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ENGELHARD

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April 21, 1993

John H. Austin, Chief
Decommissioning and Regulatory Branch
Division of Low-Level Waste Management
and Decommissioning, NMSS
U.S. Nuclear Regulatory Commission
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11555 Rockville Pike
Rockville, MD 20852

Subject: Decontamination Plan for the Interior of the Plainville, Massachusetts Plant of Engelhard Corporation

Dear Mr. Austin:

In voluntary cooperation with the Nuclear Regulatory Commission (NRC), Engelhard Corporation is submitting our decontamination plan ("Plan") for the interior of our Plainville, Massachusetts facility. This Plan was prepared by Engelhard's consultant, Dr. Robert E. Berlin in accordance with the NRC's approved action plan for timely cleanup of Site Decommissioning Management Plan sites. It is Engelhard's intent to perform additional decontamination of the plant interior to assure that the residual surface contamination levels conform with current regulatory standards and achieve as low as reasonably achievable exposure levels.

Engelhard is looking forward to hearing your evaluation of our Plan and discussing it with you. In the meantime, if you have any questions concerning the Plan, please contact me at (508) 695-7811.

Yours truly,

Donald P. Chabot
Senior Environmental Engineer

cc: J. Parrott

H/42

DECONTAMINATION PLAN
FOR INTERIOR OF PLAINVILLE, MASSACHUSETTS
PLANT OF ENGELHARD CORPORATION

Prepared for:
Engelhard Corporation
Route 152
Plainville, Massachusetts 02762

Prepared by
Robert E. Berlin, D.P.H.
William Duggan Ph.D.

April, 1993

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1.0 INTRODUCTION

This decontamination plan (the "Plan") covers the anticipated program for revisiting the radiological decontamination of interior walls and floors at the Engelhard Corporation's Plant on Route 152 in Plainville, Massachusetts. A separate plan has been developed for the radiological characterization of the exterior regions of the site. This facility was formerly operated by the D.E. Makepeace Division of Engelhard Industries, Inc. for the fabrication of nuclear fuel elements under U. S. Atomic Energy Commission (AEC) licenses SNM-185 and SUB-172 from 1957 until the licenses were terminated. License termination occurred after nuclear operations ceased in 1962, a decontamination program was conducted by Engelhard, and the AEC validated that the residual contamination levels and exposure levels in the building interior were within then-established regulatory limits.

The final radiological survey (close-out survey) of the facility after decontamination was submitted to the AEC on June 27, 1963 as part of a request to terminate the licenses (Weiss-1963). Based on an AEC Division of Compliance close-out inspection, validation that residual levels were within the specified limits, a recommendation by AEC Compliance personnel that the licenses be terminated (Lorenz-1963), and concurrence by the Source and Special Nuclear Materials Branch (Lane-1963) of this recommendation, Engelhard was notified that no future facility license would be required (Director-1963).

A radiation survey of the Plainville facility conducted in July, 1988, however, showed that the gamma radiation levels in certain areas of the plant building were elevated based on current exposure criteria. Alpha radiation measures of surface wipes and, subsequently, of strippable coatings confirmed that the surfaces and recesses (cracks, grooves) contained material that could have produced the elevated gamma levels. The results of this measurement program are described in Section 2.0.

Engelhard proposes to perform additional decontamination of the facility interior as described in this Plan, to assure that the residual surface contamination levels conform with current regulatory standards (see Section 3.0) and achieve as low as reasonably achievable exposure levels (ALARA). After acceptable residual levels have been validated by a final survey, the Nuclear Regulatory Commission (NRC) will be requested to confirm these levels and document the successful final completion of decontamination.

2.0 RELEVANT PLANT OPERATIONAL HISTORY

Makepeace, predecessor of the current Engelhard Corporation, manufactured nuclear fuel elements at its plant on Route 152 in Plainville, Massachusetts from 1957 until cessation of operations in 1962. Manufacturing operations involved the use of natural uranium, enriched uranium, and depleted uranium. Figure 2-1 is a current site plan of the facility, with the portion of the plant used for nuclear fuel fabrication in the 1957-62 period shown in relation to the remainder of the plant and exterior grounds. Fuel element fabrication operations were totally segregated from the non-nuclear manufacturing and other operations.

The interior layout of buildings 1 and 2, which were the only buildings existing at the time of nuclear fuel fabrication, is shown in figure 2-2. The building interior and equipment used in the fuel fabrication operations were decontaminated and a final radiological survey performed by Engelhard Industries in 1963 (Weiss-1963). Based on the results of this survey and a confirmatory survey conducted of the building interior and equipment by the AEC (Lorenz-1963), the facility license was terminated (Director-1963). The decontaminated equipment had been removed from the plant and sold to the Italian government. Subsequently, the area used for nuclear fabrication was converted to other non-nuclear metal fabrication operations.

A radiation survey was conducted of the plant building in July, 1988 as a part of a multi-phase site assessment initiated by Engelhard Corporation to identify areas of environmental concern. The results of this survey have provided the basis for the development of the proposed interior decontamination program.

Based on a review of historical documentation, the interior areas of the plant in which the nuclear material was handled and processed were delineated, and became the principal locations for the radiation survey. In addition, the contaminants of concern were clearly identified as U238, U235, and U234.

3.0 PLANT AREAS TO BE EVALUATED FOR DECONTAMINATION

3.1 Survey Results

A radiation survey was conducted in July, 1988 of the interior of buildings No. 1 and 2 (as shown in the layout drawing of Figure 2-2). The purpose of the survey was to obtain rapid gross measurements in these potentially contaminated areas of the plant and pinpoint those locations, if any, where above background gamma and/or alpha levels would be present. This combined scoping and characterization survey involved an initial screening of the building interior and a follow-up, more detailed assessment of locations where hot spots were identified.

The interior areas initially surveyed were identified by a review of historical information and confirmed by plant personnel as those areas believed to have been used in the former nuclear fuel processing activities. These areas consisted of:

1. Basement area under north end of building No. 1; surveyed on a 10 ft. x 10 ft. grid (where unobstructed by equipment), with follow-up measurement in the region of exhaust fan filters.
2. Metal stairs leading from the basement to the upper floor.
3. Open factory floor area of building No. 1; initially surveyed on a 10 ft. x 10 ft. grid, and subsequently on a 20 ft. x 20 ft grid (where unobstructed by equipment).
4. Partitioned offices, laboratories and work areas generally around periphery of building surrounding open floor area along east side of buildings Nos. 1

and 2. Measurements were taken at selected locations (doorway, corners, walkways) where contamination might preferentially collect. More extensive mapping was made of areas showing instrument readings above background.

5. "Tunnel" ramp area at south end of building.
6. In the south and north parking lots and adjacent wooded areas remote from the plant to establish background levels.

The radiological survey included the following components:

- The plant areas surveyed were examined for access and condition. Plant personnel provided a description of operations conducted at each location.
- A reference grid was established using markers at the grid block corner. A 10' x 10' grid was initially used over the entire floor in the nuclear fabrication area. In regions where radiation levels were uniformly at background, a 20' by 20' grid was subsequently used (See Figure 3-1).
- Ambient gamma levels were measured at fixed points at the intersection of the grid blocks at three feet above the surface in open floor areas and of selected locations in partitioned rooms shown in Figure 2-2. A recently calibrated Victoreen 290 meter was used. Areas within the grid blocks, wall surfaces, and equipment were concurrently scanned by the operator by moving the instrument over the surface at a slow speed.
- Surface alpha activity was measured at the same locations as the gamma measurements on, or close to, the surface. A Victoreen 290 meter with alpha probe 489-60 was used.

