UNITED STATES DEPARTMENT OF COMMERCE
National Bureau of Standards
Gaithersburg, Maryland 20899

March 15, 1988

Mr. Charles Peterson
Technical Review Branch
Division of High-Level Waste Management
Office of Nuclear Materials Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Re: Monthly Letter Status Report for February 1988 (FIN-A-4171-7)

Dear Mr. Peterson:

Enclosed is the February 1988 monthly progress report for the project "Evaluation and Compilation of DOE Waste Package Test Data" (FIN-A-4171-7). The financial information is reported separately.

Sincerely,
Charles G. Interrante

Charles G. Interrante
Program Manager
Corrosion Group
Metallurgy Division

Enclosure

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Monthly Letter Report for February 1988

Published March 1988

(FIN-A-4171-7)

Performing Organization: National Bureau of Standards (NBS)
Gaithersburg, MD 20899

Sponsor: Nuclear Regulatory Commission (NRC)
Office of Nuclear Materials Safety and Safeguards
Washington, DC 20555

Task 1 -- Review of Waste Package Data Base

A draft of "Evaluation and Compilation of DOE Waste Package Test Data, Draft Biannual Report Covering the Period August 1987-January 1988," National Bureau of Standards, NUREG/CR-4735, Volume 4, February 29, 1988 was delivered on March 1, 1988, to the NRC for review. The draft will be sent to the Washington Editorial Review Board (WERB) on or about March 16, 1988. The final report will be issued on May 30, 1988.

Appended to this report are the following three Draft Reviews not previously submitted (see p. 8, Attachment A).

1. UCID-20895, "Application of EQ3/6 to Modeling of Nuclear Waste Glass Behavior in a Tuff Repository," May 1986.
2. Smith, H. D. , "The Influence of Copper on Zircaloy Spent Fuel Cladding Degradation Under a Potential Tuff Repository Condition", UCRL-15993, SANL-622024, March 1987.
3. "Final Report of the Defense High-Level Waste Leaching Mechanisms Program," Chapter 2, Surface Layers in Leached Borosilicate Glass High-Level Defense Nuclear Waste Forms, PNL-5157, August 1984.

STATUS OF REVIEWS OF NNWSI REPORTS

NNWSI -- Reports identified and assigned for review this month.

Five reports on four subjects were identified for review on Nevada Nuclear Waste Storage Investigation (NNWSI) during this month. Two reports evaluate austenitic stainless steels as candidates for the metal canister, one report deals with the effect of radiation on moisture, a third describes a model for glass dissolution, and the other report discusses the importance of understanding chemical fundamentals in developing data for models. These reports are briefly described and then listed below.

A literature review of the phase stability of type 304L, 316L stainless steels, and alloy 825 indicates that both of these 300 series stainless steels are metastable alloys at repository temperatures, and alloy 825 is stable at all temperatures [Bullen, 1987]. Sensitization brought about by the depletion of chromium by carbide precipitation occurs with both 304L and 316L stainless steels. Precipitation of carbide also takes place in alloy 825, but the titanium carbide, rather than chromium carbide, is the preferred precipitate, and the effect of chromium depletion is reduced.

The results of a study of the stress corrosion susceptibility of type 304, 304L, and 316L stainless steels in a simulated tuff groundwater environment at elevated temperatures reveals that sensitized type 304 stainless is susceptible to failure at elevated temperatures in irradiated and nonirradiated conditions [Westerman, 1987]. U-bend specimens of Type 304L resisted failure except when the environment was irradiated. Slow-strain-rate studies of 316L in J-13 water at 95°C resisted failure.

A study of the effects of radiation on the nitrogen/oxygen/water gas system shows that nitric acid, nitrous oxides, and ammonia may form in repository conditions [Reed, 1987]. These products increase the potential for stress corrosion cracking and pitting of copper-based alloys in a repository environment.

Using the EQ3/6 computer code package, the dissolution of West Valley and Defense Waste Product Facility glasses in J-13 water are evaluated [Bruton, 1987]. The results indicate that the effects of radionuclide oxide and hydroxide precipitation limit the concentrations of radionuclides and other elements in solution. However, radiolysis and materials interactions were not considered in these reactions.

This report emphasizes the importance of understanding fundamental chemistry, thermodynamics, and kinetics when modeling the behavior of elements that exhibit a wide range of valances [Rard, 1987]. Ruthenium is used as an example, and Rard shows that failure to consider the known chemistry of ruthenium results in large differences in predicted solubilities.

NNWSI -- Reports identified and assigned for review this month.

1. Bullen, D. B., Gdowski, G. E., and McCright, R. D., "Impact of Phase Stability on the Corrosion Behavior of the Austenitic Candidate Materials for NNWSI," UCRL-97562, October 1987.

2. Reed, D. T. and Van Konynenburg, R. A., "Effect of Ionizing Radiation on Moist Air Systems," UCRL-97936, December 1987.

3. Westerman, R. E., Pitman, S. G., and Haberman, J. H., "Corrosion Testing of Type 304L Stainless Steel in Tuff Groundwater Environments," UCRL-21005, SANL 616-007, December 1987.

4. Bruton, C. J., "Geochemical Simulation of Dissolution of West Valley and DWPF Glasses in H-13 Water at 90°C," UCRL-96703, November 1987.

5. Rard, J. A., "Thermodynmaic Data Bases for Multivalent Elements: An Example for Ruthenium," UCRL-96555, Rev. 1, November 1987.

NNWSI -- Review is continuing on the following 19 reports.

1. UCRL-94708, "Carbon-14 in Waste Packages for Spent Fuel in a Tuff Repository," October 1986.

2. UCRL-94633, "Experimental Study of the Dissolution Spent Fuel at 85°C in Natural Groundwater," December 1986.

3. UCRL-95962, "Hydrogen Speciation in Hydrated Layers on Nuclear Waste Glass," January 1987.

4. UCRL-94658, "Integrated Testing of the SRL-165 Glass Waste Form," December 1986.

5. UCRL-91258, "Leaching Savannah River Plant Nuclear Waste Glass in a Saturated Tuff Environment," November 1984.

6. UCRL-92891, "LWR Spent Fuel Characteristics Relevant to Performance as a Wasteform in a Potential Tuff Repository," June 1985.

7. ANL-84-81, "NNWSI Phase II Materials Interaction Test Procedures and Preliminary Results," January 1985.

8. HEDL-TME 85-22, "Results from Cycles 1 and 2 of NNWSI Series 2 Spent Fuel Dissolution Tests," May 1987.

9. UCRL-94363, "Hydrological Properties of Topopah Spring Tuff - Laboratory Measurements," December 1985.

10. UCRL-53761, "Waste Package Performance Assessment: Deterministic System Model Program Scope and Specification," October 1986.

11. HEDL-7540, "Technical Test Description of Activities to Determine the Potential for Spent Fuel Oxidation in a Tuff Repository," June 1985.

12. HEDL-SA-3627, "Predicting Spent Fuel Oxidation States in a Tuff Repository," April 1987.

13. UCRL-53702, "Spent Fuel Test - Climax: An Evaluation of the Technical Feasibility of Geologic Storage of Spent Nuclear Fuel in Granite," March 1986.

14. UCRL-53767, "Geomechanics of the Spent Fuel Test - Climax," July 1987.

15. UCRL-92311, "Gamma Radiation Effects on Corrosion, I. Electrochemical Mechanisms for the Aqueous Corrosion Process of Austenitic Stainless Steels," February 1985.

16. Aines, R. D., "Plan For Glass Waste Form Testing For NNWSI", UCID-21190, September 1987.

17. Knauss, K. G., "Reaction of Vitric Topopah Spring Tuff and J-13 Ground Water under Hydrothermal Conditions Using Dickson-Type, Gold-Bag Rocking Autoclaves", UC RL-53795, November 1986.

18. McCright, Halsey, S. G., Konynenburg, R. A., "Progress Report on the Results of Testing Advanced Conceptual Design Metal Barriier Materials Under Rilevant Environmental Conditions for a Tuff Repository", UCID-21044, December 1987.

19. Wilson, C. N., "Microstrctural Characteristics of PWR Spent Fuel Relative to its Leaching Behavior", UCRL-15976, SANL-522-006, April 1985.

WASTE FORM DEGRADATION

A review of Chapter 2, "Surface Layers in Leached Borosilicate Glass High-Level Defense Nuclear Waste Forms," of PNL-5157 Final Report of the Defense High-Level Waste Leaching Mechanisms Program is included in this report (see p. 13, Attachment A). Chapter 3, "Environmental Interaction," may be completed by the end of March and Chapter 4, "Dissolution of Specific Radionuclides," is expected to be completed a month thereafter.

WASTE FORM DEGRADATION -- No new reports have been identified this month.

WASTE FORM DEGRADATION -- Review is continuing on the following 11 reports.

1. "Long Term Leach Behavior of West Valley HLW Glasses," P. B. Macedo, et al., ANS Spectrum, 1986.

2. "Leach Mechanisms of Borosilicate Glass Defense Waste Forms -- Effects of Composition," A. Barkatt, et al., Waste Management '86: Waste Isolation in the U.S.-Technical Programs and Public Education, March 1986.

3. "Chemical Determination of West Valley Waste Form Products," D. M. Oldman, J. R. Stimmel, and J. H. Marlow, March 1987.

4. PNL-5157, "Final Report of the Defense High-Level Waste Leaching Mechanisms Program," August 1984.

5. "Physical Chemistry of Glass Surfaces," J. Non-Cryst. Solids, 1978.

6. DP-MS-83-135, "Process Technology for Vitrification of Defense High-Level Waste at the Savannah River Plant," Paper for presentation in the proceedings of the American Nuclear Society Meeting on Fuel Reprocessing and Waste Management, August 1984.

7. DP-MS-86-96, "Process and Mechanical Development for the Savannah River TRU Waste Facility," Paper proposed for presentation at the American Nuclear Society International Meeting, Spectrum '86, September 1986.

8. PNL-4382, "Materials Characterization Center's Workshop on Leaching Mechanisms of Nuclear Waste Forms," May 19-21, 1982.

9. "Large Scale Leach Testing of DWPF Canister Sections," Proceedings of the Materials Research Society Symposium, "Scientific Basis for Nuclear Waste Management X," December 1986.

10. "Waste Glass Leaching: Chemistry and Kinetics," Proceedings of the Materials Research Society Symposium, "Scientific Basis for Nuclear Waste Management X," December 1986.

11. "Method for Showing Compliance with High-Level Waste Acceptance Specifications," Waste Management '86: Waste Isolation in the U.S. Technical Programs and Public Education, Volume 2, High-Level Waste, March 1986.

TASK 2 -- Identification of Additional Data Required and Identification of Tests to Generate the Data

NBS lead workers are continuing their studies concerning the types of additional data and verification tests needed to demonstrate that the DOE waste package designs will meet the performance objectives of 10 CFR 60.

Conclusions, results, and recommendations for the work reviewed to date are given in each review form under the heading GENERAL COMMENTS OF REVIEWER.

TASK 3 -- Laboratory Testing

The work on each of the four projects reported below is on schedule with the work statements listed in their respective proposals. The work conducted in February 1988 is reported below. Work conducted in previous months was reported earlier.

Title of Study: Evaluation of Methods for Detection of Stress Corrosion Crack Propagation in Fracture Mechanics Samples.
Principal Investigator: Charles Interrante

No new progress to report this month.

Title of Study: Effect of Resistivity and Transport on Corrosion of Waste Package Materials.
Principal Investigator: Edward Escalante

The corrosion rates of steel specimens that are being tested in the various environments selected for this study are, in general, exhibiting a decrease with time. Resistivity of the poorly conducting systems has increased slightly, but otherwise, resistivities have remained fairly constant during the exposure period. Similarly, the transport properties have remained relatively unchanged. In this coming month, the steel specimens will be removed from their exposure cells for determination of weight loss by gravimetric measurements.

Title of study: Corrosion Behavior of Zircaloy Nuclear Fuel Cladding
Principal Investigator: Anna C. Fraker

The purpose of this work is to characterize the corrosion behavior of Zircaloy in terms of passivity, breakdown of passivity and susceptibility to localized corrosion. A review of corrosion of Zircaloy has been conducted and a draft of this review is attached (see p. 22, Appendix B).

Electrochemical measurements are directed toward understanding the passivation and protection of Zircaloy and of the breakdown of passivation. These measurements also are carried out to determine any tendency for pitting in the saturated J-13 water environment. Five different forms of Zircaloy are being tested including bulk Zircaloy-2 alloy, bulk Zircaloy-4 alloy, Zircaloy-2 tubing, Zircaloy-2 tubing with an oxide coating, and Zircaloy-4 tubing. Numerous tests are being conducted to assure reproducibility and to obtain data to explain corrosion reactions which are occurring. Tests performed during the past month are described below.

All corrosion tests were conducted in saturated J-13 water at 95°C. The solution pH was 8.5. Additional anodic polarization measurements were made on Zr-4 tubing, Zr-2 tubing, and on Zr-2 tubing with oxide coating.

Additional cyclic anodic polarization measurements also were made on Zr-2 tubing with oxide coating and on the Zr-4 alloy. All material passivate and breakdown at 0.8 volts vs a saturated calomel electrode or higher. There is some hysteresis in the current vs potential in the cyclic polarization measurements and this is being investigated. This high current can be due to pitting, rate of applying the potential or to environmental factors.

Future work on this project includes additional anodic polarization measurements and some pitting susceptibility tests involving electrical stimulation. Materials to be tested include the five types listed above and also specimens of welded tubing.

Microstructural characterization will be conducted utilizing techniques of light microscopy, scanning electron microscopy and energy dispersive x-ray analysis.

TASK 4 -- General Technical Assistance

A joint briefing for NRC staff and contractors was held at NBS on February 25, 1988. Presentations were made, by NBS staff members, on NMSS funded activities of both the Institute for Materials Science and Engineering (IMSE) and the Center for Chemical Engineering (CCE).

An NRC Workshop on EBS Performance was attended at the White Flint Building, Rockville MD, by A. Fraker and C. Interrante on February 24, 1988.

Dr. C. Interrante participated in an international workshop on Corrosion of Waste Containers on February 9-10, 1988 in Winnipeg, Manitoba, Canada. A trip report will be enclosed in the March report. However, a draft is available now and it can be delivered to NRC personnel by special request.

The West Valley Demonstration Technical Exchange with the NRC held in West Valley, New York on February 2-3, 1988 was attended by Dr. C. Interrante. A trip report is enclosed (see p. 39, Attachment C).

Dr. C. Interrante attended the ASTM C26.07 Subcommittee Meeting in Albuquerque, New Mexico on January 25-27, 1988. A trip report is enclosed (see p. 50, Attachment C).

NBS Review of Technical Reports on the High Level Waste Package for Nuclear Waste Storage

DATA SOURCE

(a) Organization Producing Data

Lawrence Livermore National Laboratory, Livermore, CA.

(b) Author (s), Reference, Reference Availability, Date

Aines, R. D., "Application of EQ3/6 to Modeling of Nuclear Waste Glass Behavior in A Tuff Repository," UCID-20895, May, 1986.

DATE REVIEWED: 10/8/87; Revised 2/2/88.

TYPE OF DATA

Preliminary development of glass degradation modeling capabilities for repository performance assessment modeling, using the geochemical modeling code EQ3/6.

MATERIALS/COMPONENTS

None given.

TEST CONDITIONS

None given.

METHODS OF DATA COLLECTION/ANALYSIS

Development of computer geochemical code.

AMOUNT OF DATA

3 Tables

1. Species and hydration reactions of the hypothetical oxide and silicate components of glass (Grambow, 1984)
2. Phases reported to form on nuclear waste glass.
3. Additional precipitates on nuclear waste glass.

UNCERTAINTIES IN DATA

None given.

DEFICIENCIES/LIMITATIONS IN DATABASE

None given.

KEYWORDS

Computer program, planned work, geological modeling code, defense high level waste (DHLW).

GENERAL COMMENTS OF REVIEWER

EQ3/6 is a geochemical modeling code which can be used for repository performance assessment modeling. This report describes preliminary development of glass degradation modeling capabilities using this code. The authors believe that our current understanding of glass leaching mechanisms and the interaction of glass with an aqueous environment has advanced to the point where it is now feasible to begin designing models for long-term behavior of waste glass under repository conditions. The report outlines the principles to be used in design such a model. A staged development is outlined that would take a number of years to complete. Milestones of this staged development are listed in the report and at each stage the modeling effort would be verified with experimental work.

Because the model is only in its initial planning stage, sufficient detail is given to judge the validity of the final product in assessing radionuclide release under realistic repository conditions. Even when completed and checked against experiment, it is difficult to see how the model could be sufficiently comprehensive and accurate to predict exactly the performance of the waste package. However, when the final model is checked against experiment, it could probably be used to predict the effects of changes in various parameters. Judgment of the effectiveness of the model for long-term performance prediction must at the least await its experimental verification in the short-term.

APPLICABILITY OF DATA TO LICENSING

[Ranking: key data ( ), supporting data (X)]

(a) Relationship to Waste Package Performance Issues Already Identified

This report relates to NNWSI ISTP issue 2.3.2.1.2, the rates of dissolution associated with the potential waste form dissolution mechanisms.

(b) New Licensing Issues

(c) General Comments on Licensing

NBS Review of Technical Reports on the High Level Waste Package for Nuclear Waste Storage

DATA SOURCE

(a) Organization Producing Data

Westinghouse Hanford Company, Richland, Washington.

(b) Author(s), Reference, Reference Availability

Smith, D. H., "The Influence of Copper on Zircaloy Spent Fuel Cladding Degradation Under a Potential Tuff Repository Condition," UCRL-15993, SANL 622024, Lawrence Livermore National Laboratory, March 1987.

DATE REVIEWED: 2/7/88.

TYPE OF DATA

Experimental.

MATERIALS/COMPONENTS

Materials Characterization Center's Approved Testing Material, ATM-101 spent fuel rods were wrapped in copper foil of 99.999 wt. percent purity to make a bundle and placed in a 0.1M $Cu(NO_3)_2$ solution in a fused silica jar with a Pyrex lid. Some areas of spent fuel rods were polished to permit observation of a newly formed oxide film.

TEST CONDITIONS

Each bundle contained approximately 400 g of spent fuel, and the gamma radiation dose rate at the bundle surface was about 1000 Rd/h. The $Cu(NO_3)_2$ solution was held at a temperature of 90°C, and the solution pH was approximately 4.5. Tests were conducted for periods of two and five months. Lost liquid due to sampling was replaced with an equal amount of stock solution. Solution lost due to evaporation was replaced with an equal volume of deionized water.

METHODS OF DATA COLLECTION/ANALYSIS

Inductively coupled plasma optical emission spectroscopic analysis was used to detect Zr. Specimens were photographed at the end of the test. X-Ray diffraction was used to identify $Cu_2(OH)_3NO_3$ deposits and the partially oxidized copper wrap. Specimens were sectioned for microscopic observation. Metallographic techniques were used to view the cladding with the original oxide and cross sections showing the metal/oxide interface. Electron probe analysis, with a profile line sensitivity of 0.1 % of 1 %, was conducted on the oxide film cross section, and no Cu was detected. Scanning electron Microscopy (SEM) was used to evaluate polished and unpolished areas of the specimens and also the oxide/ metal interface. Energy dispersive x-ray analysis (EDX) showed the presence of Fe and Si but Cu was found in only one of eighteen specimens studied. Auger electron spectroscopy was coupled with ion milling to produce elemental concentration profiles through the oxide film and into the Zircaloy as a function of time. The observation of copper was considered as a contaminant on the surface.

AMOUNT OF DATA

There are two tables and six figures.

Tables

Table I. A Comparison of Some Expected Tuff Repository Environmental Conditions with Those in Which Copper has been Observed to have Influenced Zircaloy Corrosion.

Table II. Average Observed Ion Milling Time to Achieve a 90% Decrease in Surface Oxygen Concentration and an Equivalent Increase in Surface Zirconium Concentration.

Figures

1. Schematic of Corrosion Cell Used for the 2-Month and 5-Month Experiments. Copper foil wrap with a copper wire tie holds the bundle together. Zircaloy plugs are press fit to mechanically seal each cladding section.

2. Before and After Photographs of the Cladding Bundle Used in the 2-Month Experiment. Discontinuity in texture of deposits about half way up on the copper wrap indicates the water level during the experiment. Note that the polished cladding is still shiny after two months.

3. Sectioning Diagram for Each Ring Specimen (see figure 2). Ring segments were evaluated via SEM, Auger/ion milling, electron microprobe and metallography.

4. Example of Thick Films on H. B. Robinson Spent fuel Cladding From the 5-Month Experiment.

5. Scanning Electron Micrographs of Cladding Samples With Thin Oxide From the 2-Month Experiment: a) Total specimen with well defined boundary between polished (right) and unpolished (left) areas, b) High magnification SEM micrograph of boundary showing oxide (dark) and metal (light) areas. Notice that the oxide-metal interfact shows no topographical expression.

6. Auger Electron Spectrum for Specimen P2 from the 2-Month Experiment, Copper, sodium, and calcium seem to be present on the undisturbed surface and are quickly removed by sputtering, i.e., the surface after 30 seconds of sputtering (Post-sputter surface) doesn't show these elements. All 12 specimens from 2- and-5-month experiments exhibited very similar spectra.

UNCERTAINITIES IN DATA

Calculated oxide film thicknesses on the Zircaloy were 115 Å after two months and 145 Å after five months. Experimental values were similar to these but the scatter in the data was greater that the difference in the thickness values.

DEFICIENCIES/LIMITATIONS IN DATABASE

None given.

KEYWORDS

Experimental data, supporting data, microscopy, spectroscopy, surface film, x-ray diffraction , laboratory test, Yucca Mountain, 0.1 M $Cu(NO_3)_2$ solution, Cu, acidic solution, 90 C temperature, copper, spent fuel(BWR), Zircaloy, spent fuel cladding, degradation, oxidation, corrosion.

GENERAL COMMENTS OF REVIEWER

These tests were conducted to investigate whether copper ions accelerate zirconium alloy corrosion in acid environments and whether crud induced local corrosion (CILC) would occur in a repository environment. Neither accelerated corrosion nor crud-induced localized corrosion were observed after these tests. The testing conditions used are not representative of those in the repository or of the conditions under which accelerated corrosion and crud-induced localized corrosion would occur. Nodular corrosion, the precursor to CILC in Zircaloy was produced by other workers at a temperature of 510°C and a pressure of 1500 psig, and it would not have been expected under conditions of the testing described in this report. Additional tests designed to accelerate local corrosion of Zircaloy should be conducted before conclusions are made regarding its behavior in the repository environment.

APPLICABILITY OF DATA TO LICENSING

[Ranking: key data ( ), supporting (X)]

(a) Relationship to Waste Package Performance Issues Already Identified

This report relates to NNWSI ISTP issue, 2.3.6, regarding potential damage and failure mechanisms for the fuel rod cladding.

(b) New Licensing Issues

(c) General Comments on Licensing

NBS Review of Technical Reports on the High-Level Waste Package for Nuclear Waste Storage

DATA SOURCE

(a) Organization Producing Report

Pacific Northwest Laboratory Operated for the Department of Energy by the Battelle Memorial Institute, Columbus, OH.

(b) Author(s), Reference, Reference Availability

"Final Report of the Defense High-Level Waste Leaching Mechanisms Program," Chapter 2, Surface Layers in Leached Borosilicate Glass High-Level Defense Nuclear Waste Forms, PNL-5157, August 1984.

DATE REVIEWED: 8/17/87; Revised 2/29/88.

TYPE OF DATA

(1) Scope of the Report

Extensive review of experimental data and data analyses relating to the chemical composition, morphology, and crystallinity of leached surface layers formed on borosilicate waste glasses by various types of leachants. Data obtained from contracting laboratories reports and other literature.

(2) Failure Mode or Phenomenon Studied

Growth of alteration layers in glass subject to leaching.
Alteration layer growth mechanism.
Alteration layer thickness and morphology.
Composition of alteration layers and other solid products.
Elemental leach depths.
Growth rates of leached surface films.

MATERIALS/COMPONENTS

Defense Waste Reference Glass (DWRG)
TDS-131 Glass
PNL-76-68

TEST CONDITIONS

(1) State of the Material being Tested

Glass monoliths and powders.

(2) Specimen Preparation

DWRG and TDS-131 glass surfaces were leach tested as-cast, polished with 3-μ diamond grit, thermally fractured, 600-grit polished, 360-grit polished, 400-grit polished, and with 600-grit scratches on 3-μ polish.

(3) Environment of the Material being Tested

IAEA Water Replacement Testing.
MCC-1 Static Leaching Testing.
Flowing Leachant Testing.
Water Exchange Testing.

Test Pressures: ambient and hydrothermal conditions.
Test Temperatures (°C): 20, 70, 90, 138, 160, 201, 225, 230, 247, and 250.
Exposed Surface Area to Solution Volume Ratio (SA/V, [m^{-1}]): 10 to 20, 20 to 50, 0.1, 10, 1.2 x 10^{-5}, 2300, 7, 360.
Test Time: 209 days, 14 days, 28 to 400 days, 6 months, 143 days, 1 to 2 years, 1800 h, 158 h, 102 h, 361 h.
Leachant Type: Highly Dilute Deionized Water, Grande Ronde-type Silicate Water, IAEA Deionized Water, Brine.
Leachant Flow Rate (cm^3/h), 0.5, 50.
Water Exchange Rates (volume %): 25% over 1 to 30 days.
Solution pH: 5.5, 11.4, 9.6, 10.6, 9.9, 12.4, 10.3 to 10.7.
Solution Eh: -3 mV.

Additional materials in the test environments: basalt, ductile iron, canister metal.

METHODS OF DATA COLLECTION/ANALYSIS

Scanning electron microscopy (SEM), energy dispersive x-ray spectroscopy (EDXS), secondary ion mass spectrometry (SIMS), x-ray photoelectron spectroscopy (XPS), chemical solution concentration analyses, sputter-induced photon-induced spectroscopy (SIPS), Auger electron spectroscopy (AES), scanning Auger spectroscopy (SAM), powder x-ray diffraction (XRD), optical microscopy.

AMOUNT OF DATA

There are seven tables.

Table 2.1--"Comparison of Calculated Elemental Leach Depths, from Solution and Gel Layer (EDXS) Concentration Data, with Those Observed by SEM/EDXS in a DWRG Alteration Region Produced in 183 Days of IAEA-Type Testing in Deionized Water at 90°C." Calculated Layer Thickness and SEM/EDXS-Based Layer Thickness, both in microns, are given for nine elements.

Table 2.2--"SEM/EDXS Comparison of Alteration Layer Thickness and Chemical Composition on 600-Grit-Polished DWRG Monoliths Exposed to Different Static Leaching Environments at the University of Florida. Atomic ratios

were determined by quantitative EDXS using DWRG and pure phase nepheline reference standards, with the experimental uncertainty estimated at 10%." Composition data for six elements are given normalized with respect to Si for four different test cases.

Table 2.3--"Elemental Ratios observed by Quantitative EDXS in Alteration Layers Produced by 270 Days of Static Deionized Water MCC-1 Leach Testing at 90°C on Two Samples of the DWRG (estimated uncertainty 10%). Composition data for seven elements are given normalized with respect to Si for two different test cases.

Table 2.4--"Elemental Distributions Determined by EDXS in a 1-Micron Alteration Layer Separated from a Thermally Fractured Sample of the DWRG (Figure 2.2). MCC-1 leach conditions: 209 days in static deionized water at 90°C. Uncertainty of determinations estimated at 10%." The elemental composition for seven elements is given normalized to Si content for three layers: 0.0-0.5 micron, 0.5-1.0 micron, and the bulk glass.

