PNL-MA-527
Rev. 5

Application for Renewal of Special Nuclear Materials License SNM-942

Compiled by the
Staff of Battelle, Pacific Northwest Laboratories

May 1, 1979

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Pacific Northwest Laboratories

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APPLICATION FOR RENEWAL OF

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RICHLAND, WASHINGTON 99352

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APPLICATION FOR RENEWAL OF SPECIAL NUCLEAR MATERIALS LICENSE SNM-942
(Revision 5, May 1, 1979)

1.0 CRITERIA AND ADMINISTRATIVE PROCEDURES

1.1 GENERAL

This is an application to the Nuclear Regulatory Commission (NRC) for the renewal of Special Nuclear Materials License, SNM-942, covering the receipt, possession and use of special nuclear material for broad research and development.

Applicant

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All of the above officers are United States citizens. No control or ownership is exercised over the applicant by any alien, foreign corporation, or foreign government.

Organization of the License Application

This total application is divided into Part I and Part II.

Part I contains the criteria and administrative procedures set up to assure the maintenance of high quality health and safety conditions for all Battelle-Northwest work performed under this special nuclear materials license. The criteria and administrative procedures in Part I may not be changed without prior approval from the Nuclear Regulatory Commission.

Part II presents additional descriptive material as evidence of the technical competence, management control procedures and philosophy at Battelle-Northwest. This competence, control, and philosophy assure adequate nuclear health and safety performance in all of the Laboratories' activities.

Location Where Licensed Material Will Be Used

The primary work location is the Battelle-Northwest controlled buildings and facilities located on or adjacent to the Department of Energy's Hanford

Site at Richland, Washington. These facilities include those of the Pacific Northwest Laboratory (PNL) operated for the Department of Energy (DOE) by Battelle-Northwest (BNW) and those privately owned by BNW. Additional temporary work locations include sponsor's laboratories and facilities except in Agreement States.

Battelle-Northwest has entered into two contracts with DOE involving these facilities: 1) a Prime Operating Contract, EY-76-C 06-1830, to operate both the government owned and certain of the Battelle-Northwest-owned laboratory facilities in carrying out assigned DOE research and development programs, and 2) a Use Permit Contract, EY-76-C-06-1831, permitting the use of certain government-owned laboratory facilities in conducting contract research for industry, for government agencies, and for its own account. Battelle-Northwest also conducts contract research for its own account in privately owned facilities in the BNW Richland Research Complex located immediately south of the Hanford 300 Area. This license is intended to cover the work conducted under the Use Permit Contract, EY-76-C-06-1831, plus any other work conducted by Battelle-Northwest (predominately in the above location) which requires a special nuclear materials license.

A map and description of the Hanford Site and environs with plot plans showing the locations of Battelle-Northwest controlled buildings and facilities, are in Part II of this application.

Special Nuclear Materials to be Handled in Battelle-Northwest Controlled Facilities

License coverage is sought for enriched uranium and all isotopes of plutonium. These materials may be handled in any physical and chemical form for all research and development purposes except for administration to humans. The maximum quantity of licensed materials which will be in inventory under the control of Battelle-Northwest at any time will be less than one effective kilogram, as defined in subparagraph 70.4(t) of 10 CFR Part 70.

Since the maximum quantity of licensed material is relatively small compared with normal inventories in use by Battelle-Northwest for DOE programs under Operating Contract EY-76-C-06-1830, the potential risks to the health and safety of onsite and offsite personnel will not be significantly increased by addition of the licensed work.

Radioactive Materials to be Handled Temporarily in Sponsor's Facilities Except in Agreement States

License coverage is also sought for the temporary use of special nuclear material for research and development purposes in a sponsor's facility except in Agreement States. Temporary work under the terms of this license will in each case by limited to a quantity less than a minimum critical mass.

The use of the licensed materials in sponsor's facilities will be limited as necessary to assure a high degree of safety using engineered and administrative safeguards which are entirely under control of Battelle-Northwest and therefore do not create a situation of dual responsibility between Battelle-Northwest and sponsor personnel. Alternatively, where the sponsor is licensed by the NRC, it may be preferable in some cases to transfer the material entirely to the sponsor's control. In either case, responsibility will be clearly delineated.

Examples of Work to be Performed Under the License

Battelle-Northwest will perform contract research and development activities for its own account and for many sponsors, both government and industrial, in practically all areas of the physical and life sciences except human medicine. Much of this contract research work will be nonnuclear in character. However, it is proposed to include the laboratory's broad and competent nuclear research capabilities in the spectrum of research services offered.

Research activities may involve handling quantities approaching one effective kilogram of fissile materials in both nonmetallic and metallic forms. Small amounts of special nuclear materials are used in support of research and development work related to the production and processing of nuclear fuels and fuel material. In addition, special nuclear materials are used in a wide variety of non-fuel research and development programs, including the following areas:

- Research in radiobiology
- Development of improved means for the dosimetry of ionizing radiation
- Measuring, minimizing, and controlling radioactivity released to the environment

- Reactor system development, as well as reactor materials and component development
- Study of irradiation effects
- Development of improved activation analysis techniques
- Reprocessing of irradiated fuels and neutron target materials for recovery of products and radionuclides
- Development of radioactive waste processing procedures.

No special nuclear materials will be produced under this license since it does not cover the operation of a nuclear reactor nor insertion of any licensed material into a nuclear reactor.

Financial Qualifications

The net worth of the Battelle Memorial Institute (BMI) is approximately $155 million. The BMI annual business volume for 1978 exceeded $294 million.

Previous License Numbers

No license numbers prior to SNM-942 have been issued to Pacific Northwest Laboratories of the Pacific Northwest Division of Battelle Memorial Institute by the Nuclear Regulatory Commission.

1.2 REQUEST FOR APPROVAL OF ALTERNATE METHODS

The major portion of the work with radioactive materials performed by Battelle-Northwest is under the Operating Contract EY-76-C-06-1830 with DOE. That portion of the work with radioactive materials performed by BNW under the license represents a small amount both in dollars and in amount of radioactive material involved. The work under the Operating Contract is closely related to activities of other Hanford contractors, including Rockwell International's Rockwell Hanford Operations, the Westinghouse Hanford Company, and the Hanford Environmental Health Foundation. Because of the close relationship among the Hanford contractors, both geographically and programmatically, it is very important that radiation protection standards be maintained uniformly among the various Hanford contractors. In order to achieve and maintain this uniformity the Richland Operations Office of DOE has issued directives in the form of DOE-RL Manual Chapters and the Hanford Services and Facilities Catalog.

The Hanford Services and Facilities Catalog requires that all Hanford contractors utilize certain Hanford-wide services provided by a specified contractor; for example:

- All maintenance, repair and calibration of radiation survey instrumentation is performed for all contractors by Battelle-Northwest.
- All bioassay samples and personnel dosimeters for employees of all Hanford contractors, and all samples obtained for the Hanford Environmental Surveillance Program are processed by one contractor - U. S. Testing Company.
- One Battelle-Northwest component makes all in-vivo determinations, evaluates the results of all personnel exposure measurements, compiles the data obtained using one common data processing program, routinely reports the results to the concerned contractors, maintains the exposure record files, and makes all necessary reports, again for all Hanford contractors to meet the requirements established by DOE-RL.
- Another Battelle-Northwest component conducts the Environmental Surveillance Program, by scheduling, obtaining (but not processing), evaluating and reporting the results of samples taken and measurements made throughout the Hanford environs.

All of these programs are established and performed to meet the specific requirements of DOE-RL. Notwithstanding the fact that Battelle-Northwest may conduct a specific plant-wide radiation protection service program, Battelle-Northwest cannot unilaterally change that program without the concurrence of all involved contractors and DOE-RL.

The Richland Operations Office issues supplements to certain DOE Manual Chapters to provide specific guidance for Hanford contractors in interpretation of the requirements of the basic DOE Manual Chapters. These Manual Chapters are transmitted to the contractors for compliance; Battelle-Northwest and the other Hanford contractors have little latitude in the application of the contained limits and methods.

Work performed by Battelle-Northwest that requires a Special Nuclear Materials license is carried out in the same facilities at the same time and by the same people as work performed for DOE under the Operating Contract. It is neither technically or administratively feasible to apply two different exposure measurement and control programs simultaneously to the same employees. The exposure which an employee may receive from licensed materials cannot be distinguished from that which he may receive from materials used under the Operating Contract.

Because the Battelle-Northwest Radiation Protection Program is designed to comply with requirements in DOE Manual Chapters, certain radiation protection standards or practices differ from those specified in Title 10 Parts 20 and 70 of the Code of Federal Regulations. Those radiation protection standards or practices that differ from particular paragraphs are described here.

<u>Occupational Exposure Limits</u>

The annual and long-term exposure limits applied by Battelle-Northwest for work under the Operating Contract are based on those contained in DOE Manual Chapter 0524. The BNW exposure limits are as follows:

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	Annual	Calendar Quarter
Whole Body, Head and Trunk, Gonads, Lens of Eye, Red Blood Marrow, Active Blood Forming Organs	5 rem	3 rem
Unlimited areas of the skin (except hands, forearms and feet) Other organs. tissues, and organ systems (except bone)	15 rem	5 rem
Bone, Hands, Forearms, Feet[a]	30 rem	10 rem

(a) All reasonable effort shall be made to keep exposures to forearms and hands to the general limit for the skin.

DOE requires the total dose to include dose received both from external sources and internally deposited radioactive materials.

The 10 CFR 20 quarterly permissible dose limits appear to have been established as one-fourth of the desired annual exposure in order to eliminate the need for separately stating the appropriate annual limit. In contrast, the DOE quarterly limits are presented to demonstrate the degree of nonuniformity of accumulation of exposure through the year which is permissible as established by the Federal Radiation Council (FRC) and the International Commission of Radiological Protection (ICRP). Since Battelle-Northwest personnel rarely exceed the quarterly limits specified in 10 CFR 20, seldom is it necessary or desirable to expose personnel as nonuniformly as the DOE quarterly limits permit. The few cases where such exposure has been necessary have been related to whole body exposure rather than exposure to the skin or extremity. In those cases, the 3 rem/q DOE limit is applied [same as permitted by paragraph 20.101 (b)] except that the combined annual whole body exposure from external and internal sources is limited to 5 rem in the year.

The Battelle-Northwest quarterly exposure limits described above are submitted as an alternate to the quarterly limits contained in paragraph 20.101(a). The purpose in requesting approval of the quarterly limits in DOE Manual Chapter 0524 as an alternate to the 10 CFR 20 quarterly limits is to aviod possible confusion, misunderstanding, or concern on the part of

Battelle-Northwest or other Hanford employees. This could result from the change itself or from the resulting inconsistency between contractors rather than the need for additional exposure.

Every new employee is required to complete an exposure history questionnaire to aid in the evaluation of internal dose and to assure that the new employee does not exceed a quarterly or annual limit as a result of his/her combined exposure for the year (both onsite and offsite exposure). In the event that the new employee has been occupationally exposed prior to employment at Battelle-Northwest, administrative controls will be imposed to restrict exposure for the remainder of the year until such time that the prior exposure record is obtained. These controls include the assumption that he/she has received 1.25 rem for each quarter or fraction thereof in the current year prior to employment with Battelle-Northwest. Additionally, if the accrued or assumed exposure exceeds any quarterly or annual limit, the employee will not be permitted to receive additional exposure while working for Battelle-Northwest until his/her exposure is within the appropriate limits. Any special exposure controls deemed necessary because of either real or assumed exposure will be provided in writing to the employee's supervisor, to Radiation Monitoring and to the employee's exposure records file.

This exposure history satisfied all requirements for NRC Form 4 with the exception of Item 9 (insertion of calculated dose) and Item 13 (permissible dose remaining). Previously, exemptions were requested for these two items; however, since annual exposure in excess of 5 rem is not permitted, it is not believed necessary to maintain an NRC Form 4.

Pursuant to paragraph 20.501, it is requested that Battelle-Northwest be granted an exemption from the numerical values contained in paragraph 20.101(a) and to substitute the Battelle-Northwest occupational exposure limits described on page 1.2-3.

Calendar Quarter

The calandar quarter used in the Hanford-wide program is not as defined in paragraph 20.3. The exposure year at Hanford consists of four quarters ending on the last Friday of March, June, September and December. No quarter is less than 12 weeks nor more than 14 weeks in length in accord with a portion of the definition presented in paragraph 20.3. However, the remaining days in December, if any, become a part of the new exposure year.

A change of the calendar quarter to meet one of the definitions presented in paragraph 20.3 would impact heavily across the plant. The DOE-RL contract with U.S. Testing Company specified that dosimeter change shall be on the last Friday of each month and that the calendar year will end on the last Friday of December. The U.S. Testing Company dosimeter processing schedules and the exposure records data processing program schedules are based on this definition. The last Friday of each month was chosen since Friday is the only day of the week that all Hanford contractor employees other than firemen are at work, regardless of shift schedule.

Pursant to paragraph 20.501, it is requested that the calendar quarter as defined above be accepted in lieu of the definition of calendar quarter contained in paragraph 20.3(a)(4).

Reports to Prior Employees

Exposure reports are provided to prior employees as required by DOE Manual Chapter 0525 and paragraph 20.401(a), within 30 days of the request. These reports include the accumulated exposures to beta particles, photons, and neutrons for the entire period of employment together with information regarding deposition of radioactive material, if appropriate. The reports also include a summary by calendar quarters of the whole body skin, whole body penetrating, and extremity exposures for the current calendar year. Since exposures by calendar quarter are not maintained in the data processing file, and in some cases the employee's exposure may span a period in excess of 30 years at the plant, the normal procedure does not include the reconstruction of data to provide exposures by quarters or lesser periods as required by paragraph 20-401(a), other than for the current year. Additionally, if the employee is on a quarterly dosimeter exchange frequency, it is physically impossible to provide exposures for the current year by lesser periods than quarterly. On an individual case, if there is a necessity to report these data on a quarterly frequency, it would be possible to do this for the entire employment period. This would be accomplished by obtaining data which is currently maintained on microfilm for each employee.

Pursuant to paragraph 20.501, it is requested that the requirements for providing exposure by calendar quarter for other than the current calendar year and for lesser periods than quarterly as required in paragraph 20.401(a) be waived.

Reports of Exposure on Termination

DOE Manual Chapter 0525 requires the reporting of exposure for terminated employees to the System Safety Development Center (SSDC) in Idaho Falls, Idaho within 30 days after the terminated employee's exposure has been determined or within 30 days after the individual's termination date, whichever is later. A copy is also provided to the employee upon request. This report contains the same information which is to be submitted to the Director of Management and Program Analysis, USNRC, as required in paragraph 20.408. The past organization of the Federal Agencies dealing with nuclear energy presented the situation in which two identical reports could have been sent to the same agency by two different routes which could possibly result in an apparent doubling of an employee's exposure to radiation. This situation was alleviated with an exemption in license SNM-942. Although Federal Agency reorganization has occurred, the possibility still remains that the compilation of the same exposure records by two separate records centers for whatever purposes presents the possibility of doubling an employee's apparent exposure.

Pursant to paragraph 20.501, it is requested the requirements of DOE Manual Chapter 0525 be deemed to satisy the parallel of requirements of paragraph 20.408 and that the requirements of paragraph 20.408 continue to be waived.

Exposure Records and Reports for Current Exposure Year

All Hanford contractor employee's exposure records are compiled using automatic data processing methods. Each month, reports reflecting any action in the employee's exposure data file are reported in the form of computer printout reports. For employees who are monitored persuant to paragraph 20.202 or DOE Manual Chapters, a summary report provides the dose for the current period, calendar year to date, and extrapolated dose to the end of the year, and is issued at least quarterly to management and Radiation Monitoring.

The thermoluminescent multipurpose dosimeter uses LiF chips to measure beta, photon and neutron radiation. The dosimeter is constructed to provide a measure of the skin dose and a one centimeter tissue depth dose to the whole body. Quality factors of 10 and 3 are used to determine dose equivalents to body organs for fast and thermal neutrons, respectively.

For employees who are provided extremity dosimeters, another data processing report is also provided on a monthly frequency. The sum of the employee's accumulated derma dose plus any special measurements made for the extremity is considered the employee's extremity exposure.

Annual summations are provided for each employee's exposure record file, and in the form of an annual exposure report card to the employee.

The exposure records and reports for the current exposure year include all of the information required on Form NRC 5 with the exception of Item 13 (running total for calendar quarter) and Item 18 [additional exposure allowable under 5(N-18) rems] as required in paragraph 20.401. The various data on the monthly exposure reports have permitted management to effectively maintain BNW employees' exposure below 3 rem per quarter. The addition of the quarterly total to these reports would not change the exposure control program but would increase the cost of the Hanford plant exposure records program since any change would necessarily affect the entire plant. No accounting is made of the amount of exposure remaining within the formula since an employee's annual exposure is limited to 5 rem.

Pursuant to paragraph 20.501, it is requested that exemption to the requirements of paragraph 20.401(a) be granted to the extent that Items 13 and 18 of Form NRC 5 need not be completed.

Caution Signs, Labels and Signals

The methods used by Battelle-Northwest in identifying those locations where radiation protection controls are required, differ in detail from those specified in paragraph 20.203. All locations where significant radiation exposure can be received, whether externally or internally, are posted with signs bearing the standard radiation symbol together with the words "Radiation Zone". Radiation Zones are established to limit casual (non-Radiation Zone) exposure to less than one-tenth of the occupational radiation exposure limits. All areas which would be required to be posted by paragraph 20.203 (as a radiation area, high radiation area, airborne radioactivity area or radioactive material area) are included within the Battelle-Northwest requirement for posting as a Radiation Zone. All significant quantities of radioactive materials or radiation generating machines are stored and used in Radiation Zones in conformance with established Radiation Protection Procedures.

The placement of signs denoting Radiation Zones is such that at least one sign is visible from any avenue of approach. These signs normally make no reference to either the nature of existing radiation conditions or the radiation protection measures required within the Radiation Zone. Such information is contained on the Radiation Work Procedure which applies to that specific work location and to the personnel authorized to enter the area. Tight control is exercised over all visitors by means of local building security for buildings outside of the exclusion area and by security patrol for buildings or areas within the Hanford Site exclusion area. Visitors are not permitted to enter any Radiation Zone unless escorted by an employee thoroughly familiar with the radiological status and radiation protection requirements.

Radiation Work Procedures detail the requirements for protective clothing, personnel monitoring devices, surveillance of work by Radiation Monitoring, the locking out of process equipment, and other such requirements which can best be defined by the local groups actually performing the work. Although normally prepared for use over an extended period, occasionally a Radiation Work Procedure will authorize work for only a short period. Radiation Work Procedures require approvals of operating management, building management and Radiation Monitoring supervision.

The radiation protection requirements on the Radiation Work Procedures are established by Radiation Monitoring based on either the exposure potential associated with the work planned or on the radiological status of the area as determined from frequent area surveys of locations accessible to personnel. Results of all such measurements are preserved in the radiation protection records.

This practice of 1) uniformly posting all areas where significant exposure may be received as "Radiation Zones" and 2) specifying the existent radiological conditions and radiation protection requirements on the Radiation Work Procedure required to be prepared for every Radiation Zone has been used for many years within the laboratories and is consistent with the procedures of other Hanford contractors.

The DOE facilities operated by Battelle-Northwest are designed in accordance with Radiological Design Criteria (currently documented as BNWL-MA-3) which have been in effect for a number of years. These criteria include a requirement to provide locks or interlocks for areas where dose rates in excess of 1 rem/hr or airborne concentrations in excess of 1000 MPCs may be encountered. Since much of the work for DOE involves kilocurie or megacurie quantities of fission products, transuranium elements, etc., it is not practical to provide

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physical access controls below these levels. As described earlier, all work in Radiation Zones, including areas where high dose rates or airborne concentrations may be encountered, is controlled by RWP provisions.

Pursuant to paragraph 20.501, it is requested that the requirements in paragraphs 20.203(b) (use of the words - "Caution Radiation Area"), 20.203(c)(1) (use of the words - "Caution High Radioactive Area"), 20.203(d) (use of the words - "Caution Airborne Radioactivity Area"), and 20.203(e) (use of the words - "Caution Radioactive Material") be waived in lieu of the use of the standard Hanford Radiation Zone sign described above together with the associated Radiation Work Procedure. All areas that would be required to be posted by paragraph 20.203 will be included within areas posted as Radiation Zones. Additionally, it is requested that the level of 1 rem/hr be accepted as the dose rate at which physical safeguards including locks or interlocks shall be required rather than the levels specified in paragraph 20.203(c)(2).

Records of Liquid Waste Disposals

Most of the buildings in the 300 area where Battelle-Northwest performs work under the license are connected to liquid radioactive waste systems operated by the Hanford Engineering Development Laboratory (HEDL) contractor. It is not possible to distinguish liquid wastes generated in licensed activities from those wastes generated in DOE contract activities, and in some cases, it is not possible to identify the contributions to the system from a given building or those arising from the activities of a given contractor. Measurements are made and records are kept by the HEDL contractor of the total radioactivity disposed to these systems.

Pursuant to paragraph 20.501 it is requested that an exemption be granted relative to the requirement in paragraph 20.401(b) for maintaining records of disposal of licensed materials to the 300 area Liquid Waste systems.

Criticality Detection System

Paragraph 70.24(a)(1) of 10 CFR 70 requires that a criticality detector system be maintained "...in each area in which special nuclear material subject to such license is handled, used or stored"... In those buildings where BNW works with substantial quantities of fissile materials (e.g., 306-W, 325, 308) and the fissile material storage building (303-C), criticality detector systems are provided. Those buildings where lesser quantities of fissile materials are used are established as isolated facilities as described in BNWL-MA-25, "Criticality Safety Procedures", Procedure 1, part III.B. An isolated facility is any facility where the inventory of fissile material is limited to less than 45% of a minimum critical mass (MCM). An exception to this definition of an isolated facility has been made, with the concurrence of DOE-RL Manual Chapter 0530, for the Calibration Facility (3745 Building). Although the combined fissile inventory in the 3745 Building isolated facility exceeds a MCM, the bulk of the material is in the form of encapsulated calibration sources having a combined mass that is less than 10% of the critical mass of the material in that form. Non-encapsulated fissile material within the facility is limited to a total of 15 grams. Buildings currently established as isolated facilities in which work with licensed materials may be performed include the 3720, 3708, and Life Sciences Laboratory I (LSL I) buildings in the 300 Area of the Hanford Site. Criticality detection systems are not provided in these buildings. Typical current uses of fissile materials in these buildings are performance of various chemical and physical analyses and measurements on samples or specimens and studies of the deposition, uptake or biological effects of these materials on animals and plants.

Pursuant to paragraph 70.14 it is requested that conditions of installing criticality detection systems only in facilities containing more than 45% of a minimum critical mass be accepted as an alternate to the criteria described in paragraph 70.24(a).

1.3 MINIMUM TECHNICAL SPECIFICATIONS AND CAPABILITIES

Organization and Personnel Competence

Organization

(1) Battelle-Northwest will maintain a staff department specifically responsible for establishment and conduct of all safety programs. This department, which is responsible to assure compliance with Battelle, State, and Federal regulations and policies, will be maintained separate from operating departments. This department will serve as the Battelle-Northwest official contact with the Nuclear Regulatory Commission. Responsibilites of this department will include:

- Establishing the policies, standards, and limits to be applied throughout the Pacific Northwest Laboratories in Nuclear Safety, Criticality Safety, Radiation Protection, Nuclear Materials Management and Industrial Safety.
- Providing review and approval on the design modification or development of facilities, equipment, and methods to be used in all work. Included in these approvals are Project Proposals, Facility Design Criteria, Facility Modification Permits, Safety Analysis Reports, Safety Assessment Documents, Radiation Work Procedures and Criticality Safety Specifications.
- Performing inspections, audits, and reviews of facilities and procedures and initiating changes necessary to assure a high level of personnel protection and compliance with all Battelle-Northwest and State and Federal requirements.
- Evaluating, recording, and reporting radiation exposure received by personnel within Battelle-Northwest controlled facilities and by all Battelle-Northwest employees.
- Measuring and recording radiological conditions in all work locations where sources of radiation are present and prescribing the protection methods to be employed in performing the work.
- Conducting a surveillance program to define the geographical and biological distribution of radioactive materials in the plant environs, determining the status of the plant environs with respect to

applicable limits and guides, and establishing appropriate guides for the controlled release of radioactive materials from Battelle-Northwest controlled facilities.

- Performing nuclear safety analyses for reactors, critical facilities, and laboratories containing fissile materials or large inventories of radionuclides.
- Establishing and maintaining a transfer, inventory, and forecast system for source and special nuclear materials.
- Planning and coordinating programs designed to cope with serious accidents within Battelle-Northwest facilities.
- Participating in formal investigations of incidents involving Battelle-Northwest personnel or Battelle-Northwest controlled facilities.
- Maintaining records and providing necessary reports to meet all Battelle-Northwest as well as State and Federal requirements in the areas described above.

(2) Battelle-Northwest will maintain a Safety Review Council as established in Management Guide 12.7 of the Battelle, Pacific Northwest Division Management Guide to review program designs and safety analyses where the direct or indirect consequences of a credible accident are deemed to be of substantial magnitude. Matters may be submitted to the Safety Review Council for consideration by any Department Manager, higher authority, or a member of the Safety Review Council. The Safety Review Council or council chairman can determine whether a formal review is required in each case. Copies of the prepared procedure and analysis are provided to all members of the Council for review and comment. A formal review by the Council as a group is held if requested by any member. The Council has access to all information and facilities required in the discharge of its responsibilities.

Review by this Council provides the Battelle-Northwest safety system with an additional authoritative step which is intended to assure that necessary engineering and administrative capabilities are incorporated to minimize the likelihood and consequences of a serious accident. Results of reviews performed by the Council are reported to the Director, Battelle-Northwest.

Examples of important matters to be considered for review by the Safety Review Council include:

- Nuclear safety criteria for the design and operation of facilities and equipment.
- Proposals for conducting safety analyses or research programs involving significant risks for sponsors.
- Safety Analysis Reports or Operating Safety Analysis Reports.
- Plans for implementing operating safety limits, audit and inspection programs, and operator training programs.
- Departmental plans for response and recovery from major accidents in facilities requiring safety analysis reports.
- Proposed changes in the mode of operation or facilities modification that increase either the probability or consequences of a significant accident.
- Evaluations of potentially significant safety interactions within Battelle facilities or with other Hanford contractors.
- Proposed nuclear safety policies and programs and other selected policies and programs of the Pacific Northwest Laboratories.
- Any activity not covered above that could have substantial safety implications.

Members of the Council are selected by the Director of Battelle-Northwest from persons recognized as authorities in specific fields such as atmospheric dispersion, biological effects of radiation, chemistry, containment, critical mass physics, fluid flow, heat transfer, legal liabilities, metallurgy, pressure vessels, reactor physics, operation and engineering, risk evaluation, and industrial safety. The Council may be supplemented by other resources or specialists within Battelle.

Qualifications and Responsibilities

(1) The manager of the organization responsible for radiation protection will be a college graduate (preferably also a Certified Health Physicist) with

recognized substantial experience in the field of radiation protection. A minimum of seven years experience, including at least three years in the general area of health physics and the radiological sciences, will be required for this position. This organization will include at least five experienced people who are college graduates and preferably also Certified Health Physicists.

(2) The manager of the organization responsible for administration of the laboratory-wide nuclear and criticality safety program will be a college graduate with recognized competence in the field of nuclear safety and critical mass physics. A minimum of five years experience, including at least two and one-half years in nuclear safety work, will be required for this position.

(3) The manager of the organization responsible for approving Criticality Safety Specifications for technical adequacy and for performing technical reviews of Battelle-Northwest facilities and operations from a criticality safety standpoint will be a college graduate with a minimum of seven years experience, including at least five years in criticality safety work.

(4) The Senior Engineer, Nuclear Safety, who is responsible for directing independent audits will have at least five years of technical experience with at least three years in criticality safety work.

(5) The Safety Review Council will be appointed by the Director of Battelle-Northwest. Members of this group will be selected from persons recognized as authorities in specific fields related to safety.

(6) The manager of each Battelle-Northwest program will be technically trained in the field of endeavor (or an associated field of endeavor) which is the basis of the work to be performed. He/she will have experience required to operate in accordance with Battelle-Northwest policy and the contractual obligations established by DOE-RL that may affect the program. He/she will be responsible for operating safety, insuring that personnel follow established rules.

Procedures

Radiation Protection

Formal administrative procedures for radiation protection are maintained by Battelle-Northwest. Periodic reviews are made of these procedures by trained health physicists to assure their adequacy. These procedures are changed only with the approval of the Manager, Occupational and Environmental Safety Department, or qualified higher authority. Radiation Protection Procedures and specific Radiation Work Procedures are reviewed periodically with employees and are kept readily available to them.

Comprehensive dosimeter, monitoring, survey, bioassay, and whole body counting programs are maintained by Battelle-Northwest. The evaluating, recording, and reporting of radiation exposure, as determined by these programs for all Battelle-Northwest employees and visitors, meet high professional standards and will continue to reflect the contractual requirements. Any changes in the programs or the exposure evaluation and recording procedures will require the review and approval of the manager responsible for radiation protection.

A high quality environmental surveillance program is maintained for DOE-RL to permit a continuing evalution of the status of the environs in respect to applicable limits and the impact of environmental contamination on surrounding population.

Radiation protection training is a continuing program under Battelle-Northwest. The formal training programs range from those for the professional in radiation protection to programs for individuals whose knowledge of radiation is incidental to their work. An initial general radiation protection orientation is presented to new employees of Battelle-Northwest. This program is supplemented throughout the service of the employee to assure sufficient knowledge of radiation protection practices and procedures and changes in these practices and procedures. Specific training is presented to radiation monitoring personnel, and others who require special skills in the conduct of safe work. This program of training will be continued at a level to assure that radiation protection requirements are met and that the work with radiation or radioactive materials is conducted safely.

