Final Report: Massachusetts Beryllium Screening Program for Former Workers of Wyman-Gordon, Norton Abrasives, and MIT/Nuclear Metals

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Final Report: Massachusetts Beryllium Screening Program for Former Workers of Wyman-Gordon, Norton Abrasives, and MIT/Nuclear Metals

I. Introduction and background

The overall objective of this project was to provide medical screening to former workers of Wyman-Gordon Company, Norton Abrasives, and MIT/Nuclear Metals (NMI) in order to prevent and minimize the health impact of diseases caused by site related workplace exposures to beryllium. The program was developed in response to a request by the U.S. Department of Energy (DOE) that had been authorized by Congress in Section 3162 of the 1993 Defense Authorization Act, urging the DOE to "carry out a program for the identification and ongoing evaluation of current and former DOE employees who are subjected to significant health risks during such employment." This program, funded by the DOE, was an amendment to the medical surveillance program for former DOE workers at the Nevada Test Site (NTS). This program's scope included workers who had worked for organizations that provided beryllium products or materials to the DOE as part of their nuclear weapons program. These organizations have been identified as Beryllium Vendors.

BUSPH submitted a program scope of work for Wyman Gordon and Norton to the DOE. The proposal is attached (Wyman Gordon Program Description).

Program facilities: Background and workforce description

<u>Wyman Gordon</u>

Founded in Worcester, Massachusetts in 1883, Wyman Gordon is a manufacturing corporation that currently has 17 plants in 5 sites worldwide. According to Wyman-Gordon officials, the company currently employs a workforce of approximately 3,400 individuals. Today, Precision Castparts Corporation (PCC) owns Wyman-Gordon.

Located at 244 Worcester Road (Route 122) in North Grafton, Massachusetts is Wyman Gordon's North Grafton facility. An additional facility - the Millbury plant (1529 Grafton Road) - is located on an adjacent property to the west of the Grafton facility in Millbury, Massachusetts. In the past, the Millbury plant was primarily used for research and development purposes. Today the plant is designated as office space, and moreover, the company headquarters. The scope of our work mainly focused on the North Grafton facility.

Interviews and risk-mapping sessions with former Wyman-Gordon employees were conducted with the assistance of the United Steelworkers of America Local 2285 (WG Risk Mapping Summary attached). BUSPH staff contacted Wyman-Gordon management requesting information on the workplace and its beryllium operations in

North Grafton as well as assistance in locating the workforce. Unfortunately Wyman-Gordon chose not to cooperate with our requests.

Norton Abrasives (Saint-Gobain)

Norton was founded in Worcester, Massachusetts in approximately 1885. It was established to respond to the need for grinding wheels for the manufacture and maintenance of machinery. Norton states that it made the first grinding wheel that could be precision-made and mass-produced.

Norton Abrasives was an Atomic Weapons Employer and Beryllium Vendor from 1943 to 1961. Norton manufactured refractory products from boron, beryllium uranium and thorium for the AEC. Work was done both at the Worcester facility and at a facility in Canada. As early as 1943, Norton was providing boron to the SAM Laboratory. In late 1945, Norton was subcontracted by Brush Beryllium to fuse beryllium oxide. Norton developed methods for shaping beryllium powder into rods and hexagonal rings using molds. It also used the process to produce beryllium oxide-uranium oxide hexagonal rings. By 1949, at least one death from beryllium poisoning had been recorded at Norton. Norton also provided thorium and uranium products to the MED/AEC. The company produced uranium crucibles for Argonne and fused thoria slugs that were irradiated in Hanford reactors. Contracts indicate Norton continued to produce refractory materials for the AEC until 1961.

Interviews and two risk-mapping sessions with former Norton employees were conducted in Worcester (Norton facility Risk Mapping Summary attached). BUSPH staff contacted Norton/Saint-Gobain management requesting information on the workplace and its beryllium operations in Worcester as well as assistance in locating the former workforce. Unfortunately, Norton chose not to cooperate with our requests, as the company was involved in a conflict with a United Auto Workers organizing drive and it perceived our interest in their beryllium history to be adversarial and a component of the UAW's initiative. Unlike Wyman-Gordon, there was not a union at Norton and we were unable to receive information about the former worker cohort.

MIT/NMI

MIT began operations for the Manhattan Engineering District (MED) in 1942 and operated at the Cambridge facility and the facility in the Watertown Arsenal (Watertown, MA) through 1954. MIT processed and conducted early metallurgical testing on uranium metals, beryllium, zirconium and thorium. In 1954 research continued under Nuclear Metals. Some of the most important developments initiated at MIT and NMI included the development of depleted uranium penetrators, beryllium tubing, and tubular transition joints that connect otherwise incompatible metals and zirconium (with trace amounts of Halfnium) clad fuel elements.

NMI moved to Concord, Massachusetts in 1958. The original facility consisted of three principal buildings, designated as Building A, B, and C. Building A contained office space and research laboratories. Building B contained services (cafeteria, laboratories, etc.). Building C was initially configured for use as the main production facility, including foundry equipment for melting metals, extrusion presses, metal working equipment, pickling and etching tanks, and electroplating equipment.

The site was originally a specialty metal research and development facility that was licensed to process low-level radioactive substances. From 1957 to October 1972, the Site was owned and operated by a succession of companies that were engaged principally in research and development contract work. Since 1972, NMI and its subsidiaries have owned and operated the site. After 1972 NMI developed a manufacturing orientation. Building D was constructed in 1978 to expand the production capabilities of the facility. Building E was constructed in 1983 and was used to house the radioactive waste processing operations.

We interviewed several former MIT/NMI employees but did not conduct a risk-mapping activity. NMI did not cooperate with requests for process information or employee and retiree contact data (MIT/NMI summary attached).

II. Outreach information

Project staff collaborated with retiree organizations and personnel at the beryllium vendors in order to identify and locate eligible former workers. Outreach activities included direct mailings to former workers, media outreach, and advertising. The United Steelworkers of America Local 2285 provided an up-to-date roster of approximately 650 former Wyman-Gordon workers. Unions did not represent the majority of the workforce at Norton Abrasives and NMI, therefore project staff held discussions with the successor companies of Norton Abrasives and NMI to identify and locate former workers. Formal requests were made to obtain a roster of former workers of MNI; however, the predecessor company would not release names of former employees for the beryllium-screening program. Recruitment efforts proceeded without a roster, and after an initial round of press releases and advertisements former workers supplied a 1991 NMI telephone directory and a Home Address Directory from the 1960's. Project staff conducted an Intelius people search to verify current names and addresses and conduct notification mailings. Further outreach activities conducted for each facility are described in detail in Attachment 1.

Table 1, Outreach Information, describes the notification effort. A total of 1,499 notification letters were sent to former workers to inform them of the beryllium-screening program, and invite them to participate. Notification mailings also included educational material concerning beryllium sensitivity and disease, the reason for the screening program, and steps that they need to take to participate. The notification mailing contained an Initial Contact Form and a business reply envelope, which served to determine individual's eligibility, level of interest in the program, and preliminary health status. All individuals who worked at one the facilities during periods of beryllium work were eligible for screening regardless of their job title or tasks. Former workers who did not respond to the initial mailing were sent two additional mailings four to six weeks apart. Of the number of people notified, 617 responded and expressed interest in being screened for beryllium sensitivity, and of those 539 were able to travel to the screening location. The remaining 78 former workers who lived out-of state or were unable to travel, were given the option of having their blood drawn by their own PCP, and a kit with instructions and a shipping label was supplied by project staff.

Table 1. Outreach Information

Outreach Method	N
Number of total mailings (includes 1st, 2nd, and 3rd)	1499
1st notifications mailed	1170
Number reached through other forms of outreach	
Newspaper (article or ad)	20
Word-of-Mouth	20
Flier	1
Other	11
Number that responded	982
"Not interested"	365
"interested"	536
"out of state"	78
total interested	617

III. Medical Screening

The medical screening sites were selected based on the location of the beryllium facilities, the corresponding distribution of former workers, and the occupational health expertise of clinic staff.

<u>Marlboro Hospital</u>

The Wyman-Gordon and Norton screenings were conducted at Marlborough Hospital. As part of UMass Memorial Health Care, Marlborough Hospital is a nationally recognized academic medical center. The hospital contains an Occupational Health service staffed with a physician and staff specializing in this area. Former workers from Wyman Gordon and Norton were screened at this facility from 2003 to 2005. The hospital, located in Marlborough, is near both Wyman Gordon and Norton facilities.

Individual participants completed an informed consent, medical and occupational questionnaire, and received a beryllium lymphocyte proliferation test (BeLPT). A posteroanterior radiograph of the chest was offered to participants who reported shortness of breath or any CBD related respiratory symptom on their medical questionnaire. A plain film reading was obtained from a certified radiologist at the clinical site, followed by interpretation by a certified B reader according to the 2000 ILO International Classification of radiographs of Pneumoconiosis.

Spirometry was offered to those participants who reported shortness of breath of any respiratory symptom considered consistent with CBD. Forced Vital Capacity (FVC), Forced Expiratory Volume in the first second (FEV-1), and FEV-1/FVC was measured. See Wyman-Norton program description (attached) for a more comprehensive review of the screening program.