Table 2.5--"Solid Reaction Products Observed in Dissolution Testing of the DWRG and TDS-131 Glass at 90°C (GND = groundwater, DI = deionized water)." The mineral phases and their nominal stoichiometry are given.

Table 2.6--"Crystalline Products Identified in Reaction of Glass and Water Under Hydrothermal Conditions." The temperature, time, grams of water, and crystalline phases are listed for 23 runs.

Table 2.7--"Disposition of elements in DWRG Upon Reaction with Water."

There are 34 figures.

Figure 2.1--"SEM Micrographs of the Alteration Layers Formed on 3-Micron-Grit-Polished DWRG in 28 Days of Deionized Water leaching at 90°C Under MCC-1 Conditions." Three micrographs are given, at 200x, 2000x, and 5000x magnification.

Figure 2.2--"Seven SEM Views of Two Alteration Layers Formed on a Sample of the As-Cast DWRG with a Thermal Fracture Surface. Leach conditions: 209 days, deionized water, 90°C, SA/V = 10 to 20 m^{-1}." The micrographs show Alteration Layers at 2000x, Outer Surface at 5000x, Bottom Surface of Outer Layer at 5000x, Upper Surface of Inner Alteration Layer at 5000x, Bottom Surface of Inner Alteration Layer at 2000x, Bottom Surface of Inner Alteration Layer at 5000x, and Leached Glass Surface Magnification at 2000x.

Figure 2.3--"Six Alteration Layers Formed on a Sample of TDS-131 Glass During Flow Test Leaching at the University of Florida. conditions: 50 cm^3/h, deionized water, 90°C, 600 grit surface polish." The magnification is 2000x.

Figure 2.4--"Three SEM Micrographs of the 30-Micron-Thick Alteration Zone Formed on a 360-Grit-Polished DWRG Sample in 183 Days of Water Exchange Testing at Catholic University. conditions: deionized water, 25% volume

water exchange at intervals from 1 to 30 days, 90°C, SA/V = 7 m^{-1}." The micrographs show Outer Surface at 300x, Edge View at 1000x, and Inner Surface at 300x.

Figure 2.5--"Plot of Calculated Alteration Layer Densities on Leached DWRG Surfaces as a Function of Flow Rate of Deionized and Simulated Groundwaters. The data were taken from water replacement test at Catholic University with effective flow rate calculated at a normalized SA/V x t value." Surface Layer Density in g/cm^3 ranging from 0.5 to 2.5 is plotted versus Flow Rate in m/yr from 0 to 100. Data are given for deionized water at both 70°C and 90°C and for silicate water at 70°C.

Figure 2.6--"SEM Micrographs of the Alteration Layers Produced on Samples of the DWRG in 28 Days of MCC-1 Type Testing in Deionized Water at 90°C as a Function of Surface Finish." Three micrographs all at 2000x magnification show the effects of the use of 3 μ diamond, 600 grit powder, and 400 grit paper.

Figure 2.7--"SEM Micrographs Showing Pitting of the DWRG Beneath the Alteration Layer, Produced During Static Leaching Under Various Conditions." Four micrographs are shown all at 200x magnification: Deionized Water, 28 days, 3 micron polish; Deionized Water, 28 days, 600 grit polish; Deionized Water, 143 days; Deionized Water + Canister Metal, 7 days.

Figure 2.8--"SEM Micrographs Demonstrating the Effects of precipitate Deposition on the Extent of Pitting of the DWRG Surface During Leaching. conditions: 7 days MCC-1 leaching at 90°C in deionized water with an equal surface area of the reference canister metal and DWRG." Four micrographs are given: Top Surface of DWRG at 2000x; Bottom Surface of DWRG at 2000x; Top Leached Glass Surface at 200x; Bottom Leached Glass Surface at 200x.

Figure 2.9--"SEM Comparison of Surface Precipitate Formation on the DWRG in Deionized Water at 90°C With and Without the Reference canister Metal Present After 143 Days of Static Leaching Under MCC-1 Conditions." Two micrographs are given.

Figure 2.10--"SEM Micrographs of the Precipitates Formed on the Reference Canister Metal in Deionized Water Leaching with the DWRG at 90°C After 143 Days." Two micrographs are given, one at 2000x and the other at 5000x magnification.

Figure 2.11--"Growth of the Alteration Zone on Samples of the DWRG as a Function of Time of Exposure to Deionized Water at 90°C Under MCC-1 Conditions (except where noted). Several conditions and surface finishes are represented. Open circles = TDS-131, 0.5 cm^3/h flow DI water; closed circles = 3-micron polished samples of DWRG (MCC-1); squares = DWRG with 600-grit polish (MCC-1); diamonds = DWRG with 3-micron polish + an equal surface area of RCM (MCC-1); triangles = thermally cracked sample of as-cast DWRG (MCC-1). The arrows indicate that portions of the layers were significantly thicker; the dashed lines show the regions bound by the

uncertainty in the measurements." Alteration layer thickness (microns) from 0 to 6 is plotted against days leached from 0 to 200.

Figure 2.12--"SIPS Depth Profiles for Polished DWRG After 100 H in Deionized Water at 90°C at SA/V = 0.1 m^{-1}. At the earliest stages, congruent dissolution of the DWRG depletes all elements except Si and B in the surface film." The intensity in photon counts per second from 10 to 10^5 is plotted versus depth in μm from 0 to 0.3 for eight elements.

Figure 2.13--"SIPS Depth Profiles for Polished DWRG After 28 Days in Deionized Water at 90°C at SA/V = 0.1 m^{-1}. At this stage of dissolution the surface film shows the formation of a layer of hydrated Fe formed either by adsorption or precipitation." The intensity in photon counts per second from 10 to 10^5 is plotted versus depth in μm from 0 to 0.4 for eight elements.

Figure 2.14--"SIPS Depth Profiles for Polished DWRG After 100 H in Deionized Water at 90°C at SA/V = 10 m^{-1}. Later in the dissolution process an outer layer is formed in the alteration zone as hydrated Mg and Mn precipitate or absorb at the water-glass interface." The intensity in photon counts per second from 10 to 10^5 is plotted versus depth in μm from 0 to 0.6 for five elements.

Figure 2.15 A and B--"SIMS Depth Profiles for Polished TDS-131 Glass AFter 28 Days at 90°C in Deionized Water at SA/V = 10 m^{-1}. The profiles show the multiple layer structure of the elemental distribution in the alteration zone. Ca and Sr are enriched in the inner layer." In both figures intensity in counts per second from 1 to 100000 are plotted versus depth in μm from 0 to 4. Profiles for four elements are given in A and profiles for four other elements are given in B.

Figure 2.17--"EDXS Depth Profiles of the IAEA Leach-Tested Sample Shown in Figure 2.4." For eight elements, weight percent is plotted versus depth in microns (0 to 150.0). Weight percent scales vary for elements: 0 to 8 for Ca, Mi, and Al; 0 to 12 for Na; 0 to 16 for Mn and U; 0 to 40 for Si and Fe.

Figure 2.18--XPS Spectra of the Fe 2p Electron Levels in the Bulk DWRG and in the Alteration Layers. The spectra show the Fe to be more oxidized inn the leached layers." The spectra for the surface of the gel layer, the bottom of the gel layer, and the glass surface beneath the gel layer are given as amplitude plotted versus the binding energy (eV) from 750.0 to 700.0.

Figure 2.19--"XPS Spectra of the U 4f Electron Levels in the DWRG and UO_2. The comparison shows the DWRG to have U in the $UO_{2.x}$ chemical state." The spectra for the bulk glass and the UO_2 are given as counts/100 (from 0 to 75.00) plotted versus the binding energy in eV (from 415.0 to 365.0).

Figure 2.20--"XPS Spectra of a Clean DWRG Surface and a Sample That Has Been Exposed to a High-SA/V Leach Solution for 2 Weeks at 90°C. The short exposure under near steady-state conditions has produced both leaching and

precipitation reactions." The spectra are given in counts/100 (from 0 to 32 for the original surface and from 0 to 20 for the specimen after leaching) plotted versus the binding energy (eV) from 1095 to 95.

Figure 2.21--"SEM Micrograph of the Alteration Products Formed on a Sample of the DWRG After 6 Months of Static Leaching at 90°C in Deionized Water at a High SA/V."

Figure 2.22--"SEM Micrographs and EDXS Spectrum of Analcime Formed in the 90°C Deionized Water Leaching of the DWRG at High SA/V. A similar analcime type formed in TDS-131 glass leaching has a factor of 10 higher Cs content." The spectrum has no units but does give the stoichiometry of the analcime; there are two micrographs.

Figure 2.23--"SEM Micrographs and EDXS Spectrum of a Weeksite-Type [$Na_2(UO_2)(Si_2O_5)_3.H_2O$] Uranium-Containing Crystalline Phase formed in Both silicate and Deionized Water Leaching of the DWRG and TDS-131."

Figure 2.24--"SEM Micrographs and EDXS Spectrum of a Tobermorite-Type Product [$Ca_5(OH)_2Si_6O_{16}.8H_2O$] Formed in Leaching of the DWRG and TDS-131 Glasses at 90°C at High SA/V."

Figure 2.25--"SEM Micrograph and EDXS Spectrum of a Hydrated Aluminum Containing Product Formed in Near-Steady-State Deionized Water Leaching of the DWRG at 90°C and High SA/V (as in Figure 2.20)."

Figure 2.26--"SEM Micrograph and EDXS Spectrum of a Hydrated Silica Precipitate Observed in Silicate Water Leaching of the DWRG at 90°C and an SA/V of 360 m^{-1}."

Figure 2.27--"SEM Micrograph, EDXS Spectrum, and XRD Pattern of the Mixed Magnesium Oxychloride [$Mg_2(OH)_3Cl.4H_2O$-$Mg_{10}(OH)_{18}Cl_2.H_2O$] Preferentially Formed on the Surface of the DWRG in MCC-1 Static Leaching in Brine at 90°C for 28 Days."

Figure 2.28--"Plot of the Experimental Runs and the REaction REsults as Sketches of the Surface of the Glass Samples, Approximately as Viewed at 50x. In the lower portion of the figure, no crystalline phases were observed; scratches were enhanced by the reaction. In the upper portion of the figure, crystalline reaction products are common and their abundance and morphology are indicated." Temperature is plotted both as °C (from 50 to 250) and as 1000/T in kelvins (from 2.75 to 2.00) versus the log t in h (from 1.25 to 3.5).

Figure 2.29--"EDXS Trace and SEM Micrographs of Analcime Crystals. Upper right, analcime crystals with calcium silicate spheres, run 3-C (201°C, 1800 h). Scale bars 50 microns.)"

Figure 2.30--"EDXS Trace and SEM Micrographs of Weeksite Clusters. Left, tapered weeksite crystals over an analcime crystal, calcium silicate sphere (see Figure 2.34) to top right, run 3-C (201°C, 158 h). Right, (run 20-F, 230°C, 1800 h) bluntly terminated blades of weeksite; in the

background are analcime, calcium silicate (Figure 2.31) and two forms of silica. (See Figure 2.34 right top and bottom). Scale bars 100 microns."

Figure 2.31--"EDXS Trace and SEM Micrographs of Calcium Silicate Crystals from run 20-F (230°C, 1800 h). Additional phase in right-hand panel is silica. Scale bars 25 microns."

Figure 2.32--"EDXS Trace and SEM Micrographs of Fibrous Calcium silicate Phase (run 21-D, 225°C, 361 h). The shorter, brighter, feathery phase is weeksite. The disks are analcime crystals which were trapped between the glass slice and gold capsule when they grew. Scale bars 50 microns."

Figure 2.33--"SEM Micrographs of Crystalline Calcium silicates. The EDXS trace would be the same as Figure 2.32 except for the lack of SR. (A), run 21-D (225°C, 361 h). In (B) there are two morphologies present which give the same EDXS trace (run 3-D, 247°C, 102 h)."

Figure 2.34--"EDXS Trace and SEM Micrographs of "Silica" Phases. Stout prisms (left): this morphology resembles that of quartz (SIO_2) although DCP/AES analysis shows the presence of Li and B in addition to Si, run 20-C (230°C, 1800 h). Laths (bottom right): the individual crystals resemble those figured by Savage (1981), although the organization in the cluster is different (run 20-F, 230°C, 1800 h). Ragged cluster (top right): sphere in background is calcium silicate (see Figure 2.33 A), run 21-D (2255°C, 361 h). Scale bars 25 microns."

UNCERTAINTIES IN DATA

The uncertainties in the data are not discussed in the review and the original references must be applied to for that information.

DEFICIENCIES/LIMITATION IN DATABASE

None given.

KEY WORDS

Data analysis, literature review, microscopy, spectroscopy, visual examination, x-ray diffraction, laboratory, air, brine, deionized, simulated groundwater, ambient pressure, high pressure, high temperature, static (no flow), glass (defense waste reference glass), TDS-131, PNL 76-68, defense high-level waste (DHLW), matrix dissolution (glass), formation of alteration layers in glass.

GENERAL COMMENTS OF REVIEWER

This report provides information on the physical and chemical properties of leached glasses. A physical picture of the alteration layers produced by leaching of the glass waste form is as follows. The contact of water with the glass surface initiates the formation of the alteration layer. This occurs by leaching away the soluble cations, leaving a skeletal structure of the original form which retains the initial geometrical dimensions. The growth of the alteration layer proceeds into the glass with cracks and microscale roughness accelerating the process as much as an order of magnitude. Pit formation in the altered glass surface is common with pits preferentially appearing on stress lines and in areas of surface disruption. Polished or smooth fractured surfaces produce alteration layers with distinct layering; roughened or poorly polished surfaces form alteration layers that are highly convoluted. In all cases (except when they slough off) the alteration layers have good integrity and a well-defined boundary with the bulk glass.

Surface layers on the leached glass include crystalline deposits imbedded in an amorphous precipitate. This material is in contact with the generally amorphous altered layer. The interface between the altered layer and the bulk glass is physically and chemically well defined except for a reaction zone, generally less than 1 micrometer thick, which exhibits extensive pitting and is depleted in the more soluble elements (B, Li, Na). The properties of the altered layer are influenced by reactions with the aqueous environment and are not due to diffusion effects. Dilute leachants produce thick low-density layers while concentrated leachants produce thin high-density surface layers.

Additional leaching experiments conducted under hydrothermal conditions at temperatures as high as 250°C accelerated the dissolution-crystallization process but produced products identical to those formed at lower temperatures. This incidcates that the precipitation reactions do not change significantly over this temperature range.

The presence of reactive solids, such as canister metal or ductile iron in the leach system with initially air-saturated deionized water, significantly accelerates the removal of silica from the glass and leads to the formation of colloidal complexes and well-defined crystalline precipitates on the surface. Small node-like and flocculent precipitates are common in all systems where water flow is low enough for saturation to occur. This may indicate that crystallization on the altered layer is occuring. However, in deoxygenated deionized water the reaction is much less agressive which indicates the importance of the Eh in this case.

In summary, the report has provided a great deal of information concerning the physical and chemical nature of the altered layer including its chemical composition, the distribution of elements within it, the composition and nature of crystalline deposits formed on the surface and its rate of formation under several specific leaching conditions.

In spite of this valuable information, the most important aspect of the leach mechanism is that the alteration layer is more a product of the leachate concentration than of any property of the glass. Might not the fact that thick alteration layers are found in high leach rate, dilute leachate environments and thin alteration layers are found in low leach rate, concentrated leachate environments suggest that it plays only a minor role in glass leaching?

APPLICABILITY OF DATA TO LICENSING

Ranking: key data ( ), supporting data (X)

(a) Relationship to Waste Package Performance Issues Already Identified

Related to ISTP issue, 2.3.2.1.1, which waste form dissolution mechanism or mechanisms are most likely?

(b) New Licensing Issues

(c) General Comments on Licensing

Corrosion of Zircaloy

The purpose of this paper is to discuss corrosion of zirconium and Zircaloy. The zirconium alloys termed Zircaloys were developed for use in the nuclear industry. Zircaloy's corrosion behavior as nuclear fuel cladding and in subsequent long term nuclear waste storage are of particular interest. Zircaloy cladding, which is tubing with a wall thickness of approximately 0.8 mm to 1 mm, surrounds UO_2 nuclear fuel pellets during the time when the fuel is in reactor service, in temporary storage and in long term nuclear waste storage. The Environmental Protection Agency (EPA), in 40 Code of Federal Regulations (CFR) Part 191, requires that no more than one part in 10^5 of a 1000 year inventory of radionuclides be released annually for 10,000 years[1]. The Nuclear Regulatory Commission (NRC) requires that nuclear waste be reliably contained for a period of 300 to 1000 years[2,3]. The question regarding whether Zircaloy cladding can be given any credit for acting as a barrier to radionuclide release remains to be answered.

Determinations of Zircaloy durability and whether credit can be allowed for Zircaloy cladding acting as a barrier against radionuclide release must include considerations of the specific Zircaloy, its metallurgical condition, its corrosion resistance and its history in service and storage. Corrosion initiation and behavior will be affected by the type of reactor and exposure of the cladding, the composition of the crud which was present on the fuel rods and how the fuel rods were cleaned.

It has been shown that intact cladding controlled radionuclide release, and that radionuclide release increased with increased exposed area of the spent fuel[4]. Solubility of the spent fuel will be a factor in the amount and type of radionuclides released, and oxidized fuel has increased aqueous solubility. Oxidation of the spent fuel could occur at rates greater than those previously predicted due to a lower activation energy for oxygen diffusion at grain boundaries in the spent fuel. Spent fuel volume expansion resulting from oxidation could cause stress cracks in the Zircaloy cladding. Oxidation of spent fuel and solubilities of U and UO_2 are not addressed further in this discussion of Zircaloy cladding corrosion.

Some background information will be given on the metallurgical aspects of zirconium which relate to corrosion resistance and mechanical durability of the Zircaloy. Zirconium corrosion resistance and reactions in various environments will be discussed along with selected forms of corrosion.

Zirconium attains its corrosion resistance through the presence of a surface oxide film, and some information on the oxidation of zirconium will be given. There are many references relating to Zircaloy corrosion in the nuclear power industry, and only a few are cited in this brief review.

Zirconium

Zirconium was discovered in 1789 by Martin Heinrich Klaproth when he was studying semiprecious stones from Ceylon[5]. Klaproth, in 1794, found another new element which he named titanium, but titanium had been discovered in 1791 by Gregor and called Menachin. Zirconium is less corrosion resistant than titanium.

Zirconium accounts for 0.028 percent of the earth's crust and is the 19th most abundant element. It is found as $ZrSiO_4$ in beach sand in regions throughout the world and as ZrO_2 and $ZrSiO_4$ deposits in Florida, California, Oregon, Idaho, Brazil, Australia and India[5,6]. Berzelius produced impure zirconium in 1824, and van Arkel and de Boer produced high purity zirconium in 1925 using an iodide decomposition process. The Kroll process for producing zirconium involves magnesium or sodium reduction of $ZrCl_4$ and was developed in 1946 by the U. S. Bureau of Mines in Albany, Oregon.

Zirconium is pyrophoric, and small pieces with a high surface to volume ratio will ignite easily. Large pieces are oxidation resistant at high temperatures[7].

Zirconium has a melting point of 1930°C (3506°F) and a specific gravity of 6.53 g/cm^3. It is suitable for use in high temperature, high mechanical strength and ductility applications. Zirconium has a tensile strength of 110 MPa (16 ksi) at 427°C (800°F) and 552 MPa (80 ksi) at room temperature[8]. Its modulus of elasticity is 9.9×10^4 MPa (14.4×10^3 ksi) and the shear modulus of zirconium is 3.6×10^4 MPa (5.25×10^3ksi)[6].

Zirconium has a low neutron scattering cross section. This, combined with its high temperature mechanical properties, adequate thermal conductivity, and the stability of these properties after irradiation, makes it a good material for nuclear reactor applications.

Nuclear grades of zirconium are free of hafnium. Hafnium has many properties similar to zirconium and usually is found associated with zirconium, and zirconium sponge could contain a few percent of hafnium. The hafnium is undesirable for most nuclear applications because hafnium has a high neutron cross section[7].

Zirconium has a close-packed-hexagonal (cph) crystal structure (alpha Zr) at room temperature and undergoes an allotropic transformation to a body-centered-cubic structure (beta Zr) at 870°C (1600°F). Some elements, including Al, Sb, Sn, Be, Pb, Hf, N, O, and Cd, are alpha stabilizers and raise the transformation temperature of alpha to beta. Other elements, such as Fe, Cr, Ni, Mo, Cu, Nb, Ta, V, Th, U, W, Ti, Mn, Co and Ag, are beta stabilizers and have the opposite effect and lower the alpha to beta transformation temperature[7].

Zirconium and its dilute alloys exhibit strong anisotropy, and in wrought form, these materials have a preferred crystallographic orientation. Orientation textures developed during processing will cause mechanical properties to vary with rolling and transverse directions.

Most of the alloying elements form intermetallic compounds, and distribution, size and properties of these phases are important to corrosion resistance in steam or hot water[9]. Zircaloy-2 and Zircaloy-4 usually are forged in the beta region, then solution treated at 1065°C (1950F) and water quenched. The uniform distribution of fine intermetallic compounds produced by heat treating and quenching is preserved by hot working in the alpha region below 790°C (1472°F)[7].

Alloys used for fuel cladding in the nuclear industry are primarily Zircaloy-2 for boiling water reactors (BWR) and Zircaloy-4 for pressurized water reactors (PWR)[11] with Zr-2.5Nb being used in smaller amounts. These alloys have increased strength and reduced ductility in comparison with zirconium. Corrosion resistance of these dilute zirconium alloys is slightly diminished but very similar to that of zirconium. One instance in which zirconium alloys can have superior corrosion resistance to the base zirconium metal is in high temperature water or steam. Alloying with small amounts of Sn, Fe, Cr and Ni improves resistance to high temperature water corrosion. The Zr-2.5 Nb is less corrosion resistant than the Zircaloys except in steam at temperatures above 400°C (750°F), and it is used for pressure tubing in some reactors. Compositions of these three zirconium alloys are given in Table 1.

Table 1. Composition of Selected Zirconium Alloys

Alloy	Sn	Fe	Cr	Ni	Nb	Other
Zircaloy-2	1.5	0.12	0.10	0.05		
Zircaloy-4	1.5	0.20	0.10	0.005		
Zr-2.5Nb					2.5	

Oxidation

Zirconium forms a visible oxide film at 200°C (400°F) and has a loose white scale at 425°C (800°F). Oxidation rates for zirconium in various media at temperatures are tabulated[6,7]. Zirconium and its alloys usually show a decreasing corrosion rate in high temperature water which may be followed by a rapid linear rate of attack. Kinetics of the early stages of zirconium oxidation (pretransition) have been described as approximately cubic with the cube of the oxide thickness being proportional to time[10,11]. This is shown schematically in Figure 1. At a critical thickness, dependent on environmental factors, such as temperatures of 280°C and above, the kinetics change, and a transition to linear growth with time occurs. The post transition, thicker film is not protective, and a protective film rapidly reforms to begin a new cycle of film growth. It has been shown that in water at 360°C, these repeated cycles of cubic and linear kinetics occur[12].

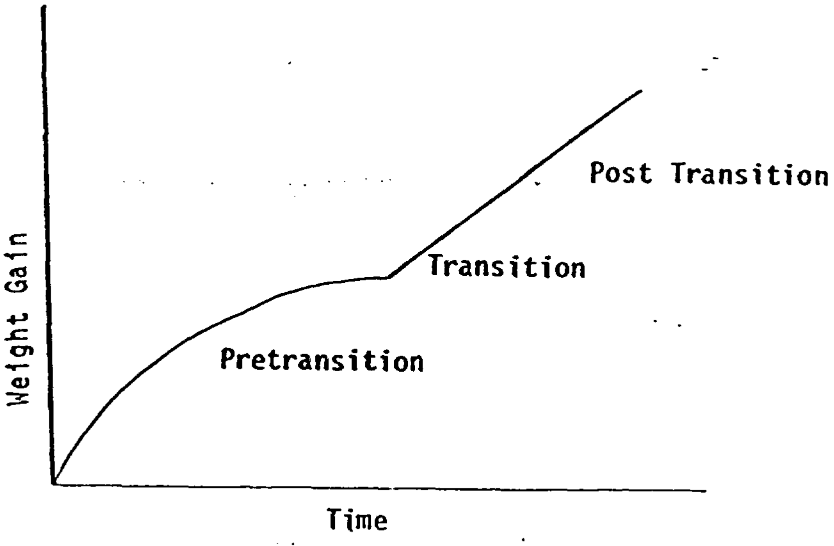

Figure 1. Zirconium Oxidation

In studies of high temperature water Zircaloy-2 corrosion, it was postulated that oxygen diffuses through the corrosion film by easy paths such as grain boundaries or other discontinuities[13]. Experiments conducted at 355°C to study transport of oxygen and hydrogen (as deuterium) in growing corrosion films showed oxygen diffusion at grain boundaries and other short circuit diffusion pathways[13]. High concentrations of hydrogen also were observed in these studies. Other high temperature studies, with an applied tensile stress, showed that the corrosion rate of Zircaloy-2 in steam was 1.2 to 2 times higher at 300°C than at 400°C to 475 C°[14].

The oxidation rate in the pretransition region is enhanced by reactor radiation and is related to the fast neutron flux[15]. Pretransition oxidation curves for zirconium in water or steam, fused salt or air at 350°C are essentially the same[11]. The structure of the initial oxide film in terms of grain boundaries and other defects appears to be important in the further oxidation or growth of the film.

Calculations based on weight gain at a temperature of 180°C and projected for 10,000 years, show depths of oxidized Zircaloy ranging from 4 um to 53 um, and it was concluded that at this temperature and below, failure of the Zircaloy due to oxidation should not occur[16]. Results of other corrosion tests based on oxidation and weight gain are given in Table 2[17]. Some of these data indicate that the cladding would fail. If the water temperature is below 250°C when it reaches the Zircaloy cladding, the oxidation rate could change and possibly could become lower.

CORROSION RESISTANCE

Zirconium readily oxidizes to form a protective surface film and is resistant to strong acids, alkalis and to organic acids. Carbon and nitrogen impurity contents of 40 and 300 ppm, respectively, increase the corrosion rate of zirconium. Zircaloy-2 has less than 0.006%N. The addition of tin to Zirconium counteracts detrimental effects of absorbed gas on corrosion resistance[6,7].

Zirconium is attacked by fluoride ions, wet chlorine, aqua regia, concentrated sulfuric acid, hydrofluoric acid, ferric chloride and cupric chloride. An extensive table showing corrosion rates of zirconium in various media is given in reference 6 which indicated that the information should be used only as a guide and that further tests, in situ, should be conducted to verify the corrosion resistance in a given medium. A table, showing corrosion rates in various media, is included in reference 7. Much of the information on reactions in acids and alkalies is taken from references 6 and 7, but it is verified in numerous other references.

Sulfuric Acid, H_2SO_4 - Zirconium is corrosion resistant in sulfuric acid in concentrations up to 60% up to boiling temperatures, and concentrations of 80% at room temperature. This resistance is lower for welded material and heat affected zones even at lower acid concentrations. This resistance is the result of a protective cubic ZrO_2 film with a small amount of a monoclinic zirconium oxide phase present[1]. Concentrations of sulfuric acid above 70% result in the formation of a looser less protective film, $Zr(SO_4)_2.4H_2O$ and also the formation of hydrides. These films, consisting of zirconium sulfate, zirconium hydrides and small zirconium metal particles, can be pyrophoric. Impurities in the sulfuric acid such as Fe^{+2}, Cu^{+2}, Cl^-, NO^{3-} and seawater, have detrimental effects on Zircaloy corrosion resistance to sulfuric acid[19].