Criticality Safety

For work that involves fissionable materials, Battelle-Northwest follows the Two-Contingency Policy. A sufficient number of limits and controls are exercised to assure that before a criticality accident is possible, at least two unlikely, independent and concurrent or sequential changes must occur in one or more of the conditions specified as essential to nuclear safety. To implement this Two-Contingency Policy, formal procedures for the control of fissionable materials are maintained.

The principal procedure for control of fissionable materials is the Criticality Safety Specification (CSS). Criticality Safety Specifications are written procedures which give limits that, when followed, will ensure criticality safety in facilities processing, storing, or otherwise handling significant quantities of fissionable material. Any work involving more than 45% of the minimum critical mass of fissionable materials is conducted in a nuclear facility under an approved Criticality Safety Specification. An approved Criticality Safety Specification is required for any work involving fissionable materials, with the following exceptions:

- Natural and depleted uranium, and thorium.
- Work in a facility where only exempt quantities, less than about 3% of the minimum critical mass assuming spherical geometry and optimum water reflection and moderation, are present.
- Work in an isolated facility where the amount of fissionable material does not exceed one of the limits in Table 1.3-1 or Table 1.3-2. Also, fissionable material in the form of encapsulated sources containing more than Table 1.3-1 or Table 1.3-2 values may be handled under isolation control upon written agreement with DOE-RL.

An isolated facility is defined as one which may contain more than 3% but less than 45% of the minimum critical mass, assuming spherical geometry and optimum water reflection and moderation. Fissionable material in the form of encapsulated sources containing more than 45% of a minimum critical mass may be handled under isolation control upon agreement between Battelle-Northwest and DOE-RL. An isolated facility shall be physically separated by at least 6 feet from any other work involving fissionable materials. Each isolated facility is established by mutual agreement between the nuclear safety group and the responsible manager of the operating component.

TABLE 1.3-1

Weight Percent ^{235}U	Allowable Weight kg U	g ^{235}U
1.0	900	9000
1.5	168.8	2532
1.7	121.4	2065
2.0	81.1	1622
2.5	49.1	1228
3.0	35.1	1053
3.5	27.9	977
4.0	22.0	880
4.5	18.3	823
5.0	15.6	783
8.0	7.9	632
10.0	5.85	585
20.0	2.46	496
25.0	1.88	472
30.0	1.5	450
40.0	1.07	428
50.0	0.826	413
75.0	0.501	376
93.0	0.396	369
96.0	0.384	369
97.0	0.380	369
100.0	0.369	369

TABLE 1.3-2

Isotope	Limit
Np-237	18,900 g
Am-241	32,400 g
Cm-244	6,345 g
Pu (Fuel)	
- Less than 50% Pu-238	230 g (total Pu)
- More than 50% Pu-238	1957 g (total Pu)
Uranium (any enrichment)	(see Table 1.3-1)
U-233	256 g
Cm-243	67 g
Cm-247	67 g
Am-242	9 g
Cm-245	9 g
Cf-249	9 g

The mandatory criticality safety limits are identified through a technical analysis of the specified work involving fissionable material. The analysis will be made by a competent criticality safety specialist and will be documenced by issuance of a Basis Letter. These technical bases will be reviewed and approved by the Senior Specialist, Criticality Safety. The Basis Letters will be maintained in a permanent file by the nuclear safety group.

Facility Criticality Safety Representatives or their appointed delegates will be responsible for obtaining new or revised Criticality Safety Specifications. Assistance of the Senior Specialist, Criticality Safety is available to provide technical bases for establishing criticality safety limits. The nuclear safety group will provide assistance in preparing and distributing the Criticality Safety Specifications.

Each Criticality Safety Specification shall be approved or concurred to by the following or their authorized representatives:

- Criticality Safety Specialist
- Senior Specialist, Criticality Safety
- Senior Engineer, Nuclear Safety
- Manager, Nuclear Safety
- Building Manager of the building in which the CSS will be used
- Criticality Safety Representative of the building
- Manager of the Operating Component in the affected facility

Approval by the responsible manager formally establishes the specification as a written instruction to all members of the organization. Approval by the manager of the nuclear safety group shows that the specification is consistent with DOE and Battelle-Northwest policies and regulations and with good safety practices. The signature of the Senior Specialist, Criticality Safety, establishes that the technical bases for the specification are correct. The steps to be followed in obtaining a CSS are outlined in Table 1.3-3.

In establishing Criticality Safety Specifications, fissionable material is defined as material which will support a neutron chain reaction with fast and/or thermal neutrons. This means ^{239}Pu, ^{241}Pu, ^{233}U, ^{235}U, ^{242}Am, ^{243}Cm, ^{245}Cm, ^{247}Cm, ^{249}Cf, and ^{251}Cf, in any form (metal, alloy, solution or compound). ^{238}Pu, ^{240}Pu, ^{242}Pu, ^{237}Np, ^{244}Cm and ^{241}Am are fissionable for these nuclides are expected to support a chain reaction, but only with fast neutrons. Criticality is not possible with these nuclides in aqueous solution. Any other fissionable transuranium nuclides will be considered that may be specifically identified in the future. Natural uranium, although fissionable, is excluded due to its large minimum critical mass.

Before a building can be designated as a nuclear facility in which greater than 45% of a minimum critical mass of fissionable material may be handled, a Safety Analysis Report (SAR) is required. Also, any significant modification or additional work not previously covered in an SAR requires a safety analysis in a supplemental SAR. A Safety Analysis Report is the result of a thorough study and analysis that is performed to assure that potential major nuclear hazards have been incorporated to reduce the probability of major accidents and to minimize the consequences in the unlikely event of their occurrence. The safety analysis considers foreseeable nuclear accidents that would substantially threaten 1) the safety of personnel or the public, 2) the use of or damage to property and 3) the continuity of operation of facilities.

Each SAR, and each revision, requires the approval of the responsible Department Manager and the Safety Review Council. Additionally, review by the Richland Operations Office of DOE is required by Manual Chapter 0530 if the facility is allowed to contain more than one minimum critical mass of fissionable materials.

Safety Factors and Assumptions. Criticality safety limits used in establishing Criticality Safety Specifications will be based on data from experimental measurements or, if direct experimental data are not available, on limits obtained from a calculational method that can be shown to be accurate or conservative when compared to experimental measurements. Safe limits will be obtained by reducing the critical value of a safe margin commensurate with interpolations and extrapolations to measurements and calculations. The maximum fractions that independently satisfy the two

CRITICALITY SAFETY SPECIFICATIONS

TABLE 1.3-3

Step	Operating Organization	Criticality Safety	Nuclear Safety
1	Determines that a new or revised CSS is needed. Inform Nuclear Safety of need. Submits request for a Basis Letter to Criticality Safety.		
2		Reviews operation, evaluates criticality potential and contingencies. Prepares technical basis in form of a Basis Letter to Operating Organization with copy to Nuclear Safety.	
3	Prepares CSS on standard master forms.		Places Basis Letter in "Basis Letter File" kept by Nuclear Safety. Assists in preparation of CSS as requested by originator.
4		Reviews and approves CSS. Signatures: Senior Specialist, Criticality Safety.	
5			Reviews and approves CSS. Signatures: Sr. Eng. Nuclear Safety; Manager, Safety.
6	Reviews and approves CSS. Signatures: Bldg. Manager; Criticality Safety Representative; Operating Manager.		
7			Dates, duplicates, and distributes approved CSS.

contingency criteria for criticality safety are:

- 0.45 of critical mass
- 0.75 of critical volume
- 0.75 of critical mass per unit area
- 0.85 of critical slab thickness
- 0.85 of critical cylinder diameter
- 0.95 k_{eff}

Neutron Reflection. Safe limits will be based on full water reflection except when less reflection can be assured by the Two-Contingency Policy. Instances in which less than full water reflection may be assumed are:

- Fixed, unreflected process vessels in a sealed hood or cell into which access is controlled.
- Unreflected containers of vessels wrapped with sufficient cadmium of other nuclear poison sheeting to assure nominal reflection.
- Individual storage units in a storage array (less than full water reflection may be assumed for some arrays in the interaction calculations).

Neutron Moderation. Safe limits will be based on optimum water moderation, unless other than optimum moderation can be assured by the Two-Contingency Policy. Instances in which nonoptimum water moderation may be assumed are:

- Fissionable material in watertight containers.
- Fissionable material in watertight glove boxes in which the amount of moderating material introduced into the glove box is limited and controlled. (Automatic overhead room fire sprinklers are permitted if the glove boxes are critically safe by geometry under flood conditions. Under the situation where a glove box is not safe by geometry under flooded conditions, the mass limit is reduced such that criticality would not be possible.)
- Fissionable material stored in a vault or room which specifically excludes water flooding or significant moderation by other materials.

- Fuel rods securely bundled (close packed).
- Systems in which the moderator is solid, thus fixing a H/X ratio to a certain value or range of values as in the case of fissionable materials in polystyrene or other compact substance.
- Fuel rods or groups of fuel rods separated by sufficient water or equivalent material to prevent neutron interaction.
- Systems in which the concentration of fissionable material is other than optimum and the concentration can be limited within a safe range by the Two-Contingency Policy.

For vessels or units in arrays in which neutron interaction contributes to reactivity, allowance factors to obtain safety margins depend on the method used to calculate the critical number of units in the array and on how well the method predicts criticality for arrays that have been measured experimentally. For those arrays that can be accurately computed, the maximum allowable k_{eff} will be 0.95 at a 95% confidence level; and for arrays that compare less favorably with experimental measurements, k_{eff} for the array will be limited to 0.85 - 0.90, depending on comparisons to measurements.

Special Reflectors and Moderators. The above limits are based on reflection and moderation of light water. For instances where fissionable material processing or handling involves special reflectors or moderators, such as D_2O, carbon, beryllium or heavy metal reflectors, criticality safety will be assessed on an individual basis.

Emphasis is placed on moderation control in glove boxes in which unmoderated special nuclear material is processed. Controls employed are as follows:

- Whenever the supply of water or oil is unlimited, potential flooding due to the rupture of a water or oil line is controlled by means of continuous operator surveillance, quick acting shutoff valves, or water detectors located on the floor of the glove box.

- A limited quantity of hydrogenous liquid is permitted in a glove box for cleaning purposes, provided that the liquid is not mixed with the special nuclear material. As an added margin of safety, the amount of liquid permitted is limited to an amount that would be safe, even if mixed with the fissionable material.

Other Administrative and Technical Controls. Geometry control of fissionable material is the preferred means of criticality safety control and is used wherever feasible. When processing fuel elements of more than one plutonium or uranium enrichment, at least two positive means of identifying each enrichment are required (e.g., fuel dimensions, color coding, labeling, etc.).

Prior to blending PuO_2 with UO_2, criticality safety is based entirely on the critical parameters for PuO_2, with no credit for reduced reactivity due to UO_2. After blending, allowance in the limits may be given for UO_2 content if the correctness of the blend is confirmed by a sample analysis.

Plutonium polymer is assumed present in plutonium solution systems unless absence of such polymer is assured by acid concentration control and routine cleanouts of equipment.

Criticality safety dimensions are attributed to spherical geometry, unless equipment design assures a geometry less favorable to criticality than spherical (e.g., cylinder or slab).

Safe cylinder and slab dimensions for process vessels are based on the most reactive form of the fissionable material that can reach the vessels.

The structural integrity of safety related items such as shelving for fissile material storage is at least three times the load capacity permitted by Criticality Safety Specifications.

Sumps are required to be safe in the event of a credible leakage and accidental spillage from vessels and piping linked to the sump.

Vacuum headers, vent headers, and similar header systems are reviewed in detail for potential criticality hazards.

Pipe connections are not permitted between a fissionable solution system controlled by safe geometry and a system controlled by safe mass.

In processes conducted behind massive shielding, soluble and fixed neutron poisons such as boron in solution, Pyrex Raschig rings, and steel plates containing boron or gadolinium may be used as a primary means of criticality safety control. When a soluble neutron poison is used as a primary means of criticality control in a solution system, at least two independent administrative controls must be used against omission of the poison (e.g., combinations of attenuation instrument, chemical analysis, double check of addition, etc.).

In processes not conducted behind massive shielding, fixed poisons may be used as a primary means of criticality control, if the positive design measures and maintenance controls assure that the poison is always present, and that leaching of the poison away from the matrix does not occur.

Soluble poisons may not be used as a primary criticality control in unshielded facilities.

Applicable Criticality Safety Specifications are posted in all processing and storage areas.

Criticality Safety Specifications and other procedures for the control of fissionable material are reviewed periodically for compliance with DOE and Battelle-Northwest policies and regulations and good safety practice. Also, the contents of Criticality Safety Specifications and other procedures are periodically reviewed with employees to assure their familiarity. Audits are performed monthly by a member of the facility operating staff to assure that the operation of a facility complies with the appropriate procedures and Criticality Safety Specifications.

Audits will be conducted to assure that a facility is being operated within the proper category of criticality safety control; that the handling of fissionable material is adequately covered by a CSS; that the limits and controls of applicable CSS are being met; and that good safety practices are in effect. The Chairman of the Safety Review Council will be provided a copy of each audit report. A summary report of these audit activities will be made to the Battelle-Northwest Director at monthly intervals.

Criticality Safety Training

Criticality safety training is required to acquaint all personnel with the criticality alarm signal and emergency response, and to inform personnel handling or using fissionable material of the basic Battelle-Northwest criticality safety rules. Periodic training (minimum annual frequency) in emergency action required for an accidental nuclear criticality shall be conducted for all nonreactor nuclear facility personnel.

The minimum training program requirements for all personnel involved in working with fissionable materials at nonreactor nuclear facilities (those performing work and those providing supervisory guidance) consist of:

(1) Three of four quarterly training sessions which may be primarily work oriented criticality safety topics such as new procedures or specifications, unusual occurrences involving criticality safety, discussion of selected criticality safety specifications for clarity and understanding, and discussion of audit and appraisal results. The following topics shall be covered in at least one training meeting each 24 month period:

- basic criticaltiy principles;
- methods of criticality safety control; and
- company policy and procedures for maintaining criticality safety.

(2) Each individual shall demonstrate a satisfactory knowledge of the requirements and procedures pertinent to the individual job assignment. The demonstration may be oral, written, operation, or all three. Reexamination is required:

- at least annually on emergency procedures; and
- at least once every two years on all other subjects in which the examinee is expected to be proficient.

(3) A file record of the training, including an auditable record of the testing, shall be maintained for each individual. The training records shall be maintained for a minimum of two years. Records shall be sufficient to show the following:

* Training material covered and its relevancy to criticality safety.
* Clear indication of the presence or absence of those individuals required to receive the training.
* Demonstrates that each individual has a satisfactory knowledge of the subjects and procedures pertinent to his job assignment.

Criticality Detection System

A criticality detection and alarm system is required in any facility containing greater than exempt quantities of fissile materials except those facilities administratively controlled as isolated facilities. The criticality detection and alarm system consists of detectors, comparator panel, howler circuit, audible alarms, power-loss annunciator, a central annunciator and the necessary wiring and controls. Audit and trip signals are fed to an annunciator and comparator unit which provides 2-out-of-n coincidence operation and signals any malfunction or loss of power to the system. When two or more detectors in one location are tripped, cycling klaxon howlers, which are provided throughout the building, are activated. A detailed description of the system design criteria, performance tests, detector placement, calibration and maintenance instructions, and operating experience is available in Criticality Detection and Alarm System, edited by C. R. Richey and T. W. Jeffs, Battelle, Pacific Northwest Laboratories, December 1977. A description of the system follows.

Detector

Neutron sensitive detectors are located where at least two detectors will trip with a minimum foreseeable criticality burst from either a liquid or metal system. This burst produces 20 rads in soft tissue of combine neutron and gamma radiation at an unshielded distance of two meters from the reacting material within one minute. The neutron to gamma ratio is taken to be 0.3 with an average neutron energy of 1 MeV. At least three detectors shall be located within 300 feet of any fissible material. Lesser distances shall be used to compensate for intervening shielding and to ensure the alarm system will trip following the minimum foreseeable burst.

Comparator

The comparator panel annunciates both visually and audibly any failure or alarm condition of any detector in the building. The comparator will activate the alarm when two-out-of-n ($n \geq 3$) detectors trip the alarm circuit. Redundant trip circuits shall be included in the comparator.

All circuitry and controls associated with the comparator unit shall be protected against unauthorized tampering by the use of key lock doors and switches or key lock switches.

Howler Control Circuit

The howler control circuit shall be fail-safe.

The fail-safe solid-state electronic timing device should be used for the howler timer.

Calibration and Testing

Each criticality detector contains an internal audit circuit which will function at least once per minute to detect failure of the detectors. To further assure optimal operation of the criticality detectors, the detectors shall be replaced annually with others newly tested and calibrated by personnel of the plant radiation instrument calibration and repair facility. The electronics of the comparator unit shall be tested annually. The criticality alarm system in each building shall be tested quarterly by tripping the system with a neutron source.

Emergency Power

The criticality alarm system in all buildings will be connected to emergency power if it is available. For those buildings, where emergency power is not available, in the event of an emergency or planned power outage, all work with radioactive materials including fissible materials will be terminated immediately. Process areas in which activities with fissionable materials continue during a power outage will have emergency power supplied to all portions of the criticality alarm system.

An annunciator of signal power loss to the criticality alarm system will be installed in each building at a location which is occupied during normal building use.

Criticality Alarm Signal

The criticality alarm signal (ah-oo-gah) is unique and will not be used for any purposes other than to signal immediate evacuation in the event of accidental criticality. The alarm signal will be audible throughout the building and at any location along the outside of the building.

Radiation Emergencies

Battelle-Northwest emergency procedures are maintained in conformance with DOE-RL directives which require that each separate facility emergency procedure conform to the plan for that plant area in which the facility is located regardless of which of the several Hanford contractors may operate the facility.

The objectives of these procedures are to minimize the risk to employees and members of the public in the vicinity of the Hanford Site, and secondarily to minimize damage to or loss to use of valuable facilities and equipment in the event of an accidental criticality, fire, explosion, or release of radioactive materials.

Procedures applying to Battelle-Northwest and Pacific Northwest Laboratory (PNL) facilities are reviewed periodically by trained radiation protection and safety personnel to assure both their adequacy and their conformance to DOE-RL directives. These procedures contain specific information regarding the sound of the various emergency signals, their meaning, the appropriate action to be taken, the location of the staging area to which employees are to evacuate, and the specific plan of accountability for personnel.

The criticality alarm signals and the appropriate personnel response to these signals will remain uniform in accordance with the established Hanford Standards throughout Battelle-Northwest and PNL laboratories facilities. The response to other alarm signals such as fire alarms is maintained uniform throughout the laboratories. However, the signals in Battelle-Northwest owned facilities may be different from those in the DOE owned facilities. The fire alarm system for the Battelle-Northwest facilities is connected to the Richland fire department; the fire alarm system for DOE facilities is connected to the DOE fire department. The criticality alarm signals will be tested quarterly, and the fire alarm signals will be tested semiannually.

Facility emergency procedures will be reviewed annually with the involved personnel. Practice sessions will be performed in all Battelle-Northwest facilities at least annually to assure that employees know the meaning of emergency signals, and know the immediate action response appropriate to each.

The systems established by DOE-RL, whereby DOE-RL, management of Hanford contractors and members of established emergency and technical support teams are notified, will be used in emergency situations.

The authorities and responsbilities of the emergency director and the members of the radiological emergency staff are defined in writing.

Specialized plans for Battelle-Northwest groups who have special responsibilities in emergencies (viz., environmental monitoring, radiation monitoring, and the radiological emergency staff) are maintained together with special training programs by Battelle-Northwest. These plans will be reviewed at least annually.

Medical, firefighting, and access control personnel are employees of contractors other than Battelle-Northwest. Emergency plans and training programs for these groups are established by management of the contractor organizations involved to meet DOE-RL requirements.

Kits containing instruments capable of measuring dose rates that might be encountered during rescue entries following a nuclear excursion or similarly serious accident and self-reading pocket ionization dosimeters capable of measuring gamma doses up to 600 R are maintained at locations near but not in Battelle-Northwest or PNL facilities where radioactive and/or fissionable materials are used. These kits also contain respiratory protective equipment and protective clothing necessary for building re-entry.

Facilities and Equipment

Plans for new facilities or significant modification of existing facilities will be reviewed by radiation protection, safety, and operating organization personnel for adequacy of shielding, interlocks, alarms, ventilation, containment, and Radiation Zone posting. In addition, new facilities, major modifications of facilities, or the establishment of alternate uses for existing facilities may be reviewed by the Safety Review Council. This review will cover the adequacy of engineered safety features and the administrative controls to be provided. The suitability of a facility for performance of licensed work will be judged by the same standards which are used when similar decisions are made for work under the Operating Contract.

The work performed under this license will be so planned and controlled as to not materially increase radiation or criticality safety hazards over those encountered in the performance of work under the Operating Contract with DOE.

Gaseous effluent treatment systems are installed on the exhaust system of any building where a potential exists for the evolution of airborne radioactive contamination. The gaseous effluent systems are designed to maintain effluent releases as far below the limits specified in 10 CFR 20 as practicable. Except for certain filters installed directly in or on the hood or glove box in such a way that periodic testing is not feasible, all HEPA filters are tested upon installation to assure that they meet design objective of 99.95% efficiency test for cold DOP smoke with particle sizes between 0.3 and 0.8 μm. All HEPA filters, with the exception of those identified above, are tested at least annually thereafter to assure continued proper function. Failure to meet the requirements result in replacement and testing as soon as practicable. If continued generation of effluents prior to replacement is deemed unadvisable, the operation is terminated pending replacement of the treatment system.

Protective clothing, respiratory protective equipment, radiation detection and measurement instruments, and dose rate measurement systems and equipment are intended to be uniform for license and Operating Contract work. The services, equipment, and procedures used will be in accordance with DOE contractual requirements established by DOE-RL.

Materials

Special nuclear materials used in Battelle-Northwest controlled facilities under this license will be identified as such and maintained separately from materials used under the Operating Contract.

Special nuclear materials handled temporarily in a sponsor's facility, except in Agreement States, under the terms of this license, will be retained in Battelle-Northwest custody at all times while in the sponsor's facility and will be identified and maintained separately from any other radioactive materials. If fissionable, the material will be kept at least ten feet from other fissionable materials.

Shipment of special nuclear materials other than those specified in 10 CFR 71 paragraphs 71.11 and 71.12 will not be made until proposed procedures have been approved by NRC.

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1.4 CERTIFICATE

The applicant and the offical executing this certificate on behalf of the applicant named in Part 1.1 above, certify that all information contained in this application, including any supplements attached hereto, is true and correct to the best of our knowledge and belief.

Pacific Northwest Laboratories of
Pacific Northwest Division of
Battelle Memorial Institute

Applicant

By: ______________________

Director, Pacific Northwest Laboratories
Pacific Northwest Division
Battelle Memorial Institute

Date: May 1, 1979

2.0 LICENSE APPLICATION DESCRIPTIVE SUPPLEMENT

PREFACE TO PART 2

The material which follows in Part 2 of this License Application describes the Battelle-Northwest controlled buildings and facilities which are located throughout the 560 square mile Hanford Works. It also outlines the operating procedures and philosophy currently in practice for the safe handling of fissionable materials and for the protection of all personnel from any adverse effects of ionizing radiation. These are the procedures currently used by Battelle-Northwest in conducting the Department of Energy's (DOE) programs under Operating Contract EY-76-C-06-1830 for the Richland Operations Office.

The procedures have evolved from many years of safe operation at the DOE's Hanford Site. As programs change, personnel assignments, facilities and procedures can be expected to continue to evolve.

As already stated in Part 1 of this application, the same nuclear health and safety procedures which are used for DOE will be employed for licensed work performed by Battelle-Northwest. These procedures outlined in Part 2 may be changed without prior notification or approval of the Nuclear Regulatory Commission provided that the changed procedures remain within the overall criteria stated in Part 1 of this Application, and that the changes are made with appropriate Battelle-Northwest internal review and approval steps as outlined in Part 1.

2.1 THE HANFORD SITE

The U.S. Department of Energy's Hanford Site, shown in Figure 2.1-I, is located in the southeastern part of the state of Washington just north of where the Yakima and Snake Rivers flow into the Columbia River. The site occupies an area of 1500 km^2 (560 square miles) and was chosen because of its proximity to abundant quantities of electric power and pure water and relative isolation from dense population centers.

Geologically the area encompassing the site is an irregular structural and topographical basin underlain by basalt flows that have been depressed below sea level in some areas and upward in others. Fluvial, lacustrine, aeolian, and glacial sediments overlie much of the basalt and form terraces of other subordinate physiographic features. Dominate features are the anticlinal ridges forming the Saddle Mountains to the north of the site, the Rattlesnake Hills to the south, and Yakima and Ahtanum Ridges to the west, and Gable Mountains in the center of the site. The crests of these surrounding ridges rise to 762 m (2500 ft.) and 914 m (3000 ft.). Those areas occupied by site facilities are located at elevations between 122 m (400 ft.) and 213 m (700 ft.).

Hanford's climate is mild and very dry with usually moderate winters and warm summers. Light cloud cover and light precipitation are characteristic of the region. The average annual precipitation is approximately 16 cm (6.3 in.), of which more than half occurs between October and February. The average maximum and minimum temperatures in July are 33°C (92°F) and 16°C (61°F). For January, the respective averages are 3°C (37°F) and -6°C (22°F).

Prevailing winds are westerly with an average monthly velocity range from about 14 km/hr (9 mph) in the summer to 10 km/hr (6 mph) in the winter. Normal wind conditions are occasionally perturbed by short periods of high winds. Peak gust velocities to 112 km/hr (70 mph) have been recorded. However, winds of hurricane or tornado force have never been observed. The region is a typical desert area with frequent strong inversions that occur at night and break during the day, causing unstable and turbulent conditions. Near the plant production sites, the prevailing winds are from the northwest with strong drainage and cross winds causing disturbed flow patterns.

Neg 30123-1

FIGURE 2.1-I. Geographic Relationship of Hanford Works to the Pacific Northwest

POOR ORIGINAL

The Columbia River flows through the Hanford Site and forms part of the eastern boundary. The average monthly flow rate past the site ranges from about 1700 m^3/sec (60,000 ft^3/sec) during low water months to more than 11,300 m^3/sec (400,000 ft^3/sec) during peak periods in the early summer. Barge transportation on the Columbia River is available from the Pacific Ocean to Hanford.

The desert plain on which the Hanford Site is located has a sparse covering of vegetation primarily suited for grazing. The most broadly distributed type of vegetation on the site is the sagebrush/cheatgrass/bluegrass variety. The mule deer is the most abundant big game mammal on the site while the most abundant small game animal is the cottontail rabbit.

Approximately 250,000 live within an 80 km (50 mile) radius of the Hanford Site. The principal urban center in the vicinity of the site is the Tri-Cities area (Richland, Pasco, and Kennewick) which is located along the Columbia River southeast of the site. These three communities have a combined population of approximately 80,000.

The land within this area is predominatly agricultural. Wheat is grown on the high ground, and varied crops and orchards are found on the irrigated land of the Columbia Basin and lower Yakima Valley. Industrialization, though not extensive, is growing especially in the vicinity of Pasco and Kennewick. The potential of the area for future expansion is favored by the availability of cheap electricity, water, and river transportation.

Facilities on the Hanford Site, shown in Figure 2.1-II, include the historic reactor facilities for plutonium production located along the Columbia River, in what is known as the 100 Areas. (Operating facilities within the Hanford Site are identified by area numbers). In the middle of the site, on a plateau about 11.2 km (7 miles) from the river are the 200 Areas where the fuel processing and waste management facilities are located. The 300 Area, just north of the city of Richland, contains the reactor fuel manufacturing facilities and research and development laboratories. The Fast Flux Test Facility (FFTF) is located in the 400 Area approximately 11.2 km (7 miles) northwest of the 300 Area.

