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100 AREA GROUNDWATER BIODENITRIFICATION BENCH-SCALE TREATABILITY STUDY PROCEDURES

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SUMMARY

This document describes the methodologies and procedures for conducting the bench-scale biodenitrification treatability tests at Pacific Northwest Laboratory[a] (PNL). Biodenitrification is the biological conversion of nitrate and nitrite to gaseous nitrogen. The tests will use statistically designed batch studies to determine if biodenitrification can reduce residual nitrate concentrations to 45 mg/L, the current maximum contaminant level (MCL). These tests will be carried out in anaerobic flasks with a carbon source added to demonstrate nitrate removal. At the pilot scale, an incremental amount of additional carbon will be required to remove the small amount of oxygen present in the incoming groundwater. These tests will be conducted under the guidance of Westinghouse Hanford Company (WHC) and the 100-HR-3 Groundwater Treatability Test Plan (DOE/RL-92-73) and the Treatability Study Program Plan (DOE/RL-92-48) using groundwater from 100-HR-3.

In addition to the procedures, requirements for safety, quality assurance, reporting, and schedule are given. Appendices include analytical procedures, a Quality Assurance Project Plan, a Health and Safety Plan, and Applicable Material Data Safety Sheets.

The procedures contained herein are designed specifically for the 100-HR-3 Groundwater Treatability Test Plan, and while the author believes that the methods described herein are scientifically valid, the procedures should not be construed or mistaken to be generally applicable to any other treatability study.

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1.0 INTRODUCTION

This document describes the methodologies and procedures for conducting the bench-scale biodenitrification treatability tests at Pacific Northwest Laboratory[a] (PNL). Biodenitrification is the biological conversion of nitrate and nitrite to gaseous nitrogen. The tests will use statistically designed batch studies to determine if biodenitrification can reduce residual nitrate concentration to 45 mg/L, the current MCL. Groundwater samples will be tested from two wells in 100-HR-3. These tests will be conducted under the guidance of Westinghouse Hanford Company (WHC) and the 100-HR-3 Groundwater Treatability Test Plan, DOE/RL-92-73, using groundwater from 100-HR-3. Past experiments will be used to determine the range to test for each independent variable (Koegler et al. 1989; Brouns et al. 1990; Truex et al. 1992). An additional set of batch tests will be performed to confirm the observed microbial growth and denitrification kinetics. The overall objective is to demonstrate that the performance levels (45 mg/L) for nitrate in 100 Area groundwater can be met with the biodenitrification process. The conclusions will be based on groundwater samples taken from two wells chosen by WHC. In addition, the effects of the following parameters will be determined:

- Presence of inhibitory compounds
- Carbon limitations
- pH dependence
- Temperature dependence
- Carbon source (acetate and methanol) dosage comparison
- Chromium and radionuclide uptake.

After values for these parameters have been determined, and the effects of possibly inhibitory compounds have been evaluated, a final set of batch studies will be performed at the best temperature, pH, and carbon source to evaluate the site specific reaction rate kinetics with analyses performed at a PNL Quality Assurance (QA) level II. Sludge composition and stabilization will not be addressed in these procedures. Filtration characteristics as

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measured by total and volatile suspended solids will be measured during one test to give an indication of the sludge filtration properties.

The data will be used to further evaluate the feasibility of biodenitrification as groundwater remediation technology for the 100-HR-3 Operable Unit and will provide information required for a pilot scale system. In parallel to these biodenitrification tests, Westinghouse Hanford Company (WHC) is conducting tests of both ion exchange and chromium reduction/precipitation. The results from these lab tests will be used to determine which system, biodenitrification/chromium precipitation or ion exchange, should be further evaluated for use in remediating 100-HR-3 groundwater. This determination will be based on the performance data and minimal cost information obtained from these lab tests. A report will be issued at the conclusion of the testing to summarize the biodenitrification results. These results will be used to aid in performing the Phase 3 Remedy Design (pilot-scale) treatability study for 100-HR-3. Further details regarding an overview description of the as yet unwritten Phase 3 (pilot-scale) test should reference the document - U.S. Department of Energy, Richland Operations Office (DOE-RL), 1992b, "100 Area Feasibility Study Phases 1 and 2", Decisional Draft, DOE-RL-92-11, U.S. Department of Energy, Richland, Washington.

2.0 SCOPE AND OBJECTIVES

Statistically designed batch studies will be performed to determine if biodenitrification can achieve the required performance level for nitrate removal in the 100 Area groundwater, as reflected in groundwater samples from two wells. The performance level for nitrate is 45 mg/l in drinking water; this is equivalent to 10 mg/l of nitrate nitrogen, designated as NO^-_3 - N. The performance level for chromium (VI) and total chromium is 80 μg/l and 100 μg/l, respectively. These tests will be conducted under the guidance of the 100-HR-3 Groundwater Treatability Test Plan, DOE/RL-92-73, using groundwater from 100-HR-3 and the Hanford denitrifying consortium. Specific test objectives are listed below:

- determine if inhibitory compounds are present - This objective will be accomplished by comparing denitrification rates in 100-HR-3 groundwater to denitrification rates in a simulated groundwater under identical conditions. Because of the possibility that the 100 Area groundwater may contain compounds which inhibit microbial denitrification, tests must be run to determine if the rate and extent of denitrification in the groundwater is comparable to the rates commonly expected.

- determine the extent to which carbon limitations affect denitrification - This will be done to insure that nitrate will indeed be the rate limiting nutrient and to determine the effects of carbon limitations on denitrification rates. Since the MCL for nitrate is 45 mg/L, a pilot-scale system may be operated in a carbon limited manner and still remove enough nitrate to effectively remediate the effluent water.

- determine denitrification rates at pH values 6, 7, and 8 - The biochemical reactions for biodenitrification results in an increase in the solution pH. Depending on the buffering capacity of the groundwater, this increase may be large or small and may affect denitrification rates. In addition, information on the effect of pH on denitrification rates may play a significant role in integrating chemical and biological treatment at this site since pH control plays an important role in chemical precipitation. Initial measurements of groundwater pH are between 7.6 and 8.0.

- determine the effect of temperature on the rate of denitrification. Even with a relatively stable groundwater temperature, an ex-situ process at the Hanford site may expect certain temperature fluctuations throughout the year. This objective, specifically, is to determine denitrification rates at 15°C, 20°C,

and 25°C. Generic rate expressions that account for the effect of temperature on denitrification rates exist, but the constants need to be determined under site-specific conditions. Denitrification rates observed by Dawson and Murphy (1972) gave values for the coefficients in Equation 7 of $k_0 = 3.195 \times 10^{11}$ mg/L NO_3^- (mg cells h)$^{-1}$, and E = -16800 cal (g-mole)$^{-1}$. The groundwater temperature in the 100 Area is typically in the range 17 to 20 °C.

- determine carbon source and dosage - The role of the carbon source is important in determining denitrification and biomass production rates. The carbon sources that will be compared are acetate and methanol. Methanol is an industry standard because of its cost, but acetate may give faster denitrification rates. Dosage will be determined by analyzing observed yield values after removing nitrate and producing biomass. The desirable carbon source would be inexpensive, and support a high denitrification rate, while produce a small amount of biomass. Initial dosage will be determined from Equation 5 or 6. These tests will give data to predict the amount of carbon source required to remove a specific amount of nitrate from groundwater. The ratio of carbon source to nitrate removed is relatively insensitive to the reactor size.

- Final confirmation tests -

  - Confirm that performance levels can be met - After optimal values for the parameters given above have been chosen, and the effects of possibly inhibitory compounds have been evaluated, a final set of integrated batch tests will be performed to evaluate the site specific reaction rate kinetics and determine if denitrification can reach the desired performance levels of 45 mg/L in 100 Area groundwater.

  - Determine the amount of chromium and radionuclide adsorption to biomass - Although some information is available on the extent of chromium uptake by the Hanford denitrifying consortia, the information on the extent of radionuclide adsorption is limited.

  - Recommend bioreactor types for pilot scale tests - Bioreactor types that should be evaluated at the pilot scale will be recommended based on denitrification rates observed in these tests. The recommendation will not include information about costs.

3.0 EXPERIMENTAL DESIGN AND PROCEDURES

Section 3 gives some technical background for the process of biodenitrification and the process parameters that affect the rate of denitrification. The experimental approach and equipment list gives a summary of the test to be run from this test procedure. Test procedures are then outlined in detail.

3.1 Experimental Background

The fundamental principle of bioremediation is the biological degradation of unwanted compounds into more inert or desirable compounds. For example, biodegradation of a gasoline spill in the presence of air would produce carbon dioxide, a gas found in low concentrations in ambient air. In the absence of oxygen, other substances can be used by bacteria to degrade organic carbon. One such substance is nitrate. Degradation of nitrate by the microbial process of denitrification produces inert nitrogen gas through the reaction series in Equation 1.

$$NO_3 \rightarrow NO_2 \rightarrow NO \rightarrow N_2O \rightarrow N_2 \qquad (1)$$

The Hanford consortia of denitrifiers has been shown to reduce both nitrate and nitrite. The production of ammonia is rarely seen in a consortia undergoing the denitrification process, since ammonia has a high chemical energy and is a valuable nutrient source for bacteria. Of the small amount of ammonia that may be produced, most will quickly be assimilated into biomass.

3.1.1 Carbon Source Additions

Both acetate and methanol additions will be calculated by:

- measuring initial nitrate and nitrite concentrations
- using the stoichiometric relationships (Eq. 2 to 6) that incorporate dissimilatory nitrate/nitrite reduction, biomass synthesis, and scavenging soluble oxygen. These relationships (US EPA 1975) are averages for many complex metabolic reactions and as such are approximations of what will be observed with the Hanford consortia.

Overall Nitrate Removal with Methanol

$$NO_3^- + 1.08CH_3OH + 0.24H_2CO_3 = 0.056C_5H_7NO_2 + 0.47N_2 + 1.68H_2O + HCO_3^- \quad (2)$$

Overall Nitrite Removal with Methanol

$$NO_2^- + 0.67CH_3OH + 0.53H_2CO_3 = 0.04C_5H_7NO_2 + 0.48N_2 + 1.23H_2O + HCO_3^- \quad (3)$$

Overall Oxygen Removal with Methanol

$$O_2 + 0.93CH_3OH + 0.056NO_3^- = 0.056C_5H_7NO_2 + 1.04H_2O + 0.59H_2CO_3 + 0.056HCO_3^- \quad (4)$$

When combined, these stoichiometric relationships allow the calculation of methanol requirements to bioremediate nitrate and nitrite. An additional factor of 1.5 has been included to insure sufficient carbon source to deplete nitrate.

Overall Methanol Requirement

$$C_m = 1.5\ (\ 0.56\ NO_3^- + 0.35\ NO_2^- + 0.93DO) \quad (5)$$

where:

C_m = required methanol concentration, mg/L
NO_3^- = nitrate concentration to remove, mg/L
NO_2^- = nitrite concentration to remove, mg/L
DO = dissolved oxygen concentration to remove, mg/L

The dissolved oxygen must be taken into consideration since oxygen is a more energetically favorable electron acceptor. If, for example, the

dissolved oxygen were ignored and only enough carbon source was added to remove nitrate, the bacteria would still remove the oxygen first and then proceed with denitrification. Of course, the carbon source would run out before all the nitrate was consumed. Examination of Equation 5 will show that under anaerobic conditions the dissolved oxygen concentration is zero and therefore does not influence the methanol requirement at all. The results will be published as obtained and will not need to be corrected. Pilot scale designers and operators will have to measure the dissolved oxygen concentration and add enough carbon source to remove the oxygen.

Acetate will be used in the form of potassium nitrate or dilute acetic acid for multiple use as a possible pH controlling agent and carbon source. Although acetate provides a faster denitrification rate, its use is less common because of cost considerations. A suitable reference for acetate addition has not been located at this time that provides stoichiometric information on nitrate, nitrite, and dissolved oxygen. Acetate addition will be calculated based on Equation 6 adapted from Table IV of McCarty et al. (1969) and will provide a safety factor of 1.5 in the acetate additions to insure sufficient carbon source to deplete available nitrate.

Overall Acetate Requirement

$$C_a = 1.5\ (0.81\ NO_3^-) = 1.22\ NO_3 \qquad (6)$$

where:

C_a = required acetate concentration, mg/L

3.1.2 Temperature Dependence

The temperature dependence of the denitrification rate can be fitted with a least squares fit of a logarithmic transformation (Dawson and Murphy 1972) with an Arrhenius' Law model of the form:

$$k = k_o\ e^{-(\frac{E}{RT})} \qquad (7)$$

where k_o = frequency factor
E = activation energy (cal g-mole^{-1})
R = universal gas constant (cal g-mole^{-1} °K^{-1})
T = absolute temperature (°K)

Because the coefficients represent overall averages of many complex individual metabolic reactions this test procedure will not precisely define the coefficients k_o and E. It will indicate whether results follow typical temperature dependencies. The groundwater in the 100 Area typically ranges between 17 and 20 °C.

3.1.3 Phosphorous Requirements

Phosphorous is a member of the group of chemical elements commonly called micronutrients. These elements are required for microbial growth, though in far smaller amounts than carbon, nitrogen, hydrogen, and oxygen. Hydrogen and oxygen exist in great abundance as the components of water. In this application, a carbon source, acetate or methanol, will be added to bioremediate a nitrogen source, nitrate. Thus all the primary components for bioremediation will be present in the planned tests. Phosphorous is required in the approximate molar ratio of 300:1 carbon:phosphorous by the microbial cell for production of important biological substances such as genetic material (nucleic acids) and the cell wall (phospholipids). In some cases, a scarcity of phosphorous can limit cell production, which in turn limits the denitrification rate. Phosphate will be added to groundwater samples with the carbon source in the ratio of 0.05 mg PO_4^- per mg acetate or methanol. Phosphoric acid could have multiple use as a phosphorous source and a pH controller.

3.1.4 pH Effects

Highest denitrification rates are found between pH of 7.0 to 7.5 (EPA 1975). Lower denitrification rates occur outside of this range. Typical

range for the effects of pH on the percent of maximum denitrification rate are shown in Table 3-1.

TABLE 3-1. Effect of pH on Denitrification Rates

	Percent of Maximum Rate	
pH	High	Low
<6	<60%	35%
6-7	100%	35%
7-8	100%	65%
8-9	95%	<20%

3.1.5 Hanford Denitrifying Consortia

The Hanford denitrifying consortia was obtained from Hanford groundwater (Koegler et.al., 1989) and has been shown to remove nitrate to concentrations less than 45 mg/L, the current MCL (Brouns et.al. 1990). The consortia was initially obtained for tests to degrade carbon tetrachloride and nitrate simultaneously. During these tests it was found that a fluidized bed bioreactor (FBR) gave greater volumetric denitrification rates 10-20 times higher than those obtained in continuous culture. This was because of the order-of-magnitude increase in the amount of biomass present in the reactor as a result of the presence of an attachment medium. Specific denitrification rates ranged from 35-359 mg NO_3^-(g VSS h)$^{-1}$, while the average was 44 mg NO_3^-(g VSS h)$^{-1}$. These values were obtained at 30°C. The average observed yield for nitrate was 0.97 mg NO_3^- (mg VSS)$^{-1}$, while for acetate a range of 3.3 to 10.8 mg acetate (mg VSS)$^{-1}$ was reported. These results should be viewed with some amount of caution since the tests were carried out in a fed-batch system under feast or famine conditions.

3.2 Experimental Approach

The primary goal of this work is to provide information on the applicability of biodenitrification for treating 100-HR-3 groundwater. Microorganisms grown in batch culture will be used to determine the effects of various parameters and operating conditions on the denitrification rate. The principal parameter of interest is determining if any unknown inhibitory

agents are present in 100-HR-3 groundwater that would prevent biodenitrification from occurring.

The batch cultures will be grown in anaerobic shake flasks. Each parameter will be evaluated by at least 2 individual flasks to insure reproducability.

- The first task of the batch tests will determine if inhibitory compounds are present.
- Task two will determine if carbon concentration is rate limiting.
- The third task is to determine the effect of pH (6, 7, or 8) on the denitrification rate of the Hanford consortia.
- The fourth task will determine the effect of temperature on denitrification rates.
- The fifth task will compare the acetate and methanol as a carbon source. The comparison will be based on denitrification rate and cell production.
- The sixth task is to determine the ability to meet performance levels (45 mg/L) for nitrate removal (part A) and to quantify the amount of chromium and radionuclide uptake by biomass (part B).

The final report, the seventh task, will list raw data, summarize the effect of each variable, and recommend two bioreactor types for pilot scale development based on observed denitrification rates.

3.3 Equipment Description

The principal test equipment will be a commercially available rotary shaker/incubator. Custom-made Erlenmeyer flasks that contain the culture media will be kept at a set temperature and shaken at 150 rpm to insure complete mixing during the individual 1 to 2 week tests.

Item	Manufacturer
environmental rotary shaker	New Brunswick
ion chromatograph	Dionex
pH meter, model 250 A	Orion
gas chromatograph, 5890 Series II	Hewlett Packard
custom anaerobic flasks, 500 ml, Hungate-type anaerobic seal	Bellco, Inc.
fermentor	New Brunswick
autoclave	Consolidated Machine Corp.
refrigerator	Kenmore
environmental Chamber	Bally Engineered Structures. Inc.
balance, AE 160	Mettler
laminar flow hood	Labconco

3.4 Test Procedures

Detailed test procedures are divided into tasks that are given in sections 3.4.1 to 3.4.7.

3.4.1 Determine the Presence of Inhibitory Compounds

1) Measure nitrate and nitrite concentration, and pH in groundwater according to the method given in Appendix A.

2) Calculate acetate concentration required to deplete nitrate and oxygen from each well based on equation 6.

3) Make a simulated groundwater (SGW) (Table 3-2) with nitrate concentrations equal to the highest measured nitrate concentration.

4) Add 300 mL SGW to two shake flasks. Autoclave. Repeat steps 5 to 12 for each of the two wells.

5) Add 300 mL groundwater to two 500 mL shake flasks, and 100 mL groundwater to a 150-mL Erlenmeyer flask.

6) Add phosphate (300:1 C:P molar ratio) to the flasks.

7) Sparge the liquid of each flask with sterile helium to remove atmospheric oxygen.

8) Add 0.1 ml (~$2x10^6$ cells/mL) Hanford denitrifying consortia inoculum to each flask.

9) Add calculated amount of sterile acetate to each flask.

10) Measure and record pH in the Erlenmeyer flask from each well. Save this sample for possible future reanalysis.

11) Incubate in a dark shake chamber at 150 rpm at room temperature.

12) Aseptically sample each flask for nitrate, nitrite, acetate, and denitrifying cell numbers according to methods given in Appendix A.

13) Sample at 4, 8, and 12 h.

14) Sample for nitrate, nitrite, and acetate only at 2, 6, and 10 h.

15) Determine final pH on remaining liquid after final sampling.

16) If no significant statistical difference (95% confidence interval)is observed in the rate or extent of denitrification between groundwater, and simulated groundwater it will be concluded that no inhibitory compounds were present in the sample. If it is

determined that an unknown inhibitory compound is limiting denitrification rates, the test will be repeated. At the same time, WHC will be notified that provisions for identifying an inhibitory agent should be sought. Actually identifying any inhibitory agent is beyond the scope of this project.

TABLE 3-2. Composition of Chemicals Added to Make a Phosphate Buffered Simulated Groundwater[a]

Compound	mg/L	(M)
Na_2SiO_3-$9H_2O$	4.55E+02	1.60E-03
Na_2CO_3	1.60E+02	1.51E-03
Na_2SO_4	1.33E+02	9.38E-04
KOH	2.00E+01	3.57E-04
$MgCl_2$-$6H_2O$	2.15E-01	1.06E-06
$CaCl_2$-$2H_2O$	1.48E-02	1.00E-07
KH_2PO_4	6.80E+01	5.00E-04
NaCl	3.30E+01	5.65E-04
pH	7.0	

(a) Based on analysis of sulfate and chloride of well 199-D5-15. Other trace compounds are based on the SGW used by Brouns et al. (1990).

3.4.2 Determine the Effect of Carbon Loading

1) Measure nitrate and nitrite concentration and pH according to methods given in Appendix A on a composite groundwater sample made from equal volumes of water from each of two wells.

2) Calculate acetate concentration required to deplete nitrate and oxygen based on Eq. 6.

3) Add 300 mL composite groundwater to six 500 mL shake flasks, and add 100 mL to a 150-mL Erlenmeyer flask.

4) Add phosphate (300:1 C:P molar ratio) to the flasks.

5) Sparge the liquid of each flask with sterile helium to remove atmospheric oxygen.

6) Add 0.1 mL (~$2x10^6$ cells/mL) Hanford denitrifying consortia inoculum to each flask.

7) Add sterile acetate to each of the shake flasks in the ratios of 0.5, 0.667, and 1.0 times the amount calculated in step 2 above. This will give carbon concentrations of 0.75, 1.0 and 1.5 times the stoichiometrically required amount.

8) Measure and record pH on the 150-mL Erlenmeyer flask. Save this sample for possible future reanalysis.

9) Incubate in a dark shake chamber at 150 rpm at room temperature.

10) Aseptically sample each flask for nitrate, nitrite, acetate, and denitrifying cell numbers (MPN) according to methods given in Appendix A.

11) Sample at 4, 8, and 12 h.

12) Sample for nitrate, nitrite, and acetate only at 2, 6, and 10 h.

13) Determine final pH on remaining liquid after final sampling.

14) If no significant statistical difference (95% confidence interval)is observed in the rate or extent of denitrification between carbon-limited composite groundwater and carbon-rich composite groundwater, it will be concluded that additional carbon was not required for balanced microbial growth. If it is determined that carbon limitations are controlling denitrification rates it will be emphasized in the results.

3.4.3 Determine pH Dependence of Denitrification Rate

1) Measure nitrate and nitrite concentration and pH according to methods given in Appendix A on a composite groundwater sample made from equal volumes of water from each of two wells.

2) Measure pH in groundwater according to method given in Appendix A.

3) Calculate acetate concentration required to deplete nitrate and oxygen based on Eq. 4.

4) Add 300 mL groundwater to six 500-mL shake flasks.

5) Add 5.0×10^{-4} molar phosphate buffer to all flasks.

6) Raise pH in two flasks to pH 8 using sterile 1M NaOH.

7) Lower pH in two flasks to pH 6 using sterile 1M HCl.

8) Adjust pH in two flasks to pH 7 using either sterile HCl or NaOH as required.

9) Sparge the liquid of each flask with sterile helium to remove atmospheric oxygen.

10) Add 0.1 mL ($\sim 2 \times 10^{6}$ cells/mL) Hanford denitrifying consortia inoculum to each flask.

11) Add calculated amount of sterile acetate to each of the shake flasks.

12) Incubate in a dark shake chamber at 150 rpm at room temperature.

13) Aseptically sample each flask for nitrate, nitrite, acetate, and denitrifying cell numbers (MPN) according to methods given in Appendix A.

14) Sample at 4, 8, and 12 h.

15) Determine final pH on remaining liquid after final sampling.

16) If no significant statistical difference (95% confidence interval)is observed in the rate or extent of denitrification between the different pH flasks, it will be concluded that no pH effects were measured in the sample. In the more likely case that pH does have an effect on denitrification rates, data will be used to determine the pH-dependency.

3.4.4 Determine Temperature Dependence of the Denitrification Rate

1) Measure nitrate and nitrite concentration and pH according to methods given in Appendix A on a composite groundwater sample made from equal volumes of water from each of two wells.

2) Calculate acetate concentration required to deplete nitrate and oxygen based on Eq. 6. Repeat steps 3 to 13 for each of the three temperatures, 15, 20, and 25°C.

3) Add groundwater to two 500 mL shake flasks, and 100 mL groundwater to a 150-mL Erlenmeyer flask.

4) Add phosphate (300:1 C:P molar ratio) to the flasks.

5) Sparge the liquid of each flask with sterile helium to remove atmospheric oxygen.

6) Add 0.1 mL ($\sim 2 \times 10^6$ cells/mL) Hanford denitrifying consortia inoculum to each flask.

7) Add calculated amount of sterile acetate to each of the shake flasks.

8) Measure and record pH on each 150-mL Erlenmeyer flask. Save this sample for possible future reanalysis.

9) Incubate in a dark shake chamber at 15°C, 20°C, or 25°C.

10) Aseptically sample each flask for nitrate, nitrite, acetate, and denitrifying cell numbers (MPN) according to methods given in Appendix A.

11) At 15°C, sample at 8, 24, and 32 h. Sample for nitrate, nitrite and acetate only at 4, 12, and 28 h.

12) At 20°C, sample at 4, 8, and 12 h. Sample for nitrate, nitrite and acetate only at 2, 6, and 10 h.

13) At 25°C, sample at 3, 6, and 9 h. Sample for nitrate, nitrite and acetate only at 2, 4, and 7 h.

14) Determine final pH on remaining liquid after final sampling.

15) If no significant statistical difference (95% confidence interval) is observed in the rate or extent of denitrification between treatments, it will be concluded that no temperature effects were measured in the sample. In the more likely case that temperature does have an effect on denitrification rates, data will be used to estimate coefficients k_o and E for the published Arrhenius' Law temperature-dependent rate expression in Equation 7.

3.4.5 Compare Acetate and Methanol as a Carbon Source

1) Measure nitrate and nitrite concentration, and pH according to methods given in Appendix A on a composite groundwater sample made from equal volumes of water from each of two wells.

2) Calculate acetate concentration required to deplete nitrate and oxygen based on Eq. 6.

3) Calculate methanol concentration required to deplete nitrate and oxygen based on Eq. 5.

4) Add groundwater to three 500-mL shake flasks and 100 mL groundwater to a 150-mL Erlenmeyer flask for each carbon source.

5) Add phosphate (300:1 C:P molar ratio) to the flasks.

6) Sparge the liquid of each flask with sterile helium to remove atmospheric oxygen.

7) Add 0.1 mL (~2×10^6 cells/mL) Hanford denitrifying consortia inoculum to each flask.

8) Add calculated amount of sterile acetate or methanol to each of the shake flasks.

9) Measure and record pH for each Erlenmeyer flask. Save this sample for possible future reanalysis.

10) Incubate in a dark shake chamber at room temperature.

11) Aseptically sample each flask for nitrate, nitrite, acetate or methanol, and denitrifying cell numbers (MPN) according to methods given in Appendix A.

12) Sample at 4, 8, and 12 h. Sample for nitrate, nitrite and acetate or methanol only at 2, 6, and 10 h.

13) Determine final pH on remaining liquid after final sampling.

14) If no significant statistical difference (95% confidence interval)is observed in the rate or extent of denitrification between carbon sources, it will be concluded that no effects were measured in the sample. In the more likely case that the carbon source does have an effect on denitrification rates, data will be used to estimate yield coefficients and denitrification rates.

3.4.6 Large Volume Denitrification for Chemical Precipitation

1) Measure nitrate and nitrite concentration, and pH according to methods given in Appendix A on a composite groundwater sample made from equal volumes of water from each of two wells.

2) Using the carbon source determined to give the optimum denitrification rate per unit cost in task 3.4.5, calculate the concentration required to deplete nitrate and oxygen either by "a" for acetate, or "b" for methanol.

   a) Calculate acetate concentration required to deplete nitrate and oxygen based on Eq. 6.

   b) Calculate methanol concentration required to deplete nitrate and oxygen based on Eq. 5.

3) Add phosphate (300:1 C:P molar ratio) to the flasks.

4) Add 0.5 mL (~$2x10^6$ cells/mL) Hanford denitrifying consortia inoculum/L of total groundwater added to the fermentor.

5) Add calculated amount of sterile acetate or methanol to the fermentor.

6) Incubate in a dark vessel at 150 rpm at optimum temperature determined in task 3.4.4.

