

JCN – J5167

**MONTHLY LETTER STATUS REPORT
For November 2002**

Project Title: Spent Fuel Review Assistance
Period of Performance: February 3, 1997 – December 31, 2003
JCN: J5167
PNNL Project Manager: M. A. Khaleel (509-375-2438)
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Facsimile: 509-375-6605
NRC Project Manager: P. Kinney (301-415-7805)
NRC Technical Monitor: C. Bajwa (301-415-1237)

Project Objective: The objective of this project is to conduct safety and environmental reviews and development of regulatory guidance related to Independent Spent Fuel Storage Installations and Dry Cask Storage facilities.

Task Orders 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 & 11 COMPLETED

Task #12

Title: Development and Analysis of Spent Fuel and Radioactive Material Cask Models for Casework Evaluations

JCN: J5167

PNNL Task Manager: T. E. Michener (509-375-2162)
NRC Technical Monitor: C. Bajwa (301-415-1237)

OBJECTIVE

The objective of this task order is to provide package analyses in support of ongoing casework using the ANSYS, ANSYS LS-DYNA FEA, COBRA-SFS, and Star-CD packages.

PROGRESS DURING REPORTING PERIOD

In November PNNL staff performed the following:

- An all-inclusive 2D BTF model was constructed to provide predictions of time/temperature response results regarding two potential fire scenarios. All results, modeling details, and simulations have been provided to the technical monitor.
- Preliminary results for the 3D Baltimore Tunnel Fire simulation have been postponed until January 2003 due to continued conflicts between model execution size and available computational resources. Further measures will be taken to reduce the model to a reasonable size without compromising prediction capability and accuracy. A 3D BTF model representing the current model status was provided to the NRC Technical Monitor.

JCN - J5167

- Due to the evolving support requirements for the TN-32PT, BTF, 24PHB analyses, thermal modeling support for the MP-197/DSC 61BT and DSC 52BT will be performed at a later date.

TRAVEL

Tom Michener attended a public meeting on ongoing transportation related efforts on November 19, 2002 at NRC Headquarters. This was possible at minimum cost, as staff member was already attending a conference in the DC area during this period.

REPORT, PAPERS, AND PUBLICATIONS

None.

ANTICIPATED AND ENCOUNTERED PROBLEM AREAS

Preliminary results for the 3D BTF simulation were not obtained over this period either due to continued conflicts between model execution size and available computational resources. Steps will continue to be taken in the near future to reduce the model to a reasonable size without compromising prediction capability and accuracy.

There will be a shortfall in funding for this task due to an unanticipated increase in assigned subtasks by the technical lead. The funding level will need to be supplemented (and the corresponding scope) to reflect the new demands of this task.

PLANS FOR NEXT REPORTING PERIOD

PNNL staff will continue to support the TN24PHB review efforts via COBRA-SFS confirmatory analyses and investigations into the ANSYS modeling approach used by the applicant. The associated Calculation Package documentation will be reviewed. It is anticipated that additional COBRA-SFS modeling efforts will be necessary as new information is provided by TN West. Results of the new predictions will be provided to the NRC technical monitor in December.

PNNL staff will continue to take steps in the near future to reduce 3D BTF model size without compromising prediction capability and accuracy.

PNNL staff will also continue to develop the MP 197 transport package, construct the 52BT NUHOMS evaluation model, and review of the TN24PHB SAR.

FINANCIAL STATUS AND VARIANCE ANALYSIS

See attached financial status report. The cost and funding information reported on the Cost Status by Element Table includes the necessary adjustments to account for the DOE Adder. All other cost information reflects only the Pacific Northwest National Laboratory costs and does not include the DOE Adder.

PROPERTY AND SOFTWARE

None.

Task #13

Title: Dynamic Structural Analyses in Support of Risk-Informing 10 CFR Part 71

JCN: J5167

PNNL Task Manager: H. E. Adkins (509-372-6629)
NRC Technical Monitor: D. T. Huang (301-415-3381)

OBJECTIVE

The objectives of this task are to: 1) compare the structural analyses results of NUREG-6672 using the ANSYS LS-DYNA FEA packages with selected spent fuel transportation packages currently certified by the NRC; 2) determine the deformed geometry and cladding integrity of three selected pressurized water reactors (PWR) high burn-up (50, 60, and 75 GWD/MTU) spent nuclear fuel assemblies suitable for transport in the systems identified; 3) train selected NRC staff members in the use of ANSYS LS-DYNA in cask analyses; 4) provide continued support on high burn-up material and thermal issues.