- Locations showing either elevated (above background) gamma and/or alpha readings were noted for further evaluation and potential decontamination.
- Surface wipes (smears) were taken in areas that might have been particularly susceptible to past deposition and collection of particulates and from locations at which the gamma and alpha surveys showed elevated readings (See Table 2.1 and Figure 3-2). An area of approximately 100 cm^2 was wiped using a dry filter paper to obtain each smear.
- Airborne particulates were collected on a filter using a Hi-Vol air pump operated for approximately 30 minutes at breathing zone height in a number of selected locations in the building (See Figure 3-3). The filters were subsequently read for alpha, beta and gamma activity.
- The wipes and filters were individually packaged in glassene envelopes, labeled, recorded, and sent to the Material Leak Test Center in New York (an NRC licensed laboratory) to be read. The results reported by the laboratory were recorded, and a report was prepared. The material in the report is summarized in this decontamination plan.

All measurements (instrument, wipes, air filters) showed essentially background gross radiation levels in all areas surveyed with the exception of the locations described below. Background gamma levels measured in the external plant locations ranged between 18-22 μr/hr. Interior background surface alpha levels were approximately 20 dpm/100 cm^2.

The Scrap Melt Room and Adjacent Corridor Area (Building No. 2)

The gamma survey results showed elevated radiation levels over a wide range of the floor in this area with readings of up to a maximum value of 110 μr/hr and an average of 83 μr/hr over the floor area. The alpha survey and the surface wipes confirmed somewhat elevated levels, up to 40 dpm/100 cm^2, at these locations. The air filters collected at breathing zone heights did not show any alpha or beta/gamma levels above background.

It was therefore concluded that minor radiological contamination exists in this area, most likely in the form of particulates that have become embedded in the surface of the floor and that have adhered to the lower region of the walls in certain locations. The floor appears to have a relatively thick layer of dirt and grease which had been built up over an extended period and holds particulates tracked into the area.

The Room to the Immediate North of the Scrap Melt Room (Building No. 2)

Neither the gamma or alpha survey showed any readings in this area above background levels, either at the bottom level or on the metal platform or stairs. However, one floor wipe and the duplicate at the same location, read at the slightly elevated level, up to 40 dpm/100 cm^2.

It is likely that some of the fugitive dust has been tracked from the adjacent scrap melt room and corridor area to this room and became imbedded in the surface dirt and grease in individual spots. The floor surface shows the same long-term buildup of dirt.

The Precious Metal Storage Area (Vault) (Building No. 2)

The gamma survey results showed elevated radiation levels over a wide range of the floor in the precious metal storage area with the highest readings obtained at the back of the room at and beyond the mesh wire fencing which is normally inaccessible to plant workers. The maximum reading was 114 μr/hr, and the average was 38 μr/hr over the floor area. The alpha survey and surface wipes confirmed slightly elevated levels, up to 40 dpm/100 cm^2, at these locations.

Minor radiological sources (hot spots) exist across the entire floor area with the highest concentration in the collected dirt and residue beyond the fence at the back of the room. The floor has the same appearance as in the scrap melt room, dirt and grease covered, in which particles containing radioactivity have apparently become embedded in the surface dirt.

The Tunnel Ramp at the Wall Near the Capped Pipes (Building No. 2)

The gamma survey results showed elevated radiation levels adjacent to and above four of the capped pipes on the inner (north) wall of the ramp with a maximum level of 100 μr/hr measured at the second pipe from the top of the ramp. Neither the alpha survey or the analysis of surface wipes at these locations confirmed the existence of a radiological source, since these results were essentially at background levels.

The Region Adjacent to the Filters on the Fans in the Basement (Building No. 1)

Gamma survey readings taken in the basement at the north end of the building showed elevated levels only adjacent to the filtered side of the bank of fans. These levels ranged up to a maximum reading of 75 μr/hr and averaged 61 μr/hr across the entire face of the filters. However, none of the alpha survey results in the basement, including those at the fan or filter, were elevated. The surface wipes taken on the filter grid and a sample of material collected from the filters also showed essentially background levels. It was concluded that the gross gamma survey results were not representative and were likely reflecting the presence of electrical equipment.

3.2 Potential Plant Locations to be Decontaminated

Based on the results of the survey described in Section 3.1, it is anticipated that selective decontamination of floor areas, including recesses in the concrete, cracks and regions around pipe penetrations and lag bolts, and of the lower regions of walls will be required in the following interior plant locations:

- The former scrap melt room and adjacent corridor area in building No. 2.
- The former precious metal storage area in building No. 2.
- The room to the immediate north of the scrap melt room in building No. 2.

In addition, it is possible that localized accumulations of material will have to be removed from grooves in the tunnel ramp at the wall near the capped pipes in building No. 2.

The plant area encompassing these locations has been thus designated as the "affected area" for the building decontamination program. The remainder of the building will therefore be considered to be "unaffected" and is not expected to contain residual radioactivity. The affected and unaffected areas are shown on Figure 3-4.

A follow-up detailed Characterization Survey of the affected areas and adjacent locations will be conducted by the selected decontamination contractor to verify the above described results and pinpoint locations to be decontaminated before the program starts. In addition, a Remediation Control Survey will be conducted to assess the ongoing effectiveness of the decontamination effort and a Final Status Survey will be conducted after decontamination is completed to validate that the plant interior meets residual contamination standards (See Sections 4.0 and 5.0).

4.0 CLEANUP CRITERIA

Engelhard proposes to decontaminate the plant building surfaces, including recesses and penetrations to achieve acceptable residual surface contamination levels. The surface contamination levels to be used as guidelines will be those specified by the NRC in "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Byproduct, Source or Special Nuclear Material" (NRC-1987) as they apply to UNAT., U235, and U238 and associated decay products. These residual surface activity guidelines are:

- Average (over 1 m^2) - 5,000 dpm/100 cm^2
- Maximum - 15,000 dpm/100 cm^2
- Removable - 1,000 dpm/100 cm^2

While these guidelines represent the upper limit, the decontamination program will emphasize achieving residual contamination levels that are ALARA considering existing technical and economic constraints.

The decontamination program will also provide a level of protection to the public and future onsite non-nuclear workers consistent with current radiation exposure guidelines and with the objective of achieving ALARA exposure levels. The objective of the decontamination program will be to achieve the NRC specified in-plant exposure rates of less than 5 μr/hr (above background) as measured 1 meter from the floor and lower wall surfaces and averaged over floor areas not to exceed about 10 m^2 as set forth in the draft "Manual for Conducting Radiological Surveys in Support of License Termination." ("Draft Manual") (ORAU-1992).

It is anticipated that the demonstrated performance of the plant decontamination in accordance with this Plan and the incorporated cleanup levels, as concurred in by the NRC, will result in Engelhard's release by the Commission from any further obligation to the NRC now or at anytime in the future to conduct additional cleanups.

5.0 DECONTAMINATION WORK SCOPE

The objective of the interior decontamination program of the Plainville facility is to achieve levels that meet current NRC residual radioactive contamination guidelines and result in exposure levels that permit unrestricted building occupancy by non-nuclear workers as defined in Section 4.0.