7) Sample the fermentor for nitrate, nitrite, acetate or methanol, and denitrifying cell numbers (MPN) according to methods given in Appendix A.

8) Sample at 4, 8, and 12 h. Sample for nitrate, nitrite and acetate or methanol at 2, 6, and 10 h.

9) Determine final pH on remaining liquid after final sampling.

10) Transfer 10 L of denitrified groundwater using chain of custody procedures, to WHC for chemical precipitation testing. Any available composition data will be transferred to WHC at the same time. Exposure of the denitrified liquid to ambient air will be minimized so that water chemistry will change as little as possible.

11) With the remaining liquid, analyze for total suspended solids and volatile suspended solids. Also, any other liquid will be poured into a graduated cylinder so that qualitative information on settling characteristics can be observed.

3.4.7 Final Confirmation Testing

1) Measure chrome (VI), nitrate and nitrite concentration and pH according to methods given in Appendix A on a composite groundwater sample made from equal volumes of water from each of two wells.

2) Using the carbon source determined to give the optimum denitrification rate per unit cost in task 3.4.5, calculate the concentration required to deplete nitrate and oxygen either by "a" for acetate, or "b" for methanol.

   a) Calculate acetate concentration required to deplete nitrate and oxygen based on Eq. 6.

   b) Calculate methanol concentration required to deplete nitrate and oxygen based on Eq. 5.

3) Add 300 ml groundwater to four 500-mL shake flasks and 100 mL to a 150-mL Erlenmeyer flask.

4) Add phosphate (300:1 C:P molar ratio) to the flasks.

5) Sparge the liquid of each flask with sterile helium to remove atmospheric oxygen.

6) Add 0.1 mL (~$2x10^6$ cells/mL) Hanford denitrifying consortia inoculum to each flask.

7) Add calculated amount of sterile acetate or methanol to each of the shake flasks.

8) Measure and record pH for the Erlenmeyer flask. Save this sample for possible future reanalysis.

9) Incubate in a dark shake chamber at 150 rpm at optimum temperature determined in task 3.4.4.

10) Aseptically sample each flask for nitrate, nitrite, acetate or methanol, chromium(VI), and denitrifying cell numbers (MPN) according to methods given in Appendix A. Since this is a confirmational test, sample twice the volume required for nitrate, nitrite, and carbon source so that duplicate samples can be sent to the 325 lab for inter-laboratory comparison.

11) Sample at 2, 4, 6, 8, and 12 h.

12) Determine final pH on remaining liquid after final sampling.

13) At 12 h, in addition to regular samples, remove the required volume for additional samples to be sent to the 325 lab to be analyzed for

total chromium in solution
gross alpha and beta radioactivity.

14) Filter the remaining liquid in each flask through a 0.45-μm glass fiber filter approved for total suspended solids (TSS) measurements. Samples of the filtrate to be sent to the 325 lab for analyses are

chromium (VI) in filtrate
total chromium in filtrate
gross alpha and beta in filtrate.

4.0 REQUIREMENTS

Aside from the pure technical aspects of this project, other considerations are safety, quality assurance, analytical accuracy, reporting, and schedule. These issues are addressed in Section 4 and supported by documentation found in the Appendices.

4.1 Safety

No unusual physical hazards will be involved. Temperatures will range from approximately 15°C to 25°C. The groundwater (collected by PNL) may contain up to 2 ppm total chromium and up to 110 ppm nitrate. Neither the chromium nor the nitrate is a volatile substance, and neither is considered a safety hazard at these concentrations. The materials "methanol, acetate, and nitrate" will be used at low concentrations in the lab tests as a microbial energy source. A Health and Safety Plan is given in Appendix C. The MSDS for compounds in use are given in Appendix D.

4.2 Quality Assurance (QA)

The goal of this project is to provide quality data to aid in designing a pilot-scale denitrification and chromium facility. Every effort will be made to meet both the spirit and the letter of the existing QA requirements. The guiding document for this effort is the Quality Assurance Project Plan (QAPjP) given in Appendix B.

This test procedure document, including the QAPjP in Appendix B, was developed and approved by the project quality engineer responsible for support, K. R. Martin.

4.3 Analytical Accuracy

The data quality objectives found in Table 6.1 of Appendix B are designed so that only gross errors in data quality would fall outside the range for relative percent difference and percent recovery. Actual data is expected to be of much higher accuracy and precision. The most important parameter to this study, nitrate, is expected to have a relative percent difference of approximately 5 to 10 percent at concentrations above 20 mg/L. The percent recovery for an NIST standard of 10 mg/L is expected to be in the range of 90-

110 percent. Other constituents, including chromium, are expected to have an RPD of ≤20 percent and a %R of 80 to 120 percent.

4.4 Reporting

The project manager, B. M. Peyton, will meet with cognizant WHC staff at least twice monthly to update the status of the project. These test procedures outline the tasks and schedules to be met. In an effort to assist WHC in meeting a TPA milestone, a draft final report of initial findings will be submitted to WHC on Monday, May 31, 1993. Further data analysis and report writing will be required before submission of the final report to WHC for comment on Monday, July 26, 1993. The format of the final report has not yet been determined.

4.5 Schedule

The projected schedule for accomplishing the tasks outlined in this document is shown in Fig. 4.1; the groundwater sampling schedule is given in Table 4.1.

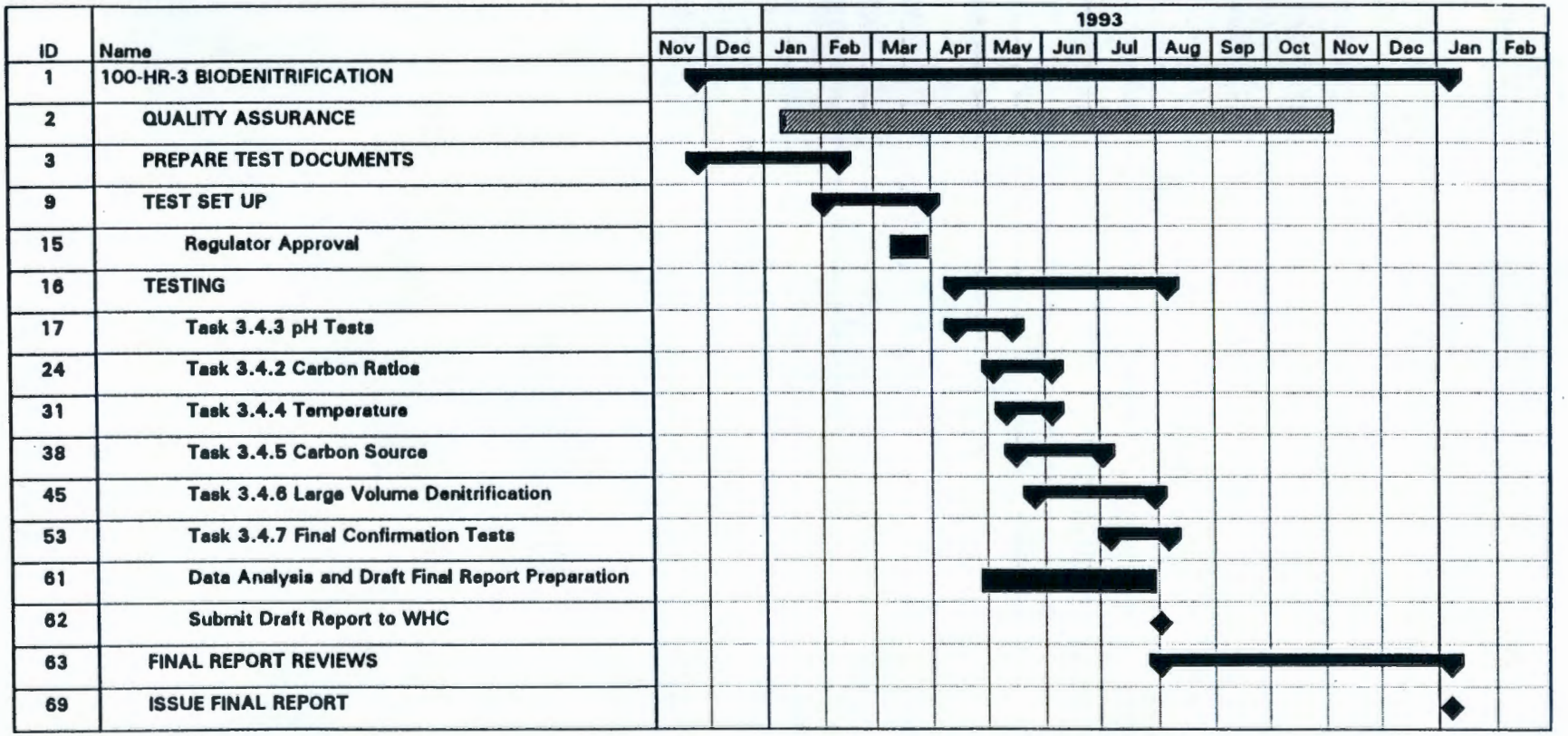

FIGURE 4-1. Schedule for 100 Area Biodenitrification Study

TABLE 4.1. Groundwater Sampling Schedule

DATE	WELL LOCATIONS	VOLUME NEEDED (liters)	DELIVERED TO
March 30, 1993	199-D5-15 199-H4-4	2 2	324 Bldg Rm 115 c/o Brent Peyton
April 20, 1993	199-D5-15 199-H4-4	2 2	324 Bldg Rm 115 c/o Brent Peyton
May 11, 1993	199-D5-15 199-H4-4	2 2	324 Bldg Rm 115 c/o Brent Peyton
June 15, 1993	199-D5-15 199-H4-4	10 10	324 Bldg Rm 115 c/o Brent Peyton
July 13, 1993	199-D5-15 199-H4-4	2 2	324 Bldg Rm 115 c/o Brent Peyton

5.0 REFERENCES

Brouns, T. M., S. S. Koegler, W. O. Heath, J. K. Fredrickson, H. D. Stensel, D. L. Johnstone, and T. L. Donaldson. 1990. *Development of a Biological Treatment System for Hanford Groundwater Remediation: FY 1989 Status Report.* PNL-7290, Pacific Northwest Laboratory, Richland, Washington.

Dawson, R. N. and K. L. Murphy. 1972. "The Temperature Dependency of Biological Denitrification." *Water Research*, 6, p 71-83.

Koegler, S. S., T. M. Brouns, W. O. Heath, and R. J. Hicks. 1989. *Biodenitrification of Hanford Groundwater and Process Effluents: FY 1988 Status Report.* PNL-6917, Pacific Northwest Laboratory, Richland, Washington.

McCarty, P. L., L. Beck, and P. St. Amant. 1969. *Biological Denitrification of Wastewaters by Addition of Organic Materials.* Proceedings of the 24th Industrial Waste Conference, May 6, 7, and 8. Lafayette, Indiana.

Truex, M. J., D. R. Brown, and D. B. Elliott. 1992. *Cost/Benefit Analysis Comparing Ex-Situ Treatment Technologies for Removing Carbon Tetrachloride from Hanford Groundwater.* PNL-8334, Pacific Northwest Laboratory, Richland, Washington.

United States Environmental Protection Agency (EPA). 1975. *Process Design Manual for Nitrogen Control.* Office of Technology Transfer, 628.3 US84PO.

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APPENDIX A

ANALYTICAL PROCEDURES

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Most probable number (MPN) for denitrifying bacterial number.

Materials

1) Culture medium, 8.0 g of nutrient broth and 0.5 g of potassium nitrate (KNO_3) (5.0 mM) per liter. Place 10 mL of medium in 16- by 125-mm Hungate tubes (have butyl rubber septa in screw caps, catalog no. 2047 of Bellco Glass Inc., Vineland, N.J.) and autoclave 15 min at 6.8 kg (15 lb) of pressure.

2) Dilution bottles of 0.85% saline

3) Gastight syringes (disposable tuberculin type)

4) Durham tubes

Procedure

1) Autoclave at 121 °C for at least 15 min.

2) Collect 1 mL sample from bioreactors and prepare serial dilutions (10^{-3} to 10^{-7}).

3) Inoculate media tubes (five per dilution) with inverted Durham tube with 0.1 mL of the appropriate serial dilution using 1-mL disposable syringes.

4) Incubate at room temperature for 14 days.

5) Indication of gas in the inverted Durham tube is considered evidence of denitrification.

6) Denitrification populations will be estimated using MPN table found on page 9-78 of Standard Methods for the Examination of Water and Wastewater, 17th - edition.

7) For confirmation of denitrification use the diphenylamine test for the presence of nitrate and nitrite.

pH by Electrometric Method

Method 150.1 EPA "Methods for Chemical Analysis of Water and Wastes", EPA-600 4-79-020

Suspended Solids, both Total and Suspended

Method 2540 in Standard Methods for the Examination of Water and Wastewater, LS Clesceri, AE Greenberg, and RR Trussel (Eds.), 17th Edition, 1989.

Ion Chromatography for Nitrate, Nitrite, and Acetate Concentration

PNL-ALO-212 (Equivalent to US EPA Method 300.0)

Gas Chromatography for Methanol

Introduction

A GC analysis will be used to determine the methanol concentration in water.

GC Conditions

column	Restek R_{TX}-5 (30 m x 0.25 mm 1.0 μm)
injector	220°C
oven	35°C isothermal
transfer line	250°C
injection	1 μL split 79.5 to 1

Calibration

The GC will be calibrated using known concentrations that bracket the methanol concentrations to be measured. Sample concentrations will be calculated using linear regression of the instrument response to known methanol concentrations.

APPENDIX B
QUALITY ASSURANCE PROJECT PLAN

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100 AREA BIODENITRIFICATION TREATABILITY STUDY

QUALITY ASSURANCE PROJECT PLAN No. WTC-071, REV 0

PREPARED BY

PACIFIC NORTHWEST LABORATORY
P.O. BOX 999
RICHLAND, WASHINGTON 99352

Issue Date: 2/23/93

Approvals/Concurrence:		Dates
Project Manager	Brent M. Peyton BM Peyton (Author)	2/22/93
Process Quality Line Mgr.	B.O. BARNES for JEM JE McGarrah (Concur)	2/23/93
Line Manager	D B Anderson DB Anderson (Approve)	2/22/93

2.0 TABLE OF CONTENTS

Modifications or revisions to this QA Project Plan are discussed in Section 21, Document Control.

Distribution:

PNL

KR Martin
JE McGarrah (PQD File Copy)
BM Peyton

WHC

JB Duncan
Joan Woolard

3.0 QUALITY ASSURANCE PROGRAM

This Quality Assurance (QA) project plan applies to the Pacific Northwest Laboratory (PNL) 100 Area Biodenitrification Treatability Study Project. This project is staffed by members of the Bioremediation Group of the of the Waste Technology Center.

The QA program described herein was developed to address the U.S. Environmental Protection Agency's (EPA) QAMS-005/80, Interim Guidelines for Preparing Quality Assurance Project Plans. This QA Project Plan refers to PNL's Quality Assurance Manual, PNL-MA-70, Part 1 and Part 2: Good Practices Standard, and associated administrative procedures contained in Volume I of the manual. PNL-MA-70 is based on the 18 elements for a QA program presented in ASME NQA-1, Quality Assurance Program Requirements for Nuclear Facilities and is in the process of being approved by DOE-RL. In addition this plan meets the majority of the requirements of DOE order 5700.6C. Further enhancements to the QA program with special emphasis on use of Continuous Improvement processes are in progress.

The work conducted under this Quality Assurance Project Plan has been determined to be overall PNL Impact Level II. The project Work Breakdown Structure (WBS) is in Table 3-1. Specific client requirements stated on the Statement of Work (Work Order) number ED3316 will be implemented.

Battelle

Program: Biodenitrification
Date: 1/18/93 Rev.No. 1

Index No.	WBS Element Level 1	2	3	WBS Element Title	WBS Element Code	Impact Level I	II	III	Remarks
1	X			100 Area Biodenitrification	00		X		
2		X		Project Management	01		X		
3			X	Project Management	0101		X		
4			X	Quality Assurance	0102		X		
5		X		Test Plan	02		X		
6		X		Testing	03		X		
7			X	Materials	0301		X		
8			X	Equipment	0302		X		
9			X	Analysis	0303		X		
10		X		Reporting	04		X		

4.0 PROJECT DESCRIPTION

The bench-scale biodenitrification treatability tests will use statistically designed batch studies to confirm the effects of temperature, pH, carbon source, and rate limiting nutrients on the rate and extent of biodenitrification. In addition to determining the effects of these parameters, information will also be gathered to determine the presence of inhibitory compounds, and the extent of chromium uptake. These tests will be conducted using the 100 area groundwater and a denitrifying consortium obtained from Hanford groundwater, and are being conducted to meet the work plan milestones for treatability tests for the 100-HR-3 Operable Unit.

After optimal values for these parameters have been determined, and the effects of possibly inhibitory compounds have been evaluated, a final set of integrated batch studies will be performed to evaluate the site specific reaction rate kinetics. Preliminary measurements of sludge properties, total suspended and volatile solids will be made in these tests.

The four major milestones are also shown and are scheduled for the following dates:

1)	2/15/93	Submit final test procedures
2)	5/31/93	Submit draft final to WHC
3)	9/1/93	Submit decisional draft to RL
4)	10/29/93	Submit final report to regulators

The intended end use of the data is to aid in performing the Phase 3 treatability study for 100-HR-3.

Table 4.1 Contaminants of Concern

Chromium
Nitrate Nitrogen
Gross Alpha
Gross Beta

4.2 Change Control (Scope, Schedule, Budget)

Requests for changes in project scope, schedule or budget from that detailed in the Project Management Plan must be formally made by letter. A Change Request/Record and Change Control Log (reference PNL-MA-95, Research Project Management Manual, Section 4.5) must be used by the project manager to document changes in scope, schedule, or budget. Changes other than changes in scope, schedule, or budget are discussed in Sections 15.2, 20.0, and 21.1 of this QA project plan.

5.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

Line authority, Quality Assurance authority and support within PNL, and interfaces with Westinghouse Hanford Company (WHC) are shown in Exhibit 5.1.

Changes to organizational/interface structures shown in Exhibit 5.1, with exception of the Project Manager, that do not reflect a change in the overall scope of the activities or a change of requirements will not require a QA project plan revision but will be incorporated in the next required revision of the QA Project Plan.

The responsibilities of key PNL personnel are summarized in Table 5.1.

EXHIBIT 5.1 Project Interfaces

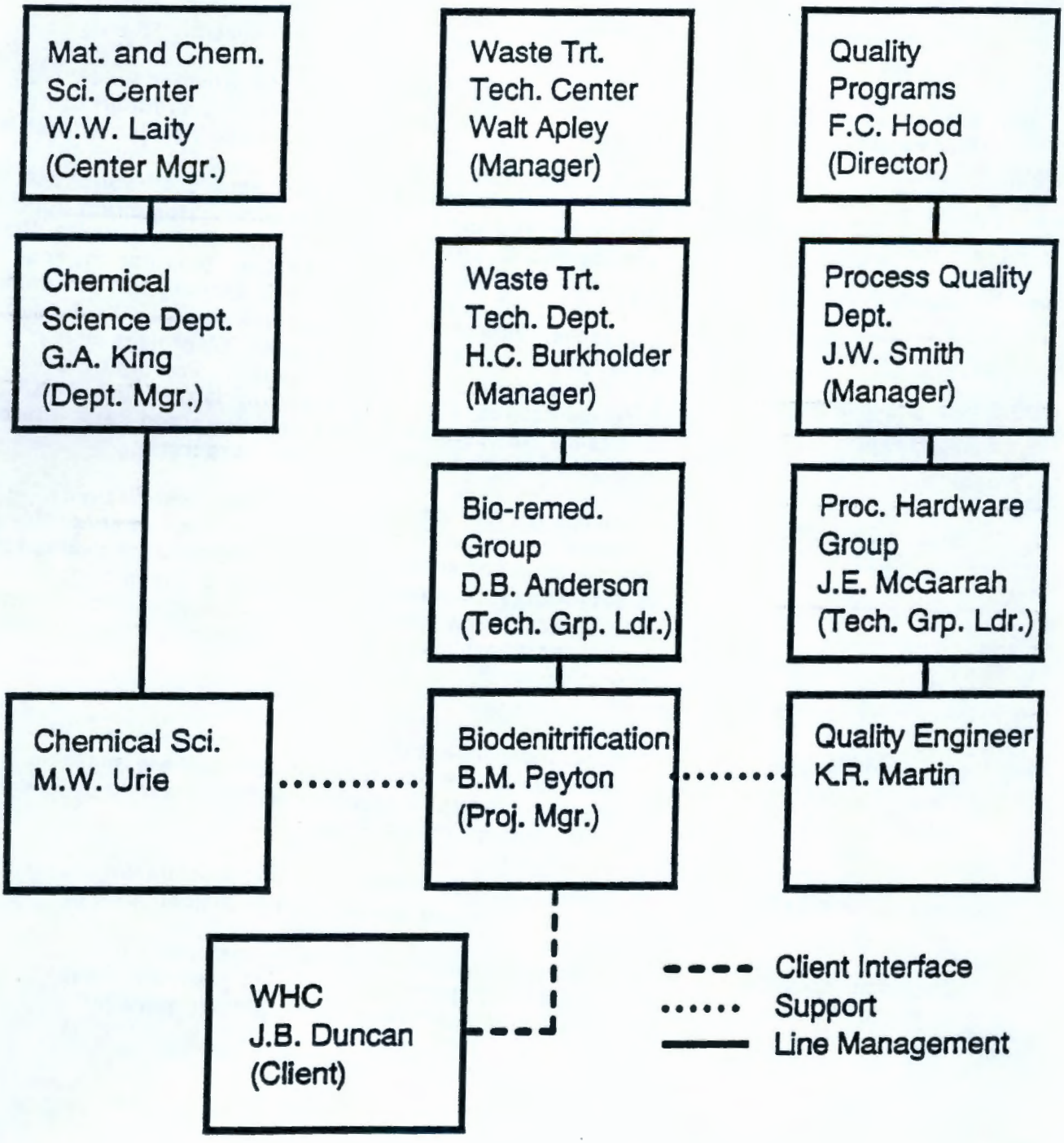

TABLE 5.1. Responsibilities of Key Personnel

Personnel	Responsibilities
Section Manager (DB Anderson)	Provides management review of the project. Assures appropriate and qualified staff are available.
Project Manager (BM Peyton)	Interfaces with WHC project lead and provides weekly reports of activities. Provides overall PNL direction of the project and day-to-day activities necessary to accomplish all project objectives. Ensures that the QA project plan is prepared and implemented and that data, QA information, and reports are produced in a timely manner. Has direct contact with the PNL Quality Engineer. Coordinates all Quality Control (QC) activities including the scheduling, preparation, and submittal of QC samples to PNL laboratories, and evaluates the results. Interacts with the Sample Analysis Task Leader to investigate suspect results. Prepares QA project plan in coordination with PNL Quality Engineer. Prepares the Experimental Test Plan. Interacts with lab personnel and directs the lab operations. Analyzes corrected data. Interprets data generated and prepares technical reports.
Quality Engineer (KR Martin)	Transmits QA records to WHC at project completion. Provides the Project Manager with QA requirements interpretation and implementation assistance. Provides for Quality Assurance training as necessary. Provides for independent quality assurance reviews, surveillances, and data quality and traceability audits. Is responsible for reviewing QA project plans.
Quality Engineering Group Leader. (JE McGarrah)	Provides independent Quality Assurance reviews, assures appropriate and qualified QA staff are available to support the project. Is responsible for reviewing and has sign-off authority for QA Project Plans.
Independent Tech Rev. (MJ Truex)	Provides independent technical review of project documents to assure and improve technical quality.
Technical Specialist (P Prado) (BL Champion)	Provides technical expertise for implernenting the experimental program, and performs preliminary data analysis before submission to the project manager.

6.0 QA DATA QUALITY OBJECTIVES FOR MEASUREMENT DATA

Data uses and needs along with performance goals and decisions to be made with the data generated by this project can be found in the 100 Area Biodenitrification Treatability Test Plan. This section of the QAPjP addresses the performance criteria: precision, accuracy, completeness, comparability and representativeness (PARCC). Detection Limits and performance levels to be attained for the analytes of interest can be found in Table 6.1.

6.1 DQO Definitions

ACCURACY - a measure of the bias of a system or measurement. It is the closeness of agreement between an observed value and an accepted value.

For this project, accuracy of chemical analyses shall be determined through the analysis of matrix spikes or standard reference material (SRM), as appropriate. SRMs are materials that have been certified by a recognized authority (e.g., National Institute of Standards and Technology) and which are treated and analyzed as an actual sample. When appropriate, matrix spikes shall be performed by adding a known quantity of target analytes into a sample of water and preparing and analyzing the sample the same as a regular sample.

For measurements where matrix spikes and/or SRMs are used, percent recovery shall be used.

$$\%R = 100 \times \frac{S-U}{C_{sa}}$$

%R = percent recovery
S = measured concentration in spiked aliquot
U = measured concentration in unspiked aliquot
C_{sa} = actual concentration of spike added

PRECISION - a measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions.

For this project, measures of analytical precision shall be determined by the analysis of laboratory duplicates. Laboratory duplicates will be prepared by homogenizing and splitting a sample in the laboratory, and carrying the subsamples through the entire analytical process. Precision can be expressed in terms of the relative percent difference (RPD).

$$RPD = \frac{(C_1 - C_2)}{[(C_1 + C_2)/2]} \times 100$$

RPD = relative percent difference

C_1 = larger of the two observed values
C_2 = smaller of the two observed values

COMPLETENESS - a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions.

$$\%C = 100x\frac{V}{n}$$

V = Number of Valid Data Points Acquired
n = Total Number of Data Points

Refer to Table 6.1 and 6.2 for completeness objectives.

DETECTION LIMIT - Detection limit is the minimum concentration of a substance that can be measured and reported. Method Detection Limit (MDL) is the minimum concentration of a substance that can be identified, measured, and reported with 99 percent confidence that the analyte concentration is greater than zero.
The analytical lab shall be required to demonstrate the ability to meet a Practical Quantitation Limit (PQL) using recognized procedures for detection limit determination. Detection limits required shall be passed on to the analytical laboratory via the Statement of Work. These detection limits shall be lower than the performance levels stated in the 100-HR-3 Groundwater Treatability Test Plan, Table 1.2, with the exception of chromium (VI) which has a detection limit of 100 ppb.

MDL is defined as follows:

$$MDL = t_{(n-1,\ 1-\alpha=0.99)} = S$$

MDL = method detection limit
S = standard deviation of the replicate analyses
$t_{(n-1,\ 1-\alpha=0.99)}$ = Students' t-value appropriate to a 99% confidence level and a standard deviation estimate with n-1 degrees of freedom

REPRESENTATIVENESS - Expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition.

Representativeness will be addressed primarily in the sample design, through the selection of sampling sites and procedures. WHC shall conduct this portion of the project. Representativeness also will be ensured by the proper handling, proper homogenization, and storage of samples. Representativeness of samples selected for analysis shall be

addressed in section 11 of the 100 Area BiodenitrificationTest Plan. Representativeness of data will be discussed, when appropriate, in deliverable reports.

COMPARABILITY - expresses the confidence with which one data set can be compared to another.

Comparability for this project will not be quantified, but shall be addressed through the use of accepted laboratory methods. The use of standard reporting units also will facilitate comparability with other data sets. Comparability between spike recoveries between batches shall be analyzed for possible recovery corrections. Inter-laboratory comparisons shall be made for data collected from Task 3.4.6. Comparability of other data will be discussed, when appropriate, in the final report.

6.2 Corrective Action for Results Outside Established DQOs

Results outside the established criteria in Tables 6.1, and 6.2 shall be brought to the attention of the Task Leader and the Project manager who shall determine and document the appropriate corrective action. See Section 11.2 for documenting corrective actions. These actions may include, but are not limited to, review of data and calculations, flagging of suspect data or re-analyses of individual or entire batches of samples.