Privately owned facilities located within the Hanford Site boundaries are: The Washington Water Power Supply System (WWPSS) generating station and

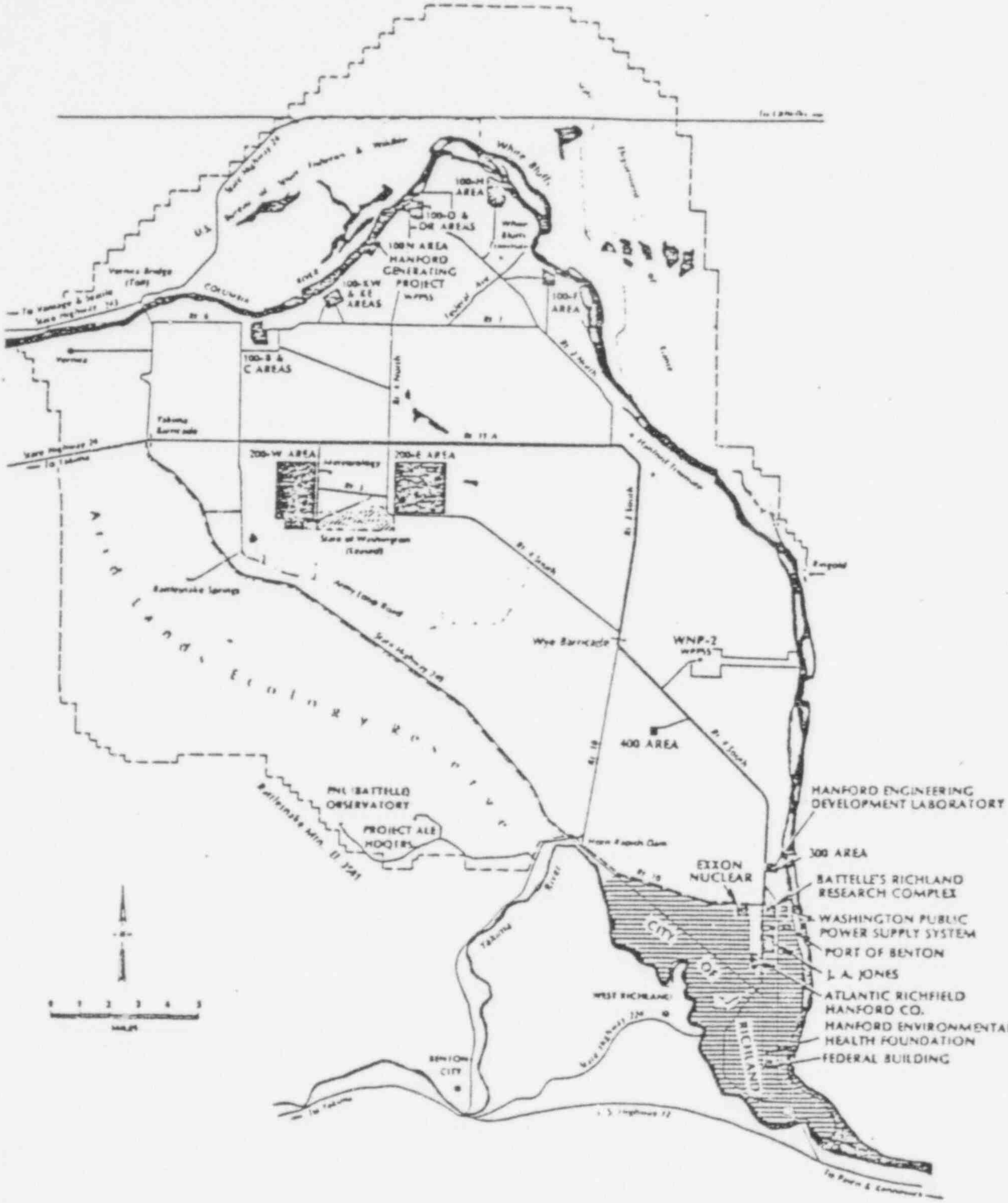

FIGURE 2.1-II. Map of Hanford Reservation

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office buildings located within the 100 Areas. Three WWPSS nuclear reactors under construction about 16 km (10 miles) northwest of the 300 Area; a commercial waste burial site southwest of the 200 East Area; and the Exxon Fuel Fabrication Facility located immediately adjacent to the southern boundary of the site.

Detailed descriptions of the Hanford Site are found in several government documents. An example is ERDA-1538, Final Environmental Statement, Waste Management Operations, Hanford Peservation, Richland, Washington, Volumes 1 and 2.

2.2 BATTELLE-NORTHWEST OPERATING CONTRACT

The nature and amount of work performed by Battelle-Northwest under the Operating Contract EY-76-C-06-1830 is not expected to be significantly different from that performed in the past. The work will be performed in the same facilities by the same personnel, and will require substantially the same types and amounts of radioactive materials as in the past. A wide variety and large amounts of radioactive materials are required for DOE work. Examples of current and past holdings include:

Plutonium	700 kg
Enriched >75% ^{235}U	187 kg
<75% ^{235}U	14,000 kg
Natural U	13,000 kg
Depleted	3,500 kg
^{233}U	7 kg
Heavy Water (tritium contaminated)	405 kg
Thorium	1,600 kg
Discrete Byproduct Radionuclides, over 100 kinds	Millicurie to curie quantities of each

In addition, megacurie quantities of mixed fission products or separated byproducts have been periodically used due to special DOE programs such as the Nuclear Waste Vitrification Project and the interinvolvement with the balance of the Hanford complex.

Battelle-Northwest is required to provide the following services to all Hanford contractors:

- Evaluate, procure, calibrate, and provide all portable radiation monitoring instrumentation and provide instructions for its use.
- Provide calibrated radiation sources.
- Provide special dosimetry services, including processing and evaluating criticality dosimeters.
- Maintain radiological portions of the two emergency control centers.
- Conduct the environmental radiological surveillance program.

- Provide exposure evaluation and radiation exposure record services.
- Provide atmospheric physics services.
- Provide whole-body counter, wound counter, thyroid counter and lung counter services.
- Develop improved equipment and methods for advancing radiation protection technology.

Other Hanford Contractors

In addition to Battelle-Northwest, several other contractors were selected to administer various portions of the Hanford site operations, and to provide specified services to all Hanford contractors. Battelle-Northwest is required to obtain selected services from other Hanford contractors to the extent required under the Operating Contract. Examples are:

- From the Support Services Contractor

  Protective clothing and respiratory protection equipment, decontamination and processing; fire protection; site security; motor pool and railroad transportation services; electrical distribution system; Central Stores and warehousing; offsite shipping and receiving; radioactive waste storage and burial services; and heavy equipment decontamination services.

- From the Radiation Services Contractor

  Dosimeter processing; bioassay sample analysis; environmental sample analysis.

- From the Reactor Development Contractor

  Water, sewer, and steam systems in the 300 Area; 300 Area emergency power supply system; 300 Area landlord services.

- From the Environmental Health Contractor

  Medical services; radiosurgery; mask fitting; HEPA Filter testing; sampling and analysis of non-radioactive pollutants.

- From the Automatic Data Processing Contractor

  Computer and data processing services.

- From the Architect-Engineer Contractor

  Design and engineering services; engineering standards.

- From the Onsite Construction Contractor

  Construction, alteration, and repair services; special fabrication and heavy sheet metal shop services.

Research and Development Work for Battelle's Own Account

In addition to the Operating Contract, Battelle Memorial Institute also has a Use Permit Contract EY-76-C-06-1831 with DOE. This contract authorizes Battelle-Northwest to perform research and development work for Battelle's own account in specified government facilities, and using government property, provided, among other things:

- The work is carried on in such a manner and at such times as not to substantially interfere with the performance of Operating Contract work.
- The government is fully compensated for the government-owned facilities, materials, labor, etc., used in the work.
- Specific approval is obtained, in writing, from DOE-RL prior to use of any government-owned byproduct, source, or special nuclear materials which are in the custody of Battelle-Northwest under the Operating Contract.
- Battelle-Northwest informs DOE-RL in writing of each new research and development program and of pertinent details of the work, including Battelle's evaluation of the health and safety hazard involved, if any.
- Use Permit work with special nuclear materials is conducted under NRC License SNM-942, Docket 70-984, granted February 10, 1966, as amended.

The intent of the Use Permit Contract is to enable Battelle, in addition to performing private work in its own research complex, to utilize the specified government-owned facilities in performing research and development work for its own account, and for government and private industry. Where the radioactive materials required in connection with the Use Permit Contract work will not be expended, or where relatively large amounts of material are required to be used for only a short time, permission will be sought to use government-owned materials which are currently in the Laboratories' custody. In other cases, the work may involve non-government-owned radioactive materials, received from the sponsor and subsequently returned to him. It is expected that the amounts of these materials would normally be quite small compared with the amounts of materials on hand for Operating Contract work. The potential risks to the health and safety of onsite and offsite personnel are not expected to be significantly increased.

2.3 FACILITIES CONTROLLED BY BATTELLE, PACIFIC NORTHWEST LABORATORIES

Battelle, Pacific Northwest Laboratories (Battelle-Northwest or BNW) controls two types of facilities in which special nuclear material licensed work may be performed. The first type of facilities consists of Battelle-Northwest-owned buildings located on private land south of and adjacent to the Hanford 300 Area. The second type of facilities consists of U.S. Department of Energy (DOE)-owned buildings which comprise the Pacific Northwest Laboratory (PNL). PNL is operated for DOE by Battelle Memorial Institute under Operating Contract EY-76-C-06-1830. Another contract, Use Permit Contract EY-76-C-06-1831, with DOE authorizes BNW to perform licensed work for private sponsors or for BNW's own account in most PNL facilities.

Many of the PNL facilities as well as many of the DOE facilities of the Hanford Engineering Development Laboratory (HEDL) are located in the Hanford 300 Area about four miles north of Richland. The HEDL facilities are operated and maintained by another DOE contractor, the Westinghouse Hanford Company (WHC). Figure 2.3-I depicts the 300 Area.

The research activities for a number of DOE programs require BNW to share certain HEDL buildings with WHC. Consequently, DOE has assigned select portions of these buildings to PNL to be occupied by BNW. Because of the Use Permit Contract, BNW may perform licensed work in these assigned areas of the HEDL facilities. WHC provides, maintains and tests building radiation protection services (e.g., ventilation, criticality alarms) in these shared HEDL buildings. BNW and WHC have made a formal agreement, the WHC/BNW Joint Occupancy Procedure to assure that the radiation protection services shall meet the frequency and rigor requirements of both BNW and WHC. In addition, the agreement states "WHC shall support BNW's requlatory (sic) and state license requirements by making necessary records available for audit or review by appropriate inspectors." The agreement assures that any and all conditions of BNW's special nuclear materials license will be complied with in the jointly occupied building.

Work and storage of materials under License SNM 942 has been performed or may be performed primarily in three 300 Area buildings: The 306 Metal Fabrication Development building; the 308 Fuels Laboratory; and the BNW areas of the 325 Radiochemistry Building. Work with licensed materials has

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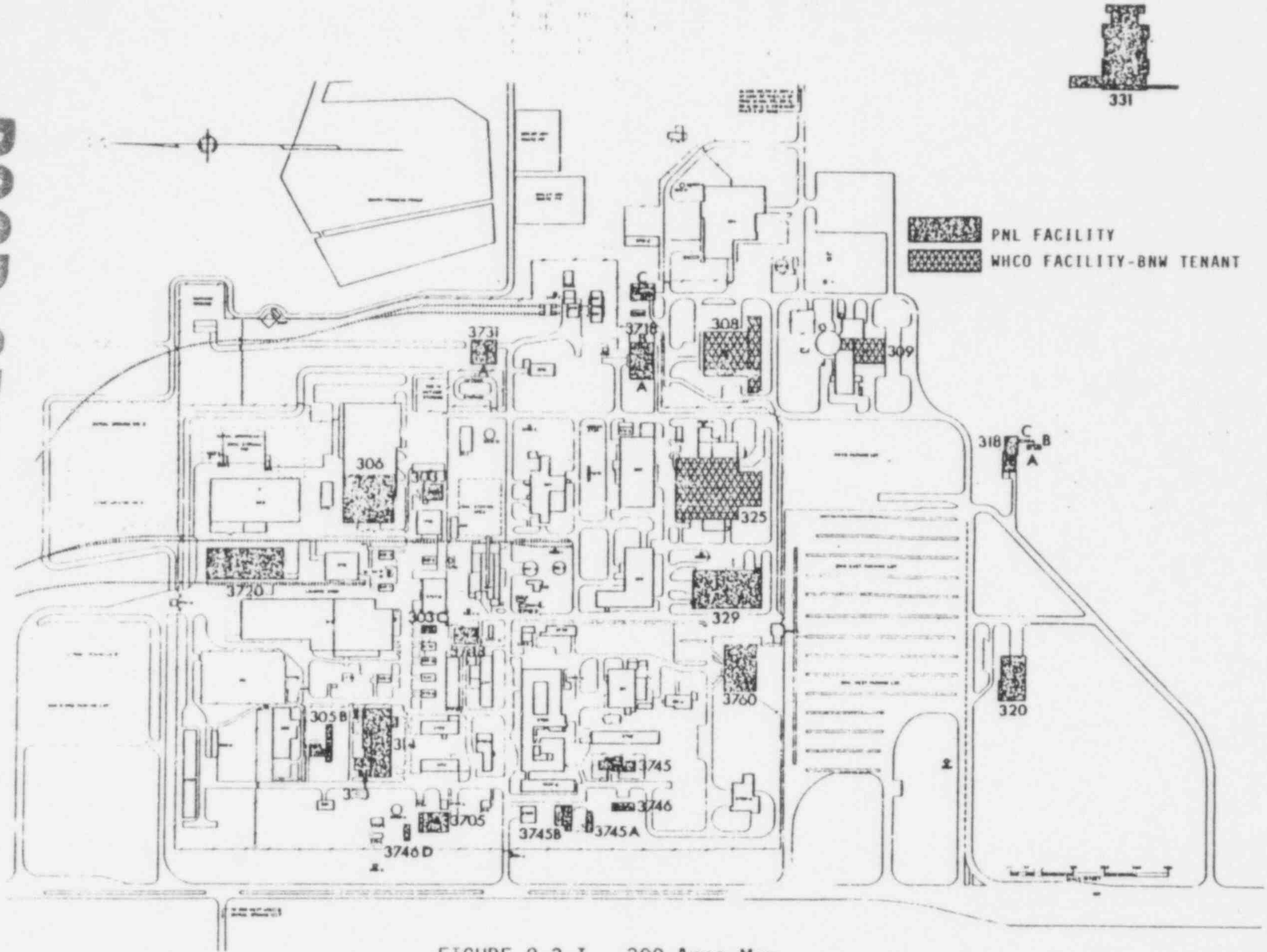

FIGURE 2.3-I. 300 Area Map

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been performed in the 231-Z Plutonium Metallurgy Laboratory building located in the Hanford 200 West Area. This building is being phased out as a Plutonium facility and is being restored as a general DOE research and development laboratory. Descriptions of these facilities and recent activities performed in each are provided.

Licensed work with small quantities of fissile material may in the future be performed in any of several other BNW controlled buildings designed for work with radioactive materials. Brief descriptions of some of these buildings are also provided.

325 Building - Radiochemistry

The 325 Building located in the 300 Area of the Hanford Reservation, is a two-story concrete and steel structure, with a basement, having a total area of approximately 140,000 square feet. Laboratories occupy 32,000 square feet and offices total 11,000 square feet. The building is operated by HEDL with certain portions of the building, including the 325-A High Level Radiochemistry Facility (HLRF), assigned to PNL. As in other shared buildings, special detailed agreements for the 325 Building are included in the WHC/BNW Joint Occupancy Procedure. Safety requirements and emergency plans are established by the HEDL Building Administrator with BNW approval. These agreements specify that the responsibility for safety analyses for the 325 Building rests with HEDL. If a supplement to a Safety Analysis Report (SAR) is required that would involve only facilities assigned to PNL primarily, BNW would prepare the document and HEDL would provide concurrence signature.

The main portion of the building contains over 50 laboratories with about 200 hoods for low level radioactive work as well as many glove boxes for plutonium work. Research instruments include emission spectrographs, mass spectrometers, spectrophotometers, electron microscopes, flame photometers, radiation measuring instruments, and laser apparatus.

A shielded Analytical Laboratory annex, 325 B, on the west side of the building has six equal cells, 5 1/2 ft by 6 ft by 9 1/2 ft high with shielding equivalent to 7 1/2 inches of lead. The working areas in front of the cells are isolated from the rear (access) side which is a radiation controlled zone. All work in the cells is performed with slave-type manipulators. This laboratory is used in support of research and development studies in areas such as waste management, fission product recovery, and plutonium recycle work. Kilocurie amounts of radioactive materials having dose rates as great as 2000 R/hr are handled within this facility.

A High Level Radiochemistry Laboratory annex, 325-A, is located on the east side of the 325 Building. It has three radiochemistry cells designed to contain 1 MCi of 1 MEV gamma- emitting material. The cells are 15 ft high and 7 ft deep. Two are 6 ft wide, and one is 15 ft wide. These cells constructed of 4 ft thich high density concrete are used for high level chemical process research, development, and demonstration programs involving kilocurie to megacurie quantities of gamma emitting radioisotopes. Approximately 26,000 gallons of underground shielded storage facilities are provided for the storage of high level radioactive process solutions and wastes.

Engineered safety features include hoods, glove boxes, shielded cells, special ventilation systems for contamination control, emergency power systems for essential loads, and comprehensive fire protection systems. Most process vessels are engineered to be critically safe by geometry.

The ventilation systems are designed to furnish adequate ventilation to all zones and to assist in the confinement of radioactive materials by maintaining pressure differentials and by filtration of exhausted air. Air is passed through the building on a "once through" basis. The supply system, equipped with heating coils, spray chambers, and filters provides fresh air to the building via a forced air duct system.

Exhausts from laboratories, hoods, gloveboxes and cells are HEPA filtered. These filters are tested to at least 99.97% efficient for collecting particles 0.3 μm and greater. Glove box exhaust air passes through two HEPA filters in series, and all room and hood air is filtered through one HEPA filter before release. Exhaust from the multicurie cells is filtered through at least two HEPA filter banks in series. Where required, charcoal adsorbers may be used to collect radioactive iodine. Treated exhausts from 325 facilities are currently released through a common stack. Previously the Analytical Annex (325-B) was exhausted through a seperate stack. The change to the common stack began in March 1978.

The 325 stack release is sampled and monitored to control radioactive material releases. Release figures for 1978 were:

Total Released	α (^{239}Pu)	4 μCi
Mixed Fission Products	MFP	37 μCi
	^{131}I	180 μCi
Average Concentration	α (^{239}Pu)	2.0×10^{-15} μCi/cc
	MFP	2.0×10^{-14} μCi/cc
	^{131}I	$<2.0 \times 10^{-13}$ μCi/cc
Maximum Concentration	α (^{239}Pu)	2.1×10^{-14} μCi/cc
	MFP	2.2×10^{-13} μCi/cc
	^{131}I	2.3×10^{-12} μCi/cc

Three drain systems handle liquid wastes from the building. A sanitary sewer handles all liquid wastes from drinking fountains, the lunch room, labatory areas, service and other similar areas. Coolant streams and other potentially contaminated liquid wastes are disposed to the 300 Area retention waste system. Low level contaminated wastes are disposed to 300 Area contaminated waste system. These systems are further described in section 2.8.

Large quantities of high activity wastes from the multicurie cells are retained in underground hold-up tanks, and shipped in shielded casks to the 200 West Area for disposal by Rockwell Hanford Operations.

Emergency power is provided to the building from the 300 Area emergency power system. In the event of a loss of this power, a diesel generator in the basement of the 325 Building will automatically operate one exhaust fan to maintain building air flow at a minimum acceptable level.

Automatic fire sprinklers and fire extinguishers are installed throughout the 325 Building.

Radiation protection instruments include hand and shoe counters, room air samplers and air monitors, exhaust air samplers and air monitors, waste line monitors, gamma area monitors, and criticality detectors. Local and remote alarms are provided for the exhaust air monitors, waste line monitors, and criticality detectors.

308 Building - Plutonium Fuels Laboratory

This 53,000 square foot laboratory building is operated by the Westinghouse Hanford Company and is employed for research and development in areas of technology related to fabricating reactor fuel elements containing plutonium.

BNW operates a PNL laboratory on the second floor of the 308 Building for:

- the investigation of radiation effects in ceramic materials
- the development of a process to solidify nuclear waste materials into glass
- development of specialty mixed-oxide fuel pellets.

This PNL laboratory is composed of two rooms and is available for licensed work.

Laboratory techniques for ceramic work include an alpha implantation with subsequent measurement of helium release, alpha and gamma spectroscopy, X-ray diffraction, thermogravemetric analysis, and capacitance manometry. The nuclear waste solidification work includes glass formation from a wide variety of elements, including depleted UO_2, thermal devitrification of glass, X-ray diffraction and cermagraphy. Future work may include doping of glass with actinide elements and subsequent measurement of leaching by water. The fuel-pellet fabrication work employs milling, blending, pressing, and sintering techniques.

Approximately 8 people work in the BNW laboratory space in the 308 Building. The Manager of the BNW Materials Department has the responsibility for the safe operation of this laboratory. Landlord responsibility for the 308 Building is assigned to WHC. General relationships and responsibilities of BNW and WHC for the joint occupancy are established in the basic agreement, WHC/BNW Joint Occupancy Procedure; special detailed agreements for the 308 Building are included. Safety requirements and emergency plans for the building are established by the HEDL Building Administrator, with BNW's approval.

The general laboratory portion of the 308 Building is constructed of reinforced concrete and masonry units. Reinforced concrete columns support the steel-framed roof. Non load-bearing wall panels are constructed of concrete blocks. All block surfaces exposed to the building interior are plastered to provide a smooth, continuous, decontaminable surface. A systematic arrangement of ventilation supply and exhaust ducts allows freedom in room and equipment arrangement while maintaining contamination control. Electrical switchgrear and service piping headers are located in galleries that are isolated from the potentially contaminated zones.

Air is supplied primarily to the corridors of the 308 Building. The exhaust system for the laboratory area is separate from the exhaust system for the glove boxes. All systems are carefully controlled to maintain glove boxes at 1.0 in. H_2O negative to the laboratory areas, the laboratory areas slightly negative to the corridors, and the entire building at 0.05 in. H_2O negative to the atmosphere. Two high efficiency filters are in series between any laboratory area and the environs and three high efficiency filters are between any glove box and the environs. Each filter is protected from dust loading by a one or two inch thick fiber glass roughing filter. The final filter bank, which is common for both exhaust systems, located ahead of the exhaust fans is protected from fire damage by an automatic fog deluge system.

The gaseous effluent released from the 308 Building in 1978 were:

Total Released

	α (^{239}Pu)	0.1 μCi
	Mixed Fission Products (MFP)	0.9 μCi

Average Concentration

	α(^{239}Pu)	2.0×10^{-15} μCi/cc
	MFP	2.0×10^{-14} μCi/cc

Maximum Concentration

	α(^{239}Pu)	3.2×10^{-15} μCi/cc
	MFP	3.2×10^{-14} μCi/cc

The 308 Building is served by all three of the 300 Area waste disposal systems, viz, sanitary, retention waste and contaminated waste systems (see Part 2.8).

Criticality detection in the building consists of two comparators with 9 neutron detectors. The systems are operated in 2 out of 6 (first floor) and 2 out of 3 (second floor) coincidence modes. Either system activates alarms throughout the building and at the 300 Area Patrol Headquarters.

The building is equipped with an air sampling system with a capacity of 1900 cubic feet per minute. There are approximately 65 installed air samplers in the building. In addition, mobile continuous alpha air monitors are available for use throughout the building.

Emergency power is provided to the building from the 300 Area emergency power system.

The process area of the building is equipped with a sprinkler fire protection system. Heat detection devices are located in the ceiling of each laboratory room, in room exhaust ducts, and inside glove boxes to give early warning of excessive temperature rise. A heat detector system at the top of ventilation riser plenum actuates a deluge valve in the plenum to keep hot fire gases and burning particles from destroying the filter bank.

306-W Building

The west portion of the 306 Building (designated as 306-W) is a PNL facility operated by BNW; the east portion (306-E) is a HEDL facility operated by WHC. The PNL-occupied portion of the 306 Building contains:

- a diversified metal working facility for performing a variety of nonrepetitive fabrication development jobs
- the PNL speciality Shop that provides machining services for uranium, thorium and other materials of equivalent radiological consequence
- The Thorium Oxide Fuel Development Laboratory (TOFDL) for Fabrication of uranium and thorium dioxide nuclear fuel pellets
- a SNM storage area
- support laboratories.

The 306 Building is of steel construction with a tar and gravel roof over steel decking. Exterior walls are 8-in concrete brick. The 306-W portion of the building is 193 ft in the east-west direction and 160 ft in the north-south direction. A 25 ft high bay area provides about 30,000 ft^2 of floor space; the remaining 2000 ft^2 of the first floor is office space having a ceiling height of 8 ft. Additional office space and an equipment room are located above the first floor office area. a 12-in.

thick concrete firewall divides the building into approximately equal 306-E and 306-W portions. This wall has a sealed personnel door and a large, steel, sealed equipment door; both doors have a 1-1/2 hour UL fire rating.

The 306-W Facility is occupied by approximately 50 persons. The Manager of Materials Department of BNW has overall responsibility for the safe and effective use of the 306-W Building.

A variety of nonrepetitive fabrication development operations are performed in the Diversified Metal-Working Facility. Metal melting is performed in vacuum or inert gas chambers. Metal deformation and heat treating processes such as forging, extrusion, rolling, drawing, and swaging compaction are conducted. Encapsulation methods are used on hot operations such as extrusion, heat treating, and compaction involving powder and/or radioactive materials such as uranium and thorium. Some chemical operations are performed to remove lubricants and oxides from metal surfaces or to remove metal mandrels and encapsulating materials such as copper or iron.

The Speciality Shop provides machining services for uranium, thorium, and other materials with similar low specific radioactivity. Metal-working equipment includes lathes, a honing machine, a milling machine, a power hacksaw, grinders, and drill presses. The bulk of radioactive material handled is depleted uranium with only an occasional machining service performed on thorium or enriched uranium.

The principal materials processed in the TOFDL are uranium and thorium dioxide (UO_2 and ThO_2). Typically these materials are received in powder form and are converted to nuclear fuel pellets in a series of processing steps which may involve part or all of the following: weighing, blending, screening, hammermilling, ballmilling, wet or dry binder addition, drying, slugging (preprocessing), granulating, pellet pressing, hole drilling, sintering, centerless grinding, ultrasonic cleaning, and drying. All handling of UO_2 and ThO_2 in powder form is conducted in hoods.

The SNM Storage Area serves as the site for packaging and unpackaging SNM shipments and storage of these materials. Three basic types of storage are provided:

- the normal and depleted uranium and thorium storage cages (2 cages)
- the low enriched (<5.1 wt% ^{235}U) uranium storage racks (2 racks)
- the high-enriched (≥5.1 wt% ^{235}U) uranium storage cabinets (2 cabinets).

Engineered safety features include an independent ventilation system for contamination control, hoods in the TOFDL for processing oxide powders, safety interlocks on the hydrogen furnace system to prevent an accumulation and ignition of an explosive gas mixture, an emergency power system for emergency lighting and the alarm systems, and a comprehensive fire protection system.

Independent ventilation systems serve four distinct areas within the 306-W Building.

- The first floor section is served by two roof top units that provide ventilation, heating, and refrigerated cooling.
- The main high bay area single-pass supply air is provided through independent roof mounted H & V units consisting of pre-filters, steam heating coils, and an evaporative cooling section. Exhaust from this section is discharged through three roof-mounted exhaust systems, which include medium efficiency pre-filters and one stage of HEPA filtration. Vacuum air samplers are installed in the exhaust air ducts to sample air released to the atmosphere.
- Air flow through the TOFDL is partly supplied by a single- s refrigerated HVAC system. In addition, supplied-air hoods are used to reduce the amount of tempered air needed. The exhaust air is discharged through two stages of HEPA filters by an exterior mounted fan. A vacuum air sampler is installed in the exhaust duct to sample air released to the atmosphere.

Continuous operation of the 306-W ventilation system provides a differential negative pressure (at least 0.05 psig) with reference to atmospheric pressure for control of potential airborne contamination in the north high-bay area. Processing operations with materials in powder form are conducted in hoods or glove boxes. A minimum airflow of 125 ft/min is provided at the hood face to give adequate control for airborne contamination in the hoods.

Furnace systems for the processing of nuclear fuel pellets and powders, using hydrogen mixtures greater than 5% hydrogen, are equipped with safety features to preclude an accumulation and ignition of an explosive mixture. The manifold for the hydrogen mixture supply is equipped with a double pressure reducing station and a pressure relief pop valve set less than 75 psig. Whenever a flowing explosive mixture is being used, a source of inert gas is always available to the furnace system to purge the furnaces manually before hydrogen mixture is introduced and at the completion of a process cycle. A second inert gas safety system is on standby to purge a furnace automatically in the event of a furnace power failure or hydrogen mixture supply failure. In addition, a burn-off system is provided to burn any potentially explosive mixture flowing from the furnace. A safety interlock system prevents the flow of the hydrogen mixture to the furnace in the event of burn-off failure, gas pressure drop, or power failure.

The building is covered by an automatic wet-pipe sprinkler system. Fire alarm pull boxes and fire extinguishers of the appropriate types are located throughout the building. Fire alarms in the building are connected with the 300 Area fire alarm system. The activation of any sprinkler head sounds an alarm in the 300 Area Fire Station and the 306 Building.

Radiation protection instruments include hand and shoe counters, exhaust air samplers, and criticality detectors.

The building is served by evacuation sirens and an emergency telephone system.

231-Z Building

The 231-Z Building, located in the 200-West Area of the Hanford site was used extensively for metallurgical research on plutonium and its alloys, as well as for fabrication development work on plutonium components and reactor fuels containing plutonium or other alpha-emitting materials. Large quantities of plutonium (200-400 kg) were routinely handled and stored in the facility. In January 1975, the Division of Military Application (DMA) advised BNW of their intention to phase out the General Weapons Development Program, conducted by BNW Materials Department in the 231-Z facility. With the phasing out of the Weapons Development work, a commitment was made to decontaminate and restore the 231-Z facility for use as a nonplutonium DOE laboratory.

Future work may include electrochemical decontamination research for the Nuclear Fuel Cycle and Production Division of DOE. This project involves the handling and processing of transuranic-contaminated metal. Other programs for the facility may also involve the handling of radioactive materials. Thus, the objectives and scope of the decontamination and restoration requirements are:

- removal of all obsolete glove boxes, related plutonium processing equipment, and contaminated services and utilities
- decontamination of the facility to radiation levels as low as practicable
- restoration of the facility to render it useful as a multipurpose DOE research and development laboratory.

The 231-Z facility is a two-story building of reinforced concrete and concrete block construction. The second floor is essentially one large, open bay with a floor area of 23,500 ft^2 used for piping, ventilation ducts, filter cages, miscellaneous storage, and supporting facilities (vacuum pump hydraulic equipment, etc.) for equipment on the first floor. The first floor area is 27,000 ft^2; 20,000 ft^2 is usable laboratory space. In addition to the main laboratory, there is a 3000 ft^2 office extension of concrete block construction. The office building is attached to the laboratory structure and isolated from the laboratory area by air locks.

Approximately 70 people are assigned to work at the 231-Z facility. The Manager of the Materials Department has the overall responsbility for the safe and effective use of the 231-Z Building.