To achieve this objective, a qualified decontamination contractor will be selected to perform a phased work scope. The selected contractor will provide, as part of this proposal, a work plan describing the tasks to be performed, schedule, instrumentation and equipment to be used, residual contamination standards to be met, health and safety precautions to be taken to maintain worker exposure at ALARA levels, QA/QC standards and procedures, and steps to be used to minimize the generation of contaminated waste.

The program to be performed is intended to follow the procedural steps and achieve the objectives defined in the Draft Manual.

The following program will be performed:

1) A Scanning Survey of the designated affected area (100% of surface) and unaffected area (10% of surface) will be conducted to pinpoint any locations of elevated activity. At suspected affected area locations, direct measurement of alpha and beta-gamma surface activity will be performed on a pre-established grid. A minimum of 30 random measurements will also be performed in the designated unaffected plant survey units. Smears will be collected at each measurement location. Swabs or strippable gel coatings will be used to collect samples from small penetrations. The smears, swabs, and coatings will be packaged and sent to

a licensed laboratory facility for analysis. Gamma exposure rates will be measured at 1 meter from floor surfaces. The results of these building surveys will be recorded on appropriate forms and the contractor, in consultation with Engelhard, will interpret the results to establish those locations requiring decontamination. The affected area designation will be re-evaluated based on the results of the surveys and revised if necessary. Instrument selection for the surveys will be consistent with the recommendations in the Draft Manual.

2) Background radiation levels will be validated in the plant building interior, at locations other than in buildings 1 and 2, where no licensed nuclear operations were performed. Statistically significant background levels will be established.

3) All identified elevated areas will then be decontaminated as follows:

- Loose dirt will be collected by sweeping and/or vacuuming.
- Locations characterized by surface accumulations of imbedded dirt and grease will be scraped and/or subjected to other surface treatment techniques in a manner that removes the contamination while minimizing waste generation.
- More aggressive techniques will be used (as necessary) to remove material collected in recesses and cracks, around floor penetrations and lag bolts, and around buried piping. This will include strippable coatings, scabbling, and core drilling individually or in combination. Strippable coatings will be initially applied to shallow recesses and cracks to remove imbedded dirt. Scabbling and core drilling will be employed if contamination remains inaccessible or if the surface concrete is contaminated.

4) The effectiveness of each phase of the decontamination effort (described in (3) above) in reducing residual radioactivity to within guideline levels will be monitored as the decontamination proceeds by performing an ongoing Radiation Control Survey. This Survey, which will guide the extent and phases of decontamination and assure that the remediation workers and the public are protected against excessive exposure, will use direct radiation exposure from the surface as the parameter for making in-operation determinations that guideline values have been attained.

5) Upon determination that residual contamination levels have been reduced to within guideline levels, a Final Status (termination) Survey will be conducted. The Final Status Survey will demonstrate that total surface activity, removable activity, and exposure rate are within the guideline values (See Section 4.0). The methodology used to conduct the Final Status Survey will be consistent with the approach described in (1) above and with the procedures described in the Draft Manual for building interiors. The Survey methodology and results will be documented, and a report prepared incorporating the results of the Survey (See Section 10.0 for a discussion of the report contents) and relevant data from the prior Scoping, Characterization, and Control Surveys.

6) The final status (termination) survey report will then be submitted to the NRC with a request that the plant building be released for unrestricted use. If the NRC requests that the Oak Ridge Associated Universities (ORAU) (or other contractor) perform a confirmatory survey to validate the adequacy and accuracy

of the Final Status Survey, Engelhard will provide access and assistance to ORAU to perform their survey.

7) As decontamination proceeds, the waste generated will be collected, and samples analyzed for gross activity and total uranium. TCLP analyses will be performed on representative samples of the decontamination waste. Liquid wastes will be solidified and packaged for offsite disposal. Disposition of waste will be a function of whether it is a radioactive or mixed waste.

6.0 ORGANIZATION AND RESPONSIBILITIES

The plant decontamination program will be conducted by Engelhard with Mr. Donald Chabot functioning as the onsite Program Manager. Mr. Chabot, Plant Engineer at the Plainville facility, is currently responsible for site characterization and remediation activities. As Program Manager, he will supervise the activities of the decontamination contractor, audit their health and safety operations, assure that the proposed work scope is achieved, and that survey results clearly demonstrate that residual contamination guidelines have been achieved. Mr. Chabot will be Engelhard's point of contact with the NRC.

Mr. Chabot will be assisted in performing these functions by Drs. Robert Berlin and William Duggan, who are self-employed contractors. Both Drs. Berlin and Duggan are knowledgeable about the Plainville operations, have extensive experience with comparable facility remediation programs, are familiar with the decontamination programs to be conducted, and are experienced in performance of radiation surveys. They will provide onsite technical support, and assist in the selection of subcontractors, performance of surveys, interpretation of results, and preparation of the survey report.

Resumes for Mr. Chabot and Drs. Berlin and Duggan are provided in Appendix A.

The decontamination contractor will be selected by use of a formal bidding process. An NRC-licensed contractor will be selected that is experienced in performing comparable decontamination jobs and whose personnel have the appropriate health and safety training and medical certification. The selected contractor will be required, at a minimum to:

- Commit qualified and experienced key personnel to the project for its duration
- Provide a detailed work plan and realistic schedule
- Identify the instrumentation and equipment to be used and their operating characteristics
- Demonstrate how residual contamination guidelines are to achieved and validated
- Establish the necessary insurance coverage
- Provide a qualified health and safety plan adapted to the project conditions
- Establish QA/QC procedures and guidelines

Analytical services for gross alpha/beta levels on smears and TCLP analyses as necessary will be obtained from a licensed contract laboratory.

7.0 SAMPLE ANALYSIS

Analytical services for gross alpha/beta levels on the smears and TCLP analyses, if necessary, will be obtained from a well-established licensed laboratory that has documented procedures for the handling of the smears, performance of analyses, and recording of results. A QA/QC program which assures the validity of the analytical results and is consistent with NRC/EPA standards will be required.

The filter paper smears will be individually packaged in standard glassene envelopes as they are collected, labeled and numbered, and the locations of each smear recorded. Chain of custody documentation will be used to establish location and custody of the samples as they are shipped from the site to the analytical laboratory. Precautions will be taken to avoid contamination of the smears in transit or at the laboratory.

The methods used to analyze the smears will be capable of measuring levels below the established released guidelines, with detection sensitivities between 10 and 25% of the guidelines. It is currently anticipated that the filter paper smears will be counted for gross alpha and beta in a low background gas proportional counter that has the measurement sensitivity to achieve this value.

The laboratory will provide the analytical results in their standard reporting format together with a quality assurance report for each batch of smears.

8.0 HEALTH AND SAFETY

The decontamination of the plant will be planned and monitored to assure the health and safety of the decontamination workers, other onsite personnel, and the public. Thus, policies and procedures will be followed to assist personnel in minimizing the risk of injury; to assure that exposure to any hazardous agents and release of contaminants is controlled to ALARA levels; and to comply with the applicable Federal and State of Massachusetts regulations. Organizationally, this will be accomplished at both the plant management and at the decontamination sub-contractor levels.