Table 6.1. Data quality objectives for samples. References are listed at the bottom of Table III.

Analyte or Parameter (Measurement Method)	EPA Level	Analytical Method	Detect. Limit	Units of Measure	RPD	%R	Completion
Temperature (Thermometric)	III	Method 170.1 Ref. 1	NA	°C	≤20%	NA	90%
pH (Electrometric)	III	Method 9040 Ref. 2	NA	pH units	≤20%	NA	90%
Methanol (gas Chromatography)	III	Method in Test Procedure Appen. A	NA	mg/l	≤40%	50-150%	75%
Acetate (Ion Chromatography)	III	SOP # 93-BR6-0001	1	mg/l	≤40%	50-150%	75%
Nitrate (Ion Chromatography)	III	SOP # 93-BR6-0001	1	mg/l	≤40%	50-150%	75%
Nitrite (Ion Chromatography)	III	SOP # 93-BR6-0001	1	mg/l	≤40%	50-150%	75%

Table 6.1 (cont.). Data quality objectives for samples.

Analyte or Parameter (Measurement Method)	EPA Level	Analytical Method	Detect. Limit	Units of Measure	RPD	%R	Completion
Total Suspended Solids	III	Method 2540 Ref. 3	NA	mg/l	≤40%	NA	75%
Total Volatile Solids	III	Method 2540 Ref. 3	NA	mg/l	≤40%	NA	75%
Gross Alpha	III	PNL-ALO-460 PNL-ALO-461	10	pCi/L	≤40%	50-150%	75%
Gross Beta	III	PNL-ALO-462 PNL-ALO-463	30	pCi/L	≤40%	50-150%	75%
Bacterial Numbers (MPN)	III	Method 47-3 Ref. 5 modified for Durham tube confirmation.	1000	Bacterial Number	10-1000%	NA	75%
Chromium (VI) (Colorometric)	III	PNL-ALO-227	100	µg/L	≤40%	50-150%	75%
Chromium, Total (Atomic Absorption)	III	PNL-ALO-211	50	µg/L	≤40%	50-150%	75%

1- U.S. Environmental Protection Agency. Methods for the Chemical Analysis of Water and Wastes. EPA-600/4-79-020. March 1983.
2- U.S. Environmental Protection Agency. Test Methods for Evaluating Solid Waste. Third Edition. SW-846, 1986.
3 - Standard Methods for the Examination of Water and Wastewater. LS Clesceri, AE Greenberg, and RR Trussel (Eds.), 17th Edition, 1989.
4- Found in PNL-MA-567 Analytical Chemistry Laboratory (ACL) Procedure Compendium Vol. III and Vol. V.
5- Methods of Soil Analysis, Part 2 - Chemical and Microbiological Properties, Second Edition, A.L. Page, R.H Miller, and D.R. Keeney (Eds.), American Society of Agronomy, Inc., Madison, Wisconson, 1982.
NA - Not Applicable

7.0 SAMPLING PROCEDURES

7.1 Sample Site Selection and Collection

Westinghouse Hanford Company (WHC) shall be responsible for site selection and collection of the groundwater used on this project.

7.2 Laboratory Sample Selection

Sample homogenization shall be achieved by shaking liquid samples for approximately 30 seconds prior to separation for laboratory tests and analyses.

8.0 SAMPLE CUSTODY

8.1 Groundwater Sample Chain-of-Custody

The chain-of-custody for groundwater samples submitted for use in Laboratory Scale Testing shall be initiated by PNL. The resulting samples shall be controlled in accordance with PNL-MA-567, Procedure AD-2, Groundwater Sample Chain-of-Custody.

8.2 Corrections to Chain of Custody

If an error is made on any field or laboratory documentation, an individual may correct the error by drawing a line through the error and entering the correct information. The error shall not be obliterated. All non-editorial corrections shall be initialled and dated.

9.0 CALIBRATION PROCEDURES AND FREQUENCY

All measurement and test equipment (M&TE), for which PNL is responsible, shall be controlled in accordance with PNL-MA-70 Administrative Procedure PAP-70-1201, Calibration Control System.

Category 1 M&TE shall be calibrated by an approved metrology organization. All organizations providing Category 1 calibration services shall be evaluated by the PNL Process Quality Department in accordance with PNL-MA-70 Quality Assurance Procedure QAP-70-701, Preaward Evaluations/Surveys, before being utilized.

Category 2 M&TE shall be calibrated by the user. Requirements for documenting user calibration of Category 2 M&TE are included in PNL-MA-70 Administrative Procedure PAP-70-1201, Calibration Control System.

Any analytical lab performing work shall be designated in the Statement of Work as responsible for calibration of analytical equipment. Category 3 M&TE is not calibrated but is performance checked in the field and is for indication only. Performance checks shall be recorded on the Field Record Form.

10.0 ANALYTICAL PROCEDURES

Characterization and Bench Scale Analyses: Chemical constituents to be analyzed for, as well as corresponding standard analytical methods to be used are shown in Table 6.1 and 6.2.

11.0 DATA REDUCTION, VALIDATION, AND REPORTING

Exhibit 11.1 presents the data reduction, validation, review, and reporting process in flow-chart format. The following sections briefly describe the data reduction, validation, and reporting procedures that shall be used for the evaluation of test results. Specific data validation methods are described in Section 12 as part of the required internal QC. All completed data packages shall be reviewed and approved by the project manager before submission to WHC.

11.1 Data Management Procedures

Analytical results for the characterization samples must be managed in accordance with PNL-MA-567 Procedure DM-1, Analytical Data Handling and Verification Procedure and section 5.10 of QAMS-005/80.

11.2 Process for Handling Suspect or Unacceptable Data

When the initial data review identifies suspect data, that data must be investigated to establish whether it reflects true conditions or an error. The process flow chart is shown in Exhibit 11.1. The investigation must be documented using a Request for Data Review (RDR) (Exhibit 11.2). The Project Manager shall issue RDR numbers and maintain a log in a numbered LRB, of all RDRs generated identifying their status (i.e., date issued, and date closed).

If a data value is determined to be in error, the source of the error shall be investigated, the correct value established if possible, and the erroneous value replaced with the correct value. If the investigation concludes that the data are suspect (possibly in error) but a correct value cannot be determined, the data must be flagged in the comments column to indicate its suspect status.

If the source of the error was a noncompliance with an established requirement or procedure, a Deficiency Report (DR) shall be generated in accordance with PNL-MA-70 Administrative Procedure PAP-70-1502, Controlling Deviations from QA Requirements and Established Procedures. If the source of error was due to the nonconformance of an item, then a Nonconformance Report (NCR) shall be generated in accordance with PNL-MA-70 Administrative Procedure PAP-70-1501, Nonconformance Reports. As a minimum, the Project Manager and the Quality Engineer shall be copied on the data investigation documentation (RDR). Nonconformance reports shall be sent to the WHC cognizant engineer (JB Duncan) and cognizant QAE (RG Dieffenbacher) for disposition concurrence prior to initiating the disposition.

Exhibit 11.1

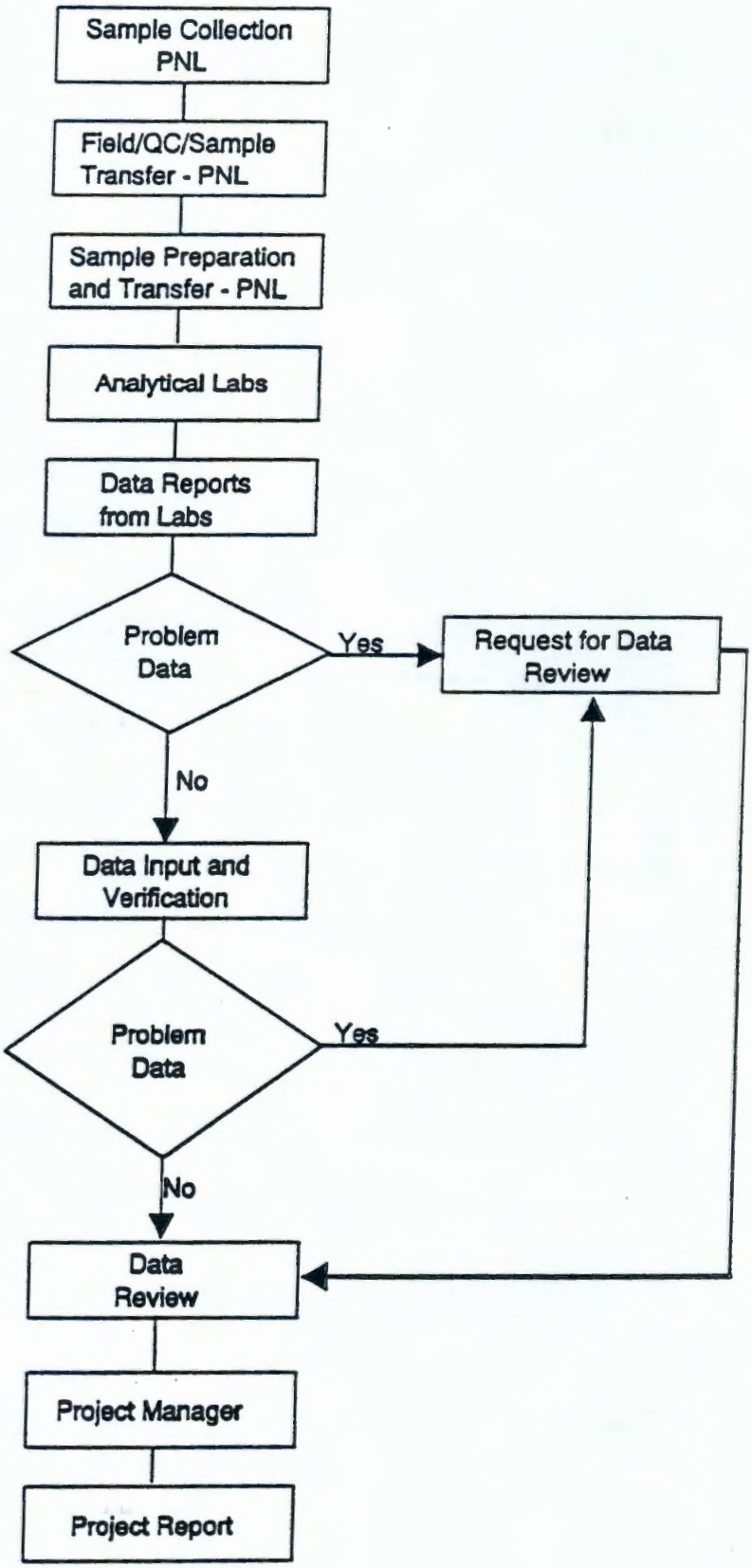

EXHIBIT 11.2

1 ***Request for Data Review (RDR)*** ***No.:*** _____

Originator: _____ Date: _____ Phone #: _____ MSIN: _____

Project: _____ Manager: _____ Phone #: _____ MSIN: _____

Sample #: _____ Well #: _____ Collection Date: _____

Constituent: _____ Value: _____ Other: _____

---

2 ***Reason for Review***

---

3 ***Data Review Findings***

Reviewer: _____ Date: _____ Attachments: _____

---

4 ***Response/Action***

Laboratory Coordination: _____ Date: _____
Signature When Complete

---

5 ***Data Base Management Action***

Data Base: _____ Date: _____
Signature When Complete

---

6 ***RDR Closure***

_____
Laboratory Coordination Task Leader Signature Date

_____ _____
Originator's Signature Date Quality Engineer Signature Date

---

7 ***Distribution***

Originator Project Manager Data Management Reviewer
Laboratory Coordination RDR Logbook (original) Quality Engineer

ADDITIONAL DISTRIBUTION AFTER CLOSURE:

12.0 INTERNAL QUALITY CONTROL CHECKS

12.1 Physical and Chemical Test Quality Control Checks

Laboratory Scale Tests: Quality Control (QC) checks for the Laboratory Scale tests that require analysis of the contaminants of concern include the analysis of a blind duplicate every 10 samples and the analysis of blank samples when applicable. In addition, QC checks for the chemical analyses and physical analyses indicated in Tables 6.1 and 6.2, respectively, are specified in the test method or procedure.

Characterization Analyses: The requirements for an internal laboratory QC program that is implemented through the laboratory's analytical procedures shall be passed to the Analytical Chemistry Laboratory (ACL) via Statement of Work (SOW).

QC checks for the chemical analyses indicated in Table 6.1 to be performed in the ACL are specified in the test method or procedure.

12.2 Acceptable Limits/Results Requiring Action

The acceptance limit for blind standards is ±2 standard deviations (s.d.). In inter-laboratory comparisons using actual field samples, difference between laboratory results of 2.8 s.d is allowed. This criterion is based on the reproducibility limit, with 95% confidence that random error is not responsible for the difference.

13.0 PERFORMANCE AND SYSTEM AUDITS

Compliance and real-time surveillances are performed by Quality Engineers of the PNL Quality Verifications Department (QV). One compliance and two real-time surveillances shall be performed to ensure that specific requirements are being implemented. Surveillances are performed in accordance with PNL-MA-70 Quality Assurance Procedure QAP-70-1001, Planning and Performing Surveillance. Surveillances will be planned and scheduled to assure that all QA program elements identified herein are being effectively implemented during the project life-cycle, and to assure the accuracy of the total measurement system as it pertains to the accuracy of this WHC activity.

Audits are planned and performed in accordance with PNL-MA-70 Quality Assurance Procedure QAP-70-1801, Internal Audits. Quality Assurance audit personnel are qualified in accordance with PNL-MA-70 Quality Assurance Procedure PAP-70-204, QA Audit Personnel Qualification. Currently, there are no audits scheduled on this project. Any performance audits conducted during the life of this project shall be performed by WHC personnel.

The results of surveillances and audits will be made available to project and line management, as well as to individuals contacted.

14.0 PREVENTIVE MAINTENANCE

Routine equipment and facility maintenance and instrument services ensure the timely and effective completion of a measurement effort. Analytical laboratory equipment maintenance is the responsibility of the technical specialist in charge of the analytical laboratory in the 324 building (BL Champion), however, ultimate responsibility resides with the project manager (BM Peyton). Preventative maintenance will be performed per the manufacturer's instructions and stock critical spare parts shall be kept on-hand to insure the most timely repair of the instruments possible.

15.0 CORRECTIVE ACTION

Corrective action must be initiated by the Project Manager or cognizant Task Leader when unplanned deviations from procedural, contractual or regulatory requirements occur. The need for corrective action may be revealed by observations of measurement system response, during data reasonableness checks (brief comparison of newly collected data against observed historical trends), when discrepancies are noted during instrument calibration, or during data analysis.

15.1 Measuring and Test Equipment (M&TE) Calibration Discrepancies

Instruments or equipment found to be operating outside acceptable operating ranges (as specified in the applicable technical procedure or manufacturer's instructions) shall be investigated. A Calibration Discrepancy shall be initiated in accordance with PNL-MA-70 Administrative Procedure PAP-70-1201, Calibration Control System, when it is determined that M&TE is not within calibration and that data have been collected after the calibration expired.

15.2 Deviations from Procedures or Requirements

Unplanned deviations from procedural, contractual, or regulatory requirements must be documented by completing a Deficiency Report (DR) in accordance with PNL-MA-70 Administrative Procedure PAP-70-1502, Controlling Deviations from QA Requirements and Established Procedures. The DR shall identify the deviated requirement, the cause of the deviation, whether any results were effected, and corrective action needed to remedy the immediate problem and to prevent recurrence.

Planned deviations, documented (including justification) and approved by the Project Manager or Task Leader in advance, do not constitute a deficiency as defined in PAP-70-1502 and do not require development of a DR.

15.3 Corrective Action for Significant Conditions Adverse to Quality

When significant conditions adverse to quality are identified, the cause of the conditions and the corrective action taken to preclude repetition shall be documented and reported to immediate management for review and assessment by a Corrective Action Request (CAR) in accordance with PNL-MA-70 Administrative Procedure PAP-70-1602, Corrective Action. "Significant" conditions are identified in Section 4.2.1.1 of PAP-70-1602.

16.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

Deviations from this QA project plan, as well as the results of surveillances and audits, shall be documented, described and reported to the Project Manager. Quality Assurance related information shall be reviewed by the cognizant PNL Quality Engineer.

Problems identified by project personnel shall be reported to the project manager immediately for resolution. Problems involving data quality or sample integrity, shall be thoroughly documented.

Line management shall be included on the distribution of all audit reports. Significant problems encountered in day-to-day operations must be reported to line management immediately by the Project Manager.

17.0 RECORDS

17.1 Records Management

Project records shall be indexed and maintained in accordance with PNL-MA-70 Administrative Procedure PAP-70-1701, Records System. A Records Inventory and Disposition Schedule (RIDS) must be prepared and submitted for review and approval by the Records Specialist and Quality Engineer. Records retention schedules shall be based on DOE Order 1324.2A, Records Disposition, and applicable regulatory requirements.

- The Project Manager shall assure that documents are reviewed for technical adequacy, accuracy, and completeness to verify that the documents support fitness for operation and conformance to specifications and procedures.

- Any problems or deficiencies noted in the records shall be properly resolved and documented in accordance with PNL's deficiency/ nonconformance system (see Section 20).

17.2 Turnover of Records To WHC

All PNL generated record copy, quality affecting documents shall be transmitted to WHC at the completion of the project. These activities must be coordinated through the PNL Records Specialist and reviewed by the project QE prior to transmittal.

18.0 PROCUREMENT CONTROL

18.1 Purchase Requisitions and Subcontracts

Procurement of items and subcontracted services are governed by PNL-MA-70 Administrative Procedure PAP-70-401, Preparation, Review, and Approval of Purchase Requisitions.

18.2 Work Orders and Work Package Authorizations

Work Package Authorizations (WPAs) or Work Orders (WOs) to individuals or groups outside the project organization shall be generated and issued in accordance with PNL-MA-70 Administrative Procedure PAP-70-404, Obtaining Services Via Work Orders. As appropriate (as specified in PAP-70-404), a letter of instruction (LOI) or statement of work (SOW) shall accompany each WO or WPA.

19.0 STAFF TRAINING

Staff performing activities affecting quality shall be issued documented training assignments, including applicable administrative and technical Procedures and this QA project plan, according to PAP-70-201, Indoctrination and Training. Documentation of training shall be maintained by Laboratory Training. The project manager (BM Peyton) and QA representative (KR Martin) shall assure that technicians are trained in the approved analytical procedures and that training is documented in a numbered Laboratory Record Book (LRB).

Requirements for the training of analytical staff to the procedures or methods to be performed shall be passed to the analytical laboratories via Statement of Work in accordance with Section 18.0, Work Orders and Work Package Authorizations.

20.0 NONCONFORMANCES AND DEFICIENCIES

For materials found to be in nonconformance with specifications, a Nonconformance Report (NCR) shall be generated and the item(s) dispositioned in accordance with PNL-MA-70 Administrative Procedure PAP-70-1501, Nonconformance Reports.

Unplanned deviations from Procedures, plans, specifications, or related documents shall be documented using a Deficiency Report (DR) in accordance with the requirements in PNL-MA-70 Administrative Procedure PAP-70-1502, Controlling Deviations from QA Requirements and Established Procedures. Potentially impacted data shall be segregated or flagged by the project manager pending evaluation of the deficiency's impact on the data and final disposition of the DR.

See also Section 11, Data Reduction, Validation and Reporting, for handling suspect or unacceptable data and Section 15, Corrective Actions, for corrective actions.

21.0 DOCUMENT CONTROL

21.1 QA Project Plan Control

Distribution and control of this QA project plan shall be performed in accordance with PNL-MA-70 Administrative Procedure PAP-70-205, Quality Assurance Plans.

Modifications to this QA project plan shall be made in accordance with Section 4.6 of PNL-MA-70 Administrative Procedure PAP-70-205, Quality Assurance Plans, that is, either by revision or by issue of an Interim Change Notice (ICN). Any PNL staff member may request an interim change to this QA project plan at any time by submitting a Document Change Request (DCR) to the Project Manager or Quality Engineer.

21.2 Technical Procedure Control

Many of the technical procedures referenced by this QA project plan are contained in PNL-MA-567, Procedures for Ground-Water Investigations, WAC 173-303, WAC 173-340, and WHC-CM-7-7, Section EII 5.8, and Methods of Soil Analysis, Part 1 and Part 2. PNL-MA-567 is distributed and controlled by PNL Document Control. Deviations from existing procedures shall be thoroughly documented in a Laboratory Record Book in accordance with the PAP-70-1101, and will require WHC approval prior to implementation.

New technical Procedures, whether they will be included in PNL-MA-567 or not, shall be developed in accordance with PNL-MA-70 Administrative Procedure PAP-70-1101, Test Planning, Performance, and Evaluation and controlled in accordance with Administrative Procedure PAP-70-601, Document Control. All technical Procedures shall be distributed and controlled by PNL Document Control.

21.3 Laboratory Record Book (LRB)

The LRB shall be maintained in accordance with PNL-MA-68, Section 6.4, and additional requirements in PNL-MA-70 administrative procedure PAP-70-1701.

22.0 Document Reviews

Document reviews of reports to the client shall be performed in accordance with the requirements in Administrative Procedure, PAP-70-604, Independent Technical Review.

23.0 Software Controls

Commercial software, e.g. , computer spreadsheets and data bases, will not be covered by Software Control Procedures per PNL-MA-70. Calculations and databases kept on or performed with commercial software shall be treated as "hand calculations" and, as such, shall be covered by PAP-70-301. For calculation checks, the checker shall verify that the program performs as expected with both a check of the programming and hand calculations that compare input and output.

APPENDIX C
HEALTH AND SAFETY PLAN

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100 Area Biodenitrification Bench-Scale Treatability Study

Health and Safety Plan

January 1993

Work Order ED3316

CONTENTS

1.0 INTRODUCTION

1.1 GENERAL CONSIDERATIONS AND REQUIREMENTS

The purpose of this Health and Safety Plan (HSP) is to establish standard health and safety procedures for Pacific Northwest Laboratory (PNL) employees engaged in performing laboratory tests for the 100-HR-3 Operable Unit. These laboratory tests include demonstrating that performance levels for nitrate (45 mg/L) removal can be met in 100 Area groundwater and testing for inhibitory compounds as described in the accompanying Biodenitrification Test Procedures.

All PNL staff performing these tests shall do the following:

- Read the HSP and attend a kick-off safety meeting to review and discuss the HSP.
- Follow all relevant health and safety procedures in this HSP, the Environment, Safety and Health (ES&H) Plan, and the Building Emergency Procedure (BEP) both issued by the Waste Technology Center. The ES & H plan and the BEP are attached in the Appendix.

Employees are encouraged to bring any questions and concerns to the project manager. If a pertinent issue arises the project manager will determine the need to change and specify changes in the referenced documents.

1.2 DESIGNATED SAFETY PERSONNEL

Each laboratory in 324 building has a designated laboratory monitor whose name is posted on the wall outside the door. This person is responsible for worker's safety and health within the day to day operations. Conversely, no one will perform work within a laboratory without verbal approval of the laboratory monitor.

1.3 TRAINING

All staff performing laboratory work within the designated labs in 324 will be trained personnel.

Further, before engaging in any laboratory work all PNL staff must fill out a training questionnaire that is used to determine which PNL and PNL Center-specific course must be taken. The need for refresher training is automatically tracked once a worker has completed the initial training. Many of the training courses must be completed prior to setting foot in the laboratory. For the biodenitrification tests to be performed in this project the following courses are mandatory before entering the laboratory setting or alternatively attendance is required at the next course offering after the need to work in the labs is established. Courses relevant to the biodenitrification include:

EESC-ESH-001	Environmental Safety and Health OJT
EP-BEP-3720	Emergency Procedures for 324
SAF-FP-001	Use of Portable Fire Extinguishers
SAF-IS-020	Safety Shower/Eyewash Use
SAF-WM-001	Hazardous and Mixed Waste Management
SAF-HM-020	Hazard Communication Staff Laboratory Worker

Again, the laboratory monitor for each lab also instructs each worker about specific requirements and operations in each particular lab.

2.0 GENERAL PROCEDURES

The following personal hygiene and work practice guidelines are intended to prevent injuries and adverse health effects. A chemical laboratory poses a multitude of health and safety concerns because of the variety and number of hazardous substances present. These guidelines represent the minimum standard procedures for reducing potential risks associated with this project and are to be followed by all laboratory workers <u>at all times</u>.

2.1 GENERAL WORK SAFETY PRACTICES

2.1.1 Work Practices

The following work practices must be observed.

- Eating, drinking, smoking, taking certain medications, chewing gum, and similar actions are prohibited while in the laboratory.
- Personnel shall avoid direct contact with contaminated materials unless necessary for sample manipulation or required observation. Surgeon's gloves and safety glasses are required at all times when performing work on the contaminated liquids.
- Be alert to potentially changing exposure conditions as evidenced by such indications as perceptible odors.

2.1.2 Personal Protective Equipment

- Levels of protection shall be appropriate to the hazard to avoid either excessive exposure or additional hazards imposed by excessive levels of protection. These personal protective equipment specifications must be followed at all times, as directed the project manager.

- Each employee must have available safety glasses.

- Personnel should be alert to the symptoms of fatigue and its effects on the normal caution and judgment of personnel.

2.1.3 Personal Decontamination

- Thoroughly wash hands before eating or putting anything in the mouth to avoid hand-to-mouth contamination.

2.1.4 Emergency Preparation

- A multipurpose dry chemical fire extinguisher shall be available in the hall outside every lab. An eye wash unit shall be available in each lab where there is potential for exposure of personnel to an extent warranting such emergency measures.

3.0 SCOPE OF WORK AND POTENTIAL HAZARDS

While the information presented in the 100 Area Biodenitrification Treatability Test Plan is believed to be representative of the constituents and quantities of wastes at the time of discharge, the present chemical nature, location, extent, and ultimate fate of these wastes in and around the liquid disposal facilities are not certain. The emphasis of the biodenitrification studies will be to characterize the nature and extent of nitrate removal in groundwater, collect data to determine the efficacy of performing biodenitrification, and to aid in the design of a pilot-scale bioreactor.

3.1 WORK TASKS

Work tasks are described in the 100 Area Biodenitrification Bench Scale Treatability Study Procedures.

3.2 POTENTIAL HAZARDS

Existing data indicate that hazardous substances may be encountered during laboratory testing; these are very low-level radionuclides, heavy metals, and methanol.

Potential hazards include the following:

- Very low level alpha and beta radiation from radioactive materials in the groundwater.

- Internal radiation resulting from radionuclides present in contaminated groundwater entering the body by ingestion or through open cuts and scratches.

- Dermal exposure to groundwater contaminated with radionuclides.

- Dermal exposure to groundwater contaminated with inorganic or organic chemicals, and toxic metals.

- Physical hazards such as electrical shocks from bench top equipment.

- Slips, trips, falls, bumps, cuts, pinch points, and other hazards typical when performing wet chemical studies in the laboratory.

3.3 ASSESSMENT AND MITIGATION OF POTENTIAL HAZARDS

Exposure to toxic chemical substances through dermal exposure is not expected to pose a significant problem for the identified tasks given the use of the designated protective clothing, surgeons gloves and safety glasses.

4.0 PERSONAL PROTECTIVE EQUIPMENT

Personal protective clothing and respiratory protection shall be selected to limit exposure to anticipated chemical hazards. Work practices and engineering controls will also be used to control exposure, because a personal protective equipment ensemble alone cannot protect against all hazards. The following guidelines will be used to specify personal protective equipment ensembles, based on the potential hazards associated with low concentration of chromium and methanol.

- Occupational Safety and Health Standards, 29 CFR 1910.120 (OSHA 1988a).

- Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities (NIOSH et al. 1985).