PROGRESS DURING REPORTING PERIOD

In November PNNL staff performed the following:

- PNNL staff conducted further discussions with NRC staff (via tele-conference) on the proposed Critical Strain Energy Density (CSED) methodology. Additional comments were provided at that time.
- PNNL staff reviewed the NRC staff generated compilation of comments on Anatcech's CSED approach in relation to fracture toughness and failure prediction in general. PNNL staff communicated that failure was not the only important criteria but that extent of failure and geometry changes of the fuel were also important for NRC analyses. A number of alternatives to obtain this information were communicated at that time.
- Construction of the first of two ANSYS/LS-DYNA models of SNF transport systems has been further postponed. PNNL staff have primarily focused on the material properties portion of this task as funding is somewhat limited. Construction of these two models is anticipated to begin no later than January 2003. This has been discussed with the NRC Technical Monitor.
- PNNL staff reviewed ASTM Standards E399-74, E813-89 and E1820-99 on measurement of fracture toughness
- PNNL staff reviewed open literature data on fracture toughness from Zircaloy specimens and created a database of fracture toughness data of irradiated and unirradiated Zircaloy from this literature.

TRAVEL

None.

REPORT, PAPERS, AND PUBLICATIONS

None.

ANTICIPATED AND ENCOUNTERED PROBLEM AREAS

None.

PLANS FOR NEXT REPORTING PERIOD

Over the next reporting period, PNNL staff plan to develop fracture toughness correlations designed to predict the fracture toughness of uniform hydrided zirconium cladding. Staff also plan to finish compiling yield strength and ultimate tensile strength data for high burnup fuel and then develop correlations with this data that can be directly applied to the current initiative.

FINANCIAL STATUS AND VARIANCE ANALYSIS

See attached financial status report. The cost and funding information reported on the Cost Status by Element Table includes the necessary adjustments to account for the DOE Adder. All other cost information reflects only the Pacific Northwest National Laboratory costs and does not include the DOE Adder.

PROPERTY AND SOFTWARE

None.

Task #14

Title: Inelastic Buckling Capacity of High Burn-up Fuel Subject to End Impact Loads

JCN: J5167

| | | |
|------------------------|--------------|----------------|
| PNNL Task Manager: | H. E. Adkins | (509-372-6629) |
| NRC Technical Monitor: | D. T. Tang | (301-415-8535) |

OBJECTIVE

The objectives of this task are to: 1) Compute inelastic buckling capacity and corresponding strain ductility demands for selected PWR spent fuel clads under simulated cask handling or drop accidents, using the ANSYS computer code; 2) Train selected NRC staff members in the use of ANSYS for fuel clad inelastic buckling analyses.

PROGRESS DURING REPORTING PERIOD

In November PNNL staff performed the following:

- Significant improvements to the ANSYS buckling model were made, including:
 - Inclusion of pin and spacer grid geometry for actual fuel (B&W 15x15 for the time being).
 - Specification of gradient temperature profile in pin.
 - Inclusion of temperature dependent cladding material properties (elastic modulus, Poisson's ratio, yield stress, failure stress, and failure strain)
 - Inclusion of initial bowed geometry of pin (for perturbation purposes).
 - Inclusion of nonlinear spring elements for spacer grid, tie plate, and pin-to-pin interactions.
 - Inspection of multiple current fuel assembly geometries to aid in accurate definition of boundary conditions.
 - Enhanced solution control procedures for faster solution of buckling capacity.
 - Enhanced post-processing of results to monitor solution behavior and verify buckling results and characteristics.
 - Enhanced post-processing of results to identify deformation, stress, and strain levels in the pin.
- Progress report provided to the NRC Technical Monitor.

TRAVEL

None.

REPORT, PAPERS, AND PUBLICATIONS

None.

ANTICIPATED AND ENCOUNTERED PROBLEM AREAS

None.

PLANS FOR NEXT REPORTING PERIOD

Over the next reporting period PNNL staff will extend the model solution to capture post-buckling behavior. PNNL staff will also conduct discussions with the NRC Technical Monitor to assure emphasis is being placed on items needed to enhance Argonne National Laboratory (ANL) high burnup testing results comparisons. Another progress report will be provided to the NRC Technical Monitor.

PNNL staff will also verify arc-length solution methodology for post-buckling behavior, include geometry for additional PWR fuels (other than the B&W 15x15), extend modeling from beam elements to 3D element geometry, and perform sensitivity analyses.

JCN - J5167

FINANCIAL STATUS AND VARIANCE ANALYSIS

See attached financial status report. The cost and funding information reported on the Cost Status by Element Table includes the necessary adjustments to account for the DOE Adder. All other cost information reflects only the Pacific Northwest National Laboratory costs and does not include the DOE Adder.

PROPERTY AND SOFTWARE

None.