Operation of the facility is by qualified personnel who receive a general orientation covering all aspects of the Materials Department work procedures and the operating procedural manual for the building. All employees are assigned to work with experienced personnel until they become proficient in their assigned work areas. Where applicable, personnel receive formal training in radiation protection, criticality safety, and/or glove box operations. Operating personnel designated by management and Occupational and Environmental Safety personnel make periodic inspections of the facility to insure compliance with SAR, CSS, and RWP requirements.

Engineered safety features include: four independent ventilation systems; glove boxes and hoods; power for emergency lighting, alarm systems, and certain selected parts of the ventilation system; an automatic steam-driven blower for emergency ventilation to the glove boxes; a fire suppression sprinkler and alarm system; and a criticality alarm system.

Four separate, independent systems serve the ventilation requirements of the 231-Z Building. The main laboratory room ventilation and air conditioning is provided by a central recirculating system. Air recirculated by this system passes through two banks of HEPA filters before returning to the laboratory area. In the event of air contamination, an air monitor, located between the two HEPA filter banks, will alarm and automatically change damper positions in the system, converting it to a once-through system that discharges to the atmosphere following passage through the HEPA filter banks. Emergency electrical power is provided to maintain ventilation in the more crucial laboratory areas. In the glove boxes, a negative differential pressure relative to that in the lab areas is maintained by a single-pass ventilation system which contains two testable HEPA filters and one nontestable HEPA filter in the exhaust. An automatic steam-driven blower will maintain a negative glove box pressure in the event of an electrical power outage.

Release figures for the 231-Z Building, hood and glove box exhaust system, for 1978 were:

Total Released	α (^{239}Pu)	4.5 μCi
Average Concentration	α (^{239}Pu)	6.1×10^{-14} μCi/cc
Maximum Concentration	α (^{239}Pu)	9.3×10^{-12} μCi/cc

These releases primarily resulted from contaminated ductwork after the HEPA filter banks and do not accurately reflect the activities currently being performed in the building. Efforts have been made and are being continued to reduce the releases.

The building is covered by an automatic wet pipe fire suppression sprinkler system with heat detecting devices located throughout the first floor of the laboratory area. Those devices may be found in glove boxes, hoods and the storage vaults. The complete fire protection system includes automatic alarms, annunciators, and supervisory panels located in a central location. The system also alarms at the 200 Area Fire Station.

Radiation protection instruments include hand and shoe counter, air monitors, exhaust air samplers, and criticality detectors. The building is also served by evacuation sirens and an emergency telephone system.

Other Battelle-Northwest Controlled Facilities Where Licensed Work with Small Quantities of Material May Be Performed

3720

The 3720 Building, Consolidated Service Facility, is a 27,000 ft^2 facility in the 300 Area providing space for various research departments - Atmospheric Sciences, Chemical Technology, Materials, Water and Land Resources, and the Craft and Operation Services Department. Approximately 52% of the space is occupied by the research departments (including radiological research), 37% by the Craft and Operation Services Department, and 11% by building service equipment. Fifty employees from the listed research departments and 200 Craft Services personnel are located in 3720 Building

A wide variety of activities are conducted in this facility and include:

- cutting, polishing, sanding and mounting of uranium samples (up to 4% ^{235}U enrichment)
- sample decc mination of irradiated molybdenum, nickel, rhenium, vanadium, niobium, iron, platinum, titanium, gold, copper, tantalum, zinc, stainless steel and graphite, followed by annealing, electrochemical thinning and electron microscopy examination
- study of high termperature transport and deposition behavior of plutonium, uranium, fission products, and tritium, including examination and analysis of residues
- experimental studies involving methyl iodide spiked with ^{131}I
- determination of diffusivity of hydrogen isotopes in Niobium-Zirconium alloys and in Vanadium including tensile testing of samples and electron microscope examination
- chemical research studies of transuranium and fission product concentrations in crib core samples
- boiling of uranium nitrate solutions and storage of uranyl nitrate and uranium oxide pellets
- chemical analysis of uranium samples enriched to 1.25% ^{235}U.

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Activities involving the handling or radioactive material in 3720 Building are conducted in HEPA filtered fume hoods or glove boxes. It is recognized that the 3720 Building exhaust system was not optimally designed for efficient operation for current activities. Improvements to the building exhaust system have been initiated.

Currently nine exhaust systems serve the research portion of the 3720 Building. These systems have several drawbacks: they do not have provisions for continuous monitoring and sampling of the effluent flow; the design of their HEPA filter boxes makes it difficult to change filters; and portions of the existing galvanized exhaust ducts are badly corroded and should be replaced. The objectives of the improved building exhaust system should be: reducing the number of exhaust points to a minimum for more effective sampling; improving effluent sampling capabilities; improving filter-testing and monitoring capabilities; and putting new filter boxes to simplify filter replacements.

3708

The 3708 or Radiation Measurement Laboratory serves as a laboratory for several research and development groups. The structure is one-story concrete block on grade with a concrete foundation and slab floor. Of 3868 ft^2 total area, 3196 ft^2 is used for storage with 672 ft^2 utilized as a common area.

The building is equipped for work with small quantities of highly radioactive materials including plutonium. Air is supplied to the laboratory rooms through overhead diffusers. Room air is exhausted through a roughing filter and a HEPA filter; glove box air, after undergoing the same process, combines with room air and passes through an additional HEPA filter bank before being released from the building.

Provisions are made to sample the air in the room and stack and to measure the airborne contamination released from or spread within the facility. A separate building vacuum system is provided which meets the operational requirements of the sampling equipment.

Potentially contaminated liquid wastes are transferred to a receiver tank and taken to the 300 Area retention waste system or to the 300 Area contaminated waste system, depending on sample results.

The Alpha Radiation Facility is a room in 3708 occupied soley by the Nuclear Waste Technology Programs Department. The personnel of the Process Demonstration section, NWT Department control access tothe facility.

The Alpha Radiation Facility and its attendant safety requirements are the responsibility of the Manager of Nuclear Waste Process Demonstration section. The facility is classified as an Isolated Facility, which administratively limits the amount of fissionable material in the facility to 0.45 of a minimum critical mass. Radiation work procedure is reviewed annually. No criticality audits are required; however, the facility is surveyed daily during use; and if it is operating on a standby status, the facility is surveyed weekly by radiation monitoring.

A fire, temperature and smoke detector alarm system has been installed in the 3708 Building. Rooms are protected by combustion particle detectors. Glove boxes are equipped with quick-disconnect fittings and distribution piping to permit application of dry chemical fire extinguishing materials. Fire extinguishers ar in accessible positions for use by personnel.

331

The 331 Building or Life Sciences Laboratory I, located in the 300 Area, is suited for the performance of a wide variety of biological and ecological research studies. The laboratory provides facilities in which to conduct research in radiation biology relevant to the needs of the expanding use of nuclear energy. It contains quarters for housing and caring of colonies of large and small animals. Special facilities are provided for performing inhalation toxicology, large animal radionuclide metabolism and toxicity, physiology, pathology, ecology, and aquatic studies primarily related to the effects of specific radionuclides and radiation in living systems.

The laboratory consists of three basic elements molded together into a single building.

The primary element is a three-story structure with a projected area of 67,000 ft^2 consisting of two laboratory floors with a mechanical-electrical services floor sandwiched in between.

The main laboratory floor blends into the single-story large animal facilities and the administrative wing discussed below. It contains (1) a multi-room inhalation toxicology exposure suite and related metabolism rooms, (2) a large, 26 ft^2 cobalt irradiation room, (3) an electron microscope suite, (4) dosimetry, isotope preparation, plant physiology, terrestrial ecology, aquatic biology and biochemistry laboratories, (5) supporting counting room, change room, radiation protection facilities, offices, instrument, electrical and mechanical maintenance shops, a receiving area, and mechanical and electrical equipment rooms.

The second element, occupying about 19,000 ft^2, consists of (1) a swine barn, its supporting facilities, and related specialty bay for more intensive studies requiring special environments and life supporting systems; (2) a dog run complex and its supporting functions housing the dog colony; and (3) shared facilities consisting of a whole body counting facility, an examination room, a surgery, a diagnostic x-ray room, and supporting cold termperature rooms.

The third element, occupying a gross area of about 11,500 ft^2, consists of an entrance foyer and court and a two-story administrative wing. This element houses administrative and clerical personnel, a few researchers, a receptionist, conference rooms, library, lunchroom, copying machine room and mail delivery room.

Heating and ventilation are provided by a central system which utilizes steam and hot water for heating and evaporation and refrigeration for cooling. Rooms requiring more precise temperature control than is possible using evaporation cooling have supplemental chilled water coils in the supply air ducts. These include the small animal quarters, inhalation toxicology exposure complex, electron microscope suite and the counting room.

Process exhausts include nonfiltered and single- and double-HEPA filtered systems. These are provided to protect the building occupants and the environs.

Special services piped through the building include laboratory vacuum, air sampling vacuum, deionized water, gas, and compressed air. A raw river water system including a deaerator, head tanks, and water chillers and heaters provides conditioned and unconditioned river water to the aquatic biology facilities.

Fire protection is provided by a wet sprinkler system throughout all parts of the building.

Outside facilities include a gas storage structure and process, sanitary, and animal waste systems, a river water-storm system, a service yard, parking areas, and aquatic ponds.

The 331-A Building or Virology Laboratory provides laboratory space for the study of viruses. Swine and cats are used in this endeavor. Of 2800 ft^2 total area, office, laboratory and work space take up 2123 ft^2 and 677 ft^2 serves as common area (one office and three labs). The facility is a rectangular one-story concrete block building with a flat, wood frame, built-up roof. The ventilation supply consists of two basic components, a refrigerant-cooled air conditioning system for the main laboratory and office area, and an evaporative cooling system for the swine barn area. Heating is provided by steam coils in the supply ducts. The ventilation system is zoned to control the potential spread of viral contamination. A central HEPA filtered exhaust system provides this control. Lighting and alarm systems are of standard design. Clean-up facilities are provided for laboratory personnel but no lunchroom or restroom are included. A crematory is located to the east of the laboratory.

One hundred and fifty research and associated staff personnel from PNL Biology and Ecosystems Departments are residents of 331 Buildings.

Administrative controls are documented in 331 Building Emergency Procedures, Radiation Control Procedure, Radiation Work Procedures, etc. These procedures are reviewed and updated annually. The facility is classified as an Isolated Facility, which administratively limits the amount of fissionable material in the facility to 0.45 of a minimum critical mass.

Mobile Verification Measurement Facility

The Mobile Verification Measurement Facility (MVMF) is a specially constructed mobile van containing a real-time non-destructive analysis (NDA) system. Real-time means that an item can be evaluated within a few minutes without the normal laboratory and computational delays. The NDA system is used for performing both inventory verifications and sample measurements of nuclear materials. Included in the system are passive and active neutron and gamma ray measurement equipment with supporting electronics and a mini-computer-based acquisition and display system.

Nuclear material standards such as a plutonium or enriched uranium are utilized in the calibration of the NDA equipment. These standards are packaged and remain in sealed metal containers while located in the MVMP. Transp... standards within the MVMP is in compliance with the requirements specified in "Radioactive Materials Shipping Manual" PNL-MA-81.

The MVMF is denoted as a PNL Isolated Facility, limiting the amount of fissionable located in the van at one time to 0.45 of a minimum critical mass. Nuclear material brought into the van shall be packaged in sealed metal containers (or within two cans with tape-sealed slip lids). Unpacking of nuclear material to a point of breaching the metal container is prohibited.

Any person operating the van is trained in the operating of the Halon fire extinguishing system.

The automatic Halon fire extinguishing system can be initiated automatically through installed smoke detector or manually. In the event of a fire, the recirculating air conditioning system in the van would retain the Halon inside for a longer period of time, thus contributing to its fire fighting effectiveness.

EDL

The Engineering Development Laboratory (EDL) is a Battelle owned facility located in the Battelle Richland Research Complex adjacent to the Hanford 300 Area. See Figure 2.3-I. The building is designed for research, development and testing or uranium fuels; it is not intended for work with unsealed plutonium. It consists of a high bay area, several general purpose laboratories and offices. The air supply and exhaust system for the high bay and laboratory portion of the building is separate from the one for the office and administrative areas. Supply air is provided through overhead diffusers at a slightly lower volume than the approximately 17,000 cfm exhaust volume. The exhaust passes through one high efficiency filter preceded by a roughing filter before being released to the environs. An additional high efficiency filter would be placed in the exhaust from special equipment or areas where uranium in a powered form was to be handled. No liquid radioactive waste system is provided. Any contaminated liquid wastes will be collected, and disposed of by a mmercial waste disposal firm. The building is equipped with a sprinkler fire protection system.

PSL

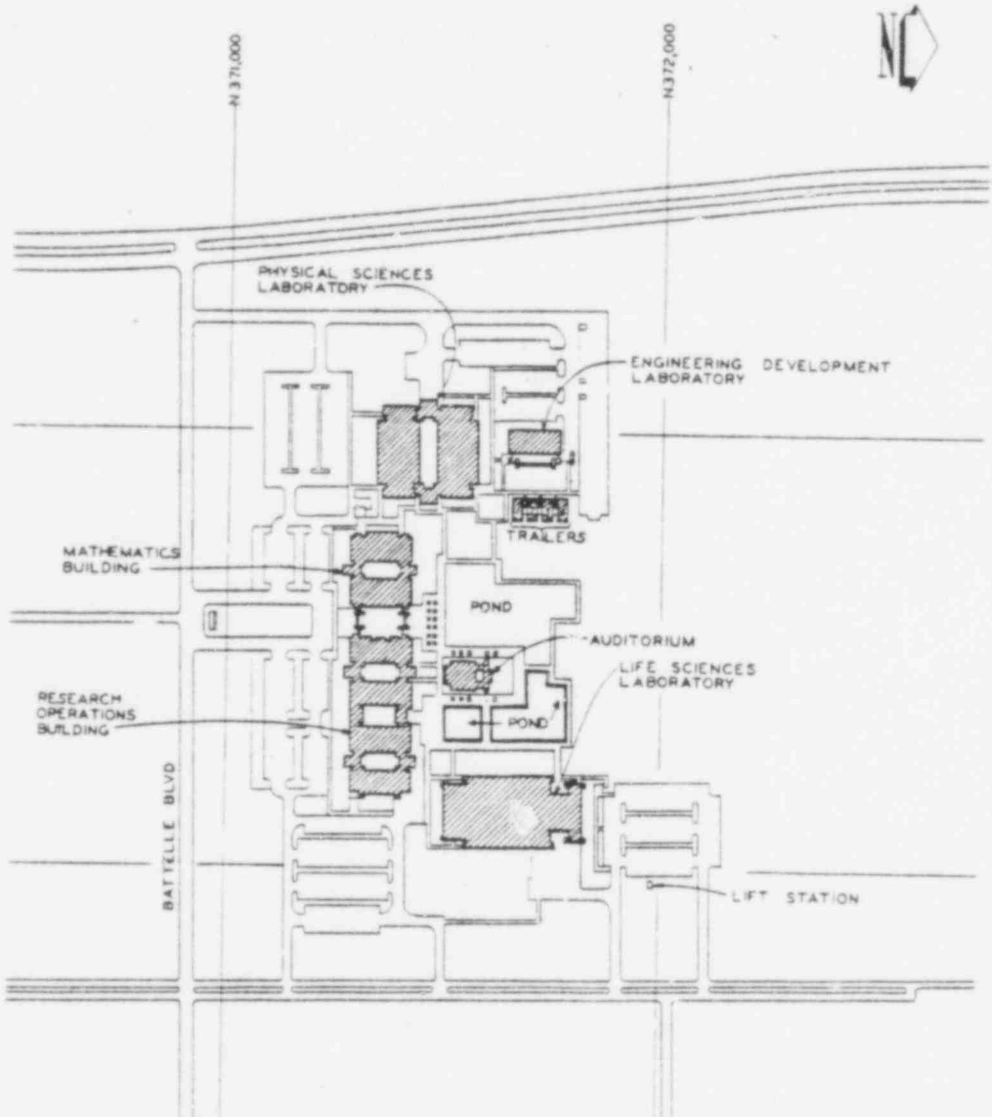
A portion of the Physical Sciences Laboratory Building (PSL), also a Battelle owned facility, is equipped for work with small quantities of radioactive materials. Supply air is provided to these laboratories through overhead diffusers and air from these rooms is exhausted through the hoods. The air passes through two HEPA filters banks before reaching the atmosphere. The hoods automatically compensate when they are closed to exhaust the room via a bypass. The exhaust system has two exhaust fans, either of which can accomodate the entire exhaust capacity. The electrical load from these is automatically transferred to an emergency power system in the event of power failure. Solid and liquid radioactive wastes are collected, and disposed of by a commercial waste disposal firm. The laboratories in which work with radioactive material is performed are equipped with an air sampling vacuum system.

LSL II

The Life Sciences Laboratory II, located in the Richland Research Complex, is suited for the performance of a wide variety of biological and ecological research studies. The laboratory provides facilties in which to conduct radiation biology research relevant to expanding private and government business.

The laboratory has major facilities for housing colonies of research animals in a closely regulated environment. These animals are used in many programs which include studies of the biological effects of radioactive materials, metabolic studies using small quantities of radionuclides as tracers and studies of hazardous non radioactive materials such as cigarette smoke and various other carcinogens.

FIGURE 2.3-I



POOR ORIGINAL

RICHLAND RESEARCH COMPLEX

The facility was constructed to allow the safe use of moderate quantities of radioactive materials although current uses of radionuclides are small. Principle activities with radioactive materials involve animal inhalation of ^{85}Kr, ^{222}Rn and uranium dust.

In addition, the use of all unsealed transuranic materials are restricted to that contained in animals, their excreta, tissue sections and microscope slides.

Several exhaust ventilation systems serve LSL II. Two systems, the fume hood systems, are provided to exhaust areas where radioactive materials may be used. Depending upon the area or laboratory room, all exhaust air is filtered through either one or two HEPA filter banks in series. The high efficiency filters are testable with DOP smoke while installed in the ventilation system.

Releases from the two systems in 1978 were:

Total released

α	0.5 μCi
β-γ	1.6 μCi

Average release concentration

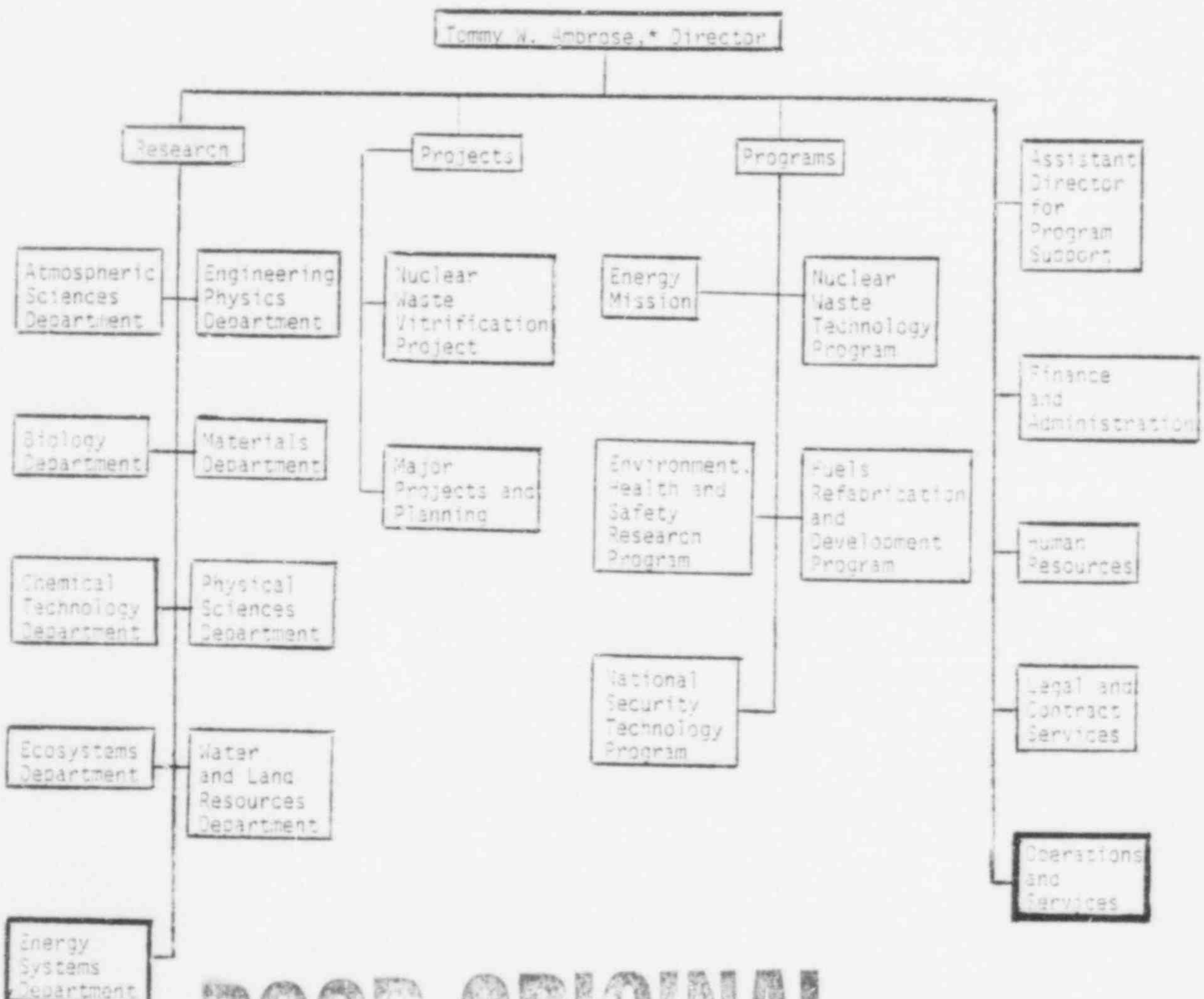
α	6.2×10^{-16} μCi/cc
β-γ	2.0×10^{-14} μCi/cc

Like the Physical Sciences Building, LSL II is not equipped with a liquid radioactive waste sewer system. To the extent possible, contaminated liquids are collected and sent to a commercial radioactive waste disposal firm or sent to the 300 Area animal waste treatment facility. The one exception is the wash water from the automatic cage washers. This wash water may contain slightly contaminated animal excreta. The total activity released to the wash water will not exceed 10 nanocuries per day. This water is released to the sanitary sewer system. The volume of wash water is about 64,000 liters per day. In addition, the automatic cage wash system shall be turned off if an accidental release greater than 5×10^{-5} μCi/ml is detected.

2.4 BATTELLE-NORTHWEST ORGANIZATION

As of September 30, 1978, Battelle-Northwest is organized as shown in Exhibit I.

EXHIBIT I



POOR ORIGINAL

Operations and Services Division

All work with radioactive materials is carried out under programs established by the Operations and Services Division, which is organized as follows:

- Operations & Services Division
  W. D. Richmond, Director
  - Occupational & Environmental Safety Dept.
    C. M. Unruh, Manager
  - Facilities Planning & Engineering Dept.
    J. L. Boyd, Manager
  - Communications Department
    J. R. Sletager
  - Craft & Operations Services Department
    D. L. Weaver, Manager

Occupational and Environmental Safety Department

The Occupational and Environmental Safety Department of the Operations and Services Division establishes and carries out all safety programs for Battelle-Northwest. In addition, the Department carries out certain radiation protection programs for the entire Hanford Complex. The Department is organized as follows:

- Occupational & Environmental Safety Dept.
  C. M. Unruh, Manager
  H. V. Larson, Associate Manager
  - Radiation Standards & Engineering
    J. M. Selby, Manager
    - Radiological Calibrations
  - Radiation Monitoring
    J. J. Jech, Manager
  - Environmental Evaluations
    P. E. Bramson, Manager
  - Personnel Dosimetry
    K. R. Heid, Manager
    - Radiation Records
  - Safety & Nuclear Materials Management
    H. L. Henry, Manager

Radiation Standards and Engineering functions are:

- To establish the Battelle-Northwest Radiation Protection Program.
- To evaluate technological and socioeconomic developments in the field of radiation protection.
- To provide authoritative consultation to others with regard to the development or application of regulations, technical recommendations, and procedures for radiation protection.
- To provide liaison with the Department of Energy and other regulatory agencies with reference to the Radiation Protection Program, radioactive materials license, special nuclear materials license, and waste disposal permits.
- To coordinate radiation protection training for Battelle-Northwest employees, visitors from offsite and others.
- To assure that Battelle-Northwest Radiation Protection Program, as well as radiation protection services provided by Battelle-Northwest to other contractors, meet applicable DOE requirements.
- To audit Battelle-Northwest operations and facilities to ensure adherence to established radiation protection procedures and practices.
- To provide consultation during the design of new or modified facilities to ensure that adquate radiation protection criteria are included.
- To establish Battelle-Northwest Emergency Plans and Procedures which are compatible with DOE-RL emergency plans and those of other contractors which are part of site-wide emergency plans.
- To participate in formal investigations of radiation exposure involving Battelle-Northwest employees.
- To procure, maintain, calibrate and provide portable personnel radiation monitoring instruments, and to establish portable instrument performance specifications and procurement standards for the Hanford Complex.
- To provide a comprehensive radiation standards and calibrations laboratory.

<u>Radiation Monitoring</u> functions are:

- To establish the Radiation Monitoring Program to meet Battelle-Northwest radiation protection requirements.
- To provide complete and effective radiation monitoring services for all departments of Battelle-Northwest, as well as for the U.S. Government and other Hanford contractors on request.
- To provide authoritative counsel to customer management regarding work with radioactive materials in order to minimize hazards to personnel, facilities, and environs.
- To investigate high personnel exposures and conditions and factors involved in radiation incidents and to issue reports including recommendations for corrective action.
- To remain in a state of preparedness to cope with serious radiation events through a continuing program of education and training.
- To provide field dosimetery services.

<u>Environmental Evaluations</u> functions are:

- To design and conduct environmental surveillance programs that define the geographical and biological distribution of airborne and waterborne radioactivity from Hanford sources, and water quality parameters affected by Plant operations.
- To provide comprehensive evaluations of field data to determine the potential impact of environmental contaminants on man and his economy.
- To determine the status of the environs of Hanford facilities with respect to applicable limits and guides.
- To maintain an emergency environmental program.
- To coordinate Battelle-Northwest's waste disposal practices. Includes maintaining the waste disposal practices in conformance with DOE, state and other federal waste disposal and pollution control requirements.

<u>Personnel Dosimetry</u> functions are:

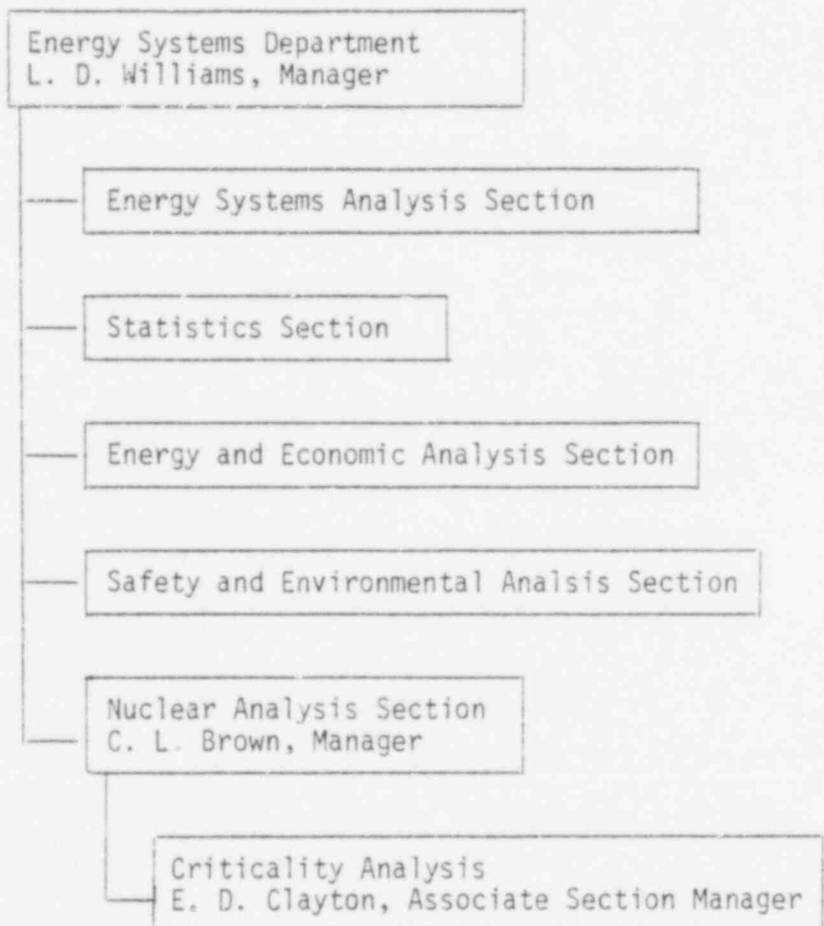
- To design and establish bioassay sampling and whole body counter examination programs for varying degrees of potential for radiation exposure to Hanford employees from internal emitters.
- To provide professional evaluations of the extent of internally deposited radionuclides in project employees and visitors using the best available interpretive techniques.
- To provide professional interpretations of dose from external sources to organs of interest.
- To aggressively apply research findings to dosimetry programs, and to conduct equipment evaluation studies and field tests of prototypical and new commercial equipment.
- To anticipate new needs for internal and external dosimetry services arising from process and function changes of customers and to identify areas of needed research and development leading to improved technology and methodology.
- To establish, implement, and audit a functional, legally sound radiation protection records system.
- To prepare as required for administrative, professional or legal use, reports of radiation dose received by individuals.
- To establish and maintain a quick response standby dose evaluation system to assure accurate and timely radiation dosimetry for emergencies.
- To conduct studies of dosimetry records to determine the incidence, distribution and other pertinent parameters of exposure.
- To participate in formal investigations of incidents involving Battelle-Northwest Laboratory personnel or facilities and to prepare the formal statement of the exposure received by personnel.