Nitric Acid, HNO_3 - Zirconium is resistant to nitric acid in concentrations up to 65 wt. percent and at a stress limit of 150MPa up to temperatures of 120°C[20]. Other studies[21] showed high corrosion resistance for zirconium in 70 percent nitric acid at room temperature and little effect on the SCC susceptibility by the presence of $FeCl_3$, seawater, NaCl and ions released from stainless steel. Fluoride ions should be avoided and chlorine in the gaseous phase should be avoided as well as high stresses at elevated temperatures in 70 percent HNO_3.

Hydrochloric Acid, HCl; Phosphoric Acid, H_3PO_4; Alkalies; Saline Solutions - Zirconium is resistant to all concentrations of hydrochloric acid to temperatures above boiling. Zirconium is resistant to phosphoric acid at concentrations up to 55 percent and at temperatures above boiling. Zirconium is resistant to alkalies. It is resistant to saline solutions to boiling temperatures except for solutions containing $FeCl_3$ and $CuCl_2$.

Water and Steam - Corrosion resistance of Zircaloy-2 and Zircaloy-4 in high temperature water and steam is superior to that of unalloyed zirconium. Corrosion resistance of Zr-2.5Nb is generally less than that of the Zircaloys but in steam, at temperatures in excess of 400°C (750°F), Zr-2.5Nb has superior corrosion resistance. The corrosion resistance of Zr-2.5 Nb can be improved by heat treating.

FORMS OF CORROSION

Corrosion processes within the tubing with the nuclear fuel environment must be considered as well as corrosion behavior of the outer surface of the cladding which is exposed to environments of the reactor, temporary storage and permanent storage. Most cladding failures until now have initiated at the inner tubing wall. A discussion of the forms of corrosion and the corrosion behavior of zirconium in various media are given in references 6, and 7. Discussions of Zircaloy cladding corrosion under repository type conditions and effects on radionuclide containment are given in reference 17. Some selected information on corrosion behavior is given in the following sections.

Uniform Corrosion

Uniform corrosion, also known as general corrosion, may be described as an electrochemical attack covering the entire surface of the exposed metal. Metals and alloys subject to uniform corrosion become thinner or completely corrode as a result of this uniform attack over the surface. Zirconium is resistant to uniform corrosion due to the protective oxide layer which forms on the surface. Uniform corrosion and subsequent thinning of Zircaloy would become a problem only if the protective surface oxide film underwent a transition to the thicker nonprotective oxide described in the section on oxidation.

Some uniform corrosion data on zirconium are tabulated in reference 17 and the part relating to the tuff environment was taken from HEDL-TME 83-28, 1983 by R. E. Woodley. At temperatures of 250°C, the metal thickness loss after 300 years in aqueous media was calculated to be 0.02 mm and air or steam, the loss was 0.008 mm. At 300°C, the metal thickness loss in an aqueous environment was 0.2 mm and in air or steam, was 0.1 mm. At higher temperatures of 350°C in both the aqueous and in the air or steam media, the metal thickness loss was 1.0 mm, and at 400°C, the metal thickness loss was 4.4 mm in aqueous media and 6.3 mm in air or steam media. The lower temperature data indicate no significant amount of corrosion due to general corrosion, but the higher temperature data indicate amounts of corrosion which exceed the thickness of the cladding wall. These data indicate that additional high temperature oxidation data and knowledge of the repository storage temperature and environment would be needed to make a prediction of the effects of uniform corrosion.

Stress Corrosion Cracking

Stress corrosion cracking (SCC) is a complex form of localized corrosion that occurs in the presence of a corroding environment and a tensile stress[22]. SCC can occur without warning and can be catastrophic. Factors important in determining mechanisms of SCC include electrochemical reactions, mechanical properties and condition of the material. Anodic dissolution at the crack tip and a concentrated stress at the crack tip can lead to failure. Adsorption of ionic species in the strained area of the crack tip can also lead to failure. Some SCC failures appear to result from a series of brittle fractures. There are other mechanisms, related to these, which can lead to SCC failure. The U-bend test or other similar tests can be applied to determine whether a metal undergoes SCC, but since SCC has an incubation period, the absence of SCC failure does not mean that the material is immune[23]. Additional information on a materials susceptibility to SCC can be obtained from slow strain rate testing.

Zirconium and its alloys are resistant to SCC in seawater, most aqueous environments and some sulfate and nitrate solutions. SCC of zircaloy can occur in concentrated methanol, solutions containing heavy metal chlorides, ferric chloride solutions, copper chloride solutions, organic solutions with chloride, gaseous iodine or fused salts. Liquid metal embrittlement has been reported for zirconium in contact with molten cesium and with liquid sodium or cadmium[9, 24].

Data show that if the electrode potential of Zircaloy-2 is raised to a value which is slightly more positive than its corrosion potential in neutral dilute sodium chloride solutions at 25°C, SCC will occur[25, 26]. SCC from the fuel side of the cladding can result from effects of fission products such as iodides[27, 28].

The estimated in-reactor failure rate for LWR fuel cladding is 0.01 percent[29]. Earlier in-reactor failure rates in BWRs were as high as one percent. Less than 0.002 percent of Zircaloy fuel rod failures, under reactor conditions, are caused by waterside corrosion[29,30]. During in-reactor service, there is some creepdown of the cladding and also expansion of the fuel occurs causing localized stress regions in the cladding.

The Hoop stress, s, defined as $s = pr/t$, where p is pressure in MPa, r is the radius of the tube in meters and t is the wall thickness of the tube in meters, can be an important factor in failures initiating from the inside of the cladding. The importance of the Hoop stress increases when the ratio of the tube diameter to the tube wall thickness is greater than a factor of ten. Approximate measurements for Zircaloy-2 and Zircaloy-4 are an outside diameter of 12 mm with a wall thickness of 0.9 mm and an outside diameter of 11 mm and a wall thickness of 0.9, respectively.

Calculations of the minimum Hoop stress necessary for SCC due to iodine gave values of 200-220 MPa at 400°C[31] and 216 MPa at 300°C[32,33]. Hoop stresses in rods stored below 60°C have been estimated to be in the range of 1.7 MPa to 3.7 MPa with some having a Hoop stress of 5.4 MPa[34,29]. In late 1978, General Electric began He pressurizing BWR fuel rods to 0.3MPa, and Westinghouse began He pressurizing PWR fuel rods to 3 or 3.4 MPa[29] The estimate then for the Hoop stress in a BWR rod was 3.1 MPa at 100°C and 9.2 MPa for a PWR fuel rod[35,29].

Calculations of the Hoop stress during the containment period at 300°C result in approximately 22.7 for BWR rods and 82.5 for PWR rods[29,30]. These Hoop stresses are much lower than the 200 - 220 MPa described as necessary to produce SCC, but the total considerations regarding whether SCC, from inside the cladding, will occur must also include inner tube wall surface defects, local stresses, texture of the inner surface, localized chemical inhomogeneities either in or on the surface, whether hydriding has occurred and whether the fuel rod was pressurized. Inner surface texture can affect susceptibility to SCC[36], and this effect can be reduced by modifing the texture to increase the density of basal planes in the radial direction[37].

Effects of Hydrogen

Failures due to hydrogen pick-up by a material are due to the combination of the embrittling effects caused by hydride formation or hydrogen adsorption and the presence of stress. Other factors such as temperature and chemical environment also play a role in this type of failure. Hydrogen embrittlement failures have an incubation period as does SCC and crack propagation is similar in hydrogen embrittlement and SCC. Crack initiation mechanisms for SCC and hydrogen embrittlement are different, and cathodic protection methods which can be applied to prevent or delay SCC can be sources of hydrogen and are not appropriate for use against hydrogen embrittlement.

Zircaloy-2 is more subject to hydrogen pick-up than is Zircaloy-4. Examples of cladding failures attributed to hydrogen adsorption from hydrogen produced during corrosion have been reported[38]. An earlier source of hydrogen was water left in the fuel inside of the cladding, but this was eliminated by drying the fuel.

The solubility of hydrogen in Zircaloys is approximately 60 ppm at 300°C and is 1 ppm at 20°C[16,39,40,41]. Exceeding this solubility will result in the formation of brittle hydrides. The hydrogen content of spent fuel claddings has been reported to be in a range of 80 to 150 ppm and also less than 50 ppm[16]. Sources of hydrogen available to the cladding include hydrogen generation by corrosion processes, hydrogen present in the reactor cooling water and other possible sources. A general or uniform corrosion rate in excess of 3 mils per year would result in embrittlement except in oxidizing environments[23].

Pitting

Pitting is a severe form of localized corrosion and the damage which results is difficult to assess. Pitting occurs at sites of breakage in the protective surface film, defects in the material and at other discontinuities. The initiation of the pit occurs when the disparity at the pit site permits the exposure of the metal to the chemical ions. There is an electrode potential difference between the pit site and the remainder of the protected metal surface. Once the exposure has occurred, a pit develops as is shown in Figure 2.

The small area of the pit (acting as the anode) compared to the larger area of the remaining surface (acting as the cathode) results in a high corrosion current density at the base of the pit. As pitting occurs, metal ions can react with the environment to form precipitates which in some cases, may cause a film to cover the top of the pit. As pitting progresses, corrosion products, such as metal ions and hydrogen, within the pit, cannot escape. These corrosion products within the pit lower the pH into a more acid region and pitting is accelerated.

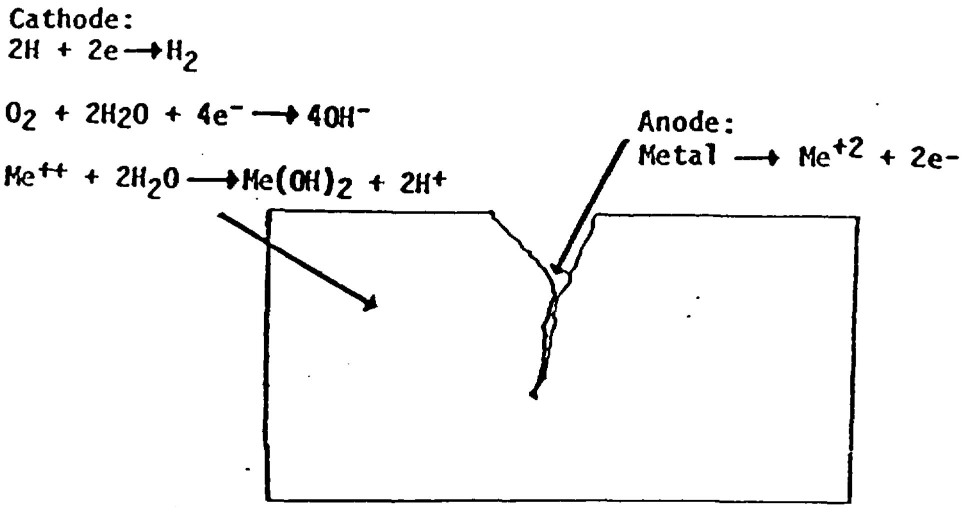

Figure 2. Schematic drawing showing anodic and cathodic areas and some reactions of pitting corrosion.

Materials can be tested for susceptibility to pitting, and a method for this test is described in ASTM F-746[42]. Techniques for pit propagation measurements also have been described[43]. A method of pitting evaluation is described in ASTM G46, Standard Recommended Practice for Examination and Evaluation of Pitting Corrosion[44] and involves locating the pits, then determining the density and depth. The pitting factor is used to show the damage of some pits and can be described as

$$\text{Pitting Factor} = \frac{\text{Deepest Metal Penetration}}{\text{Average Metal Penetration.}}$$

This shows that for a pitting factor of one, uniform or general corrosion is occurring.

Zirconium surface films readily reform if broken, but zirconium is not completely immune to pitting. Pitting does occur in hydrochloric acid solutions which contain ferric or cupric ions and possibly in other environments. Fluorine, chlorine, bromine and iodine in aqueous or gaseous forms could cause pitting to occur.

Crevice Corrosion

Crevice corrosion is a form of localized corrosion which occurs at occluded areas such as gaskets, threads, overlaps and places which are deprived of the surrounding environment. Damaging ionic species can become concentrated in creviced areas causing conditions similar to those developed in pitting. Zirconium is resistant to crevice corrosion. Since zirconium obtains its corrosion resistance by the formation of a protective surface film, crevice corrosion could occur.

Nodular Corrosion and Crud Induced Localized Corrosion

Nodular corrosion and crud induced localized corrosion were found in the late 1970's. These forms of fuel cladding corrosion have been described in detail in reports from the General Electric Company[45,46,47]. Nodular corrosion was first observed in 1979 and it was determined to be related to crud induced localized corrosion (CILC) which was observed by the same authors in 1978. Although CILC was found first, the explanation of the mechanism indicates that it is preceded by nodular corrosion.

CILC was found to occur in systems which had copper present[42]. The most frequent type of crud found on cladding in BWR service is mostly Fe_2O_3 which is fluffy, loosely adherent, has a low density and has good heat transfer in boiling conditions. If copper is present in the system, the crud or scale deposits are mostly a combination of Fe_2O_3 and CuO. These deposits are tightly adherent, have a high density and low thermal conductivity under boiling conditions. Fifty percent of the cation content in these deposits was copper as opposed to ninety percent iron in the more usual crud. These copper bearing cruds flake off, and also these cruds have been found between layers of white ZrO_2 on the cladding surface. Reactions of the oxide with copper result in delamination, severe local corrosion or pits in the regions 20 to 40 inches and occasionally at 80 to 100 inches from the lower end of the fuel rod. CILC failures are associated with soluble copper in the water which could come from corrosion or wear of tubing or other parts containing copper. CILC failures occur more frequently in $(U,Gd)O_2$ rods but failure can occur in UO_2 rods. The power exposure threshold must be sufficient to produce fuel failure. These failures occur in only a small fraction of the rods.

These damaging crud deposits are most commonly found on top of the protective oxide and are associated with white oxide nodules. The protective film formed on Zircaloy in Boiling Water Reactor (BWR) service is a black oxide. Figure 3 is a schematic drawing of Zircaloy cladding with possible surface oxides or crud coatings.

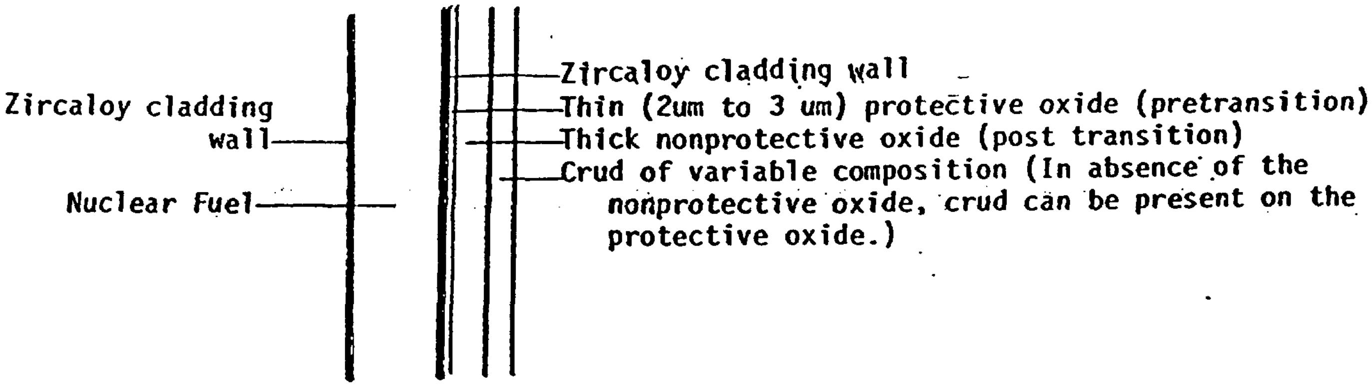

Figure 3. Zircaloy Cladding Section Showing Oxides and Crude Layers on Outer Surface.

Some localized lens shaped white oxides also develop, and these nodules grow faster than the adherent uniform black oxide film. The nodules are not as adherent or protective and are sites for scaling or other reactions. Nodular corrosion has been studied and variables which affect it have been discussed[44]. The main precipitate which is present in Zircaloy-4 is $Zr(Fe,Cr)_2$, and $Zr(Fe,Cr)_2$ and $Zr_2(Fe,Ni)$ are present in Zircaloy-2. The nodules do not form at these precipitate sites or at grain boundaries as might be expected. Both alloys become more resistant to nodule formation after heat treating in the alpha-beta or beta phase regions above 830°C. This increased resistance is attributed to a redistribution of solute elements in the Zircaloy. A mechanism is given based on the effects of the solute depletion on the composition and structure of the black uniform surface oxide.

Detrimental effects of the presence of copper on nodular corrosion have been described[45]. Effects of other elements on nodular and uniform corrosion in steam at 400°C and 500°C have been studied, and results showed that iron and nickel improved both uniform and nodular corrosion resistance of Zircaloy but both increased the amount of hydrogen pick-up. Tin decreased the nodular corrosion resistance, and niobium improved nodular corrosion resistance and improved resistance to hydrogen pick-up[48].

WELDS OF ZIRCONIUM

The high reactivity of zirconium necessitates that welding be carried out in a vacuum or as a second choice, in an atmosphere of argon or helium. Studies involving effects of impurities in H_2SO_4 on corrosion resistance of zirconium showed that corrosive effects due to impurities were greater in welded areas[19]. Contamination with hydrogen, oxygen or nitrogen should be avoided by argon purging during welding to prevent embrittlement of the welded area[23].

REPOSITORY ENVIRONMENT

The repository environments for locations involving basalt, salt and tuff were reviewed previously[17] and conditions were given in some detail. Some of the information from this reference relating to the tuff repository is presented here. The tuff repository is located in the state of Nevada and is in the Topopah Spring Member of the Paintbrush Tuff at Yucca Mountain. The tuff is in unsaturated devitrified zones with twelve percent porosity and contains five volume percent water[17,49]. Oxygen is expected to be present. Water flow has been stated to be 6 to 8 mm per year, but this could change.

Radiation present will be gamma and will be approximately 10^4 rads per hour. This repository probably will not pressurize after closing and the water will boil off leaving a residue of salts which may or may not redissolve.

Water taken from the Jackass Flats J-13 Well in the tuff repository area contains a number of ions in small concentrations including Li+, Na+, K+, Mg^{+2}, Ca^{+2}, Sr^{+2}, Ba^{+2}, Be, Al^{+3}, SiO_2. F^-, Cl^-, CO_3^{-2}, HCO_3^-, SO_4^{-2}, NO_3^-, PO_4^{-3}. The pH of the water will be 7.1 and could be higher (more basic) due to saturation. The water pH could shift to the acidic range due to radiolysis of $N_2/O_2/H_2O$ mixtures. Analytical work still is needed to show whether pore water at the tuff repository site has the same composition as the J-13 water.

Calculations of the temperatures, over extended times, involve a given repository design and assumptions used, such as the absence of packing material, and are subject to change. Calculated temperature versus time profiles for a tuff repository are given in reference 17 and show a centerline temperature of 330°C which decreases to 100°C after 300 years. Some calculations showed that fuel centerline temperatures were in excess of the 350°C limit[50]. The calculated temperature at the canister was approximately 245°C and decreased to 80°C after 200 years.

Summary

Zirconium is a reactive metal which becomes highly corrosion resistant, to various media, due to the formation of a protective surface oxide film. Low alloy zirconium alloys, such as Zircaloy-2 and Zircaloy-4 which are used for nuclear fuel cladding are resistant, within limits, to acids, alkalies and organic acids. Corrosion of Zircaloys in water and steam is increased with temperature and with carbon and nitrogen impurity contents. Zirconium is not corrosion resistant to fluoride ions, wet chlorine, aqua regia, concentrated acids and ferric chloride and cupric chloride.

Additional electrochemical and corrosion data are needed for predicting Zircaloy corrosion behavior in a long term nuclear waste repository. Temperatures may range from 330°C to 100°C for the first 300 years, and general uniform corrosion might not be a problem under these conditions. However, additional information on mechanisms of oxidation and passivity, along with effects of ions present and other environmental factors, would be useful for predicting the likehood of localized corrosion.

Zircaloy may be subject to stress corrosion cracking initiating from the inside of the cladding or from the outside of the cladding. Hydrogen embrittlement and liquid metal embrittlement may occur, and there is a possibility of pitting occurring. The literature contains many references of research carried out to address these localized corrosion problems in reactor service. Research is needed now to address conditions of nuclear waste storage, including environmental and material variations which could occur over time.

Metallurgical conditions of the cladding including orientation textures, defects, impurities and histories in reactor service and storage should be established and cataloged. These factors, also, will affect the corrosion and durability of the cladding.

Aspects of Zircaloy corrosion which need further study include the following. In addition, variations in repository conditions, such as composition of the water, temperature and ions present, must be considered.

1. Structural formation of the protective oxide film, its stability and transition, and how this film is affected by temperatures, wetting, drying and other conditions of the repository.

2. Crystallographic textures of both the inner and outer surface of the cladding should be determined.

3. Effects of surface texture on stress corrosion cracking and other mechanical and corrosion failures should be determined.

4. Effects of the presence of iodine on stress corrosion cracking should be measured.

5. Susceptibility of Zircaloy to stress corrosion cracking should be determined using slow strain rate or other appropriate measurements.

6. Pitting susceptibility of Zircaloy in environments containing ferric chloride, cupric chloride, fluorine and also in the presence of varying pH should be determined. Zircaloy is reasonably corrosion resistant throughout the pH range of 1 to 12 but this corrosion resistance can be affected by impurities.

7. Passive behavior and oxide film stability on Zircaloy in repository environments should be characterized.

8. Effects of welding on localized and general corrosion of Zircaloy should be studied.

9. Effects of service history and repository environment on hydrogen uptake and hydrogen embrittlement cracking should be studied.

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Notes taken by C. Interrante at a West Valley Demonstration Project Technical Exchange with NRC held February 2-3, 1988, West Valley, NY

February 2, 1988

Jim Pope, West Valley Nuclear Services -- Today's agenda gives us an opportunity to meet and hear those who are the principals involved in the West Valley program. Some of these West Valley presenters will be presenting, at Tucson, abbreviated papers of parts of talks to be given at this meeting.

Eli Mastis and Jim Pope of the West Valley Demonstration Project warmly welcomed those present and set forth their objectives for the meeting:

- Status of Product
- Status of Process Testing Plans and Results
- Status of the Waste Acceptance Process
    1. Preliminary Specifications -- Proposals for reserved items
    2. Waste Compliance Plan -- Finalized in 1988
    3. Waste Qualification Report -- Presently half completed on product data collection

Tom Gutmann, Department of Energy-Office of Civilian Radioactive Waste Management made a few remarks on behalf of DOE. In recent legislation, an MRS has been authorized, but will not be built until a license is granted for construction of a repository.

In the spring, a Mission Plan is expected. It should take into account the recent legislative dictates. Key people/offices were cited:

Systems Integration
    Licencing and Transportation -- R. Stein and K. Klein

Facilities, Siting ... -- S. Kale

Resource Management -- Sam Russo

External Relations -- Tom Issacs/ Lake Barrett

C. Peterson, NRC made a few remarks on the NRC, which included the divisions within the Office of Nuclear Materials Safety and Safeguards.

The Director of the NMSS is Hugh Thompson.
Div. Safeguards and Transportation: R. Burnett (Director)
Div. Ind. and Med. Nuclear Safety: R. Cunningham (Director)
Div. of Low-Level Waste Mgt. and Decommissioning: M. Knapp (Director)

Div. of High-Level Waste Management: R. Browning (Director)/
M. Bell (Deputy Director)
Branches -- Operations
-- Systems Engrg. and Eval.
-- Technical Review -- R. Ballard (Chief)

Rich Humphrey -- Vitrification Project Mgr. at WVDP, spoke on the vitrification schedule for production of about 300 logs, which will be made and placed into their interim storage facility, where they will be stacked two high. The DOE/NRC Review of their Waste Qualifications Reports is planned for 1991, with the expectation that by October 1992 hot operations will begin.

Facilities will cost over 80 million dollars and about 10 million of that total is now built/constructed and the balance is either under contract (12 million) or planned.

Steve Barnes -- Mgr. Process Development spoke on WVNS Vitrification Process.

Pretreatment involves (1) Purex supernatant processing, (2) Purex sludge washing and (3) Waste blending and homogenization sodium removal is done in both 1 and 2, and excess Na is not desired in the glass.

The ion-exchange medium (zeolite) picks up Cs and Sr, which apparently will be put back into the sludge and thereby into the vitrified waste.

Grinding of the sludge (and of the zeolite alone) is used to break up any large solids that may be present in the waste; this is done to be conservative and make homogeneous that which is to be vitrified.

Sampling is planned to be done on the output of the melter feed tank, but not necessarily of the actual pour. After I asked about the possibility for sampling the pour nondestructively, Dr. John Plodnic indicated that IR (infrared) methods are being explored and Mr. Barnes indicated that the melter pour streams did have 2 or 3 inches of space available for an NDE probe, should one prove to have value for assessments of the composition of the loaded glass as it is poured into the canister.

The homogeneity of the sludge in storage was found to be such that the standard deviation of constituents measured is about 0.6 to 0.7 percent absolute.

Results at a testing program indicate that grinding of feed slurry improves the standard deviation of the slurry analysis by factors of 3 to 5.

Canister impact tests were conducted. Drops were made from height of 7 m onto concrete pads. Drops were oriented so that the bottom of the canister receives the impact load. Results are available from 5 drop tests conducted.

J. M. Pope, WVNS spoke on Waste Acceptance.

The program and the documentation needed in the waste acceptance process are on schedule. Their detailed plans for testing and process control are well coordinated and are expected to successfully qualify the waste form as being acceptable for licensing purposes. The waste acceptance process involves various forms of documentation, which were enumerated.
The radionuclide release, based on MCC-3 tests (< 1 g/m^2/d release) and on MCC-1 tests (< 1 g/m^2/d for B, Si, Na, U, Cs), may easily demonstrate for the elements listed that the release rates will be acceptable. The question is how to demonstrate acceptable release rates for other elements not in this list but present in the sludge and thus are present in the glass. Do the elements that can be measured in the full-scale process adequately represent those present in hot, loaded glass. If there is an area of uncertainty that is of concern to Dr. Pope, this would be it.

A proposed schedule was furnished for the Waste Compliance Plan and WVDP is on schedule, with the final draft for concurrence being expected to be completed in September 1988.

Dr. V. Oversby, (LLNL) suggested that the NRC position papers have been adopted by NNWSI, and thus in the review process, WVDP should closely scrutinize these papers as an integral part of the review and peer-review process.

The Technical Support Programs used for the WVDP were described (outlined) briefly.

About 80 grams of thorex glass (loaded with WNDP's sludge) will be made and tested using MCC-1 AND MCC-3 tests.

Ken Routt, WVNS spoke on Process Modeling and Testing.

The concern of WVDP is to assure that each batch has a composition in the range of specified or acceptable compositions. A mass balance is done using a computer code (MASBAL) involving differential equations that are solved numerically. Various assumptions of selected parameters (energy balance, chemical reactions, etc.) are made, and these assumptions are being tested. The code is used to determine the compositions of every species that is in the glass being melted. The assumptions (e.g., the holding tank is assured to be well mixed) are critical to the calculations made using this code. Thus, C_i, the concentration of a constituent, is sampled, and it has been found that an acceptably uniform region exist over a large fraction of the total tank volume. Concentrations in a region at the bottom of the tank have greater uncertainty. A tracer is placed in the tank to determine the level, or region, below which C_i is no longer acceptable. During production (hot operations) the tracer can be used to determine whether or not C_i glass is equal to C_i expected.