Donald Chabot, the Engelhard decontamination program manager, with radiological support (See Section 6.0), will provide management oversight in health and safety. This will involve joint development with the sub-contractor and approval of the decontamination health and safety plan, establishing and maintaining access control to the work areas, auditing ongoing health and safety to assure that contamination control and radiation control support surveys are conducted, and that the protective work rules established for the project are adhered to in order to meet ALARA levels.

As primary criteria for selection of a decontamination contractor, the company will be licensed by the NRC and thus possess a qualified and approved generic health and safety plan which can be readily adapted to conditions at the Plainville site. The personnel assigned to the project will have received the appropriate health and safety training, and be medically qualified. A project radiation safety officer (RSO) will be appointed who will be responsible for assuring adherence to the provisions of the health and safety plan and thus for the protection of the workers and the public.

The primary health and safety concerns during the decontamination operations will be potential exposure through inhalation, ingestion, and direct exposure to radiation and the common potential industrial hazards found in factory buildings.

During the final survey, after residual guidelines have been achieved, only the common industrial hazards will be of concern. The health and safety plan will consider both situations.

Based on the results of the prior plant radiological surveys, it appears that radiological contamination is confined to discrete locations in the plant building and is at relatively low levels. In selecting and applying the techniques to remove the contamination, controls will be exercised to prevent dispersion and thus minimize any potential exposure of decontamination workers. The protective guidelines and measures established in the health and safety plan will be based on the results of the pre-decontamination surveys, and will be revised if actual conditions during decontamination require a different level of protection.

At the time decontamination is performed, there will be no processing operations conducted in any of the affected areas of the building or adjacent locations. Thus, aside from the personnel involved in the decontamination operations, there will be no Engelhard personnel in these locations.

The components of the health and safety program to be conducted during the decontamination program and surveys are covered by the site-specific health and safety plan and include:

- Facility background

- Organizational responsibilities
- Project hazard analysis
- Worker training - inclusive of mandated general health and safety training, OSHA training for hazardous waste sites (as required); site-specific radiological and hazards training; short-duration "tailgate" safety meetings.
- Access control to affected area - including delineation of decontamination area and clean area.
- Site safe work practices
- ALARA program - management commitment and practices to assure ALARA exposure levels.
- Personnel monitoring and protective equipment - use of protective clothing; personnel monitoring; area airborne particulate monitoring; criteria for use of respiratory protective equipment.
- Environmental monitoring.
- Radiation and contamination control - personnel radiation control measures (as required); procedures for minimizing contamination of field equipment; equipment survey and decontamination procedures.
- Contingency Plans - responsibilities; first aid and/or professional medical treatment for accidents and injuries; material release; operation shutdown criteria; communication.
- Record keeping - responsibilities; forms and documentation.

9.0 QUALITY ASSURANCE PLAN

A quality assurance (QA) program will be implemented for the decontamination program and surveys consistent with the projected magnitude of the decommissioning effort as described in this Plan. The QA program will operate from the pre-decontamination additional characterization survey through final validation of the data and interpretation of the results.

Mr. Thomas Brown, Engelhard Corporate Manager of Environmental Affairs, will be QA Officer for the project. Mr. Brown, who will not be involved in the ongoing survey activities, will represent Engelhard's management QA oversight of the work and will coordinate the results of his QA oversight with the Project Manager, Donald Chabot. Mr. Brown will be the focal point for QA activities and validate that decontamination and survey activities are conducted in accordance with established policies and procedures. He will oversee the site activities by conducting periodic audits and reviewing selected field and analytical data to validate adherence to procedures and acceptable data quality. Mr. Brown's resume is provided in appendix A.

In implementing the QA program, guidelines for acceptable QA practices and procedures will be obtained from (1) NRC Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Program - Effluent Streams and the Environment," 1979, and (2) ANSI/ASME NQA-1, "Quality Assurance Program Requirements for Nuclear Facilities," 1989. Decontamination and laboratory subcontractor QA procedures will be evaluated as part of the selection process to assure compliance with Engelhard and regulatory QA standards.

All radiological surveys will be performed by Messrs. Berlin and Duggan or other trained and qualified personnel, and will be conducted in accordance with standard, written procedures. Each step of the plant decontamination and surveys will be documented thus developing a stand alone record of the decommissioning process that will be suitable for internal audit and regulatory review. Survey procedures developed for this project will be based on the guidance provided in NUREG/CR-5849. The Project Manager, Mr. Chabot, will approve all procedures and any subsequent revisions.

All instrumentation used in performing the surveys will be maintained in accordance with vendor specifications. Calibration schedules will be established and adhered to for all instruments and analytical equipment. The instrumentation will be calibrated based on NIST-traceable standards or standards of other acceptable organizations, and calibration records will be maintained. Daily tests of instrumentation will be performed against performance criteria prior to its use and any instruments failing to meet the criteria will not be used. Engelhard considers instrumentation calibration and demonstrated performance to be a significant aspect of the QA program, and care will be taken to assure that this is properly done and validated by audit of the program.

The data management program will conform with established QA procedures and the guidance provided in NUREG/CR-5849. In-progress field procedural and measurement information will be recorded in bound logs or pre-developed forms comparable to those in the ORAU Survey Procedures Manual of 1990 (ORAU-1990). Laboratory analytical data will be recorded on standard forms. All calculations using the recorded field data or laboratory results will be reviewed and formally validated. Mr. Chabot will maintain control of original records, logs, and other project documentation through final report preparation. Duplicates of important records and data will be kept in Engelhard's corporate office in Iselin, New Jersey. The records will be archived for five years after completion of the final confirmatory survey and release of the site.

The selected laboratory(s) will be required to meet NRC/EPA QA standards for sample handling and preparation, analysis, and record keeping. Field and laboratory duplicate samples at a ratio of 1 for every 10 samples will be obtained. All samples collected in the field (wipes, material samples) will be carefully packaged, labeled, and recorded. Sample custody will be maintained by a responsible individual at all times with standard chain-of-custody records used to document custody from the field through laboratory analysis.

Surveillance of the effectiveness of the QA program will be validated at the project level by continuous monitoring of the work against defined procedures and standards. Scheduled and unannounced QA audits will be performed by the QA officer and the results recorded on checklists. Any deficiencies will be documented, and project personnel will be required to resolve these deficiencies.

10.0 DOCUMENTATION AND REPORTS

Engelhard will assure that the documentation developed during the decontamination program will be complete and unambiguous, and will be sufficient to permit an independent re-creation and evaluation of the decontamination process and the final radiological status of the plant.

The data collected at each step during the interior decontamination program will be recorded in tabular form and on scale drawings and archived by Engelhard. This will include the results of the Pre-decontamination survey, the In-Progress Radiation Control survey, and the Final Status Survey. This material, together with information provided in this Plan (i.e. relevant history and prior survey data) and by the decontamination subcontractor in their proposal and final summary report (i.e. work plan, health and safety plan and data QA/QC documentation) will provide the basis for the development of the final status report.