5.0 DECONTAMINATION PROCEDURES

Bench top biodenitrification studies require the use of groundwater with known chemical and very low level radiological contamination. Consequently it is possible that personnel and equipment could be contaminated with hazardous chemical and radiological substances.

5.1 PERSONNEL DECONTAMINATION

All personnel who exit the laboratory will remove surgeons gloves before leaving the laboratory.

5.2 EQUIPMENT DECONTAMINATION

Equipment decontamination methods will generally consist of water washing with a detergent and water. Wash liquids used for decontamination purposes must be properly disposed of in accordance with applicable PNL, state and federal regulations.

6.0 CONTINGENCY AND EMERGENCY RESPONSE PLANS

The following procedures have been established to deal with emergency situations that might occur during laboratory operations. As a general rule, in the event of an unanticipated, potentially hazardous situation indicated by, visible contamination, unusual or excessive odors, or other indications, lab workers shall temporarily cease operations and call the project manager.

6.1 EMERGENCY SIGNALS

Signal	Meaning	Action
Gong (2 Strokes per second)	Fire	Evacuate building. Move upwind. Keep driveways clear.
Siren, steady blasts, 3 to 5	Evacuation	Proceed promptly to designated stages area. Listen for emergency information. Follow instructions.
Crash alarm telephone bell, steady ringing, Room 112	Area emergency	Answer crash alarm telephone. Relay message exactly as received to the Building Emergency Director.
Wavering Siren	Take cover	Stay inside, await instructions.
Howler	Critically	Run away from building proceed to designated area.

Note: Recorded message and sound of signals on 373-2345.

Refer to building emergency procedures in Appendix B for staging area locations.

6.2 PROCEDURE FOR PERSONNEL INJURED IN THE LABORATORY

If an injury occurs, fellow laboratory members will provide appropriate assistance. Only trained, certified personnel should attempt to give first aid, phone 375-2400 and ask for immediate assistance. If able, the injured person should proceed to the nearest available source of first aid which is in the 3706 building (376-3315).

On notification of a serious injury, call the single point of contact emergency phone number 375-2400 and/or Emergency Medical Aid Station 811-0000.

6.3 PROCEDURES FOR FIRE AND EXPLOSIONS

The dry chemical fire extinguishers that are required outside all laboratories are effective for fires involving ordinary combustibles (e.g., wood, plastic), flammable liquids, and electrical equipment. They are appropriate for small, localized fires such as a garbage can of waste, a small burning piece of laboratory equipment, or a hood fire. No attempt should be made to use the provided extinguishers for well-established fires or large areas or volumes of flammable liquids. Call the emergency phone number 375-2400.

In the event of a fire or explosion, the following steps are to be taken.

1. Actuate fire alarm pull box. (The building fire alarm system is tied directly to the 300 Area Fire Station.)

2. Telephone the PNL Single Point Contact on 9-375-2400 to report the fire.

3. Fire extinguishers, strategically located throughout the building, may be used to control small fires; however, NO personal risk is to be taken for this purpose.

   Always actuate a fire alarm pull box before attempting to control even a small fire. Report the fire to 9-375-2400, or have a co-worker make the call.

4. If a fire alarm is actuated, all personnel should leave the building and walk upwind at least 100 feet from the building.

5. If you actuate a fire alarm pull box, ensure that someone goes to the main entrance of the building to meet the Fire Department personnel with details as to location, hazards, and any special recommendations.

6. After the fire has been extinguished --

   If the site of the fire is restricted, the area should not be disturbed until the investigations have been completed.

7. If a fire extinguisher has been discharged, notify your Building Manager. The Building Manager will contact PNL Safety to arrange for the extinguisher to be refilled.

If the fire cannot be readily controlled, take the following steps.

1. On discovering a fire or explosion in the lab alert all staff to evacuate and call the emergency number 375-2400.

2. Isolate the fire to prevent spreading if possible.

3. Clear the area of all personnel working in the immediate vicinity.

6.3 EMERGENCY TELEPHONE NUMBERS

It is preferred that you use the PNL single point of contact emergency response telephone number 375-2400 and allow them to respond accordingly and alert others. If per chance something goes wrong, these other numbers may prove useful.

Local resources:	Hanford Emergency Response Team	373-3800
Medical Aid Station	3706 Building	376-3315
Emergency Medical Aid	300 Area	811-0000
Ambulance:	Hanford Fire Department (they will dispatch ambulance)	373-3800
Hospital:	Kadlec Medical Center, Richland	946-4611
Police (local or state):	Hanford Patrol Operations Center	373-3800
	300 Area Operations	376-3505
Fire Department:	Hanford Fire Department (300 Area)	376-3301
Poison Control Center:		800-572-5842
Radiation Protection:	PNL	376-4703

EMERGENCY CONTACTS

Industrial Safety:	P. A. Wright (PNL)	376-1634
Radiation Protection:	T. Moreno (PNL)	376-3083
Health Physics:	J. R. Berry (PNL)	376-3057
Technical Lead:	B. M. Peyton (PNL)	376-0537

7.0 REFERENCES

PNL-MA-6 Radiation Protection

PNL-MA-43 Industrial Hygiene, Occupational Safety and Fire Protection

PNL-MA-11 Emergency Preparedness

Occupation Safety and Health Standards 29 CFP 1910.120 (OSHA 1988a)

Occupation Safety and Health Guidance Manual for Hazardous Waste Site Activities (NIOSH et al. 1985)

DOE. 1992. 100 Area Soil Washing Treatability Test Plan, DOE/RL-92-51 Decisional Draft, September 1992, U.S. Department of Energy, Richland, Washington.

Appendix A

Waste Treatment Technology Center Environment, Safety and Health Plan.

WASTE TECHNOLOGY CENTER

ENVIRONMENTAL, SAFETY, AND HEALTH (ES&H) PLAN

FOR CY-1992

REVISION 01

APRIL 1992

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CONTENTS

WASTE TECHNOLOGY CENTER ES&H PLAN

I. POLICY

A. STATEMENT

It is the Laboratory's policy to provide a safe and healthful working environment for its staff members and to operate in a manner that ensures protection of the public and the environment.

It is Waste Technology Center policy to comply with the letter and spirit of all environmental, safety and health (ES&H) laws and regulations. It is the duty of every staff member to follow established procedures and to continually evaluate potential risks associated with any activity. The individual is not to rely solely on others to define how to perform a job, but must evaluate the directions received and proceed in accordance with safe practices. Staff members will not knowingly engage in unsafe practices--regardless of who instructed them to do so. It is the duty and right of each staff member to know the health aspects (hazards) of the working environment and not to undertake any work that is perceived to be unsafe. Work will be halted until the individual's concern is addressed. The individual is not to restart that work until the situation is evaluated and action is taken.

It's the responsibility of each staff member and line manager to adequately address the environmental, safety, or health concerns raised by another. Staff members will not be required to perform tasks that they feel might jeopardize ES&H policies. Task leaders, project managers, and line managers will take an active role in the evaluation and prompt resolution of staff ES&H concerns.

Safe and environmentally sound operation of the Laboratory's facilities requires that every staff member accept the responsibility for the implementation of the ES&H program. It is imperative that all staff members strive for continuous improvement in the ES&H program. As part of this process, when deficiencies are identified or incidents occur, prompt action must be taken to correct the problem and prevent reoccurrence. Management will make every effort to recognize staff members when demonstrating on the job safety. The safety record, attitude, and awareness of each individual will be evaluated in the yearly Staff Development Review process. Appropriate ES&H goals will be included in each SDR. Line managers will periodically review the ES&H performance of their staff during routine and special activities to verify that Safe practices are being employed.

All work conducted in the Laboratory or by Laboratory staff shall be thoroughly evaluated for environmental, safety, and health risks and appropriate procedures and controls developed to address identified risks before work is started. In addition, a formal line management self-assessment program is in place to provide additional assurance that Center activities are conducted consistent with good safety practices and pertinent ES&H policies and guidelines.

B. GUIDING PRINCIPLES

1. Laws, regulations, DOE orders, and PNL policies applicable to operations will be complied with in the conduct of the Laboratory's activities.

2. Adequate and timely training for all staff members in environmental, safety, and health requirements and issues will be emphasized as a fundamental element of the Laboratory's ES&H program.

3. Work at the Laboratory will be planned in a manner to ensure compliance with all relevant ES&H requirements. During the conduct of work, any operation that is not in compliance or that poses unacceptable health, safety, or environmental risks or costs will be suspended.

4. The Laboratory will build an organizational culture that consistently places the health and safety of the staff, public, and environment above all other considerations. This culture will be created through staff involvement and training, by establishing staff goals in the performance appraisal process, and through self-assessment practices, proactive risk avoidance, and prompt attention to deficiencies.

C. MANAGEMENT/STAFF RESPONSIBILITIES AND ASSIGNMENTS

ES&H compliance depends on implementation by management and full participation and compliance by all staff. The WTC Environmental Compliance Specialist and the Operations Manager are responsible for program development, and provide Center-wide assistance to all staff for fulfilling the ES&H requirements.

C.1 Center/Directorate Manager

Center/Directorate managers are responsible and fully accountable for environmental protection, safety, and health practices and performance within their organizations. Development and implementation of the organizations ES&H program is the responsibility of the Center Manager.

ES&H Program Responsibilities

- Ensures the overall development and implementation of the Centers ES&H program. Specific responsibilities of this program may flow down to the WTC Environmental Compliance Specialist and Operations Manager.
- Selectively participates in WTC-wide safety walkthrough inspections/assessments including a quarterly assessment of compliance to the 324 Building Operational Safety Requirements (OSRs).
- Maintains an open door policy for safety concerns and ensures prompt corrective action in response to these concerns, inspections or occurrence reports.
- Ensures that resources are available to Department Managers to implement necessary ES&H program measures.
- Serves on the Center Safety Committee. Ensures that concerns expressed by the committee are promptly addressed.
- Serves as the Lead Facility Manager for the 324 Building.

C.2 Line Managers

Line managers are responsible and fully accountable for the environmental protection, safety and health practices and performance of their staff members. This includes recognizing and correcting potential health and environmental hazards in the work conducted by their organization, implementing control procedures and practices to eliminate hazards or reduce them to ALARA, and providing a safe and healthful work place.

ES&H Program Responsibilities

- Reviews and approves a Preliminary Safety Review and Risk Assessment for each project.
- Reviews and approves the Project Management Plan (PMP) or equivalent document for each project and assures that any unusual safety issues are appropriately addressed. Ensures that the PMP appropriately addresses waste minimization and waste management guidelines.
- Ensures that appropriate safety documentation, (e.g., Safety Analysis Report (SAR), Operational Readiness Plan (ORP), Safety Evaluation Document (SED), etc., is in place before beginning work and ensures that all work is carried out in compliance with these requirements.
- Ensures that Laboratory Safety has been made aware of any proposed project that involves a significant safety issue.
- Acts by assignment as a Facility Manager for the 324 Building.
- Interfaces with Building Manager concerning significant changes in programmatic requirements that may impact the building emergency procedures or have significant safety implications to the facility, occupants, equipment, or environment.
- Approves safety related procedures and other operational documents as required.
- Maintains an open-door policy for safety issues and resolves safety issues promptly.
- Reports safety related inspection findings to the Operations Manager to incorporate into the WTC Compliance Tracking System. Sets specific schedules for resolving findings and ensures prompt follow up action. Conducts lessons learned and root-cause analyses as appropriate.
- Ensures that ONE action is timely and thorough and communicates the results of safety audits/inspections and ONEs to the staff.
- Ensures that a Laboratory Manager and Monitor are assigned to each work area.
- Ensures that planned organizational safety meetings are held.
- Inspects all department-responsible facilities to verify that safe practices are being employed and to identify and evaluate hazards in the work place. Assures that staff are informed about all hazards associated with their activities.
- Conducts, with the Building Manager, quarterly, documented safety assessments of significant and high-risk activities for which they are responsible.
- Appoints a Departmental Organizational Safety Representative for their Department.
- Ensures that staff exposure to ionizing radiation and nonradiological hazards is maintained as low as reasonably achievable (ALARA) and that appropriate dosimetry is being used. Assures that the ALARA concept is covered at safety meetings at least annually (D7W20 and D7W30).
- Maintains a current Training Plan addressing the safety training requirements and training status for all assigned staff and assures that all staff receive the appropriate training to perform the assigned work.
- Ensures that new center staff and staff assigned from other organizations receive timely and appropriate ES&H orientation.

C.3 Group Leaders

Group Leader ES&H responsibilities are focused on day-to-day operations.

ES&H Program Responsibilities

- Conducts frequent walk-through inspections of work areas.
- Ensures that work is carried out in compliance with all procedures, Operational Safety Requirements or other limits and controls necessary to assure safe operations.
- Maintains an open-door policy for safety issues.

- Identifies and evaluates hazards in the work place. Ensure that staff are informed about hazards associated with these tasks.
- Confirms that assigned operating space facilities are appropriately posted with emergency information.
- Confirms that staff assigned to work on the project have the required training for the job.
- Confirms that all safety related procedures are approved and posted, where appropriate, before initiation of the work.

C.4 Project Manager or Task Leader

A successful ES&H program requires that the Project Mangers know what the ES&H issues are with respect to the project and what has and is being done to address them.

ES&H Program Responsibilities

- Conducts frequent walk-through inspections of assigned (Project Manager) areas. Promptly resolves deficiencies noted. Performs root-cause analyses as appropriate.
- Prepares the preliminary safety review and risk assessment documents for a project and informs Laboratory Safety and the WTC ECS if the project will generate solid, gaseous, or liquid effluent.
- Prepares and obtains the necessary approvals for safe operating procedures to support the project.
- Ensures that the PMP describes all significant safety and waste management issues in the project.
- Identifies job-specific training required for the work and assure that it is complete and properly documented before initiating work.
- Confirms that all physical controls are in place prior to initiation of work.
- Initiates Operational Readiness Reviews (ORR's) if required.
- Resolves promptly safety concerns expressed by project staff.
- Preplans for project safety, including such items as: waste disposal during and after the project; adequacy of facilities to safely house the project (ventilation, fire protection, sewers, etc.); and personnel exposure where hazardous materials are involved.
- Regularly monitors project activities to ensure that all safety issues are addressed and procedures and requirements are complied with.
- Maintains an open door policy for safety issues.
- Performs ES&H assessments of significant or high-risk projects.

C.5 Staff Members

Staff members are expected to be cognizant of and act in accordance with environmental-, safety- and health-related procedures, postings and pertinent regulations. They are expected to be aware of the safety and environmental aspects of their work activities and to take action to prevent unsafe or environmentally damaging conditions or actions. A successful ES&H program begins with each staff member.

ES&H Program Responsibilities

- Participates in the preparation of safety documentation, procedures, etc.
- Completes job specific safety training before initiating work.
- Refers any safety inquiries from the public or news media to Press Relations and WTC line management.
- Maintains own exposure to radiological and nonradiological hazards to levels consistent with ALARA.

- Is familiar with the PMP and performs assigned work safely and responsibly according to applicable limits, PNL Manuals, SOPs, JHBs (or JSAs), RWPs, CSSs, etc.
- When visiting or working offsite, staff must ensure they have received the necessary site specific training.
- Informs the immediate line manager and project manager or task leader about any safety concerns.
- Provides safety guidance for, and reviews safety performance of less experienced personnel working near him/her.
- Ensures good housekeeping in the work area and that equipment is maintained and properly identified.
- Reports any off-normal events to his/her immediate line manager. For emergencies or where the line manager is not **immediately** available, contacts 375-2400.
- Coordinates all appropriate activities with the WTC Environmental Compliance Specialist (ECS) to ensure changing compliance requirements are communicated, chemicals and wastes are properly managed, and environmental compliance deficiencies are identified and corrected in a timely manner.
- Receives ECS approval for all chemical procurements. This is accomplished by having the ECS initial the purchase requisition.
- Notifies the ECS prior to generating hazardous wastes.
- Ensures all chemical and waste containers are properly labeled and stored.
- Updates the chemical inventories when storing or removing materials in designated areas.
- Immediately identifies any known or suspected chemical and waste management deficiencies to the ECS.
- Notifies the Laboratory monitor prior to conducting activities in his or her assigned area.

C.6 Operations Manager

The Operations Manager assures that Center-specific environmental compliance requirements are articulated to Center staff, that Center environmental compliance goals are defined and formalized, and that Center research staff have access to onsite guidance concerning ES&H compliance matters. The Operations Manager reports directly to the Center Manager.

ES&H Program Responsibilities

- Assists in conducting safety inspections of Center facilities and coordinates Center Manager involvement in planned inspections.
- Chairs the WTC Safety Committee. Ensures that safety suggestions/concerns are brought up for discussion in committee meetings.
- Assists, on request, departments with their training plans and safety meetings agendas.
- Provides support to WTC staff thorough the Environmental Compliance Specialist, Industrial Hygiene Specialist, NEPA Representative, and Hazardous Material Custodian for chemical and waste management, waste minimization, industrial hygiene, and OSHA compliance activities.
- Periodically reviews all Center staff radiation exposures
- Acts by assignment as a 324 Building Facility Manager.
- Maintains an open door policy concerning safety issues.
- Reviews and approves a Preliminary Safety Review and Risk Assessment for each project.
- Maintains the WTC Compliance Tracking System.
- Assures that appropriate lessons learned and/or root-cause analyses are performed at the Building or Center level.

C.7 Environmental Compliance Specialist

The Environmental Compliance Specialist (ECS) interfaces with PNL service components, ensures that WTC ES&H planning documentation is in place, that requirements for training of WTC staff on environmental matters are defined in department training plans, and that appropriate ES&H compliance inspections are performed. The ECS is line managements's advocate for safe and proper handling of hazardous materials that might pose environmental problems and personnel exposures. The ECS provides a single point of contact for operational and policy concerns related to ES&H activities and acts as the center focal point for NEPA and occupational health operational support. The ECS reports to the WTC Operations Manager.

ES&H Program Responsibilities

- Assists project staff in the preparation of NEPA documentation.
- Responsible for the development, training, and implementation of the Centers Chemical Hygiene Program.
- Responsible for the development and implementation of the 324 Building Facility Effluent Monitoring Plan (FEMP).
- Assures that the WTC is staffed with qualified HMCs and assistants. Provides necessary training to selected staff.
- Develops and maintains an Environmental Compliance Training Plan for WTC staff.
- Interfaces with Laboratory Safety, DOE-RL, and other regulatory organizations as required regarding Environmental Compliance and Permit issues.
- Takes the lead in obtaining facility upgrades to improve our environmental compliance posture.
- Serves as the principle contact for questions regarding hazardous materials of environmental and personal exposure concern. Interfaces with Laboratory Safety, WM&EC Section staff as necessary.
- Maintains a consolidated and current listing of the locations of all materials, chemicals, and waste within the assigned areas of responsibility. (Laboratory Monitors will provide bimonthly updates of individual facility inventories as a basis for the consolidated listing.)
- Conducts and documents monthly walk-through inspections of WTC laboratory and chemical storage areas.
- Serves as a resource for facility occupants regarding compatible storage of chemicals.
- Provides waste minimization and pollution prevention advice and recycling options to staff.
- Ensures that Material Safety Data Sheets are available in the building for all chemicals that have MSDS's.
- Maintains an inventory of waste materials awaiting disposal and provides assistance in designating waste.
- Assists (on request) WM&EC staff and WTC Line Management in the conduct of assessments/inspections of assigned areas.
- Assists programmatic staff in packaging, handling, and disposal of waste materials.
- Maintains an up-to-date log of action on surveillance findings generated as a result of his/her own inspections. Keeps the WTC Operations Manager appraised of the status of these inspections, subsequent findings, and actions taken.

C.8 Laboratory Manager

A laboratory manager is designated for each lab. This individual is typically a line manager and is responsible for ensuring that the laboratory/facility has a safe working environment and that those working in the facility have addressed all safety issues related to the work to be performed. The Laboratory Manager delegates day-to-day operating responsibility and authority to the Laboratory

Monitor. See Appendix A for a list of assigned Laboratory Managers and Monitors. Specific Laboratory Manager responsibilities are as follows:

ES&H Program Responsibilities

- Coordinates external audits and surveillances of the laboratory.
- Ensures that any deficiencies noted during safety audits are addressed promptly and correctly.
- Ensures that the laboratory has a qualified Laboratory Monitor.
- Exercises shutdown authority for the laboratory if unsafe conditions are noted.
- Ensures issues have been satisfactorily resolved before authorizing start up of a laboratory that has been shutdown for safety reasons.

C.9 Laboratory Monitor

The Laboratory Monitor has day-to-day responsibility for safety within assigned work areas. Duties include maintaining a current inventory of chemicals and other materials under their cognizance, assuring that the work area is appropriately posted identifying potentially hazardous activities, facilitating resolution of any deficiencies noted during ES&H and housekeeping inspections, and assuring that staff working in the area have received the necessary ES&H training to perform work in the area. The Laboratory Monitor has shutdown authority for operations/activities that pose an immediate threat to the laboratory occupants and facility. The Laboratory Monitor reports to Line Manager responsible for the work area in question. The Laboratory Monitor has shutdown authority for operations and activities within the laboratory that post an immediate threat to continued safe operation. A current list of laboratory monitors is located in appendix A.

ES&H Program Responsibilities

- Takes the lead, consistent with Environmental Compliance Specialist (ECS) guidance, to maintain a current inventory of the chemicals and other materials under their cognizance.
- Posts and maintains current emergency notification listings by the main entry door of the laboratory consistent with PNL-wide guidelines.
- Acts as the principal contact for proposed or ongoing laboratory work and coordinates facility and maintenance activities. Ensures that new work to be introduced into the laboratory or work area is consistent with the intended use of the work area.
- Resolves with responsible staff any deficiencies noted by safety and housekeeping inspections and ensures issues have been satisfactorily resolved before authorizing start up of a laboratory that has been shut down for safety reasons.
- Is familiar with any job specific training required for work in the laboratory and ensures that all staff working with equipment, chemicals, materials, and generated waste in the laboratory have received the necessary job-specific training.
- Ensures that all staff assigned to work in the laboratory maintain their work area in a safe and orderly manner.
- Monitors work and ensures that it is performed consistent with procedures and requirements of the laboratory.
- Coordinates audits of assigned space.
- Posts appropriate operating guidelines (e.g., Safe Operating Procedure, Job Hazard Breakdown, Criticality Safety Specification, Radiation Work Permit, etc.) and job-specific warning signs (e.g., warnings for eye protection, radiation area, carcinogens, high voltage, etc.) where required.
- Ensures all chemicals and wastes are properly labeled and stored in assigned area.

C.10 WTC Safety Committee Representative

Organizational representatives are assigned from and represent the following WTC organizational components:

- D7W10
- D7W20
- D7W30

The specific duties and responsibilities of the WTC Safety Committee Representative are as follows:

- Represents WTC and other 324/327 Building organizations.
- Keeps informed of current safety morale, awareness and implementation/ concerns within organization(s) represented.
- Provides feedback to the Department Manager and staff regarding safety issues.
- Assists management on inspections and corrective actions.

II. SCOPE

Policies, guidelines, and requirements establishing controls to assure that activities are conducted in a safe manner and with minimal impact on the environment are defined below. In addition, WTC programs providing additional guidance and control in the area of ES&H are discussed. Specifically, these programs include Waste Minimization and Pollution Prevention, Chemical and Waste Management, Chemical Hygiene, and Safety.

A. OCCUPATIONAL HEALTH AND SAFETY

Occupational Safety
Staff members and visitors are protected from occupational injury and hazards such as moving machinery, high temperatures, chemical exposure, electrical hazards, motor vehicle and office hazards by controls specified in PNL-MA-43 "Health and Safety Management" and safe/standard operating procedures, job hazard breakdown, job safety analyses, and center-level waste minimization, Chemical and Waste Management, and Chemical Hygiene Programs. Appendix B provides other sources of safety guidance.

Radiation Protection
Staff members and visitors are protected from radiological hazards by controls specified in PNL-MA-6 "Radiation Protection" and radiation work procedures (RWPs) for specific operations.

Emergency Preparedness
Staff members and visitors are protected during emergencies by controls specified in PNL-MA-11 "Emergency Preparedness" and the 324 Building emergency plan.

Industrial Hygiene
Staff members and visitors are protected from occupational illness and health hazards such as high noise areas, chemical handling by controls specified in PNL-MA-43 "Industrial Hygiene, Occupational Safety, and Fire Protection Programs" and safe/standard operating procedures, job hazard breakdowns, job safety analyses, and center-level chemical hygiene program.

A.1 WTC Safety Program

The Waste Technology Center takes a proactive position in developing and implementing programs to ensure the welfare and safety of our research staff. Specific WTC safety requirements are defined below.

Program Objectives

- Assist in providing and maintaining a safe working environment for Center Staff
- Clearly define Center safety policy and the responsibilities of WTC staff concerning safety matters
- Motivate all staff members to a high level of safety consciousness
- Assist in ensuring good communication between staff members and management on safety matters
- Provide an annotated list of sources of safety guidance
- Assure appropriate self-assessment of research activities

Training

Staff assigned to work in laboratory areas will receive training for the specific facility, equipment, and hazards associated with the work they are to perform. Line (Department) Managers are responsible for ensuring that staff receive the necessary safety training. Documentation and status of safety training for staff members is maintained by the PNL Training Coordinator. Duplicate records to provide easy day-to-day reference will be maintained by the Department Manager. Attendance at safety training meetings and should also be documented.

Job Specific Safety Training

Job-specific safety training requirements apply to both on site and off site research facilities under the control of the WTC. The Department Training Plan will address the job-specific training requirements of assigned staff. Typical areas that the plan might address are: radiation work considerations, facility/equipment SOPs, hazardous chemical handling, crane operation, pollution prevention, and waste minimization.

Training on PNL/WTC Safety Policies/Requirements/Procedures

The Department Manager or other qualified individuals will review general safety policies and procedures with each new staff member. The review will include the information listed under the employee orientation in PNL-MA-43, as well as the information contained in this Plan. **This orientation should be accomplished and documented before staff are assigned to project activities.** The Environmental Compliance Specialist will, on request, provide an orientation on the WTC ES&H Plan and PNL-MA-50, **Facility Operational Controls.**

Emergency Preparedness Training

Every year and upon initial hire/building reassignment, each staff member will receive training/retraining on the building emergency procedures. For WTC components occupying space in facilities managed by another contractor or DOE, WTC staff will comply with the requirements of the respective building safety plan/emergency procedures regarding training relating to emergency response.

Vehicle and Office Safety Training

Vehicle operations, office safety and housekeeping will be periodically reviewed with all staff members.

Safety Meetings

Documented safety meetings for all WTC staff will be held periodically to carry out appropriate safety training. The minimum frequency of safety meetings for each WTC organizational component is defined in Appendix C. Safety meetings may be part of a periodic organizational staff meeting.

Occurrence Reporting and Investigating

Prompt and accurate reporting of incidents is the basis for early resolution and recovery. After first attempting to stabilize and control any off-normal event, the WTC staff should then contact their immediate line manager, acting facility manager, and follow the WTC reporting guidelines. (Call the single point of contact [SPC] on 375-2400 if the line manager is not available.) The line manager will take appropriate additional action. Investigation and reporting shall be in accordance with the requirements of PNL-MA-7, Off-Normal Event Reporting System. Temporary and permanent corrective action for off-normal events will be developed by WTC line management in consultation with appropriate support organizations.

Self-Assessment

Line Managers inspect/assess all assigned work areas and high-risk projects on a scheduled basis. Section IV provides a description of the WTC self-assessment program.

A.2 WTC Chemical Hygiene Guidelines

WTC Chemical Hygiene guidelines were implemented to ensure employees receive information and training on the hazards of chemicals present in their work area at the time of initial assignment to a work area, and prior to assignments involving new exposure situations. Further chemical hygiene information can be obtained from Cameron Andersen, the WTC Chemical Hygiene Specialist (376-4410), or Rich Johanson, the PNL Chemical Hygiene Officer (376-1586).