JCN - J5167

SPENT FUEL REVIEW ASSISTANCE

M. A. Khaleel
(509) 375-2438
November 2002

| | <u>Current Month</u> | <u>FYTD</u> | <u>Cumulative To Date</u> |
|--|--------------------------|-----------------|-------------------------------|
| I. Direct Staff Labor Hours | 337.0 | 646.5 | 15,381.3 |
| II. Direct Salaries | 18,778 | 37,897 | 804,415 |
| Materials & Services (Excluding ADP) | 5 | 42 | 14,548 |
| ADP Support | 0 | 0 | 0 |
| Subcontracts | 0 | 0 | 57,316 |
| Travel Expenses | 997 | 2,253 | 49,056 |
| Indirect Labor Costs | 9,006 | 18,275 | 357,206 |
| Other Direct Costs | 1,574 | 3,469 | 82,835 |
| G&A, Nuclear, and Serv Assmt | 13,558 | 27,646 | 594,203 |
| Total PNNL Costs | <u>\$43,918</u> | <u>\$89,582</u> | <u>\$1,959,579</u> |
| Percent Spent | | 67% | 98% |
| Total Costs to NRC (Includes DOE Adder) | <u>\$45,236</u> | <u>\$92,269</u> | <u>\$2,022,143</u> |

III. Overall Funding Status

PNNL Available Funding (Adjusted: Reflects DOE Adder Initiated in FY92)

| <u>Total JCN Funding</u> | <u>Prior FY Carryover</u> | <u>FY03 Projected Funding Level</u> | <u>FY03 Funds Received to Date</u> | <u>FY03 Funding Bal. Needed</u> |
|------------------------------|-------------------------------|---|--|-------------------------------------|
| \$2,004,498 | \$56,832 | \$582,524 | \$77,670 | \$504,854 |

NRC Funding Provided to DOE

| <u>Total JCN Funding</u> | <u>Prior FY Carryover</u> | <u>FY03 Projected Funding Level</u> | <u>FY03 Funds Received to Date</u> | <u>FY03 Funding Bal. Needed</u> |
|------------------------------|-------------------------------|---|--|-------------------------------------|
| \$2,068,100 | \$58,537 | \$600,000 | \$80,000 | \$520,000 |

JCN - J5167

Task Funding Status (PNNL dollars)

| Task No. | NRC \$ Task Funds | PNNL \$ Task Funds | NRC Funds Rec To Date | PNNL Funds Rec. To Date | Monthly Costs | Cumulative Costs | Remaining Funds | Additional NRC Funds Requested |
|-----------------|----------------------|-----------------------|-----------------------------|-------------------------------|------------------|---------------------|--------------------|--------------------------------------|
| Completed Tasks | 1,779,234 | 1,724,043 | 1,738,100 | 1,684,106 | 0 | 1,682,355 | 1,751 | 41,136 |
| 12 | 250,000 | 242,718 | 250,000 | 242,718 | 24,164 | 238,727 | 3,992 | 0 |
| 13 | 200,000 | 194,175 | 50,000 | 48,544 | 10,276 | 24,170 | 24,374 | 150,000 |
| 14 | 62,000 | 60,194 | 30,000 | 29,126 | 9,478 | 14,326 | 14,800 | 32,000 |
| Total | 2,291,234 | 2,221,130 | 2,068,100 | 2,004,498 | 43,918 | 1,959,579 | 44,917 | 223,136 |

JCN - J5167

Task 14 - Inelastic Buckling Capacity of High Burn-up Fuel Subject to End Impact Loads

1. Financial Summary

PNNL Available Funding (Adjusted: Reflects DOE Adder Initiated in FY92)

| | | | | |
|---------------------|-------------------|---------------------|----------------------|----------------------|
| Authorized | Funding | | Total | Cumulative |
| Cost Ceiling | Obligation | Period Costs | Costs to Date | Percent Spent |
| \$60,194 | \$29,126 | \$9,478 | \$14,326 | 49.2% |

NRC Funding Provided to DOE

| | | | | |
|---------------------|-------------------|---------------------|----------------------|----------------------|
| Authorized | Funding | | Total | Cumulative |
| Cost Ceiling | Obligation | Period Costs | Costs to Date | Percent Spent |
| \$62,000 | \$30,000 | \$9,762 | \$14,756 | 49.2% |

2. Task Cost Status:

| | | | |
|--|----------------|---------------------|-------------------|
| | Current | Fiscal | Cumulative |
| | Month | Year to Date | To Date |
| Direct Staff Labor Hours | 62.0 | 101.5 | 101.5 |
| Labor | \$7,961 | \$12,809 | \$12,809 |
| Travel Expenses | \$1,517 | \$1,517 | \$1,517 |
| Service Equipment Centers | \$0 | \$0 | \$0 |
| Other Intermediate Costs | \$0 | \$0 | \$0 |
| Value Added Overheads | \$0 | \$0 | \$0 |
| Services - Other RL Contractors | \$0 | \$0 | \$0 |
| Procurements | \$0 | \$0 | \$0 |
| Subcontracts | \$0 | \$0 | \$0 |
| Total PNNL Costs | <u>\$9,478</u> | <u>\$14,326</u> | <u>\$14,326</u> |
| Total Costs to NRC | <u>\$9,762</u> | <u>\$14,756</u> | <u>\$14,756</u> |
| (Includes DOE Adder) | | | |