<u>Safety and Nuclear Materials Management</u> functions are:

- To assure that high standards of nuclear safety are maintained throughout all laboratory divisions, and to assure that these standards are responsive to government and other regulations.
- To perform nuclear safety analyses for reactors, critical facilities, and laboratories containing large inventories of fissile materials or radionuclides.
- To prepare and approve in conjunction with other departments, mandatory written specifications delineating safe operating limits for facilities.
- To perform periodic audits to assure that written specifications are appropriate and that operations conform to these instructions.
- To provide consultation during the design of new or modified facilities to ensure that adquate nuclear safety features are included.
- To provide liaison with the Department of Energy in obtaining approval of operating safety limits and other administrative controls as described in DOE Manual Chapters.
- To establish and maintain a transfer, inventory, and forecast system for source and special nuclear materials received, held or shipped by Battelle-Northwest.
- To develop and maintain a system for nuclear material safeguards and measurements.
- To prepare consolidated source and special nuclear material reports as required by DOE.
- To provide assistance and coordination of effort for all offsite radioactive material shipments by Battelle-Northwest.
- To coordinate nuclear material procurements, transfers, project control, disposal of excess materials, material write-offs and process losses.
- To develop and implement an audit program to evaluate nuclear material inventories and internal control procedures within Battelle-Northwest.

Energy Systems Department

The Nuclear Analysis Section of the Energy Systems Department provides authoritative experimental and theoretical information in nuclear criticality safety. This section allows for an independent review group outside the Occupational and Environmental Safety Department in the criticality safety program of the Battelle-Northwest Laboratories. The Energy Systems Department is organized as follows:



The Nuclear Analysis Section and the Criticality Analysis subgroup provide consultation in the design of facilities and processes involving fissionable materials. The section also reviews the criticality safety of all fissionable material shipments.

The Criticality Analysis subgroup prepares the "basis letter" for Criticality Safety Specifications which control the use of fissionable materials in BNW controlled buildings. This letter contains the technical limits which are adequate to preserve the criticality safety two contingency policy. The subgroup also provides experimental data on criticality physics parameters for Battelle-Northwest as well as other DOE contractors.

The Battelle-Northwest Safety Review Council

Another group which has responsbilities in the field of radiation safety is the Battelle-Northwest Safety Review Council. Members of the Council are selected by the Director of Battelle-Northwest from persons recognized as authorities in their specific fields. Their capabilities include, but are not limited to, atmospheric dispersion, biological effects of radiation, chemistry, containment, critical mass physics, fluid flow, heat transfer, legal liabilities, metallurgy, pressure vessels, reactor physics, operation and engineering, risk evaluation, and industrial safety. The function of the Council is to review the direct and/or indirect consequences of credible accident in Battelle facilities and advise the Director of the results of this review. This system assures that all necessary capabilities are brought to bear on engineered and administrative safeguards in order to minimize the likelihood and consequences of a serious accident.

2.5 RADIATION PROTECTION PROCEDURES

To ensure that an optimum radiation protection program with a continuing commitment to keeping radiation exposures as low as readily achievable is maintained, a number of formal procedures have been established at Battelle Northwest. These procedures cover the subjects of radiation protection, shipment of radioactive material, environmental surveillance, waste disposal, accident evaluation and safeguards review, and emergency planning. Following is a description of these procedures and the manner in which they are utilized in the radiation protection program.

Occupational Exposure Limits and Records

Occupational exposure is controlled to composite dose standards essentially the same as those established by the NCRP, ICRP, and the Department of Energy. These limits are spelled out in Procedure 1 of BNWL-MA-6, Radiation Protection Procedures.

Information on prior exposure histories is obtained on all employees at hire-in on Form 54-3000-467, Personal Radiation Exposure History (Exhibit II). Actual exposure information is normally obtained from the new staff member's previous employer or employers. Records for each individual for whom Battelle-Northwest has exposure control responsibilities are maintained in individual folders, into which all results obtained from the external and internal exposure measurement program are periodically filed. These results are supplemented by evaluations and interpretations whenever necessary.

An Investigation of Lost Dosimeter Results (Form 54-3000-493) is issued to supplement the individual's exposure record if a routine dosimeter result is lost or otherwise unobtainable. A copy of this form is included as Exhibit III.

In addition to this routine exposure information, any unusual incident in which the individual may have been involved or any unusual exposure he may have received is investigated, documented on Form BB-1200-080, Localized Exposure Report (Exhibit IV), Form 54-3000-497, Radiation Occurrence Report (Exhibit V), or on Form BD-1200-038, Skin Decontamination and Personal Effects (Exhibit VI), and placed in the individual's record file. References to medical treatment or work restrictions which are occasionally required as a consequence of an incident are also retained in this file as outlined in Procedures 1 of BNWL-MA-6.

2.5-2
EXHIBIT II

EMPLOYER	RADIATION PROTECTION RECORDS PERSONAL RADIATION EXPOSURE HISTORY

NAME (LAST) (FIRST) (MIDDLE) (MAIDEN)	SOCIAL SECURITY NO.	BIRTHDATE	BIRTHPLACE (CITY AND STATE)	SEX

* RESIDENCE OR MAIL ADDRESS	WORK LOCATION / ORG CODE	SUPERVISOR / PHONE	EMPLOYMENT DATE	PAYROLL OR IDENT. NO.

1. HAVE YOU EVER KNOWINGLY WORKED WITH PLUTONIUM? ☐ YES ☐ NO
2. HAVE YOU EVER WORKED WITH OTHER RADIOACTIVE MATERIALS? ☐ YES ☐ NO
   (FOR EXAMPLE, URANIUM, THORIUM, RADIUM, STRONTIUM-90) (IF YES, SPECIFY WHICH)
3. HAVE YOU EVER WORKED WITH OR IN THE PROXIMITY OF RADIOACTIVE SOURCES OR RADIATION SOURCES OR RADIATION GENERATING EQUIPMENT? ☐ YES ☐ NO
   (INCLUDING SCHOOL, MILITARY SERVICES, INDUSTRY)
4. HAVE YOU EVER WORKED FOR A HANFORD CONTRACTOR BEFORE? ☐ YES ☐ NO

IF THE ANSWER IS YES TO 1, 2, OR 3 ABOVE, PLEASE PROVIDE THE FOLLOWING INFORMATION

EMPLOYER FOR WORK INDICATED ABOVE ________
EMPLOYER'S ADDRESS (INCLUDE ZIP CODE) ________
DATES EMPLOYED ________ BEGIN: ________ END: ________

EMPLOYER FOR WORK INDICATED ABOVE ________
EMPLOYER'S ADDRESS (INCLUDE ZIP CODE) ________
DATES EMPLOYED ________ BEGIN: ________ END: ________

EMPLOYER FOR WORK INDICATED ABOVE ________
EMPLOYER'S ADDRESS (INCLUDE ZIP CODE) ________
DATES EMPLOYED ________ BEGIN: ________ END: ________

EMPLOYER FOR WORK INDICATED ABOVE ________
EMPLOYER'S ADDRESS (INCLUDE ZIP CODE) ________
DATES EMPLOYED ________ BEGIN: ________ END: ________

FOR RM USE ONLY	DOSIMETER	ROUTINE IVC (SEE BACK FOR LIST)	ROUTINE BIOASSAY		CONCURRENCE
	☐ NONE	TYPE	RADIONUCLIDE	FREQUENCY	
	☐ TEMP ☐ J ☐ T		(1)	(1)	
	☐ TLD BASIC	FREQUENCY			
	☐ TLD MONTHLY		(2)	(2)	
	☐ TLD QUARTERLY				RADIATION PROTECTION

REMARKS

POOR ORIGINAL

I CERTIFY: (1) THAT THE INFORMATION PROVIDED HEREIN IS CORRECT AND COMPLETE TO THE BEST OF MY KNOWLEDGE AND (2) HAVE READ THE PRIVACY ACT STATEMENT, COPY ATTACHED.

____
SIGNATURE

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CONTRACTOR

RADIATION PROTECTION RECORDS

INVESTIGATION OF LOST DOSIMETER RESULT

TO

DATE

№ 8002

FOR

PAYROLL NO & SUFFIX

AREA

TYPE

☐ MULTIPURPOSE T. L. DOSIMETER
☐ BASIC T. L. DOSIMETER
☐ T. L. RING DOSIMETER
☐ OTHER ______

PERIOD COVERED

FROM ______ TO ______

REASON FOR LOSS OF DOSIMETER RESULT

RADIATION MONITORING ESTIMATE OF DOSE DURING PERIOD

POCKET DOSIMETER RESULTS DURING PERIOD

METHOD(S) USED FOR ESTIMATING DOSE

	NON PENETRATING	PENETRATING	FAST NEUTRONS	THERMAL NEUTRONS	TOTAL
BODY DOSE					//////
EXTREMITY DOSE					

DATE

SIGNATURE (RADIATION MONITORING)

DOSE TO BE RECORDED IN THE EXPOSURE RECORD

SUPPLEMENTARY EXPOSURE DATA

	NON PENETRATING	PENETRATING	FAST NEUTRONS	THERMAL NEUTRONS	TOTAL
BODY DOSE					//////
EXTREMITY DOSE	//////	//////	//////	//////	

DATE

SIGNATURE

54-3000-493 (3-72)

POOR ORIGINAL

EXHIBIT IV

Battelle
Pacific Northwest Laboratories

RADIATION PROTECTION RECORDS

LOCALIZED EXPOSURE REPORT

INDIVIDUAL INVOLVED NAME			PAYROLL NO.		BADGE ID NO.
SHIFT ASSIGNMENT	AREA	CRAFT	DATE OF EXPOSURE	TIME	LOCATION

TYPE OF EXPOSURE

(SPECIFY LOCATION)

☐ EYE ☐ LOCAL, PENETRATING ____________

☐ LOCAL, SKIN ____________

SOURCE INVOLVED

☐ SKIN CONTAMINATION ☐ CLOTHING CONTAMINATION ☐ PARTICULATE ☐ BEAM

DESCRIPTION AND SKETCH (SPECIFY SIZE AND SHAPE OF SOURCE)

POOR ORIGINAL

DOSE ESTIMATE						BEAM		
FOR SURFACE CONTAMINATION		WINDOW OPEN		WINDOW CLOSED				
		DIAL READING	RANGE	DIAL READING	RANGE		DIAL READING	RANGE
UNSHIELDED READING	SCREEN @ CONTACT					W/O		
	SCREEN @ 6" CONTACT							
READING INNER SIDE OF GARMENT	SCREEN @ CONTACT					W/C		
	SCREEN @ 6" CONTACT							

CORRECTION FACTOR USED	ESTIMATED DOSE RATE	TYPE OF INSTRUMENT USED	INSTRUMENT NO.

ESTIMATED DISTANCE OF SOURCE TO SKIN	SURFACE AREA OF SKIN EXPOSED cm^2	DURATION OF EXPOSURE

IS SOURCE BEING SENT IN FOR FILM STUDY ? ☐ YES ☐ NO

DATE ____________ REPORTED BY ____________

BB-1200-080 (2 - 65)
AEC-RLOO RICHLAND, WASH.

EXHIBIT V

CONTRACTOR	RADIATION PROTECTION RECORDS **RADIATION OCCURRENCE REPORT**

OCCURRENCE TIME AND DATE	BLDG.	REPORTED BY	DISTRIBUTION:
REFER TO RWP NO.	SURVEY NO.	AIR SAMPLE LOG NO.	PERSONAL DOSIMETRY BNW ( )

PERSONS INVOLVED AND DISCUSSION OF INCIDENT

NAME	PAYROLL NO.	NATURE OF INVOLVEMENT

POOR ORIGINAL

REPORT NO.	DATE	INVESTIGATED BY:

54-3000-497 (2-66) AEC-RL RICHLAND, WASH.

EXHIBIT V I

BATTELLE-NORTHWEST RICHLAND, WASHINGTON	RADIATION PROTECTION RECORDS SKIN DECONTAMINATION AND PERSONAL EFFECTS

NAME	PAYROLL NO.	DATE	TIME OF OCCURENCE AM PM
AREA / BLDG / ROOM	AIR SAMPLE LOG NUMBER		SURVEY LOG NUMBER
ISOTOPE(S) INVOLVED	CHEMICAL FORM		PHYSICAL FORM

ITEM NO.	SKIN AREA OR PERSONAL EFFECTS	TIME OF SURVEY	METER DEFL.		SURVEY	
			WO	WC	RESULTS	INSTRUMENTS
					c/m d/m	
					c/m d/m	
					c/m d/m	
					c/m d/m	
					c/m d/m	

DECONTAMINATION INFORMATION

ITEM NO.	DECONTAMINATION AGENT USED	TIME	SURVEY		SKIN CONDITION AFTER TREATMENT
			INSTRUMENT	RESULTS	

POOR ORIGINAL

REMARKS

RADIATION MONITOR

BD-1200-038 (1-71) AEC-RL RICHLAND, WASH

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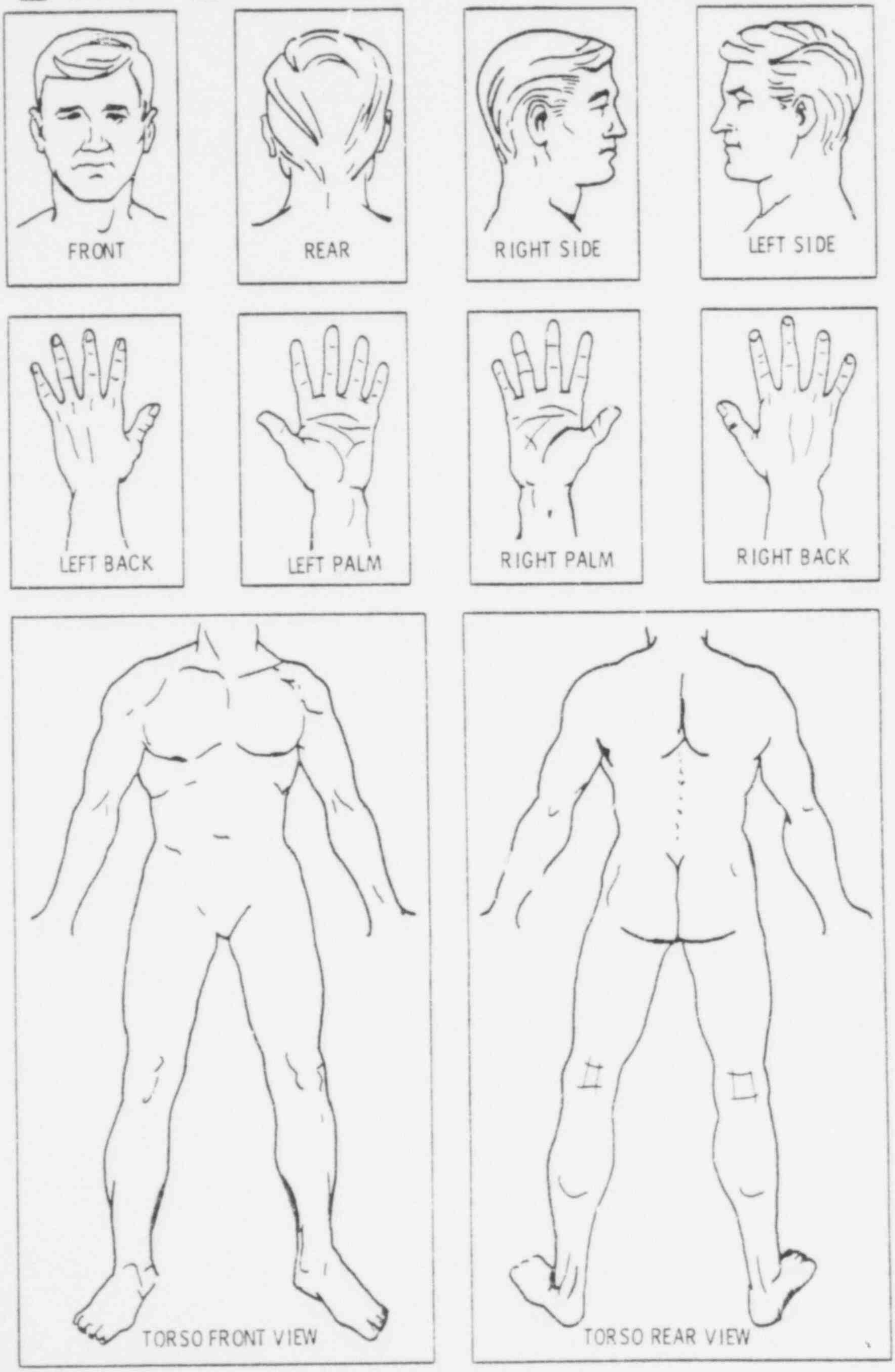
EXHIBIT VI(Page 2)

INDICATE AFFECTED SITES

☐ SKIN ☐ PERSONAL EFFECTS ☐ PROTECTIVE CLOTHING



The records in the file are periodically microfilmed; one set of microfilm records is maintained in the individual's folder as the permanent exposure history, and a second set is maintained in a records center. Data or procedures used in obtaining, evaluatir, and recording personnel exposure are maintained in historical files for future use in reevaluating or reinterpreting employee exposure histories. The records of exposure received by visitors are maintained permanently in bound books and cross-referenced for easy access.

External Exposure Control

The external radiation exposure of employees is maintained as low as practicable through the application of operational controls somewhat lower than the basic exposure limits. For example, the annual whole body penetrating radiation dose equivalent is controlled to 4 rem/year. Other Battelle-Northwest operational controls are listed in Procedure 2, BNWL-MA-6. Limiting employee radiation dose to within the operational controls is the responsbility of the first line supervisor working closely with Radiation Monitoring as stated in Procedure 2, BNWL-MA-6. Exposure accumulation control during the progress of work between dosimeter exchange periods is provided by normal monitoring methods such as self-reading pencils, dose rate measurement and timekeeping, special study of dose accumulation for jobs which have stable dose rates.

Internal Exposure Control

Radiation exposure from internally deposited radionuclides is reduced to a practical minimum by limiting exposure to contaminated breathing air. Ventilation system designs assure air flow from clean areas to potentially contaminated areas. High efficiency filter systems, remote handling equipment, fume hoods, and sealed glove boxes are utilized to isolate radioactive materials from the working environment. Highly radiotoxic materials such as ^{239}Pu and ^{90}Sr are rigorously controlled to avoid direct contact with personnel. These materials are normally processed in sealed glove box systems, and are provided with double containment upon removal from the sealed systems. When it is necessary to perform work in a contaminated or potentially-contaminated environment, protective measure are taken, ranging from restrictions on exposure time for work with materials of low radiotoxicity to the wearing and respiratory protection devices when working with highly radiotoxic materials or high concentrations of other radioisotopes.

Masks and suits are used only after they have been tested and approved by the Environmental Health Sciences Section of the Hanford Environmental Health Foundation (HEHF). Mask fitting services are also available for use by Battelle-Northwest and other Hanford contractors. HEHF also provides training in the use of respiratory protection devices to all individuals who may need to use these devices. Individuals must be trained prior to being fitted for a mask.

Following use by an individual, each mask undergoes a series of cleaning and testing steps, including decontamination (if necessary), inspection, repair (if necessary), and sterilization; each filter is given a pressure-drop test as well. All this work is performed by another contractor at a central Hanford facility.

Protective clothing, which meets Hanford standards, is used to protect personnel from direct contact with radioactive material and secondarily as a contamination control technique. Strict procedures are observed in handling this clothing with laundry services provided by another contractor. Practices and procedures observed are described in Part IV.A of Procedure 3, BNWL-MA-6.

Close surveillance is maintained over any broken-skin injuries in potentially contaminated areas, since Battelle-Northwest experience has shown this to be a very significant mode of entry leading to internal exposure. Procedures for dealing with such injuries are found in Part IV.B of Procedure 3, BNWL-MA-6.

Concentrations of radioactive materials in drinking water are maintained below the levels permitted in the drinking water of persons not occupationally exposed to radiation and do not represent a significant mode of personnel exposure.

Measurement of Radiation Exposure

The measurement of external radiation exposure received by employees and visitors having access to plant manufacturing and laboratory areas is achieved primarily through the use of individually-assigned thermoluminescent dosimeters (TLD). All persons including many visitors, are required to wear a dosimeter continuously while they are within any laboratory or manufacturing area, including all Pacific Northwest Laboratory facilities. In tour groups, 10%

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of the individuals are assigned dosimeters. Dosimeters are processed automatically and the results are calculated electronically, making the results promptly available to management on Data Processing Reports. The TL dosimeter measurement is supplemented, as required, by measurements made with TL finger ring dosimeters and by measurements made with monitoring instruments in cases where dosimeters cannot provide the necessary information. Procedure 2 of BNWL-MA-6 outlines this program.

Routine bioassay and in vivo examinations are used to assess radiation exposure from internally-deposited radionuclides. The frequency and type of measurement is established on the basis of the exposure potential of the individuals' work assignement and the radionuclide(s) of concern and is dependent upon the physical and biological properties of the materials with which he works. Procedure 3 of BNWL-MA-6 deals with this aspect of exposure measurement.

Evaluation of the internal deposition and resultant dose commitment for significant depositions possibly associated with unusual occurrences may involve extended bioassay and in vivo examination plus analyses for important parameters such as particle size, solubility, air concentrations, and isotopic compositions. Therapeutic treatments which may be advisable are administered by the Occupational Medicine Section of the Hanford Environmental Health Foundation.

Visitor Controls

Special controls are imposed upon visitors to assure that their exposures are maintained within the applicable limits. Three types of visitors are recognized in Battelle Northwest Laboratory facilities:

- Employees of DOE-RL or other Hanford contractors, to whom occupational exposure controls are applied.
- Adult transient business visitors for whom occupational exposure histories are not maintained, and for whom special exposure controls are established.
- Tour visitors, including children, upon whom very tight restrictions are imposed. Such visitors are permitted access to Radiation Zones only on rare occasions and under carefully controlled conditions.

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Procedure 4 of BNWL-MA-6 describes the visitor exposure control program in more detail.

Control of Access to Radiation Sources

The access of the public to much of the Pacific Northwest Laboratory is controlled through access restrictions imposed by the Department of Energy, since most BNW facilities are located within the Hanford site area. Enforcement of these access restrictions is provided by another Hanford contractor. Access to Battelle-Northwest private facilities in North Richland is controlled and enforced by Battelle-Northwest.

Added control is provided by identifying as Radiation Zones all places where significant radiation exposure can be received and establishing a Radiation Work Procedure (RWP) for the zone. The purpose of these zones is to limit casual exposure to less than one-tenth of the occupational radiation exposure limits. The use of the radiation zone and its relation to the RWP is described in Part 1 under Caution Signs and Labels.

The Radiation Monitoring group participates in the preparation of Radiation Work Procedures, but it is clearly understood that the responsbility for achieving a high degree of radiation safety rests with line management, as outline in Procedure 5, BNWL-MA-6. A copy of the Radiation Work Procedure Form (54-3000-496) is included as Exhibit VII.

Radiation Protection Instruments

Portable radiation monitoring and surveying instruments are provided to all Hanford contractors, including Battelle-Northwest, from a central Hanford instrument pool operated for DOE-RL by Battelle-Northwest. Instruments in general use throughout Battelle-Northwest and other contractor facilities include the CP and Juno for beta and gamma dose-rate monitoring, the Snoopy (rem meter) for neutron dose rate monitoring, both thin-window and standard GM instruments for beta-gamma contamination surveying, and scintillation and proportional type instruments for alpha contamination surveying. In addition, special portable moinitoring instruments are available to cover non-routine situations.

EXHIBIT VII

CONTRACTOR

RADIATION PROTECTION RECORDS

RADIATION WORK PROCEDURE

NUMBER	SUPERSEDES NO.	VALID FROM TO	REQUESTED BY

LOCATION

DESCRIPTION OF JOB

RADIATION CONDITIONS

SURFACE CONTAMINATION	AIRBORNE CONTAMINATION	PERSONNEL DOSE RATES
TYPE:	TYPE:	TYPE: ☐ γ ☐ β ☐ n
POTENTIAL: ☐ LOW ☐ MEDIUM ☐ HIGH	POTENTIAL: ☐ LOW ☐ MEDIUM ☐ HIGH	ESTIMATED MAX.:
OTHER:		

PROTECTIVE EQUIPMENT REQUIREMENTS

PERSONNEL DOSIMETERS	BODY	FEET	HANDS	HEAD	RESPIRATORY
☒ FILM BADGE	☐ NO PERSONAL OUTER CLOTHING	☐ SHOE COVERS	☐ CANVAS GLOVES	☐ CAP	☐ HALF MASK
☐ NEUTRON BADGE	☐ ONE PAIR COVERALLS	☐ CANVAS BOOTS	☐ SURGEONS GLOVES	☐ HOOD	☐ ASSAULT MASK
☐ GAMMA PENCILS	☐ TWO PAIR COVERALLS	☐ RUBBERS	☐ WATERPROOF GLOVES	☐ WATERPROOF HOOD	☐ CHEMOX
☐ SELF READING PENCILS	☐ WATERPROOF OUTER LAYER	☐ BRITISH LEGGINGS	☐ WATERPROOF GAUNTLET	☐	☐ FRESH AIR
☐ FINGER RINGS	☐ LAB COAT	☐ HIP BOOTS	☐ LEATHER GLOVES	☐	☐ RESPIRATOR

RADIATION MONITORING REQUIREMENTS

☐ INTERMITTENT BY RM — CONTACT RM FOR MONITORING WHEN:

☐ CONTINUOUS MONITORING BY RM — CONTINUOUS MONITORING REQUIRED UNTIL:

☐ RELEASE SURVEY ON AREA OR EQUIPMENT REQUIRED

☐ OTHER:

SPECIAL INSTRUCTIONS

☐ HAND COUNT WHEN LEAVING ZONE

☐ PERSONAL SURVEY WHEN LEAVING ZONE

☐ OBSERVE DUAL STEPOFF PAD PROCEDURE

☐ OBSERVE GENERAL FACILITY RADIATION WORK PROCEDURE

☐ PROTECTIVE CLOTHING TO BE SURVEYED PERIODICALLY

☐ SPECIAL PROTECTION FOR CUTS, ABRASIONS, IRRITATIONS OR INFECTIONS

☐ MASKS TO BE WORN AS REQUIRED BY RM

☐ IN CASE OF INJURY, FLUSH WOUND WITH CLEAN RUNNING WATER, NOTIFY RM IMMEDIATELY

APPROVALS

OPERATIONS	
RADIATION MONITORING	

54-3000-495 (2-66) AEC RL RICHLAND, WASH.

These instruments are distributed from a central facility where they are calibrated and serviced at intervals of from 1 to 4 weeks, depending on the type of instrument and the usage. All instrument maintenance is also performed at a central repair facility. Table 2.5-I more completely describes the portable radiation monitoring equipment routinely used in Battelle Northwest facilities.

Instruments and instrument systems used in routine control activities such as remote area monitors, hand and shoe counters, air samplers, continuous stack and room air monitors, laboratory sample counters, and semiportable contamination survey instruments are assigned to either building management or the resident Radiation Monitoring group.

Remote area gamma monitoring equipment is installed in locations where there is a potential for employees to be exposed to very high dose rates. The radiation detectors are adjusted to sound appropriate alarms if radiation levels become excessive. The alarms are set to trip at various levels, but in all cases the level is adjusted to assure adequate warning under circumstances in which radiation would present an immediate hazard to personnel in the vicinity.

Contamination control and detection is maintained at the primary exit from radiation zones. All personnel are required to perform or obtain personal detection type surveys at the primary exit from radiation zones. Both portable and semi-portable detection instruments are used at the exits and intermittently within the work area as a contamination control technique. Personnel monitors are provided also for contamination checks at frequently used building exits. All persons who enter Radiation Zones are instructed to use these prior to entering the lunchroom area or leaving the building. Three general types of counters currently used in Pacific Northwest Laboratory facilities are the beta-gamma hand and shoe counter, the combination alpha and beta-gamma hand and shoe counter and a table top multi-probe monitor.

A listing of semi-portable and stationary instrumentation used in Battelle Northwest Laboratory facilities is found in Table 2.5-II.