The Si, Al, and Cr in the brick are added to the melt by the breakdown of the brick and a mass balance is used during cold operations to determine (characterize) what goes into the poured glass and what goes to the bottom of the melter. Residence time of a tracer in the stream can be tracked, and this information gives useful insight into operations of the system to be expected during hot operations. Likewise during idling of the melter, the compositions of some of the components can be used to determine the expected effects of idling time on later pour composition.

A schedule for the activities for the period from September 1987 to September 1989 was presented.

Dr. P. Maceda, Catholic University of America -- Glass Durability Testing and its Relationship to the Process/Product Model

Outlined the problem of production of a processable and durable glass that has acceptable leachability. Nothing new was presented.

Ian Pegg, Catholic University of America -- Vitrification Process Characterization

Discussed a statistical model of the compositional variations in the West Valley melter. He concluded on the points that when compared with the West Valley target compositions, there is a region >100 poise that is too viscous and another <20 poise that is not viscous enough. There is (on the handout plot that showed these regions) another region of low durability. The remaining broad range of composition has acceptable viscosity and durability. The WVDP glass was shown to fit in the acceptable regions. The 99 percent confidence limits (2.6 times the S.D., σ, for a system with two variables) were shown to be well within the bounds of acceptable glass:

For two variables, 99% of all measurements of x lie within x ± 2.6 σ:

$$-2.6 < \frac{x-\bar{x}}{\sigma} < 2.6$$

where the two variables x_1, x_2 have normal distributions.

For six variables:

$$-4.1 < \sqrt{\sum_{j=1}^{6} X_j^2} < 4.1.$$

On the assumption that the tank is homogeneous, the analytical error is at the five percent level and the mass balance holds true, it was shown that when one goes to an extreme (to the 99% confidence limit) for a constituent like aluminum and in a direction that would adversely affect durability, other constituents tend to "automatically" be at the opposing extreme (to increase durability), so that the durability is good at these extreme values for any single value of a constituent that affects durability. Thus, if iron goes up thorium goes down, but it can be argued that these constituents are covariant, so the argument presented is questionable. Oversby argued that the limits on compositional determinations taken from the mixing tank can and should be used to compute the limits to be expected in the poured glass, and this would be an easy, unequivocal means of determining the compositions needed for durability assessments.

Aaron (Ron) Barkatt, Catholic University of America -- Use of Natural Analogs to Validate Accelerated Leach Tests

Repository-relevant leach tests were discussed. The pulsed-flow test was described as being capable of establishing mechanisms and as being applicable to repository flow rates, due to its high surface-to-volume ratio and the moderately long residence time in the test container. The normalized residence time, $T_r \bullet S/V$, where T_r = residence time, S = Surface area of glass, V = volume of the leachant, is given in units of d/m. The normalized residence time (used in tests) was shown to be in the range of, although slightly less than, that which would be expected for the long times of a repository. Factors affecting surface roughness were portrayed (on the basis of empirocal work) to effect results of leaching by about a factor of three or four.

At very long times, the chemistry of a leachant becomes dominated by the chemistry of the glass, so that the effect of chemistry of the water was regarded as being relatively unimportant to the leach rate to be expected for a given glass.

In a more durable glass proposed for use at WVDP, the results of MCC-3 tests and of the flow tests both showed good leaching behavior, with annual release rates within that permitted under the 10^{-5} criteria.

How do we use the experimental data for three to five year tests to predict the behavior over thousands of years? One method is via natural analogues. Two types of tektites were given as examples, one of land exposure and one type of sea-bed exposure. SiO_2 contents varied from low to high, and it might even be argued that some are not unlike the proposed waste glasses. It was found that very low leach rates (near zero) could be obtained when Mg was present in sea water at 90°C. Surface analyses and model development have yet to be done, so the mechanism by which Mg decreases leach rates is not understood. Magnesia oxy-silicates have been observed (according to Plodnic) in the glass exposed under the WIPP experiment.

P. Macedo, Catholic University of America summarized that processibility has many factors. Viscosity is overwhelmingly important. Conductivity is somewhat (but not very) sensitive to compositions. Crystallization is the third factor determing processibility, and it, too, is composition dependent.

D. Pye, Alfred University -- Physical Property Testing of West Valley Glass.

Waste must be stored at a temperature $T < (T_G-100)$, so T_G, the glass transition temperature, must be established. Other characteristics of the glass must be known to effectively process glass.

A question on the effect of the ferrous/ferric (Fe^{+2}/Fe^{+3}) ratio on the behaviors of the WVDP glass has been studied at Alfred University. Mossbauer Spectroscopy was used to vary this ratio, and chemical analyses were used to verify the results. Both dilatometric (volume change) and enthalphy (mcal/s) vs temperature measurements were used to measure T_G. Results of the measurements showed that compositions of glass containing Fe^{+2}/(Fe total) of 0, 0.10 and 0.48 have, respectively, T_G values of 478, 474 and 464°C. Residual crystallization of about 1 percent was observed in these glasses when heated at 700°C. The volume percent of crystals varied as a function of time and the observations were plotted on a T T T (time, temperature, transformation) diagram that gave the equicrystallinity lines. The glass with more divalent iron had greater amounts of crystallinity and the nose of the curve occurs at lower temperatures and shorter times, and this type of glass also had lower T_G and lower viscosity. These are all results of the reducing conditions that are used to produce the divalent state for the irons.

The crystallinity was characterized (no data were shown), by both Profs. Macedo and Pye, to be unimportant to the durability of this particular glass.

Spinel, cerium-thorium, actinite and a phosphate phase were identified.

A residual crystal content at 1 vol percent was observed in the reference glass even after melting for 18h at 1000°C. The partially reduced state of Fe^{+2} is obtained by using sugar, which puts carbon in the bath, scavenges the available oxygen and reduces (Fe^{+3} goes to Fe^{+2}) the iron.

G. Mellinger, Battelle, Pacific Northwest Laboratory -- West Valley Product Testing

Seven-day MCC-3 tests of WVCM-50 showed that redox has no significant effect (over the range studied) on the durability. These Battelle data were portrayed as being complementary to work done at Alfred University and Catholic University.

Boron is a good indicator of the release of all radioactive species in the glass. Boron and Lithium tend to represent the upper bound for leaching. A model to relate the normalized boron release rate (in the MCC-3 test) to the behavior of other constituents of the glass was developed and used successfully to predict actual measured compositions. It was shown that the maximum release predicted by the model (based on boron leaching) is 0.043 $g/m^2 \bullet d$ and statistical statements or confidence bands can be readily developed from the data, e.g. 95 percent confidence that the glasses have release rates < 0.07 $g/m^2 \bullet d$.

Canister Impact Test results indicated that, as a result of seven-foot drop tests, peak axial strain at 44 percent and hoop strain at eight percent were sustained without canister breach.

A database is being developed by MCC on Nuclear Waste Glass Properties. This database was reviewed. Mark Fry (DOE) has recently received copies of a report on it. Properties prediction and modeling of data are expected benefits from this effort.

The validation and correlation of analytical methods used for conducting interlaboratory activities is being studied by the MCC.

D. Veltkamp, CPAC (University of WA) spoke on the Role of CPAC in supporting WVNS. CPAC is at the University of Washington and it is an NSF Center for Process Analytical Chemistry (CPAC). Their main effort is to use current technology for evaluation of existing analytical data on feed composition and glass composition in order to obtain information about the WVNS process. These analyses can be useful in development of models to aid in control of the melter operations and ensure product quality.

A systems approach is used in these analyses. Components of the process are studied alone and in relation to each other. "First Principle" (theoretical) models were contrasted with "Data" based models, with advantages and disadvantages of each being enumerated. For WVNS, CVA has done theoretical modeling and CPAC is doing data based models. They use a multivariate approach in n-dimension space and use methods for projecting their findings in a lower dimensional projection, which is a most intelligible dimension for most of us.

The principal component analyses (PCA) uses this type of projection. With it, the important variables are identified in their effects on processes.

Barry Wise of CPAC spoke on Chemical engineering aspects of the process at WVDP in relation to the confidence in the composition and properties of glass produced there. He too used the principal component analysis (PCA), or Eigenvalue vectors, to describe principal components whose values are unusual (deviates from the norm or steady state) enough to draw attention to that component. Data from live runs at WVDP were used for all illustrations.

Other work is being done by CPAC and Alfred University and sponsored by NSF. This is on viscosity and conductivity models and/or prediction methods. Some viewgraphs in the handout were not discussed due to time limitations.

D. Shugars, WVNS spoke on Quality Assurance and the 18-point program required in NQA-1, and its 14 supplements, as well as the requirements of DOE 5000.3 and .6.

Their current work in the area of testing and development were portrayed as being controlled to HLW QA Program requirements, where appropriate. The QA program at Catholic University was described and given in outline form in the handout.

Jim Pope, WVNS reiterated that their efforts are aimed at quantitative characterizations of the melting process. Process models based on scientific understandings as well as those based on data are being developed and interrelated. Product models by CUA, PNL-MCC, and Alfred University are being developed for composition, durability, processibility and other important product-related information or characteristics.

Larry Eisenstatt, WVNS stressed that they have only one batch of waste, and one waste stream may be easier to handle analytically in coming into compliance with waste acceptance plans. Full-scale equipment is being used to test the methods to be used in the hot runs. Sampling will be done on the glass that is made at West Valley. Operators will have guides on compositional variations that will result in acceptable production glass. Limited crystallization can be expected in the West Valley glass, based on heat-treatment test results. The lab-produced crystallivity did not significantly affect leachability.

The Waste Compliance Plan is to be available for concurrence by the end of fiscal year 1988, and waste qualification reports will follow that.

A copy of the minutes drafted after the meeting by DOE and NRC personnel and their contractors is attached.

WEST VALLEY DEMONSTRATION PROJECT
TECHNICAL EXCHANGE WITH THE NRC
FEBRUARY 2-3, 1988

LOCATION: WEST VALLEY DEMONSTRATION PROJECT

MEETING SUBJECT; STATUS OF THE WVDP WASTE FORM AND PROCESS QUALIFICATION

AGREEMENTS

1. DOE and NRC will exchange documents relevant to the West Valley Demonstration Project published since the last previous technical exchange at West Valley in February 1987.
2. DOE will provide NRC with copies of papers to be presented at Waste Management '88 relevant to the West Valley Demonstration Project.

DOE OBSERVATIONS

1. Process qualification testing is being performed with the full scale equipment.
2. The vitrification process is being characterized to assess its capabilities, i.e. to remain within the compositional tolerances.
3. Product testing is based on defining compositional ranges within which the process can operate.
4. Considerable progress has been made in quantifying the regions of durability and processability (e.g. viscosity) in which West Valley expects to operate to meet the WAPS.
5. Testing vitrification activities on duplicate samples at different sites such as PNL, CUA, and AU are being performed with common results indicating consistency of glass test results.
6. The WVDP has a solid, integrated effort underway among various organizations to obtain process and product data which are substantial and it appears that an adequate basis will be established to allow hot start operations.
7. Cooling history, especially those expected from processing, cause only limited increases in crystallization as shown through microscopic examination. There appears to be little effect of crystals on leach testing.

8. The emphasis of WVDP qualification testing is showing compliance with the waste acceptance preliminary specifications.

NRC OBSERVATIONS

1. Certain agreements made by the NRC at the Technical Exchange last year are apparently still open items.

   a. A preliminary plan for the frequency of sampling of the melter feed product will be provided in the Waste Compliance Plan currently scheduled for release in September of 1988. WVDP is coordinating input from Savannah River with regard to the Waste Compliance Plan and resolution of WAPS.

   b. Sampling Capability

   The capability for sampling glass shards from the top of the production canisters is included in test plans.

   c. The effect of iron corrosion products in the groundwater on leaching behavior of glasses has not yet been assessed.

2. WVDP has implemented the following items:

   a. Process sampling has been or is being developed for the material in the CFMUT (Concentrator Feed Makeup Tank), the FMT (Feed Melter Tank) and the feed to the melter.

   b. Envelope conditions are being established for the WVDP to meet process and WAPS criteria some of which are independent of the actual repository conditions. Two viscosity boundaries define processability and corrosivity limits. A third boundary has been tentatively defined based on durability (leachability) that appear to be sensitive to composition.

   c. Canister Closure

   The final closure design is still under development

   d. In the glass formulation it is planned to have iron in the ferric state and chromium in a reduced state. The combined effect of ferric iron in the glass and elemental iron in the stainless steel canister has yet to be determined.

   e. WVDP believes on the basis of tests with an on-site scale mockup that all sludge can be removed from the sludge tank by use of five strategically placed pumps and three to four subsequent water washes using about five volumes of water per original volume of sludge.

Eli Maestas 2/3/88
DOE-West Valley Project Office

Charles [illegible] 3 Feb 88
Nuclear Regulatory Commission

EM:007:88 - 0131:88:01

Trip Report, Submitted by C. Interrante, on ASTM Meetings and Subcommittees C26.07, C26.13, and the Task Group on Accelerated Testing

ASTM Subcommittee C26.13 on Mined Geologic Repository Waste Package Materials Testing

Monday, January 25, 1988 (see attached copy of attendance sheet)

The purpose of ASTM subcommittee C26.13 on Mined Geologic Repository Waste Package Materials Testing is the promulgation of consensus standards for post-emplacement performance of waste package materials and components. This is in support of the national high level waste disposal program. The scope of the subcommittee standards activities includes:

The identification of needed standards.

The promulgation of test methods and practices for characterization and performance testing.

The promulgation of guides and practices for the design of waste package materials performance tests and for interpretation of the results of these tests for use in the repository licensing process.

Repository Waste Package Materials Testing Subcommittee-Chairman is Thomas A. Thornton Battelle Project Management Division 505 King Ave, Columbus, OH; tel: 614-424-4935. The Chairman of the Accelerated Testing Task Group of C26.07 was present: Richard K. Baluvelt, P.O. Box 32, Miamisburg, OH 04453-420000, Monsano Research Corp., Mound Facility; tel: 513-865-3698.

Chairman Thornton pointed out that the Salt & BWIP projects have to date been the offices of DOE that have promoted this project. They are now inactive and the representative of LLNL's NNWSI efforts, Joseph Farmer, indicated that his management was interested, and perhaps even enthusiastic, in fostering this work.

The question raised by Alan Berusch (DOE) was "What value would this Subcommittee serve that would not be served by DOE/NRC meetings?" It was pointed out by C. Interrante that the ASTM forum has been very successful in bringing together educators, producers, users, and government to solve various problems related to standardization, testing and methods. [Ed. No one ever did point out the obvious disadvantages of working with ASTM: Whenever a diverse cross-section of experts develops consensus standards within ASTM, the resulting standard (or practice) can differ from what any particular party (government or an agency of the government) wants.]

Up for its third committee ballot is a corrosion standard (aimed at salt repositories). Currently under development is an accelerated testing standard. This is a task group that is incipient. Expectations are that various commercial interests will draw in other participants from this country. In addition, the interests of other governments will lead to a natural expansion of this C26.13 Subcommittee.

C. Peterson pointed out that NRC prepares general technical positons (GTP's) on various topics related to waste management. These could be of great value to this ASTM effort.

Much discussion went into Berusch's question, and it was asked who would develop the standards. The Chairman indicated that the project must develop these standards for its own purposes. This must be done from scratch, i.e. without any prexisting procedures. The ASTM was pictured as a highly credible, open forum for development of (at least minimal) requirements for standards (and practices) that have wide acceptance.

Mr. Berusch indicated that DOE feels it can not afford large outlays of funds to support this effort in the face of the point that they can contract to develop a standard or practice, and this can be done independently of any ASTM involvement. ASTM staff manager Ken Pearson who had just joined our meeting spoke briefly on the depth of involvement from outside sources. ASTM is the largest voluntary consensus standards body in the world. A document is often developed by as few as four or five principal workers. Then, it is reformatted into ASTM's recommended form and style. The document is then reviewed by ASTM members and this may lead to nearly no changes or to extensive changes. Sometimes the balloting through subcommittee or committee leads to great improvements when viewed by the balance of the interested technical community. Often, new technologies are brought into view of the task group by other members of the Committee. Further, there is a mechanism for mandatory (every 5-years) revisions of ASTM documents, so as to assure that the documents are kept current. ASTM keeps records on microfilm to document the handling of a ballot and its negative views. Existing ASTM standards can be referenced, referenced with exceptions, or a new standard can be developed by rewriting an existing standard. In these ways, duplicate efforts on new documents are minimized and, through referencing, the updating that is done in these standards tends to keep the new documents current with pertinent advances in technologies associated with testing and methods.

The Charter for this subcommittee was discussed. The question was how broad should the scope be. A draft scope distributed earlier was considered by Mr. Berusch to be too inclusive of areas that are the responsibility of DOE only. Martin Mertz of Battelle Northwest indicated that when he reviewed existing standards none seemed applicable to the following areas: 1. The identification of needed standards concerning the post emplacement performance of high-level waste packages in the repository environment. 2. The adoption of pertinent existing standards.
The balance of the meeting was spent developing a new draft scope statement. The next steps are as follows:

a. Approve a scope
b. Determine needed Task Groups
c. Obtain approvals for participation in this activity.

ASTM Task Group 26.13 on Accelerated Testing

Monday, January 25, 1988

This is the fifth meeting of this task group. It is expected that the task group will be part of C26.13 in the near future. The focus of present efforts of the task group is a Draft Practice for Developing Accelerated Tests to Aid Prediction of Performance of Waste Package Materials for Geologic Disposal of High Level Nuclear Waste. Some comments have been recently received on the existing version of this draft practice. Follow-on comments will be collected over a 2- to 3-week period after this meeting. Comments related to statistical considerations or reliability have been received by mail from Andy Wilford, and these will be reviewed in the course of this meeting, if time permits.

There was considerable discussion on the purpose of the test method and fundamental definitions such as that of an accelerated test. Confirmation tests, predictive tests, characterization tests were all discussed.

The glass testing program involves two types of testing: (1) repository specific tests (or service tests). (2) an accelerated test (MCC-3).

Aquestion of concern to those at the Savannah River Plant (SRP) is "What is the relationship between the results the accelerated test (MCC-3) and the lifetime prediction to be made under service conditions that are repository specific. They noted that a document like the proposed accelerated testing practice would have been of great value in development of methods for glass even eight years ago. Today, it should aid both in development of tests on other materials and in the processes involved in licencing.

The DOE has not yet decided whether development of an accelerated test document within ASTM is worthy of DOE support. DOE may be inclined to develop tests of their own and disregard this effort on the basis of considerations of costs alone. On the other hand, it may be supported at some level if it is regarded as a pertinent, timely activity that will effectively contribute to the DOE efforts. It seemed clear to this writer that if neither NRC nor DOE wanted to champion the development of this accelerated testing standard, this work will not be done now, as support from others seems to be insufficient at this time.

The general feeling of those present was that the consensus standard(s) that can be developed in ASTM could help to smooth the path to approval of a license application. At the very least, the process of standards development within ASTM promotes and sharpens awareness of the views of peers who are interested in the same technical areas. [Ed. What was not mentioned (but likely was understood by most) is the fact that a consensus standard, developed within ASTM, on accelerated testing may be regarded as suitable by some and unsuitable by others. No single party is guaranteed to have his way in the consensus process.]

Some questions that came up include "How do you do quality assurance (QA) on a model?" It was pointed out that, if modeling is adequately covered in such a document, at the very least, one would hope to be able to point to the accelerated testing document and indicate what a model should look like.

At the close of the task group meeting on Monday, it was decided that Sections 17, 18 & 19 were set up for discussion on Tuesday, with a plan to complete our work to bring work on Section 20 on precision and bias to our respective statistical experts.

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Tuesday, January 26, 1988 -- Continue Task Group Meeting on Accelerated Testing

Line by line discussion of the draft practice continued with emphasis on Sections 17 through 20. May 15 is the target for a completed draft for task group ballot.
March 1 action items --
(1) C. Interrante - terminology will be sent to Merz after receiving, in the mail, Wilford's comments on the document.
(2) Mar. 1 - Wilfords comments will be sent to all
(3) C. Peterson - rewrite of part 18
(4) J.F. rewrite selected part(s).

April 1 -- T. Thornton sends pratice draft to task group

June 15 -- Task group members return comments to T. Thornton

July 25 -- Meeting in Toronto Kings Edward Hotel
(meet Mon. in p.m. through Wed. a.m.)

Members of the task group are urged to carefully review this Draft Practice for Accelerated Tests etc.

C26.01, the Editorial Subcommittee of C-26, which is chaired by Sandy Frattali (NRC, Washington, DC), should be contacted for input on this document.

450 450 *4500480* COST CENTER STATEMENT 97F

FISCAL YEAR TO DATE

FOR PAY PERIOD 17 ENDING 08/29/87 AR-1

PREPARED FOR: 450 TITLE: NRC WASTE MANAGEMENT PROGRAM COST CENTER NUMBER 4500480

SPONSOR: NUCLEAR REGULATORY AGENCY PROG/TASK 14200 TERM. DATE 11/30/87 BASIS: OBLIGATION

(AMOUNTS SHOWN ARE ROUNDED TO THE NEAREST DOLLAR)

	11.1	11.2	TOTAL
FISCAL YEAR TO DATE WORK HOURS	15533	6	15539
THE WORK YEARS CONVERSION FACTOR IS 1775 LABOR HRS PER WORK YEAR — WORK YRS (CONVERTED PER FACTOR)	8.75	.00	8.75

	** PRIOR	YEARS **	** CURRENT	YEAR **		2		
OBJECT CLASS	$ ACCRUALS	UNLIQ $ OBLIGS	$ ACCRUALS	UNLIQ $ OBLIGS	T $ TOTAL	AUTHOR-IZATION	BALANCE	COMMITS.
11.1 PERSONNEL COMPENSATION-SPONSORING DIV			354434		354434	XXXX		
11.2 PERSONNEL COMPENSATION-OTHER DIVISIONS			87		87	XXXX		
11.9 PERSONNEL BENEFITS-MATCHING COSTS			44420		44420	XXXX		
71.1 APPLIED CENTER OVERHEAD			121895		121895	XXXX		
72.1 APPLIED LABORATORY/INSTITUTE OVERHEAD			32894		32894	XXXX		
80.1 BUREAU OVERHEAD APPLIED TO LABOR			186193		186193	XXXX		
TOTAL-LABOR AND OVERHEADS			739923		739923			
21.0 TRAVEL DOMESTIC-OBLIGATION	0	0	0	465	465	XXXX		
21.1 TRAVEL DOMESTIC-PER DIEM	150	0	2651	0	2651	XXXX		
21.2 TRAVEL DOMESTIC-COMMON CARRIER	0	0	2125	386	2511	XXXX		
21.3 TRAVEL DOMESTIC-OTHER TRAVEL EXPENSES	261	0	840	0	840	XXXX		
21.4 TRAVEL DOMESTIC-MILEAGE ALLOWANCE	106	0	16	0	16	XXXX		
21.5 TRAVEL-OTHER	0	0	54	0	54	XXXX		
22.1 TRANSPORTATION OF THINGS	0	0	35	50	85	XXXX		
22.6 TRANSPORTATION OF THINGS CHG OF STATION	2207	0	1941	0	1941	XXXX		
23.1 STANDARD LEVEL USER CHARGES	0	0	30	0	30	XXXX		
23.3 OTHER TELEPHONE TELEGRAPH TELETYPE SVCS	16	0	79	0	79	XXXX		
24.3 PRINTING PAGE CHARGES + REPRINTS	0	0	0	23	23	XXXX		
26.1 SUPPLIES-DIRECT PURCHASE OTHER	0	0	6103	8056	14159	XXXX		
26.2 SUPPLIES-DIRECT PURCHASE ADP SUPPLIES	0	0	12699	246	12945	XXXX		
26.7 SUPPLIES-STOREROOM ISSUES	0	0	2927	0	2927	XXXX		
26.8 EQUIPMENT-PERSONAL APPEAL ITEMS	0	0	481	329	810	XXXX		
27.7 SCIENTIFIC AND TECHNICAL SERVICES	0	0	4081	24419	28500	XXXX		
27.8 OTHER CONTRACTS	87	0	0	0	0	XXXX		
28.8 OTHER PROCUREMENTS	0	0	453	0	453	XXXX		
29.2 ADP SERVICES - OTHER	0	0	0	445	445	XXXX		
29.3 TRAINING - TUITION AND FEES	0	0	2440	0	2440	XXXX		
29.4 STORAGE OF HOUSEHOLD GOODS	11	0	0	0	0	XXXX		
29.5 MAINTENANCE AND REPAIR OF ADP EQUIPMENT	0	0	0	431	431	XXXX		

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Received w/Ltr Dated 3/15/88

29.6 MAINTENANCE AND REPAIR OTHER EQUIPMENT	0	0	0	475	475	XXXX		
29.7 SCIENTIFIC AND TECHNICAL SERVICES	4700	0	6000	13200	19200	XXXX		
29.8 OTHER PROCUREMENTS	0	0	199	0	199	XXXX		
29.9 NONTRAVEL EXPENSES	220	0	875	0	875	XXXX		
31.1 EQUIPMENT-OTHER	0	0	5368	2510	7878	XXXX		
31.3 EQUIPMENT-ADP	0	0	21027	0	210.7	XXXX		
32.0 COMPUTER SERVICES - GAITHERSBURG	0	0	767	0	767	XXXX		
53.3 DRAFTING + GRAPHIC ARTS	0	0	1011	0	1011	XXXX		
60.2 SHOPS - GAITHERSBURG	0	0	180	0	180	XXXX		
60.3 SHOPS - ADJ OF COMPLETED JOBS	0	0	-45	0	-45	XXXX		
67.2 TRAINING-FEES	0	0	120	0	120	XXXX		
67.5 MISC COST TRANSFERS-OTHER THAN LABOR	0	0	56	0	56	XXXX		
67.7 NBS NETWORK FEES	0	0	266	0	266	XXXX		
TOTAL OTHER OBJECTS	7758	0	72779	51035	123814			
COST CENTER TOTAL	7758	0	812702	51035	863737	971048	107311	9597

1 FOR ACCRUAL COST CENTERS THIS TOTAL INCLUDES BOTH CURRENT YEAR ACCRUALS AND ACCRUALS OF PRIOR YEAR UNLIQUIDATED OBLIGATIONS. FOR COST CENTERS ON AN OBLIGATION BASIS, THIS TOTAL INCLUDES ONLY CURRENT YEAR ACCRUALS AND UNLIQUIDATED OBLIGATIONS.

2 FOR ACCRUAL COST CENTERS THE AUTHORIZATION INCLUDES AN AMOUNT FOR PRIOR YEAR OBLIGATIONS. FOR PROJECTS ON AN OBLIGATION BASIS, THE AUTHORIZATION IS FOR CURRENT YEAR OBLIGATIONS ONLY.