JCN - J5167

**Task 13 - Dynamic Structural Analyses in Support of Risk-Informing
10 CFR Part 71**

1. Financial Summary

PNNL Available Funding (Adjusted: Reflects DOE Adder Initiated in FY92)

| <u>Authorized</u> <u>Cost Ceiling</u> | <u>Funding</u> <u>Obligation</u> | <u>Period Costs</u> | <u>Total</u> <u>Costs to Date</u> | <u>Cumulative</u> <u>Percent Spent</u> |
|--|-------------------------------------|---------------------|--------------------------------------|---|
| \$194,175 | \$48,544 | \$10,276 | \$24,170 | 49.8% |

NRC Funding Provided to DOE

| <u>Authorized</u> <u>Cost Ceiling</u> | <u>Funding</u> <u>Obligation</u> | <u>Period Costs</u> | <u>Total</u> <u>Costs to Date</u> | <u>Cumulative</u> <u>Percent Spent</u> |
|--|-------------------------------------|---------------------|--------------------------------------|---|
| \$200,000 | \$50,000 | \$10,584 | \$24,897 | 49.8% |

2. Task Cost Status:

| | <u>Current</u> <u>Month</u> | <u>Fiscal</u> <u>Year to Date</u> | <u>Cumulative</u> <u>To Date</u> |
|---------------------------------|--------------------------------|--------------------------------------|-------------------------------------|
| Direct Staff Labor Hours | 89.5 | 108.0 | 207.5 |
| Labor | \$10,210 | \$12,605 | \$23,931 |
| Travel Expenses | \$0 | \$0 | \$0 |
| Service Equipment Centers | \$61 | \$61 | \$234 |
| Other Intermediate Costs | \$0 | \$0 | \$0 |
| Value Added Overheads | \$0 | \$0 | \$0 |
| Services - Other RL Contractors | \$0 | \$0 | \$0 |
| Procurements | \$6 | \$6 | \$6 |
| Subcontracts | \$0 | \$0 | \$0 |
| Total PNNL Costs | <u>\$10,276</u> | <u>\$12,672</u> | <u>\$24,170</u> |
| Total Costs to NRC | <u>\$10,584</u> | <u>\$13,052</u> | <u>\$24,897</u> |

(Includes DOE Adder)

JCN - J5167

**Task 12 - Development of Analysis of Spent Fuel & Radioactive Material Cask
Cask Models for Casework Evaluations**

1. Financial Summary

PNNL Available Funding (Adjusted: Reflects DOE Adder Initiated in FY92)

| Authorized Cost Ceiling | Funding Obligation | Period Costs | Total Costs to Date | Cumulative Percent Spent |
|----------------------------|-----------------------|--------------|------------------------|-----------------------------|
| \$242,718 | \$242,718 | \$24,164 | \$238,727 | 98.4% |

NRC Funding Provided to DOE

| Authorized Cost Ceiling | Funding Obligation | Period Costs | Total Costs to Date | Cumulative Percent Spent |
|----------------------------|-----------------------|--------------|------------------------|-----------------------------|
| \$250,000 | 250,000 | \$24,889 | \$245,890 | 98.4% |

2. Task Cost Status:

| | Current Month | Fiscal Year to Date | Cumulative To Date |
|---------------------------------|------------------|------------------------|-----------------------|
| Direct Staff Labor Hours | 185.5 | 437.0 | 1,729.6 |
| Labor | \$24,164 | \$60,172 | \$222,799 |
| Travel Expenses | \$0 | \$1,912 | \$6,066 |
| Service Equipment Centers | \$0 | \$459 | \$632 |
| Other Intermediate Costs | \$0 | \$0 | \$0 |
| Value Added Overheads | \$0 | \$0 | \$0 |
| Services - Other RL Contractors | \$0 | \$0 | \$0 |
| Procurements | \$0 | \$43 | \$9,230 |
| Subcontracts | \$0 | \$0 | \$0 |
| Total PNNL Costs | \$24,164 | \$62,586 | \$238,727 |
| Total Costs to NRC | \$24,889 | \$64,464 | \$245,890 |
| (Includes DOE Adder) | | | |

MONTHLY FORECAST VS ACTUAL - PNNL EXPENSE BY TASK

[illegible]