United States
Enrichment Corporation

2 Democracy Center
6903 Rockledge Drive
Bethesda, MD 20817

Tel: (301) 564-3200
Fax: (301) 564-3201

USEC

United States
Enrichment Corporation

June 13, 1997

Mr. Randall M. DeVault
Regulatory Oversight Manager
Office of the Assistant Manager for Enrichment Facilities
U.S. Department of Energy
P.O. Box 2001
Oak Ridge, TN 37831-8651

Dear Mr. DeVault:

United States Enrichment Corporation (USEC) - Paducah Gaseous Diffusion Plant (PGDP) - Portsmouth Gaseous Diffusion Plant - Docket Nos. 70-7001/70-7002 - HGSYSTEM/UF_6 Issues and Plans for Resolution

The purpose of this letter is to notify the Department of Energy (DOE) of several issues regarding the HGSYSTEM/UF_6 computer code suite used for consequence analysis as part of the DOE SAR Upgrade Program and our plans for resolution. This letter is in follow-up to a discussion between yourself and Mr. Stephen Routh on June 9, 1997.

As required by Issue 2 of the Paducah and Portsmouth Compliance Plans, USEC is preparing amendments to its NRC Certification Applications to incorporate the results and analyses of the DOE SAR Upgrade Program presented in KY/EM-174 for Paducah and POEF-LMES-89 for Portsmouth. During a recent verification and validation of the HGSYSTEM/UF_6 suite, several issues affecting the DOE SARUP consequence analysis results were identified by USEC/LMUS. A summary of the issues follows:

Issue 1

For scenarios involving building wake effects or plume lift off, the version of HGSYSTEM/UF_6 used for the DOE SARUP calculated the consequences using a method inconsistent with the documentation. Specifically, the "Briggs well mixed wake model" and "lift off correction factor" employed by the suite have been modified due to reviewers' comments, but the results were not been updated.

Issue 2

The DOE DAC results are being used as baseline test cases for USEC/LMUS's code verification and validation (V&V). However, the V&V effort cannot be completed without documentation of the known variance in results using the previous calculation of the "well mixed wake model" or the "lift off correction factor."

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Recip: NMSS/FCSS

Additional detail regarding the "lift off correction factor" and the "Briggs well mixed wake model" is provided in the enclosure.

As previously discussed with members of the DOE/LMES SARUP team, we have concluded that the following tasks must be performed to satisfactorily resolve these issues for submittal of the certificate amendments required by Compliance Plan Issue 2:

1. Develop a technical justification and basis for submitting to the NRC the older results presented in the current DOE SARUP DACs.

2. Either (a) define and defend an acceptance criteria to use in the V&V [allowing USEC/LMUS to establish the acceptable range of comparable results between old and new computer runs], or (b) provide additional cases using the new analysis techniques for use in the V&V.

As agreed with you in the June 9, 1997 telephone conversation, USEC will work with LMES to complete the above tasks.

If you have any questions, please contact Steve Routh at (301) 564-3251 or J.D. Sohl at (502) 441-6607. There are no new commitments contained in this submittal.

Sincerely,

Robert L. Woolley
Nuclear Regulatory Assurance and Policy Manager

Enclosure: HGSYSTEM/UF_6 Use of "Briggs Well-Mixed Wake Model"

cc: DOE Site Safety Representative, PGDP
DOE Site Safety Representative, PORTS
R. C. Pierson, NRC
NRC Resident Inspector - PGDP
NRC Resident Inspector - PORTS

HGSYSTEM/UF_6 Use of "Briggs Well-Mixed Wake Model"

The well-mixed wake model (or Briggs model) is an empirical formula that provides a conservative best-fit to wind tunnel data. Two wind tunnel experiments focused on buoyant plumes affected by building wakes. The latter set of wind tunnel experiments involved complicated release simulations for a variety of vent configurations, building shapes, and wind angles. The equation for the model used in the DOE SARUP dispersion/consequence DACs is:

$$C_c = \left(\frac{Q_c}{u_H R^2}\right) \frac{e^{-9.1\cdot(F_{**})^{0.6}}}{\left[0.0123 + 0.117\left(\frac{x}{R}\right)^{8/3} + 3.39\left(\frac{x}{R}\right)^{16/3} F_{**}^{8/3}\left(\frac{W_B}{H_B}\right)^{8/9} + \left(\pi\frac{\sigma_y\sigma_z}{R^2}\right)^4\right]^{1/4}} \quad , \qquad (1)$$

where

Q_c is the mass flux (kg/s) of the plume constituent (either UO_2F_2 or HF) involved in the building wake,
u_H is the wind speed at the top of the building (m/s),
R^2 is the scaling area in the wake (m^2), with R being the representative scaling length of the building (m),
F_{**} is the nondimensional buoyancy flux term,
x is the downwind distance from the source to the receptor (m),
W_B is the width of the building (m),
H_B is the height of the building (m), and
σ_y and σ_z are the Gaussian horizontal and vertical dispersion parameters, respectively (m).

In Equation (1), the numerator term, $e^{-9.1\cdot(F_{**})^{0.6}}$, is defined as the "lift off correction factor," or B_{LO}, and describes the decrease in ground-level concentration due to buoyant lifting of the plume. This is shown as

$$B_{LO} = e^{-9.1\cdot(F_{**})^{0.6}} \quad , \qquad (2)$$

where F_{**} is the nondimensional buoyancy flux of the term. This term is calculated as

$$F_{**} = \frac{F_o}{u_H^3 W_B} \quad , \qquad (3)$$

where F_o is the buoyancy flux calculated using the standard Briggs plume rise equations (m^4/s^3).

During the peer review[1] of the HGSYSTEM/UF_6 suite, Dr. Briggs suggested that a slight modification to the well-mixed wake model was required to ensure that "better preditions would be produced for wider range of building shapes and release configurations." The Briggs model was modified to:

$$C_c = \left(\frac{Q_c}{u_H R^2} \right) \frac{e^{-6 (F_*)^{0.4}}}{\left[0.037 + 0.03 \left(\frac{x}{H_B} \right)^2 + F_*^2 \left(\frac{x}{H_B} \right)^4 + \left(\pi \frac{\sigma_y \sigma_z}{R^2} \right)^3 \right]^{1/3}} , \qquad (4)$$

and the "lift off correction factor" was redefined as

$$B_{LO} = e^{-6 (F_*)^{0.4}} . \qquad (5)$$

Equation (4) is consistent with the documentation presented in the HGSYSTEM/UF_6 manuals. However, results from previous analyses performed using Equation (1) to model well-mixed wake effects and plume lift off have not been updated in the DOE SARUP with the new relationship presented by Equation (4).

Based on runs made by USEC/LMUS, for the cascade facilities scenarios in the DOE SARUP, the use of Equation (4) generates a 20 to 30 percent increase in consequences over the results calculated by Equation (1), in the near-field (100 to 500 meters). At the site boundary, the difference results in a 5 to 10 percent increase in consequences.

No determination of the impact on the results for UF_6 handling and storage facilities scenarios has been made by USEC/LMUS; however, this issue could affect scenario results that were calculated using the UF_6MIXER, POSTMIX, POSTAP, or POSTHEG codes.

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[1]Britter, R., G. Briggs, I. Sykes, *HGSYSTEM/UF_6 Peer Review Panel Report*, September 3, 1996.