Cambridge Health Alliance

The Occupational Health Program at Cambridge Health Alliance conducted medical screening for former MIT/NMI workers. The program is affiliated with Harvard Medical School and Harvard School of Public Health and is staffed by world-renowned physicians with faculty appointments at both schools. The Cambridge Health Alliance site is located at Assembly Square in Somerville, within 15 miles of the former Nuclear Metals beryllium facility.

Individual participants completed an informed consent, medical and occupational questionnaire, and received a beryllium lymphocyte proliferation test The screenings at CHA offered a posteroanterior radiograph of the chest to all participants. A plain film reading was obtained from a certified radiologist at the clinical site, followed by interpretation by a certified B reader according to the 2000 ILO International Classification of radiographs of Pneumoconiosis.

Spirometry was offered to all participants. Forced Vital Capacity (FVC), Forced Expiratory Volume in the first second (FEV-1), and FEV-1/FVC was measured. See NMI.doc (attached) for a more comprehensive review of the screening program.

IV. Participation Indicators

A total of 519 participants were screened, 35 of who were unable to travel to the screening site and received an out-of-state BeLPT kit (see Table 2, Participant Indicators). The screening took place at Marlborough Hospital for former workers of Wyman Gordon and Norton, and Cambridge Health Alliance for MIT and Nuclear Metals former workers.   94% of all participants were men and the average age was approximately 65. Prior to the screening, all participants first met with trained research assistants and were given the opportunity to ask any questions before providing their informed consent to participate. Participants also completed occupational and medical histories prior to the screening and these were reviewed by the research assistants for completeness at the screening.

Table 2. Participant Indicators

	Male	Female	Total
Average Age at Exam	65.9	64	
Attended Local Screenings	458	26	484
Out of State Participants	30	5	35
Total	488	31	519

Table 3. Beryllium Vendors Where Participants Worked

Company	Number worked at in some capacity*	Number worked at as primary location
Total worked at Wyman Gordon		389
Wyman Gordon Millbury	47	
Wyman Gordon Grafton	263	
Wyman Gordon Worcester	161	
Wyman Gordon Facility unspecified	83	
Total worked at Norton		39
Norton	50	
MIT/Nuclear Metals, Inc.		92
MIT	14	
Nuclear Metals, Inc.	88	
Total All Locations		519

* There were 519 unique participants. Some participants worked at multiple locations. For reporting purposes participants who worked at multiple locations were assigned to one primary location based on the following criteria: 1) If they reported working with beryllium at only one site, they were assigned to that cohort, 2) If they did not report working with beryllium at any location (did not know or left question blank) they were assigned to the facility where they worked the longest.

V. Lab Studies/Findings

The screening tests included a chest X-ray, a pulmonary function test, and a BeLPT. These tests, as well as a work and medical history questionnaire, were administered to participants who attended the screening at Marlborough Hospital or Cambridge Health Alliance. A total number of 241 chest X-rays with B-readings were performed. 6 (2.5%)

had an abnormal B-reading (equal to or greater than 1/0). Pulmonary function tests were performed on 280 individuals with 140 (50%) testing abnormal. There were 519 Beryllium Lymphocyte Proliferation tests and 27 individuals had at least one abnormal. 20 (3.86%) participants had two positive LPT's and are considered sensitized.

Table 4. Results

Screening Test	Wyman–Gordon	Norton Abrasives	MIT & NMI	TOTAL
	# (%)	# (%)	# (%)	# (%)
BeLPT (N)	**389**	**39**	**91***	**519**
BeLPT Status Normal	370 (95%)	37 (95%)	82 (90%)	489 (94%)
Individuals single positive	2 (0.5%)	1 (2%)	4 (4%)	7 (1%)
Individuals double positive	15 (4%)	1 (2%)	4 (4%)	20 (4%)
Chest X-Ray with B-reading (N)	**156**	**13**	**72**	**241**
Chest X-Ray Normal	82 (53%)	6/13 (46%)	44 (61%)	132 (55%)
Chest x-Ray abnormal**	71 (46%)	7/13 (54%)	28 (39%)	106 (44%)
Spirometry Tests (N)	**189**	**14**	**77**	**280**
Spirometry Tests Normal	90 (48%)	5 (35%)	45 (58%)	140 (50%)
Spirometry Tests Abnormal	99 (52%)	9 (64%)	32 (42%)	140 (50%)

*The total number of BeLPTs includes 1 individual from MIT/NMI who has an indeterminate status.
** For WG there were 3 people with CXR and B-reading that was "normal" but with "chronic changes" These did not count as normal, or abnormal, but they are included in the denominator.

VI. Conclusion and recommendations

This study of three US DOE beryllium vendors evaluated 519 individuals who were exposed to beryllium under very different circumstances. The occupations, job tasks, and materials differed markedly from site to site. Many individuals had not worked with beryllium for at least a decade. The preliminary results that have been summarized for this report suggest that beryllium exposure, even when it ceased many years before, remains an on-going concern for previously exposed workers.

The medical screening program recommended that all single positive individuals contact the US Department of Labor and participate in their Chronic Beryllium Disease evaluation program. Unfortunately we have not completed follow-up on this group to determine how many of the 20 sensitized have CBD. The literature suggests that among newly sensitized individuals approximately eight percent are diagnosed with CBD in each succeeding year. It is likely, therefore, on follow-up to discover that many of the sensitized have CBD and that the others may go on to develop CBD at a later date.

The sensitized group, because of the long period of time between their last exposure and their evaluation, need to have continual medical assessment. At the same time, the larger group that tested negative should have Be-LPT re-testing offered at least every three years. The re-testing should also include spirometry and chest x-ray as described above.

Attachment 1

TECHNICAL PROPOSAL

PROPOSAL SUBMITTED TO: DATE: 6/13/03

Libby White
Department of Energy
Office of Environmental Safety and Health
EH-6
1000 Independence Ave., S.W.
Washington, DC 20585-0270

PROJECT TITLE: Medical Screening and Surveillance of Former Beryllium-Exposed Workers at Wyman-Gordon and Saint-Gobain/Norton Abrasives

DATES OF PROPOSED PROJECT: 07/01/03-6/30/04

PRINCIPAL INVESTIGATOR: Lewis D. Pepper, MD, MPH
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A Proposal for the Detection of Beryllium Sensitization and Chronic Beryllium Disease Among Workers at Wyman-Gordon and Norton Abrasives (Saint Gobain)

The overall objective of this project is to develop a medical surveillance and screening program for former workers of Wyman-Gordon and Norton Abrasives in order to prevent and minimize the health impact of diseases caused by site-related beryllium exposures. The development of a medical screening/surveillance program for workers who are at increased risk of beryllium related disease is vitally important. First, such workers cannot obtain from their own physicians expert advice about beryllium related disease, because such physicians typically have little experience with occupational disease, especially with an unusual exposure such as beryllium. Second, since the exposure to beryllium at Wyman-Gordon and Norton occurred over three decades ago, a concerted effort to mine the collective memories of surviving former workers will be crucial to understanding the nature and extent of exposure to beryllium at the facilities and consequent risk of disease. Third, the complicated nature of beryllium related disease and the equally complex compensation program established for workers so affected requires that educational and outreach activities be conducted to assure that workers understand how their health might be affected and how they might receive compensation.

Facilities

Wyman-Gordon: It supplied beryllium powder forgings and beryllium blanks to the Rocky Flats plant and beryllium metal and parts to the Y-12 plant. A 1961 document states that approximately 50% of the beryllium work at this site is for the AEC, while the remainder is for DOD. Information provided to date suggests that Wyman-Gordon was a AEC/DOE beryllium vendor between 1959 – 1966.

Norton Abrasives (Saint-Gobain): It was an Atomic Weapons Employer; Beryllium Vendor, 1943-1961. Norton manufactured refractory products from boron, beryllium uranium and thorium for the AEC. Work was done both at the Worcester facility and at a facility in Canada. As early as 1943, Norton was providing boron to the SAM Laboratory. In late 1945, Norton was subcontracted by Brush Beryllium to fuse beryllium oxide. Norton developed methods for shaping beryllium powder into rods and hexagonal rings using molds. It also used the process to produce beryllium oxide-uranium oxide hexagonal rings. By 1949, at least one death from beryllium poisoning had been recorded at Norton. Norton also provided thorium and uranium products to the MED/AEC. The company produced uranium crucibles for Argonne and fused thoria slugs that were irradiated in Hanford reactors. Contracts indicate that Norton continued to produce refractory materials for the AEC until 1961.

The proposed medical screening and education program for beryllium-exposed will contain the following program elements:

1. Cohort identification and location
2. Cohort notification and outreach
3. Exposure assessment

4. Medical protocol
5. Notification and Education
6. Data analysis
7. Follow-up
8. Evaluation

1. Cohort Identification and Location

The proposed beryllium medical screening and education program will be established for the Wyman-Gordon and Norton workers who were potentially exposed to beryllium in the course of their employment. A complete listing of such workers, including any occupational details that might be available (such as date of hire, date of termination, etc.), will be constructed using all available data sources. These sources will include personnel records from the employer, lists of union members, and personal knowledge of current and former Wyman-Gordon and Norton workers. Hopefully, social security number and recent address will also be available.