The final status report will generally adhere to the following outline:

1.0 Background information

2.0 Site information

- 2.1 Type and location of facility
- 2.2 Description of plant/site
- 2.3 Ownership
- 2.4 Plant conditions at time of final survey

3.0 Relevant operating history

4.0 Results of previous surveys

5.0 Decommissioning program

- 5.1 Objectives
- 5.2 Release guidelines
- 5.3 Work plan/procedures

6.0 Final status survey procedures

- 6.1 Survey objectives
- 6.2 Organization and responsibilities
- 6.3 Instruments and equipment
- 6.4 Survey procedures/parameters
- 6.5 Records

7.0 Survey findings and results

- 7.1 Survey results (Tabulated data, analysis and interpretation)
- 7.2 Comparison of results with guideline value

8.0 Waste disposal

9.0 Summary and program overview

Appendices:

- Tabular records of data and results of data interpretations
- QA/QC records
- Health and safety records
- Chain of custody / manifest records

11.0 DISPOSAL OF DECONTAMINATION WASTE

Existing criteria and acceptable practices for the packaging, transport and disposal of decontamination waste will be adhered to and required of the decontamination contractor. Thus, the radioactive waste generated by the decontamination operations will be immobilized and packaged for disposal as low level radioactive waste (LLW). The free water content in the waste package will be restricted based on NRC transport regulations.

Arrangements will be made for waste disposal prior to initiation of the decontamination program to allow for immediate shipment of waste from the site. The waste will be disposed in a commercial facility licensed to accept LLW. It is currently anticipated, based on the status of LLW disposal nationally and in Massachusetts, that arrangements will be made to ship the waste to the Barnwell South Carolina LLW burial site.

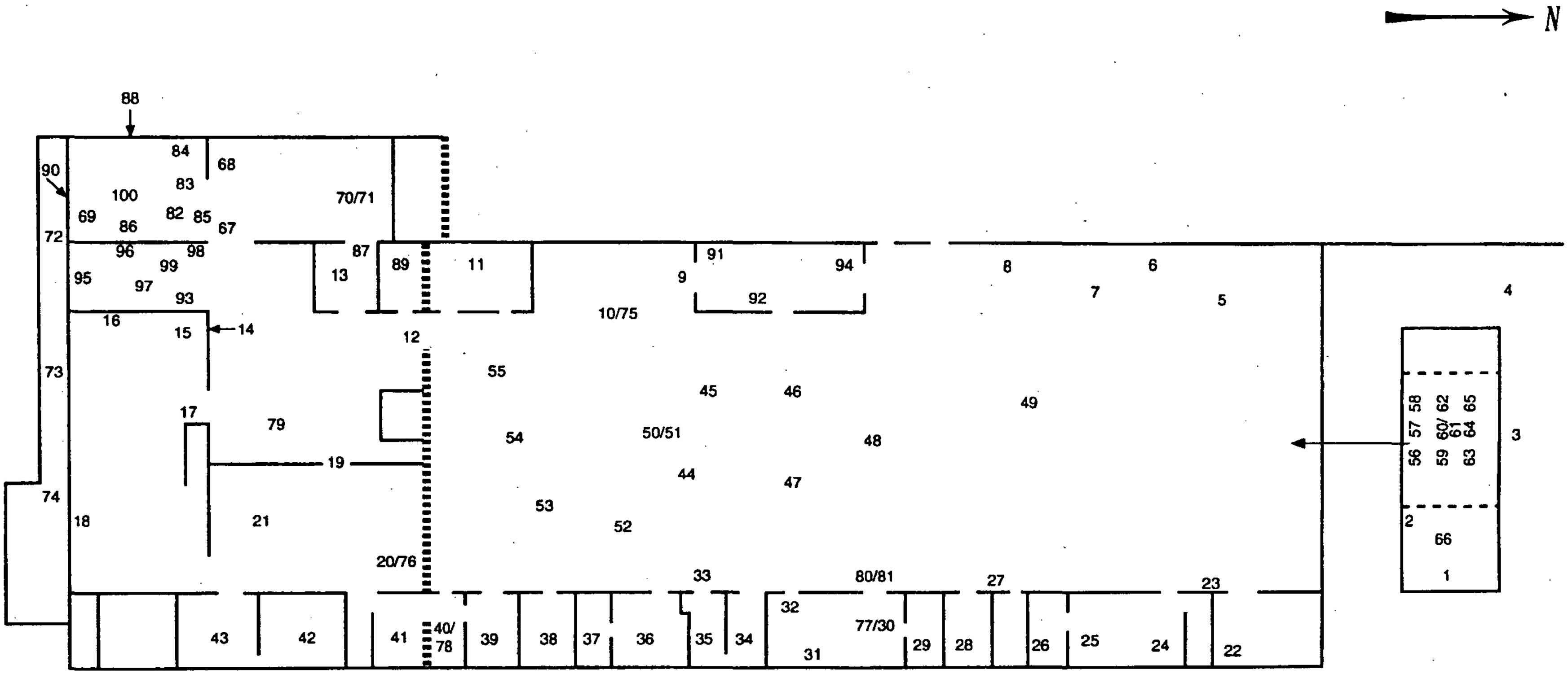
If any of the waste is determined to be mixed waste, (i.e. radioactive and hazardous waste) this waste material will be segregated and stored on site pending treatment to eliminate the mixed waste status or to await availability of a disposal facility that will accept a mixed waste. Such storage of waste may be subject to permitting or licensing requirements.

REFERENCES

Weiss-1963	Letter, N.W. Weiss of Engelhard to D.A. Nussbaumer of USAEC, Subject: Cancellation of SNML-185 and SUB-172, June 27, 1963.
Lorenz-1963	AEC Memo, W.R. Lorenz to R. B. Chitwood, Subject: Engelhard Industries, Inc., Makepeace Division, Attleboro, Massachusetts License No. SNM-185 and SUB-172 - Request for Close-Out Inspection, August 13, 1963.
Lane-1963	AEC Memo, J.J. Lane to Files, Subject: Termination of Engelhard Industries Licenses SNM-185 and SUB-172. Dockets 70-139 and 40-768, September 19, 1963.
Director-1963	Director of Division of Licensing and Regulation to Engelhard Industries, September 27, 1963.
NRC-1987	USNRC, "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material," Policy and Guidance Directive FC 83-23, August 1987.
ORAU-1990	Oak Ridge Associated Universities, "Survey Procedures Manual for the ORAU Environmental Survey and Site Assessment Program", March, 1990.
ORAU- 1992	Oak Ridge Associated Universities (J.D.Berger), "Manual for Conducting Radiological Surveys in Support of License Termination" (draft), NUREG/CR-5849, ORAU-92/C57, June 1992.