The chemical hygiene guidelines have been developed to comply with OSHA requirements outlined in 29 CFR 1910.1450, "Occupational Exposure to Hazardous Chemicals in Laboratories."

Employee Information

- The WTC Chemical Hygiene Specialist in room 108 can provide information regarding the OSHA requirements in 29 CFR 1910.1450, "Occupational Exposure to Hazardous Chemicals in Laboratories," and the PNL Chemical Hygiene Plan located in Section 3.0 of PNL-MA-43, "Industrial Hygiene, Occupational Safety, and Fire Protection Programs."
- Permissible exposure limits (PELs) for OSHA-regulated substances and recommended exposure limits for other hazardous chemicals not listed by OSHA can be obtained from review of 29 CFR 1910, sub-part Z, table Z-1-A; material safety data sheets (MSDSs); and other guides and literature available from the WTC Chemical Hygiene Specialist in room 108.
- Current postings at the entrance to laboratories include information related to OSHA-required hazard communication, emergency contacts, spill kit location, required personnel protective equipment (PPE), inventory of chemicals with associated hazards and permissible exposure limits, and a copy of this chemical hygiene guide.
- Information on the hazards, safe handling, labeling, and storage of hazardous chemicals can be obtained from review of Material Safety Data Sheets (MSDSs); PNL-MA-43, "Industrial Hygiene, Occupational Safety, and Fire Protection Programs"; and WTC Chemical and Waste Management Guidelines. Other reference materials are available from the WTC Chemical Hygiene Specialist in room 108 and from Occupational and Radiological Safety (ORS) in the 337 Building (376-1586). MSDSs are located in room 108 of the 324 Building.

- Information regarding the proper disposal of hazardous chemicals and wastes can be obtained from review of PNL-MA-8, "Waste Management and Environmental Compliance," and the WTC Chemical and Waste Management Plan, or by contacting Cameron Andersen, the WTC Environmental Compliance Specialist (376-4410).
- Technical procedures, test instructions, test plans, job hazard breakdowns, or safe operating procedures are required for performing tests, experiments, and routine laboratory operations involving hazardous chemicals. (Reference PNL-MA-50, Section 5.0.) These procedures are to identify the necessary personal protective equipment and special procedures (e.g., rubber gloves, aprons, eye protection, respirators, local exhaust ventilation requirements, laboratory fume hoods, special work practices and emergency procedures) required to perform the specified task involving hazardous chemicals. Laboratory Safety, the Building Manager, and Line Management are the current minimum approvals or concurrence for such procedures.
- The use of carcinogenic and highly toxic chemicals requires a chemical safety protocol. PNL-MA-43, Section IH 3.0 "Toxic Chemicals, Carcinogens and Biological Materials" can be referenced for information on preparing chemical safety protocols.
- Report all signs and symptoms associated with hazardous chemical exposure to the WTC Chemical Hygiene Specialist on 376-4410. All staff members have the right to request health evaluations if there is reason to believe that exposure to a substance is resulting in any toxic effect. Staff are also required to participate in any initiated worker health evaluation programs. This includes the wearing of personal air sampling and chemical dosimeters used to measure airborne concentrations of chemical contaminants. Results of the sampling can be obtained by contacting line management.

Employee Training

- All staff members working with hazardous chemicals must attend lesson SAF-HM-020. SAF-HM-020 identifies the requirements of the laboratory standard OSHA 29 CFR 1910.1450 and PNL's Chemical Hygiene Plan (PNL-MA-43, Section IH 2.0). Contact Laboratory Training (376-7157) to schedule training for SAF-HM-020.
- Staff must review and sign the chemical safety protocol before working with highly toxic and carcinogenic chemicals. A list of WTC highly toxic and carcinogenic chemicals and the laboratory where they are used is provided in appendix A.
- Staff members must read the MSDS and Chemical Safety Protocol (for carcinogenic and highly toxic materials) or similar reference material for each substance they will be using in work activities. The comparable reference material shall include information on:

  - Methods and observations that may be used to detect the presence or release of a hazardous chemical. These include, but are not limited to, intermittent monitoring techniques, continuous monitoring devices, and visual appearance or odor of hazardous chemicals when being released.
  - The physical and health hazards of the chemical.
  - Protective measures such as appropriate work practices, emergency procedures, and personnel protective equipment to be used when working with the chemical.

B. PROTECTION OF THE ENVIRONMENT AND THE PUBLIC

Chemical and Waste Management

Waste generation, such as liquid effluents, air emissions, hazardous chemicals, and radioactive waste is minimized and controlled in accordance with the requirements in PNL-MA-8 "Waste Management and Environmental Compliance;" PNL-MA-822, "Waste Minimization and Pollution Prevention Awareness programs;" Environmental Compliance Management Plan (February 7, 1990); WAC 173-303; WTC chemical and waste management guidelines, WTC

waste minimization/pollution guidelines, standard operating procedures, job hazard breakdowns, and job safety analyses.

Environmental Compliance

Activities of the Waste Technology Center are managed to protect the environment and comply with environmental requirements by implementation of the controls specified in PNL-MA-8 "Waste Management and Environmental Compliance," the Environmental Compliance Management Plan, Tri-Party Agreement requirements, NEPA documentation, standard operation procedures, job hazard breakdowns, job safety analyses, WTC Chemical and Waste Management Guidelines, and WTC waste minimization and Pollution Prevention guidelines.

B.1 WTC Chemical and Waste Management Guidelines

Program Objectives

The WTC is committed to the safe use, storage, and disposal of all chemical products and waste materials generated from our research and development activities. This plan details the requirements for managing these chemicals and wastes consistent with PNL and regulatory requirements. It serves as the WTC and facility-specific plan for buildings and facilities occupied by WTC staff. The objective of the plan is to present a comprehensive chemical and waste management program that is tailored to the specific needs of WTC staff and is consistent with PNL chemical and waste management policies outlined in PNL-MA-8 "Waste Management and Environmental Compliance" and pertinent sections of PNL-MA-43 "Industrial Hygiene, Occupational Safety, and Fire Protection Programs."

Specific Guidelines

Labeling

Container labeling is an essential component of a comprehensive chemical and waste management plan. The labeling distinguishes waste from valuable product (waste segregation), indicates the hazards associated with the material (hazard communication), and identifies the responsible owner (material management). The HMC maintains a thorough inventory of chemical and waste container identification labels for staff use. The following sections identify the basic labeling requirements for the more common situations. The HMC should be contacted for specific labeling requirements not identified in the following examples. Refer to appendix D for specific labeling requirements.

Storage Requirements

Chemical products and valuable test materials are managed by the WTC in such a manner to avoid interpretation as speculatively accumulating hazardous wastes. The future value of all research chemicals and test solutions are evaluated on a routine basis to ensure that programmatic missions exist to support their continued management. All materials deemed "waste like" because of condition, composition, or lack of future research value will be designated and properly disposed of in a timely manner in accordance with standard PNL waste management policies. Refer to appendix E for specific storage requirements.

Hazardous Waste Disposal

Hazardous Wastes are those wastes that meet the criteria established in WAC 173-303, 40 CFR 261 sub-parts C and D, and the EPA. Hazardous waste must be further classified as dangerous waste (DW) or extremely hazardous waste (EHW). In general, a hazardous waste is any unwanted, nonradioactive, solid, liquid or gas, or a mixture substances having properties capable of producing adverse effects on human health, safety, or environment. If the waste exhibits any one of the following characteristics, it may be classified as hazardous.

acidic	shock-sensitive	carcinogenic
basic	asphyxiant	teratogenic
pyrophoric	irritant	bioaccumulative
ignitable	reactive	controlled substance
toxic	mutagenic	
oxidizer	heavy metal	

The ECS or WM&EC can further assist in the designation of waste products. Once designated, hazardous wastes are disposed of by filling out a chemical disposal request. The chemical disposal request must be filled out by the generator, approved by the ECS, and then submitted to WM&EC for disposal at through their permitted facility. Contact the ECS for disposal forms and assistance in preparing them.

Chemical Inventory Evaluation

When the revised 324 Building OSR for chemical inventory management comes into effect, the chemical inventory within the 324 will be evaluated at least quarterly for compliance with this OSR.

B.2 WTC Waste Minimization and Pollution Prevention Program

The Waste Technology Center (WTC) seeks to operate in a manner that minimizes the generation of waste and maximizes the concentration, recovery, and recycle of waste products to the greatest extend economically practicable. This will be achieved by buying only what is needed, limiting the production of waste material, reducing the volume of waste, and recycling materials wherever possible.

Because the WTC is an organization involved in research and engineering, the emphasis of our minimization effort will be directed toward 'up-front' planning, avoiding the purchase of excess amounts of materials and limiting the amount of waste generated. The wide mix of work conducted necessitates a familiarity with minimization policies and practices concerned with a range of radioactive, RMW, and hazardous materials and waste. Because of the great range in size and type of projects conducted, the focus of our waste minimization will be towards minimizing waste generated through a careful review of the project before experimental activities are initiated.

Pollution prevention will be emphasized, primarily, through implementation of center-wide waste minimization and chemical/waste management activities. Staff training will be an integral part of the WTC waste minimization and pollution prevention program.

Waste Minimization

Waste minimization will be addressed on a project basis. The Project Management Plan or other independent documented analysis will be the primary means of documenting a waste minimization evaluation conducted by the Project Manager. This evaluation must be completed before commencing work. The WTC Environmental Compliance Specialist will selectively review these evaluations. The features of the WTC waste minimization process are summarized below:

1. A waste minimization assessment or evaluation of the planned process(s) will be conducted for projects involving experimental activities. Specifically, issues that should be addressed in a waste minimization assessment include, but are not limited to, the following:

   A. Need for quantities and types of chemicals/materials specified.
   B. Potential alternate chemicals/materials.

C. Process flow changes that could minimize waste.
D. Approaches to reducing the volume and toxicity of waste generated (e.g. chemical recycling, reclaiming).
E. Approaches to reducing spills, leaks, chemical makeup errors, an unnecessary experiment runs.
F. Quantities and type of waste generated and how it is to be managed to minimize storage and disposal costs.

2. The waste minimization assessment will be documented in the PMP under a "Waste Minimization" section. The waste streams expected to be generated (total quantity and constituents) will be listed and key considerations (See paragraph 1 above.) that were addressed during the waste minimization evaluation will be noted. Quantitative estimates of waste reduction resulting from the process(es) selected over alternate approaches considered should be included. An assessment of the qualitative improvements in the waste to be generated should also be discussed. (Other sections of the PMP will address environmental compliance issues related to disposal of any waste material, including environmental permits and funds required to dispose of any waste.)

3. For those projects where a FY-90 PMP has already been prepared and approved, a memo to the project file with copy to the Section Manager will be prepared summarizing how the question of waste minimization has been addressed in the project.

4. The subject of waste minimization, will be discussed, at least annually, at a section staff or other general meeting. This discussion will be documented.

Additional Waste Minimization Guidance

Specific waste minimization guidance concerning LLW, TRU, RMW, hazardous waste, chemical recycling, and exceptions to waste minimization is available in Section 3.0, of PNL-MA-8, Waste Management and Environmental Compliance, and PNL-MA-822, Waste Minimization & Pollution Prevention Awareness Program Plan (Draft dated July 1989). Key areas concerning cost accounting, training, and technology transfer are specifically addressed in PNL-MA-822, Sections 4.3, 5.2, and 7.0, respectively. The Waste Management and Environmental Compliance Section, of the Laboratory Safety Department will provide support as necessary on specific waste minimization questions.

Pollution Prevention Guidelines

All WTC projects are reviewed by the ECS for compliance with the National Environment Policy Act (NEPA). This review aids to ensure that any effluent discharges from the conduct of research activities is in accordance with Federal, State, DOE, and PNL regulations. NEPA evaluations are conducted and documented prior to the commencement of research programs. The 324 Building Facility Effluent Monitoring Plan (FEMP) details the facility monitoring systems installed for detecting effluent releases to the environment. Further Pollution Prevention guidelines are embodied within the Center Waste Minimization and Chemical and Waste Management guidelines. In addition, housekeeping is closely related to pollution prevention. Ongoing line management housekeeping inspections, waste management audits and inspections, and responsible chemical management within individual laboratories and storage areas will collectively contribute to pollution awareness.

C. FACILITIES SAFETY

Fire Protection

Programs and facilities, equipment, and other property entrusted to the Waste Technology Center are protected from fire or other accidental loss through controls specified in PNL-MA-

43 "Industrial Hygiene, Occupational Safety, and Fire Prevention Programs", other facility related manuals such as PNL-MA-50 and PNL-MA-90, and safe/standard operating procedures, job hazard breakdowns, and WTC Safety Guidelines.

When the revised 324 Building OSR for fire-safety inspection comes into effect, the Lead Facility Manager will ensure that a monthly fire-safety inspection of the 324 Building is conducted.

Nuclear Safety

The use of fissile materials by the Waste Technology Center requires the implementation of special controls, which are given in PNL-MA-25 "Criticality Safety" and criticality safety specifications (CSSs), operational safety requirements (OSRs) and safe/standard operating procedures.

III. ES&H SELF-ASSESSMENT PROGRAM PLAN FOR 1992

A. PURPOSE & SCOPE

The purpose of this self-assessment program is to provide for continual evaluation of work activity performance within the WTC and to identify successes and areas for improvement. The self-assessment program is an integral part of the management of WTC activities. Line management must regularly review the distribution of their time between technical management and assessment of safe operations. Assurance that operations are conducted safely and consistent with ES&H requirements must receive the required emphasis. This plan provides 1) an integrated Center-level program for documented management inspections, 2) assessments of significant or high-risk areas within the center, 3) full implementation of an existing WTC commitment control system, and 4) implementation of a graded trend/root cause analysis program. The program applies to all facilities, operations, and projects/activities assigned to the WTC.

The implementation of this self-assessment program will include the identification and evaluation of deficiencies, root cause, corrective actions, trends and lessons learned as applied in a graded manner depending upon risk/hazard. For example, root cause evaluation will be applied only to events at the Off Normal Occurrence level or higher when management has dictated a need for detailed evaluation. Lessons learned will be used when personal injury accidents occur.

Specific WTC goals with a schedule and implementation steps related to selected self-assessment elements listed below are provided in Appendix F, WTC ES&H GOALS AND IMPLEMENTATION SUMMARY.

B. SELF-ASSESSMENT PROGRAM IMPLEMENTATION ELEMENTS

1. Management Inspections (Assessments)

   Self-evaluations will be performed to monitor ongoing operations and compliance to safety requirements. Checklists should be used as appropriate for inspections and incorporate evaluation criteria from PNL manuals, Operational Safety Requirements [OSRs]), and other formal performance criteria sources. The specific, documented assessments that are currently being performed or will be carried out are as follows:

   - Scheduled assessments of significant experimental activities (particularly high-risk projects) by Line Management,

- Quarterly assessment of 324 and 327 Building OSR Compliance under the direction of the Lead Facility Manager,

- Scheduled walk-through inspections of all assigned work areas to assess environment, health, and safety issues by Line Management,

- Monthly WTC ES&H Specialist building inspections of the WTC managed Buildings,

- Monthly Lead Facility Manager (or designee) management building fire inspections in the 324 Building (This item will become active when the corresponding Operational Safety Requirement in the revised 324 Building SAR is approved by DOE-RL.),

- Quarterly Lead Facility Manager (or designee) hazardous chemical inventory and inspections in the 324 Building (This item will become active when the corresponding Operational Safety Requirement in the revised 324 Building SAR is approved by DOE-RL.),

- Monthly Criticality Safety Inspection of compliance to criticality safety requirements in fissionable material facilities (324 and 327 Buildings) by the Criticality Safety Representative, and

- Quarterly Facility Operational controls inspection by the Lead Facility Manager.

2. **Reporting Assessments/Inspection Findings**
   Line managers will document assessments/inspections and forward this document to the WTC Operations Manager within 3 working days of the audit or inspection.

3. **Finding Tracking**
   The Operations Manager will input audit/inspection findings into the WTC Compliance Tracking System and periodically update the system as required to reflect the current status of audit/inspection findings.

4. **Management Follow-up of Finding Resolution**
   Each line manager, as appropriate, will follow up to verify that assessment findings are promptly addressed and that action on findings is reported to the Operations Manager. Line management will also report the action and/or status of findings to effected WTC staff as appropriate. (The Operations Manager will periodically publish a status report of action and/or status of findings to WTC staff.)

5. **Continuous Improvement**
   The WTC Operations Manager will ensure that an annual WTC-wide 'lessons learn'/trend analysis is completed after each calendar year. The self-assessment plan for CY-1993 will reflect lessons learned from CY-1992 self-assessment activities. Specific lessons learned evaluations and root cause analyses will be performed as required by the cognizant line manager using a graded approach that takes into account the risk/hazard associated with the deficiency.

6. **Contributing External Assessment Activities**
   A variety of assessment activities are conducted regularly throughout the year by organizations external to the WTC but typically involve participation of WTC staff. These focus on significant or high-risk operations utilizing specific performance objectives and criteria to accomplish the assessment. Examples of these are as follows:

- Annual Nuclear Facility Safety Appraisal (324, 327, and 3630 Buildings)
- Semi-Annual Criticality Safety Audit (324 and 327 Buildings)
- PNL Environmental Compliance Annual Facility Inspection
- Routine Occupational & Radiological Safety Facility Inspections
- Annual PNL Safeguards Internal Material Balance Area Operations Review
- Annual PNL/DOE Safeguards Witnessed Physical Inventory of Material Balance Areas.

IV. ES&H LABORATORY/CENTER GOALS

The Laboratory has established ES&H goals for all managers and staff members. These Goals or performance requirements reflect the Laboratory's expectations for ongoing performance in ES&H. They provide guidance to managers and staff in identifying continuous improvement efforts in the area of ES&H and, as appropriate, specifying improvement goals in the SDR process.

Specific procedures and guidance provided in PNL's ES&H manuals are minimum requirements. PNL's commitment to continuous improvement implies that wherever it is feasible, PNL staff and managers will seek to go beyond these minimum requirements. Performance requirements (goals) for Level 1 managers are listed in MG 2.0, Appendix A, under the separate headings of "Environmental Compliance" and "Safety." The following principles underlie these performance requirements:

- Managers are accountable for establishing the process by which ES&H requirements are implemented and communicated to staff and for promoting staff input to the process.
- Staff are responsible for implementing the process established by line managers and for providing input to its development and improvement. This implementation by WTC management staff is reflected in the goals and specific implementation action presented in Appendix F.

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APPENDIX A

WTC STAFF ASSIGNMENTS FOR CHEMICAL AND WASTE MANAGEMENT

324 Building/Facility Common Space - WTC Center Manager -- J. L. McElroy
Environmental Compliance Specialists -- C. M. Andersen
324 Building/Facility - HAZARDOUS MATERIAL CUSTODIAN -- C. M. Andersen

SPACE	LABORATORY MONITOR	LABORATORY MANAGER
EDL-101	Tom Brouns	Harry Burkholder
EDL-102	Chris Chapman	Harry Burkholder
Module 1.	Dan Janke	Harry Burkholder
2, 3	Dan Janke	Harry Burkholder
4.	Tom Brouns	Harry Burkholder
5.	Bill Heath	Harry Burkholder
6.	Matt Cooper	Harry Burkholder
7, 8	Joe Perez	Harry Burkholder
11	Dan Janke	Harry Burkholder
12, 14	Greg Whyatt	Chuck Allen
13	Dan Janke	Harry Burkholder
15, 16, 17, 18	Joe Perez	Harry Burkholder
Tank Pit	Joe Perez	Harry Burkholder
Lab 115	Rod Skeen	Harry Burkholder
Lab 207/Lab 208	Dana Thomas	Harry Burkholder
Lab 210	Mike Elliott	Harry Burkholder
Lab 212	Lynette Jagoda	Chuck Allen
High-Bay	Rob Gaskill	Chuck Allen
Room 145, 147	Chuck Bigelow	Jim Seay
Room 146	Dan Janke	Harry Burkholder
Room 18	Chuck Bigelow	Jim Seay
Room 309A	Cheryl Thornhill	Chuck Allen
Chem Makeup Room	Joe Perez	Harry Burkholder
Head Tank Room	Chuck Bigelow	Jim Seay
Cask Handling	Chuck Bigelow	Jim Seay
Truck Lock	Chuck Bigelow	Jim Seay
324 Bldg. North LLW Storage	Jim Gose	Jim Seay
D Cell	Cheryl Thornhill	Jim Seay
A, B Cells	Chuck Bigelow	Jim Seay
C Cell	Jeff Surma	Jim Seay
ISV Site	Jim Jeffs/Tom Powell	Harry Burkholder
SMF Facilities	Randy Thornhill	Jim Seay
Room 3E, 3F, 3G	Randy Thornhill	Jim Seay

April 13, 1992

APPENDIX A
WTC STAFF ASSIGNMENTS FOR CHEMICAL AND WASTE MANAGEMENT
CONT.

SPACE	LABORATORY MONITOR	LABORATORY MANAGER
327 Building	Del DesChane	Jim Seay
336 Building	Joe Westsik	Chuck Allen
3730 Building	Del DesChane	Jim Seay
Wellsian Way Warehouse	Cameron Andersen	Don Knowlton
3718E&G Warehouses	Cameron Andersen	Don Knowlton
324 Building Yard	Larry Maples	Lynn Eberhardt
1234 Kaiser Yard	Cameron Andersen	Don Knowlton

APPENDIX B

SOURCES OF SAFETY GUIDANCE

PNL Environment, Safety and Health Plan Issued by W. R. Wiley
Provides overall guidance for safety within PNL, stressing line management responsibility.

Management Guide 11.2 Safety, Summarizes PNL policies and responsibilities in assuring a safe working environment.

PNL-MA-6 Radiation Protection. Establishes basic radiation protection standards applicable to all PNL work with radioactive materials or radiation-generating devices. Designed to minimize radiation exposures of personnel and releases of radioactive material to the environment.

PNL-MA-7 Off-Normal Event Reporting System. Provides guidelines for reporting of all off-normal events, including unusual occurrences. Describes overall system, notifications, investigation, reporting, and recovery.

PNL-MA-8 Waste Management and Environmental Compliance. Presents procedures and requirements related to the handling and storage of radioactive and/or nonradioactive hazardous waste materials.

PNL-MA-25 Criticality Safety. Describes requirements for preventing accidental criticality in the handling, storage, and use of fissionable materials.

PNL-MA-42 Manager's Guide to Safety. Provides a concise summary of the information managers need to know or be aware of in establishing and maintaining safety programs. In addition, the "Guide" contains a list of the primary contacts in Laboratory Safety who can answer safety-related questions.

PNL-MA-43 Health and Safety Management. Gives guidance for industrial safety within PNL. Includes 28 chapters and Appendices on a variety of Safety related topics.

PNL-MA-50 Facility Operational Controls. Provides guidelines for integrating PNL facility operations and the individual operating occupant groups to ensure that; 1) the individual operations are each conducted in an effective, safe, secure and environmentally acceptable manner; 2) several individual operations are mutually compatible; 3) the facility systems (e.g., exhaust ventilation systems) are designed and operated to provide the necessary capacity and capability to support the needs of the individual operations and ensure the safe, secure, and environmentally acceptable operation of the combined operations. Defines

APPENDIX C

MATRIX OF SAFETY MEETING RESPONSIBILITIES

Org. Code	Safety Meetings Minimum Freq per yr.	Responsible Manager
7W00	1	JL McElroy
7W10	1	GW McNair
7W20	4	CR Allen*
7W30	4	Burkholder

* Includes 324, 327, 336 and 3730 Buildings.

APPENDIX D

CONTAINER LABELING REQUIREMENTS

The following identifies the minimum labeling requirements for the more common situations. The WTC Environmental Compliance Specialist should be contacted for specific lebeling requirements not identified in the following examples.

Chemical Containers
Chemical containers must be identified with the following information:

Material Description
Responsible Person
Responsible Program
Date Received
Hazard Information

Hazardous Waste Containers
Hazardous waste containers must be identified with the following information:

Material Description
Responsible Person
Responsible Program
Date Generated
Hazard Information

Empty Drums
Empty new or used drums are required to be identified with the following information:

Previous Contents (if used)
Responsible Person
Responsible Program
Date

Miscellaneous Containers
The following minimum information must be affixed to all other containers.

Contents
Responsible Person
Date
Hazard Information

APPENDIX E

CHEMICAL AND WASTE STORAGE REQUIREMENTS

Chemicals

Chemical products are approved for storage only in designated areas. Currently labs 115, 207, 208, 210, 212, EDL-101 and 3718G warehouse are approved for chemical storage. The lab monitor and ECS should be notified when significant quantities of chemicals are stored or remvoed from designated areas. Chemicals must be packaged in the original container or one of equivalent integrity. The ECS should be notified when new chemicals are procured to ensure the material is stored in a compatible arrangement with other products. Section OS 2.0 of PNL-MA-43 provides further guidance on chemical storage.

Hazardous Waste

Hazardous wastes are approved for storage in satellite accumulation and <-90 day areas only.

Satellite Accumulation Area - A satellite accumulation area shall be a location at the point of waste generation (hazardous or mixed) where wastes initially accumulate. It is under the control of the operator of the process generating the waste. Hazardous waste accumulation limits for a satellite area are; 55 gallons for a dangerous waste and 1 quart for an extremely hazardous waste.

Less Than 90-Day Storage Area - All waste accumulation that is not satellite accumulation is <-90 day storage. Generally, <-90 day storage is used to collect waste from multiple generators. The quantity limits for accumulation are based on building codes. The waste regulations limit the time of accumulation. The 90-day clock begins when a waste is first designated or whan a waste has been moved from a satellite accumulation area.

There are stringent management requirements associated with operating either storage area. The HMC should be contacted prior to generating a hazardous waste to assist in the setup and management of either area.

Chemical Inventory

Each laboratory and designated storage area must maintain its own chemical inventory. The laboratory or storage area inventory must show additions or removal of chemicals from a laboratory or storage are. Chemical containers that are emptied must be noted on the inventory and properly disposed of. Chemical utilization log sheets are used to record the flow of chemicals into and out of each storage area. Laboratory monitors are required to update the inventories on a bimonthly basis and provides these updated inventories to the ECS for inclusion into the PNL-wide system.

PNL is in the process of developing a comprehensive inventory system and the WTC will adopt this system upon implementation.

APPENDIX F
WTC ES&H GOALS AN IMPLEMENTATION SUMMARY

LABORATORY ES&H GOAL:

Each organization shall implement a formal line management ES&H self-assessment program.

Center ES&H Goal: Self-Assessment:

The Center will continue to develop its self-assessment program. The self-assessment program will be composed of management walk-through inspections, safety training, documented audits of significant or high-risk operations, the implementation of a formal commitment control system and, an a root-cause/lessons learned/annual trend analysis program.

The self-assessment program will utilize criteria to determine if pertinent performance objectives have been satisfactorily met.

Implementation Steps:

Step 1: Prepare a self-assessment program plan describing inspection/assessments, commitment control, and trend/root cause analysis activities. Provide a copy of the plan to the Performance Assurance Group, Facilities & Operations Directorate.

Schedule: By April 15, 1992
Assignment: The Center Operations Manager

Step 2: Review and modify the self-assessment program plan based on lessons learned during the year.

Schedule: December 31, 1992
Assignment: The Center Operations Manager with input from the Center Management Team.

Center ES&H Goal: Line Management Inspections (Assessments):

Line management will conduct scheduled inspections or reviews of work areas and significant or high-risk projects or activities. These inspections will be documented and any items found that need to be corrected will receive appropriate attention. Line management will then follow up to verify that items needing correction have been addressed.

Implementation Steps:

Step 1: Provide the Center Operations Manager with a schedule of ES&H walk-through inspections for 1992.