We plan to refine the initial list by determining if any employees were inadvertently missed or wrongly included in the initial roster. In order to accomplish this task we will (1) more extensively review and analyze the information sources mentioned above, and (2) interview knowledgeable individuals about the data sources and how they may have changed over time. We hope to gain the assistance of knowledgeable former workers so that we can verify the existing information as we use it to locate former employees. Finally, we will seek the assistance and advice of the Advisory Panel in this process of cohort refinement.

A list of likely beryllium-exposed workers will be developed using information generated during the exposure assessment. Individual eligibility criteria will consist of an individual's work history, job title, occupation, work location, start and stop date, and others. This information will be used to generate the cohort roster of at-risk individuals to-be-notified, along with the following site characteristics:

- Buildings where beryllium was used
- Beryllium-exposed occupations including trades likely to be directly (machinists) and/or indirectly (maintenance) exposed
- Years beryllium used at site
- Year beryllium use buildings cleaned and rehabbed for non-beryllium use
- other criteria to be determined based on review of site documents and AP advice

Once the cohort refinement is completed, we will create a final cohort roster database that will include all of the information needed for follow-up and for merging with any other databases. We will also conduct analyses to determine the age distribution of the cohort, and the distributions of duration and calendar years of employment. These analyses will facilitate prioritization of follow-up, notification, and medical surveillance efforts.

Next, we will determine which cohort members have died. This task will be accomplished first by searching Social Security Administration (SSA) records. The SSA has legislative approval to report vital status to researchers (James Coughlin; Office of Research and Statistics, SSA; personal communication with Ann Aschengrau, September 1997). Using a person's name and social security number, the SSA will classify cohort members into the following categories: (1) presumed alive, (2) deceased, (3) status unknown, and (4) invalid social security number. In addition to SSA records, we will interview knowledgeable individuals and others, and review company and union records to determine if individuals without valid social security numbers or whose status is unknown have died.

Next, we will trace cohort members presumed to be alive in order to determine their current addresses and telephone numbers. Tracing resources will include contractor and union records, information from knowledgeable individuals, searches of state driver license records, and internet databases with telephone numbers and addresses such as Switchboard, 411, Yahoo People Search. In addition, we are planning to obtain up-to-date addresses on cohort members who are Medicare beneficiaries (e.g., aged 65 years and over) from the Center for Medicare and Medicaid Services (CMS). CMS (formerly HCFA) will release the current addresses of cohort members, provided that we follow a simple protocol that includes sending the Medicare beneficiaries an introductory letter describing the purpose of the project. Currently there is a moratorium on the release of this data to researchers. We will contact the agency and request a waiver based on an on-going agreement we have for the Nevada Test Site former worker program.

The BUSPH Data Coordinating Center (DCC) will maintain the core cohort and related databases in Microsoft Access. This database will hold the work history, mortality status, and personal information from the previously mentioned sources. The BUSPH Data Coordinating Center, maintains strict confidentiality of the cohort roster and all project databases. Access to the database is password restricted.

The DCC will create a Medical Surveillance Tracking database to enter all the data obtained from each screening. This database will be similar to the NTS project database. It will include information from the medical and occupational questionnaire, as well as from the medical tests. It will be updated and new fields added as the questionnaire and protocol are modified.

A Tracking database (FileMaker Pro) will be used to follow a participant's status within the identification, notification, and screening process. The prototype for this is being used by the NTS project.

2. Cohort notification and outreach

Potentially exposed Wyman-Gordon workers need to be notified about their risk status and about the availability of beryllium screening. This will be done in two ways. First, members of the cohort will receive a letter explaining the program and inviting them to participate. This letter will also include highly readable educational material concerning beryllium sensitivity and disease, the reason for their inclusion in this program, and steps that they need to take to participate in the screening. Protection of confidentiality will be emphasized.

A second component of notification will be an outreach effort to increase community awareness about the program and encourage potential participants to sign up for the beryllium screening program. This will involve attendance at any civic organizations, social functions, and other locations where former Norton and Wyman-Gordon workers might be found. Former workers will provide specific details to project staff about outreach mechanisms that are most likely to be fruitful. The Steelworkers Local Union #2285 and the local United Auto Workers, along with the assistance of MASSCOSH, will play a lead role in designing and conducting outreach.

3. Exposure Assessment

Details about exposure to beryllium at the Wyman-Gordon facility are not clear. There may be better documentation for Norton Abrasives. In order to update the hazards to which this former worker cohort were exposed and to utilize the information to assist the screening design, we propose to draw on the following sources of information:

a. Facility Records, Reports, and Databases

We will conduct preliminary library and on-line research and initial interviews with unions, retired workers, and current employees. We will look for the relevant data sources to determine the nature and extent of hazards used and potential exposures at the Norton and Wyman-Gordon facilities. Potential data sources include personal and area sampling data, incident and accident occurrence reports, and safety and health progress reports. Since Norton and Wyman-Gordon were vendors to the AEC and were involved in specific AEC/DOE site programs, we will request the assistance of the relevant DOE area offices to provide information they may have about these two organizations. The Oak Ridge office will also be contacted.

Project staff will set up meetings with vendor personnel from the safety and health, medical, engineering, environmental, information services, information coordination and public relations departments. We hope that these groups will be helpful to the project in advising us on the availability and location of relevant records and other types of documentation. Project staff also will meet with union trainers, business managers and retirees to further inform us about the existence and whereabouts of materials needed for the hazard assessment.

Within one month of the approval of this proposal we will send project staff members to visit the vendors to identify, locate, and collect industrial hygiene data. To prepare for the visit, we will review the publicly available records pertaining to beryllium at these two locations.

b. Other Sources of Information

We propose conducting focus groups and risk mapping exercises with former Norton and Wyman-Gordon workers. We intend to enlarge our understanding of the hazard environment with their information and opinions. We will utilize this information to help fill in the gaps of missing data, but also (and perhaps more importantly) to provide us with an understanding that can only be gained from a lifetime of work experience.

We intend to obtain and review information from former workers about their experience at the facilities to increase our understanding of the sites' hazards and problems. We will ask workers whether there were health issues during their work tenure that we are not addressing. Descriptions of these data collection methods follows:

Focus Groups

Project team members will organize and facilitate focus groups of former workers, managers and supervisors and health and safety professionals in order to gather firsthand information from those who worked at the two facilities. Participants will be identified and recruited by the project manager. The project research assistant and MassCOSH staff will facilitate the sessions.

Interviews with Former Workers
Individual interviews with former workers who reside in the Worcester area will be conducted. These are extremely helpful in providing background information on the history of operations at the sites and can provide us with a personal view of what it was like to work there. Some former workers may prefer to speak with us about these issues in a one-on-one setting. The project manager, P.I., and research assistant will conduct the interviews.

Risk Mapping
Risk mapping is a participatory method of constructing retrospective assessments of workplace exposures. Risk mapping draws on the knowledge of former workers from on-the-job experience and has provided the NTS project with vital information on the underground workplace in different time periods. We will consider utilizing a risk mapping exercise. Mark griffon, a project consultant, will run these sessions.

4. Medical Protocol

Individuals will be included in the beryllium-testing program if they have been identified as potentially exposed to beryllium as described previously. Each individual first signs an informed consent to participate in the program. The components of the screening, which will be detailed in the informed consent, are as follows:

1. A detailed medical and work history questionnaire will be completed, including questions about beryllium exposed jobs and tasks, and respiratory questions modified from the American Thoracic Society's Epidemiology Standardization project. This will be developed by the P.I.
2. A posteroanterior radiograph of the chest will be obtained. A plain film reading will be obtained from a certified radiologist at the clinical site, followed by interpretation by a certified B reader according to the 1970 ILO International Classification of radiographs of Pneumoconiosis.
3. A Beryllium Lymphocyte Proliferation Test (Be-LPT). The Be-LPT will be sent to one of the DOE qualified laboratories. If the initial Be-LPT is positive, borderline, or indeterminate, a repeat test will be performed and sent to the same laboratory (a split sample, which may be required, will be sent to a second DOE qualified laboratory).
    a. if second test is positive, participant will be treated as Be sensitive
    b. if second test is negative, individual will be re-evaluated in three years
4. Spirometry will be performed, collecting Forced Vital Capacity (FVC), Forced Expiratory Volume in the first second (FEV-1), and FEV-1/FVC. A NIOSH-certified spirometry technician using established American Thoracic Society techniques will perform the spirometry test. Results will be interpreted based on *a priori* criteria for the evaluation of obstructive and/or restrictive findings.

All laboratory and x-ray results (including completed B-reading) will be reviewed by Dr. Lewis Pepper when they are received after the screening. Individuals with a health condition requiring immediate attention will be contacted by telephone and instructed to seek follow-up. Members of the BUSPH staff are available at a toll-free number to provide additional medical consultation.