PAGES 32 THROUGH 33 REDACTED FOR THE FOLLOWING REASON:

(b)(4)

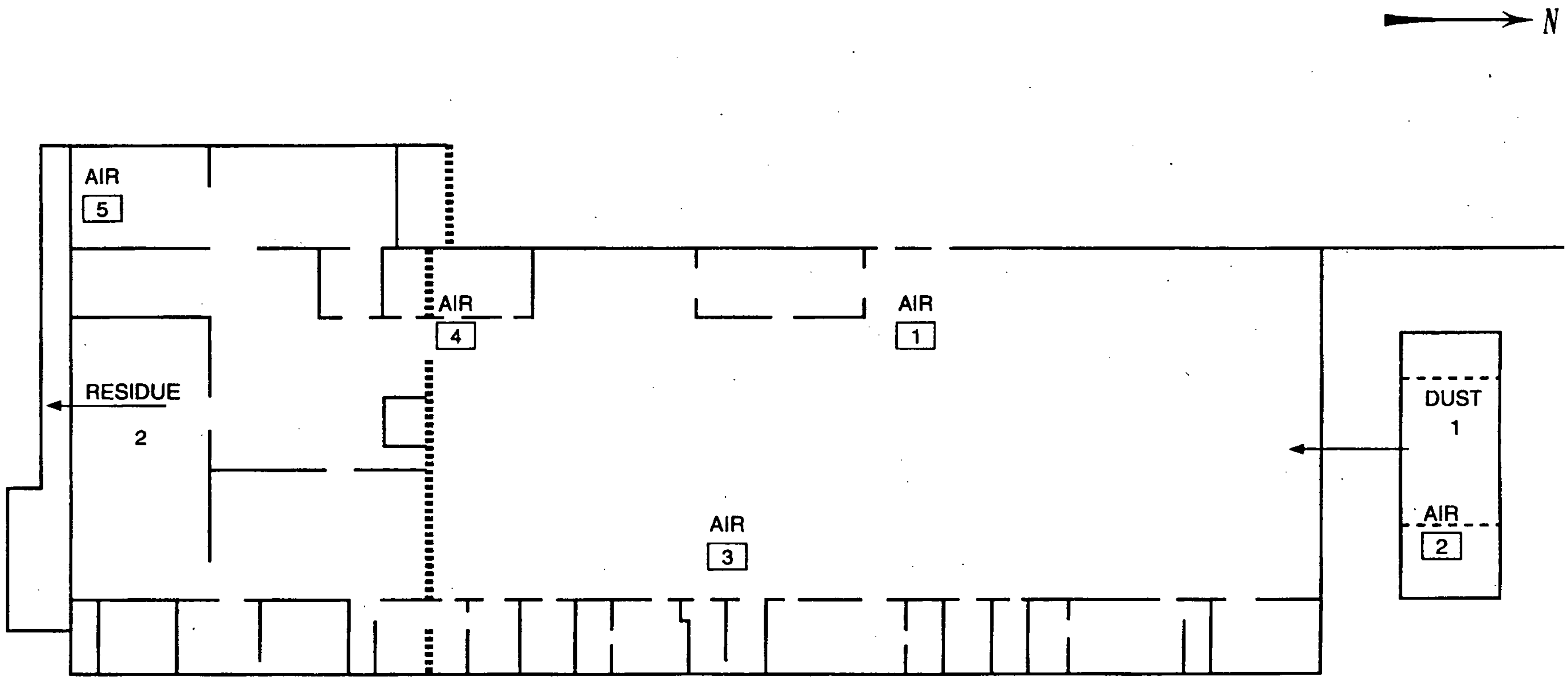


EXPLANATION

"42" Plant interior locations where surface wipes were collected.

Surface Wipe Test Locations in Buildings 1 & 2

Figure 3-2



Location of Air and Particle Samples in Buildings 1 & 2

PAGE 36 REDACTED FOR THE FOLLOWING REASON:

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Table 2-1
LOCATIONS OF SURFACE WIPES TAKEN ON 7/14/88 AND 7/15/88
(Refer to Figure 3-2 for locations)

Wipe No.	Location	
1	Basement:	old rack with electrical control panel: top and rear sections
2	Basement:	electrical switch boxes on wooden wall board
3	Basement:	middle selection wipe by electrical clock area
4	Basement:	pipe at base of stairs (overhead pipe)
5	Main floor:	by fan and electrical junction box, just before cage on 'I' beam 20 ft. from window. Wipe 10 ft. from floor.
6	Main floor:	floor by cage area below fire extinguisher
7	Main floor:	side of 'I' beam by drums near 4-tank hook-up
8	Main floor:	top of electrical control boxes
9	Main floor:	floor by gate
10	Main floor:	'I' beam sides at 6 feet
11	Main floor:	piping overhead as you enter room
12	Main floor:	gold vault, left side looking into vault (metal post at 6 feet)
13	Main floor:	left side vent by door (looking into room)
14	Main floor:	2 electrical boxes adjacent to 3 push button switch
15	Main floor:	just inside Melt Room 2nd 'I' beam 6 feet from floor
16	Main floor:	top off frame in Melt Room, of broken glass window (on wall side)
17	Main floor:	side wall adjacent to door leading into office in Melt Room
18	Main floor:	windows in Melt Room 7 to 8 feet from floor
19	Main floor:	metal cage and locker room wall areas
20	Main floor:	window area in shower room
21	Main floor:	Ceiling of air conditioner: sitting-lunch area room
22	Main floor:	solder room side wall by 1st. set of windows
23	Main floor:	vent over Solder Room doors (outside room)
24	Main floor:	top of hood
25	Main floor:	top of pipes
26	Main floor:	top of electrical furnace
27	Main floor:	pipes 12 feet high on wall
28	Main floor:	radiator, Die Room
29	Main floor:	women's room window frame and radiator
30	Main floor:	men's room window frame
31	Main floor:	small machine shop radiator, left side (as you look into room)
32	Main floor:	small machine shop wooden bench top and sides
33	Main floor:	electrical panel
34	Main floor:	sprinkler pipe old Main entrance
35	Main floor:	wipe office: radiator interior
36	Main floor:	contact test area inside of radiator

Wipe No.	Location	
37	Main floor:	Lab. office, floor
38	Main floor:	Lab. balance room wall
39	Main floor:	Lab. hood vent over glass sider, 1st hood as you enter room
40	Main floor:	Lab. electrical junction boxes by fire extinguisher
41	Main floor:	Lab. filter wipe
42	Main floor:	Lab. wipe over major control panel
43	Main floor:	wipe in Lab. area on top of electrical box by double doors
44	Main floor:	'I' beam wipe 6' from floor. Beam is 4th from wall "A"
45	Main floor:	floor wipe as noted
46	Main floor:	floor wipe as noted
47	Main floor:	floor wipe as noted
48	Main floor:	floor wipe as noted
49	Main floor:	floor wipe as noted
50	Main floor:	floor wipe as noted
51	Duplicate wipe of #50 area wipe	
52	Floor as noted	
53	Floor as noted	
54	Floor as noted	
55	Floor as noted	
56	Basement:	grid for vent
57	Basement:	grid for vent
58	Basement:	grid for vent
59	Basement:	grid for vent
60	Basement:	grid for vent
61	Basement:	grid for vent, repeat for #60 area
62	Basement:	grid for vent
63	Basement:	grid for vent
64	Basement:	grid for vent
65	Basement:	grid for vent
66	Pipe in carpenter room	
67	Upper level:	floor area
68	Upper level:	floor area
69	Upper level:	floor area
70	Upper level:	floor
71	Upper level:	repeat area of #70 (duplicate)
72	Upper level:	window in hallway
73	Upper level:	electrical junction box, top of box
74	Upper level:	wipe of pipe
75	Upper level:	repeat of area wipe #10 (duplicate)
76	Upper level:	repeat of area wipe #20 (duplicate)
77	Upper level:	repeat of area wipe #30 (duplicate)

Wipe No.	Location	
78	Upper level:	repeat of area wipe #40 (duplicate)
79	Upper level:	machine room window wipe
80	Upper level:	machine room electrical junction box, wipe on top of box
81	Upper level:	machine room electrical junction box, repeat of wipe area #80
82	Upper level:	floor wipe as noted
83	Upper level:	floor wipe as noted
84	Upper floor:	floor wipe as noted
85	Upper level:	floor wipe as noted
86	Upper level:	wall wipe as noted
87	Upper level:	floor area of room A
88	Upper level:	doorway floor as noted
89	Upper level:	floor of room 8
90	Upper level:	pipe in tunnel
91	Upper level:	wire area: desk top
92	Upper level:	Metal Coin Room (vault) 1st. section: floor
94	Upper area:	wire area by 480 Volt junction box (top of box)
95	Upper level:	inner vault mid-section of shelves section: floor
97	Upper level:	inner vault floor center of room
98	Upper level:	inner vault general floor wipe
99	Upper level:	inner vault floor
100	Upper level:	inner vault floor area

APPENDIX A

PERSONNEL RESUMES

Thomas S. Brown

Corporate Manager, Environmental Affairs
Engelhard Corporation
(b)(6) [redacted]

Ex 6

Credentials:

B.S. Chemical Engineering
Drexel University

M.S. Environmental Health Engineering
University of Texas

Experience:

1978 - Present — Engelhard Corporation

Corporate Manager, Environmental Affairs: Corporate oversight and leadership of environmental compliance programs.