450 450 4500480

COST CENTER STATEMENT
FISCAL YEAR TO DATE
FOR PAY PERIOD 18 ENDING 09/12/87

PREPARED FOR: 450 TITLE: NRC WASTE MANAGEMENT PROGRAM COST CENTER NUMBER 4500480

SPONSOR: NUCLEAR REGULATORY AGENCY PROG/TASK 14200 TERM. DATE 11/30/87 BASIS: OBLIGATION

(AMOUNTS SHOWN ARE ROUNDED TO THE NEAREST DOLLAR)

THE WORK YEARS CONVERSION FACTOR IS 1775 LABOR HRS PER WORK YEAR

	11.1	11.2	TOTAL
FISCAL YEAR TO DATE WORK HOURS	16112	6	16118
WORK YRS (CONVERTED PER FACTOR)	9.08	.00	9.08

OBJECT CLASS	** PRIOR YEARS ** $ ACCRUALS	UNLIQ $ OBLIGS	** CURRENT YEAR ** $ ACCRUALS	UNLIQ $ OBLIGS	1 $ TOTAL	2 AUTHORIZATION	BALANCE	COMMITS.
11.1 PERSONNEL COMPENSATION-SPONSORING DIV			369253		369253	XXXX		
11.2 PERSONNEL COMPENSATION-OTHER DIVISIONS			87		87	XXXX		
11.9 PERSONNEL BENEFITS-MATCHING COSTS			46376		46376	XXXX		
71.1 APPLIED CENTER OVERHEAD			130182		130182	XXXX		
72.1 APPLIED LABORATORY/INSTITUTE OVERHEAD			34538		34538	XXXX		
80.1 BUREAU OVERHEAD APPLIED TO LABOR			193322		193322	XXXX		
TOTAL-LABOR AND OVERHEADS			773758		773758			
21.0 TRAVEL DOMESTIC-OBLIGATION	0	0	0	465	465	XXXX		
21.1 TRAVEL DOMESTIC-PER DIEM	150	0	2651	0	2651	XXXX		
21.2 TRAVEL DOMESTIC-COMMON CARRIER	0	0	2463	48	2511	XXXX		
21.3 TRAVEL DOMESTIC-OTHER TRAVEL EXPENSES	261	0	840	0	840	XXXX		
21.4 TRAVEL DOMESTIC-MILEAGE ALLOWANCE	106	0	16	0	16	XXXX		
21.5 TRAVEL-OTHER	0	0	54	0	54	XXXX		
22.1 TRANSPORTATION OF THINGS	0	0	35	50	85	XXXX		
22.6 TRANSPORTATION OF THINGS CHG OF STATION	2207	0	1941	0	1941	XXXX		
23.1 STANDARD LEVEL USER CHARGES	0	0	30	0	30	XXXX		
23.5 OTHER TELEPHONE TELEGRAPH TELETYPE SVCS	16	0	76	0	76	XXXX		
24.3 PRINTING PAGE CHARGES + REPRINTS	0	0	0	23	23	XXXX		
26.1 SUPPLIES-DIRECT PURCHASE OTHER	0	0	12135	2113	14248	XXXX		
26.2 SUPPLIES-DIRECT PURCHASE ADP SUPPLIES	0	0	12945	0	12945	XXXX		
26.7 SUPPLIES-STOREROOM ISSUES	0	0	2938	0	2938	XXXX		
26.8 EQUIPMENT-PERSONAL APPEAL ITEMS	0	0	481	369	850	XXXX		
27.7 SCIENTIFIC AND TECHNICAL SERVICES	0	0	4081	24419	28500	XXXX		
27.8 OTHER CONTRACTS	87	0	0	0	0	XXXX		
28.8 OTHER PROCUREMENTS	0	0	453	0	453	XXXX		
29.2 ADP SERVICES - OTHER	0	0	0	465	465	XXXX		
29.3 TRAINING - TUITION AND FEES	0	0	2440	0	2440	XXXX		
29.4 STORAGE OF HOUSEHOLD GOODS	11	0	0	0	0	XXXX		
29.5 MAINTENANCE AND REPAIR OF ADP EQUIPMENT	0	0	0	490	490	XXXX		

29.6 MAINTENANCE AND REPAIR OTHER EQUIPMENT	0	0	0	475	475	XXXX		
29.7 SCIENTIFIC AND TECHNICAL SERVICES	4700	0	6000	13200	19200	XXXX		
29.8 OTHER PROCUREMENTS	0	0	199	0	199	XXXX		
29.9 NONTRAVEL EXPENSES	220	0	875	0	875	XXXX		
31.1 EQUIPMENT-OTHER	0	0	5368	2510	7878	XXXX		
31.3 EQUIPMENT-ADP	0	0	21027	0	21027	XXXX		
52.0 COMPUTER SERVICES - GAITHERSBURG	0	0	767	0	767	XXXX		
53.3 DRAFTING + GRAPHIC ARTS	0	0	1011	0	1011	XXXX		
60.2 SHOPS - GAITHERSBURG	0	0	180	0	180	XXXX		
60.3 SHOPS - ADJ OF COMPLETED JOBS	0	0	-45	0	-45	XXXX		
65.1 PLANT SERVICES	0	0	52	0	52	XXXX		
67.2 TRAINING-FEES	0	0	120	0	120	XXXX		
67.5 MISC COST TRANSFERS-OTHER THAN LABOR	0	0	56	0	56	XXXX		
67.7 NBS NETWORK FEES	0	0	287	0	287	XXXX		
TOTAL OTHER OBJECTS	7758	0	79476	44607	124083			
COST CENTER TOTAL	7758	0	853234	44607	897841	971048	73207	95

1 FOR ACCRUAL COST CENTERS THIS TOTAL INCLUDES BOTH CURRENT YEAR ACCRUALS AND ACCRUALS OF PRIOR YEAR UNLIQUIDATED OBLIGATIONS. F COST CENTERS ON AN OBLIGATION BASIS, THIS TOTAL INCLUDES ONLY CURRENT YEAR ACCRUALS AND UNLIQUIDATED OBLIGATIONS.

2 FOR ACCRUAL COST CENTERS THE AUTHORIZATION INCLUDES AN AMOUNT FOR PRIOR YEAR OBLIGATIONS. FOR PROJECTS ON AN OBLIGATION BASIS THE AUTHORIZATION IS FOR CURRENT YEAR OBLIGATIONS ONLY.

450 450 *4500480* COST CENTER STATEMENT 1030

FISCAL YEAR TO DATE

FOR PAY PERIOD 19 ENDING 09/26/87 AR-1

PREPARED FOR: 450 TITLE: NRC WASTE MANAGEMENT PROGRAM COST CENTER NUMBER 4500480

SPONSOR: NUCLEAR REGULATORY AGENCY PROG/TASK 14200 TERM. DATE 11/30/87 BASIS: OBLIGATION

(AMOUNTS SHOWN ARE ROUNDED TO THE NEAREST DOLLAR)

THE WORK YEARS CONVERSION FACTOR IS 1755 LABOR HRS PER WORK YEAR

	11.1	11.2	TOTAL
FISCAL YEAR TO DATE WORK HOURS	16985	6	16991
WORK YRS (CONVERTED PER FACTOR)	9.68	.00	9.68

	** PRIOR YEARS **		** CURRENT YEAR **		1	2		
OBJECT CLASS	$ ACCRUALS	UNLIQ $ OBLIGS	$ ACCRUALS	UNLIQ $ OBLIGS	$ TOTAL	AUTHORIZATION	BALANCE	COMMITS.
11.1 PERSONNEL COMPENSATION-SPONSORING DIV			391654		391654	XXXX		
11.2 PERSONNEL COMPENSATION-OTHER DIVISIONS			87		87	XXXX		
11.9 PERSONNEL BENEFITS-MATCHING COSTS			49333		49333	XXXX		
71.1 APPLIED CENTER OVERHEAD			142709		142709	XXXX		
72.1 APPLIED LABORATORY/INSTITUTE OVERHEAD			37023		37023	XXXX		
80.1 BUREAU OVERHEAD APPLIED TO LABOR			204099		204099	XXXX		
TOTAL-LABOR AND OVERHEADS			824905		824905			
21.0 TRAVEL DOMESTIC-OBLIGATION	0	0	0	465	465	XXXX		
21.1 TRAVEL DOMESTIC-PER DIEM	150	0	2651	0	2651	XXXX		
21.2 TRAVEL DOMESTIC-COMMON CARRIER	0	0	2463	48	2511	XXXX		
21.3 TRAVEL DOMESTIC-OTHER TRAVEL EXPENSES	261	0	840	0	840	XXXX		
21.4 TRAVEL DOMESTIC-MILEAGE ALLOWANCE	106	0	16	0	16	XXXX		
21.5 TRAVEL-OTHER	0	0	54	0	54	XXXX		
22.1 TRANSPORTATION OF THINGS	0	0	37	50	87	XXXX		
22.6 TRANSPORTATION OF THINGS CHG OF STATION	2207	0	1941	0	1941	XXXX		
23.1 STANDARD LEVEL USER CHARGES	0	0	30	0	30	XXXX		
23.5 OTHER TELEPHONE TELEGRAPH TELETYPE SVCS	16	0	76	0	76	XXXX		
24.3 PRINTING PAGE CHARGES + REPRINTS	0	0	23	0	23	XXXX		
26.1 SUPPLIES-DIRECT PURCHASE OTHER	0	0	12280	1769	14049	XXXX		
26.2 SUPPLIES-DIRECT PURCHASE ADP SUPPLIES	0	0	12945	0	12945	XXXX		
26.7 SUPPLIES-STOREROOM ISSUES	0	0	3188	0	3188	XXXX		
26.8 EQUIPMENT-PERSONAL APPEAL ITEMS	0	0	850	0	850	XXXX		
27.7 SCIENTIFIC AND TECHNICAL SERVICES	0	0	4876	23624	28500	XXXX		
27.8 OTHER CONTRACTS	87	0	0	0	0	XXXX		
28.8 OTHER PROCUREMENTS	0	0	501	0	501	XXXX		
29.2 ADP SERVICES - OTHER	0	0	0	445	445	XXXX		
29.3 TRAINING - TUITION AND FEES	0	0	2619	0	2619	XXXX		
29.4 STORAGE OF HOUSEHOLD GOODS	11	0	0	0	0	XXXX		
29.5 MAINTENANCE AND REPAIR OF ADP EQUIPMENT	0	0	69	421	490	XXXX		

COST CENTER STATEMENT

29.6 MAINTENANCE AND REPAIR OTHER EQUIPMENT	0	0	475	0	475	XXXX	
29.7 SCIENTIFIC AND TECHNICAL SERVICES	4700	0	[illegible]	[illegible]	[illegible]	XXXX	
29.8 OTHER PROCUREMENTS	0	0	399	0	399	XXXX	
29.9 NONTRAVEL EXPENSES	220	0	875	0	875	XXXX	
31.1 EQUIPMENT-OTHER	0	0	5368	2510	7878	XXXX	
31.3 EQUIPMENT-ADP	0	0	21027	0	21027	XXXX	
52.0 COMPUTER SERVICES - GAITHERSBURG	0	0	767	0	767	XXXX	
53.3 DRAFTING + GRAPHIC ARTS	0	0	1011	0	1011	XXXX	
60.2 SHOPS - GAITHERSBURG	0	0	180	0	180	XXXX	
60.3 SHOPS - ADJ OF COMPLETED JOBS	0	0	-45	0	-45	XXXX	
65.1 PLANT SERVICES	0	0	52	0	52	XXXX	
67.2 TRAINING-FEES	0	0	120	0	120	XXXX	
67.5 MISC COST TRANSFERS-OTHER THAN LABOR	0	0	56	0	56	XXXX	
67.7 NBS NETWORK FEES	0	0	308	0	308	XXXX	
TOTAL OTHER OBJECTS	7758	0	84596	39988	124584		
COST CENTER TOTAL	7758	0	909501	39988	949489	971048	21559

1 FOR ACCRUAL COST CENTERS THIS TOTAL INCLUDES BOTH CURRENT YEAR ACCRUALS AND ACCRUALS OF PRIOR YEAR UNLIQUIDATED OBLIGATIONS. FOR COST CENTERS ON AN OBLIGATION BASIS, THIS TOTAL INCLUDES ONLY CURRENT YEAR ACCRUALS AND UNLIQUIDATED OBLIGATIONS.

2 FOR ACCRUAL COST CENTERS THE AUTHORIZATION INCLUDES AN AMOUNT FOR PRIOR YEAR OBLIGATIONS. FOR PROJECTS ON AN OBLIGATION BASIS, THE AUTHORIZATION IS FOR CURRENT YEAR OBLIGATIONS ONLY.

450 450 *4500480* COST CENTER STATEMENT 1003

FISCAL YEAR TO DATE

FOR PAY PERIOD 20 ENDING 09/30/87 AR-1

PREPARED FOR: 450 TITLE: NRC WASTE MANAGEMENT PROGRAM COST CENTER NUMBER 4500480

SPONSOR: NUCLEAR REGULATORY AGENCY PROG/TASK 14200 TERM. DATE 11/30/87 BASIS: OBLIGATION

(AMOUNTS SHOWN ARE ROUNDED TO THE NEAREST DOLLAR)

THE WORK YEARS CONVERSION FACTOR IS 1755 LABOR HRS PER WORK YEAR

	11.1	11.2	TOTAL
FISCAL YEAR TO DATE WORK HOURS	17322	6	17328
WORK YRS (CONVERTED PER FACTOR)	9.87	.00	9.87

OBJECT CLASS	** PRIOR YEARS ** $ ACCRUALS	UNLIQ $ OBLIGS	** CURRENT YEAR ** $ ACCRUALS	UNLIQ $ OBLIGS	1 $ TOTAL	2 AUTHORIZATION	BALANCE	COMMITS.
11.1 PERSONNEL COMPENSATION-SPONSORING DIV			400942		400942	XXXX		
11.2 PERSONNEL COMPENSATION-OTHER DIVISIONS			87		87	XXXX		
11.9 PERSONNEL BENEFITS-MATCHING COSTS			50559		50559	XXXX		
71.1 APPLIED CENTER OVERHEAD			147903		147903	XXXX		
72.1 APPLIED LABORATORY/INSTITUTE OVERHEAD			38053		38053	XXXX		
80.1 BUREAU OVERHEAD APPLIED TO LABOR			208567		208567	XXXX		
TOTAL-LABOR AND OVERHEADS			846111		846111			
21.0 TRAVEL DOMESTIC-OBLIGATION	0	0	0	465	465	XXXX		
21.1 TRAVEL DOMESTIC-PER DIEM	150	0	2651	0	2651	XXXX		
21.2 TRAVEL DOMESTIC-COMMON CARRIER	0	0	2463	48	2511	XXXX		
21.3 TRAVEL DOMESTIC-OTHER TRAVEL EXPENSES	261	0	840	0	840	XXXX		
21.4 TRAVEL DOMESTIC-MILEAGE ALLOWANCE	106	0	16	0	16	XXXX		
21.5 TRAVEL-OTHER	0	0	54	0	54	XXXX		
22.1 TRANSPORTATION OF THINGS	0	0	37	50	87	XXXX		
22.6 TRANSPORTATION OF THINGS CHG OF STATION	2207	0	1941	0	1941	XXXX		
23.1 STANDARD LEVEL USER CHARGES	0	0	30	0	30	XXXX		
23.3 OTHER TELEPHONE TELEGRAPH TELETYPE SVCS	16	0	76	0	76	XXXX		
24.3 PRINTING PAGE CHARGES + REPRINTS	0	0	23	0	23	XXXX		
26.1 SUPPLIES-DIRECT PURCHASE OTHER	0	0	12285	1769	14054	XXXX		
26.2 SUPPLIES-DIRECT PURCHASE ADP SUPPLIES	0	0	12945	0	12945	XXXX		
26.7 SUPPLIES-STOREROOM ISSUES	0	0	3188	0	3188	XXXX		
26.8 EQUIPMENT-PERSONAL APPEAL ITEMS	0	0	850	0	850	XXXX		
27.7 SCIENTIFIC AND TECHNICAL SERVICES	0	0	4876	23624	28500	XXXX		
27.8 OTHER CONTRACTS	87	0	0	0	0	XXXX		
28.8 OTHER PROCUREMENTS	0	0	501	0	501	XXXX		
29.2 ADP SERVICES - OTHER	0	0	0	445	445	XXXX		
29.3 TRAINING - TUITION AND FEES	0	0	2619	0	2619	XXXX		
29.4 STORAGE OF HOUSEHOLD GOODS	11	0	0	0	0	XXXX		
29.5 MAINTENANCE AND REPAIR OF ADP EQUIPMENT	0	0	69	421	490	XXXX		

29.6 MAINTENANCE AND REPAIR OTHER EQUIPMENT	0	0	475	0	475	XXXX	
29.7 SCIENTIFIC AND TECHNICAL SERVICES	4700	0	8544	10656	19200	XXXX	
29.8 OTHER PROCUREMENTS	0	0	399	0	399	XXXX	
29.9 NONTRAVEL EXPENSES	220	0	875	0	875	XXXX	
31.1 EQUIPMENT-OTHER	0	0	5368	2510	7878	XXXX	
31.3 EQUIPMENT-ADP	0	0	21027	0	21027	XXXX	
52.0 COMPUTER SERVICES - GAITHERSBURG	0	0	767	0	767	XXXX	
53.3 DRAFTING + GRAPHIC ARTS	0	0	1011	0	1011	XXXX	
60.2 SHOPS - GAITHERSBURG	0	0	180	0	180	XXXX	
60.3 SHOPS - ADJ OF COMPLETED JOBS	0	0	-45	0	-45	XXXX	
65.1 PLANT SERVICES	0	0	52	0	52	XXXX	
67.2 TRAINING-FEES	0	0	120	0	120	XXXX	
67.5 MISC COST TRANSFERS-OTHER THAN LABOR	0	0	56	0	56	XXXX	
67.7 NBS NETWORK FEES	0	0	308	0	308	XXXX	
TOTAL OTHER OBJECTS	7758	0	84601	39988	124589		
COST CENTER TOTAL	7758	0	930712	39988	970700	971048	348

1 FOR ACCRUAL COST CENTERS THIS TOTAL INCLUDES BOTH CURRENT YEAR ACCRUALS AND ACCRUALS OF PRIOR YEAR UNLIQUIDATED OBLIGATIONS. FOR COST CENTERS ON AN OBLIGATION BASIS, THIS TOTAL INCLUDES ONLY CURRENT YEAR ACCRUALS AND UNLIQUIDATED OBLIGATIONS.

2 FOR ACCRUAL COST CENTERS THE AUTHORIZATION INCLUDES AN AMOUNT FOR PRIOR YEAR OBLIGATIONS. FOR PROJECTS ON AN OBLIGATION BASIS, THE AUTHORIZATION IS FOR CURRENT YEAR OBLIGATIONS ONLY.

450 450 *4500480*

COST CENTER STATEMENT
FISCAL YEAR TO DATE
FOR PAY PERIOD 21 ENDING 10/24/87

AR-1

PREPARED FOR: 450 TITLE: NRC WASTE MANAGEMENT PROGRAM COST CENTER NUMBER 4500480

SPONSOR: NUCLEAR REGULATORY COMMISSION PROG/TASK 14200 TERM. DATE 11/30/87 BASIS: OBLIGATION

(AMOUNTS SHOWN ARE ROUNDED TO THE NEAREST DOLLAR)

THE WORK YEARS CONVERSION FACTOR IS 1775 LABOR HRS PER WORK YEAR

	11.1	11.2	TOTAL
FISCAL YEAR TO DATE WORK HOURS	1072	3	1075
WORK YRS (CONVERTED PER FACTOR)	.60	.00	.61

OBJECT CLASS	** PRIOR YEARS ** $ ACCRUALS	UNLIQ $ OBLIGS	** CURRENT YEAR ** $ ACCRUALS	UNLIQ $ OBLIGS	1 $ TOTAL	2 AUTHOR-IZATION	BALANCE	COMMITS.
11.1 PERSONNEL COMPENSATION-SPONSORING DIV			24458		24458	XXXX		
11.2 PERSONNEL COMPENSATION-OTHER DIVISIONS			81		81	XXXX		
11.9 PERSONNEL BENEFITS-MATCHING COSTS			3927		3927	XXXX		
71.1 APPLIED CENTER OVERHEAD			10105		10105	XXXX		
72.1 APPLIED LABORATORY/INSTITUTE OVERHEAD			2391		2391	XXXX		
80.1 BUREAU OVERHEAD APPLIED TO LABOR			14091		14091	XXXX		
TOTAL-LABOR AND OVERHEADS			55053		55053			
21.0 TRAVEL DOMESTIC-OBLIGATION	0	465	0	0	0	XXXX		
21.2 TRAVEL DOMESTIC-COMMON CARRIER	0	48	0	0	0	XXXX		
22.1 TRANSPORTATION OF THINGS	0	50	0	0	0	XXXX		
26.1 SUPPLIES-DIRECT PURCHASE OTHER	18	1769	0	0	0	XXXX		
26.7 SUPPLIES-STOREROOM ISSUES	0	0	358	0	358	XXXX		
27.7 SCIENTIFIC AND TECHNICAL SERVICES	0	23624	0	0	0	XXXX		
29.2 ADP SERVICES-OTHER	445	0	0	0	0	XXXX		
29.5 MAINTENANCE AND REPAIR OF ADP EQUIPMENT	0	421	0	0	0	XXXX		
29.7 SCIENTIFIC AND TECHNICAL SERVICES	0	10656	0	0	0	XXXX		
31.1 EQUIPMENT-OTHER	0	2510	0	0	0	XXXX		
52.0 COMPUTER SERVICES-GAITHERSBURG	0	0	2	0	2	XXXX		
60.2 SHOPS-GAITHERSBURG	0	0	500	0	500	XXXX		
67.7 NBS NETWORK FEES	0	0	42	0	42	XXXX		
TOTAL OTHER OBJECTS	463	39543	902	0	902			
COST CENTER TOTAL	463	39543	55955	0	55955	100000	44045	2615

1 FOR ACCRUAL COST CENTERS THIS TOTAL INCLUDES BOTH CURRENT YEAR ACCRUALS AND ACCRUALS OF PRIOR YEAR UNLIQUIDATED OBLIGATIONS. FOR COST CENTERS ON AN OBLIGATION BASIS, THIS TOTAL INCLUDES ONLY CURRENT YEAR ACCRUALS AND UNLIQUIDATED OBLIGATIONS.

2 FOR ACCRUAL COST CENTERS THE AUTHORIZATION INCLUDES AN AMOUNT FOR PRIOR YEAR
THE AUTHORIZATION

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450     450  4500480                          COST CENTER STATEMENT                                                82
                                                FISCAL YEAR TO DATE
                                       FOR PAY PERIOD 23 ENDING 11/21/87                                          AR-

PREPARED FOR: 450                TITLE:    NRC WASTE MANAGEMENT PROGRAM                     COST CENTER NUMBER 4500480

SPONSOR: NUCLEAR REGULATORY COMMISSION              PROG/TASK  14200   TERM. DATE  11/30/87     BASIS:    OBLIGATION

 (AMOUNTS SHOWN ARE ROUNDED TO THE NEAREST DOLLAR)                                              11.1       11.2      TOTAL
                                                      FISCAL YEAR TO DATE WORK HOURS            2381          5       2386
THE WORK YEARS CONVERSION FACTOR IS 1775 LABOR HRS  PER WORK YEAR   WORK YRS  (CONVERTED PER FACTOR)  1.34  .00       1.34

                                          ** PRIOR  YEARS **    ** CURRENT YEAR **                2
OBJECT                                                UNLIQ                 UNLIQ        1       AUTHOR-
CLASS                                     $ ACCRUALS  $ OBLIGS $ ACCRUALS  $ OBLIGS   $ TOTAL   IZATION    BALANCE    COMMITS.

11.1 PERSONNEL COMPENSATION-SPONSORING DIV                      54417                  54417      XXXX
11.2 PERSONNEL COMPENSATION-OTHER DIVISIONS                       135                    135      XXXX
11.9 PERSONNEL BENEFITS-MATCHING COSTS                           8729                   8729      XXXX
71.1 APPLIED CENTER OVERHEAD                                    22464                  22464      XXXX
72.1 APPLIED LABORATORY/INSTITUTE OVERHEAD                       5316                   5316      XXXX
80.1 BUREAU OVERHEAD APPLIED TO LABOR                           31324                  31324      XXXX

                 TOTAL-LABOR AND OVERHEADS                     122385                 122385

 21.0 TRAVEL DOMESTIC-OBLIGATION                 0         0         0      1249       1249      XXXX
 21.1 TRAVEL DOMESTIC-PER DIEM                 223         0         0         0          0      XXXX
 21.2 TRAVEL DOMESTIC-COMMON CARRIER             0        48         0       247        247      XXXX
 21.3 TRAVEL DOMESTIC-OTHER TRAVEL EXPENSES    129         0         0         0          0      XXXX
 21.4 TRAVEL DOMESTIC-MILEAGE ALLOWANCE          4         0         0         0          0      XXXX
 22.1 TRANSPORTATION OF THINGS                   0        50         0         0          0      XXXX
 23.0 ROLM TELEPHONE CHARGES                     0         0        28         0         28      XXXX
 26.1 SUPPLIES-DIRECT PURCHASE OTHER           841       946         0      1971       1971      XXXX
 26.2 SUPPLIES-DIRECT PURCHASE ADP SUPPLIES      0         0       600        75        675      XXXX
 26.7 SUPPLIES-STOREROOM ISSUES                  0         0       572         0        572      XXXX
 27.7 SCIENTIFIC AND TECHNICAL SERVICES        980     22644         0         0          0      XXXX
 29.2 ADP SERVICES-OTHER                       445         0         0         0          0      XXXX
 29.3 TRAINING-TUITION AND FEES                  0         0         0       350        350      XXXX
 29.5 MAINTENANCE AND REPAIR OF ADP EQUIPMENT    0       421         0         0          0      XXXX
 29.7 SCIENTIFIC AND TECHNICAL SERVICES          0     10656         0         0          0      XXXX
 29.9 NONTRAVEL EXPENSES                         7         0         0         0          0      XXXX
 31.1  EQUIPMENT-OTHER                        2510         0         0         0          0      XXXX
 52.0 COMPUTER SERVICES-GAITHERSBURG             0         0         2         0          2      XXXX
 60.2 SHOPS-GAITHERSBURG                         0         0       500         0        500      XXXX
 67.7 NBS NETWORK FEES                           0         0        84         0         84      XXXX

                    TOTAL OTHER OBJECTS       5139     34765      1786      3892       5678
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                         COST CENTER TOTAL      5139     34765     124171      3892     128063     100348    -27715       70
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1 FOR ACCRUAL COST CENTERS THIS TOTAL INCLUDES BOTH CURRENT YEAR ACCRUALS AND ACCRUALS OF PRIOR YEAR UNLIQUIDATED OBLIGATIONS. FOR COST CENTERS ON AN OBLIGATION BASIS, THIS TOTAL INCLUDES ONLY CURRENT YEAR ACCRUALS AND UNLIQUIDATED OBLIGATIONS.

2 FOR ACCRUAL COST CENTERS THE AUTHORIZATION INCLUDES AN AMOUNT FOR PRIOR YEAR OBLIGATIONS. FOR PROJECTS ON AN OBLIGATION BASIS, THE AUTHORIZATION IS FOR CURRENT YEAR OBLIGATIONS ONLY.