Dr. Lewis Pepper will review the beryllium LPT results. All individuals with positive or borderline LPT results will be contacted by Dr. Pepper who will explain the meaning of the test result and answer any questions the participant may have. Individuals with one positive Be-LPT will be urged to submit a claim to the EEOICP. Follow-up medical evaluations continue to be organized by the ORISE beryllium program until the individual receives notification of claim adjudication. Once a claimant's request for medical monitoring has been approved by DOL, participants are mailed a list of centers and encouraged to schedule their own appointments. The DOL EEOICP manages follow-up for all approved claimants.

Under the Department of Labor (DOL) program established under the Energy Employees Occupational Illness Compensation Program Act of 2000 (EEOICPA), one abnormal BeLPT meets the definition of beryllium sensitization, suggesting that project participants with a positive result may be sensitized to beryllium, and therefore eligible for benefits under the program. This program pays for periodic medical examinations for all current and former Department of Energy (DOE) and DOE contractor employees and employees of beryllium vendors with one or more abnormal BeLPT. If project participants need to travel an extended distance to see a medical specialist, the program also will reimburse them for the cost of the travel. Additionally, the law calls for compensation in the amount of $150,000, for those who develop chronic beryllium disease (CBD). It is important for our participants to enroll in the DOL program as soon as possible so that future medical expenses for the management and care of their beryllium-related health effects will be covered. We believe that by providing this information in both the informed consent form and the results letters, we will assist as many individuals as possible in applying for occupational health benefits for which they may be entitled.

An educational component of the screening program is crucial in order to maximize participation and to assure that participants understand beryllium-related health risk and their entitlement to compensation. This component includes developing materials for notification and outreach, as noted above, and identifying and addressing reasons for non-participation in the screening program. These activities will be conducted by the Steelworkers Local Union #2285 and the United Auto Workers with the assistance of MASSCOSH. These activities are as important as the medical screening activities in conducting an effective occupational screening program.

Periodic Medical Screening and Surveillance

Be-LPT re-testing should occur at least every three years for individuals who previously had tested Be-LPT negative. The re-testing should also include spirometry and chest x-ray as described above. The re-testing would be done as a part of this program.

Project Health Screening Work Group

A project sub-committee periodically will review the screening protocol and addresses the need for additional screening tests. This group will review the compiled beryllium hazard data and make recommendations for additions or modifications to the current screening protocol. The groups to be screened will be identified based on a number of likely characteristics including building, job title, year worked, and site location. In addition, a job-exposure matrix, based on the exposure data gathered, will be created to guide the development of appropriate job-task clinical modules.

The information sources for this are diverse. Some will prove more informative than others. In many cases there will be inadequate quantitative data and we will be forced to rely upon information generated during interviews, focus groups and the like. We have utilized this approach in the assembling of the NTS project protocol and are confident that we will be able to address the needs of the Norton and Wyman-Gordon groups which are:

- Identify a group at risk of disease based on their exposure to beryllium
- Identify and characterize the extent of beryllium hazards
- Characterize adverse health outcomes associated with exposure to these substances
- Update the medical protocol including questionnaire and tests that can assist in the early identification of work-related health problems

5. Notification and Education

We will communicate risk information both through community and individual notification efforts to potential screening participants, and through the provision of educational material at the screening and in other settings. Notification materials will be periodically updated and revised as a result of feedback from participants, our Advisory Panel, and institutional review boards. These materials will include the notification letter, an informational brochure about the project, a question and answer sheet about the screening program, and an initial contact form.

An educational component of the screening program is crucial in order to maximize participation and to assure that participants understand beryllium-related health risk and their entitlement to compensation. This component includes developing materials for notification and outreach as noted above and identifying and addressing reasons for non-participation in the screening program. These activities will be conducted by the Steelworkers Local Union #2285 and United Autoworkers with the assistance of MASSCOSH. These activities are as important as the medical activities in conducting an effective occupational screening program.

Community notification efforts will include:

- Outreach to local unions and retiree groups by the project manager, including attendance at union meetings and other union functions, retiree breakfasts, and ongoing communication with union business managers
- Announcements in union newsletters
- Publicity through local media outlets including newspaper and TV
- Posters and brochures in all the union halls, the Worcester area libraries, senior centers, as well as the Worcester Labor council

6. Data Analysis

A well-designed and user-friendly administrative and medical database is critical to a high quality beryllium-screening program. It will assure that scheduling, results-reporting and other program communications will occur in a complete and timely fashion. A database will also facilitate analysis of aggregate medical and exposure results from the program for reporting to interested parties and to participants through the program newsletter. Aggregated data will remove personal identifiers. The database will also contribute to assessment of the effectiveness of the program in beryllium sensitivity and disease detection.

Data Entry of Medical Screening results

Data will be abstracted onto a Data Elements Form and then key punched by BUSPH staff. This file will be sent to the BUSPH DCC where the data will be transferred into the Microsoft Access cohort database. Concurrently, the Medical and Occupational History Questionnaire will be copied and sent to BUSPH where the project staff will review the questionnaires and clean the data using the established protocol. The cleaned questionnaires will be sent out for keypunching and then returned to BUSPH. The information will be downloaded and entered into the core database

Information from the medical forms will never be released in a manner that could result in the direct identification of a project participant. In addition, the results of the project will be released in aggregate both in the final project report and in any articles in scientific journals.

7. Follow-up

The results of the medical testing will yield individual participants who require medical follow-up. A detailed protocol will be developed to describe appropriate medical follow-up. This will include a follow up by personal physicians and pulmonary specialists. This function will be performed by BUSPH (described above).

Participants who may be eligible for federal compensation or state workers' compensation will require assistance in understanding and pursuing such benefits. Since there is no local DOE/DOL Resource Center, one or more Gordon-Wyman and Norton current or former workers, selected by the local union, will be trained to provide such assistance and advocacy to program participants. MASSCOSH staff will play a supplemental role in this effort.

Project personnel and resources in will be used to assist participants with the federal compensation program EEOICPA. BUSPH staff will respond to medical questions regarding eligibility criteria and requests for medical records. Dr. Lewis Pepper may complete occupational histories and write diagnosis letters for project participants who do not have personal physicians. These may be submitted as documentation for compensation programs. Dr. Pepper has performed a similar function for the Las Vegas DOE Resource Center and the Seattle DOE Claims Office in efforts to assist claimants.

8. Evaluation

Measures of success (or failure) of the program must be developed for every step listed above, including: ability to obtain a complete and accurate list of former Wyman-Gordon workers; success in notifying such workers about the beryllium screening program; success of participants in completing the specimen collection for beryllium screening; logistic difficulties in specimen transport and accurate laboratory assessment; success in assuring that program participants receive appropriate medical follow up; rate of participation in the beryllium screening program; and rate of compensation by the Federal Government for beryllium-related disease.

The screening program will issue quarterly results of the screening program, including data measures that reflect the elements of the program evaluation as noted above.

Organizational resources

The Department of Environmental Health at Boston University School of Public Health offers unique resources and the experience needed to accomplish this project. For last six years, The Dept of Environmental Health has been funded by the US DOE to conduct a medical screening and surveillance program for former DOE nuclear weapons workers at the Nevada Test Site. The program is a collaborative effort with University of California at San Francisco Occupational Health Program, the Southern Nevada Building and Construction Trades Council, and the University of Nevada Family Medicine Program. Medical screening is conducted for workers who may have been exposed to silica dust, diesel exhaust, ionizing radiation, beryllium, and noise. To date over 3,000 workers have participated in this activity.

The Boston University School of Public Health is one of sixteen schools and colleges that constitute Boston University (founded in 1839). The Schools of Medicine, Dentistry, and Public Health are located on a separate campus in the South End of Boston. The School of Public Health has ample office and instructional space and extensive laboratory and computer facilities, including a large inventory of microcomputers, access via high speed Ethernet to the University's central computing facility, and a special laboratory for students' computer use and instruction. The Alumni Medical Library houses major collections of the Medical School and School of Public Health.

The Environmental Health department (EH) of Boston University School of Public Health conducts programs in occupational and environmental health research program as well as carrying out a teaching program for MPH and ScD candidates. David Ozonoff, MD, MPH, is the current chair of the department.

Key Personnel

Dr. Lewis Pepper, MD, MPH, Principle Investigator: Dr. Pepper is currently the P.I. on the US DOE funded Medical Screening of Former Nevada test Site Nuclear Weapons Workers. Dr. Pepper is an occupational health physician who has conducted research at US DOE facilities since the early 1990's. He was a co-Investigator on an ATSDR funded project working with union and community representatives at DOE facilities in Ohio, helping to establish worker health concerns and to evaluate relevant occupational epidemiologic studies of the worker populations. In 2000, Dr. Pepper completed a five-year study of Organizational Restructuring and Downsizing at US DOE facilities.

Deb Cebrik, MS, Project Manager: Currently Ms. Cebrik is the research assistant for the Nevada Test Site Project. Ms. Cebrik has maintained and upgraded the NTS project data management and reporting systems. Ms. Cebrik has primary responsibility for managing the NTS beryllium component and with Dr. Pepper will be responsible for arranging all aspects of the Norton and Wyman Gordon program.

Partners

Steelworkers Union Local #2285 has represented the current 450 workers and former workers (including 600 retirees) at the Gordon-Wyman. Inc. facility in Grafton, Massachussetts in previous decades. The current president is Mr. Paul Soucy.