Operations Manager, Seneca Plant: Budget responsibility and accountability for managing four operating departments and utilities and maintenance. Covered start-up of relocated operations.

Operations Manager, Delancy Street Plant: Budget responsibility and accountability for managing three operating departments during period of plant shutdown and relocation.

Manager, Plant Services, Delancy Street Plant: Budget responsibility and accountability for managing five service departments, environmental engineering, project engineering, maintenance, construction, and utilities.

Manager, Environmental Engineering, former Engelhard Industries Division: Budget responsibility and accountability for managing divisional group supporting all division plants in areas of environmental compliance.

Environmental Engineer, former Engelhard Industries Division: Responsible for programs supporting plant compliance with waste water, hazardous waste, and toxic substance rules.

1975 - 1978 — Delaware River Basin Commission

Acting director of joint industry/government funded program investigating need for and availability of disposal capacity for "exotic" wastes.

Section chief of water quality section responsible for obtaining and publishing water quality data for the mainstream of the Delaware River.

Participated in review of projects proposed for Commission approval to determine conformance with Commission rules.

1973 - 1975	Gibbs & Hill, Consulting Engineers
	Environmental engineer participating in various municipal and industrial waste water treatment design projects.
1969 - 1973	Manville Corporation
	Research engineer participating in various projects investigating applicability of various technologies to water and waste water treatment.

DONALD P. CHABOT

WORK EXPERIENCE

	ENGELHARD CORPORATION – Route 152, Plainville, MA 02762
Senior Environmental Engineer (December 1989 to present)	Fully responsible for taking all the actions necessary for full compliance with all federal, state, and local environmental regulations as it relates to designated sites. Develop and administer various environmental and contractor safety programs. Develop written plans and actions to satisfy regulatory agencies. Site remediation responsibility for compliance with RCRA's Corrective Action, DEP's MCP, NRC's Site Decomissioning Management Plan requirements.
Environmental Engineer (December 1986 to December 1989)	Developed plans, designed specifications, produced cost estimates and other data needed to pursue the acquisition of new technology or the correction of existing technology to comply with current or anticipated laws or environmental matters. Project engineering responsibility for the application of technical knowledge and expertise in conjunction with engineering, organizational and planning skills to successfully manage all aspects of environmental projects. Assessed the affects of current and proposed manufacturing technology on the environment, specifically water and air as well as the generation of hazardous waste. Managed operation of plant environmental systems including wastewater treatment, fume scrubbers, dust collectors, hazard alarms, cooling towers, and city water. Developed and administrate various environmental programs: hazardous waste, hazardous material inventory control, waste minimization, source reduction, pretreatment, SARA 313, regulatory permitting, and etc.
Plant Engineer (November 1985 to December 1986)	Project management responsibility for aspects of facility projects. Assessed the affects of proposed manufacturing technology on production processes. Managed operation of plant systems and utilities.
	PHILLIP A. HUNT CHEMICAL – One Wellington Road, Lincoln, RI 02895
Plant Engineer (August 1982 to November 1985	Engineered and executed planned maintenance, repairs and replacements. Supervised maintenance force. Engineered and supervised projects. Responsible for generation and distribution of power and other utilities.

REFINEMET INTERNATIONAL – 162 Main Street, Woonsocket, RI 02895

Process Engineer/ Production Manager (1978 to 1981)

Duties included design and implementation of process Improvements, laboratory benchwork, quality control, equipment design and specifications.

EDUCATION

B.S., Chemical Engineering, Georgia Institute of Technology (b)(6) [redacted] EX 6

Robert E. Berlin
(b)(6)
(212) 920-0294 (College Office)

EX 6

EXPERTISE: Health Physics and Industrial Safety
Radiological Assessment
Waste Management

ACADEMIC EXPERIENCE

Associate Professor, Manhattan College

1983-Present

- Mechanical Engineering Department-Teach undergraduate design courses. Coordinate and teach graduate programs in nuclear power and waste management/facility restoration. Reactor Administrator, Manhattan College Zero Power Reactor. Licensed Senior Reactor Operator. Radiation Safety Officer for reactor facility.

- Environmental Engineering Department-Teach graduate courses in hazardous waste management.

1985-Present Visiting Lecturer, Columbia University School of Public Health

INDUSTRIAL EXPERIENCE

1983-Present

Consultant in Radioactive Waste Management, Facility Restoration, and Radiological Health. Development and performance of facility restoration programs, radiological impact assessments, contamination studies, monitoring programs. Regulatory liaison and preparation of license applications, EAs, ERs, RI/FS. Technology assessments and site applications. Development of H&S plan and manuals, QA plans, and operating manuals. Facilities include CERCLA designated Denver Radium Site; thorium-contaminated sites in Michigan, Illinois, and Florida; former fuel fabrication facility in Massachusetts; U.S. Radium site in New Jersey and DOE/ORNL waste burial site.

1980-1983 President, Waste Management Group, Inc.:

- Provided consultation services to government agencies and industrial firms in the management of hazardous chemical and radioactive waste forms. Developed industrial safety, health physics and monitoring programs, performed environmental impact assessments, and assisted in regulatory compliance and licensing action.

- Prepared monitoring manuals for mining and milling facilities; waste management and transportation section of EIS for TMI-2 accident cleanup; and developed methodology for impact assessments for DOE site remedial action program. (FUSRAP).

1973-1980 Associate, Dames & Moore

- Performance of a range of programs at LLW sites, uranium facilities, and contaminated sites involving the modeling of sources, pathway dispersion, and receptor impacts through air and water pathways; validation of performance of performance objectives; determination of stabilization covers based on diffusion analysis; and assessment of impacts of projected accident conditions.

- Development of industrial safety and health physics programs for a variety of nuclear facilities with primary emphasis on contaminated facilities and waste disposal sites. Work included definition of procedures, preparation of operating manuals, development of job descriptions and organizational responsibilities in accordance with Federal and State Regulatory Standards.

- Project Manager of Dames & Moore's technical support to NRC in generating the 10 CFR Part 61 regulation for LLW disposal.

- Development of criteria and guidelines for LLW management practices at DOE laboratories consistent with 10 CFR 61, performance of LLW management facility assessments at ORNL, and preparation of guidelines for review and approval of LLW disposal sites.