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450 450 4500480

COST CENTER STATEMENT
FISCAL YEAR TO DATE
FOR PAY PERIOD 26 ENDING 01/02/88

860
AR-1

PREPARED FOR: 450
TITLE: NRC WASTE MANAGEMENT PROGRAM
COST CENTER NUMBER 4500480

SPONSOR: NUCLEAR REGULATORY COMMISSION
PROG/TASK 14200 TERM. DATE 11/30/87
BASIS: OBLIGATION

(AMOUNTS SHOWN ARE ROUNDED TO THE NEAREST DOLLAR)

THE WORK YEARS CONVERSION FACTOR IS 1775 LABOR HRS PER WORK YEAR

	11.1	11.2	TOTAL
FISCAL YEAR TO DATE WORK HOURS	3945	5	3950
WORK YRS (CONVERTED PER FACTOR)	2.22	.00	2.23

OBJECT CLASS	** PRIOR YEARS ** $ ACCRUALS	UNLIQ $ OBLIGS	** CURRENT YEAR ** $ ACCRUALS	UNLIQ $ OBLIGS	1 $ TOTAL	2 AUTHOR-IZATION	BALANCE	COMMITS.
11.1 PERSONNEL COMPENSATION-SPONSORING DIV			88818		88818	XXXX		
11.2 PERSONNEL COMPENSATION-OTHER DIVISIONS			135		135	XXXX		
11.9 PERSONNEL BENEFITS-MATCHING COSTS			14234		14234	XXXX		
71.1 APPLIED CENTER OVERHEAD			36631		36631	XXXX		
72.1 APPLIED LABORATORY/INSTITUTE OVERHEAD			8669		8669	XXXX		
80.1 BUREAU OVERHEAD APPLIED TO LABOR			51078		51078	XXXX		
TOTAL-LABOR AND OVERHEADS			199565		199565			
11.5 PERSONNEL BENEFITS-CASH AWARDS	0	0	750	0	750	XXXX		
21.0 TRAVEL DOMESTIC-OBLIGATION	0	0	0	1767	1767	XXXX		
21.1 TRAVEL DOMESTIC-PER DIEM	223	0	782	0	782	XXXX		
21.2 TRAVEL DOMESTIC-COMMON CARRIER	0	48	327	330	657	XXXX		
21.3 TRAVEL DOMESTIC-OTHER TRAVEL EXPENSES	129	0	74	0	74	XXXX		
21.4 TRAVEL DOMESTIC-MILEAGE ALLOWANCE	4	0	13	0	13	XXXX		
21.5 TRAVEL-OTHER	0	0	57	0	57	XXXX		
22.1 TRANSPORTATION OF THINGS	0	50	4	0	4	XXXX		
23.0 ROLM TELEPHONE CHARGES	0	0	70	0	70	XXXX		
23.5 OTHER TELEPHONE TELEGRAPH TELETYPE SVCS	0	0	574	0	574	XXXX		
26.1 SUPPLIES-DIRECT PURCHASE OTHER	841	906	1022	1333	2355	XXXX		
26.2 SUPPLIES-DIRECT PURCHASE ADP SUPPLIES	0	0	1246	75	1321	XXXX		
26.7 SUPPLIES-STOREROOM ISSUES	0	0	1097	0	1097	XXXX		
27.7 SCIENTIFIC AND TECHNICAL SERVICES	980	22644	0	0	0	XXXX		
28.8 OTHER PROCUREMENTS	92	0	0	0	0	XXXX		
29.2 ADP SERVICES-OTHER	445	0	0	0	0	XXXX		
29.3 TRAINING-TUITION AND FEES	0	0	0	700	700	XXXX		
29.5 MAINTENANCE AND REPAIR OF ADP EQUIPMENT	0	421	150	0	150	XXXX		
29.6 MAINTENANCE AND REPAIR OTHER EQUIPMENT	0	0	0	275	275	XXXX		
29.7 SCIENTIFIC AND TECHNICAL SERVICES	0	10656	0	0	0	XXXX		
29.9 NONTRAVEL EXPENSES	7	0	370	0	370	XXXX		
31.1 EQUIPMENT-OTHER	2510	0	0	0	0	XXXX		

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450     450  4500480                         COST CENTER STATEMENT                                                        861
52.0 COMPUTER SERVICES-GAITHERSBURG              0        0          2        0          2       XXXX
53.3 DRAFTING + GRAPHIC ARTS                     0        0         12        0         12       XXXX
60.2 SHOPS-GAITHERSBURG                          0        0       1530        0       1530       XXXX
67.7 NBS NETWORK FEES                            0        0        147        0        147       XXXX

                      TOTAL OTHER OBJECTS     5231    34725       8227     4480      12707


                       COST CENTER TOTAL      5231    34725     207792     4480     212272     107348    -104924      1549
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1 FOR ACCRUAL COST CENTERS THIS TOTAL INCLUDES BOTH CURRENT YEAR ACCRUALS AND ACCRUALS OF PRIOR YEAR UNLIQUIDATED OBLIGATIONS. FOR COST CENTERS ON AN OBLIGATION BASIS, THIS TOTAL INCLUDES ONLY CURRENT YEAR ACCRUALS AND UNLIQUIDATED OBLIGATIONS.

2 FOR ACCRUAL COST CENTERS THE AUTHORIZATION INCLUDES AN AMOUNT FOR PRIOR YEAR OBLIGATIONS. FOR PROJECTS ON AN OBLIGATION BASIS, THE AUTHORIZATION IS FOR CURRENT YEAR OBLIGATIONS ONLY.

450 - - -450 4500480 .00) AR-1

COST CENTER STATEMENT
FISCAL YEAR TO DATE
FOR PAY PERIOD 02 ENDING 01/30/88

PREPARED FOR: 450

TITLE: NRC WASTE MANAGEMENT PROGRAM

COST CENTER NUMBER 4500480

SPONSOR: NUCLEAR REGULATORY COMMISSION

PROG/TASK 14200 TERM. DATE 11/30/88 BASIS: OBLIGATION

(AMOUNTS SHOWN ARE ROUNDED TO THE NEAREST DOLLAR)

THE WORK YEARS CONVERSION FACTOR IS 1775 LABOR HRS PER WORK YEAR

	11.1	11.2	TOTAL
FISCAL YEAR TO DATE WORK HOURS	4887	5	4892
WORK YRS (CONVERTED PER FACTOR)	2.75	.00	2.76

OBJECT CLASS	** PRIOR YEARS ** $ ACCRUALS	UNLIQ $ OBLIGS	** CURRENT YEAR ** $ ACCRUALS	UNLIQ $ OBLIGS	$ TOTAL	AUTHORIZATION	BALANCE	COMMITS.
11.1 PERSONNEL COMPENSATION-SPONSORING DIV			110998		110998	XXXX		
11.2 PERSONNEL COMPENSATION-OTHER DIVISIONS			135		135	XXXX		
11.9 PERSONNEL BENEFITS-MATCHING COSTS			17782		17782	XXXX		
71.1 APPLIED CENTER OVERHEAD			45469		45469	XXXX		
72.1 APPLIED LABORATORY/INSTITUTE OVERHEAD			10830		10830	XXXX		
80.1 BUREAU OVERHEAD APPLIED TO LABOR			63813		63813	XXXX		
TOTAL-LABOR AND OVERHEADS			249027		249027			
11.5 PERSONNEL BENEFITS-CASH AWARDS	0	0	750	0	750	XXXX		
21.0 TRAVEL DOMESTIC-OBLIGATION	0	0	0	974	974	XXXX		
21.1 TRAVEL DOMESTIC-PER DIEM	223	0	1535	0	1535	XXXX		
21.2 TRAVEL DOMESTIC-COMMON CARRIER	0	48	327	682	1009	XXXX		
21.3 TRAVEL DOMESTIC-OTHER TRAVEL EXPENSES	129	0	121	0	121	XXXX		
21.4 TRAVEL DOMESTIC-MILEAGE ALLOWANCE	4	0	30	0	30	XXXX		
21.5 TRAVEL-OTHER	0	0	57	0	57	XXXX		
22.1 TRANSPORTATION OF THINGS	0	50	9	0	9	XXXX		
23.0 ROLM TELEPHONE CHARGES	0	0	98	0	98	XXXX		
23.5 OTHER TELEPHONE TELEGRAPH TELETYPE SVCS	0	0	718	0	718	XXXX		
26.1 SUPPLIES-DIRECT PURCHASE OTHER	1611	136	1232	2238	3470	XXXX		
26.2 SUPPLIES-DIRECT PURCHASE ADP SUPPLIES	0	0	1246	75	1321	XXXX		
26.7 SUPPLIES-STOREROOM ISSUES	0	0	1287	0	1287	XXXX		
27.7 SCIENTIFIC AND TECHNICAL SERVICES	980	22644	0	0	0	XXXX		
28.8 OTHER PROCUREMENTS	92	0	0	0	0	XXXX		
29.2 ADP SERVICES-OTHER	445	0	0	0	0	XXXX		
29.3 TRAINING-TUITION AND FEES	0	0	700	0	700	XXXX		
29.5 MAINTENANCE AND REPAIR OF ADP EQUIPMENT	0	421	150	0	150	XXXX		
29.6 MAINTENANCE AND REPAIR OTHER EQUIPMENT	0	0	0	275	275	XXXX		
29.7 SCIENTIFIC AND TECHNICAL SERVICES	7799	2857	0	0	0	XXXX		
29.9 NONTRAVEL EXPENSES	7	0	743	0	743	XXXX		
31.1 EQUIPMENT-OTHER	2510	0	0	0	0	XXXX		

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450     450  4500480                              COST CENTER STATEMENT                                                    864
52.0 COMPUTER SERVICES-GAITHERSBURG                  0        0        2        0        2      XXXX
53.3 DRAFTING + GRAPHIC ARTS                         0        0       12        0       12      XXXX
60.2 SHOPS-GAITHERSBURG                              0        0     1530        0     1530      XXXX
60.3 SHOPS-ADJ OF COMPLETED JOBS                     0        0       -1        0       -1      XXXX
65.1 PLANT SERVICES                                  0        0      131        0      131      XXXX
67.7 NBS NETWORK FEES                                0        0      189        0      189      XXXX

                       TOTAL OTHER OBJECTS       13800    26156    10866     4244    15110

                        COST CENTER TOTAL        13800    26156   259893     4244   264137    257348     -6789        439
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1 FOR ACCRUAL COST CENTERS THIS TOTAL INCLUDES BOTH CURRENT YEAR ACCRUALS AND ACCRUALS OF PRIOR YEAR UNLIQUIDATED OBLIGATIONS. FOR COST CENTERS ON AN OBLIGATION BASIS, THIS TOTAL INCLUDES ONLY CURRENT YEAR ACCRUALS AND UNLIQUIDATED OBLIGATIONS.

2 FOR ACCRUAL COST CENTERS THE AUTHORIZATION INCLUDES AN AMOUNT FOR PRIOR YEAR OBLIGATIONS. FOR PROJECTS ON AN OBLIGATION BASIS, THE AUTHORIZATION IS FOR CURRENT YEAR OBLIGATIONS ONLY.

LABOR JOURNAL

FOR PAY PERIOD 17, 08/16/87 TO 08/29/87

COST CENTER NUMBER 4500480

ASGD DIV	WORK ORDER	REQ DIV	EMPLOYEE NAME	HOURS PAID +	COMP WORK -	LEAVE USED =	HOURS WORK	HOURS THIS CC	BASE RATE *1r	BASE COST	AVG RATE *.r	TOTAL COST	ADJUSTMENTS NBS-12 PP
450			ANDERSON DAVID	80		8	72	16	31.59	505	72.13	1154	
450			BERTOCCI UGO	80		24	56	16	41.07	657	93.77	1500	
450			BOYER PAUL	80		24	56	32	18.61	595	42.49	1340	
450			COLEMAN VALERIE	80		9	71	71	5.65	401	12.90	9[illegible]6	
450			ESCALANTE EDWARD	80			80	48	32.23	1547	73.59	3532	
450			FRAKER ANNA	80		4	76	40	37.91	1517	86.56	3462	
450			HALL DALE	80		40	40	20	36.86	737	84.16	1683	
450			HARRIS JONICE	80		24	56	28	17.71	496	40.44	1132	
450			HARRIS JOYCE	80		44	36	36	13.29	478	30.34	1092	
450			HARRISON STEVEN	80			80	80	14.01	1121	31.99	2559	
450			INTERRANTE CHARLES	80			80	80	34.02	2721	77.67	6214	
450			LINZER MELVIN	80		40	40	20	38.97	779	88.98	1780	
450			LOHR DEBRA	15			15	15	8.82	132	20.14	302	
450			RICKER RICHARD	80		8	72	36	28.04	1009	64.02	2305	
450			RUFF JR ARTHUR	80		48	32	8	41.07	329	93.77	750	
450			RUSPI JILL	73			73	73	19.11	1395	43.63	3185	
450			SHULL ROBERT	80		8	72	32	26.52	849	60.55	1938	
450			STOUDT MARK	80			80	32	14.01	448	31.99	1024	
								-----		------		------	
			TOTAL SPONSOR LABOR					683		15716		35888	
430			BRADY CHARLES	80		28	52	3	28.04	84	64.02	192	
								-----		------		------	
			TOTAL OTHER LABOR					3		84		192	
			COST CENTER TOTAL LABOR					686		15800		36080	

*1r BASE RATE INCLUDES 22.5% LEAVE SURCHARGE
*2r AVERAGE RATE IS OBTAINED BY APPLYING THE FOLLOWING OVERHEAD RATES TO THE SUM OF THE BASE RATE PLUS BENEFITS (13.2%):
BUREAU OH 42.5%, LAB OH 9.8%, CENTER OH 49.4%, BLDG DEPR/DOC OH .0%.

<<< THIS RECORD IS BEING DISCLOSED FROM A PRIVACY ACT SYSTEM OF RECORDS (COMMERCE/DEPT-1).
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420 420 4209480 AR-3

LABOR JOURNAL

FOR PAY PERIOD 17, 08/16/87 TO 08/29/87

COST CENTER NUMBER 4209480

ASGD DIV	WORK ORDER	REQ DIV	EMPLOYEE NAME	HOURS PAID +	COMP WORK -	LEAVE USED =	HOURS WORK	HOURS THIS CC	BASE RATE*1r	BASE COST	AVG RATE*2r	TOTAL COST	ADJUSTMENTS NB3-12 PP
420			COYLE THOMAS	80		8	72	18	41.07	739	88.52	1593	
			TOTAL SPONSOR LABOR					18		739		1593	
			COST CENTER TOTAL LABOR					18		739		1593	

*1r BASE RATE INCLUDES 22.5% LEAVE SURCHARGE

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BUREAU OH 42.5%, LAB OH 9.8%, CENTER OH 38.1%, BLDG DEPR/DOC OH .0%.

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COST CENTER NUMBER 4209480

F 4

COST CENTER NUMBER 4202490

M 3

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420     420  4203480                         L A B O R   J O U R N A L                                                        AR-3

                                    FOR PAY PERIOD 17, 08/16/87 TO 08/29/87                                                   PAGE  259

                                                                                                             COST CENTER NUMBER  4203480
ASGD  WORK  REQ                              HOURS   COMP  LEAVE  HOURS   HOURS  BASE    BASE        AVG     TOTAL     ADJUSTMENTS
DIV   ORDER DIV      EMPLOYEE NAME            PAID + WORK - USED = WORK  THIS CC RATE*1r COST       RATE*2r  COST      NBS-12  PP

420              PLANTE ERNEST                  80             24     56     56  34.91   1955       75.24    4213
                                                                            -----        ------              ------
                 TOTAL SPONSOR LABOR                                         56          1955                4213

                 COST CENTER TOTAL LABOR                                     56          1955                4213









*1r BASE RATE INCLUDES 22.5% LEAVE SURCHARGE
*2r AVERAGE RATE IS OBTAINED BY APPLYING THE FOLLOWING OVERHEAD RATES TO THE SUM OF THE BASE RATE PLUS BENEFITS (13.2%):
    BUREAU OH 42.5%, LAB OH  9.8%, CENTER OH 38.1%, BLDG DEPR/DOC OH   .0%.
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420     420  4201480                        L A B O R   J O U R N A L                                                      AR-3
                                      FOR PAY PERIOD 17, 08/16/87 TO 08/29/87                                          PAGE  255
                                                                                                      COST CENTER NUMBER  4201480
ASGD  WORK  REQ                              HOURS    COMP   LEAVE   HOURS    HOURS  BASE    BASE        AVG      TOTAL     ADJUSTMENTS
DIV   ORDER DIV     EMPLOYEE NAME             PAID  + WORK  - USED  = WORK   THIS CC RATE*1r COST       RATE*2r   COST      NBS-12  PP
420              ONDIK HELEN                   80                     80       24   38.97    935        83.99     2016
                                                                              -----        ------              ------
                 TOTAL SPONSOR LABOR                                           24            935                  2016
                 COST CENTER TOTAL LABOR                                       24            935                  2016




*1r BASE RATE INCLUDES 22.5% LEAVE SURCHARGE
*2r AVERAGE RATE IS OBTAINED BY APPLYING THE FOLLOWING OVERHEAD RATES TO THE SUM OF THE BASE RATE PLUS BENEFITS (13.2%):
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                                                                                                  COST CENTER NUMBER  4201480
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L A B O R J O U R N A L

FOR PAY PERIOD 18, 08/30/87 TO 09/12/87

COST CENTER NUMBER 4500480

ASGD DIV	WORK ORDER	REQ DIV	EMPLOYEE NAME	HOURS PAID +	COMP WORK −	LEAVE USED =	HOURS WORK	HOURS THIS CC	BASE RATE*1r	BASE COST	AVG RATE*2r	TOTAL COST	ADJUSTMENTS NBS-12	PP
450			ANDERSON DAVID	80		8	72	16	32.65	522	74.55	1193		
450			BERTOCCI UGO	80		32	48	16	41.07	657	93.77	1500		
450			BOYER PAUL	80		24	56	32	18.61	595	42.49	1360		
450			ESCALANTE EDWARD	80		18	62	48	32.23	1547	73.59	3532		
450			FRAKER ANNA	80		48	32	32	37.91	1213	86.56	2770		
450			HALL DALE	80		16	64	32	36.86	1180	84.16	2693		
450			HARRIS JONICE	80		48	32	16	17.71	283	40.44	647		
450			HARRIS JOYCE	80		32	48	48	13.29	638	30.34	1456		
450			HARRISON STEVEN	80		8	72	72	14.01	1009	31.99	2303		
450			INTERRANTE CHARLES	80		26	54	54	34.02	1837	77.67	4194		
450			LINZER MELVIN	80		16	64	32	38.97	1247	88.98	2847		
450			LOHR DEBRA	15			15	15	8.82	132	20.14	302		
450			RICKER RICHARD	80		8	72	36	28.04	1009	64.02	2305		
450			RUFF JR ARTHUR	80		24	56	16	41.07	657	93.77	1500		
450			RUSPI JILL	68		10	58	58	19.11	1108	43.63	2531		
450			SHULL ROBERT	80		16	64	32	26.52	849	60.55	1938		
450			STOUDT MARK	80		16	64	24	14.01	336	31.99	768		
								-----		------		------		
			TOTAL SPONSOR LABOR					579		14819		33839		
			COST CENTER TOTAL LABOR					579		14819		33839		

*1r BASE RATE INCLUDES 22.5% LEAVE SURCHARGE

*2r AVERAGE RATE IS OBTAINED BY APPLYING THE FOLLOWING OVERHEAD RATES TO THE SUM OF THE BASE RATE PLUS BENEFITS (13.2%):
BUREAU OH 42.5%, LAB OH 9.8%, CENTER OH 49.4%, BLDG DEPR/DOC OH .0%.

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COST CENTER NUMBER 4500480

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420     420  4209480                        L A B O R   J O U R N A L                                                   AR-3
                                     FOR PAY PERIOD 18, 08/30/87 TO 09/12/87                                     PAGE  262
                                                                                              COST CENTER NUMBER  4209480
ASGD  WORK   REQ                             HOURS   COMP  LEAVE  HOURS   HOURS  BASE     BASE        AVG     TOTAL    ADJUSTMENTS
DIV   ORDER  DIV    EMPLOYEE NAME             PAID + WORK - USED = WORK  THIS CC RATE*1r  COST       RATE*2r  COST     NBS-12  PP

420               COYLE THOMAS                  80             16     64       7  41.07    288       88.52    620
                                                                           -----        ------              ------
                  TOTAL SPONSOR LABOR                                          7           288                620

                  COST CENTER TOTAL LABOR                                      7           288                620




*1r BASE RATE INCLUDES 22.5% LEAVE SURCHARGE
*2r AVERAGE RATE IS OBTAINED BY APPLYING THE FOLLOWING OVERHEAD RATES TO THE SUM OF THE BASE RATE PLUS BENEFITS (13.2%):
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                                                                                              COST CENTER NUMBER  4209480
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420    420  4203480                  L A B O R   J O U R N A L                                          AR-3
                                  FOR PAY PERIOD 18, 08/30/87 TO 09/12/87                          PAGE  257
                                                                                   COST CENTER NUMBER  4203480
ASGD  WORK   REQ                               HOURS   COMP   LEAVE  HOURS   HOURS  BASE      BASE       AVG      TOTAL    ADJUSTMENTS
DIV   ORDER  DIV     EMPLOYEE NAME              PAID + WORK - USED = WORK  THIS CC RATE*1r COST       RATE*2r  COST     NBS-12  PP

420               PLANTE ERNEST                  80              8     72      72  34.91    2514      75.24    5417
                                                                              -----        -------            ------
                  TOTAL SPONSOR LABOR                                          72           2514               5417

                  COST CENTEP TOTAL LABOR                                      72           2514               5417




*1r BASE RATE INCLUDES 22.5% LEAVE SURCHARGE
*2r AVERAGE RATE IS OBTAINED BY APPLYING THE FOLLOWING OVERHEAD RATES TO THE SUM OF THE BASE RATE PLUS BENEFITS (13.2%):
    BUREAU OH 42.5%, LAB OH  9.8%, CENTER OH 38.1%, BLDG DEPR/DOC OH    .0%.
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                                                                                   COST CENTER NUMBER  4203480
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H 3

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420     420  4201480                    L A B O R   J O U R N A L                                                AR-3
                                  FOR PAY PERIOD 18, 08/30/87 TO 09/12/87                                        PAGE  251
                                                                                              COST CENTER NUMBER  4201480
ASGD  WORK  REQ                           HOURS   COMP  LEAVE  HOURS   HOURS  BASE    BASE       AVG     TOTAL   ADJUSTMENTS
DIV   ORDER DIV    EMPLOYEE NAME          PAID  + WORK - USED  = WORK  THIS CC RATE*1r COST      RATE*2r COST    NBS-12  PP
420               ONDIK HELEN               80             18     62     16  40.02    640      86.26   1380
                                                                        -----        ------            ------
                  TOTAL SPONSOR LABOR                                    16            640              1380
                  COST CENTER TOTAL LABOR                                16            640              1380
```

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*1r BASE RATE INCLUDES 22.5% LEAVE SURCHARGE
*2r AVERAGE RATE IS OBTAINED BY APPLYING THE FOLLOWING OVERHEAD RATES TO THE SUM OF THE BASE RATE PLUS BENEFITS (13.2%):
    BUREAU OH 42.5%, LAB OH  9.8%, CENTER OH 38.1%, BLDG DEPR/DOC OH   .0%.
<<< THIS RECORD IS BEING DISCLOSED FROM A PRIVACY ACT SYSTEM OF RECORDS (COMMERCE/DEPT-1).
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                                                                                              COST CENTER NUMBER  4201480
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B 3

450 450 4500480

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AR-3

FOR PAY PERIOD 19, 09/13/87 TO 09/26/87

COST CENTER NUMBER 4500480

ASGD DIV	WORK ORDER	REQ DIV	EMPLOYEE NAME	HOURS PAID +	COMP WORK -	LEAVE USED =	HOURS WORK	HOURS THIS CC	BASE RATE 1	BASE COST	AVG RATE 2	TOTAL COST	ADJUSTMENTS NBS-12 PP
450			ANDERSON DAVID	80		8	72	32	32.65	1045	74.55	2386	
450			BERTOCCI UGO	80		43	37	24	41.07	986	93.77	2250	
450			BOYER PAUL	80		32	48	28	18.61	521	42.49	1190	
450			ESCALANTE EDWARD	80		40	40	40	32.23	1289	73.59	2944	
450			FRAKER ANNA	80		4	76	76	37.91	2881	86.56	6579	
450			HALL DALE	80			80	40	36.86	1474	84.16	3366	
450			HARRIS JONICE	80		14	66	40	17.71	709	40.44	1618	
450			HARRIS JOYCE	80		5	75	75	13.29	997	30.34	2276	
450			HARRISON STEVEN	80		4	76	76	14.01	1065	31.99	2431	
450			INTERRANTE CHARLES	80			80	80	34.02	2721	77.67	6214	
450			LINZER MELVIN	80		24	56	56	38.97	2182	88.98	4983	
450			LOHR DEBRA	34			34	34	8.82	300	20.14	685	
450			PUGH EDISON	80		4	76	8	41.07	329	93.77	750	
450			RICKER RICHARD	80			80	40	28.04	1122	64.02	2561	
450			RUFF JR ARTHUR	80		16	64	16	41.07	657	93.77	1500	
450			RUSPI JILL	80			80	80	19.11	1529	43.63	3490	
450			SHULL ROBERT	80		16	64	64	26.52	1697	60.55	3875	
450			STOUDT MARK	80		16	64	64	14.01	897	31.99	2047	
			TOTAL SPONSOR LABOR					873		22401		51145	
			COST CENTER TOTAL LABOR					873		22401		51145	

1 BASE RATE INCLUDES 22.5% LEAVE SURCHARGE

2 AVERAGE RATE IS OBTAINED BY APPLYING THE FOLLOWING OVERHEAD RATES TO THE SUM OF THE BASE RATE PLUS BENEFITS (13.2%):
BUREAU OH 42.5%, LAB OH 9.8%, CENTER OH 49.4%, BLDG DEPR/DOC OH .0%.

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H 3

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420     420  4203480                  L A B O R   J O U R N A L                                                   AR-3
                                 FOR PAY PERIOD 19, 09/13/87 TO 09/26/87                                      PAGE  299
                                                                                         COST CENTER NUMBER  4203480
ASGD  WORK   REQ                             HOURS   COMP  LEAVE  HOURS   HOURS  BASE    BASE       AVG      TOTAL    ADJUSTMENTS
DIV   ORDER  DIV     EMPLOYEE NAME           PAID  + WORK - USED = WORK  THIS CC RATE 1  COST       RATE 2   COST     NBS-12  PP
420               PLANTE ERNEST               80             8     72      72   34.91    2514       75.24    5417
                                                                          -----          ------              ------
                  TOTAL SPONSOR LABOR                                      72            2514                5417
                  COST CENTER TOTAL LABOR                                  72            2514                5417




 1  BASE RATE INCLUDES 22.5% LEAVE SURCHARGE
 2  AVERAGE RATE IS OBTAINED BY APPLYING THE FOLLOWING OVERHEAD RATES TO THE SUM OF THE BASE RATE PLUS BENEFITS (13.2%):
    BUREAU OH 42.5%, LAB OH  9.8%, CENTER OH 38.1%, BLDG DEPR/DOC OH   .0%.
<<< THIS RECORD IS BEING DISCLOSED FROM A PRIVACY ACT SYSTEM OF RECORDS (COMMERCE/DEPT-1).
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FURTHER DISCLOSURES SHOULD BE RESTRICTED ON A NEED-TO-KNOW BASIS, AND THE RECORD SHOULD BE DESTROYED WHEN

COST CENTER NUMBER 4201145

E 3

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420 420 4201480

LABOR JOURNAL

FOR PAY PERIOD 19, 09/13/87 TO 09/26/87

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COST CENTER NUMBER 4201480

ASGD DIV	WORK ORDER	REQ DIV	EMPLOYEE NAME	HOURS PAID +	COMP WORK -	LEAVE USED =	HOURS WORK	HOURS THIS CC	BASE RATE 1	BASE COST	AVG RATE 2	TOTAL COST	ADJUSTMENTS NBS-12	PP
420			ONDIK HELEN	80		45	35	35	40.02	1401	86.26	3019		
			TOTAL SPONSOR LABOR					35		1401		3019		
			COST CENTER TOTAL LABOR					35		1401		3019		

1 BASE RATE INCLUDES 22.5% LEAVE SURCHARGE

2 AVERAGE RATE IS OBTAINED BY APPLYING THE FOLLOWING OVERHEAD RATES TO THE SUM OF THE BASE RATE PLUS BENEFITS (13.2%):

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450      450 4500480                     L A B O R   J O U R N A L                                                  AR-3

                                 FOR PAY PERIOD 20, 09/27/87 TO 09/30/87                                        PAGE  287

                                                                                          COST CENTER NUMBER  4500480

ASGD  WORK  REQ                               HOURS   COMP  LEAVE  HOURS   HOURS  BASE    BASE      AVG     TOTAL    ADJUSTMENTS
DIV   ORDER DIV     EMPLOYEE NAME              PAID + WORK - USED = WORK  THIS CC RATE*1r COST     RATE*2r  COST     NBS-12   PP

450               ANDERSON DAVID                24                   24     24  32.65     784     74.55    1789
450               BERTOCCI UGO                  24                   24     16  41.07     657     93.77    1500
450               ESCALANTE EDWARD              24                   24     24  32.23     774     73.59    1766
450               FINK JAMES                    24                   24     24  19.13     459     43.68    1048
450               FRAKER ANNA                   24                   24     24  37.91     910     66.56    2077
450               HALL DALE                     24                   24     24  36.86     885     84.16    2020
450               HARRIS JONICE                 24                   24     24  17.71     425     40.44     971
450               HARRIS JOYCE                  24              8    16     16  13.29     213     30.34     485
450               HARRISON STEVEN               24              8    16     16  14.01     224     31.99     512
450               LINZER MELVIN                 24                   24     24  38.97     935     88.98    2136
450               LOHR DEBRA                     5                    5      5   8.82      44     20.14     101
450               PUGH EDISON                   24             16     8      8  41.07     329     93.77     750
450               RICKER RICHARD                24                   24     24  28.04     673     64.02    1536
450               RUFF JR ARTHUR                24              4    20     12  41.07     493     93.77    1125
450               RUSPI JILL                    24                   24     24  19.11     459     43.63    1047
450               SHULL ROBERT                  24                   24     24  28.65     688     65.41    1570
450               STOUDT MARK                   24                   24     24  14.01     336     31.99     768
                                                                         -----         ------            ------
                  TOTAL SPONSOR LABOR                                     337            9288             21201

                  COST CENTER TOTAL LABOR                                 337            9288             21201




*1r BASE RATE INCLUDES 22.5% LEAVE SURCHARGE
*2r AVERAGE RATE IS OBTAINED BY APPLYING THE FOLLOWING OVERHEAD RATES TO THE SUM OF THE BASE RATE PLUS BENEFITS (13.2%):
    BUREAU OH 42.5%, LAB OH  9.8%, CENTER OH 49.4%, BLDG DEPR/DOC OH   .0%.
<<< THIS RECORD IS BEING DISCLOSED FROM A PRIVACY ACT SYSTEM OF RECORDS (COMMERCE/DEPT-1).
FURTHER DISCLOSURES SHOULD BE RESTRICTED ON A NEED-TO-KNOW BASIS, AND THE RECORD SHOULD BE DESTROYED WHEN IT IS NO LONGER OF USE >>>

                                                                                          COST CENTER NUMBER  4500480
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I 2

K 2

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420    420  4203480                  L A B O R   J O U R N A L                                                  AR-3
                                 FOR PAY PERIOD 20, 09/27/87 TO 09/30/87                                   PAGE  221
                                                                                          COST CENTER NUMBER  4203480
ASGD  WORK  REQ                          HOURS   COMP  LEAVE  HOURS   HOURS  BASE    BASE       AVG     TOTAL    ADJUSTMENTS
DIV   ORDER DIV    EMPLOYEE NAME          PAID + WORK - USED = WORK   THIS CC RATE*1r COST      RATE*2r COST     NBS-12  PP
420              PLANTE ERNEST             24                  24      24  34.91    838      75.24    1806
                                                                      -----       ------             ------
                 TOTAL SPONSOR LABOR                                   24           838               1806
                 COST CENTER TOTAL LABOR                               24           838               1806
```