Sampling of air in the working environment is carried out by Radiation Monitoring personnel using continuous monitoring equipment, continuous sampling equipment, and spot samplers. Air samples are collected at all locations where

Table 2.5-I

Portable Radiation Detection and Measurement Instruments

Type of Instrument	No. In Central Pool	Radiation Detected	Sensitivity Range	Window or Wall Thickness
C. P. Eberline R03B	443	β, γ	0-5 R/hr	β window - 7 mg/cm^2 shield & wall - 440 mg/cm^2
X.C.P - HAPO HWS - Modified	22	β, γ	0-5 R/hr	β window - 7 mg/cm^2 shield & wall - 440 mg/cm^2
Juno - HAPO HW-4899	82	α, β, γ	0-5 R/hr 3 x 10^6 d/m	α window - 0.7 mg/cm^2 β window - 7 mg/cm^2 shield - 700 mg/cm^2
YFJ-HAPO HW-4899 Modified	9	α, β, γ	0-5 R/hr 3 x 10^6 d/m	α window - 0.7 mg/cm^2 β window - 7 mg/cm^2 shield - 700 mg/cm^2
HPC-HAPO G-590851	60	γ	0-100 R/min	860 mg/cm^2
HPC-HAPO G-590851 Modified	2	γ	0-10,000 R/min	860 mg/cm^2
TPC-HAPO HWS-5875	58	β, γ	0-500 R/hr	70 mg/cm^2
LPC-HAPO HWS-5875 Modified	28	β, γ	0-50 R/hr	70 mg/cm^2
Remeter (snoopy) Anderson-Broun	2	Neutron	0-25 rem/hr	
Remeter (snoopy) Anderson-Broun	32	Neutron	0-2.5 rem/hr	
EGM Meter Eberline	573	α, β, γ	0-10^5 c/m	Cylindrical Tube - 30 mg/cm^2 Pancake Tube - 1-3 mg/cm^2
PAM α Meter Radeco	25	α	0-10^6 d/m	0.8-1.4 mg/cm^2
PAM α Meter Eberline	268	α	0-10^5 d/m	0.8-1.4 mg/cm^2

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Table 2.5-II

Semi-Portable and Stationary Instrumentation

Type of Instrument	Function	Nos. Available
Hand and Shoe Counter	β,γ Detection	1
Hand and Shoe Counter	α,β,γ Detection	14
Scintran Meter	α or β,γ Detection	104
Ludlum Meter	α or β,γ Detection	29
Bench Poppy	α Detection	9
Floor Monitor (Eberline)	α Detection	1
Floor Monitor (Eberline)	β,γ Detection	1
Moto-aire Sampler	Air Sample Collection	10
Staplex Sampler	Air Sample Collection	5
Triton Air Monitor	Tritium Air Monitor	2
Radeco Air Monitor	Alpha Air Monitor with continuous readout, alarm, and single channel analyzer	18
β/γ Air Monitor	Continuous Cross Count, Readout and Alarm	2
α,β,γ Air Monitor	Continuous Gross Count, Readout and Alarm	2
Air Sample Counter	Coincidence air sample counting for α, β/γ and compensation for natural airborne activity	5

concentrations of airborne contaminants may reasonably be expected to reach or exceed 10% of the maximum permissible concentration in air. In most facilities the samples are collected through a central building vacuum system, with the sampling heads placed in appropriate locations. Special samples taken with portable or semi-portable sampling equipment augment the program when necessary. Sample filters are collected daily or weekly and counted for gross α and gross β in an automatic surface barrier diode detector. Air sample results are recorded and entered into data processing equipment for cumulative monthly, quarterly, and annual review information. Radiation Monitoring maintains a permanent historical file for air sampling records.

In some rooms or laboratories of Battelle-Northwest facilities there is a small, but nevertheless, real potential for a rapid release of high level airborne contaminants. In such locations a constant air monitor is employed. The constant air monitor consists of the following parts: a vacuum source, a sampling head, a detector, a recording chart or indicating meter, and an audible and/or visual alarm. The device may be used to measure either alpha or beta-gamma activity, and may employ a single channel analyzer or the coincidence technique for alpha counting.

Calibration of Radiation Protection Instruments

All radiation protection instruments, radiation check sources, and personnel dosimeters used at Hanford are calibrated by Battelle-Northwest in a well-equipped calibration and standardization laboratory. Victoreen R-meters and Radocons, calibrated by the National Bureau of Standards, and a free air ionization chamber are used as standards for all photon calibrations. Beta calibrations are generally performed using natural uranium in equilibrium with its daughters as a standard, but other sources may be used as required. Beta doses are standardized with an extrapolation chamber. PuF_4 and PuBe neutron sources, standardized against a precision long counter by the National Bureau of Standards, are available for neutron calibrations.

Portable radiation monitoring instruments are calibrated on a frequency determined by their type and use. Beta-gamma dose rate monitoring instruments are usually calibrated after 14 days of field use. The calibration provides a three-point response check and an off-scale check on each range. Radiation detection instrumentation is calibrated by checking a single point on each range plus an off-scale check. The calibration frequency of detection equipment and neutron dose rate meters is approximately once per month. At each calibration step, the instruments are thoroughly examined and maintenance or battery exchanges are provided as necessary.

Air sample equipment is calibrated with plutonium sources for alpha emitters and with RaDEF for beta emitters or other α or β sources as appropriate for the radionuclide of interest. These sources are in turn calibrated by comparing them with sources from the National Bureau of Standards.

TLD dosimeter services are currently provided by the U.S. Testing Company; however, the calibrations are provided by the Battelle-Northwest Calibrations facility. Personnel dosimeters, including pencils, may be calibrated with K-fluorescent radiation, heavily filtered x-ray spectra, gamma radiations from a one-half gram radium source, ^{60}Co gamma radiations, uranium and ^{90}Sr-Y beta radiations, and with an unmoderated PuF_4 spectrum or ^{252}Cf Spectrum.

Radiation Monitoring Survey Program

Although the administrative responsibility for radiation control is assigned to facility management, the Radiation Monitoring surveillance program provides continuity and technical back-up necessary to make radiation control effective. This monitoring provides information through air sampling and contamination and radiation level surveys.

A routine survey is one which is repeated on a definite, established schedule in order to determine contamination or radiation levels in buildings, rooms, laboratories, or other areas. The frequency for each type of routine survey in each location is determined by a combination of professional judgment and experience, and is periodically reviewed by Radiation Monitoring personnel.

A nonroutine or "special" survey is one which is carried out when requested by facility or operating personnel. This type of survey can range from determining personnel dose rates and providing contamination control during a job involving highly radioactive material, to a contamination check of equipment for release from a Radiation Zone. All survey information is recorded on Radiation Survey Report Form. A copy is presented as Exhibit VIII.

EXHIBIT VIII

Battelle
Pacific Northwest Laboratories

RADIATION PROTECTION RECORDS

RADIATION SURVEY REPORT

BLDG.	LOCATION	TIME ________ TO ________	DATE	SURVEY LOG NO.
DESCRIPTION OF JOB				

NO.	ITEM OR LOCATION MEASUREMENT	METER DEFL. WO	METER DEFL. WC	SOURCE SIZE	DIST.	BETA mrads/hr.	GAMMA mR/hr.	NEUTRON mrem/hr.	DIRECT c/m or d/m	SMEARS c/m or d/m

INSTRUMENT TYPE

☐ EGM ☐ TGM ☐ POPPY ☐ CP ☐ BFQ
☐ HGM ☐ MW-GM ☐ JUNO ☐ TPC ☐ SCINTRAN

RESPIRATORY PROTECTION REQUIRED

☐ SUPPLIED AIR ☐ FILTER ☐ NONE

PERSONNEL DOSE RATES

PHASE OF WORK	NO.	WHOLE BODY PEN. mrem/hr	WHOLE BODY SKIN mrem/hr.	EXTREMITIES mrem/hr

COMMENTS

ACTION TAKEN

POOR ORIGINAL

MAX. UNCORRECTED MEASUREMENT	MAX. CORRECTED DOSE RATE	SIGNATURE

54-1200-039 (7-71) AEC-RL RICHLAND, WASH.

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GPO 1976 696-619

EXHIBIT VIII (CONT.)

DESCRIPTION OF NEUTRON MEASUREMENTS

MEASUREMENT NUMBER	METER DEFLECTIONS			DOSE RATE mrem/hr.
	BARE TUBE	FLUXMETER	DOSIMETER	

RECOMMENDED FOLLOWUP

SKETCH

COPY SENT TO:

Radiation Occurrences, Investigations and Reports

Each unusual radiation occurrence is investigated, using established critieria. Both the formality and extent of the investigation is dependent upon the nature of the occurrence. All cases in which personnel exposure in excess of permissible limits is known or suspected are formally investigated and documented in accordance with DOE-RL requirements. One copy of the formal report is placed in the exposure history file of each individual involved, and one is placed in a master file maintained by the Occupational and Environmental Safety Department.

Facility management may elect to conduct a formal investigation of radiation occurrences which do not involve exposures in excess of permissible limits. In such cases, the committee report is normally documented and distributed to all management personnel having an interest in the occurrence, the findings of the investigation, and the recommended corrective action.

Radiation occurrences of lesser significance are normally investigated informally by Radiation Monitoring personnel assigned to the facility. Reports are written covering the findings of the investigation and the recommendations for corrective action, and copies are distributed to facility management and other affected personnel. A copy of the Radiation Occurrence Report Form (54-3000-497) used for this type of investigation is included as Exhibit V.

Investigations of both of the latter types are made to alert personnel to the problems and to reveal areas in the radiation control program which need improvement. Procedure 8 of BNWL-MA-6 treats the subject of Radiation Occurrences and Incidents.

Training

Since the success of the radiation protection program depends heavily upon individual employee performance, considerable time and effort is devoted to assuring that employees have an adequate understanding of radiation and radiation protection as it applies to their work.

Supervisors have the primary responsibility for assuring that their employees receive adequate training in radiation protection. The amount and type of training is dependent upon the kind of work they perform, and the facility or facilities in which they work. For employees who will work with radioactive materials, this begins with a detailed discussion of the radiation aspects of the assigned job. They receive further training in radiation protection practices in the course of their work from their supervisors, senior co-workers, and radiation protection personnel. Supervisors must also assure that all workers receive a radiation protection orientation given by radiation protection professionals in the Occupational and Environmental Safety Department (O&ES). A program of periodic retraining is also administered by the O&ES Department.

Training programs are presented for professional, scientific, and engineering personnel, including those engaged in radiation protection activities. Programs of this kind are offered as needed based upon personnel turnover, new developments in the field of atomic energy and changes in the business of Battelle-Northwest.

There is a policy and practice of complete and prompt communications with all Battelle-Northwest staff members regarding the radiation aspects of their work and their own individual exposure status. All information on the Battelle-Northwest radiation protection program is available in full to any staff member. A year-end report is issued to each Battelle-Northwest employee informing him of his radiation exposure for the entire year. Information and training bulletins on radiation protection matters are issued periodically to staff members. These are supplemented by articles in the plant newspaper covering radiation protection items of general interest.

2.6 CRITICALITY SAFETY PROCEDURES

In all work performed in Battelle-Northwest controlled facilities, the policy is to incorporate safety features and controls into process operations to minimize the possibility of a criticality accident. Sufficient controls are exercised to assure that before a nuclear accident is possible, at least two unlikely, independent and concurrent changes must occur in one or more of the conditions specified as essential to nuclear safety. The manual "Criticality Safety Procedures", BNWL-MA-25, describes procedures to implement this Two-Contingency Policy. These procedures require work involving more than 3% of the minimum critical mass to be either "isolated," or controlled under limits given in a "Criticality Safety Specification" depending upon the amount of fissionable material to be handled.

Facility Classifications

A Battelle-Northwest controlled facility is classified as either an exempt, isolated or nuclear facility. An exempt facility is one that contains less than 3% of a minimum critical mass. An isolated facility may contain up to 45% of a minimum critical mass while a nuclear facility may contain more than 45% of a minimun critical mass. A discussion describing the establishment of isolated and nuclear facilities is presented in section 1.3 of this license application.

The Safety Analysis Report

Before a building can be designated as a Nuclear Facility in which greater than 45% of a minimum critical mass of fissionable material may be handled, a Safety Analysis Report (SAR) is required. A Safety Analysis Report is the result of a thorough study and analysis which is performed to assure that potential major nuclear hazards have been identified and that sufficient safety features and controls have been incorporated to reduce the probability of major accidnets and to minimize the consequences in the unlikely event of their occurrence. The safety analysis considers foreseeable nuclear accidents which would pose a substantial threat to the safety of personnel or the public, the loss of use or damage to property, and the continuity of operation of facilities.

Each Safety Analysis Report, and each revision, requires the approval of the responsible Department Manager and the Safety Review Council. Additionally, review by the Richland Operations Office of DOE is required if fissionable materials are produced, processed, stored, transferred or handled in quantities and conditions with the potential for accidental criticality.

Content and Format

In order to assure that the SAR is complete and written in such a way that frequent updating will not be required, the following suggested SAR outline is provided to the facility operating component:

SAR Title: Safety Analysis Report for the ________ (Building, Facility).

A. Introduction And Summary

B. Nuclear Safety Limits

General limits on the facility or operation which provide conservative bounds on parameters within which all operations must be conducted. The Nuclear Safety Limits should be presented as an itemized list of statements.

C. Description

1. Site Description

A reference to 300 Area Site Description, BNWL-CC-1693, is sufficient for facilities in the 300 Area.

2. Facility Description

Project(s), purpose(s), and process description(s). (Simplified drawing of facility, very brief summaries.)

D. Organization and Administrative Controls

1. Organization and Assignment of Nuclear Safety Responsbilities

Very brief.

2. Administrative Controls

This section should be brief. The following areas should be discussed briefly. Additional administrative controls which are pertinent to a given facility may also be mentioned.

a. Formalized Nuclear Safety Procedures as set forth in BNW Management Guides, and BNWL-MA-25.

b. Mandatory Nuclear Safety Specifications plus required review and approvals.

c. Periodic audits for criticality safety by operating personnel and by Nuclear Safety personnel.

d. Training program for operating personnel.

e. Labeling and posting program.

E. Safety Analysis

1. Criticality Controls and Contingencies

a. Fissionable Material Description

Physical form, chemical form, isotope and enrichment, density, dimensions, and quantity, as pertinent to criticality control. This section should be very brief.

b. Criticality Potential

The presence of large quantities of fissionable material in the facility allows the possibility that a critical mass could be inadvertently assembled. (This statement or a similar brief statement will suffice.)

c. Criticality Controls and Limits

Types of control are by mass, geometry, moderation, interaction, density, reflection, or poison. Limits are quantitative restrictions on the controls; such as a mass limit. Engineered and administrative safety features are established to assure that the two-contingency policy is met. Process and equipment descriptions may be necessary in this section. The section may discuss the entire facility in general or separately discuss each portion of the facility.

1) Controls, Technical Basis for Limits, and Limits

State which of the controls are used. Briefly give the technical basis or assumptions and the most important controls and limits in general terms, as pertinent.

2) Engineered Safety Features

Engineered safety features are physical restraints which are placed between normal processes and accidental criticality. Use of the engineered safety features ensures that one or more controls, such as geometry, are adequate. Engineered safety features are preferred to administrative controls. Only those engineered features which are of considerable importance to criticality safety in a given facility need be mentioned.

d. Contingencies

Description of contingencies; credibility, taking into consideration the safeguards; and consequence. The occurrence of two contingencies concurrently should be included in the evaluation. The contingencies shall be of such a nature that they are independent, and must occur concurrently before a criticality accident is possible. Process and equipment descriptions may be necessary in this section. The section may discuss the entire facility in general, or separately discuss each portion of the facility. Interactions with other facilities in the same building should be considered. Sections c and d may be combined and discussed together.

2. Other Potential Nuclear Accidents

a. Inventory

Types of radioactive materials handled, and maximum quantity of inventory anticipated for each radioisotope. This section should be very brief. The information may be presented in a table.

b. Potential Nuclear Accidents and Principal Control Mechanisms

Credible nuclear accidents may be grouped into the three categories given below. Some of the items may not apply to a specific facility.

1) Fire and/or explosion (e.g., process or building fire, shielding window failure followed by burning or window oil hydrogen explosion, pressure system failure, etc. which could release radioactive materials to the environs).

2) Chemical reactions that could result in volatilization of radioactive materials and/or which yield significant quantities of heat and reaction gases. (e.g., metal-water reaction, "red-oil" reaction.)

3) Containment breach resulting from a moving mass (e.g., crane or heavy equipment overturn, lifted equipment dropped, mishap with a vehicle).

F. Consequences of Accidents

The radiological consequences both on-site and off-site should be stated quantitatively. If the consequences of a postulated accident are less than the reference limits given in Section I, the consequences need not be discussed in detail. If the occurrence of a certain accident is not considered credible, the consequences need not be analyzed. Assistance in calculating the consequences of accidents may be obtained from Nuclear Safety.

Revision of Safety Analysis Reports

The SAR for a facility must be revised, or a supplement to the SAR issued, if:

- A Nuclear Safety Limit is to be changed.
- A facility or process modification could increase the probability of occurrence of the maximum accident.
- A facility or process modification could increase the severity of the maximum accident.
- A facility of process modification introduces the probability of a new kind of accident not previously analyzed in the SAR.

There is no specific format for an SAR revision. Requirements for the revision are similar to those for an SAR. It should include the following information:

- Descriptions of the modified facility, equipment, and operations.
- Descriptions of engineered and procedural controls (including discussions of organization and responsibilities).
- A discussion of the nuclear hazards and evaluation of the likelihood and consequences of credible accidents.
- A listing of changed nuclear safety limits for the modified facility of new work.

The revision can be incorporated in the SAR itself, in which case the SAR is reissued with a revision number, of published separately as a supplement to the SAR.

The Criticality Safety Specification

Criticality Safety Specifications (CSS) are written procedures which give limits that, when followed, will ensure criticality safety in facilities processing, storing, or otherwise handling significant quantities of fissionable material. A detached discussion of the CSS and its importance in the criticality safety program is presented in section 1.3 of this license application. The following information is provided to supplement section 1.3 by presenting current methods to maintain accurate Criticality Safety Specifications.

Content and Format

All Criticality Safety Specifications are issued on the standard forms shown in Exhibit IX. Each specification is numbered to identify the operation and building in which the work is being performed.

The Title, Scope of Application, and Operations Involved sections are filled in with the appropriate information. "Fissionable Material Covered by this Specification" includes material nomenclature, dimensions, form (e.g., powder, metal, oxide, fuel rods, fuel plates, etc.), and content (e.g., % ^{233}U, ^{235}U, Pu, and % ^{240}Pu, etc.) where applicable if it is necessary to limit the scope of the CSS.

There are two basic requirements for a CSS: (1) the stated limits are to be adequate to preserve criticality safety under the two contingency policy; and (2) the limits are to be specified in such a way as to avoid misinterpretation. The technical limits to meet the first of these two requirements are provided in the "basis letter" from Criticality Safety. The Criticality Safety Limits section contains the technical limits recommended in the basis letter. The "Controls" section contains the administrative practices that assure the "Criticality Safety Limits" are not exceeded.

Review

Each approved specification is reviewed by the operating group at least annually and if changes are required, a revised specification is drafted (in the same manner as for a new specification). If no changes are waranted, Safety and Nuclear Materials Management and Criticality Safety Sections are notified to this effect.

EXHIBIT IX

BATTELLE-NORTHWEST RICHLAND, WASHINGTON	CRITICALITY SAFETY SPECIFICATION	SPEC. NO. REV. NO.

OPERATING COMPONENT (UNIT, SECTION, OR DEPARTMENT)	CONTRACT(S) ☐ 1830	ISSUE DATE
WORK LOCATION (BUILDING)	☐ 1831	VOID DATE

TITLE

FISSIONABLE MATERIAL DESCRIPTION (PHYSICAL FORM, CHEMICAL FORM, ISOTOPE AND ENRICHMENT, DENSITY, DIMENSIONS, AND QUANTITY AS APPLICABLE.)

OPERATION(S) INVOLVED: ☐ PROCESSING ☐ STORING ☐ TRANSPORTING WITHIN A BUILDING ☐ TRANSPORTING BETWEEN BUILDINGS

BRIEF DESCRIPTION OF OPERATIONS AND EQUIPMENT INVOLVED

LIMITS AND CONTROLS

POOR ORIGINAL

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CRITICALITY SAFETY SPECIFICATION	SPEC. NO.
	REV. NO.

TITLE

LIMITS AND CONTROLS (CONT'D.)

EXHIBIT IX

CRITICALITY SAFETY SPECIFICATION

SPEC NO.

REV. NO.

UNDER THE LIMITS AND CONTROLS GIVEN IN THIS SPECIFICATION, THE FISSIONABLE MATERIAL DESCRIBED CAN BE HANDLED SAFELY WITH RESPECT TO CRITICALITY. NO CREDIBLE ACCIDENT, EQUIPMENT FAILURE, OR SINGLE LIMIT VIOLATION CAN RESULT IN CRITICALITY. TO ENSURE CONTINUED SAFETY, VIGILANCE MUST BE EXERCISED BY OPERATING PERSONNEL TO PREVENT ANY DEVIATION FROM THE LIMITS AND CONTROLS GIVEN OR THE FORM OF FISSIONABLE MATERIAL DESCRIBED.

CRITICALITY SAFETY ANALYSIS WITHIN THE TECHNICAL LIMITS SPECIFIED THE ANALYSIS SHOWS THAT CRITICALITY WILL NOT OCCUR.		Sr. Specialist CRITICALITY SAFETY
SAFETY AND NUCLEAR MATERIALS MANAGEMENT THIS SPECIFICATION IS CONSISTENT WITH THE POLICIES OF THE BATTELLE-NORTHWEST CRITICALITY SAFETY PROGRAM AND WITH GOOD SAFETY PRACTICE.	SENIOR ENGINEER, Nuclear Safety	MANAGER, Safe[illegible]
BUILDING MANAGER THIS SPECIFICATION IS ACCEPTED FOR IMPLEMENTATION IN THE BUILDING SPECIFIED.	BUILDING MANAGER	
OPERATIONS COMPONENT THE FISSIONABLE MATERIAL AND OPERATIONS DESCRIBED ARE CORRECT. THE LIMITS AND CONTROLS ARE UNDERSTOOD AND ACCEPTED FOR IMPLEMENTATION.	CRITICALITY SAFETY REPRESENTATIVE	MANAGER

POOR ORIGINAL

DISTRIBUTION:

54-1200-135 (10-73)

PAGE _____ OF _____ PAGES

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Specifications no longer needed for operations are removed from their posted locations and files.

Special Conditions and Temporary Deviations

When a CSS is not completely applicable to a given operation and is to be revisted, or when a new CSS is to be written, temporary limits may be issued to cover the operation via a Special Condition. Special Conditions contain a statement of purpose, a listing of the CSS's affected, a clear statement regarding its time in effect, detailed statements of limits changed and/or imposed, and a justification from the Criticality Safety standpoint of the changed limits. A Special Condition must be obtained prior to the undertaking of the operating that requires it. Special Conditions are prepared for the operating organization of our Safety and Nuclear Materials Management. Approvals for a Special Condition are the same as for a Criticality Safety Specification.

During unforseen conditions, when it is required to change or suspend a CSS limit and the limit may be changed or suspended without compromising criticality safety, a Temporary Deviation may be issued by oral concurrence among authorized representatives of the operating organization, Criticality Safety and Safety and Nuclear Materials Management and the building manager. It is followed by confirmation in writing. The Temporary Deviation contains a statement of purpose, a listing of the CSS's affected, a precise statement of its time in effect, detailed statements regarding the limits changed and/or imposed, a justification from the Criticality Safety standpoint for the changed limits, and a proposal of the action to be taken to avoid the necessity of continuing the Temporary Deviation. The oral occurrence with the Temporary Deviation constitutes approval by the four parties involved. The completed preparation of the written confirmation with the signatures of the oral concurers is required to follow oral concurrence by no more than two working days.

Temporary Deviations shall be approved by the:

1. The Manager, Safety or the Senior Engineer, Nuclear Safety.
2. Operating organization by the Criticality Safety Representative of the facility.
3. Criticality Safety Section by Senior Specialist.
4. Building Manager.

Appointment of authorized representatives are confirmed by letter with copies to Safety and Nuclear Materials Management, Criticality Safety and the management or the organization involved.

Calculational Methods

Safety limits used in establishing Criticality Safety Specifications are based on data from experimental measurements; or if direct experimental data are not available, on limits obtained from a calculation method that can be shown to be accurate or conservative when compared to experimental measurements. The codes currently in use for criticality parameter calculations include GAMTEC-II, EGGNIT, THERMOS, HFN, DTF-IV, KENO-IV and the AMPX modular code systems.

The GAMTEC-II, EGGNIT, and THERMOS codes generate multigroup constants for use in the HFN multigroup diffusion or the DTF transport theory code. The GAMTEC-II and EGGNIT codes have proven to be quite successful (although conservative) for heterogeneous uranium-water systems. Correlations with experimental measurements have been good. GAMTEC-II, EGGNIT, THERMOS, HFN, and DTF are considered adequately reliable for a wide range of uranium and plutonium systems. Safety margins used are nonetheless commensurate to availability of confirmation of experimental measurements.

The KENO-IV Monte Carlo code can be used to examine many simple or complex problems which, with some reservations, may consist of any combination of boxes, containers, cylinders, spheres, or rectangular parallelepipeds. AMPX is a modular system for producing coupled multigroup neutron-gamma cross section sets. Basic neutron and gamma cross-section data are obtained from ENDF/B libraries. Most commonly used operations required to generate and collapse multgroup cross-section sets are provided in AMPX. Various analytical checks and comparisons with critical experiments are used to ensure that the results of system analyses with the various computer codes are conservative.

Neutron Interaction Calculations

For neutron interaction calculations, four methods are used: Monte Carlo Solutions, Empirical Models, Solid Angle, and Density Analog Methods. The Monte Carlo code permits a nearly exact description of the geometries and fuels involved, so that a very close k_{eff} can be obtained for the overall system. Empirical models are being developed with adequate conservatism for solution of some types of problems, such as piping intersections. The Soild Angle method is used primarily for arrays of cylinders containing solution, for which the method has been shown to be reliable. The solid angle method is used on systems for which it has been shown to be conservative. The Density Analog method is used to calculate the critical number of moderated or unmoderated units in a planar or cubical array. The method is based on the established fact that if the density or an unreflected critical system is changed uniformly, all dimensions of the system must be scaled inversely as the density change in order for the system to remain critical.

For vessels or units in arrays in which neutron interaction contributes to reactivity, allowance factors to obtain safety margins depend on the method used to calculate the critical number of units in the array and on how well the method predicts criticality for arrays that have been measured experimentally. When the Density Analog method is used, the calculated critical number of units is reduced by a factor of a least two for those cases that are known to be conservative as compared to measurements; and by a factor of between 3 and 5 when comparisons to measurements are less certain. Further, for complex shapes and geometry where the Density Analog parameters are difficult to calculate, assumptions made are always conservative. For questionable arrays, actual experimental measurements may be required. When the safety of an array is based on the calculation of k_{eff} for the array, the allowance factor required to obtain an adequate margin of safety will also depend on comparisons to experimental measurements. For those arrays that can be accurately computed, the maximum allowable k_{eff} will be 0.95; and for arrays that compare less favorably with experimental measurements, k_{eff} for the array will be limited to a lower value depending on comparisons to measurements.

Special Reflectors and Moderators

For instances where fissional material processing or handling involves special reflectors or moderators such as D_2O, carbon, or beryllium, criticality safety is assessed on an individual basis. For systems containing D_2O, carbon, or beryllium, a special nuclear criticality safety evaluation is required if the quantities involved exceed the following:

- 3.0 liters D_2O
- 9.0 kg carbon
- 1.6 kg beryllium metal
- 2.6 kg BeO
- 3.0 kg heavy metal

Other Critieria Used to Establish Limits

Sumps are required to be safe by geometry or by using fixed poisons, assuming credible leakage and accidental spillage from vessels and piping linked to the sump.

In processes conducted behind massive shielding, soluble and fixed neutron poisons such as boron in solution, Pyrex Raschig rings, and steel plates containing neutron poisons such as boron or gadolinium may be used as primary means of criticality safety control. When after soluble neutron poison is used as a primary means of criticality control in a solution system, at least two independent administrative controls must be used against omission of the poison (e.g., combinations of attenation instruments, chemical analysis, double check of addition, etc.).

In processes not conducted behind massive shielding, fixed poisons may be used as a primary means of criticality control if the positive design measures and maintenance controls assure that the poison is always present, and that leaching of the poison away from the matrix does not occur.

Soluble poisons may not be used as primary criticality control in unshielded facilities.

Criticality safety limits are posted in all processing and storage areas.

Criticality Safety Audits

Criticality safety audits of BNW facilities are performed, as a field check of the actual work, to confirm that operations with fissionable material are being conducted in conformance with applicable Criticality Safety Specifications (CSS) or with the controls for an isolated facility. Routine periodic audits are performed by the operating group (internal audits) and independently by representatives of the nuclear safety groups.

Audits by Nuclear Safety

Audits by the nuclear safety group, Safety and Nuclear Materials Management, confirm that the handling of fissionable material is adequately covered by CSS; that the limits and controls of applicable CSS are being met; and that good safety practices are in effect.

The frequency of audits is set by the auditing staff on the basis of the nature of activities, the quantities of material, etc. The minimum audit frequency is annually for Isolated Facilities and semi-annually for Nuclear Facilities. Audits are more frequent during times of physical or procedural changes in operation. Audits may be unannounced and are randomly distributed in time.

Upon arrival at the facility being audited, the auditor makes his presence known to the criticality safety representative or, in his absence, the manager of the facility. Auditors have the authority to require that the facility operations management grant them access to all parts of the facility safe to enter and to all operations records. However, auditors have no authority in facility operation. If in an auditor's opinion an unsafe condition exists in facility operation, he calls it immediately to the attention of the ranking member of facility operation management present. If agreement on remedial action is not achieved, he immediately contacts higher management of the facility and his own management to resolve the difficulty. He may also call upon the services of Safety and Nuclear Materials Management or Criticality Safety for guidance.

Reports of the results of audits are made as follows: (1) Orally at the conclusion of an audit to the criticality safety representative or to the facility manager; and (2) in writing on the Criticality Safety Audit Report Form (Exhibit X) within three working days using the following distribution:

Director - Operation and Services
Department Manager - Operations
Section Manager - Operations
Criticality Safety Representative - Operations
Senior Specialist - Criticality Safety
Manager - Safety and Nuclear Materials Management

All items of non-conformance or deficiency are submitted to the Laboratory Director and to the Chairman, Safety Review Council, at monthly intervals.

A satisfactory report with no negative responses to the "Check List of Findings," is reported on the first page of the audit report form. If there are any negative responses or if special problems exist, the second page (or additional, if needed) of the audit report form is used. A reply from facility operating management is required within one week whenever a recommendation is made to correct or improve items of nonconformance or deficiency. The reply should indicate agreement or difference and, if the former, how and by when the intent of the recommendation will be executed. If a reply of agreement of difference is not received within two weeks or if the recommendation is not implemented by the time of the next audit, this fact is reported to the Department Manager of the operating organization and to the Director - Operations and Services

Each audit re c is numbered using the building number, organization code (if one group requires auditing in that building), and the chronological order of the audit since criticality safety audits were initiated for the facility. The auditor initials the typewritten report.