Schedule: By April 20, 1992
Assignment: Center line managers[1]

Step 2: Review WTC operations and identify facilities/operations and projects deemed to be significant or high-risk operation. Prepare inspection schedules for these activities for the remainder of the calendar year and forward to the Center Operations Manager.

Schedule: By June 1992
Assignment: Center Operations Manager with input from the WTC Line Management

LABORATORY ES&H GOAL

Each organization shall schedule ES&H Training based on job requirements for all staff, including managers.

Center ES&H Goal: Safety Training

All staff will be properly trained to perform their job assignments safely and in compliance with established ES&H requirements. At a minimum, training requirements will be identified in a training matrix for each staff member.

Implementation Steps:

Step 1: Review staff training requirements in light of the Center training goals and project-specific needs and create or update a training matrix for each staff member. As staff member training requirements are met, enter that data into a database that can be audited.

Schedule: Annually
Assignments: Center line managers.

Step 2: Conduct a review of staff training status and report to the Center Manager.

---

[1]For the purposes of this document, Center Line Managers encompass the following: Center Manager, Department Managers, Section Managers, and Project Managers of high-risk projects.

Schedule: June 30, 1992
Assignments: Center Operations Manager.

LABORATORY ES&H GOAL:

Each organization shall increase individual staff member involvement and participation in the ES&H Program.

Center ES&H Goal: WTC Safety Committee:

The WTC Safety Committee will be utilized to solicit staff member ES&H Safety concerns.

Implementation Steps:

Step 1: Develop strategies to solicit safety concerns from staff.

Schedule: March 1, 1992
Assignments: WTC Operations Manager with assistance of WTC Safety Committee.

Step 2: Implement plan to solicit staff members ES&H concerns.

Schedule: April 15, 1992
Assignments: WTC Operations Manager.

LABORATORY ES&H GOAL:

Each organization shall identify the hazardous materials in the workplace and provide information on the hazards to workers and visitors who may be potentially exposed to those materials.

Center ES&H Goal: Chemical Management:

The PNL Chemical Management System will be implemented within the Center.

Implementation Steps:

Step 1: Identify support staff and schedule system training.

Schedule: February 1, 1992
Assignments: Environmental Compliance Manager.

Step 2: Inventory and barcode all WTC Chemicals for inclusion into the Chemical Management System.

Schedule: March 31, 1992
Assignments: Environmental Compliance Manager.

LABORATORY ES&H GOAL:

Each organization shall evaluate the waste streams that comprise 5% of the organizations total waste stream and identify process changes, product substitution, reclamation, or other waste minimization opportunities.

Center ES&H Goal: Waste Minimization:

WTC projects will be reviewed to determine where waste minimization measures can be implemented.

Implementation Steps:

Step 1: Review waste generation of WTC projects.

Schedule: February 1, 1992 and ongoing
Assignments: Environmental Compliance Manager.

Step 2: Communicate findings and waste minimization recommendations to project staff.

Schedule: March 1, 1992
Assignments: Environmental Compliance Manager.

Step 3: Implement minimization recommendations as appropriate, into project activities.

Schedule: Ongoing
Assignments: Environmental Compliance Manager.

Appendix B
Building Emergency Procedure for 324 Building and 3718E and 3718G Warehouses.

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Battelle
Pacific Northwest Laboratories

Project Number 93-0011.MEM

Internal Distribution

ML Bruun
LC Davenport
KM Demonia
LR Eberhardt
RJ Kofoed
SJ Kostorowski
JS Osborn
File/LB

Date January 7, 1993

To 324 Building Occupants

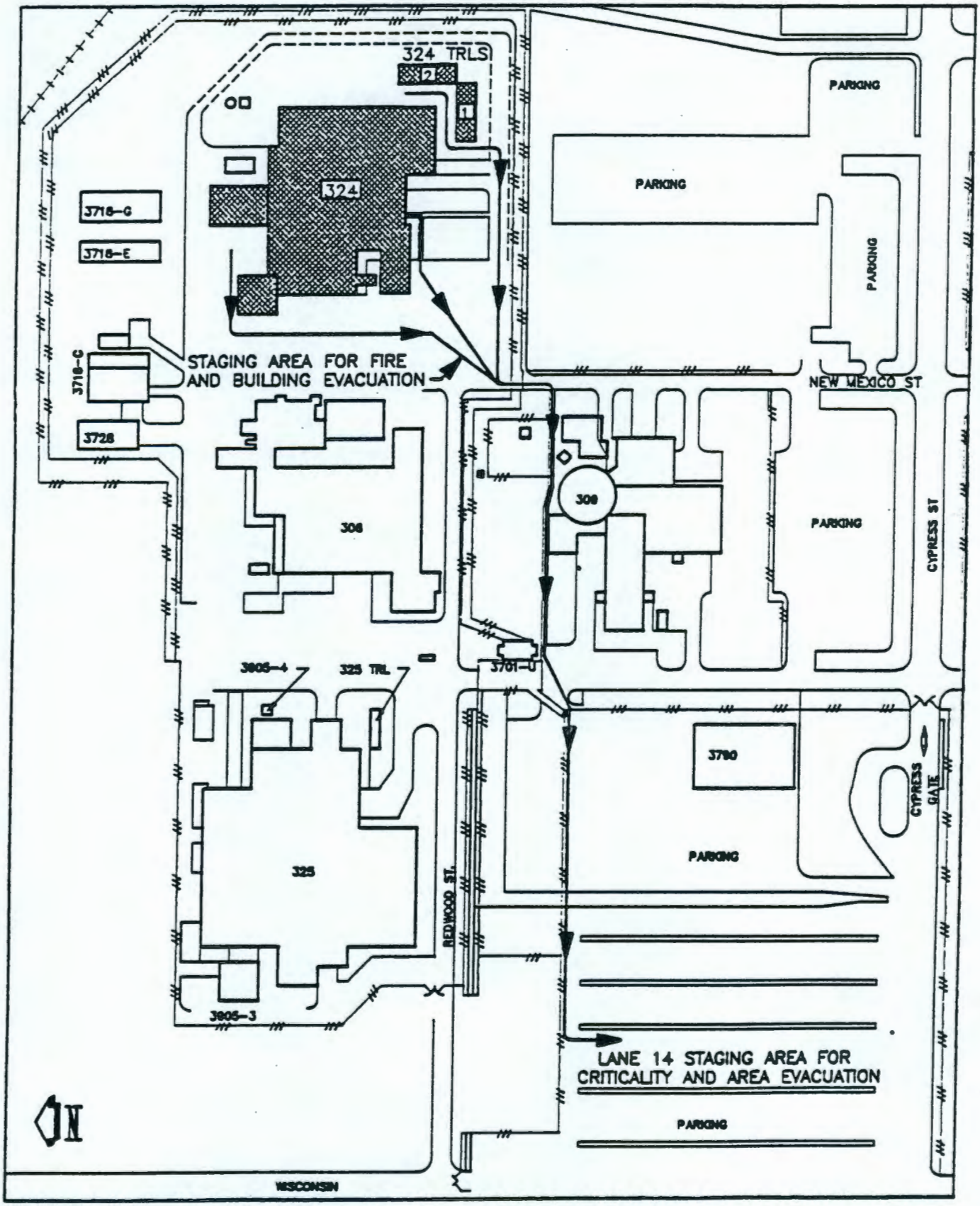
From LE Maples LEM

Subject 324 Building Criticality Alarm and Area Evacuation Route Change.

Due to the security down grades in the 300 Area the 324 Building evacuation routes for criticality alarms and area evacuations has been changed. Please review the attached revised evacuation route diagram, then replace the evacuation route diagram on Page 5 of your copy of the 324 Building Emergency Procedure with the revised copy.

If you have any questions or if further clarification is needed, please contact me on 376-9370.

LEM:skd



324 EVACUATION ROUTE

BUILDING EMERGENCY PROCEDURE

324, 3718 E&G Warehouses
Building

L. E. Maples
LE Maples,
Building Emergency Director

4/6/93
Date

April, 1993
Scheduled Revision Date

Approved:

R. J. Kofoed
RJ Kofoed,
Emergency Preparedness Office

4/6/93
Date

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INTRODUCTION

It is the policy of the Pacific Northwest Laboratory (PNL) to provide for the safety of its employees, other contractors' personnel, visitors, and members of the general public in the event of an emergency incident. The PNL line management has the responsibility to execute this policy and ensure that all employees understand this plan, their responsibilities, and know the action to be taken in an emergency. Each employee is responsible for performing his job in accordance with safety instructions and procedures and to remain alert to unsafe conditions or acts. The purpose of the Building Emergency Procedure is to provide building occupants with the information necessary to react to emergency situations that may occur in order to:

- maximize personnel safety.
- ensure continuity of leadership in emergency situations.
- minimize the effects of an accident.
- minimize property damage.
- ensure prompt communications/notifications.
- ensure an appropriate response.

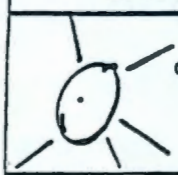
It shall be the responsibility of the Building Emergency Director (BED) to review and update the Building Emergency Procedure annually.

A. Building Emergency Signals

I. EMERGENCY REFERENCE DATA

A. EMERGENCY SIGNALS - 300 AREA*

EMERGENCY SIGNALS - 300 AREA*

SIGNAL	MEANING	RESPONSE	EMERGENCY AID
 HOWLER Ah-oo-gah! Ah-oo-gah!	Criticality	RUN! Go! Now! Run away from building. Proceed to designated area. Lane 14, south parking lot Await instructions.	Emergency Phone No. 375-2400 TELL: What has happened Where it happened What help is needed
 GONG	Fire	Vacate building by nearest exit and move upwind. Keep driveways clear.	
SIREN Steady blast for 3 to 5 minutes	Evacuation and Attention	Proceed to designated area. Lane 14, south parking lot Listen for emergency information. Follow instructions.	IN CASE YOU DISCOVER A FIRE  1. CALL FIREMEN Use telephone or fire alarm box. 2. FIGHT FIRE Use method set up for your building. 3. NOTIFY SUPERVISOR Simultaneously with above action.
SIREN Wavering for 3 to 5 minutes	Take cover (Seek Shelter)	Take cover indoors and stay there until further instructions are received from emergency authorities.	
 TELEPHONE BELL Steady ringing	Crash Alarm	Answer crash alarm telephone. Relay message exactly as received to the Building Emergency Director and others responsible for emergencies.	

*A presentation of these signals can be heard over the telephone by dialing 373-2345

Note: Call 373-2345 to hear the sound of the Hanford Site emergency signals and a recorded message.

B. Emergency Telephone Numbers

ANY EMERGENCY

PNL SINGLE-POINT CONTACT 9-375-2400

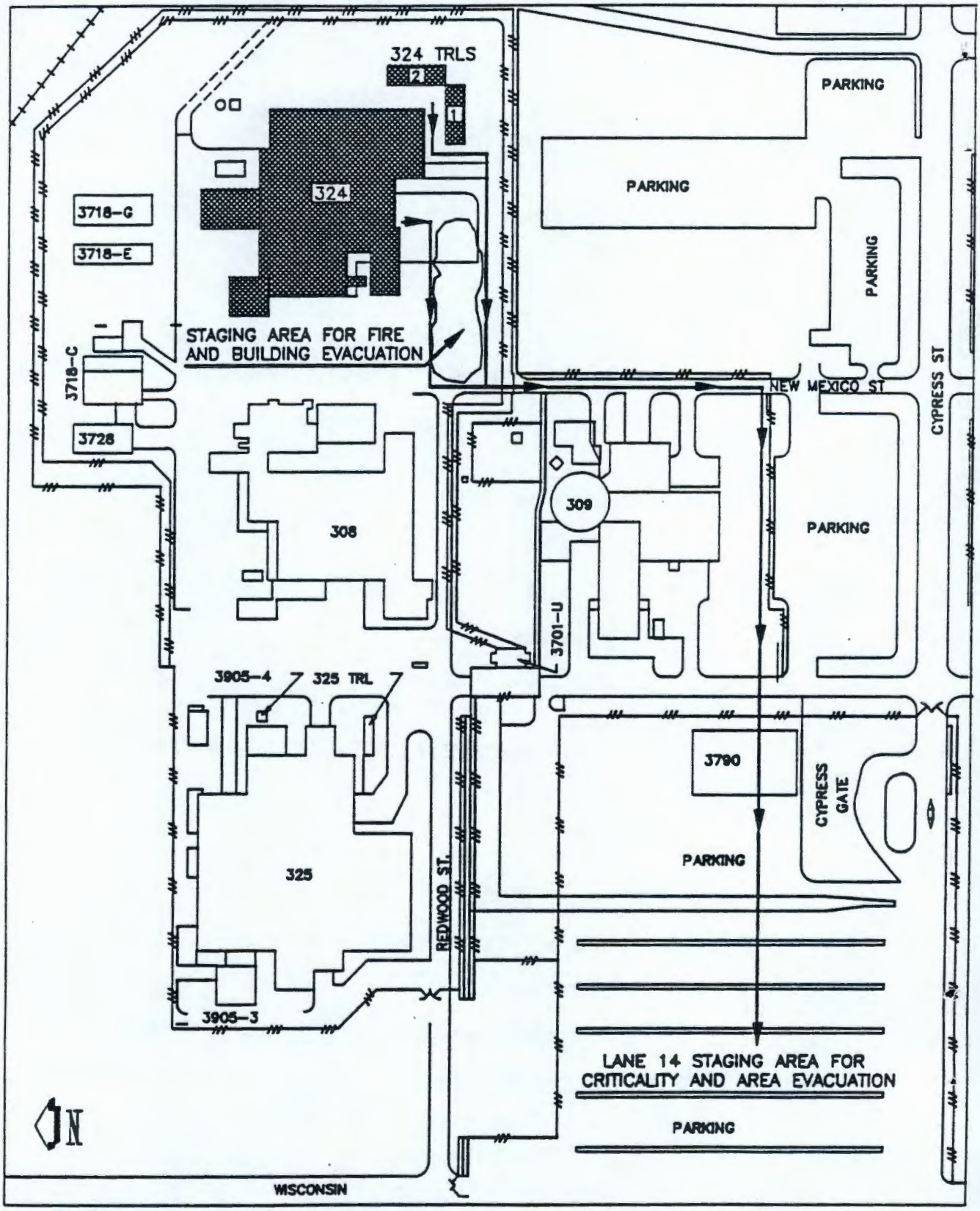
If 9-375-2400 is inoperative, call:

- Hanford Fire 811
- Hanford Ambulance 811
- Hanford Patrol 811
- Building Emergency Director

  LE Maples 376-9370
  Cellular Phone 9-948-2076
- Alternate - P.J. Gaither 376-5746
- Alternate - R.E. Thornhill 376-6769
- Exposure Evaluator 376-2222
- PNL Duty Officer(s) 9-375-2154
  (e.g. Safety - Security)
- Other Contractor Single-Point Contacts:
  - WHC - 300 Area 376-5000
  - KEH 376-7297
  - HEHF 376-6414
- Kadlec Hospital 9-946-4611
- 300 Area ECC 376-4712
- PNL 3000 Area ECC 9-375-6900
- Off Normal Events 9-375-2400

* ROUTING FROM 324 BUILDING TO LANE 14 IN SOUTH PARKING LOT:

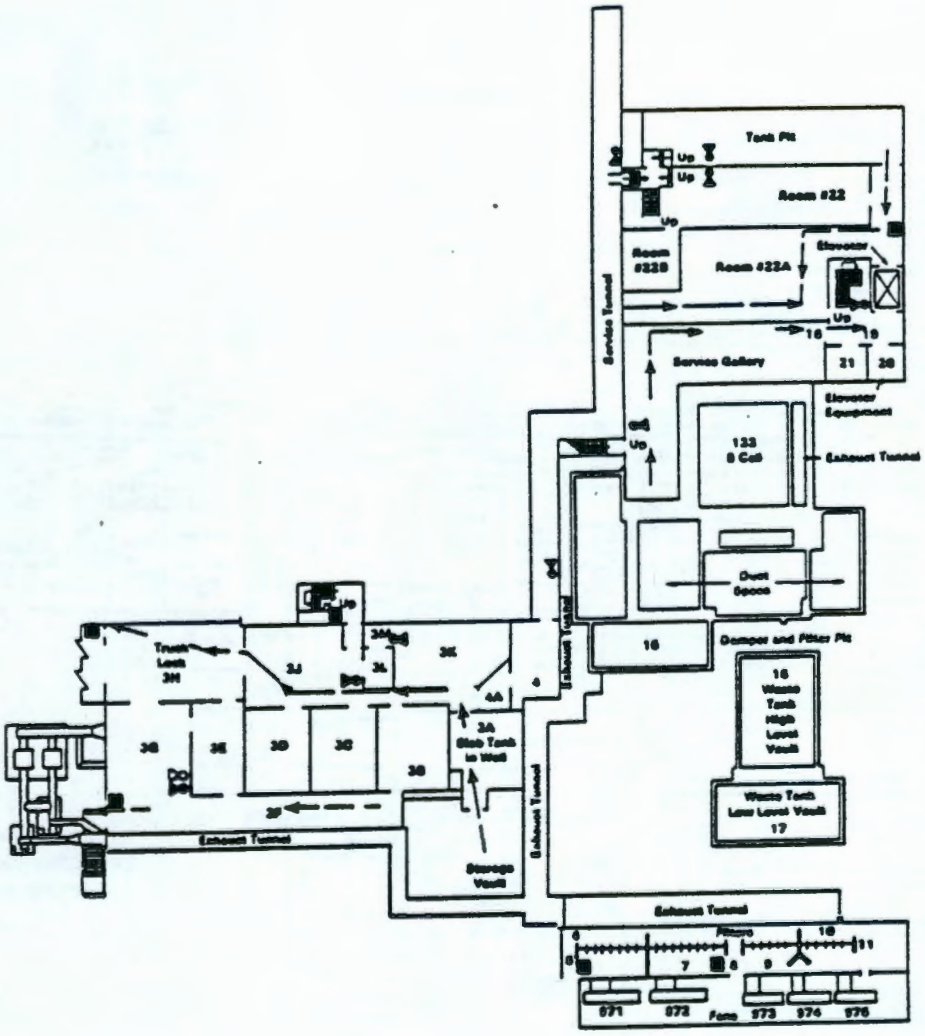
Proceed from building to personnel crash gates in protected area fence south of the east end of the 308 Building, continue around the south side of 309 Building, go through the basement of the 3790 Building and west to Lane 14.