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*1r BASE RATE INCLUDES 22.5% LEAVE SURCHARGE
*2r AVERAGE RATE IS OBTAINED BY APPLYING THE FOLLOWING OVERHEAD RATES TO THE SUM OF THE BASE RATE PLUS BENEFITS (13.2%):
    BUREAU OH 42.5%, LAB OH  9.8%, CENTER OH 38.1%, BLDG DEPR/DOC OH   .0%.
<<< THIS RECORD IS BEING DISCLOSED FROM A PRIVACY ACT SYSTEM OF RECORDS (COMMERCE/DEPT-1).
FURTHER DISCLOSURES SHOULD BE RESTRICTED ON A NEED-TO-KNOW BASIS, AND THE RECORD SHOULD BE DESTROYED WHEN IT IS NO LONGER OF USE >>>
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COST CENTER NUMBER 4201145

H 2

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 420     420  4201480                        L A B O R   J O U R N A L                                                   AR-3
                                    FOR PAY PERIOD 20, 09/27/87 TO 09/30/87                                          PAGE  218
                                                                                                          COST CENTER NUMBER  4201480
ASGD  WORK  REQ                             HOURS    COMP  LEAVE  HOURS   HOURS  BASE     BASE         AVG     TOTAL      ADJUSTMENTS
DIV   ORDER DIV     EMPLOYEE NAME            PAID  + WORK - USED = WORK  THIS CC RATE*1r COST         RATE*2r  COST       NBS-12  PP
420               ONDIK HELEN                 24                    24     18   40.02    720          86.26    1553
                                                                          -----          ------                ------
                  TOTAL SPONSOR LABOR                                      18             720                  1553
                  COST CENTER TOTAL LABOR                                  18             720                  1553
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*1r BASE RATE INCLUDES 22.5% LEAVE SURCHARGE
*2r AVERAGE RATE IS OBTAINED BY APPLYING THE FOLLOWING OVERHEAD RATES TO THE SUM OF THE BASE RATE PLUS BENEFITS (13.2%):
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 450     450  4500480                        L A B O R   J O U R N A L                                                 AA-3
                                     FOR PAY PERIOD 20, 10/01/87 TO 10/10/87                                       PAGE 267
                                                                                                 COST CENTER NUMBER 4500480
ASGD  WORK  REQ                                HOURS   COMP  LEAVE  HOURS   HOURS  BASE    BASE       AVG     TOTAL     ADJUSTMENTS
DIV   ORDER DIV     EMPLOYEE NAME               PAID + WORK - USED = WORK  THIS CC RATE*1  COST      RATE*2   COST      NBS-12  PP

450               ANDERSON DAVID                 56                  56       8  31.45    252      70.55     564
450               ESCALANTE EDWARD               56                  56      32  31.05    993      69.66    2229
450               FINK JAMES                     56             1    55      27  18.43    498      41.35    1116
450               FRAKER ANNA                    56                  56      40  36.52   1461      81.93    3277
450               HALL DALE                      56             3    53      20  35.51    710      79.66    1593
450               HARRIS JONICE                  56             8    48      16  17.06    273      38.27     612
450               HARRIS JOYCE                   56                  56      56  12.80    717      28.72    1608
450               HARRISON STEVEN                56             2    54      54  13.50    729      30.29    1636
450               INTERRANTE CHARLES             56            16    40      40  32.77   1311      73.52    2941
450               LOHR DEBRA                     26                  26      26   8.50    221      19.07     496
450               RICKER RICHARD                 56             8    48      24  27.01    648      60.59    1454
450               RUSPI JILL                     48             8    40      40  18.41    736      41.30    1652
450               SHULL ROBERT                   56                  56      16  27.60    442      61.92     991
450               STOUDT MARK                    56                  56      56  13.50    756      30.29    1696
                                                                          -----         ------            ------
                  TOTAL SPONSOR LABOR                                      455           9747             21865

                  COST CENTER TOTAL LABOR                                  455           9747             21865


*1  BASE RATE INCLUDES 18.0% LEAVE SURCHARGE
*2  AVERAGE RATE IS OBTAINED BY APPLYING THE FOLLOWING OVERHEAD RATES TO THE SUM OF THE BASE RATE PLUS BENEFITS (16.0%):
    BUREAU OH 49.5%, LAB OH  8.5%, CENTER OH 35.5%, BLDG DEPR/DOC OH   .0%.
<<< THIS RECORD IS BEING DISCLOSED FROM A PRIVACY ACT SYSTEM OF RECORDS (COMMERCE/DEPT-1).
FURTHER DISCLOSURES SHOULD BE RESTRICTED ON A NEED-TO-KNOW BASIS, AND THE RECORD SHOULD BE DESTROYED WHEN IT IS NO LONGER OF USE >>>

                                                                                                 COST CENTER NUMBER  4500480
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22

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420     420  4203480                          L A B O R   J O U R N A L                                                     AR-3
                                          FOR PAY PERIOD 20, 10/01/87 TO 10/10/87                                       PAGE  213
                                                                                                      COST CENTER NUMBER  4203480
ASGD  WORK   REO                              HOURS   COMP   LEAVE   HOURS   HOURS  BASE     BASE      AVG      TOTAL     ADJUSTMENTS
DIV   ORDER  DIV     EMPLOYEE NAME             PAID + WORK - USED  = WORK  THIS CC RATE*1   COST     RATE*2    COST     NBS-12  PP

420                PLANTE ERNEST                56              16      40      16  33.63     538     72.99    1168
                                                                             -----          ------             ------
                   TOTAL SPONSOR LABOR                                          16            538               1168

                   COST CENTER TOTAL LABOR                                      16            538               1168




*1  BASE RATE INCLUDES 18.0% LEAVE SURCHARGE
*2  AVERAGE RATE IS OBTAINED BY APPLYING THE FOLLOWING OVERHEAD RATES TO THE SUM OF THE BASE RATE PLUS BENEFITS (16.0%):
    BUREAU OH 49.5%, LAB OH  8.4%, CENTER OH 29.2%, BLDG DEPR/DOC OH    .0%.
<<< THIS RECORD IS BEING DISCLOSED FROM A PRIVACY ACT SYSTEM OF RECORDS (COMMERCE/DEPT-1).
FURTHER DISCLOSURES SHOULD BE RESTRICTED ON A NEED-TO-KNOW BASIS, AND THE RECORD SHOULD BE DESTROYED WHEN IT IS NO LONGER OF USE >>>

                                                                                                      COST CENTER NUMBER  4203480
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420     420  4201480                         L A B O R   J O U R N A L                                                  AR-3
                                   FOR PAY PERIOD 20, 10/01/87 TO 10/10/87                                        PAGE  212
                                                                                              COST CENTER NUMBER  4201480
ASGD  WORK  REQ                              HOURS   COMP  LEAVE  HOURS   HOURS  BASE     BASE       AVG     TOTAL    ADJUSTMENTS
DIV   ORDER DIV    EMPLOYEE NAME              PAID + WORK - USED = WORK  THIS CC RATE*1   COST       RATE*2  COST     NBS-12  PP
420              ONDIK HELEN                   56                   56      18  38.55     694        83.67   1506
                                                                          -----          -------             ------
                 TOTAL SPONSOR LABOR                                        18            694                1506
                 COST CENTER TOTAL LABOR                                    18            694                1506






*1  BASE RATE INCLUDES 18.0% LEAVE SURCHARGE
*2  AVERAGE RATE IS OBTAINED BY APPLYING THE FOLLOWING OVERHEAD RATES TO THE SUM OF THE BASE RATE PLUS BENEFITS (16.0%):
    BUREAU OH 49.5%, LAB OH  8.4%, CENTER OH 29.2%, BLDG DEPR/DOC OH    .0%.
<<< THIS RECORD IS BEING DISCLOSED FROM A PRIVACY ACT SYSTEM OF RECORDS (COMMERCE/DEPT-1).
FURTHER DISCLOSURES SHOULD BE RESTRICTED ON A NEED-TO-KNOW BASIS, AND THE RECORD SHOULD BE DESTROYED WHEN IT IS NO LONGER OF USE >>>

                                                                                              COST CENTER NUMBER  4201480
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J 2

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710     714  7144370                        L A B O R   J O U R N A L                                                        AR-3
                                    FOR PAY PERIOD 20, 10/01/87 TO 10/10/87                                            PAGE  726
                                                                                                    COST CENTER NUMBER  7144370
ASGD  WORK  REQ                           HOURS   COMP  LEAVE  HOURS   HOURS  BASE    BASE       AVG     TOTAL    ADJUSTMENTS
DIV   ORDER DIV    EMPLOYEE NAME           PAID + WORK - USED = WORK  THIS CC RATE*1  COST      RATE*2   COST     NBS-12  PP

714                LIGGETT JR WALTER        56                  56      56   30.18   1690      66.80    3741
                                                                       -----         ------             ------
                   TOTAL SPONSOR LABOR                                  56           1690               3741

                   COST CENTER TOTAL LABOR                              56           1690               3741

*1  BASE RATE INCLUDES 18.0% LEAVE SURCHARGE
*2  AVERAGE RATE IS OBTAINED BY APPLYING THE FOLLOWING OVERHEAD RATES TO THE SUM OF THE BASE RATE PLUS BENEFITS (16.0%):
    BUREAU OH 49.5%, LAB OH 5.0%, CENTER OH 34.3%, BLDG DEPR/DOC OH 1 .0%.
<<< THIS RECORD IS BEING DISCLOSED FROM A PRIVACY ACT SYSTEM OF RECORDS (COMMERCE/DEPT-1).
FURTHER DISCLOSURES SHOULD BE RESTRICTED ON A NEED-TO-KNOW BASIS, AND THE RECORD SHOULD BE DESTROYED WHEN IT IS NO LONGER OF USE >>>

                                                                                                    COST CENTER NUMBER  7144370
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LABOR JOURNAL

FOR PAY PERIOD 21, 10/11/87 TO 10/24/87

COST CENTER NUMBER 4500480

ASGD DIV	WORK ORDER	REQ DIV	EMPLOYEE NAME	HOURS PAID +	COMP WORK -	LEAVE USED =	HOURS WORK	HOURS THIS CC	BASE RATE *1r	BASE COST	AVG RATE *2r	TOTAL COST	ADJUSTMENTS NBS-12 PP
450			ANDERSON DAVID	80		8	72	16	31.45	503	70.55	1129	
450			BERTOCCI UGO	80		8	72	16	39.57	633	88.77	1420	
450			ESCALANTE EDWARD	80		13	67	47	31.05	1459	69.66	3274	
450			FINK JAMES	80		16	64	16	18.43	295	41.35	662	
450			FRAKER ANNA	80		8	72	36	36.52	1315	81.93	2949	
450			HALL DALE	80		11	69	33	35.51	1172	79.66	2629	
450			HARRIS JONICE	80		16	64	28	17.61	493	39.51	1106	
450			HARRIS JOYCE	80		24	56	56	12.80	717	28.72	1608	
450			HARRISON STEVEN	80		40	40	40	13.50	540	30.29	1212	
450			INTERRANTE CHARLES	80		16	64	64	32.77	2097	73.52	4705	
450			LINZER MELVIN	80	7	32	55	23	37.54	863	84.22	1937	
450			LOHR DEBRA	29			29	29	8.50	246	19.07	553	
450			PUGH EDISON	80		8	72	8	39.57	317	88.77	710	
450			RICKER RICHARD	80		8	72	36	27.01	972	60.59	2181	
450			RUSPI JILL	77		16	61	61	18.41	1123	41.30	2519	
450			SHULL ROBERT	80		8	72	36	27.60	994	61.92	2229	
450			STOUDT MARK	80		8	72	72	13.50	972	30.29	2181	
								-----		------		------	
			TOTAL SPONSOR LABOR					617		14711		33004	
430			BRADY CHARLES	80		14	66	3	27.01	81	60.59	182	
								-----		------		------	
			TOTAL OTHER LABOR					3		81		182	
			COST CENTER TOTAL LABOR					620		14792		33186	

*1r BASE RATE INCLUDES 18.0% LEAVE SURCHARGE
*2r AVERAGE RATE IS OBTAINED BY APPLYING THE FOLLOWING OVERHEAD RATES TO THE SUM OF THE BASE RATE PLUS BENEFITS (16.0%):
BUREAU OH 49.5%, LAB OH 8.4%, CENTER OH 35.5%, BLDG DEPR/DOC OH .0%.

C 2

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420    420  4203480                       L A B O R   J O U R N A L                                                          AR-3
                                     FOR PAY PERIOD 21, 10/11/87 TO 10/24/87                                           PAGE  241
                                                                                                  COST CENTER NUMBER  4203480

ASGD  WORK  REQ                                  HOURS   COMP  LEAVE  HOURS   HOURS  BASE     BASE        AVG     TOTAL   ADJUSTMENTS
DIV   ORDER DIV      EMPLOYEE NAME                PAID + WORK - USED = WORK   THIS CC RATE*1r COST       RATE*2r COST    NBS-12  PP.

420                PLANTE ERNEST                  80             56     24      24  33.63     807       72.99    1752
                                                                               -----         ------             ------
                   TOTAL SPONSOR LABOR                                          24             807                1752

                   COST CENTER TOTAL LABOR                                      24             807                1752


*1r BASE RATE INCLUDES 18.0% LEAVE SURCHARGE
*2r AVERAGE RATE IS OBTAINED BY APPLYING THE FOLLOWING OVERHEAD RATES TO THE SUM OF THE BASE RATE PLUS BENEFITS (16.0%):
    BUREAU OH 49.5%, LAB OH  8.4%, CENTER OH 29.2%, BLDG DEPR/DOC OH    .0%.
<<< THIS RECORD IS BEING DISCLOSED FROM A PRIVACY ACT SYSTEM OF RECORDS (COMMERCE/DEPT-1).
FURTHER DISCLOSURES SHOULD BE RESTRICTED ON A NEED-TO-KNOW BASIS, AND THE RECORD SHOULD BE DESTROYED WHEN IT IS NO LONGER OF USE >>>

                                                                                                   COST CENTER NUMBER  4203480
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   BUREAU OH 49.5%, LAB OH  8.4%, CENTER OH 29.2%, BLDG DEPR/OUL OH    .0%.
<<< THIS RECORD IS BEING DISCLOSED FROM A PRIVACY ACT SYSTEM OF RECORDS (COMMERCE/DEPT-1).
FURTHER DISCLOSURES SHOULD BE RESTRICTED ON A NEED-TO-KNOW BASIS, AND THE RECORD SHOULD BE DESTROYED WHEN IT IS NO LONGER OF USE >>>.

                                                                                       COST CENTER NUMBER  4201291
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B 3

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 420     420  4201480                          L A B O R   J O U R N A L                                          AR-3