Copies of all the criticality safety audit reports are retained for two years by Safety and Nuclear Materials Management.

Internal Audits by the Operating Group

Each operating group is required to establish a program for periodic internal audits. These audits are conducted at least montly for Nuclear Facilities and more often during times of frequent fissionable material movements. A record of these internal audits is maintained by the facility manager. Deficiencies and items of non-conformance are reported to the operating manager and appropriate action taken correct the situation at the time of the audit.

Internal audits are made by the operating group to confirm that:

1. The facility is operated within the limits and controls of the applicable Criticality Safety Specifications (CSS).
2. The existing CSS for the facility are adequate for the operations conducted or planned.
3. All Nuclear Facility personnel handling fissionable material understand and use the applicable CSS for their operations.
4. All postings and labelings of fissionable material are adequate and applicable (including correct addition and subtraction on inventory forms Exhibit IX).
5. Housekeeping is adequate to avoid undetected accumulations of fissionable material in obscure places.

The standard Internal Audit Form (Exhibit XII) is normally used to record the internal audits. If another form is used, all items listed above are required to be individually inspected and recorded.

EXHIBIT X 2.6-16

Battelle
Pacific Northwest Laboratories

CRITICALITY SAFETY AUDIT REPORT

PURPOSE OF AUDIT	DISTRIBUTION OF REPORT
On ____________ an audit was made of ____________ building to assess conformance with applicable Criticality Safety Requirements & BNW Management Guides. The audit was performed by ______________________ of Nuclear Safety, and ______________________ of ____________ represented Facility Management.	

CHECK LIST OF OBSERVATIONS

	YES	NO
1. Was the handling of fissile material covered by a Criticality Safety Specification or an Isolated Facility Authorization?	☐	☐
2. Was the handling of fissile material in accordance with the limits and controls given in applicable Criticality Safety Specifications or Isolated Facility Authorization?	☐	☐
3. Were the work areas satisfactorily posted with appropriate limit signs, inventory forms, specifications, and special rules?	☐	☐
4. Was the fissile material appropriately labeled so as to be easily and correctly identified?	☐	☐
5. Was the housekeeping appropriate for fissile material to be easily identified and safely handled?	☐	☐
6. Did all persons interviewed exhibit sufficient knowledge and attitude towards their work regarding cirticality safety?	☐	☐
7. Was satisfactory progress made on recommendations from previous audits? (Respond only if corrective actions were noted on previous audits.)	☐	☐
8. Was the facility free from hazards other than those covered above?	☐	☐

GENERAL COMMENTS

Date of Report	Auditor	Page 1 of ____	Audit Record Number

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CRITICALITY SAFETY AUDIT REPORT

DETAILED OBSERVATIONS

RECOMMENDATIONS

THE FOLLOWING RECOMMENDATIONS ARE MADE TO CORRECT OR IMPROVE ITEMS OF NON-CONFORMANCE OR DEFICIENCY AS NOTED ON PAGE I OR UNDER DETAILED OBSERVATIONS ABOVE. A REPLY IS REQUIRED OF FACILITY OPERATING MANAGEMENT INDICATING AGREEMENT OR DIFFERENCE AND IF THE FORMER HOW AND WHEN THEY WILL CARRY OUT THE INTENT OF THE RECOMMENDATION. THIS REPLY SHOULD BE SENT TO NUCLEAR SAFETY WITHIN ONE WEEK OF THE DATE OF RECEIPT OF THE AUDIT REPORT.

POOR ORIGINAL

DATE OF REPORT	PAGE	AUDIT RECORD NUMBER
	2 OF	

OFFICIAL USE ONLY

Criticality Safety Appraisals

To maintain a high standard of criticality safety practices at Battelle-Northwest, representatives of Safety and Nuclear Materials Management and Criticality Safety perform annual appraisals of all buildings in which greater than one minimum critical mass of fissionable material may be handled or stored. Appraisals are performed in addition to the routine periodic audits. A Criticality Safety Appraisal is a general evaluation of an operation with respect to established nuclear safety criteria and with respect to the operating philosophy of the organization being appraised.

Criticality safety appraisals include: 1) a meeting with the criticality safety representative and/or facility manager and, 2) a physical inspection of the facility. The appraisal discussion includes the following topics as they apply to that facility:

1. Internal administrative practices (e.g., audits and inspections, training, records, etc.).
2. Completeness of Criticality Safety Specification Coverage.
3. Changes in the applicability of existing Criticality Safety Specification(s).
4. Criticality Safety Procedures Manual (BNWL-MA-25).
5. Safety Analysis Report(s).
6. Battelle Management Guide 12.3 and 12.8.

During the physical inspection, all fissionable material operations and storage areas within the facility are inspected for adequacy. The observations include, but are not necessarily limited to, the following:

1. Conformance with and applicability of Criticality Safety Specifications.
2. Moderator restrictions (including water or hydraulic lines to unmoderated glove boxes).
3. Fissionable material inventory.
4. Posting and labeling of fissionable material.
5. Posting of fire fighting categories.

Battelle
Pacific Northwest Laboratories
Richland, Washington 99352

CONTINUOUS FISSILE MATERIAL INVENTORY

LOCATION BEING INVENTORIED
ROOM NUMBER ____________
WORK STATION ____________

DATE OF MATERIAL TRANSFER	DESCRIPTION OF FISSILE MATERIAL TRANSFERRED	ENTERED (E) OR REMOVED (R)	FISSILE WEIGHT IN TRANSFER / FISSILE INVENTORY AFTER TRANSFER	TRANSFER BY	VERIFIED BY
	ENTER RESULT OF PHYSICAL INVENTORY FROM PREVIOUS FORM (WRITE "FIRST ENTRY" IF NO PREVIOUS FORM). →		GRAMS		

DATE OF PHYSICAL INVENTORY		RESULT OF PHYSICAL INVENTORY *	PHYSICAL INVENTORY BY	VERIFIED BY
	WHEN FORM IS COMPLETED, TAKE A PHYSICAL INVENTORY; RECORD THE RESULTS IN BLOCK ENTITLED RESULT OF PHYSICAL INVENTORY. ENTER THIS FIGURE ON SUCCEEDING CONTINUOUS FISSILE MATERIAL INVENTORY.			

* IF THE RESULTS OF THE PHYSICAL INVENTORY EXCEED CRITICALITY SAFETY LIMITS FOR THIS LOCATION, IMMEDIATELY CONTACT THE BUILDING CRITICALITY SAFETY REPRESENTATIVE.

54-1200-152 (3-71)

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CRITICALITY SAFETY - INTERNAL AUDIT

ORGANIZATION:

*BUILDING:

*Date												
Audited by												
1. Operation Within CSS or Isolated Facility Authorization												
2. CSS or IFA Adequate												
3. Personnel Understand CSS or IFA												
4. Signs Posted												
5. Labels Complete												
6. Inventory Sheets: Correct												
Signed												
7. Housekeeping Satisfactory												
8. CSS Posted												
9. General												

* Nuclear Facility - Complete Items 1-8

* Isolated Facility - Complete Items 1-7

** Nuclear Facility - Monthly, Minimum

** Isolated Fac'lity - Quarterly, Minimum

A written report of findings and recommendations is prepared by the appraisers and also shall summarize the facility performance (based on Nuclear Safety audit reports) during the past year. The report should be issued within two weeks following the appraisal to the responsible department manager, section manager, and criticality safety representative for that facility with copies to Criticality Safety and Safety and Nuclear Materials Management. A reply from the facility operating management should be required within two weeks whenever a recommendation is made to correct or improve items of non-conformance or deficiency. The reply indicates agreement or difference and, if the former, how and when the intent of the recommendation will be executed. If a reply of agreement or difference is not received within two weeks or if the recommendation is not implemented by the time of the next audit, this fact is reported to the responsible Department Manager and to the Director - Operations and Services.

Training

Criticality safety training is required to acquaint all personnel with the criticality alarm signal and emergency response, and to inform personnel handling or using fissionable material of the basic Battelle-Northwest criticality safety rules.

The staff of Safety & Nuclear Materials Management (S&NMM) is responsible for establishing the requirements for training programs in criticality safety. In addition, through independent review and audit, S&NMM assure that adequate and effective training programs are being conducted by each of the departments handling or using fissionable materials. The staff of S&NMM and the senior specialist, Criticality Safety, are available for guidance and consultation.

The management of each organization working with fissionable materials is responsible for training their personnel in Battelle-Northwest criticality safety practices. New personnel who will be required to handle or use fissionable materials must be trained in the applicable criticality safety procedures for that facility and demonstrate a satisfactory knowledge of the required subjects. The agenda of each training session and the names of those in attendance are recorded and maintained by the operation organization. A copy of the meeting agenda and personnel in attendance is forwarded to Safety and Nuclear Materials Management for information.

Criticality safety training is conducted according to the outline presented in Table 2.6-1.

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Training Program Outlines

The following training program outlines are provided for the guidance of the responsible instructor.

A. New employee orientation presented includes the topics listed below. Personnel from S&NMM determine the material to be presented.

 1. The nature of criticality:
    - Discussion of criticality
    - Consequences of a criticality
    - BNW measures to prevent criticality (two contingency policy)

 2. Criticality alarms:
    - Klaxon horn (AH-OO-GAH) (play tape recording and give phone number for replay)
    - Immediate evacuation
    - Staging (assembly) areas

B. Training of workers assigned to Non-Reactor Nuclear Facilities (secretaries, janitors, craftsmen, etc.,) who are not involved in work with fissionable material involves instruction in the importance of not moving or handling fissionable material and in the proper emergency procedures. The Criticality Safety Representatives for each facility are responsible for the annual training of these personnel in their respective f ities.

C. Criticality safety training for personnel working with fissionable material is presented periodically during the year by the operating organization. The follwoing serves as an example of topics which may be included in these criticality safety training sessions:

 1. Introduction to the criticality safety problem:
    - Criticality, what it is and what is the problem
    - What are the direct effects of an unintential criticality
    - Indirect effects to personnel, equipment, and programs.

 2. Specific BNW control program:
    - Physical and administrative controls
    - Designation of a Criticality Safety Representative for each facility

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TABLE 2.6-1

OUTLINE OF TRAINING REQUIREMENTS

Staff Members To Be Trained	Type of Training	Evaluation By Testing	Frequency Of Training	Person Responsible For Training
All new employees	Radiation Protection Orientation	None required	Upon employment	Manager, Radiation Monitoring
Personnel in Non-reactor Nuclear and Critical Facilities not handling fissionable materials	Emergency Procedures	None required	Annually	Operating Manager
Personnel who work with or supervise working with fissionable materials	Criticality Safety Training*	Required biennially	Quarterly	Operating Manager
	Emergency Procedures*	Required annually	Annually	Operating Manager
Criticality Safety Representative and Operating Manager	Biennial Criticality Safety Training*	Required biennially	Biennially	Operating Manager
	Criticality Safety Training*	Required biennially**	Quarterly	Operating Manager
	Emergency Procedures	Required annually**	Annually	Operating Manager

* Personnel may substitute attendance at a special makeup session covering the content of the training meeting not attended.

**The Operating Manager is responsible for evaluating and testing the personnel working in his facility. He is, therefore, exempt from the testing requirements for these items.

- Establishment of criticality safety specifications for each facility and limitations on amounts and types of fissionable and moderating materials
- Transfer, storage and posting requirements
- Audits, inspections and appraisals
- Facility alarm systems and emergency procedures.

3. The individual's role in criticality safety:
   - Responsibilities
   - Criticality safety guide rules
   - Response of the individual to a criticality alarm.

The attendance at each criticality Safety Training session is monitored by each nonreactor nuclear facility to assure that individuals working with fissionable materials attend at least three training sessions per year.

D. Training on the principles of criticality safety and the technical bases for control is presented by members of the Criticality Safety section at least annually. The following technical topics may be included in the discussions with the Criticality Safety Representatives, immediate supervisors of personnel working with fissionable material, and immediate managers of the organization responsible for the overall operation of a nonreactor nuclear facility.

   1. Factors that affect criticality control:
      - Form
      - Mass
      - Geometry
      - Moderation
      - Reflection
      - Density or Concentration
      - Absorbers
      - Interaction.

   2. Criticality safety procedures:
      - Fissionable materials
      - Criticality Safety Specifications
      - Safety Analysis Reports
      - Shipping Requirements
      - Fire fighting
      - Review of past criticality incidents.

2.7 SHIPMENT PROCEDURES

Operating components initiating radioactive shipments of licensed material from Battelle-Northwest to offsite locations are responsible for preparing them to conform with applicable regulations. All Department of Transportation (DOT) and Nuclear Regulatory Commission's (NRC) rules and regulations must be adherred to. Prior to shipment of the material, the Department Shipping Representative must be apprised of the shipment. He will advise the packager on how to proceed. When the packaging has been completed and inspected by the Department Shipping Representative, he will sign off on the Offsite Radioactive Shipment Record, Form [illegible]-1200-087, attached as Exhibit XIII. The form also must be signed by the Radiation Monitor doing the survey on the package and by an authorized person of the Safety and Nuclear Materials Management Section.

Onsite shipments of radioactive materials must comply with PNL-MA-81, Radioactive Materials Shipping Manual. All onsite shipments of radioactive materials must be inspected by a qualified Department Shipping Representative. If the package is approved for shipment, the Department Shipping Representative will fill out an Onsite Radioactive Shipment Record (Form BC-1200-072, Exhibit XIV) and sign off. A radiation survey must also be made of the package and must be released by the Monitor before shipment. If the package is within the prescribed dose and contamination limits listed in PNL-MA-81, the monitor will sign off on the Onsite Radioactive Shipment Record form. A copy of the form will accompany each shipment. For shipments that are repetitive and of a long-term nature, a Standard Radioactive Shipment Procedures (SRSP), form BB-1200-043, Exhibit XV, can be made out to cover the shipment. The use of the SRSP form must be approved by the appropriate supervision in Radiation Monitoring.

EXHIBIT XIII 2.7-2

Battelle
Pacific Northwest Laboratories
Richland, Washington 99352

OFFSITE RADIOACTIVE SHIPMENT RECORD

— NO INSPECTION PERMITTED —

	MATERIAL IS	SECURITY ESCORTS
☐ ERDA-RL	☐ CLASSIFIED	☐ REQUIRED
☐ LICENSEE	☐ UNCLASSIFIED	☐ NOT REQUIRED

ORIGINATOR

COMPLETE DESCRIPTION OF CONTENTS (INCLUDE QUANTITY CHEMICAL AND PHYSICAL FORM)

_______ GRAMS FISSILE (TOTAL) SNM: ☐ YES ☐ NO

DETAILED PACKAGING DESCRIPTION (INCLUDING MARKINGS) (DESCRIBE IN DETAIL OR ATTACH A CUT-A-WAY SKETCH)

PACKAGING CONFORMS TO APPROPRIATE PACKAGING PROCEDURE: ☐ NO ☐ YES

EXEMPT FROM D.O.T. PACKAGING AND LABELING REQUIREMENTS: ☐ NO ☐ YES

SHIP TO:

COMPANY:

ADDRESS:

CITY/STATE/ZIP:

ATTENTION:

ORIGINAL CONTAINER ACCEPTABILITY DOCUMENTED ☐

CONTAINER EXAMINED; NO EVIDENCE OF DETERIORATION OR DAMAGE ☐

SEALS REQUIRED ☐ NO ☐ YES

CONTAINER NO.	SEAL NO. TI	CONTAINER NO.	SEAL NO. TI

GROSS WEIGHT	NO. OF CONTAINERS	CONTAINER SPECIFICATION CERT. OF COMPLIANCE	MAX CURIES/CONT TOTAL CURIES

SHIP:	SHIP VIA:	EXEMPT QTY ONLY	FORM 741 ROUTING
☐ PREPAID ☐ COLLECT	☐ MOTOR-RAIL ☐ AIR CARGO ☐ EXCL. USE ☐ PASSENGER	☐ MAIL ☐ UPS	

AUTHORIZED SIGNATURE	DATE	ORGANIZATION	COMPLETE COST CODE (INC. END FUNCTION)

RADIATION MONITORING

SURFACE DOSE RATE	DOSE RATE AT 3 FEET FROM SURFACE OF PACKAGE	SMEARS OF OUTER CONTAINER	RADIATION SURVEY
☐ < 0.5 mrem/hr. or ____ mrem/hr.	☐ < 0.5 mrem/hr. or ____ mrem/hr.	☐ < 2200 or ____ d/m β-γ/100 sq.cm ☐ < 220 or ____ d/m α / 100 sq.cm	NO. ______ DATE ______

ADDITIONAL DATA AND INSTRUCTIONS (INC. READINGS ON INTERNAL PACKAGING)

SIGNATURE - RMU	DATE

CERTIFICATION

TRANSPORT GROUP	MATERIAL FORM	D.O.T. RADIOACTIVE LABELS APPLIED	LARGE QUANTITY	FISSILE MATERIAL CLASS
	☐ NORMAL ☐ SPECIAL	☐ WHITE I ☐ YELLOW II ☐ YELLOW III ☐ EMPTY ☐ NONE	☐ YES ☐ N/A	☐ I ☐ II ☐ III ☐ FISSILE EXEMPT ☐ NON FISSILE

AUTHORIZATION NO.	SHIPPING DOCUMENT NO.	TYPE PACKAGE	TRANSPORT INDEX	SECONDARY HAZARD
		☐ A ☐ B ☐ N/A	TOTAL	

AIR TRANSPORT CERTIFICATION → ☐ CARGO ONLY | PASSENGER ☐ 1. (F.A.R.) RESEARCH OR MEDICAL DIAGNOSIS ☐ 2. HUMAN MEDICAL RESEARCH

THIS IS TO CERTIFY THAT THE ABOVE NAMED MATERIALS ARE PROPERLY CLASSIFIED, DESCRIBED, PACKAGED, MARKED AND LABELED, AND ARE IN PROPER CONDITION FOR TRANSPORTATION, ACCORDING TO THE APPLICABLE FEDERAL REGULATIONS FOR THE TRANSPORTATION OF HAZARDOUS MATERIALS.

AUTHORIZED SIGNATURE ▶ DATE ▶

APPROVED FOR OFFSITE SHIPMENT

B. L. NO.	DATE SHIPPED	E. T. A.	ROUTING ☐ N/A

SURVEYED BY	DATE	APPROVED FOR SHIPMENT ARHCO	DATE

CHECKED OUT OF ▶	☐ IN ☐ OUT AREA	☐ IN ☐ OUT AREA	☐ IN ☐ OUT AREA	☐ IN ☐ OUT AREA	☐ IN ☐ OUT AREA	☐ IN ☐ OUT AREA
TIME/DATE ▶						
PATROLMAN NUMBER ▶						

BC-1200-087 (10-76)

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EXHIBIT XIV 2.7-3

Battelle
Pacific Northwest Laboratories

ONSITE RADIOACTIVE SHIPMENT RECORD

(NO INSPECTION PERMITTED)

	Yes	No
Material is Classified		
SNM Material		
Security Escort Required		

SHIPPER

	Name	Contractor and Component	Building and Area	Phone
To:				
From:				
Carrier			Vehicle No.:	

Complete Description of Radioactive Contents:

Major Radionuclide(s) ______

Estimated Amount (Total Curies) ______

Estimated Max. Curies/Container ______

Grams Fissile Matl. ______

Transport Group	Quantity Category	Form
☐ I	☐ Limited	☐ Solid
☐ II	☐ LSA	☐ Liquid
☐ III	☐ Type A	☐ Gas
☐ IV	☐ Type B	
☐ V	☐ Large	
☐ VI		
☐ VII		

Material and Package Description:

______

Material is: ☐ DOE ☐ Licensee

Container: ☐ Single Trip ☐ Reusable

Name of Container or Identification Number ______

Absorbent Material Required: ☐ Yes ☐ No

Container Examined. No Evidence of Deterioration or Damage ☐

Required Labels and/or Placards Affixed To Shipment ☐

Nuclear Materials Management Review: Not Required ☐ Reviewed By ______ Date ______

This package has been prepared for onsite shipment in accordance with company shipping regulations: ➤ ______ Date ______
Shipping Organization Representative

RADIATION MONITORING

RADIATION CONDITIONS (mR/hr)

Package		Vehicle	
At Contact		At Side	
At 3 Feet		At 6 Feet	
		In Cab	

CONTAMINATION CONDITIONS (d/m / 100 cm^2)

Package

Beta-Gamma Smears ______

Alpha Smears ______

List Other Pertinent Information ______

RM Escort Required ☐ Yes ☐ No Speed Limit Restricted To: ______ MPH

RM Supervisor Review: Not Required ☐ Reviewed By: ______ Date ______
RM Supervisor

Surveyed By: ______ ______
Radiation Monitor Date

CARRIER

INSTRUCTIONS:

1. Do not leave shipment unattended between pickup and drop off points.
2. In case of accident or spill notify RM immediately. Phone No.: ______
3. Receiver to notify receiving RM and sender upon delivery.
4. Shipments during hazardous road conditions and/or congested traffic should be avoided.
5. Tie down or restrain packages to prevent shifting or loss of package during transport.
6. Declare material and present shipment record at each patrol check point.
7. Obtain RM release survey of transport vehicle after delivery of radioactive materials.
8. ______

PATROL

Patrol Checkpoint	☐ In ☐ Out Area	☐ In ☐ Out Area	☐ In ☐ Out Area	☐ In ☐ In Area	☐ In ☐ Out Area	☐ In ☐ Out Area
Time/Date						
Patrolman Number						

DISTRIBUTION: White - (Record Copy) To RM at Origin
Canary - Accompany Shipment to Receiver
Pink - Shipping Organization Representative

BC-1200-072 (6-78)

POOR ORIGINAL

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EXHIBIT XV

BATTELLE-NORTHWEST RICHLAND, WASHINGTON	RADIATION PROTECTION RECORDS STANDARD RADIOACTIVE SHIPMENT PROCEDURE		
ISSUED BY	NO.	REV. NO.	VALID FROM ________ TO ________

FOR THE SHIPMENT OF

BETWEEN

☐ NO INSPECTION DUE TO RADIATION LEVEL.
☐ NORMAL INSPECTION PERMITTED.

RADIATION CONDITIONS

PROTECTIVE CLOTHING REQUIREMENTS

MONITORING REQUIREMENTS

PACKAGING REQUIREMENTS

INSTRUCTIONS

1. [X] THE SHIPMENT SHALL BE MARKED WITH THE RADIATION SYMBOL, AND STORED IN A RADIATION ZONE WHEN NOT ENROUTE.
2. [X] PREPARATION FOR SHIPMENT, LOADING AND UNLOADING SHALL BE ACCOMPLISHED UNDER RWP CONTROL.
3. [X] IN CASE OF ACCIDENT OR SPILL, NOTIFY RM IMMEDIATELY.
4. [X] PERSONNEL BETA-GAMMA BADGE DOSIMETER REQUIRED.
5. [ ] OTHER DOSIMETER REQUIRED, TYPE ________________.
6. [X] A COPY OF THIS PROCEDURE SHALL ACCOMPANY EACH SHIPMENT.
7. [ ] NOTIFY RM ON ARRIVAL AT DESTINATION.
8. [ ] VEHICLE SHALL BE SURVEYED FOR CONTAMINATION BY RM BEFORE RELEASE.
9. [ ] THE SHIPMENT SHALL NOT BE LEFT UNATTENDED ENROUTE.

APPROVALS

OPERATIONS	RADIATION MONITORING

406 158

2.8 WASTE DISPOSAL

Licensed work is performed in the same facilities using the same equipment as work under the Operating Contract. Thus, it is not possible to distinguish between the quantities of gaseous and liquid wastes deriving from license and contract work. In general only a small fraction of the radioactivity in these streams, results from work under the license. In all cases, waste handling and disposal must comply with the requirements contained in PNL-MA-8, Waste Management.

Gaseous Waste Streams

Gaseous waste streams are released to the atmosphere only after high efficiency filtration and, in some cases, chemical treatment. Current design criteria require two to three stages of High Efficiency Particulate Air (HEPA) filters for gaseous exhaust streams from facilities where high radiotoxicity materials such as plutonium are used, and one to two stages of HEPA filtration for facilities where only low radiotoxicity materials such as uranium are used. In all facilities where high efficiency filters are designated, the filters are required to be at least 99.97% efficient for 0.3 μm particles using a hot DOP test. The filter banks after installation are required to be at least 99.95% efficient for 0.8 μm particles using a cold DOP test. Except for some filters installed in gloveboxes and hoods, filter banks are tested after each filter change, periodically during routine use and at any time when they have been unduly stressed.

Liquid Waste Systems

Most of the DOE buildings in the 300 Area where Battelle-Northwest performs work under the license are connected to liquid radioactive waste systems which serve many buildings within the 300 Area. These systems are operated by the Westinghouse Hanford Company. In some cases it is not possible to identify the contributions to the system from a given building. or those arising from the activities of a given contractor.

The waste systems that are provided for the Hanford 300 Areas are as follows:

- The 300 Area Sanitary Sewer System

  No potentially contaminated liquid wastes are disposed to the 300 Area Sanitary Sewer System.

* The 300 Area Process Sewer System

Waste management procedures do not allow releases of liquid radioactive materials to the Process Sewer System. Releases to this system are limited to dilute aqueous wastes of miscible nonradioactive chemicals, drain overflows, aquaculature overflows and small amounts of dilute thermal discharges. The process sewer system discharges directly tothe process waste trenches for percolation into the ground.

* The 300 Area Retention Waste Sewer System

The Retention Water Sewer normally receives uncontaminated waste water but radioactive material may occasionally be present because of the waste water origin. All liquid wastes in this system are initially discharged to the 307 Retention Basins. Normally the basin contents are then discharged to the process waste trenches for percolation into the ground.

A continuous in-line beta/gamma liquid effluent monitor is maintained by the Westinghouse Hanford Company. This monitor analyzes the waste stream at the 307 Retention Basins. When a radionuclide concentration exceeds the applicable limit set by Westinghous Hanford Company, the monitor alarms and automatically stops the discharge of the basin's contents to the process waste trenches. The waste water is retained and diverted to the Radioactive Liquid Waste System.

As a backup for the in-line monitor, a continuous sampler also samples the influent lines to the retention basins. These samples are taken for alpha and beta/gamma analysis in the laboratory.

Deliberate releases of high radiotoxic materials such as plutonium into the retention waste sewer are not permitted. The manual PNL-MA-8 also specifies that other radioactive waste discharged to this system must have an activity concentration less than 2 nCi/ml and that the total release for any building must be less than 100 μCi/month.

Releases to the system in 1978 were:

* Total Releases — 7.5×10^{-1} Ci (based on β-γ Uranium).
  9.8×10^{-2} Ci ^{234}U

		4.3×10^{-3} Ci ^{233}U
		9.6×10^{-2} Ci ^{238}U
• Average Concentration	α	1.5×10^{-7} µCi/cc
	β-γ	4.0×10^{-7} µCi/cc
• Maximum Concentration	α	6.3×10^{-7} µCi/cc
	β-γ	4.0×10^{-7} µCi/cc
• Total Volume		5×10^{8} gallons

- The 300 Area Radioactive Liquid Waste System (RLW)

This system is intended to handle those waste water streams which have a high risk of potential contamination or are actually contaminated with radioactive materials from laboratory operations. These waste solutions are accumulated through a stainless steel grid and tank system, adjusted to a pH of 11 and shipped by one of four 20,000 gallon, stainless steel railroad tank cars to another Hanford contractor for concentration prior to disposal. The condensates are trenched and the concentrates are transferred to the underground waste storage tanks used in support of manufacturing operations.

Releases tothe RLW is permitted without prior approval if all applicable conditions are met:

- Fissile material releases are less than 1 mg per month.
- Concentrations of alpha particle emitters are less than 100 nCi/ml. Higher concentrations are allowed if the total release does not exceed 400 mCi per month.
- Tritium releases are less than 10 Curies per month.
- Miscible organic solvents do not exceed 5% of the concentration at the entry into the RLW system.
- Total volumes are less than 500 gallons per batch or 10,000 gallons per month.

Prior concurrence with Westinghous Hanford Company is needed before wastes exceeding the above conditions can be released to the RLW system.

The liquid wastes from the 231-Z Building located in the 200 West Area are disposed to similar facilities operated by the Rockwell International's Hanford Operations.

In those facilities where radioactive liquid waste systems are not provided (the Battelle owned facilities) radioactive liquid wastes are accumulated and transferred to the Westinghouse Hanford Company, or to the commercial waste disposal firm located on the Hanford Site if the waste generated during work with licensed material can be separated from liquid waste associated with DOE contract work.

Solid Waste

Disposal of solid radioactive waste generated in Battelle-Northwest facilities from work under the operating contract is made to burial sites established by and operated in accordance with criteria established by DOE-RL. Two general types of solid waste disposal facilities are utilized: burial trenches and caissons. The type of facility used for disposal of any given material is dependent primarily upon the nature and level of the contaminant. For example, wastes containing significant quantities of long-lived highly radiotoxic materials, including plutonium, are contained for burial so that they may be recovered contamination-free for processing after burial for 20 years.

The solid radioactive wastes generated by Battelle-Northwest from work done under license are kept separate to the extent possible for disposal to the Nuclear Engineering Company, Inc., in containers provided by them. These containers are transported by them to their disposal facilities located near the center of the Hanford Reservation.

Environmental Surveillance

An extensive environmental surveillance program is conducted by Battelle-Northwest to evaluate radiological conditions in the Hanford environs. This program is designed to detect radioactive materials released to the environs by all Hanford contractors, to provide data which are used to evaluate exposure to persons in the neighborhood, and to clarify the mechanisms of distribution and reconcentration which are related to these exposures.