324 EVACUATION ROUTE

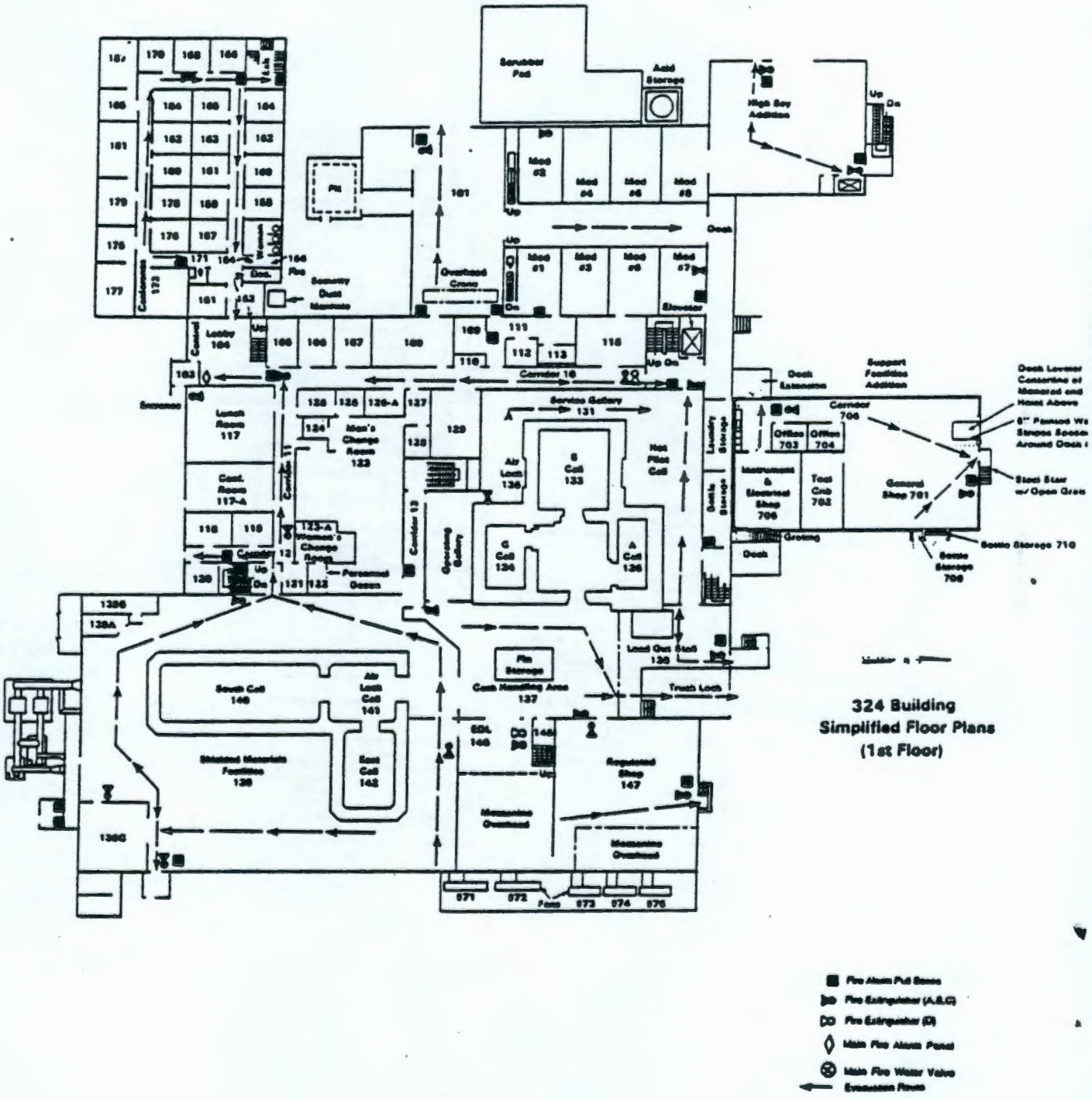
C.51

2. Basement Plan

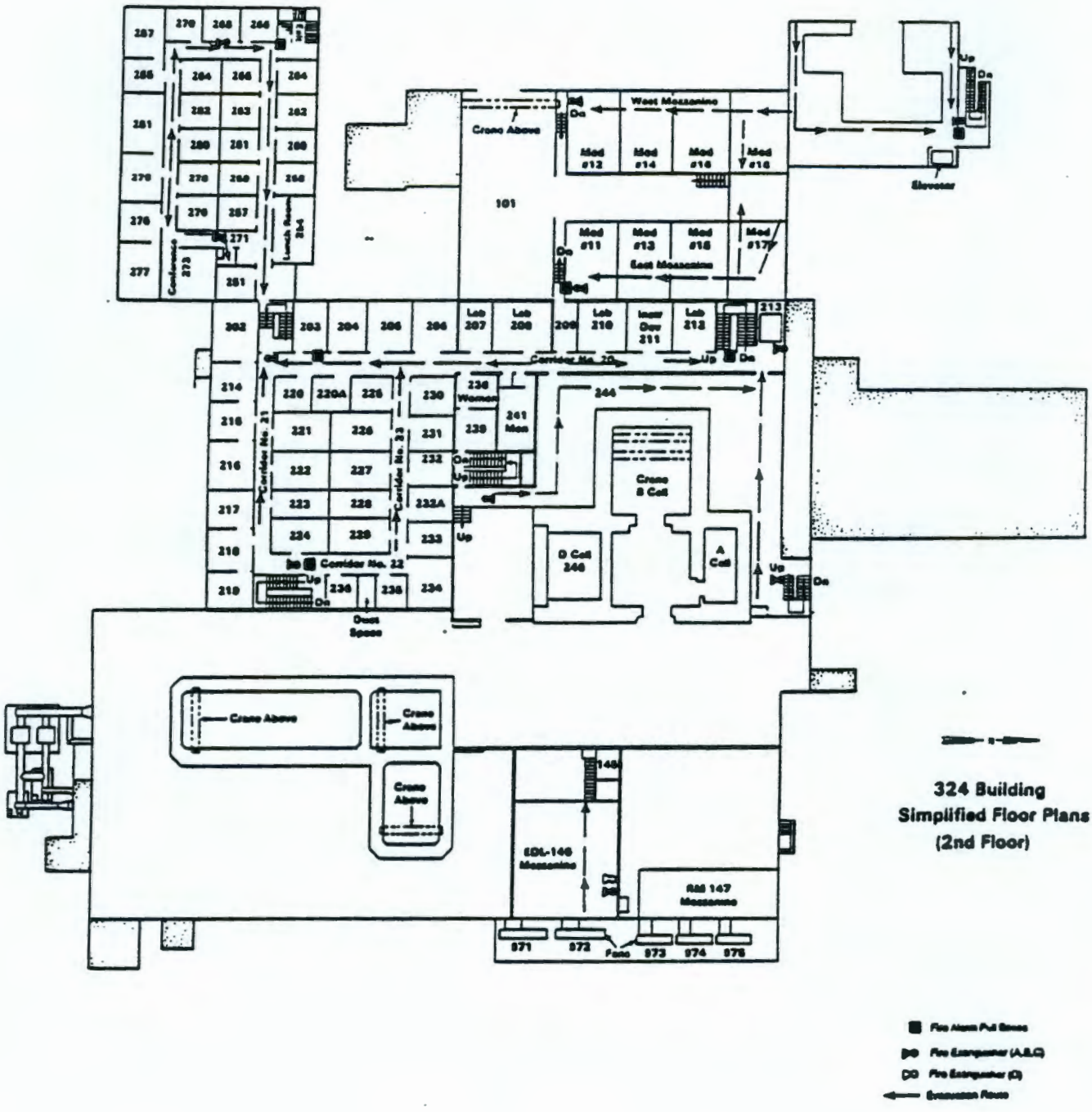


324 Building
Simplified Floor Plans
(Basement)

3. First Floor Plan

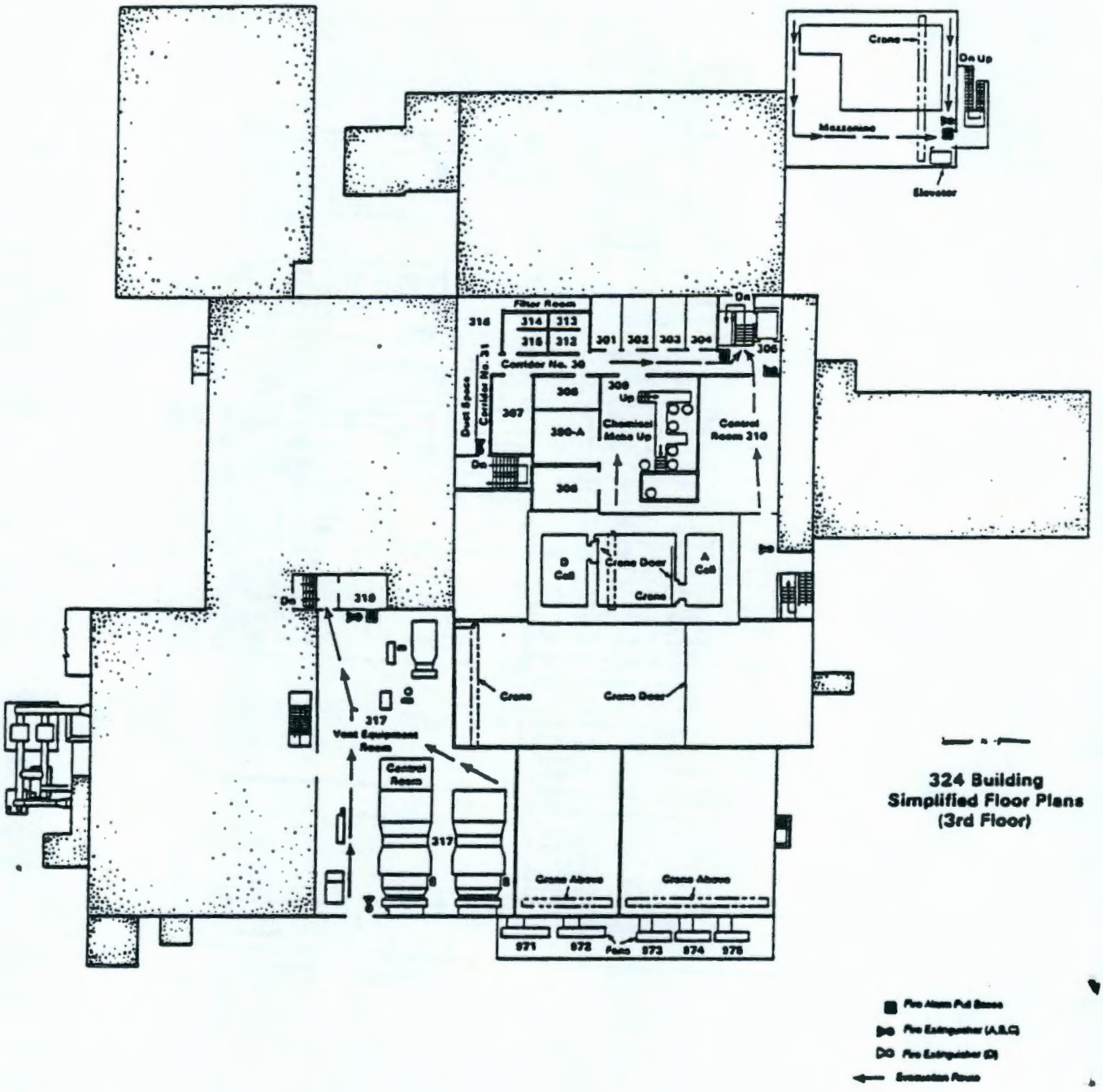


4. Second Floor Plan

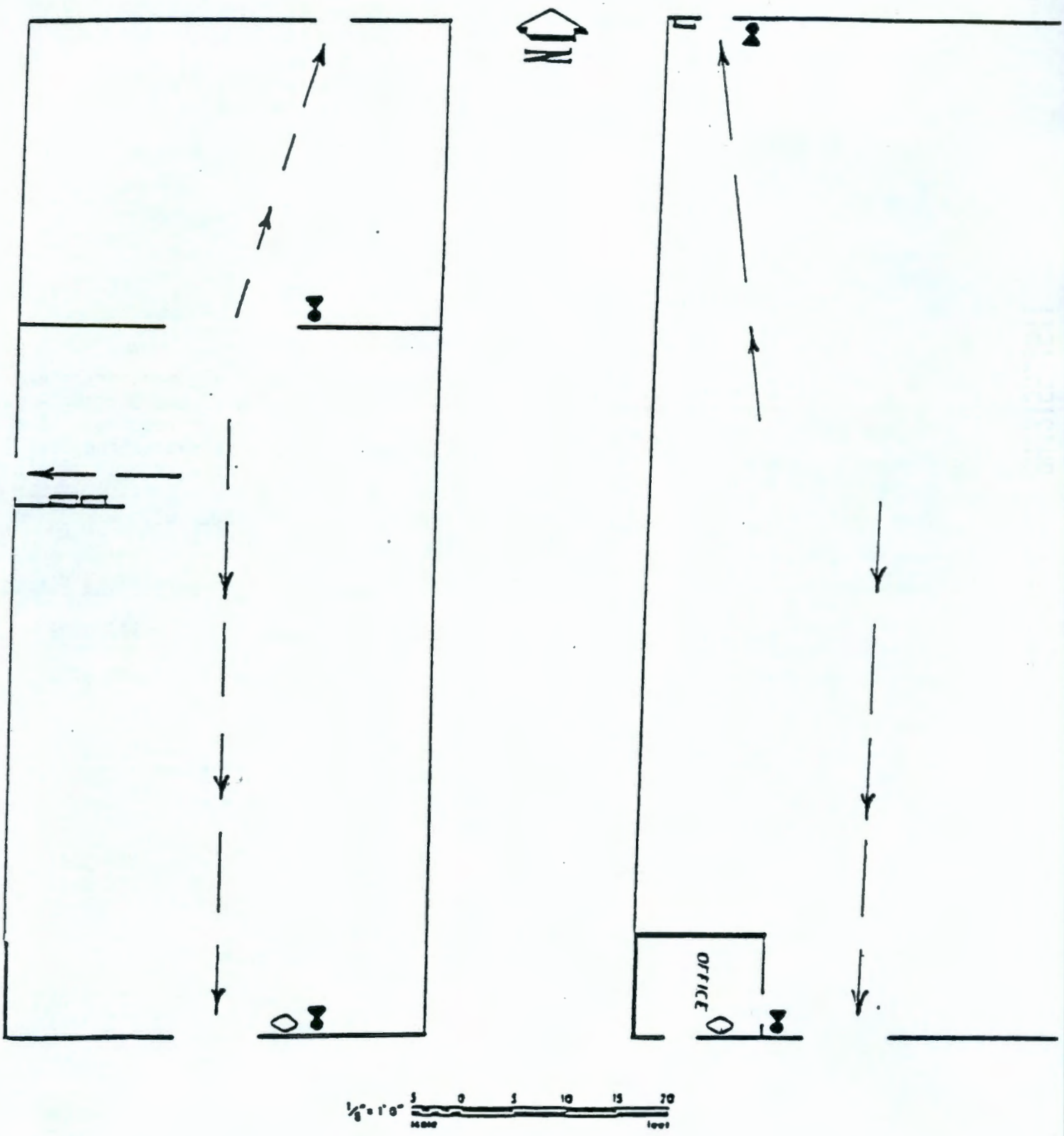


324 Building
Simplified Floor Plans
(2nd Floor)

5. Third Floor Plan



3718E and 3718G Floor Plans



3718-E
Nonregulated Chemical
& Equipment Storage

◇ Main Fire Alarm Panel
⧓ Fire Ext (A, B, C)
← Evaculation Route

3718-G
Regulated
Chemical Stora

II. AUXILIARY INFORMATION

A. Building Emergency Organization

1. Building Emergency Director

The BED has the responsibility for the welfare and safety of the building personnel and for directing efforts to control and terminate the event if his building is the site of the event.

	Name	Work Phone Number
Building Emergency Director	LE Maples	376-9370
1st Alternate	PJ Gaither	376-5746
2nd Alternate	RE Thornhill	376-6769

2. Zone Warden

Zone Wardens are responsible for determining if all personnel have left their zone, reporting the occupancy status to the Staging Area Supervisor, and determining if aid and/or rescue is required. The Zone Warden is to assist anyone requiring help in evacuating the building.

Zone 1: Rooms: 109, 111, 112, 113, Lab 115, EDL-101, 1st Floor EDL-102, and Hi-Bay

	Name	Work Phone Number
Primary:	KE Eliason	376-0979
Secondary:	JJ Higginson	376-8733

Zone 2: Rooms: SMF Galleries, EDL-146, EDL-147, Cask Handling Area, Truck lock, 1st Floor A-Cell and B-Cell Galleries, C-Cell Gallery and Change Room

Primary:	ED Smith	376-3697
Secondary:	KL Yates	376-3697

Zone 3: Rooms: 3A thru 3M, 1st Floor Offices, Conference Room and Lunch Room

Primary:	DL Haggard	376-3406
Secondary:	CJ Lemons	9-375-2741

Zone 4: Rooms: Service Tunnel, Tank Pit, Rooms 22 and 22A

Primary:	WA Sliger	376-0064
Secondary:	RL Fichter	376-0049

Zone Wardens Continued:

	Name	Work Phone Number
Zone 5: 2nd Floor EDL-102, 2nd and 3rd Floor Hi-Bay		
Primary:	SD Halstead	376-3973
Secondary:	DR Jackson	376-6769
Zone 6: Laboratories: 207 thru 212, A-Cell, B-Cell and D-Cell Operating Galleries, Room 18		
Primary:	FR Haun	376-0374
Secondary:	VR Schmeck	376-5947
Zone 7: 2nd Floor Offices 202 thru 236		
Primary:	RD Peters	376-4579
Secondary:	JE Surma	376-4905
Zone 8: Rooms 301 thru 316.		
Primary:	RS Holeman	376-5817
Secondary:	SJ Morris	376-8733
Zone 9:		
Primary: On Duty Power Operator-Room 317		
Secondary:	RD Sharp	376-1193
Zone 10: Rooms 151 thru 187 in 1st Floor New Addition		
Primary:	AB Forsythe	376-2444
Secondary:	MM Gority	376-2981
Zone 11: Rooms 251 thru 287 in 2nd Floor		
Primary:	IM Mariner	376-1499
Secondary:	RL Tidwell	376-3796
Zone 12: Maintenance Shop & 3718E		
Primary:	Mechanical Supervisor	376-3872
Secondary:	RPT Supervisor	376-3524
Zone 13: 3718G		
Primary:	CM Andersen	376-4410
Secondary:	RD Sharp	376-1193

3. Staging Area Supervisor

The Staging Area Supervisor shall direct all activities at the Building Staging Area and is responsible for notifying the Building Emergency Director if all personnel are accounted for or if help is needed.

	Name	Work Phone Number
Staging Area Supervisor	LE Maples	376-9370
1st Alternate	CE Bigelow	376-0032
2nd Alternate	PJ Gaither	376-5746

4. Facility Expertise

In the event of an emergency, specific detailed facility information may be needed. Knowledge of the building, utilities, and radiation hazards can be obtained from the following:

- Building Manager - LE Maples - 376-9370
  Cellular Phone - 9-948-2076
- Building Ventilation and Power Operation - TD Gaines - 376-5612
- Radiation Protection - JL Allen - 376-8502
- Safety - PA Wright - 376-1634
- Security/Control Room - 9-375-2400
- Crafts - PH Rojas - 376-3872

5. Unique Program laboratory Expertise

The technical knowledge of a specific program/laboratory activity is usually known by the laboratory occupant or program manager. If applicable, the following staff may be contacted in regards to emergencies or off-normal events in their laboratories:

As posted at laboratory entrances.

6. Staff Members

Give the appropriate alarm if an off-normal or emergency condition is observed. Respond as required in Section I.A.

B. Specific Emergency Actions

For any off-normal event or emergency condition not specifically addressed, call the PNL Single-Point Contact on 9-375-2400. The SPC will notify the appropriate emergency service and the Building Manager. The following guidance is offered for the specific listed incidents:

1. Fire

a. Single: Gong (Hanford Site)

b. Response/Action

- If you are notified of a fire (if time permits):

  - Shut down equipment.
  - Close doors/windows.
  - Secure nuclear materials.
  - Lock up classified documents or carry them with you.
  - Evacuate the building through the nearest normal exit that you can use safely.
  - Discard protective clothing prior to existing radiation areas if time permits.
  - Assemble upwind from the building and report your presence to the BED or delegate.
  - If wearing SWP clothing, separate yourself from other building occupants and await survey by Radiation Monitoring.

- If you discover a fire, the following steps are to be performed:

  - Sound the alarm.
  - Notify Single-Point-Contact (SPC) 375-2400 or 9-375-2400 if at a 373 or 376 exchange.
  - Fight the fire, if able to do so safely.
  - Initiate the same response as listed for the situation in which you are notified of a fire.

2. Criticality

Criticality is an event which is limited to a few specific facilities. This information is presented to provide consistent training to all staff.

a. Signal: Howler (ah OO-gah)

b. Response/Action

- Leave the building immediately
- Run
- Assemble at the Building Staging Area
- Report your presence to the designated accountability person
- If wearing SWPs, isolate yourself from other building occupants
- Notify 9-375-2400

3. Area Evacuation

a. Signal: Steady Siren (3 to 5 minutes)

b. Response/Action

- Follow instructions; evacuate through normal exits
- Shut down equipment if time permits
- Secure nuclear material(s)
- Secure classified documents or carry them with you
- Remove protective clothing prior to exiting Radiation Areas.
- Report to your Building Staging Area and accountability person

4. Area Take Cover

a. Signal: Wavering Siren

b. Response/Action

- Stay inside building.
- Notify 9-375-2400.
- If outside, take cover inside nearest building.
- Secure nuclear material(s).
- Follow the instructions of the Building Emergency Director.

5. Criminal Activity (e.g., suspicious objects, threats, sabotage)

a. Signal: None

b. Response/Action

- When condition is observed, notify 9-375-2400
- If necessary, clear the area of personnel
- Do not move any suspicious objects
- Post warnings if applicable
- Furnish emergency responders with appropriate information
- Follow the instructions of the Building Emergency Director and/or Security

6. Loss of Electrical Power

   a. Signal: None

   b. Response/Action

      - Notify 9-375-2400.
      - Close hoods and airlock doors (if applicable).
      - Shut down all equipment.
      - Secure nuclear material(s).
      - Secure classified documents.
      - Exit radiation areas in an orderly manner.

- If emergency power fails, evacuate to Building Staging Area.
  - Follow the instructions of the Building Emergency Director.

7. Leaks or Spills (radioactive, nonradioactive, [a]toxic, or hazardous material)

   a. Signal: None

   b. Response/Action

      - Get away from substance
      - Notify 9-375-2400
      - Prevent personnel exposure (e.g., set up barricade(s))
      - Take steps to contain if possible
      - Spill cleanup material is located in men's changeroom
      - Follow the instructions of the Building Emergency Director

---

[a]The "PNL Waste Management Contingency Plan," PNL-MA-824

8. Unusual, Irritating or Strong Odors

a. Signal: None

b. Response/Action

If you believe the odor may be the result of an uncontrolled release of a toxic or hazardous material, respond the following way:

- Activate building fire alarm
- Evacuate building to Building Staging Area
- Notify 9-375-2400

If the occupant has knowledge of the source and scope of the release and believes the release poses no damage,

- Notify the Building Manager
- Notify your management

If an unusual odor is detected and the source is unknown, the Building Emergency Director will determine if the building should be evacuated.

9. Emergency Evacuation From EDL-102.

a. Signal: Air Horn

b. Response/Action

- Activate the EDL-102 Air Horn by opening the green valve at one of the following exit doors. 1st and 2nd floor East doors. 1st floor North and South roll up doors.
- Evacuate the Area.
- Notify 9-375-2400.
- Notify the Building Manager.
- Notify line management.

C. Utility Disconnects

Utility disconnect may be necessary under extreme emergency conditions. The Building Emergency Director will determine if utility disconnects are necessary. Location of the utility disconnects or valves are described below:

- 324 Building

  1. Electrical - Room 317 switch gear control center.
  2. Water - PIV outside West side EDL-101 roll up door.
  3. Gas Supplies - N.A.
  4. Steam - Room 2 (service tunnel) West end.
  5. Air - EDL-102 module 2 at air dryer.
  6. Ventilation - Room 317 Exhaust/Supply Fan Control

- 3718 E Building

  1. Electrical - West wall, middle of building, near exit.

- 3718 G Building

  1. Electrical - North wall near exit.

D. Alternate Staging Area

1. In the event of extended building evacuations during inclement weather, the 325 Building lunch/conference room may be used at the Building Emergency Director's discretion.

APPENDIX D
APPLICABLE MSDS

---------- IDENTIFICATION ----------

PRODUCT #: Z6760 NAME: METHANOL ACS

CAS #: 67-56-1

MF: C1H4O1

SYNONYMS

ALCOOL METHYLIQUE (FRENCH) * ALCOOL METILICO (ITALIAN) * CARBINOL *
COLONIAL SPIRIT * COLUMBIAN SPIRIT * METHANOL (DOT) * METANOLO
(ITALIAN) * METHYL ALCOHOL * METHYL ALCOHOL (ACGIH,DOT,OSHA) *
METHYLOL * METHYLALKOHOL (GERMAN) * METHYL HYDRATE * METHYL HYDROXIDE
* METYLOWY ALKOHOL (POLISH) * MONOHYDROXYMETHANE * PYROXYLIC SPIRIT *
RCRA WASTE NUMBER U154 * UN 1230 (DOT) * WOOD ALCOHOL * WOOD NAPHTHA *
WOOD SPIRIT *

---------- TOXICITY HAZARDS ----------

RTECS NO: PC1400000

METHANOL

IRRITATION DATA

SKN-RBT 20 MG/24H MOD	85JCAE -,187,86
EYE-RBT 40 MG MOD	UCDS** 3/24/70
EYE-RBT 100 MG/24H MOD	85JCAE -,187,86

TOXICITY DATA

ORL-MAN LDLO:6422 MG/KG	CMAJAX 128,14,83
ORL-HMN LDLO:428 MG/KG	NPIRI* 1,74,74
ORL-HMN LDLO:143 MG/KG	34ZIAG -,382,69
UNR-MAN LDLO:868 MG/KG	85DCAI 2,73,70
ORL-RAT LD50:5628 MG/KG	GTPZAB 19(11),27,75
IHL-RAT LC50:64000 PPM/4H	NPIRI* 1,74,74
IPR-RAT LD50:7529 MG/KG	EVHPAZ 61,321,85

IVN-RAT LD50:2131 MG/KG EVHPAZ 61,321,85

ORL-MUS LD50:7300 MG/KG TXCYAC 25,271,82

IPR-MUS LD50:10765 MG/KG EVHPAZ 61,321,85

SCU-MUS LD50:9800 MG/KG TXAPA9 18,185,71

IVN-MUS LD50:4710 MG/KG EVHPAZ 61,321,85

ORL-MKY LD50:7 GM/KG TXAPA9 3,202,61

ORL-RBT LD50:14200 MG/KG FAONAU 48A,105,70

SKN-RBT LD50:15800 MG/KG NPIRI* 1,74,74

IPR-RBT LD50:1826 MG/KG EVHPAZ 61,321,85

IVN-RBT LD50:8907 MG/KG EVHPAZ 61,321,85

IPR-GPG LD50:3556 MG/KG EVHPAZ 61,321,85

IPR-HAM LD50:8555 MG/KG EVHPAZ 61,321,85

REVIEWS, STANDARDS, AND REGULATIONS

ACGIH TLV-TWA 200 PPM; STEL 250 PPM (SKIN) 85INA8 5,372,86

EPA FIFRA 1988 PESTICIDE SUBJECT TO REGISTRATION OR RE-REGISTRATION
FEREAC 54,4388,89

MSHA STANDARD-AIR:TWA 200 PPM (260 MG/M3) (SKIN) DTLVS* 3,155,71

OSHA PEL:8H TWA 200 PPM (260 MG/M3) FEREAC 54,2923,89

OSHA PEL FINAL:8H TWA 200 PPM (260 MG/M3);STEL 250 PPM (SKIN) FEREAC
54,2923,89

NIOSH REL TO METHANOL-AIR:10H TWA 200 PPM (SK);STEL 250 PPM (SK)
NIOSH* DHHS #92-100,92

NOHS 1974: HZD 45930; NIS 344; TNF 78840; NOS 203; TNE 737242

NOES 1983: HZD 45930; NIS 373; TNF 101075; NOS 225; TNE 1620617; TFE
388352

EPA GENETOX PROGRAM 1988, NEGATIVE: SHE-CLONAL ASSAY; CELL TRANSFORM.-
SA7/SHE

EPA GENETOX PROGRAM 1988, NEGATIVE: N CRASSA-ANEUPLOIDY; IN VITRO SCE-
NONHUMAN

EPA TSCA CHEMICAL INVENTORY, JUNE 1990

EPA TSCA SECTION 8(E) STATUS REPORT 8EHQ-0378-0108

ON EPA IRIS DATABASE

EPA TSCA TEST SUBMISSION (TSCATS) DATA BASE, JULY 1992

NIOSH ANALYTICAL METHODS: SEE METHANOL, 2000

NTP CARCINOGENESIS STUDIES;SELECTED, APRIL 1992

TARGET ORGAN DATA

SENSE ORGANS AND SPECIAL SENSES (OPTIC NERVE NEUROPATHY)

SENSE ORGANS AND SPECIAL SENSES (VISUAL FIELD CHANGES)

BEHAVIORAL (HEADACHE)

LUNGS, THORAX OR RESPIRATION (DYSPNAE)

LUNGS, THORAX OR RESPIRATION (OTHER CHANGES)

GASTROINTESTINAL (NAUSEA OR VOMITING)

ONLY SELECTED REGISTRY OF TOXIC EFFECTS OF CHEMICAL SUBSTANCES (RTECS)
DATA IS PRESENTED HERE. SEE ACTUAL ENTRY IN RTECS FOR COMPLETE INFORMATION.
DATA IS PRESENTED HERE. SEE ACTUAL ENTRY IN RTECS FOR COMPLETE INFORMATION.

---------- HEALTH HAZARD DATA ----------

ACUTE EFFECTS

MAY BE FATAL IF SWALLOWED.

HARMFUL IF INHALED OR ABSORBED THROUGH SKIN.

VAPOR OR MIST IS IRRITATING TO THE EYES, MUCOUS MEMBRANES AND UPPER
RESPIRATORY TRACT.

CAUSES SKIN IRRITATION.

EXPOSURE CAN CAUSE:

DAMAGE TO THE EYES

DAMAGE TO THE LIVER

DAMAGE TO THE HEART

DAMAGE TO THE KIDNEYS

GASTROINTESTINAL DISTURBANCES

MAY CAUSE CONVULSIONS.

TARGET ORGAN(S):

EYES

KIDNEYS

FIRST AID

IN CASE OF CONTACT, IMMEDIATELY FLUSH EYES OR SKIN WITH COPIOUS

AMOUNTS OF WATER FOR AT LEAST 15 MINUTES WHILE REMOVING CONTAMINATED
CLOTHING AND SHOES.

ASSURE ADEQUATE FLUSHING OF THE EYES BY SEPARATING THE EYELIDS

WITH FINGERS.

IF INHALED, REMOVE TO FRESH AIR. IF NOT BREATHING GIVE ARTIFICIAL

RESPIRATION. IF BREATHING IS DIFFICULT, GIVE OXYGEN.

IF SWALLOWED, WASH OUT MOUTH WITH WATER PROVIDED PERSON IS CONSCIOUS.
CALL A PHYSICIAN.

DISCARD CONTAMINATED CLOTHING AND SHOES.

ADDITIONAL INFORMATION

WARNING: CONTAINS METHANOL. MAY BE FATAL OR CAUSE BLINDNESS IF

SWALLOWED. CANNOT BE MADE NONPOISONOUS.

---------- PHYSICAL DATA ----------

BOILING PT: 64.6 C TO 64.8 C

MELTING PT: -98 C TO C

SPECIFIC GRAVITY: 0.791

VAPOR DENSITY: 1.1

VAPOR PRESSURE: 97.68 MM @ 20 C

410 MM @ 50 C

APPEARANCE AND ODOR

COLORLESS LIQUID

---------- FIRE AND EXPLOSION HAZARD DATA ----------

FLASHPOINT: 52 F BY:

AUTOIGNITION TEMPERATURE: 725 F

LOWER EXPLOSION LEVEL: 6%

UPPER EXPLOSION LEVEL: 36%

EXTINGUISHING MEDIA

CARBON DIOXIDE, DRY CHEMICAL POWDER OR APPROPRIATE FOAM.

SPECIAL FIREFIGHTING PROCEDURES

WEAR SELF-CONTAINED BREATHING APPARATUS AND PROTECTIVE CLOTHING TO PREVENT CONTACT WITH SKIN AND EYES.

UNUSUAL FIRE AND EXPLOSIONS HAZARDS

EXTREMELY FLAMMABLE.

VAPOR MAY TRAVEL CONSIDERABLE DISTANCE TO SOURCE OF IGNITION AND FLASH BACK.

---------- REACTIVITY DATA ----------

INCOMPATIBILITIES

ACIDS

ACID CHLORIDES

ACID ANHYDRIDES

OXIDIZING AGENTS

REDUCING AGENTS

ALKALI METALS

HAZARDOUS COMBUSTION OR DECOMPOSITION PRODUCTS

TOXIC FUMES OF:

CARBON MONOXIDE, CARBON DIOXIDE

---------- SPILL OR LEAK PROCEDURES ----------

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED

EVACUATE AREA.

SHUT OFF ALL SOURCES OF IGNITION.

WEAR SELF-CONTAINED BREATHING APPARATUS, RUBBER BOOTS AND HEAVY RUBBER GLOVES.

COVER WITH DRY-LIME, SAND, OR SODA ASH. PLACE IN COVERED CONTAINERS USING NON-SPARKING TOOLS AND TRANSPORT OUTDOORS.

VENTILATE AREA AND WASH SPILL SITE AFTER MATERIAL PICKUP IS COMPLETE.

WASTE DISPOSAL METHOD

BURN IN A CHEMICAL INCINERATOR EQUIPPED WITH AN AFTERBURNER AND SCRUBBER BUT EXERT EXTRA CARE IN IGNITING AS THIS MATERIAL IS HIGHLY FLAMMABLE.

OBSERVE ALL FEDERAL, STATE, AND LOCAL LAWS.

--- PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE ---

WEAR APPROPRIATE NIOSH/MSHA-APPROVED RESPIRATOR, CHEMICAL-RESISTANT GLOVES, SAFETY GOGGLES, OTHER PROTECTIVE CLOTHING.

MECHANICAL EXHAUST REQUIRED.

SAFETY SHOWER AND EYE BATH.

DO NOT BREATHE VAPOR.

AVOID CONTACT WITH EYES, SKIN AND CLOTHING.

AVOID PROLONGED OR REPEATED EXPOSURE.

DO NOT USE IF SKIN IS CUT OR SCRATCHED. WASH THOROUGHLY AFTER HANDLING.

POISON

IRRITANT.

KEEP TIGHTLY CLOSED.

KEEP AWAY FROM HEAT, SPARKS, AND OPEN FLAME.

HYGROSCOPIC

STORE IN A COOL DRY PLACE.

KEEP CONTAINER TIGHTLY CLOSED.

KEEP AWAY FROM SOURCES OF IGNITION. NO SMOKING.

DO NOT BREATHE VAPOR.

DANGER:

POISON

MAY BE FATAL OR CAUSE BLINDNESS IF SWALLOWED. VAPOR HARMFUL.

CANNOT BE MADE NON-POISONOUS.

CAUSES IRRITATION.

TARGET ORGAN(S):

EYES

KIDNEYS

HYGROSCOPIC

KEEP TIGHTLY CLOSED.

REGULATORY INFORMATION

THIS PRODUCT IS SUBJECT TO SARA SECTION 313 REPORTING REQUIREMENTS.
THE ABOVE INFORMATION IS BELIEVED TO BE CORRECT BUT DOES NOT PURPORT TO BE
ALL INCLUSIVE AND SHALL BE USED ONLY AS A GUIDE. SIGMA ALDRICH SHALL NOT BE
HELD LIABLE FOR ANY DAMAGE RESULTING FROM HANDLING OR FROM CONTACT WITH THE
ABOVE PRODUCT. SEE REVERSE SIDE OF INVOICE OR PACKING SLIP FOR ADDITIONAL
TERMS AND CONDITIONS OF SALE.