                                         FOR PAY PERIOD 21, 10/11/87 TO 10/24/87                               PAGE  240

                                                                                       COST CENTER NUMBER  4201480
ASGD  WORK  REQ                             HOURS   COMP  LEAVE  HOURS   HOURS  BASE     BASE       AVG      TOTAL     ADJUSTMENTS
DIV   ORDER DIV      EMPLOYEE NAME           PAID + WORK - USED = WORK  THIS CC RATE*1r  COST      RATE*2r   COST      NBS-12  PP
420                ONDIK HELEN                80              32     48      16  38.55    617      83.67     1339
                                                                           -----        ------              ------
                   TOTAL SPONSOR LABOR                                       16           617                1339
                   COST CENTER TOTAL LABOR                                   16           617                1339
```

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 710     714  7144370                     L A B O R   J O U R N A L                                              AR-3
                                  FOR PAY PERIOD 21, 10/11/87 TO 10/24/87                                 PAGE  792
                                                                                           COST CENTER NUMBER  7144370
                                          HOURS   COMP   LEAVE  HOURS   HOURS  BASE     BASE        AVG      TOTAL    ADJUSTMENTS
ASGD  WORK   REQ                          PAID  + WORK - USED = WORK   THIS CC RATE*1r  COST        RATE*2r  COST     NBS-12  PP
DIV   ORDER  DIV    EMPLOYEE NAME
 714                LIGGETT JR WALTER      80             8      72      72   30.18    2173        66.80    4810
                                                                       -----          ------               ------
                    TOTAL SPONSOR LABOR                                  72            2173                 4810

                    COST CENTER TOTAL LABOR                              72            2173                 4810




*1r BASE RATE INCLUDES 18.0% LEAVE SURCHARGE
*2r AVERAGE RATE IS OBTAINED BY APPLYING THE FOLLOWING OVERHEAD RATES TO THE SUM OF THE BASE RATE PLUS BENEFITS (16.0%):
    BUREAU OH 49.5%, LAB OH  5.0%, CENTER OH 36.5%, BLDG DEPR/DOC OH   .0%.
<<< THIS RECORD IS BEING DISCLOSED FROM A PRIVACY ACT SYSTEM OF RECORDS (COMMERCE/DEPT-1).
FURTHER DISCLOSURES SHOULD BE RESTRICTED ON A NEED-TO-KNOW BASIS, AND THE RECORD SHOULD BE DESTROYED WHEN IT IS NO LONGER OF USE >>>

                                                                                            COST CENTER NUMBER  7144370
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450     450  4500480                         L A B O R   J O U R N A L                                                 AR-3

                                  FOR PAY PERIOD 22, 10/25/87 TO 11/07/87                                       PAGE  510

                                                                                           COST CENTER NUMBER  4500480
ASGD  WORK  REQ                              HOURS   COMP  LEAVE  HOURS   HOURS  BASE    BASE      AVG     TOTAL    ADJUSTMENTS
DIV   ORDER DIV      EMPLOYEE NAME           PAID  + WORK - USED = WORK  THIS CC RATE*1  COST     RATE*2   COST     NBS-12  PP

450                  ANDERSON DAVID            80                  80      16  31.45    503     70.55    1129
450                  BERTOCCI UGO              80            24    56      16  39.57    635     88.77    1420
450                  ESCALANTE EDWARD          80             8    72      56  31.05   1739     69.66    3901
450                  FINK JAMES                80             8    72      16  18.43    295     41.35     662
450                  FRAKER ANNA               80                  80      40  36.52   1461     81.93    3277
450                  HALL DALE                 80            26    54      22  36.52    803     81.93    1802
450                  HARRIS JONICE             80                  80      40  17.61    704     39.51    1580
450                  HARRIS JOYCE              80            14    66      66  12.80    845     28.72    1896
450                  HARRISON STEVEN           80                  80      80  13.50   1080     30.29    2423
450                  INTERRANTE CHARLES        80             2    78      78  32.77   2556     73.52    5735
450                  LINZER MELVIN             80             8    72      40  37.54   1501     84.22    3369
450                  LOHR DEBRA                35                  35      35   8.50    297     19.07     667
450                  PUGH EDISON               80                  80       8  39.57    317     88.77     710
450                  RICKER RICHARD            80                  80      40  27.01   1080     60.59    2424
450                  RUSPI JILL                48             2    46      46  18.41    847     41.30    1900
450                  SHULL ROBERT              80                  80      40  27.60   1104     61.92    2477
450                  STOUDT MARK               80                  80      80  13.50   1080     30.29    2423
                                                                         -----         ------            ------
                     TOTAL SPONSOR LABOR                                  719          16845             37795

430                  BRADY CHARLES             80             4    76       2  27.01     54     60.59     121
                                                                         -----         ------            ------
                     TOTAL OTHER LABOR                                      2             54               121

                     COST CENTER TOTAL LABOR                              721          16899             37916




*1  BASE RATE INCLUDES 18.0% LEAVE SURCHARGE
*2  AVERAGE RATE IS OBTAINED BY APPLYING THE FOLLOWING OVERHEAD RATES TO THE SUM OF THE BASE RATE PLUS BENEFITS (16.0%):
    BUREAU OH 49.5%, LAB OH  8.4%, CENTER OH 35.3%, BLDG DEPR/DOC OH   .0%.
<<< THIS RECORD IS BEING DISCLOSED FROM A PRIVACY ACT SYSTEM OF RECORDS (COMMERCE/DEPT-1).
FURTHER DISCLOSURES SHOULD BE RESTRICTED ON A NEED-TO-KNOW BASIS, AND THE RECORD SHOULD BE DESTROYED WHEN IT IS NO LONGER OF USE >>>

                                                                                           COST CENTER NUMBER  4500480
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C 2

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420    420 4203480                      L A B O R   J O U R N A L                                               AR-3
                                FOR PAY PERIOD 22, 10/25/87 TO 11/07/87                                          PAGE  245
                                                                                                   COST CENTER NUMBER  4203480

ASGD  WORK  REQ                                HOURS   COMP  LEAVE  HOURS   HOURS  BASE    BASE       AVG     TOTAL     ADJUSTMENTS
DIV   ORDER DIV      EMPLOYEE NAME              PAID + WORK - USED = WORK  THIS CC RATE*1  COST      RATE*2   COST      NBS-12  PP

420              PLANTE ERNEST                   80                    80      80  33.63   2690      72.99    5839
                                                                              -----       ------             ------
                 TOTAL SPONSOR LABOR                                           80          2690               5839

                 COST CENTER TOTAL LABOR                                       80          2690               5839










*1  BASE RATE INCLUDES 18.0% LEAVE SURCHARGE
*2  AVERAGE RATE IS OBTAINED BY APPLYING THE FOLLOWING OVERHEAD RATES TO THE SUM OF THE BASE RATE PLUS BENEFITS (16.0%):
    BUREAU OH 49.5%, LAB OH  8.4%, CENTER OH 29.2%, BLDG DEPR/DOC OH    .0%.
<<< THIS RECORD IS BEING DISCLOSED FROM A PRIVACY ACT SYSTEM OF RECORDS (COMMERCE/DEPT-1),
FURTHER DISCLOSURES SHOULD BE RESTRICTED ON A NEED-TO-KNOW BASIS, AND THE RECORD SHOULD BE DESTROYED WHEN IT IS NO LONGER OF USE >>>

                                                                                                   COST CENTER NUMBER  4203480
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                                         L A B O R   J O U R N A L

                                FOR PAY PERIOD 22, 10/25/87 TO 11/07/87                                   PAGE  244

                                                                                          COST CENTER NUMBER  4201480
ASGD  WORK   REQ                            HOURS    COMP   LEAVE  HOURS    HOURS  BASE    BASE       AVG     TOTAL     ADJUSTMENTS
DIV   ORDER  DIV     EMPLOYEE NAME           PAID  + WORK - USED = WORK   THIS CC RATE*1   COST      RATE*2   COST      NBS-12  PP
420                 ONDIK HELEN               80             5      75       25  38.55     964      83.67    2092
                                                                           -----          ------             ------
                    TOTAL SPONSOR LABOR                                      25            964               2092
                    COST CENTER TOTAL LABOR                                  25            964               2092





*1  BASE RATE INCLUDES 18.0% LEAVE SURCHARGE
*2  AVERAGE RATE IS OBTAINED BY APPLYING THE FOLLOWING OVERHEAD RATES TO THE SUM OF THE BASE RATE PLUS BENEFITS (16.0%):
    BUREAU OH 49.5%, LAB OH  8.4%, CENTER OH 29.2%, BLDG DEPR/DOC OH    .0%.
<<< THIS RECORD IS BEING DISCLOSED FROM A PRIVACY ACT SYSTEM OF RECORDS (COMMERCE/DEPT-1).
FURTHER DISCLOSURES SHOULD BE RESTRICTED ON A NEED-TO-KNOW BASIS, AND THE RECORD SHOULD BE DESTROYED WHEN IT IS NO LONGER OF USE >>>
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A 3

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710     714  7144370                          L A B O R   J O U R N A L                                                      AR-3
                                    FOR PAY PERIOD 22, 10/25/87 TO 11/07/87                                                PAGE  823
                                                                                                      COST CENTER NUMBER  7144370
ASGD  WORK  REQ                                HOURS   COMP  LEAVE  HOURS   HOURS  BASE    BASE        AVG      TOTAL      ADJUSTMENTS
DIV   ORDER DIV     EMPLOYEE NAME               PAID + WORK - USED = WORK  THIS CC RATE*1  COST       RATE*2    COST       WBS-12  PP
714               LIGGETT JR WALTER   .          80                   80      80  30.18    2415       66.80     5344
                                                                             -----         ------               ------
                  TOTAL SPONSOR LABOR                                         80           2415                 5344
                  COST CENTER TOTAL LABOR                                     80           2415                 5344




*1  BASE RATE INCLUDES 18.0% LEAVE SURCHARGE
*2  AVERAGE RATE IS OBTAINED BY APPLYING THE FOLLOWING OVERHEAD RATES TO THE SUM OF THE BASE RATE PLUS BENEFITS (16.0%):
    BUREAU ON 49.5%, LAB ON 5.0%, CENTER ON 36.3%, BLDG DEPR/DOC ON  .0%.
<<< THIS RECORD IS BEING DISCLOSED FROM A PRIVACY ACT SYSTEM OF RECORDS (COMMERCE/DEPT-1).
FURTHER DISCLOSURES SHOULD BE RESTRICTED ON A NEED-TO-KNOW BASIS, AND THE RECORD SHOULD BE DESTROYED WHEN IT IS NO LONGER OF USE >>>

                                                                                                      COST CENTER NUMBER  7144370
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L 3

LABOR JOURNAL

FOR PAY PERIOD 23, 11/08/87 TO 11/21/87

COST CENTER NUMBER 4500480

ASGD DIV	WORK ORDER	REQ DIV	EMPLOYEE NAME	HOURS PAID +	COMP WORK −	LEAVE USED =	HOURS WORK	HOURS THIS CC	BASE RATE*1r	BASE COST	AVG RATE*2r	TOTAL COST	ADJUSTMENTS NBS-12 PP
450			ANDERSON DAVID	80		8	72	8	31.45	252	70.55	564	
450			BERTOCCI UGO	80		8	72	16	39.57	633	88.77	1420	
450			ESCALANTE EDWARD	80		9	71	51	31.05	1583	69.66	3553	
450			FRAKER ANNA	80		24	56	36	36.52	1315	31.93	2949	
450			HALL DALE	80		8	72	24	36.52	877	81.93	1966	
450			HARRIS JONICE	80		8	72	36	18.10	652	40.61	1462	
450			HARRIS JOYCE	80		16	64	64	12.80	819	28.72	1838	
450			HARRISON STEVEN	80		11	69	69	13.50	931	30.29	2090	
450			INTERRANTE CHARLES	80		40	40	24	32.77	786	73.52	1764	
450			LINZER MELVIN	80		48	32	16	37.54	601	84.22	1348	
450			LOHR DEBRA	29			29	29	8.50	246	19.07	553	
450			PUGH EDISON	80		8	72	8	39.57	317	88.77	710	
450			RICKER RICHARD	80		24	56	28	27.01	756	60.59	1697	
450			RUSPI JILL	77		8	69	69	18.41	1270	41.30	2850	
450			SHULL ROBERT	80		8	72	40	27.60	1104	61.92	2477	
450			STOUDT MARK	80		8	72	72	13.50	972	30.29	2181	
			TOTAL SPONSOR LABOR					590		13114		29422	
			COST CENTER TOTAL LABOR					590		13114		29422	

*1r BASE RATE INCLUDES 18.0% LEAVE SURCHARGE
*2r AVERAGE RATE IS OBTAINED BY APPLYING THE FOLLOWING OVERHEAD RATES TO THE SUM OF THE BASE RATE PLUS BENEFITS (16.0%):
BUREAU OH 49.5%, LAB OH 8.4%, CENTER OH 35.5%, BLDG DEPR/DOC OH .0%.
<<< THIS RECORD IS BEING DISCLOSED FROM A PRIVACY ACT SYSTEM OF RECORDS (COMMERCE/DEPT-1).
FURTHER DISCLOSURES SHOULD BE RESTRICTED ON A NEED-TO-KNOW BASIS, AND THE RECORD SHOULD BE DESTROYED WHEN IT IS NO LONGER OF USE >>>

COST CENTER NUMBER 4500480

C 2

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 710      714  7144370                    L A B O R   J O U R N A L                                                 AR-3
                                  FOR PAY PERIOD 23, 11/08/87 TO 11/21/87                                       PAGE  821
                                                                                                 COST CENTER NUMBER  7144370
ASGD  WORK   REQ                            HOURS   COMP   LEAVE   HOURS   HOURS  BASE     BASE       AVG     TOTAL    ADJUSTMENTS
DIV   ORDER  DIV       EMPLOYEE NAME         PAID + WORK - USED  = WORK  THIS CC RATE*1r COST      RATE*2r  COST     NBS-12  PP
714                 LIGGETT JR WALTER        80              8      72      72  30.18    2173      66.80    4810
                                                                         -----          ------            ------
                    TOTAL SPONSOR LABOR                                  72             2173              4810
                    COST CENTER TOTAL LABOR                              72             2173              4810




*1r BASE RATE INCLUDES 18.0% LEAVE SURCHARGE
*2r AVERAGE RATE IS OBTAINED BY APPLYING THE FOLLOWING OVERHEAD RATES TO THE SUM OF THE BASE RATE PLUS BENEFITS (16.0%):
    BUREAU OH 49.5%, LAB OH  5.0%, CENTER OH 36.3%, BLDG DEPR/DOC OH.   .0%.
<<< THIS RECORD IS BEING DISCLOSED FROM A PRIVACY ACT SYSTEM OF RECORDS (COMMERCE/DEPT-1).
FURTHER DISCLOSURES SHOULD BE RESTRICTED ON A NEED-TO-KNOW BASIS, AND THE RECORD SHOULD BE DESTROYED WHEN IT IS NO LONGER OF USE >>>

                                                                                                 COST CENTER NUMBER  7144370
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J 3

L 2

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420     420  4201480                         L A B O R   J O U R N A L                                                AR-3
                                    FOR PAY PERIOD 23, 11/08/87 TO 11/21/87                                          PAGE  235
                                                                                                     COST CENTER NUMBER  4201480
ASGD  WORK  REQ                             HOURS    COMP  LEAVE  HOURS   HOURS  BASE      BASE        AVG      TOTAL     ADJUSTMENTS
DIV   ORDER DIV    EMPLOYEE NAME             PAID  + WORK - USED = WORK   THIS CC RATE*1r  COST       RATE*2r  COST      NBS-12  PP
420               ONDIK HELEN                80            10      70      23   38.55     887        83.67    1924
                                                                          -----          ------               ------
                  TOTAL SPONSOR LABOR                                      23             887                  1924
                  COST CENTER TOTAL LABOR                                  23             887                  1924
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*1r BASE RATE INCLUDES 18.0% LEAVE SURCHARGE
*2r AVERAGE RATE IS OBTAINED BY APPLYING THE FOLLOWING OVERHEAD RATES TO THE SUM OF THE BASE RATE PLUS BENEFITS (16.0%):
    BUREAU OH 49.5%, LAB OH  8.4%, CENTER OH 29.2%, BLDG DEPR/DOC OH    .0%.
<<< THIS RECORD IS BEING DISCLOSED FROM A PRIVACY ACT SYSTEM OF RECORDS (COMMERCE/DEPT-1).
FURTHER DISCLOSURES SHOULD BE RESTRICTED ON A NEED-TO-KNOW BASIS, AND THE RECORD
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LABOR JOURNAL

FOR PAY PERIOD 24, 11/22/87 TO 12/05/87

COST CENTER NUMBER 4500480

ASGD DIV	WORK ORDER	REQ DIV	EMPLOYEE NAME	HOURS PAID +	COMP WORK -	LEAVE USED =	HOURS WORK	HOURS THIS CC	BASE RATE*1r	BASE COST	AVG RATE*2r	TOTAL COST	ADJUSTMENTS NBS-12 PP
450			BERTOCCI UGO	80		10	70	36	39.57	1424	88.77	3196	
450			ESCALANTE EDWARD	80		10	70	35	31.05	1087	69.66	2438	
450			FRAKER ANNA	80		10	70	35	36.52	1278	81.93	2868	
450			HALL DALE	80		10	70	22	36.52	803	81.93	1802	
450			HARRIS JONICE	80		16	64	24	18.10	434	40.61	975	
450			HARRIS JOYCE	80		16	64	64	12.80	819	28.72	1838	
450			HARRISON STEVEN	80		10	70	70	13.50	945	30.29	2120	
450			INTERRANTE CHARLES	80		10	70	56	32.77	1835	73.52	4117	
450			LINZER MELVIN	80		48	32	16	37.54	601	84.22	1348	
450			LOHR DEBRA	25			25	25	8.50	212	19.07	477	
450			PUGH EDISON	80		16	64	8	39.57	317	88.77	710	
450			RICKER RICHARD	80		18	62	31	27.01	837	60.59	1878	
450			RUSPI JILL	80		10	70	70	19.03	1332	42.69	2988	
450			SHULL ROBERT	80		10	70	30	27.60	828	61.92	1858	
450			STOUDT MARK	80		16	64	64	13.50	864	30.29	1939	
			TOTAL SPONSOR LABOR					586		13616		30552	
			COST CENTER TOTAL LABOR					586		13616		30552	

*1r BASE RATE INCLUDES 18.0% LEAVE SURCHARGE
*2r AVERAGE RATE IS OBTAINED BY APPLYING THE FOLLOWING OVERHEAD RATES TO THE SUM OF THE BASE RATE PLUS BENEFITS (16.0%):
BUREAU OH 49.5%, LAB OH 8.4%, CENTER OH 35.5%, BLDG DEPR/DOC OH .0%.
<<< THIS RECORD IS BEING DISCLOSED FROM A PRIVACY ACT SYSTEM OF RECORDS (COMMERCE/DEPT-1).
FURTHER DISCLOSURES SHOULD BE RESTRICTED ON A NEED-TO-KNOW BASIS, AND THE RECORD SHOULD BE DESTROYED WHEN IT IS NO LONGER OF USE >>>

H 2

420 420 4201480

LABOR JOURNAL

AR-3

FOR PAY PERIOD 24, 11/22/87 TO 12/05/87

COST CENTER NUMBER 4201480

ASGD DIV	WORK ORDER	REQ DIV	EMPLOYEE NAME	HOURS PAID +	COMP WORK -	LEAVE USED =	HOURS WORK	HOURS THIS CC	BASE RATE*1r	BASE COST	AVG RATE*2r	TOTAL COST	ADJUSTMENTS NBS-12	PP
420			ONDIK HELEN	80		8	72	32	38.55	1234	83.67	2677		
			TOTAL SPONSOR LABOR					32		1234		2677		
			COST CENTER TOTAL LABOR					32		1234		2677		

*1r BASE RATE INCLUDES 18.0% LEAVE SURCHARGE
*2r AVERAGE RATE IS OBTAINED BY APPLYING THE FOLLOWING OVERHEAD RATES TO THE SUM OF THE BASE RATE PLUS BENEFITS (16.0%):
BUREAU OH 49.5%, LAB OH 8.4%, CENTER OH 29.2%, BLDG DEPR/DOC OH .0%.
<<< THIS RECORD IS BEING DISCLOSED FROM A PRIVACY ACT SYSTEM OF RECORDS (COMMERCE/DEPT-1).
FURTHER DISCLOSURES SHOULD BE RESTRICTED ON A NEED-TO-KNOW BASIS, AND THE RECORD SHOULD BE DESTROYED WHEN IT IS NO LONGER OF USE >>>

J 3

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710     714  7144370                          L A B O R   J O U R N A L                                                  AR-3
                                       'OR PAY PERIOD 24, 11/22/87 TO 12/05/87                                      PAGE  83C
                                                                                              COST CENTER NUMBER  7144370
ASGD  WORK  REQ                               HOURS   COMP  LEAVE  HOURS  HOURS  BASE    BASE       AVG     TOTAL     ADJUSTMENTS
DIV   ORDER DIV     EMPLOYEE NAME              PAID + WORK - USED = WORK THIS CC RATE*1r COST      RATE*2r  COST     NBS-12  PP
714                LIGGETT JR WALTER           80           10      70     17   30.18    513      66.80    1136
                                                                          -----         ------             -----
                   TOTAL SPONSOR LABOR                                     17            513               1136

                   COST CENTER TOTAL LABOR                                 17            513               1136

*1r BASE RATE INCLUDES 18.0% LEAVE SURCHARGE
*2r AVERAGE RATE IS OBTAINED BY APPLYING THE FOLLOWING OVERHEAD RATES TO THE SUM OF THE BASE RATE PLUS BENEFITS (16.0%):
    BUREAU ON 49.5%, IND ON  5.0%, CENTER ON 36.3%, BLDG DEPR/DOC ON   .0%.
<<< THIS RECORD IS BEING DISCLOSED FROM A PRIVACY ACT SYSTEM OF RECORDS (COMMERCE/DEPT-1).
FURTHER DISCLOSURES SHOULD BE RESTRICTED ON A NEED-TO-KNOW BASIS, AND THE RECORD SHOULD BE DESTROYED WHEN IT IS NO LONGER OF USE >>>

                                                                                              COST CENTER NUMBER  7144370
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L A B O R J O U R N A L

FOR PAY PERIOD 25, 12/06/87 TO 12/19/87

COST CENTER NUMBER 4500480

ASGD DIV	WORK ORDER	REQ DIV	EMPLOYEE NAME	HOURS PAID +	COMP WORK -	LEAVE USED =	HOURS WORK	HOURS THIS CC	BASE RATE *1	BASE COST	AVG RATE *2	TOTAL COST	ADJUSTMENTS NBS-*2 PP
450			BERTOLLI UGO	80			80	16	39.57	633	88.77	1420	
450			ESCALANTE EDWARD	80			80	40	31.05	1242	69.66	2786	
450			FRAKER ANNA	80			80	40	36.52	1461	81.93	3277	
450			HALL DALE	80			80	8	36.52	292	81.93	655	
450			HARRIS JONICE	80			80	36	18.10	652	40.61	1462	
450			HARRIS JOYCE	80		8	72	72	12.80	922	28.72	2068	
450			HARRISON STEVEN	80			80	80	13.50	1080	30.29	2423	
450			INTERRANTE CHARLES	80			80	64	32.77	2097	73.52	4705	
450			LOHR DEBRA	25			25	25	8.50	212	19.07	477	
450			PUGH EDISON	80			80	8	39.57	317	88.77	710	
450			RICKER RICHARD	80			80	40	27.01	1080	60.59	2424	
450			RUSPI JILL	80		12	68	68	19.03	1294	42.69	2903	
450			STOUDT MARK	80			80	80	13.50	1080	30.29	2423	
			TOTAL SPONSOR LABOR					577		12362		27733	
			COST CENTER TOTAL LABOR					577		12362		27733	

*1 BASE RATE INCLUDES 18.0% LEAVE SURCHARGE
*2 AVERAGE RATE IS OBTAINED BY APPLYING THE FOLLOWING OVERHEAD RATES TO THE SUM OF THE BASE RATE PLUS BENEFITS (16.0%):
BUREAU OH 49.5%, LAB OH 8.4%, CENTER OH 35.5%, BLDG DEPR/DOC OH .0%.

J 2

B 2

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420    420 4201480                         L A B O R   J O U R N A L                                                AR-3
                                    FOR PAY PERIOD 25, 12/06/87 TO 12/19/87                                    PAGE  221
                                                                                              COST CENTER NUMBER  4201480
ASGD  WORK  REQ                              HOURS   COMP  LEAVE  HOURS   HOURS  BASE    BASE        AVG     TOTAL    ADJUSTMENTS
DIV   ORDER DIV    EMPLOYEE NAME              PAID + WORK - USED = WORK   THIS CC RATE*1  COST       RATE*2   COST     NBS-12  PP
420              ONDIK HELEN                  80              2     78     78   38.55   3007       83.67   6526
                                                                          -----         ------             ------
                 TOTAL SPONSOR LABOR                                       78           3007               6526
                 COST CENTER TOTAL LABOR                                   78           3007               6526

*1  BASE RATE INCLUDES 18.0% LEAVE SURCHARGE
*2  AVERAGE RATE IS OBTAINED BY APPLYING THE FOLLOWING OVERHEAD RATES TO THE SUM OF THE BASE RATE PLUS BENEFITS (16.0%):
    BUREAU OH 49.5%, LAB OH  8.4%, CENTER OH 29.2%, BLDG DEPR/DOC OH    .0%.
<<< THIS RECORD IS BEING DISCLOSED FROM A PRIVACY ACT SYSTEM OF RECORDS (COMMERCE/DEPT-1).
FURTHER DISCLOSURES SHOULD BE RESTRICTED ON A NEED-TO-KNOW BASIS, AND THE RECORD SHOULD BE DESTROYED WHEN IT IS NO LONGER OF USE >>>
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450 450 4500480

LABOR JOURNAL

FOR PAY PERIOD 26, 12/20/87 TO 01/02/88

AR-3.

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COST CENTER NUMBER 4500480

ASGD DIV	WORK ORDER	REQ DIV	EMPLOYEE NAME	HOURS PAID	+ COMP WORK	- LEAVE USED	= HOURS WORK	HOURS THIS CC	BASE RATE*1r	BASE COST	AVG RATE*2r	TOTAL COST	ADJUSTMENTS NBS-12 PP
450			BERTOCCI UGO	80		52	28	12	39.57	475	88.77	1065	
450			BRADY CHARLES	80		44	36	4	27.01	108	60.59	242	
450			ESCALANTE EDWARD	80		21	59	27	31.05	838	69.66	1881	
450			FRAKER ANNA	80		20	60	30	36.52	1096	81.93	2458	
450			HALL DALE	80		20	60	8	36.52	292	81.93	655	
450			HARRIS JONICE	80		20	60	27	18.10	489	40.61	1096	
450			HARRIS JOYCE	80		32	48	48	12.80	615	28.72	1379	
450			HARRISON STEVEN	80		56	24	24	13.50	324	30.29	727	
450			INTERRANTE CHARLES	80		46	34	26	32.77	852	73.52	1912	
450			PUGH EDISON	80		24	56	11	39.57	435	88.77	976	
450			RICKER RICHARD	80		20	60	30	27.01	810	60.59	1818	
450			RINKER MICHELE	50			50	50	7.49	375	16.80	840	
450			RUSPI JILL	80		24	56	56	19.03	1066	42.69	2391	
450			STOUDT MARK	80		32	48	48	13.50	648	30.29	1454	
			TOTAL SPONSOR LABOR					401		8423		18894	
			COST CENTER TOTAL LABOR					401		8423		18894	

*1r BASE RATE INCLUDES 18.0% LEAVE SURCHARGE

*2r AVERAGE RATE IS OBTAINED BY APPLYING THE FOLLOWING OVERHEAD RATES TO THE SUM OF THE BASE RATE PLUS BENEFITS (16.0%):
BUREAU OH 49.5%, LAB OH 8.4%, CENTER OH 35.5%, BLDG DEPR/DOC OH .0%.

<<< THIS RECORD IS BEING DISCLOSED FROM A PRIVACY ACT SYSTEM OF RECORDS (COMMERCE/DEPT-1).
FURTHER DISCLOSURES SHOULD BE RESTRICTED ON A NEED-TO-KNOW BASIS, AND THE RECORD SHOULD BE DESTROYED WHEN IT IS NO LONGER OF USE >>>

COST CENTER NUMBER 4500480

G 2

450 450 4500480

LABOR JOURNAL

FOR PAY PERIOD 01, 01/03/88 TO 01/16/88

COST CENTER NUMBER 4500480

ASGD DIV	WORK ORDER	REQ DIV	EMPLOYEE NAME	HOURS PAID	+ COMP WORK	- LEAVE USED	= HOURS WORK	HOURS THIS CC	BASE RATE *1r	BASE COST	AVG RATE *2r	TOTAL COST	ADJUSTMENTS NBS-12 PP
450			BERTOCCI UGO	80		8	72	16	40.36	646	90.54	1449	
450			BRADY CHARLES	80		16	64	3	27.54	83	61.78	185	
450			ESCALANTE EDWARD	80		8	72	36	31.67	1140	71.05	2558	
450			HALL DALE	80		15	65	10	37.25	373	83.57	836	
450			HARRIS JONICE	80		40	40	12	18.10	217	40.61	487	
450			HARRIS JOYCE	80		16	64	64	12.80	819	28.72	1838	
450			HARRISON STEVEN	80		10	70	70	13.76	963	30.87	2161	
450			INTERRANTE CHARLES	80		15	65	52	33.43	1738	75.00	3900	
450			LOHR DEBRA	28			28	28	8.50	238	19.07	534	
450			PUGH EDISON	80		8	72	11	40.36	444	90.54	996	
450			RICKER RICHARD	90		40	40	20	27.54	551	61.78	1236	
450			RINKER MICHELE	54			54	54	7.49	405	16.80	907	
450			RUSPI JILL	80		16	64	64	19.41	1242	43.54	2787	
450			STOUDT MARK	80		8	72	72	13.76	991	30.87	2223	
			TOTAL SPONSOR LABOR					512		9850		22097	
			COST CENTER TOTAL LABOR					512		9850		22097	

*1r BASE RATE INCLUDES 18.0% LEAVE SURCHARGE
*2r AVERAGE RATE IS OBTAINED BY APPLYING THE FOLLOWING OVERHEAD RATES TO THE SUM OF THE BASE RATE PLUS BENEFITS (16.0%):
BUREAU OH 49.5%, LAB OH 8.4%, CENTER OH 35.5%, BLDG DEPR/DOC OH .0%.
<<< THIS RECORD IS BEING DISCLOSED FROM A PRIVACY ACT SYSTEM OF RECORDS (COMMERCE/DEPT-1).
FURTHER DISCLOSURES SHOULD BE RESTRICTED ON A NEED-TO-KNOW BASIS, AND THE RECORD SHOULD BE DESTROYED WHEN IT IS NO LONGER OF USE >>>

COST CENTER NUMBER 4500480

I 2

I 2

420 420 4201480

LABOR JOURNAL

AR-3

FOR PAY PERIOD 01, 01/03/88 TO 01/16/88

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COST CENTER NUMBER 4201480

ASGD DIV	WORK ORDER	REQ DIV	EMPLOYEE NAME	HOURS PAID +	COMP WORK -	LEAVE USED =	HOURS WORK	HOURS THIS CC	BASE RATE *1r	BASE COST	AVG RATE *2r	TOTAL COST	ADJUSTMENTS NBS-12 PP
420			ONDIK HELEN	80		11	69	69	39.32	2713	90.36	6235	
			TOTAL SPONSOR LABOR					69		2713		6235	
			COST CENTER TOTAL LABOR					69		2713		6235	

*1r BASE RATE INCLUDES 18.0% LEAVE SURCHARGE

*2r AVERAGE RATE IS OBTAINED BY APPLYING THE FOLLOWING OVERHEAD RATES TO THE SUM OF THE BASE RATE PLUS BENEFITS (16.0%):
BUREAU OH 49.5%, LAB OH 8.4%, CENTER OH 40.2%, BLDG DEPR/DOC OH .0%.

<<< THIS RECORD IS BEING DISCLOSED FROM A PRIVACY ACT SYSTEM OF RECORDS (COMMERCE/DEPT-1).
FURTHER DISCLOSURES SHOULD BE RESTRICTED ON A NEED-TO-KNOW BASIS, AND THE RECORD SHOULD BE DESTROYED WHEN IT IS NO LONGER OF USE >>>

LABOR JOURNAL

FOR PAY PERIOD 02, 01/17/88 TO 01/30/88

COST CENTER NUMBER 4500480

ASGD DIV	WORK ORDER	REQ DIV	EMPLOYEE NAME	HOURS PAID	+ COMP WORK	- LEAVE USED	= HOURS WORK	HOURS THIS CC	BASE RATE *1r	BASE COST	AVG RATE *2r	TOTAL COST	ADJUSTMENTS NBS-12 PP
450			BERTOCCI UGO	80		9	71	8	40.36	323	90.54	724	
450			ESCALANTE EDWARD	80		9	71	32	31.67	1013	71.05	2274	
450			HALL DALE	80		9	71	8	38.37	307	86.08	689	
450			HARRIS JONICE	80		20	60	30	18.10	543	40.61	1218	
450			HARRIS JOYCE	80		16	64	64	12.80	819	28.72	1838	
450			HARRISON STEVEN	80		9	71	54	13.76	743	30.87	1667	
450			INTERRANTE CHARLES	80		10	70	54	33.43	1805	75.00	4050	
450			LOHR DEBRA	27			27	27	8.50	229	19.07	515	
450			RICKER RICHARD	80		9	71	21	27.54	578	61.78	1297	
450			RINKER MICHELE	38			38	38	7.49	285	16.80	638	
450			RUSPI JILL	80		17	63	63	19.41	1223	43.54	2743	
450			STOUDT MARK	80		17	63	31	13.76	427	30.87	957	
			TOTAL SPONSOR LABOR					430		8295		18610	
			COST CENTER TOTAL-LABOR					430		8295		18610	

*1r BASE RATE INCLUDES 18.0% LEAVE SURCHARGE
*2r AVERAGE RATE IS OBTAINED BY APPLYING THE FOLLOWING OVERHEAD RATES TO THE SUM OF THE BASE RATE PLUS BENEFITS (16.0%):
BUREAU OH 49.5%, LAB OH 8.4%, CENTER OH 35.5%, BLDG DEPR/DOC OH .0%.

<<< THIS RECORD IS BEING DISCLOSED FROM A PRIVACY ACT SYSTEM OF RECORDS (COMMERCE/DEPT-1).
FURTHER DISCLOSURES SHOULD BE RESTRICTED ON A NEED-TO-KNOW BASIS, AND THE RECORD SHOULD BE DESTROYED WHEN IT IS NO LONGER OF USE >>>

COST CENTER NUMBER 4500480

G 2

COST CENTER NUMBER 4201291

B 3

420 420 4201480

L A B O R J O U R N A L

AR-3

FOR PAY PERIOD 02, 01/17/88 TO 01/30/88

COST CENTER NUMBER 4201480

ASGD DIV	WORK ORDER	REQ DIV	EMPLOYEE NAME	HOURS PAID +	COMP WORK -	LEAVE USED =	HOURS WORK	HOURS THIS CC	BASE RATE*1r	BASE COST	AVG RATE*2r	TOTAL COST	ADJUSTMENTS NBS-12 PP
420			ONDIK HELEN	80		41	39	8	39.32	315	90.36	723	
			TOTAL SPONSOR LABOR					8		315		723	
			COST CENTER TOTAL LABOR					8		315		723	

COST CENTER NUMBER 4208472

K 3

420 420 4209480

L A B O R J O U R N A L

FOR PAY PERIOD 02, 01/17/88 TO 01/30/88

AR-3

COST CENTER NUMBER 4209480

ASGD DIV	WORK ORDER	REQ DIV	EMPLOYEE NAME	HOURS PAID +	COMP WORK -	LEAVE USED =	HOURS WORK	HOURS THIS CC	BASE RATE *1r	BASE COST	AVG RATE *2r	TOTAL COST	ADJUSTMENTS NBS-12 PP
420			ONDIK HELEN	80		41	39	31	39.32	1219	90.36	2801	
			TOTAL SPONSOR LABOR					31		1219		2801	
			COST CENTER TOTAL LABOR					31		1219		2801	

*1r BASE RATE INCLUDES 18.0% LEAVE SURCHARGE