- Preparation of EAs and ERs, and conduct of regulatory compliance programs for some 20 uranium projects as part of licensing and compliance activities.

- Development and performance of site remedial action programs (Maxey Flats and West Valley burial sites, and radium and thorium processing industrial facilities); design and application of air and water monitoring programs (U.S. DOE sites); and generic and site-specific migration studies.

- Represent clients in public information sessions and regulatory hearings, on the health-related and environmental effects of nuclear and waste management facilities.

1970

- Assistant to Chairman, NYS Atomic and Space Development Authority, Managed demonstration programs on power plant siting, environmental assessment and waste disposal.

1966-1970

- Manager of Direct Energy Conversion Projects, RCA. Responsible for development of Thermoelectric Technology for space and commercial applications.

ROBERT E. BERLIN

1960-1966

- Division Director, US Atomic Energy Commission. Technical and contractual management of SNAP nuclear technology and portable reactor construction projects.

1956-1960

- Senior Engineer, Pratt & Whitney Aircraft performed structural analysis of advanced reactor systems for space applications.

ACADEMIC BACKGROUND

Dr.P.H., Public Health/Environmental Science Concentration, Columbia University, School of Public Health, (b)(6)

Ex 6

M.S., Industrial Engineering, New York University, (b)(6)

M.S., Engineering Science, Rensselaer Polytechnic Institute, (b)(6)

B.S., Mechanical Engineering, City College of New York (b)(6)

REGISTRATION: Professional Engineer, New York

PUBLICATIONS: R. Berlin, C. Stanton, "Radioactive Waste Management," J. Wiley & Sons, 1988.
Numerous papers and reports on radioactive waste management, thermoelectric technology, and radiological health.

WILLIAM P. DUGGAN, Ph.L.

(b)(6) [redacted] (Home) (b)(6) [redacted] (718) 920 - 0112 (College Office)

EXPERIENCE:

Manhattan College

Assistant Professor, Mechanical Engineering 1990 - Present

- Supervisor of the College's Critical Reactor and nuclear engineering laboratory. Research in radiological environmental contamination and waste management. Instruction of undergraduate and graduate students in nuclear engineering and radiological topics, as well as basic engineering courses such as thermodynamics.

Private Consultant 1990 - Present

- Performance of projected pathway analyses and calculation of dose commitments for a former uranium fuel fabrication facility.
- Facility investigation and upgrade of thorium-contaminated industrial site. Impact assessment of remediation alternatives included evaluation of pathways and calculation of potential dose commitments to workers and off-site public. Project required establishment and execution of field health physics program.
- Project Manager of technical and management assistance contract for the New York State Energy Research and Development Authority (NYSERDA), the agency responsible for construction and operation of New York's LLRW disposal facility. Tasks included planning for interim storage needs, preparing NYSERDA's program plan, and assisting in facility design and licensing.
- Facility Investigation for geothermal power plant complex seeking to develop disposal facility for filtercake material with high radium concentrations. Duties involved assessment, through analysis and sampling, of exposures to workers and the public from radon emanations and particulate dispersion, and client support in the permitting process and public hearings.

Dames & Moore

Consultant 1990 - 1992

Senior Engineer 1989 - 1990

Project Engineer 1987 - 1989

- Project Manager for Firm's Basic Ordering Agreement with Brookhaven National Laboratory. Management and technical responsibility for environmental services task order projects, including NEPA documentation; permitting under RCRA, NESHAPs, and other environmental regulations; and appraisal of the environmental monitoring program.
- Project Manager for Dames & Moore Licensing and assessment support of Illinois LLRW Disposal Facility License application by Chem-Nuclear Systems, Inc. Coordinated multi-discipline efforts in preparation of license applications and evaluation of safety and environmental impacts for two sites.
- Performance assessment of West Valley Demonstration Project Class B and C LLRW Drum Cell. Evaluated compliance with 10 CFR Part 61 objectives, particularly with respect to intruder scenarios. Prepared position paper for WVDP use.
- Technical support in development of the Environmental Assessment and Safety Analysis Report for the West Valley Demonstration Project. Principal duties included accident analyses and system hazard classification as part of the Safety and Environmental Assessment Group.
- Technical support in preparation of a generic Safety Analysis Report for a Low Level Radioactive Waste disposal facility based on below-grade vault technology. Responsibilities included development of the environmental monitoring plan and auxiliary system requirements.
- Technical support for radon investigations as part of site assessments. Responsibilities included planning sampling program, interpreting results, and identifying possible mitigating actions.
- Project Engineer in support of an application for onsite disposal of radioactive waste under 10 CFR Part 20.302. The submittal was the first under the guidance of NUREG 1101.

EXPERIENCE:

Rensselaer Polytechnic Institute
Research Assistant 1984 - 1987
Instructor 1983 - 1984

- Research involved design and analysis of blanket and divertor systems for fusion reactors using the novel Integrated-Blanket Coil concept. As a member of the design team for the TITAN project, collaborated with UCLA, Los Alamos Laboratory, the Fusion Engineering Design Center at Oak Ridge and GA Technologies.
- Prepared and taught two laboratory courses at the senior and graduate levels involving use of the sub-critical reactor facility and various data acquisition systems, including CAMAC.

Stone & Webster Engineering Corporation
Career Development Engineer 1982 - 1983

- Responsibilities involved analysis and evaluation of engineered safeguard systems, including containment pressure and temperature effects; determination of non-accident power plant radiation source terms; and evaluation of shielding requirements.

EDUCATION:

EX 6

Rensselaer Polytechnic Institute, Troy, New York
Ph.D. Nuclear Engineering and Science, (b)(6)
Thesis: Application of the Integrated-Blanket Coil Concept to the Compact Reversed-Field Pinch Fusion Reactor.
M.S. Nuclear Engineering (b)(6)
Thesis: Heat Transfer in a Shipping Cask Containing Bundled Spent Fuel Pins
B.S. Nuclear Engineering (b)(6)

PUBLICATIONS:

Duggan, W.P. "Pathway Analysis to Establish Clean-up Criteria" Mixed Waste Regulation Conference, Atlanta, GA, June 17-18, 1991.

Berlin, R.E., Stanton, C., and Duggan, W.P. "Developing a Graduate Program in Nuclear Waste Management/Facility Restoration" Waste Management, '91, Tuscon, AZ, Feb. 24-28, 1991.

Duggan, W.P. and D. Steiner "Integrated-Blanket Coil Applications to the TITAN Reversed-Field Pinch Reactor" Proceedings of the Twelfth Symposium on Fusion Engineering, Monterey, CA, Oct. 12-16, 1987, p. 1279.

Duggan, W.P. and D. Steiner "Applications on the Integrated-Blanket Coil Concept to the Compact Reversed-Field Pinch Reactor" presented at the Seventh Topical Meeting on the Technology of Fusion Energy Reno, NV, June 1986.

PROFESSIONAL AND CIVIC

EX 6

Adjunct Assistant Professor, Rensselaer Polytechnic Institute
Engineer-In-Training, Commonwealth of Massachusetts
Member, American Nuclear Society
Member, Health Physics Society
    Treasurer, Greater New York Chapter Health Physics Society
Member Sigma Xi
Associate Member, American Society of Mechanical Engineers
Director, Rensselaer Alumni Association Club of Westchester
National Chairman, Rensselaer Fund Phonathon