---------- IDENTIFICATION ----------

PRODUCT #: 45750 NAME: ACETIC ACID

CAS #: 64-19-7

SYNONYMS

ACETIC ACID (ACGIH,OHSA) * ACETIC ACID (AQUEOUS SOLUTION) (DOT)* ACETIC ACID, GLACIAL * ACETIC ACID, GLACIAL (DOT) * ACIDE ACETIQUE (FRENCH) * ACIDO ACETICO (ITALIAN) * AZIJNZUUR (DUTCH)*ESSIGSAEURE (GERMAN) * ETHANOIC ACID * ETHYLIC ACID * GLACIAL ACETIC ACID * KYSELINA OCTOVA (CZECH) * METHANECARBOXYLIC ACID * OCTOWY KWAS

(POLISH) * UN 2789 (DOT) * UN 2790 (DOT) * VINEGAR ACID *

---------- TOXICITY HAZARDS ----------

RTECS NO: AF1225000

ACETIC ACID

IRRITATION DATA

SKN-HMN 50 MG/24H MLD	TXAPA9 31,481,75
SKN-RBT 20 MG/24H MOD	85JCAE -,304,86
SKN-RBT 525 MG OPEN SEV	UCDS** 8/7/63
SKN-RBT 50 MG/24H MLD	TXAPA9 31,481,75
EYE-RBT 50 UG OPEN SEV	AMIHBC 4,119,51
EYE-RBT 5 MG/30S RINSE MLD	TXCYAC 23,281,82

TOXICITY DATA

UNR-MAN LDLO:308 MG/KG	85DCAI 2,73,70
ORL-RAT LD50:3310 MG/KG	DMDJAP 31,276,59
IHL-MUS LC50:5620 PPM/1H	MELAAD 48,559,57
IVN-MUS LD50:525 MG/KG	APTOA6 18,141,61
SKN-RBT LD50:1060 MG/KG	UCDS** 8/7/63

REVIEWS, STANDARDS, AND REGULATIONS

ACGIH TLV-TWA 10 PPM; STEL 15 PPM 85INA8 5,4,86

EPA FIFRA 1988 PESTICIDE SUBJECT TO REGISTRATION OR RE-REGISTRATION

FEREAC 54,4388,89

MSHA STANDARD-AIR:TWA 10 PPM (25 MG/M3) DTLVS* 3,2,71

OSHA PEL:8H TWA 10 PPM (25 MG/M3) FEREAC 54,2923,89

OSHA PEL FINAL:8H TWA 10 PPM (25 MG/M3) FEREAC 54,2923,89

NIOSH REL TO ACETIC ACID-AIR:10H TWA 10 PPM;STEL 15 PPM NIOSH* DHHS

#92-100,92

NOHS 1974: HZD 01568; NIS 264; TNF 51469; NOS 150; TNE 486503

NOES 1983: HZD 01568; NIS 266; TNF 49403; NOS 169; TNE 907205; TFE 322123

EPA GENETOX PROGRAM 1988, NEGATIVE: HISTIDINE REVERSION-AMES TEST

EPA TSCA CHEMICAL INVENTORY, JUNE 1990

EPA TSCA SECTION 8(E) STATUS REPORT 8EHQ-0486-0600

EPA TSCA TEST SUBMISSION (TSCATS) DATA BASE, JULY 1992

NIOSH ANALYTICAL METHODS: SEE ACETIC ACID, 1603
OSHA ANALYTICAL METHOD #ID-118
TARGET ORGAN DATA
SENSE ORGANS AND SPECIAL SENSES (OTHER OLFACTION EFFECTS)
SENSE ORGANS AND SPECIAL SENSES (OTHER EYE EFFECTS)
BEHAVIORAL (CONVULSIONS OR EFFECT ON SEIZURE THRESHOLD)
LUNGS, THORAX OR RESPIRATION (OTHER CHANGES)
GASTROINTESTINAL (CHANGES IN STRUCTURE OR FUNCTION OF ESOPHAGUS)

GASTROINTESTINAL (ULCERATION OR BLEEDING FROM SMALL INTESTINE)

GASTROINTESTINAL (ULCERATION OR BLEEDING FROM LARGE INTESTINE)
EFFECTS ON FERTILITY (MALE FERTILITY INDEX)
EFFECTS ON NEWBORN (BEHAVIORAL)
ONLY SELECTED REGISTRY OF TOXIC EFFECTS OF CHEMICAL SUBSTANCES (RTECS)
DATA IS PRESENTED HERE. SEE ACTUAL ENTRY IN RTECS FOR COMPLETE INFORMATION.
DATA IS PRESENTED HERE. SEE ACTUAL ENTRY IN RTECS FOR COMPLETE INFORMATION.

---------- HEALTH HAZARD DATA ----------
ACUTE EFFECTS
HARMFUL IF ABSORBED THROUGH SKIN.
MAY BE HARMFUL IF INHALED.
MAY BE HARMFUL IF SWALLOWED.
VAPOR OR MIST IS IRRITATING TO THE EYES, MUCOUS MEMBRANES AND UPPER

RESPIRATORY TRACT.
CAUSES SKIN IRRITATION.
TO THE BEST OF OUR KNOWLEDGE, THE CHEMICAL, PHYSICAL, AND TOXICOLOGICAL PROPERTIES HAVE NOT BEEN THOROUGHLY INVESTIGATED.

FIRST AID
IN CASE OF CONTACT, IMMEDIATELY FLUSH EYES WITH COPIOUS AMOUNTS OF

WATER FOR AT LEAST 15 MINUTES.
IN CASE OF CONTACT, IMMEDIATELY WASH SKIN WITH SOAP AND COPIOUS

AMOUNTS OF WATER.
IF INHALED, REMOVE TO FRESH AIR. IF NOT BREATHING GIVE ARTIFICIAL RESPIRATION. IF BREATHING IS DIFFICULT, GIVE OXYGEN.
IF SWALLOWED, WASH OUT MOUTH WITH WATER PROVIDED PERSON IS CONSCIOUS.
CALL A PHYSICIAN.
WASH CONTAMINATED CLOTHING BEFORE REUSE.
---------- PHYSICAL DATA ----------

SPECIFIC GRAVITY: 1.000
APPEARANCE AND ODOR
CLEAR COLORLESS LIQUID
---------- FIRE AND EXPLOSION HAZARD DATA ----------
FLASHPOINT: NONE BY:
EXTINGUISHING MEDIA
WATER SPRAY.
CARBON DIOXIDE, DRY CHEMICAL POWDER OR APPROPRIATE FOAM.
SPECIAL FIREFIGHTING PROCEDURES
WEAR SELF-CONTAINED BREATHING APPARATUS AND PROTECTIVE CLOTHING TO

PREVENT CONTACT WITH SKIN AND EYES.
UNUSUAL FIRE AND EXPLOSIONS HAZARDS
EMITS TOXIC FUMES UNDER FIRE CONDITIONS.
---------- REACTIVITY DATA ----------
INCOMPATIBILITIES
STRONG OXIDIZING AGENTS
HAZARDOUS COMBUSTION OR DECOMPOSITION PRODUCTS
TOXIC FUMES OF:
CARBON MONOXIDE, CARBON DIOXIDE
---------- SPILL OR LEAK PROCEDURES ----------
STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED
WEAR RESPIRATOR, CHEMICAL SAFETY GOGGLES, RUBBER BOOTS AND HEAVY

RUBBER GLOVES.
COVER WITH DRY LIME OR SODA ASH, PICK UP, KEEP IN A CLOSED CONTAINER AND HOLD FOR WASTE DISPOSAL.
VENTILATE AREA AND WASH SPILL SITE AFTER MATERIAL PICKUP IS COMPLETE.

WASTE DISPOSAL METHOD
DISSOLVE OR MIX THE MATERIAL WITH A COMBUSTIBLE SOLVENT AND BURN IN A CHEMICAL INCINERATOR EQUIPPED WITH AN AFTERBURNER AND SCRUBBER.

OBSERVE ALL FEDERAL, STATE, AND LOCAL LAWS.
--- PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE ---
CHEMICAL SAFETY GOGGLES.
COMPATIBLE CHEMICAL-RESISTANT GLOVES.
NIOSH/MSHA-APPROVED RESPIRATOR.
SAFETY SHOWER AND EYE BATH.
MECHANICAL EXHAUST REQUIRED.
DO NOT BREATHE VAPOR.
AVOID CONTACT WITH EYES, SKIN AND CLOTHING.
WASH THOROUGHLY AFTER HANDLING.
IRRITANT.
HARMFUL LIQUID.
KEEP TIGHTLY CLOSED.

STORE IN A COOL DRY PLACE.
HARMFUL IN CONTACT WITH SKIN.
IRRITATING TO EYES, RESPIRATORY SYSTEM AND SKIN.
IN CASE OF CONTACT WITH EYES, RINSE IMMEDIATELY WITH PLENTY OF WATER AND SEEK MEDICAL ADVICE.
WEAR SUITABLE PROTECTIVE CLOTHING.

THE ABOVE INFORMATION IS BELIEVED TO BE CORRECT BUT DOES NOT PURPORT TO BE ALL INCLUSIVE AND SHALL BE USED ONLY AS A GUIDE. SIGMA ALDRICH SHALL NOT BE HELD LIABLE FOR ANY DAMAGE RESULTING FROM HANDLING OR FROM CONTACT WITH THE ABOVE PRODUCT. SEE REVERSE SIDE OF INVOICE OR PACKING SLIP FOR ADDITIONAL TERMS AND CONDITIONS OF SALE.

---------- IDENTIFICATION ----------
PRODUCT #: 26629-9 NAME: CHROMIUM, POWDER, -325 MESH, 99+%

CAS #: 7440-47-3
MF: CR
SYNONYMS
CHROME * CHROMIUM (ACGIH) * CHROMIUM METAL (OSHA) *
---------- TOXICITY HAZARDS ----------
RTECS NO: GB4200000
CHROMIUM
TOXICITY DATA
UNR-RAT LD50:27500 UG/KG GISAAA 37(10),27,72
REVIEWS, STANDARDS, AND REGULATIONS
ACGIH TLV-TWA 0.5 MG/M3 85INA8 5,139,86
IARC CANCER REVIEW:ANIMAL INADEQUATE EVIDENCE IMEMDT 23,205,80

IARC CANCER REVIEW:ANIMAL INADEQUATE EVIDENCE IMEMDT 49,49,90

IARC CANCER REVIEW:HUMAN INADEQUATE EVIDENCE IMEMDT 23,205,80

IARC CANCER REVIEW:HUMAN INADEQUATE EVIDENCE IMEMDT 49,49,90

IARC CANCER REVIEW:GROUP 3 IMEMDT 49,49,90
MSHA STANDARD-AIR:TWA 0.5 MG/M3 DTLVS* 3,56,71
OSHA PEL:8H TWA 1 MG(CR)/M3 FEREAC 54,2923,89
OSHA PEL FINAL:8H TWA 1 MG(CR)/M3 FEREAC 54,2923,89
NIOSH REL TO CHROMIUM METAL-AIR:10H TWA 0.5 MG/M3 NIOSH* DHHS #92-100,
92
NOHS 1974: HZD 19395; NIS 43; TNF 1375; NOS 49; TNE 16576
NOES 1983: HZD X5981; NIS 10; TNF 318; NOS 6; TNE 2034; TFE 3
ATSDR TOXICOLOGY PROFILE (NTIS** PB/89/236665/AS)
EPA GENETOX PROGRAM 1988, INCONCLUSIVE: CARCINOGENICITY-MOUSE/RAT

EPA TSCA CHEMICAL INVENTORY, JUNE 1990
EPA TSCA SECTION 8(E) STATUS REPORT 8EHQ-0680-0345
ON EPA IRIS DATABASE
EPA TSCA TEST SUBMISSION (TSCATS) DATA BASE, JULY 1992
NIOSH CURRENT INTELLIGENCE BULLETIN 4, 1975
NIOSH ANALYTICAL METHODS: SEE CHROMIUM, 7024; WELDING AND BRAZING

FUME, 7200; ELEMENTS, 7300
NIOSH ANALYTICAL METHODS: SEE ELEMENTS (ICP) 7300
NIOSH ANALYTICAL METHODS: SEE WELDING AND BRAZING FUME 7200

NIOSH ANALYTICAL METHODS: SEE ELEMENTS IN BLOOD OR TISSUE 8005

NIOSH ANALYTICAL METHODS: SEE METALS IN URINE (ICP) 8310
NTP SIXTH ANNUAL REPORT ON CARCINOGENS, 1991 : KNOWN TO BE CARCINOGENIC
OSHA ANALYTICAL METHOD #ID-125G
TARGET ORGAN DATA
GASTROINTESTINAL (TUMORS)
BLOOD (LYMPHOMA INCLUDING HODGKIN'S DISEASE)
MUSCULO-SKELETAL (TUMORS)
TUMORIGENIC (EQUIVOCAL TUMORIGENIC AGENT BY RTECS CRITERIA)
TUMORIGENIC (TUMORS AT SITE OF APPLICATION)
ONLY SELECTED REGISTRY OF TOXIC EFFECTS OF CHEMICAL SUBSTANCES (RTECS)
DATA IS PRESENTED HERE. SEE ACTUAL ENTRY IN RTECS FOR COMPLETE INFORMATION.
DATA IS PRESENTED HERE. SEE ACTUAL ENTRY IN RTECS FOR COMPLETE INFORMATION.

---------- HEALTH HAZARD DATA ----------

ACUTE EFFECTS
HARMFUL IF SWALLOWED, INHALED, OR ABSORBED THROUGH SKIN.
CAUSES EYE AND SKIN IRRITATION.
MATERIAL IS IRRITATING TO MUCOUS MEMBRANES AND UPPER RESPIRATORY TRACT.
PROLONGED EXPOSURE CAN CAUSE:
DAMAGE TO THE LIVER
DAMAGE TO THE KIDNEYS
CHRONIC EFFECTS
CARCINOGEN.
FIRST AID
IN CASE OF CONTACT, IMMEDIATELY FLUSH EYES OR SKIN WITH COPIOUS

AMOUNTS OF WATER FOR AT LEAST 15 MINUTES WHILE REMOVING CONTAMINATED
CLOTHING AND SHOES.
IF INHALED, REMOVE TO FRESH AIR. IF NOT BREATHING GIVE ARTIFICIAL RESPIRATION. IF BREATHING IS DIFFICULT, GIVE OXYGEN.
IF SWALLOWED, WASH OUT MOUTH WITH WATER PROVIDED PERSON IS CONSCIOUS.
CALL A PHYSICIAN.

---------- PHYSICAL DATA ----------

SPECIFIC GRAVITY: 7.140
APPEARANCE AND ODOR
GREY POWDER

---------- FIRE AND EXPLOSION HAZARD DATA ----------

EXTINGUISHING MEDIA
USE EXTINGUISHING MEDIA APPROPRIATE TO SURROUNDING FIRE CONDITIONS.

SPECIAL FIREFIGHTING PROCEDURES
WEAR SELF-CONTAINED BREATHING APPARATUS AND PROTECTIVE CLOTHING TO

PREVENT CONTACT WITH SKIN AND EYES.
UNUSUAL FIRE AND EXPLOSIONS HAZARDS
EMITS TOXIC FUMES UNDER FIRE CONDITIONS.
---------- REACTIVITY DATA ----------
INCOMPATIBILITIES
STRONG ACIDS
STRONG OXIDIZING AGENTS
HAZARDOUS COMBUSTION OR DECOMPOSITION PRODUCTS
NATURE OF DECOMPOSITION PRODUCTS NOT KNOWN.
---------- SPILL OR LEAK PROCEDURES ----------
STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED
EVACUATE AREA.
WEAR SELF-CONTAINED BREATHING APPARATUS, RUBBER BOOTS AND HEAVY

RUBBER GLOVES.
COVER WITH DRY LIME OR SODA ASH, PICK UP, KEEP IN A CLOSED CONTAINER

AND HOLD FOR WASTE DISPOSAL.
SWEEP UP, PLACE IN A BAG AND HOLD FOR WASTE DISPOSAL.
VENTILATE AREA AND WASH SPILL SITE AFTER MATERIAL PICKUP IS COMPLETE.

WASTE DISPOSAL METHOD
MATERIAL IN THE ELEMENTAL STATE SHOULD BE RECOVERED FOR REUSE OR

RECYCLING.
OBSERVE ALL FEDERAL, STATE, AND LOCAL LAWS.
--- PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE ---
WEAR APPROPRIATE NIOSH/MSHA-APPROVED RESPIRATOR,
CHEMICAL-RESISTANT
GLOVES, SAFETY GOGGLES, OTHER PROTECTIVE CLOTHING.
USE ONLY IN A CHEMICAL FUME HOOD.
SAFETY SHOWER AND EYE BATH.
DO NOT BREATHE DUST.
AVOID ALL CONTACT.
WASH THOROUGHLY AFTER HANDLING.
IRRITANT.
CARCINOGEN.
TOXIC.
KEEP TIGHTLY CLOSED.
LABEL PRECAUTIONARY STATEMENTS
TOXIC
MAY CAUSE CANCER.

TOXIC BY INHALATION, IN CONTACT WITH SKIN AND IF SWALLOWED.
IRRITATING TO EYES, RESPIRATORY SYSTEM AND SKIN.
IN CASE OF CONTACT WITH EYES, RINSE IMMEDIATELY WITH PLENTY OF WATER AND SEEK MEDICAL ADVICE.
AFTER CONTACT WITH SKIN, WASH IMMEDIATELY WITH PLENTY OF WATER.

IF YOU FEEL UNWELL, SEEK MEDICAL ADVICE (SHOW THE LABEL WHERE POSSIBLE).
WEAR SUITABLE PROTECTIVE CLOTHING, GLOVES AND EYE/FACE PROTECTION.

REGULATORY INFORMATION

THIS PRODUCT IS SUBJECT TO SARA SECTION 313 REPORTING REQUIREMENTS.

THE ABOVE INFORMATION IS BELIEVED TO BE CORRECT BUT DOES NOT PURPORT TO BE ALL INCLUSIVE AND SHALL BE USED ONLY AS A GUIDE. SIGMA ALDRICH SHALL NOT BE HELD LIABLE FOR ANY DAMAGE RESULTING FROM HANDLING OR FROM CONTACT WITH THE ABOVE PRODUCT. SEE REVERSE SIDE OF INVOICE OR PACKING SLIP FOR ADDITIONAL TERMS AND CONDITIONS OF SALE.

---------- IDENTIFICATION ----------

PRODUCT #: 31919-8 NAME: NITRATE, VOLUMETRIC STANDARD, SOLUTION

CAS #: 7757-79-1 IN WATER

MF: KNO3

SYNONYMS

KALIUMNITRAT (GERMAN) * NITER * NITRE * NITRIC ACID, POTASSIUM SALT *

POTASSIUM NITRATE (DOT) * SALTPETER * UN 1486 (DOT) * VICKNITE *

---------- TOXICITY HAZARDS ----------

RTECS NO: TT3700000

POTASSIUM NITRATE

TOXICITY DATA

ORL-RAT LD50:3750 MG/KG NYKZAU 81,469,83

ORL-RBT LD50:1901 MG/KG SOVEA7 27,246,74

REVIEWS, STANDARDS, AND REGULATIONS

EPA FIFRA 1988 PESTICIDE SUBJECT TO REGISTRATION OR RE-REGISTRATION

FEREAC 54,4388,89

NOHS 1974: HZD 80350; NIS 67; TNF 4730; NOS 53; TNE 36204

NOES 1983: HZD 80350; NIS 67; TNF 4503; NOS 65; TNE 66562; TFE 26088

EPA TSCA CHEMICAL INVENTORY, JUNE 1990

TARGET ORGAN DATA

EFFECTS ON NEWBORN (BEHAVIORAL)

ONLY SELECTED REGISTRY OF TOXIC EFFECTS OF CHEMICAL SUBSTANCES (RTECS)

DATA IS PRESENTED HERE. SEE ACTUAL ENTRY IN RTECS FOR COMPLETE INFORMATION.

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---------- HEALTH HAZARD DATA ----------

ACUTE EFFECTS

MAY BE HARMFUL BY INHALATION, INGESTION, OR SKIN ABSORPTION.

CAUSES EYE AND SKIN IRRITATION.

MATERIAL IS IRRITATING TO MUCOUS MEMBRANES AND UPPER RESPIRATORY TRACT.

ABSORPTION INTO THE BODY LEADS TO THE FORMATION OF METHEMOGLOBIN

WHICH IN SUFFICIENT CONCENTRATION CAUSES CYANOSIS. ONSET MAY BE

DELAYED 2 TO 4 HOURS OR LONGER.

TARGET ORGAN(S):

BLOOD

CENTRAL NERVOUS SYSTEM

TO THE BEST OF OUR KNOWLEDGE, THE CHEMICAL, PHYSICAL, AND TOXICOLOGICAL PROPERTIES HAVE NOT BEEN THOROUGHLY INVESTIGATED.

FIRST AID
IN CASE OF CONTACT, IMMEDIATELY FLUSH EYES OR SKIN WITH COPIOUS

AMOUNTS OF WATER FOR AT LEAST 15 MINUTES WHILE REMOVING CONTAMINATED
CLOTHING AND SHOES.
IF INHALED, REMOVE TO FRESH AIR. IF NOT BREATHING GIVE ARTIFICIAL RESPIRATION. IF BREATHING IS DIFFICULT, GIVE OXYGEN.
IF SWALLOWED, WASH OUT MOUTH WITH WATER PROVIDED PERSON IS CONSCIOUS.
CALL A PHYSICIAN.
WASH CONTAMINATED CLOTHING BEFORE REUSE.

---------- PHYSICAL DATA ----------

SPECIFIC GRAVITY: 1.000
APPEARANCE AND ODOR
CLEAR COLORLESS LIQUID

---------- FIRE AND EXPLOSION HAZARD DATA ----------

FLASHPOINT: NONE BY:
EXTINGUISHING MEDIA
WATER SPRAY.
SPECIAL FIREFIGHTING PROCEDURES
WEAR SELF-CONTAINED BREATHING APPARATUS AND PROTECTIVE CLOTHING TO

PREVENT CONTACT WITH SKIN AND EYES.
UNUSUAL FIRE AND EXPLOSIONS HAZARDS
EMITS TOXIC FUMES UNDER FIRE CONDITIONS.

---------- REACTIVITY DATA ----------

INCOMPATIBILITIES
STRONG REDUCING AGENTS
FINELY POWDERED METALS
HAZARDOUS COMBUSTION OR DECOMPOSITION PRODUCTS
NITROGEN OXIDES

---------- SPILL OR LEAK PROCEDURES ----------

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED
EVACUATE AREA.
WEAR SELF-CONTAINED BREATHING APPARATUS, RUBBER BOOTS AND HEAVY

RUBBER GLOVES.
COVER WITH DRY LIME OR SODA ASH, PICK UP, KEEP IN A CLOSED CONTAINER

AND HOLD FOR WASTE DISPOSAL.
VENTILATE AREA AND WASH SPILL SITE AFTER MATERIAL PICKUP IS COMPLETE.

WASTE DISPOSAL METHOD
CAUTIOUSLY ACIDIFY A 3% SOLUTION OR A SUSPENSION OF THE MATERIAL TO

PH 2 WITH SULFURIC ACID. GRADUALLY ADD A 50% EXCESS OF AQUEOUS SODIUM
BISULFITE WITH STIRRING AT ROOM TEMPERATURE. AN INCREASE IN TEMPERATURE INDICATES THAT A REACTION IS TAKING PLACE. IF NO REACTION IS OBSERVED ON THE ADDITION OF ABOUT 10% OF THE SODIUM BISULFITE SOLUTION
INITIATE IT BY CAUTIOUSLY ADDING MORE ACID. IF MANGANESE, CHROMIUM, OR MOLYBDENUM ARE PRESENT ADJUST THE PH OF THE SOLUTION TO 7 AND TREAT
WITH SULFIDE TO PRECIPITATE FOR BURIAL AS HAZARDOUS WASTE. DESTROY EXCESS SULFIDE, NEUTRALIZE AND FLUSH THE SOLUTION DOWN THE DRAIN.

OBSERVE ALL FEDERAL, STATE, AND LOCAL LAWS.
--- PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE ---
WEAR APPROPRIATE NIOSH/MSHA-APPROVED RESPIRATOR, CHEMICAL-RESISTANT
GLOVES, SAFETY GOGGLES, OTHER PROTECTIVE CLOTHING.
MECHANICAL EXHAUST REQUIRED.
SAFETY SHOWER AND EYE BATH.
AVOID INHALATION.
DO NOT GET IN EYES, ON SKIN, ON CLOTHING.
AVOID PROLONGED OR REPEATED EXPOSURE.
WASH THOROUGHLY AFTER HANDLING.
IRRITANT.
KEEP TIGHTLY CLOSED.
STORE IN A COOL DRY PLACE.
LABEL PRECAUTIONARY STATEMENTS
IRRITANT
IRRITATING TO EYES, RESPIRATORY SYSTEM AND SKIN.
TARGET ORGAN(S):
BLOOD
NERVES
IN CASE OF CONTACT WITH EYES, RINSE IMMEDIATELY WITH PLENTY OF WATER AND SEEK MEDICAL ADVICE.
WEAR SUITABLE PROTECTIVE CLOTHING, GLOVES AND EYE/FACE PROTECTION.
--------- ADDITIONAL PRECAUTIONS AND COMMENTS ---------
ADDITIONAL INFORMATION
A MIXTURE WITH CALCIUM SILICIDE IS EASILY IGNITED AND BURNS AT A VERY HIGH TEMPERATURE WHICH IS CAPABLE OF INITIATING MANY HIGH TEMPERATURE

REACTIONS. MIXTURES OF POTASSIUM NITRATE WITH: TITANIUM, ANTIMONY,

GERMANIUM OR ZIRCONIUM POWDERS, ANTIMONY TRISULFIDE, BARIUM SULFIDE,

CALCIUM SULFIDE, ARSENIC DISULFIDE, TITANIUM DISULFIDE, GERMANIUM MONOSULFIDE, MOLYBDENUM DISULFIDE, POWDERED CARBON, ARSENIC, WHITE OR RED PHOSPHOROUS, BORON PHOSPHIDE, COPPER PHOSPHIDES, SODIUM PHOSPHINATE, SODIUM ACETATE, SODIUM THIOSULFATE, THORIUM DICARBIDE,

ALUMINUM, MAGNESIUM, SODIUM OR IRON, CHROMIUM NITRIDE MAY EXPLODE OR BE DETONABLE IF HEATED, IGNITED OR STRUCK.

---------- IDENTIFICATION ----------

PRODUCT #: 31919-8 NAME: NITRATE, VOLUMETRIC STANDARD, SOLUTION

CAS #: 7757-79-1 IN WATER

MF: KNO3

SYNONYMS

KALIUMNITRAT (GERMAN) * NITER * NITRE * NITRIC ACID, POTASSIUM SALT *

POTASSIUM NITRATE (DOT) * SALTPETER * UN 1486 (DOT) * VICKNITE *

---------- TOXICITY HAZARDS ----------

RTECS NO: TT3700000

POTASSIUM NITRATE

TOXICITY DATA

ORL-RAT LD50:3750 MG/KG NYKZAU 81,469,83

ORL-RBT LD50:1901 MG/KG SOVEA7 27,246,74

REVIEWS, STANDARDS, AND REGULATIONS

EPA FIFRA 1988 PESTICIDE SUBJECT TO REGISTRATION OR RE-REGISTRATION

FEREAC 54,4388,89

NOHS 1974: HZD 80350; NIS 67; TNF 4730; NOS 53; TNE 36204

NOES 1983: HZD 80350; NIS 67; TNF 4503; NOS 65; TNE 66562; TFE 26088

EPA TSCA CHEMICAL INVENTORY, JUNE 1990

TARGET ORGAN DATA

EFFECTS ON NEWBORN (BEHAVIORAL)

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CALCIUM SULFIDE, ARSENIC DISULFIDE, TITANIUM DISULFIDE, GERMANIUM MONOSULFIDE, MOLYBDENUM DISULFIDE, POWDERED CARBON, ARSENIC, WHITE OR RED PHOSPHOROUS, BORON PHOSPHIDE, COPPER PHOSPHIDES, SODIUM PHOSPHINATE, SODIUM ACETATE, SODIUM THIOSULFATE, THORIUM DICARBIDE,

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