The United Auto Workers has represented machinists at the Norton facility for the past year.

University of Massachusetts at Lowell: Mark Griffon MS (consultant) is a health physicist and industrial hygienist who is based at University of Massachusetts at Lowell and heads a consulting firm, CPS, INC. He has conducted exposure assessments at 5 DOE facilities during the past eight years.

MASSCOSH is a non-profit education and advocacy organization dedicated to improving occupational health and safety in Massachusetts. It has a long history and an excellent reputation in the field.

Center for the Biology of Natural Systems, Queens College: Steven Markowitz, MD (consultant) is an occupational medicine physician on the faculty of Queens College with expertise in clinical and public health aspects of occupational disease. Since 1996, CBNS has been the medical partner of the Paper Allied-Industrial Chemical and Energy (PACE) International Union in sponsoring the Worker Health Protection Program at four major Department of Energy facilities (Paducah, KY; Portsmouth, OH; Oak Ridge, TN and Idaho Falls, ID).

Local Worcester medical facility: The Occupational Health Programs at Fallon Medical Clinic and Marlboro Hospital (both close to Worcester) have excellent reputations and will be sites where worker participants can have their medical testing performed.

Budget

The program budget is attached.

Timeline

Year	2003		2004				2005				2006	
Quarter	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd
Task												
Cohort identification and location	X	X	X	X								
Cohort notification and outreach		X	X	X	X	X	X	X	X	X	X	
Exposure assessment	X				X							
Medical protocol and testing		X	X	X	X	X	X	X	X	X	X	
Notification and Education		X	X	X	X	X	X	X	X	X	X	
Data analysis		X		X		X		X		X		X
Follow-up		X	X	X	X	X	X	X	X	X	X	X
Evaluation			X				X				X	

Attachment 2

Norton Facility Risk Mapping Summary Report

Facility Description

Norton conducted business for the AEC involving the manufacture of heat refractory products (including bricks and crucibles) from boron, beryllium, uranium and thorium. Norton developed a process for shaping beryllium oxide powder into rods and hexagonal rings using molds. Norton also used the process to produce beryllium oxide-uranium oxide hexagons. The processing began in the fall of 1945 and by 1947 AEC anticipated that the Norton Company in full production would use about 5000 pounds of beryllium oxide per month. (Ref: DOE Office of Worker Advocacy) According to the Office of Worker Advocacy beryllium operations ended in 1949.

The Norton Process

The Norton process involved pressing the beryllium oxide into a brick while the material is hot, namely at a temperature of about 1800 degrees Celcius. A graphite mold and core rod are breached and shaped to the proper dimensions and are several times the length of the final brick. The beryllium oxide is tamped into the graphite mold. It is then placed in a resistance furnace with a pneumatic cylinder providing end pressure on the mold assembly.

According to an NRC inspection report (ref NRC rpt), at the height of the radiation related operations in the late 50s, Norton was authorized for the possession and use of unlimited quantities of natural thorium and uranium to be used in the production of thoria and urania refractories, fused thoria and urania granular products. According to the report, Norton's records indicate that Norton possessed a maximum of about 6,000 pounds of source material at any one time. This work was conducted in Building 112. Norton provided uranium crucibles to Argonne and thoria slugs to Hanford where they were irradiated in the Hanford reactors.(ref: FUSRAP database report)

Records indicate that some work with uranium was being conducted as early as 1947. A June 10, 1947 memo discusses the production of "Black oxide ethyl" at the Norton Plant in Worcester, MA.

Risk Mapping Sessions

Risk mapping sessions were conducted in part to verify the time period during which beryllium was used at the facility, to determine the areas where beryllium was used or handled within the facility, and to the extent possible attempt to determine the high risk population of workers. Additionally, risk mapping was used to determine other exposures which took place during the AEC operations including but not limited to the radiation exposures (uranium, thorium).

Two risk mapping sessions were conducted with a total of 15 individuals. The individuals present included administrative staff, maintenance, plant manager, operations staff, and laborers.

Major Buildings of Concern – as reported by risk mapping participants

The participants in the mapping sessions had a broad range of background at the facility. Only a few of the participants had direct information on the use of beryllium or radioactive compounds within the facility. According to participants in these sessions the primary buildings of concern with regard to beryllium or radioactive material use included the IB building (#112), the Navy Building, and the R&D Building (#420).

Industrial Building (IB Building #112)

According to participants of the second session, building 112 was a pilot plant for ‘everything including nuclear for Argonne National Labs’. They reported that the AEC related operations in this building were conducted through the early 70s. One participant indicated that the uranium operations were conducted within this building from the late 50s to mid 60s. This is consistent with an NRC 1996 inspection report (ref) that indicates that Norton was licensed between 1955 and 1968. The operation included taking uranium in powder form, through furnace operations and forming pellets that were then extruded into aluminum rods. He reported that there were approximately 50-60 individuals involved in the operation. There was no urine testing but there were Geiger counters at the exits. According to participants they also machined beryllium and boron carbide armor in this building. The armor was tested in a firing range in a tunnel near building 526 (known as the coal pocket).

The NRC 1996 inspection report indicates that building 112 included a processing area for both uranium and thorium. A kiln in the processing area was used to fire refractory products made from source material. Scrap material was burned in 55 gallon drums placed under the hood/stack for the kiln. The ventilation for the facility was filtered and vented to the roof. This May 1, 1996 survey concluded that there was fixed contamination on some floor surfaces and in pipes that was in excess of the NRC criteria for release for unrestricted use.

Navy Building

The Navy Building (Buildings 124, 125, 126, and 127) was reportedly involved in both radiation work (the group reported uranium) and beryllium work. According to risk mapping participants, during peak periods there were approximately 40-60 workers in that building. Participants also reported that the Navy building was very dusty and that some workers wore respirators. According to participants the building was involved in radiation and beryllium work from the late 60s to the early 70s.

Building 420

Building 420, an R&D building, reportedly sent material to the Navy Building – participants thought that at least some of the materials were either beryllium or radioactive material. Participants believed that the beryllium and radioactive material was not received in the general plant receiving area but rather in this R&D building.

Plant 6, 7 and 8

The primary operation in the main buildings (Plant 6, Plant 7, and Plant 8) was the production of different types of grinding wheels. Plant 6 and Plant 7 were primarily involved in the production of silicon carbide type wheels (vitrified), while Plant 8, which was constructed about 10 years later, was involved in organic wheel manufacture. The Norton Company manufactured 100s to 1000s of different types of wheels.

Plant 6 (including current building numbers: 526 (Abrasives building), 528 and 530 (refractory), and 570 (Supply) were reportedly a very dusty buildings. Operations included mixing, molding, and finishing. Chemicals reportedly used in this facility included: crystallone (silicone carbide), aluminum oxide, green crystallone, and asbestos.

Plant 7 was reported to have similar operations as plant 6 but improved conditions. Plant 8 focused on organic wheel production however, participants had little knowledge of the types of organic materials used in the operations.

Building 519

Building 519, the Bond Plant, was where they made the material that, according to participants, “held the grain together”, however, the participants did not know what the chemicals were.

Building 544 (Fines Building)

According to participants this building was a very dusty building. Participants said that ventilation dampers were closed so they wouldn’t loose any material. Jobs involved in the building included classifier, systems operators, mill ops, and sizermen. A total of approximately 40 people worked in the building.

Brook Street Grinding

This building conducted rough cut and finish type machining work. The building at peak production periods included 450 people. Participants indicated that they may have done beryllium machining work there between 1960-1963.

Medical Surveillance Program for Former Department of Energy Workers at Wyman-Gordon

I. Introduction

The overall objective of this project is to carry out a medical screening program for former workers at Wyman-Gordon Company to prevent and minimize the health impact of diseases caused by site related workplace exposures (i.e., beryllium). The program was developed in response to Section 3162 of the 1993 Defense Authorization Act that urges the US Department of Energy (DOE) to "carry out a program for the identification and ongoing evaluation of current and former DOE employees who are subjected to significant health risks during such employment." This program, funded by the DOE, is an amendment to the medical surveillance program for former DOE workers at the Nevada Test Site (NTS).

II. Wyman-Gordon

Founded in Worcester, Massachusetts in 1883, Wyman Gordon is a manufacturing corporation that currently has 17 plants in 5 sites worldwide. According to Wyman-Gordon officials, the company currently employs a workforce of approximately 3,400 individuals.. Today, Wyman-Gordon is owned by Precision Castparts Corporation (PCC).

Located at 244 Worcester Road (Route 122) in North Grafton, Massachusetts is Wyman Gordon's North Grafton facility. An additional facility - the Millbury plant (1529 Grafton Road) - is located on an adjacent property to the west of the Grafton facility in Millbury, Massachusetts. In the past, the Millbury plant was primarily used for research and development purposes. Today the plant is designated as office space, and moreover, the company headquarters. The scope of this report shall apply solely to the North Grafton facility.

III. Facility Description

The North Grafton facility is approximately 232 acres in size, which includes approximately 72,100 square feet of warehouse space, and 841,500 square feet of manufacturing area. Manufacturing operations in the North Grafton plant include the forging, milling, and etching of metals for use in aircraft and aerospace industries (military and commercial aircraft). More specifically, the forgings produced in the North Grafton site are used for structural or engine components, and in other applications where large, high technology forged pieces are required (i.e., industrial gas turbine and aeroturbine applications).