2.9 EMERGENCY CAPABILITIES AND PLANS

Natural disasters and plant engendered emergencies which might result in er ironmental contamination or a criticality incident could conceivably affect the Hanford plant operation as a whole. Consequently, emergency plans and basic plans which cover the entire plant are provided to meet DOE-RL contractual requirements.

A radiological emergency staff, consisting of competent individuals in various disciplines, is established to handle any radiological emergency for the Hanford plant. The staff is on a special residential phone network which permits the rapid and simultaneous notification of each member at his home if a plant emergency should occur at a time other than normal working hours.

When a notification of plant emergency is received either at home or at work, the staff convenes at the Emergency Room Operations (ERO) center located in the Federal Building in Richland, WA. The staff will direct the activities of emergency monitoring teams and provide guidance or consultation to DOE-RL and Contractor management. The ERO contains communications equipment, radiological plotting facilities, emergency supplies, and a meeting room to provide for the needs of the emergency staff.

Each plant area has a set of plans to cope with emergencies affecting that area. Auxiliary or supporting plans for medical, fire protection, patrol, and radiation protection are included in these broad plans along with specific procedures.

Audible emergency alarm signals are standard for all Pacific Northwest Laboratory 300 Area facilities. The alarm for a critical radiation event is provided by a howler (ah-oo-gah) horn. The signal for this received from a neutron detecting device. The critical radiation event detectors and alarm locations for Pacific Northwest Laboratory facilities are chosen as necessary to meet the requirements of our Operating Contract and our Federal License.

Experience at Hanford shows that beta/gamma measurement devices such as continuous air monitors, building radiation monitors, hand and shoe counters, and the like provide additional alarms to personnel within or near facilities where critical radiation events might occur. A crash-alarm system is used within the 300 Area to notify certain key personnel of an emergency. This system is activated manually by the officer on duty at the 300 Area Patrol Headquarters. Notification for activation of the crash-alarm system is either by request from the Area Emergency Director or by signal from two or more critical radiation event detectors which read-out in the Patrol Headquarters.

A continuing training program on emergency plans and equipment is conducted for all employees. Classroom sessions are held for certain groups such as the radiological emergency staff and radiation protection personnel. Practice area and building evacuations are held at least annually. To familiarize personnel with the sound of all of the alarm signals, a special recording of all signals has been made which can be heard at any time by dialing a plant telephone number. The criticality alarm is not used for practice evacuations in order to foster a "this is the real thing - get out fast" reaction whenever it is heard.

The Hanford Nuclear Accident Dosimeter is a stationary device that provides neutron and gamma dose information following a criticality or high level radiation event. This dosimeter is required at any accessible location where personnel have occasion to enter and where a criticality or high level radiation event could conceivably occur. The dosimeter satisfies the requirements of DOE by providing a dosimetry system capable of determining (a) the neutron dose in rads, (b) the photon dose, in the presence of neutrons, from 10 to 10^4 rads, and (c) the neutron fluence in each of five intervals, which permits, calcualtion of the neutron dose equivalent in rems.

Emergency dosimetry equipment is maintained by PNL for counting and evaluation of the criticality dosimeters.

APPENDIX A

BIOGRAPHICAL SKETCHES

T. W. Ambrose, Director, Battelle Pacific Northwest Division, Battelle Memorial Institute

A Vice President of Battelle Memorial Institute, Dr. Tommy W. Ambrose is Director of Battelle's Pacific Northwest Division. He was named Director in September, 1975, and is responsible for the Institute's activities in the Pacific Northwest.

The Division is comprised of research and development laboratories at Richland, Washington, the Battelle Seattle Research Center and the Human Affairs Research Centers in Seattle, and the Marine Research Laboratory at Sequim Bay on the Olympic Peninsula.

Dr. Ambrose joined Battelle in 1969. He has held previous positions as Director of Research at the Richland Laboratories, and Executive Director of the Battelle Seattle Research Center. A native Northwesterner, Dr. Ambrose holds two degrees in chemical engineering from the University of Idaho, and was awarded his Ph. D by Oregon State University. His professional career includes extensive research management experience with Douglas United Nuclear and the General Electric Company.

Dr. Ambrose is a member of the Executive Committee of the Pacific Science Center Foundation, Seattle. He serves on the advisory committees for the colleges of engineering at the University of Washington and University of Idaho, and holds a University of Washington appointment as Affiliate Professor of Nuclear Engineering. He is on the board of directors for the Northwest College and University Association for Science, and is a member of the advisory council and the administrative board for the Joint Center for Graduate Study at Richland. He is a member of the State's Council on Postsecondary Education.

Dr. Ambrose is a member of Sigma Xi, Phi Lambda Epsilon. He is a member of the American Nuclear Society, American Institute of Chemical Engineers, and is a licensed engineer. He is listed in Who's Who in America, American Men of Science, Who's Who in the West, Who's Who in Industry and Commerce and Who's Who in American Education.

B. V. Andersen, Staff Scientist, Radiation Standards and Engineering Section, Occupational and Environmental Safety Department

Mr. Andersen received B.S. Degrees in Industrial Chemistry and Business Administration from Kansas State University in 1948 and 1949 respectively. He also received the M.S. Degree in Physical Chemistry from the same University in 1951. He has been employed at the Hanford plant since 1951, with an initial assignment in a Radiochemistry methods and development group for three years with General Electric Company. His work experience includes five years as Manager of Environmental Monitoring, five years in radioactive aerosol research and seven years in external and internal dosimetry. In 1965, Mr. Andersen transferred to Battelle-Northwest as a Senior Engineer engaged in aerosol research. From 1968 until April 1972, he has been engaged in development and application of whole body and organ measurement techniques. Mr. Andersen was assigned to development of emergency instrumentation criteria for commercial reactors, fuel fabrication and reprocessing plants from 1972 to 1976. He is currently assigned to review radiological engineering of new facilities or programs and modification of existing buildings.

During his professional employment he authored and co-authored many papers, six of which have been presented at international meetings held in Europe. He is a Certified Health Physicist and a member of the American Public Health Association, American Industrial Hygiene Association and Health Physics Society.

G. E. Backman, Staff Engineer, Environmental Evaluations Section, Occupational and Environmental Safety Department

Mr. Backman received a B.S. Degree in Chemical Engineering from the University of Colorado in 1948. He has held various managerial and technical positions in the nuclear field with General Electric, Isochem, Atlantic Richfield, Rockwell and Battelle, since that time. He participated in the "Operation Reducing" weapons test at the AEC's Pacific Proving Grounds in 1956. Since joining Battelle early in 1978, Mr. Backman has been responsible for developing procedures and serving as a consultant in the waste management field. He was certified in health physics by the American Board of Health Physics in 1960. He is a member of the Health Physics Society and has served as president of the local chapter and on numerous committees of the national society.

P. E. Bramson, Manager, Environmental Evaluations Section, Occupational and Environmental Safety Department

Mr. Bramson holds a B.S. Degree in Engineering Physics from Northwest Nazarene College. He was employed for six years by General Electric Company in Hanford's Radiological Development and Calibration Operation where he performed neutron and gamma radiation detection equipment engineering, development and calibration. In 1965, Mr. Bramson transferred to Battelle-Northwest as a Senior Engineer in whole body counter research, development and applications. Since that time he has served as Manager of an Internal Dosimeter Section, Staff Scientist in Radiation Standards and Engineering and Senior Engineer of Environmental Evaluations Section. During his professional employment he authored and co-authored numerous papers and has given subject lectures at Washington State University and the University of Washington. He is a member of the Health Physics Society.

C. L. Brown, Manager, Nu[illegible] Section, Energy Systems Department

Mr. Brown received a B.S. Degree in Chemistry from the University of Utah in 1947. He was named manager of the Nuclear Analysis Section in 1978 following three years as manager of the former Criticality and Shielding Analysis Seciton. His current responsibilities are directing studies involving criticality, safeguards and neutronics.

Mr. Brown began employment at Hanford with the General Electric Company in 1948. He joined Battelle-Northwest in 1965 as a Senior Specialist in Criticality Safety. Nearly all of his employment responsibilities have been related to plutonium handling and nuclear safety.

Mr. Brown has been an author in over 75 technical reports. He is also a member of AIChE, INMM and committees of the American National Standards Institute and the Atomic Industrial Forum.

L. A. Carter, Senior Research Scientist, Radiation Standards & Enginering Section, Occupational and Environmental Safety Department

Mr. Carter received a B.S. Degree in Chemical Engineering from the University of Nebraska in 1948. Since that time he has held various technical positions in the health physics field with the General Electric Company and Battelle-Northwest. For the past twelve years he has been responsible for developing radiation protection standards, procedures and regulations applying to Battelle-Northwest. Mr. Carter participated in the "Operation Redwind" weapons tests at the AEC'c Pacific Proving Ground in 1956. He was certified in health physics by the American Board of Health Physics in 1963. He is a charter member of the Health Physics Society, and chairman of the State and Federal Legislation Committee. He served a three-year term as a member of the Panel of Examiners of the American Board of Health Physics.

E. D. Clayton, Associate Manager, Criticality Analysis, Energy Systems Department

E. Duane Clayton (PhD, Physics, Univeristy of Oregon, 1952) is currently Associate Manager of Criticality Analysis at the Pacific Northwest Laboratory. He has over 27 years experience in the nuclear field at Hanford, which includes experimental reactor physics, critical experiment work, criticality research and analysis, and nuclear criticality safety.

Shortly after coming to Hanford, Clayton and co-workers performed experiments on graphite-uranium subcritical piles showing for the first time that a natural urainum graphite-moderated, water-cooled, reactor could be safely designed and operated such that loss of water coolant would not cause an increase in reactivity. The lattice design of the large production Hanford "K" reactors was based on the results of these early experiments.

The Plutonium Critical Mass Laboratory of the Pacific Northwest Laboratory of the DOE has been under the direction of Dr. Clayton since its inception in 1961. The research emphasis at this laboratory has been on the procurement of criticality data for development of technology on nuclear criticality control and safety for design and operation of facilities and equipment in fabrication, processing, and shipment of reactor fuels throughout the fuel cycle.

He is past chairman of the Nuclear Criticality Safety Division of the American Nuclear Society, and is currently chairman of Work Groups 12 and 15 within Subcommittee ANS-8 (Fissionable Materials Outside Reactors) of the ANS Standards Committees. Dr. Clayton was elected a Fellow of the American Nuclear Society in 1976. In the nuclear field, he is the author or co-author of over 75 DOE reports and documents, chapters in 9 books, some 40 journal publications, and some 60 papers presented at professional society meetings, conferences, and symposiums.

John P. Corley, Staff Engineer, Environmental Evaluations Section, Occupational and Environmental Safety Department

Mr. Corley has been employed at the Hanford Plan since 1947, transferring from General Electric Company to Battelle-Northwest with the Hanford Laboratories' operations in 1965. During this period, Mr. Corley was engaged in applied radiation protection work in the chemical separations and reactor plants, followed by assignments in technical analysis and preliminary process design in waste water disposal and water treatment. For several years, he conducted research studies of Planteffects on Columbia River water quality.

From 1966 to 1974, Mr. Corley managed the overall environmental surveillance and evaluation functions for the Hanford complex. In this position, he was responsible for both technical content and administration of the surveillance program, including application of new surveillance technology and preparation of appropriate reports. During and since that assignment, he has been task leader and principal investigator for a number of special studies, including an environmental surveillance rationale for fuel fabrication plants, radiological evaluations of advanced waste management concepts, radiological impact sections of environmental impact statements, and preparation of guides for the radiological surveillance and evaluation of the environment for the AIF and DOE.

Mr. Corley is a Certified Health Physicist and a member of a working group of ANSI Sub Committee N13.9 on environmental radiological surveillance.

L. G. Faust, Manager, Dosimetry Technology Section, Occupational and Environmental Safety Department

Mr. Faust received a B.S. Degree in Physics from Humboldt State College in 1959. In that same year he joined the General Electric Company at Richland, Washington, working in the areas of research and development of personnel dosimeters, dose rate determinations and shielding calculations. From 1963 to 1964 he served as supervisor of the radiation monitoring program of the Hanford Laboratories and was responsible for establishing a routine survey program which resulted in better contamination control within the facilities of the laboratory. In 1965, Mr. Faust transferred to Battelle, Pacific Northwest Laboratories. Since that time he has been engaged in various studies concerning the occupational exposure problems associated with the handling of plutonium and plutonium-bearing reactor fuels. In relation to this work he co-authored "A Guide to Good Practices at Plutonium Facilities" which is used as a handbook reference in the industry. He has also designed and directed many experiments leading to development of computer programs capable of modeling plutonium facilities such that personnel exposures can be predicted with a great degree of accuracy. The results of this work have been published in many technical reports which Mr. Faust either authored or co-authored. He is currently serving as Manager, Dosimetry Technology Section and, as such, is responsible for several DOE and NRC research and development programs.

Mr. Faust is a member of the Health Physics Society and the American Nuclear Society and has served on several committees either as a member or the chairman of working groups. He also is serving as the U.S. expert for the ISO/TC-85/Subcommittee 2/Working Group 5 on Materials and Devices for Protection Against X, Gamma, Beta and Neutron Radiations, and Equipment for Remote Manipulation of Radioactive Materials.

K. R. Heid, Manager, Personnel Dosimetry Section, Occupational and Environmental Safety Department

Mr. Heid attended Los Angeles City College and Washington State University. He has 29 years of professional experience in the radiation protection field. His professional experience, all with General Electric and Battelle, Pacific Northwest Laboratories, has included management responsibilities in radiation monitoring, environmental monitoring, radiological engineering, emergency planning, radiological calibration and personnel dosimetry. His current assignment includes responsibility for evaluation of acute and chronic exposure for all Hanford employees; development of in vivo examination equipment and associated models for interpreting dose from internally deposited radionuclides; development of personnel dosimeters to measure dose resulting from external sources of radiation; and maintenance of a legally sound occupational radiation exposure records program for the Hanford contractor employees. This work requires close liaison with medical and legal representatives.

In the area of personnel dose evaluation, he has authored about 35 papers which have been published in several different scientific journals or publications; has presented several papers including three invited papers at national or international meetings and chaired a session at an international meeting held in Europe. He served for twenty years as a member of the AEC-ERDA-DOE Radiological Emergency Team for Region 8 and the Civil Defense Emergency Team at Hanford with responsibility for training members of both teams in radiation protection matters for twelve years.

Mr. Heid is a member of the Health Physics Society and was appointed to serve on the Standards Committee for six years. He also served as a member of the HPS Standards Committee working group to prepare a standard on Performance Criteria for Bioassay Sampling. In addition, he has served on several committees appointed by DOE (or predecessors) to study methodology for expressing internal exposures.

H. L. Henry, Manager, Safety and Nuclear Materials Management Section, Occupational and Environmental Safety Department

Mr. Henry received a B.S. Degree in Chemistry from Brown University in 1937. After six years experience in explosives research and organic chemical production with the duPont Company, Mr. Henry was assigned to the Chicago Metallurgical Laboratory and later to the Clinton Laboratory where he took part in preoperational testing and initial startup of the X-10 Reactor with responsibilities for shift operation. He was a member of the staff of the Hanford Training School and arrived at Hanford in 1944 for testing and initial operation of the first production reactors. His reactor operation assignments included shift and managerial responsibilities with duPont and General Electric. Engineering assignments included management of Special Irradiation and Process Technology groups for production reactors and under General Electic and Battelle-Northwest, the management of the Experimental Reactors organization with overall responsibilities for operation and safety of three critical facilities, two sub-critical facilities and a large inventory of fissionable material. He was Senior Engineer for Nuclear Safety previous to his present assignment. Mr. Henry is a member of the American Nuclear Society and Institute of Nuclear Materials Management and is a registered Professional Chemical Engineer.

J. J. Jech, Manager, Radiation Monitoring Section, Occupational and Environmental Safety Department

Mr. Jech has a B.S. Degree in Chemistry from the University of Washington. He has more than 20 years of experience in applied radiation protection, which was obtained during his employment by the General Electric Company (1952-1965) and Battelle-Northwest (1965-present). He served as a supervisor of radiation and environmental monitoring at and for various facilities within the Hanford complex 10 years, established and maintained a radiation protection program for an R&D group during assignment with the General Electric X-Ray Department (5 years) and served as the Exposure Evaluator for the Hanford project from 1967 to 1972. In the latter position, he was responsible for initiating and coordinating activities as necessary to evaluate the exposure incurred by persons involved in radiation occurrences and for providing liaison with Industrial Medical for cases involving possible therapeutic treatment. Since 1972 he has been assigned as Manager of the Radiation Monitoring Section. He has authored and co-authored several papers for publication and for presentation at national and international meetings. He is a Certified Health Physicist and a member of the Health Physics Society.

R. L. Kathren, Staff Scientist, Occupational and Environmental Safety Department

Mr. Kathren has more than 21 years of broad experience in health physics and related areas. He originally joined Battelle-Northwest in 1967, serving first as section manager and then as senior research scientist with responsibilities in the areas of radiological calibration and standardization, instrumentation, and radiation dosimetry. Following six years as corporate health physicist to Portland General Electric Company, he rejoined Battelle-Northwest in 1978 as staff scientist in the Occupational and Environmental Safety Department.

Mr. Kathren received a B.S. Degree from UCLA in 1957 and an M.S. Degree from the University of Pittsburgh in 1962. His professional experience includes five years as a health physicist at Lawrence Livermore Laboratory of the University of California, where he was involved in a vareity of applied health physics research activities, two years as supervisory health physicist at Mare Island Naval Shipyard where he was responsible for the dosimetry program and environmental monitoring, and two years in a large local health department working in x-ray protection. Mr. Kathren has served on the adjunct faculties of Oregon State University and on the Oregon State Radiation Advisory Committee. From 1973-78 he was health physicist to Reed College and currently is on the affiliate faculty of the University of Washington at the Joint Center for Graduate Study in Richland. In 1977 he received the Elda Anderson Award for outstanding contributions to the science and art of health physics. He is certified by the American Board of Health Physics, a Diplomate of the American Academy of Environmental Engineers, and holds licenses as a professional engineer and senior reactor operator.

H. V. Larson, Associate Manager, Occupational and Environmental Safety Department

Mr. Larson received his B.S. Degree in Physics from Oregon State College in 1950 and his M.S. Degree in Physics from the same institution in 1957. From 1952 to 1964, he was employed by the General Electric Company at Hanford, first as a Radiological Physicist and then as Manager of the dosimetry functions. From 1965 to the present he has been employed by Battelle-Northwest, first as a Senior Research Scientist, and in order, as Manager of Personnel Dosimetry Section, Manager of Radiation Protection Department, Manager of Radiation Standards and Engineering Section, Manager of Environmental Evaluations Section, Acting Manager of the Occupational and Environmental Safety Department, and Associate Manager of the Occupational and Envrionmental Safety Department. During this period he has contributed heavily to the literature, performed both medical and health physics research and managed all aspects of radiation protection including dosimetric and environmental evaluations, and radiation and environmental monitoring. Mr. Larson is certified in Health Physics by the American Board of Health Physics and is a member of the Health Physics Society, American Association of

Physicists in Medicine, American Nuclear Society, and Radiation Research Society. Mr. Larson is currently a member of both the Board of Directors and the Standards Committee of the Health Physics Society.

C. R. Richey, Senior Research Engineer, Safety and Nuclear Materials Management Section, Occupational and Environmental Safety Department

Mr. Richey received his B.S. Degree in Physics from Oklahoma State University in 1951 and his M.S. Degree in Physics from the same institution in 1952. From 1952 to 1964, he was employed by the General Electric Company at Hanford, first as a physicist with the Exponential Reactor Experiments, and in order as, Senior Engineer with the Physics and Reactor Development Operation for the Hanford Production Reactors, and as Senior Physicist with the Critical Mass Laboratory. From 1965 to the present he has been employed by Battelle-Northwest, first as a Senior Research Scientist at the Critical Mass Laboratory and in order as a Research Associate with the High Temperature Lattice Test Reactor, and a Senior Engineer with Safety and Nuclear Materials Management. During this period he has contributed a number of published papers in the field of Reactor Physics, the majority of which related to the criticality of enriched uranium and plutonium assemblies. Many of the computational techniques presently utilized within Battelle-Northwest in defining criticality safety criteria were developed by Mr. Richey.

W. D. Richmond, Director, Operations and Services, Battelle-Northwest

Mr. Richmond holds a B.S. Degree in Mechanical Engineering from the University of Wisconsin and is registered as a Professional Engineer in the State of Washington. He has been at Hanford for 31 years, of which 12 years were as a project engineer, 2 years as manager of a two-production reactor plant, 6 years managing operation of the Plutonium Recycle Test Reactor and all craft services in support of Battelle-Northwest activities, and 4 years as Associate Director of Battelle-Northwest. Mr. Richmond is currently (7 years) Director, Operations and Services, with overall responsibility for industrial safety and radiation protection as well as support services. Mr. Richmond is Chairman of the Battelle-Northwest Safety Review Council.

J. M. Selby, Manager, Radiation Standards and Engineering Section, Occupational and Environmental Safety Department

Mr. Selby received a B.S. Degree in Chemistry from Kansas State University in 1954. He has a total of 25 years' experience in radiation protection including monitoring, environmental monitoring, radiological development, exposure evaluation, external and internal dosimetry, radiation protection, exposure records and radiological standards and engineering.

Since 1973 he has been manager of Radiation Standards and Engineering. He has been responsible for the solution of special problems associated with sampling, analysis and evaluation of environmental contamination. He has been in charge of several Health Physics research programs including "Technological Considerations in Emergency Instrumentation Preparedness" and Mr. Selby has authored or co-authored 25 articles. He is a member of the DOE Region 8 Radiological Assistance Team. He is a member of the Board of the Health Physics Society, Phi Lambda Upsilon Honorary Society and was certified in Health Physics by the American Board of Health Physics in 1961.

C. M. Unruh, Manager, Occupational and Environmental Safety Department

Mr. Unruh holds a M.S. Degree in Physical Chemistry from the University of Kansas. Since graduation in 1952 he has been employed in a wide variety of radiation protection activities at Hanford. Primary assignments were in the development of improved radiation protection methods and equipment. He has directed and managed the activities of the Radiological Department and Calibrations Section of the Radiation Protection Department, served as a technical staff consultant to the Director of the Environmental and Life Sciences Division and is presently Manager of the Occupational and Environmental Safety Department at Battelle-Northwest. As Manager of the O&ES Department he is responsible for the overall Battelle-Northwest radiation protection program. Various technical papers were presented at meetings such as the Health Physics Society, the American Nuclear Society, IAEA symposia and to educational groups. Mr. Unruh is a charter member and current President of the Health Physics Society and is certified by the American Board of Health Physics.

APPENDIX B

MANAGEMENT GUIDE SAFETY REVIEW COUNCIL

POLICY

At the Pacific Northwest Laboratories a formal safety review shall be made of any operation or facility that has a potential, even a remote one, for causing substantial damage or liability. Although proposed activities are reviewed for safety implications by the Occupational and Environmental Safety Department staff, a formal safety review is required when the consequences of an accident could be substantial.

The Safety Review Council is established to provide the Laboratory Director with expert safety reviews and advice on activities with significant safety implications.

The following represent the types of activities that should be reviewed by the Safety Review Council:

- nuclear safety criteria for the design and operation of facilities and equipment
- proposals for conducting safety analyses or research programs involving significant risks for sponsors
- safety analysis reports or operating safety analysis reports
- plans for implementing operating safety limits, audit and inspection programs, and operator training programs
- departmental plans for response and recovery from major accidents in facilities requiring safety analysis reports
- proposed changes in the mode of operation or facilities modification that increase either the probability or consequences of a significant accident.
- evaluations of potentially significant safety interactions within Battelle facilities or with other Hanford contractors
- proposed nuclear safety policies and programs and other selected policies and programs of the Pacific Northwest Laboratories
- any activity not covered above that could have substantial safety implications.

RESPONSIBILITIES

Line Managers

If your organization is involved in any of the activities identified in the policy statement or other activities that you feel should be considered by the Safety Review Council, submit the matter in writing to the Executive Secretary, Safety Review Council.

Submit all safety and operating analysis reports that require external approval to the Chairman, Safety Review Council, for approval and transmittal to DOE or others.

Do not commit Battelle to actions or policies that the Council has reviewed and found unfavorable without specific written approval from the Laboratory Director.

Chairman, Safety Review Council

With the concurrence of the Council, determine whether a formal review is required.

Review and approve all safety analysis reports or operating safety analysis reports that are prepared for external approval. Call for a review by the Council whenever the potential consequences of an accident could be substantial. Transmit the reports to DOE or others.

Report review results to the Laboratory Director. If the review is unfavorable, identify problem areas that are not satisfactorily resolved. (The Council is not responsible for providing solutions to the problems identified.)

Advise the Director when work by line organizations should ıeceive special safety consideration.

ORGANIZATION OF THE COUNCIL

Laboratory Director

Appoints the chairman and members of the Safety Review Council.

Specifies the period that individual Council members serve. To the extent possible, makes replacements individually to preserve continuity in the Council's work ..d to provide some turnover of membership.

Chairman, Safety Review Council

Designates a member of the Council as vice chairman, with full authority to act in the chairman's absence.

Designates a member of Occupational and Environmental Safety Department to act as Executive Secretary of the Council.

In some cases, establishes subcouncils to investigate matters in specific technical areas. A member of the Council acts as chairman of the subcouncil.

C... cations of C... l Members

Members of the Council are persons recognized as authorities in their specific fields. Council members should have sufficient knowledge of related fields so that the Council, collectively, has broad competence necessary to produce thorough safety reviews in all technical fields. Fields of special concern are:

- atmospheric dispersion
- biological effects of radiation
- chemistr
- containment
- critical mass physics
- fluid f..w
- heat transfer

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- legal liabilities
- pressure systems
- reactor physics
- operation and engineering
- risk evaluation and industrial safety.

The council may be supplemented by local resources or by specialists at Battelle-Columbus.

Qualifications of Subcouncil Members

Subcouncil members are persons with competence and experience in relevant fields. Whenever possible, persons with line responsibilities for the facility or work function being reviewed should not be included. The memberships of all subcouncils are approved by the chairman of the Safety Review Council. (on recommendation of the subcouncil chairman) and serve as long as s/he specifies.

Meeting Schedules

Meetings are called as necessary by the chairman, or in his/her absence, the vice chairman.

APPENDIX C

MANAGEMENT GUIDE RADIATION PROTECTION

Battelle
Pacific Northwest Division

TITLE **RADIATION PROTECTION**

DESIGNATED CONTACT **Richland - Manager, Occupational and Environmental Safety**

POLICY

Human exposure to ionizing radiation from both internal and external sources shall be kept as low as practicable through application of the best protective equipment, methods, and designs technically and economically feasible.

The radiation protection program established by Battelle-Northwest will meet the high professional standards of health physics, as well as remain responsive to all applicable requirements of DOE and other government regulatory agencies.

RESPONSIBILITIES

Manager, Occupational and Environmental Safety (O&ES)

Establish and maintain the overall Battelle-Northwest radiation protection program.

Establish standards and operating limits, and provide BNW services and audits in radiation protection. Maintain necessary records, prepare reports and provide BNW liaison with DOE, DOE contractors and regulatory agencies.

Assure the establishment of radiation operating procedures, such as Radiation Work Procedures, Radioactive Material Shipment, Radioactive Waste Disposal, etc., and accompanying training programs to provide satisfactory safety and protection of Battelle and DOE personnel, the public and property.

Review operating performance and establish a comprehensive audit program.

Counsel operating management and provide information on:

- matters involving new activities or efforts to improve operations
- DOE or license requirements
- radiation hazards or radiation aspects of new programs
- radiation aspects of risk assessments of work proposed at BNW or at customer's facilities.

Initiate corrective action when performance is below standard or needs improvement.

Specify radiological design criteria and provide guidance on the design and development of new facilities and equipment or the modification of existing facilities or equipment that will be used in all work performed with sources of ionizing radiation.

Apply improved methods for measuring and controlling the radiation exposure received by staff members in the course of their work.

Issue BNWL-MA-6, *Radiation Protection Procedures*, and assure that it is reviewed annually to insure adequacy.

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Develop formal radiological engineering criteria to insure a high degree of radiation protection in the operation and in the design of new facilities or modification of existing facilities. Document these criteria in BNWL-MA-3, *Radiological Design Criteria*, and assure that it is reviewed annually to insure adequacy.

Building Managers

In accordance with the laboratory-wide radiation safety program, integrate and regulate the activities of all building occupants to assure safe working conditions within the building. (Also see MG 9.1, *Facility Management*.)

Assure the building Radiation Work Procedures, Safety Analysis Reports, emergency procedures, waste control procedures and other special work procedures are prepared and kept up to date to control the kinds and quantities of radioactive material used within the building. Inform Safety and Nuclear Materials Management whenever a facility inventory of radioactive material exceeds 300 curies.

Review and approve plans for the performance of new or unusual work with sources of radiation within the building.

Participate in the investigations of accidents occurring in the building, and implement the recommendations of such investigations.

Line Managers

Assure that programs are in compliance with DOE or license requirements (contact Radiation Standards and Engineering).

Assure that personnel in your organization comply with established radiation safety rules and procedures.

Staff Members

Know and comply with radiation protection requirements for entering Radiation Zones or for working with radioactive materials.

PROCEDURES

Procedures to be used in achieving radiation protection are given in BNWL-MA-6, *Radiation Protection Procedures*, and in these closely related manuals:

- BNWL-MA-8 *Waste Management*
- BNWL-MA-11 *Emergency Preparedness*
- BNWL-MA-81 *Radioactive Materials Shipping Manual*

Radiological design criteria to insure a high degree of radiation protection in the design of new facilities or the modification of existing facilities are given in BNWL-MA-3, *Radiological Design Criteria*.