prairie Island (Units 1 and 2), Duane Arnold, and Monticello, and VC Summer.

Supported the updating of the Fire PRA for PSE&G, Salem Units 1 and 2.

Supported the Nuclear Energy Research Institute (NERI), Risk Informed Project.

*Engineer* 8/99-12/99
**Duke Engineering & Services**

Provide PRA Support to Vermont Yankee (VY) in the area of Maintenance Rule (MR). Member of VY MR expert panel.

Engineer
**Duke Engineering & Services** 3/99-7/99

Provide Hanford Tank Waste Remediation System (TWRS) nuclear safety analysis support (on-site) including preparing and reviewing hazard/accident analysis, technical safety requirements, and resource and task planning. Interfaced with and supported TWRS engineering and operations on authorization basis interpretation issues. Integrated complex technical analysis into safety analysis reports.

*Engineer/Senior Engineer* 12/97-3/99
**Duke Engineering & Services**

Worked in the Safety Assessment Group to implement plant-specific Westinghouse Owners' Group (WOG) severe accident management guidance (SAMG) for Seabrook Station and Millstone-Unit3. Defined plant specific SAMG setpoints and wrote technical support center (TSC) guidance documentation.

*Senior Nuclear Engineer* 1994-1997
**Yankee Atomic Electric Company**

Coordinated Seabrook Station's 24-Month Fuel Cycle Life Extension Project in accordance with Nuclear Regulatory Commission (NRC) Generic Letter 91-04. Established the program, and prepared and reviewed project technical evaluations.

*Senior Nuclear Engineer* 1996
**Yankee Atomic Electric Company**

Supported the 10CFR50.54(f) effort at the Millstone Unit 1 site. Duties encompassed Final Safety Analysis Report (FSAR) verification and validation activities, and plant as-built verifications to ensure licensing commitment compliance.

*Senior Nuclear Engineer* 1994
**Yankee Atomic Electric Company**

Served as a Senior Engineer supporting an engineering study to determine Seabrook Station's single component plant trip potential.

*Senior Nuclear Engineer* 1990-1995
**Yankee Atomic Electric Company**

Performed evaluations and provided recommendations for nuclear power plant design, licensing, safety and economic issues. Provided and reviewed 10CFR50.59 evaluations for Seabrook Station. Utilized knowledge in nuclear power plant fire risk analysis. Updated Maine Yankee Nuclear Power Station's Probabilistic Risk Assessment (PRA), and developed Maine Yankee's Individual Plant Examination of External Events (IPEEE). Also, supported Pilgrim Nuclear Power Station's IPEEE for fire scenarios.

*Senior Nuclear Engineer* 1985-1990
**Yankee Atomic Electric Company**

Served as Coordinator of Seabrook Station's Fire Protection Project. Established and maintained a program to identify and resolve all fire protection issues required for core load. Duties involved all work associated with Seabrook's 10CFR50 Appendix R Safe Shutdown Report, which included systems analysis, fire detection, fire barrier, fire suppression and HVAC requirements.

Conducted engineering studies on containment leakage monitoring, plant blackout, secondary component heat exchanger upgrade, hydrogen bulk gas storage, and primary component cooling water heat exchanger tube degradation.

*Senior Test Engineer* 1983-1985
**Yankee Atomic Electric Company**

Served as Test Director and System Team Engineer during Seabrook Station Phase 1, 2 and 3 start-up testing. Responsible for the extraction steam system, the heater drain system, and the emergency feedwater and start-up feedwater systems. Conducted system flushing, mechanical checkouts, initial operation of plant equipment, system acceptance testing, system hydrostatic testing and chemical cleaning activities. Also, prepared and reviewed test procedures.

*Nuclear Engineer* 1982-1983
**Yankee Atomic Electric Company**

Assigned to the Nuclear Evaluation and Support Group as a member of the PRA Systems Analysis Team. Provided expertise in system and fault tree analyses, system interactions and external events analyses for fire, internal flooding and toxic chemicals.

*Engineer* 1979-1982
**Yankee Atomic Electric Company**

Prepared and reviewed the FSARs and Technical Specifications for Seabrook Units 1 and 2. Reviewed equipment specifications, system descriptions, piping and instrumentation drawings (P&IDs), logic diagrams, and general arrangement and equipment drawings for Seabrook. Reviewed and supported high energy line break (HELB), moderate energy line, vital area and Appendix R fire analysis studies. Reviewed and supported HELB and post-loss of coolant accident (LOCA) heat-up studies performed with an outside contractor to meet NRC Bulletin 79-01 requirements. Also, performed environmental qualifications of safety-related electrical equipment, and provided on-site support for Maine Yankee Nuclear Power Station refueling outages.

*Systems Engineer* 1976-1979
**Combustion Engineering**

Worked in the Chemical Systems Section. Designed and modified various pressurized water reactor (PWR) chemical systems, including the chemical and volume control system (CVCS), the sample system (SS), and the fuel pool purification and heat removal systems. Prepared portions of the St. Lucie Unit 2 FSAR. Prepared portions of the Technical Specifications for reactor core reloads. Revised computed codes used in CVCS design. Developed an electromagnetic filter (EMF) for a comparison test program. Participated in the start-up and operation of a graphite filter and EMF test conducted at Calvert Cliffs Unit 1.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

| | | |
|---|---|---|
| In the Matter of: | ) ) | Docket No. 70-3103-ML |
| Louisiana Energy Services, L.P. | ) ) | ASLBP No. 04-826-01-ML |
| (National Enrichment Facility) | ) | |

## CERTIFICATE OF SERVICE

I hereby certify that copies of the "APPLICANT'S PREFILED TESTIMONY IN MANDATORY HEARING CONCERNING MATTERS RELATED TO NUCLEAR CRITICALITY (SAFETY MATTER NOS. 5 - 8 AND OCTOBER HEARING QUESTIONS 6.b, 6.e, 6.f, and 6.g)" in the captioned proceeding has been served on the following by hand-delivery on February 24, 2006 as shown below.

Administrative Judge
G. Paul Bollwerk, III, Chair
Atomic Safety and Licensing Board Panel
Mail Stop T-3F23
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
e-mail: gpb@nrc.gov

Administrative Judge
Paul B. Abramson
Atomic Safety and Licensing Board Panel
Mail Stop T-3F23
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
e-mail: pba@nrc.gov

Administrative Judge
Charles N. Kelber
Atomic Safety and Licensing Board Panel
Mail Stop T-3F23
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
e-mail: cnkelber@aol.com

Office of the Secretary
Attn: Rulemakings and Adjudications Staff
U.S. Nuclear Regulatory Commission
Mail Stop O-16C1
Washington, DC 20555-0001
(original + two copies)

Lisa B. Clark, Esq.
Office of the General Counsel
Mail Stop O-15D21
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

James R. Curtiss
Counsel for Louisiana Energy Services, L.P.



DC:456260.2