Prior to 1943 the North Grafton site was used for community farming. The site was acquired by the United States Reconstruction Finance Corporation and was subsequently sold to the United States Air Force. Industrial operations have been performed at the North Grafton site since 1945, at which time, the original forge shop was constructed. Since then, the facility has increased approximately four fold, with the construction of new buildings and the addition of new manufacturing processes. Wyman-Gordon purchased the facility from the United States Air Force in June 1982, and PCC – the current owner of Wyman-Gordon - acquired the company in 1999. Over an extended period of time, the facility has done both DOE, and Department of Defense (DOD) work.

The primary buildings of interest at the North Grafton facility include the Forge Shop and the Process and Maintenance Building (P&M Building). The Forge Shop and the P&M Building, connected by tunnels and overhead walkways, encompass approximately 25 acres of the North Grafton facility. Parts fabricated in the Forge Shop and the P&M Building ranged from small (1-2 feet (i.e., beryllium parts)) to very large (10-30 feet).

Other locales at the North Grafton site, that are of lesser importance to this project, include the administrative building, which is situated in the front of the Grafton Complex, and the Quonset Hut – a building that reportedly held the site's trucks and forklifts. Other buildings displayed on maps of the North Grafton facility include storage buildings, a steam plant, the APC (acid treatment) complex, and water towers.

IV. Operations Overview

A. The Forge Shop

The forge shop was constructed in the 1940's. It consisted of four primary processes or operation areas. These areas include: the furnaces, the Forge Weld Area, the Stockcut area, and the presses (an initial 18k Ton press (installed around 1945), a 35k Ton press, and several 50k Ton presses (added around 1955)),. Feed material originated in the Stockcut area, with the exception of beryllium - which was received by Wyman Gordon in a powder form and loaded into cans in the P&M Beryllium Area (now called the Lab Test Area). Molten metals coming out of the furnaces were pressed into the dies within the forge shop presses. Dies were made in the P&M die shop. Coating of rolls of asbestos paper (later fiberglass) with lube oil (graphite and water based) occurred in the Stockcut area. This paper was inserted into the dies to prevent parts from sticking to the dies.

B. Process and Maintenance Building (P&M Building)

The Process and Maintenance building had several process areas: a process and finish area, a machine area, a die shop, and a lab test area (formerly known as the Beryllium area).

Fabricated parts went from the presses to the process area where they were often chemically treated in acid and caustic baths. In the case of beryllium, this process was used to dissolve the outer can. The finish area contained several dimensional inspection tables and some hand grinding activities. In the die shop, workers constructed dies according to wooden models that were developed in the Model Shop. Dies would occasionally come back to the die shop for reworking. The machine shop involved machining of the pressed parts. The beryllium area, however, had a separate area dedicated to the machining of beryllium parts.

V. Primary Exposures

The North Grafton facility reportedly generates waste oil and sludges from forging and machine lubrication, waste acids from chemical milling and cleaning, sludges from wastewater treatment, and rinse waters from chemical milling and cleaning operations. Specific hazards encountered throughout the facility shall be described in the subsequent text.

A. Forge Shop – Press and Furnace Area

Multiple exposures in the press and furnace area of the forge shop were mentioned during the risk mapping session. These exposures included: base metals (aluminum, magnesium, titanium, copper-beryllium, beryllium, stainless steel), lube oil (graphite and water based – white and bagley), asbestos (gloves, blankets, and paper), heat, noise, vibration, carbon tetrachloride, and kerosene. The risk mapping participants mentioned that they had one furnace with radioactive labeling, however, none of them remembered working with uranium or other radioactive metals.

Participants of the Risk Mapping session further commented that the whole forge shop often looked as if "snow flakes were raining down." Anecdotally, we know that they were witnessing asbestos. Based upon this observation, it was the unanimous opinion of the group that the Forge Shop was the dustiest area in the facility. Workers were continually exposed to dust, smoke and fumes while in this area.

Risk mapping participants also mentioned that during press operations they would use air hoses between cycles to clean out the areas below the press. This method would cause dust to be distributed throughout the ambient air. Depending on the part being run, cycles could were sometimes as frequent as every five minutes. The group also indicated that clean up of the forge occurred more often on weekends than on weekdays.

The exposures during the weekend clean-up would have been similar to those mentioned above, however, the group indicated that this was very dirty work – which included cleaning the presses, the furnaces, and scarifying the floor.

Workforce

The following jobs were associated with the Forge Shop: Forge shop helpers, Oilers, Heater, Operator, Drivers, Crane Operators, and Guards (who frequently walked the cat-walk).

The following jobs were often assigned to the clean-up work: Brick Layers ("Brickees") and the Yard Gang/Laborers

B. P&M Building – Beryllium Area (Filling Room)

The beryllium Area filling room involved beryllium powder handling (loading powder into cans via a hopper operation). The individuals working in the beryllium area reported that they were required to wear half face respirators, full disposable cover-alls, and gloves. Risk mapping participants also indicated that the room had many air samplers. They reported that this area was decontaminated in the late 1970's. They further indicated that the decontamination job was performed by a sub-contractor. The primary exposure in this area was identified as beryllium.

Workforce
The workers in the area were primarily laborers (4/shift – one shift per day).

C. P&M Building – Beryllium Area (Machining)

Beryllium machining involved dry machining that was performed with local ventilation. According to the risk mapping participants, those who were involved in this process wore full PCs. The primary exposures reported in this area included beryllium and noise.

Workforce
The workers in the area included: Machinists, Drivers, Inspectors, and Janitors.

D. P&M Building - Process and Finish Area

The Process and Finish Area is the area in the facility where parts would come after the work was completed in the Forge Shop. The work in this area included chemical treatment of metal parts (e.g. Pickling) and grinding operations (both rough and finish grinding work). According to the risk mapping participants, beryllium parts would come from the Forge shop to this area. These parts would then go to the Beryllium Area Machine shop, rather than the general machine shop. The primary exposures reported in this area included: hydrofluoric acid, nitric acid, and the base metals (including any of the metals they worked on including beryllium parts).

Workforce
Workforce not collected during risk mapping session.

E. P&M Building – Machining Area

The P&M Building Machine shop was the general machine shop where all of the products from the machine shop (except Beryllium parts) were machined to final specifications. It was a large machine shop designed to handle large parts. Types of machining performed in the area included: turning, milling, grinding (vertical grinders) and die syncing. The primary exposure reported in this area included: all base metals (except beryllium), lube oil, asbestos, heat, noise, carbon tetrachloride, and kerosene.

Workforce
The workers in this area included: Welders, Pipefitters, Maintenance Mechanics, Electricians, and Machinists.

F. P&M Building – Die Shop

The P&M Building Die Shop performed the work necessary to construct the dies used in the forging process. They also did die trim work, and occasionally welding which was done to trim excess material from the edges after forging. Risk mapping participants thought it unlikely that any beryllium parts were worked on in this area. The primary exposures in this area included: base metals, steel, asbestos, noise, vibration, welding fumes, and coolants.

Workforce
The workers in this area included: Die Syncers and Die Grinders.

VI. Other Exposure Concerns

1. Beryllium Outside of Plant

In the 1960's air pollution control ducts associated with the beryllium manufacturing area exhausted from the P&M building into an area that was located near the western side of the main facility buildings (i.e., East of Bonny Brook - a perennial stream running along the West side of the facility) between the Forge Shop and the P&M Building

Several pieces of equipment, used to manufacture beryllium alloy forgings, were supposedly buried in the above-mentioned area in 1970. The Surplus Equipment Disposal Area consisted of an unlined cellar hole, which was approximately 25 feet by 25 feet and about 8 feet deep. The equipment was supposedly buried in the cellar and covered with topsoil. This area has not been evaluated, though monitoring wells are in the area. No beryllium was detected in the groundwater in those surrounding areas.

Risk mapping participants further indicated that they remembered dumping beryllium waste in on-site burial pits. They indicated that the area had been remediated approximately 10-12 years ago, but they did not remember the contractor that performed the work. These individuals also reported that beryllium decontamination work, performed by an unknown contractor, occurred in the late 1980's.

2. Radiation

Between 1958 and 1971, Wyman-Gordon held several licenses from the US Atomic Energy Commission (AEC) for the possession of magnesium-thorium alloys and uranium: the last license for this material was terminated in 1971. During this period Wyman-Gordon used solid magnesium with 3% thorium, to manufacture magnesium-thorium forgings. Approximately 50,000 pounds (167 cubic yards) of thorium-contaminated scrap and equipment were disposed on sire under 10 CFR 20.304 in approximately 25 trenches arranged in three groups. This method of disposal was inaccordance to federal regulations at the time. The trenches were roughly 2 feet deep, three feet wide, and were covered with 4 feet of soil. The bottom of the trenches were believed to be about 4-5 feet above the water table.

Risk mapping participants recalled a site that was know as the Norton pits where radioactive waste was taken. Again, participants did not remember doing forge or machine work on uranium parts, however, as previously mentioned, they did remember radioactive labels on one furnace.

VII. Outreach Strategies

A. USWA 2285

One of the more successful methods of former worker outreach has occurred while working in conjunction with Wyman-Gordon's ex-union president, Paul Soucy. Soucy, the former president of the United Steelworkers of America Local 2285, has assisted project staff by providing site maps, historical information, and most importantly, a roster of approximately 650 former Wyman-Gordon workers. The roster, which contains updated contact information, was used to aide project staff in sending letters, which described the program, to former workers. Response rate has proven to be close to 50% (48.7).

Press Conference

In coordination with UMASS Marlborough hospital, USWA Local 2285, and US Representative Jim McGovern, project staff successfully organized a press conference to publicly announce the medical screening program. The press conference resulted in the publishing of several articles that appeared in the Worcester Telegram and Gazette and the Boston Globe (Metro West). Phone calls to the project office increased substantially in the days following the press conference.

Massachusetts Coalition for Occupational Safety and Health (MASSCOSH)

MassCOSH has recently joined project staff to assist in outreach strategies. Potential outreach strategies include contacting pulmonary specialists and physicians in the Worcester area, as well as retirement groups. These strategies, like those mentioned above, will be designed to increase the program awareness and visibility.

MIT &Nuclear Metals Summary

MIT Process Information

MIT began operations for the Manhattan Engineering District (MED) in 1942 and operated at the Cambridge facility and the facility in the Watertown Arsenal (Watertown, MA) through 1954. In 1954 research continued under Nuclear Metals. Nuclear Metals than moved to Concord, MA in 1958. MIT processed and conducted early metallurgical testing on uranium metals, beryllium, zirconium and thorium. (MIT 9) Some of the most important developments initiated at MIT and NMI included the development of depleted uranium penetrators, beryllium tubing, tubular transition joints that connect otherwise incompatible metals and zirconium (with trace amounts of Halfnium) clad fuel elements. (MIT 9)

MIT worked with African Congo ore rejects for the extraction of uranium. The initial purpose of the project was to study the treatment of low-grade uranium ores with emphasis on the principles involved rather than for the specific solution of any one problem. As the work developed it was clear that the ore of much lower grade would have to be treated to provide increased uranium production. The project, therefore, was increasingly orientated to the effective processing of relatively low-grade materials. These operations were moved to the Watertown Arsenal until 1951. (MIT 10)

Beryllium Work

In one of the very early MED contracts MIT undertook development tasks which, among other things, involved some of the first known work in this country with beryllium. Initial contracts were extablished for MIT to produce beryllium billets and extrude beryllium rods for the Los Alamos facility. This extrusion work was conducted under the direction of MIT at the Revere Copper and Brass Company in Revere, MA. Although Brush Beryllium Company took over much of the large scale production work, MIT continued to play an important role in the production of unique shaped beryllium products including: foils, discs, plates, spheres and hemispheres. (MIT 12) On March 29, 1945, MIT included beryllium in a list of five extra hazardous materials for which the Institute requested additional insurance. The request was refused by the MED. Within 2 years of the decision there is evidence that MED and MIT were concerned about illnesses arising among those working on beryllium. In December of 1947 MED requested a list of MIT workers who had become critically ill due to exposure to beryllium. In March of 1950 all operations in the Hood Building were suspended on orders of the NYOO pending completion of a new ventilation system. As of March 1961 MIT estimated that approximately 250 people had worked in areas constituting a hazardous exposure to the beryllium dust. Twenty known cases of berylliosis existed at this time. Ten had been the subject of compensation claims and two deaths had resulted. (ref MIT 2) Approximately 2000 individuals had been involved in the beryllium project in some capacity from 1943-1948. (MIT 8) Based on an interview with a former worker, later a Safety Director at NMI, beryllium airborne levels were as high as 2000 micrograms per cubic meter. (MIT 3) Some air sampling reports indicate elevated airborne levels in the 10s to 100s of micrograms per cubic meter (MIT 4)

Beryllium operations reported include: Crucible manufacturing, billet manufacturing, grinding, arc welding, machining, and extrusion. (MIT 5) MIT handled beryllium in many forms including: Beryllium Flakes, Beryllium Lump, Beryllium Pebbles, Beryllium with Iron, Beryllium Billets, Beryllium Oxide, and Beryllium Chloride ($BeCl_2$). (MIT 11)

Programs which were conducted during 1947 – 1948 included the following: (MIT 7)

- Beryllium Production and Purification
- Beryllium Melting and Casting

  This includes vacuum and melting techniques, fine grain casting techniques, beryllium alloy casting (including Beryllium-Uranium alloys), and extrusion of billets. Specific developments included: development of methods for vacuum casting beryllium metal into various shapes and ingots suitable for extrusion and development of air casting techniques. (MIT 12) Beryllium originally believed to be unextrudable. "Kaufman set up a powerful extrusion press in the Hood Building near MIT and proceeded to make first-rate extruded bars" (MIT 9)

- Beryllium Fabrication of cast and powdered metal

  Including extrusion, rolling, welding and engineering testing of beryllium structure. This included the development of method for hot rolling beryllium by the use of iron jackets, development of technique for extrusion of beryllium metal by use of an iron jacket cladding a beryllium ingot, and techniques for machining both cast and extruded beryllium metal (MIT 12)

- Beryllium Testing and Metallurgy

  Including testing of physical properties and radiation damage testing.

- Uranium Metallurgy

  Including testing of uranium and uranium alloys.

- Thorium Metallurgy

  Including extrusion of cast and powdered thorium and testing of thorium and alloys.

MIT Watertown Arsenal facility

MIT operated a laboratory and a uranium ore testing facility for AEC in a building at the Watertown Arsenal. MIT developed a technique for the production of U_3O_8 known as the "resin-in-pulp" (RIP) technique. This production method was an ion exchange technique using a fluidized bed system. Initial research on African ores was conducted in the Cambridge facility and eventually transferred to the Arsenal (Building 421) in 1946. MIT conducted the research activities until 1950 at which time American Cyanamide took responsibility for the functions at the Arsenal site. In 1951 the Army indicated a need for the space being used by the AEC project and as a result AEC initiated construction of a new laboratory in Winchester, MA. The new facility was completed in 1953 and the AEC activities at Watertown Arsenal, building 421 was transferred to the new facility.

Later radiological surveys conducted by ANL discovered that several more buildings at the Arsenal were used for uranium operations during the MED/AEC era. This included buildings 34 and 41, a uranium storage area and a uranium burn area. (ref MIT 1)

Cambridge Electron Accelerator (CEA)

The Cambridge Electron Accelerator (CEA) is a basic research high energy physics laboratory utilizing an electron synchrotron of the alternating gradient type, designed to produce electrons of six billion electron volts energy with an average beam intensity of 6E12 electrons/sec. The CEA consisted of a four story laboratory and office building, a power building, a cryogenic building, an experimental building and an accelerator tunnel. The experimental building is comprised of a main experimental area (Experimental Hall), counting room and a data processing room. On July 5, 1965 there was a major accident with an explosion and a fire and one fatality. (MIT 6)

Exposure Information

Exposures identified include: beryllium (all forms), uranium (very little enriched uranium), pitchblende ore or African Congo ores (important since very high levels of radium and other high dose consequence radionuclides (Thorium, Actinium, Protactinium), acetone (in frost process), chlorinated solvents, machining fluids, zirconium metal, thorium.

Some airborne beryllium monitoring data exists. Data suggest levels ranging as high as the 10s to 100s of microgram per cubic meter. Some reports suggest that at least some employees had given blood samples for beryllium testing however, none of these results were identified. Some air sampling for uranium was also identified (less than the beryllium monitoring data). It is unclear whether any urinalysis was conducted for the testing of uranium in urine.

For external radiation exposures limited film badge reports were identified (MIT 13) including monthly summary reports from August 1952 through December 1953. These report indicate the total number monitored along with the number in excess of action level (150 mr/week for gamma and 300 mr/week for beta). Most of the reported doses in excess of the action levels were extremity measurements (indicating that the individual was wearing a wrist badge).

Nuclear Metals Process Information

The original facility consisted of three principal buildings, designated Buildings A, B, and C. Building A contained office space and research laboratories. Building B contained services (cafeteria, laboratories, etc.). Building C was initially configured for use as the main production facility, including foundry equipment for melting metals, extrusion presses, metal working equipment, pickling and etching tanks, and electroplating equipment.

The site was originally a specialty metal research and development facility that was licensed to process low-level radioactive substances. From 1957 to October 1972, the Site was owned and operated by a succession of companies that were engaged principally in research and development contract work. Since 1972, NMI and its subsidiaries have owned and operated the site. After 1972 NMI developed a manufacturing orientation. Building D was constructed in 1978 to expand the production capabilities of the facility. Building E was constructed in 1983 and was used to house the radioactive waste processing operations.

Past operations at the Site involved research and development in fundamental metallurgy, physical metallurgy, chemical metallurgy, engineering and product development, fuel element development and manufacture, and high temperature materials (NMI, 1961). Most of the operations at the Site were for the US Atomic Energy Commission and the Department of Defense. Some of the research activities and operations at the Site include:

Beryllium materials studies

- Alloying of uranium for specific properties (corrosion resistance, high stress rupture characteristics, etc.)
- Fuel element and fuel element materials testing
- Development of melting and casting techniques for beryllium and uranium alloys.
- Development of cermets, including beryllium-beryllium oxide and stainless steel uranium oxide.
- Development of machining methods for uranium, thorium, beryllium, yttrium, and other metals.
- Submarine reactor fuel elements
- Production of fuel elements for several different reactors at National Laboratories.

Investigation of materials and design problems in nose cone reentry studies, with particular emphasis on the use of materials in combination.

The focus of the Site operations shifted from research and development to large scale production in the mid 1970s. This included manufacture of depleted uranium (DU) shields, counter weights, and armor penetrators, manufacture of metal powders, beryllium and beryllium alloy parts production, and manufacture of specialty titanium parts.

Enriched Uranium Work

NMI designed and manufactured enriched uranium fuel elements for the DOEs Enrico Fermi Test Reactor in Chicago in the mid 1960s until 1975. It was called the CP-5 program. These aluminum clad extruded fuel elements were manufactured exclusively for this test reactor until NMI management surrendered their enriched uranium license from the NRC in 1975. (Robert Quinn letter, 2001) It should also be noted that enriched urnanium and thorium rods were reportedly produced for Brookhaven Natl labs (

General DU Operations

Raw DU was received at the Stie as derbies or as cut pieces and was cast and/or machined into products in the facilities. The casting process was conducted under vacuum. The melt was poured into one or more molds and allowed to solidify, possibly assisted by an inert gas back fill. The casting either represented a completed object as is, or required further processing and enhancement of surface finish by hand operations (e.g., filing or grinding, painting, electroplating, etc.)

Castings were generally made into extrusion billets by enclosing them within metal jackets to minimize oxidation or contamination spread, although extrusion of unjacketed billets also occurred. Billet stock was sometimes machined prior to encapsulation. Encapsulated billets were heated and extruded, and the encapsulation remained as a thin layer protecting the surface of the extrusion. Individual billets seldom exceeded 400 pounds.

Castings, extrusions, or formed pieces sometimes required machining either as preparation for further processing or as a finishing operation. Most of the items subjected to machining weighed less than 100 pounds each, but since several different kinds of machine tools were available, the total amount of source material involved in machining at any one time could have been approximately 10,000 pounds.

Extrusion or cut pieces were straightened, flattened, forged, or swaged at either room or elevated temperatures. Parts were cleaned by immersion in acids or by contact with organic solvents or detergents.

Research and Development

Between 1958 and 1975 the facility engaged in research and development in support of DOD initiatives. Available evidence suggests that R&D activities involved metals, metal alloys, and metal complexes, including depleted and enriched uranium, zirconium, thorium, molybdenum, titanium, and beryllium.

Thorium Operations

The facility reportedly engaged in manufacturing of thoriated tungsten rods. Waste streams historically generated from these operations may have included dust and filings.

Beryllium Operations

Beryllium metal has been and continues to be fabricated into beryllium alloy products at the site. Waste streams historically generated from these operations may have included dust and filings. NMI developed and produced on a sole source basis every single beryllium alloy end closure fuel element ring used in the N reactor at Hanford (around 1964), also had follow-on contracts through 1986. (Quinn, Robert personal letter, October 11, 2001)

Penetrators

DU penetrator (KE penetrators ??? – William Lorenzen Notes) production was a multi-step process. It began with a DU melt consisting of DU and titanium. The metal was melted under vacuum in a zirconium-coated graphite crucible. The melt was than poured into a yttrium-coated mold to form ingots.

Billets were formed by vacuum sealing the ingots in copper tubes. The billets were than extruded. Extrusions were performed in a 1400 ton extrusion press. Billets were loaded into ovens and maintained at 600 degrees C for one hour minimum prior to extrusion. The die was lubricated and the billets were pushed through the die at a constant ram speed. Immediately upon exiting the extrusion press, each rod was automatically transferred to a forced air/water mist cooling bed. Rod stock exiting this system was cool to the touch. The cooper sheath on the extruded bars was removed by acid digestion (pickling). After pickling, the extruded rods were straightened using a Sutton two roll straightener to facilitate subsequent cutting operations. The rod stock was cut into blanks of appropriate length by sawing.

Finish machining required a precision premachined blank with a uniform diameter and flat ends perpendicular to the bar axis. These requirements were met by centerless grinding to the desired finished diameter. The ends were faced flat and perpendicular to the bar axis. DU penetrator blanks were turned to their final configuration on computer numerical control (CNC) lathes.

Powder Manufacture

Metals were converted to powder by the rotating electrode process (REP) equipment. A bar of metal was rotated in a helium filled chamber where it was melted by an electric arc. As the metal liquefied, it spun off and solidified into a powder. Metals used included aluminum, steel, titanium, and nickel base super alloys. <u>William Lorenzen notes indicated that they did process beryllium metal into beryllium powders with this methodology. He also mentioned beryllium oxides and powder mostly HIP processes ??</u>

Buildings

Building A
Building A was constructed in 1958. It was used for office space, laboratory work (south end of the first floor and north end of the 2^{nd} floor), and quality control. About 60 percent of the building was built as laboratory space for analytical chemistry, chemical metallurgy, and physical metallurgy. According to technical memo (MACTEC) the past use of the building for production and handling of radioactive materials is more extensive than the original RI scooping review indicated and therefore has the greatest potential for unknown residual radioactivity and requires the most detailed characterization in order to evaluate remediation options. Removable alpha contamination found to range from 0-80 dpm/100cm^2 and fixed alpha ranging from 0-1500 dpm/100cm^2. A beryllium laboratory was set up in the 1980s at the south end of the second floor.

Building B
Building B was constructed in 1958. The building contains the boiler room, which services the entire complex, electrical switch room, locker rooms and the company clinic. Portions of Building B have been converted for other use (???? Labs – the summary section said labs in this building) during the operations of the facility. Building B is connected to Building A and Building C. Removable alpha contamination found to range from 0-80 dpm/100cm^2 and fixed alpha ranging from 0-1500 dpm/100cm^2.

Building C
Building C was built in 1958 and was used for manufacturing functions. This included foundry equipment for melting metals (capacity of 200 pounds of steel or 300 pounds of uranium), a cold crucible arc melting unit, 1000 ton and 300 ton extrusion presses, metal working equipment (100 ton vertical press, rolling mill, swaging machines, hydraulic presses, pulverizers, graders, blenders and ball mills), pickling and etching tanks, electroplating equipment, machine shop, and welding shop. According to the technical memo (MACTEC) the highest levels of residual contamination will be found in the foundry and machining areas. Surveys indicated removable contamination in the range of 25-1000 dpm/100 cm^2. Fixed alpha contamination was found to range from 1500 – 250,000 dpm/100 cm^2. Fixed beta-gamma measurements ranged from 5000 to 2E6 dpm/100 cm^2. Beryllium was used in the foundry, extrusion and pickling areas (MACTEC).

Building D
This building was built in 1978 to augment Building C due to increased production. Some of the manufacturing processes were moved from Building C to Building D (primarily machining for DU armor penetrators) and a special beryllium working area was also included. Building D is connected to Building C. Surveys indicated removable contamination from 50-200 dpm/100 cm^2. (MACTEC) HASP indicates alpha contamination levels from 100 – 500 dpm/100 cm^2 with fixed alpha from 2000 – 30,000 dpm/100 cm^2. Beryllium work has reportedly been

restricted to the north end of the building (where the present beryllium work is being conducted by Applied Technology Management). (MACTEC)

MACTEC report also says “the remaining areas have been reportedly checked for residual beryllium and cleaned to internal standards (DOE 5 ug/ft^2 as ‘below concern’”. This statement is unclear – it may imply other areas of Building D were in the past contaminated and it may be referring to other buildings within the complex .

Building E

Building E was constructed in 1984 and was added to provide additional space for finish machining and quality control of DU armor penetrators, storage of materials and supplies, treatment of liquid wastes, and processing of waste materials for shipment. Building E is connected to Building C. Surveys indicated removable contamination from 50-200 dpm/100 cm^2. (MACTEC) HASP indicates alpha contamination levels from 100 – 500 dpm/100 cm^2 with fixed alpha from 2000 – 30,000 dpm/100 cm^2.

Butler Buildings

Butler Buildings 1,2,3 and 4 were used for radioactive waste storage and waste processing. Butler buildings 1 was built in 1958, Butler building 2 was built in 1960, Butler building 3 was built in 1976 and Butler building 4 was built in 1977. Surveys in the Butler buildings indicate removable alpha contamination ranging from 0-30 dpm/100 cm^2 and fixed alpha contamination ranging from 200-2000 dpm/100 cm^2. (HASP)

Chemicals of concern mentioned in HASP report:

Arsenic (inorganic and organic), Benzene, Beryllium, Cadmium, Chromium Metal, Cobalt (elemental and inorganic compounds), Dichloroethane, Dichloroethene, Lead, magnesium, mercury, molybdenum, nickel, pcb’s, tetrachloroethane, titanium, toluene, trichloroethane, trichloroethene, tungsten, vanadium, zirconium, zirconium azides

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Attachment 4

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