

EXECUTIVE SUMMARY
RADIOLOGICAL STATUS SURVEY OF BUILDINGS AND SOIL IN SURVEY ZONE
4A AT EVANS AREA, FORT MONMOUTH, NEW JERSEY

Conducted
December 1998 to December 1999

1. **Purpose**. The purpose of this report is to document the current status of the radiological survey of the "Zone 4A" section of Fort Monmouth, Camp Evans' land and buildings conducted from December 1998 to December 1999. This report is provided to the US Army Communications and Electronics Command's (CECOM) Directorate of Safety (DS) for their review. The report is intended to support CECOM's review of Camp Evans Zone 4A status and eventual request for unrestricted release of this section of Camp Evans for public use through the US Nuclear Regulatory Commission (NRC) and New Jersey Department of Environmental Protection (NJDEP).

2. **Area Surveyed**. The section of Camp Evans covered by this report is located within the primary security fence that encloses most of the site's research buildings. The section surveyed covers approximately a one and one-half acre fenced compound located in the center of zone 4, to include a 50 foot radius extending around the outside perimeter of the Zone 4A fence-line. The zone 4A fenced area is located within the block encompassed by B Avenue to the Northwest, 6th Street to the Northeast, C Avenue to the Southeast, and 7th Street to the Southwest. Appendix C contains site maps with all zones identified.

3. **Areas Not Included in This Survey Report**. The area of 6th Street between Avenues C and B is currently being used for temporary radioactive material storage for wastes generated as a result of the Camp Evans remediation project. This area is actually on the boundary of Zones 3 and 4. To expedite the surveys in Zone 4A, radioactive waste was packaged for shipment and stored in this area. Storage and shipment of this material is provided for under separate contract between the CECOM Directorate of Safety and New World Technologies and as such is not part of the MTC activity. The CECOM Directorate of Safety will provide final survey data for this area for inclusion in an addendum to the Zone 3 and 4 report.

NMSS/RO-N-002

4. Summary of Results. To the extent surveyed, radioactivity remaining on the surveyed land and buildings is background level radiation. Scoping surveys detected radioactive material used by the US Army in seven buildings in survey zone 4A, and two outside areas having soils with elevated radioactivity. Three of the buildings required extensive remediation efforts to include the removal of sections of the sanitary sewer lines. Following the decontamination, additional surveys verified the radiation levels were below release guideline values. Based upon the results of this survey, the samples as tested fall within prescribed release limits.

5. Recommendation. CECOM Directorate of Safety should review the results of this report to determine if a request for unrestricted release for public use of the buildings and land covered by this survey should be submitted to the NRC and NJ DEP.

4. **Summary of Results.** To the extent surveyed, radioactivity remaining on the surveyed land and buildings is background level radiation. Scoping surveys detected radioactive material used by the US Army in seven buildings in survey zone 4A, and two outside areas having soils with elevated radioactivity. Three of the buildings required extensive remediation efforts to include the removal of sections of the sanitary sewer lines. Following the decontamination, additional surveys verified the radiation levels were below release guideline values. Based upon the results of this survey, the samples as tested fall within prescribed release limits.

5. **Recommendation.** CECOM Directorate of Safety should review the results of this report to determine if a request for unrestricted release for public use of the buildings and land covered by this survey should be submitted to the NRC and NJ DEP.

TECHNICAL REPORT
RADIOLOGICAL STATUS SURVEY OF BUILDINGS AND SOIL IN SURVEY ZONE
4A AT EVANS AREA, FORT MONMOUTH, NEW JERSEY

Conducted
December 1998 to December 1999

1. REFERENCES. Attachment A.

2. AUTHORITY. Base Realignment and Closure (BRAC), Army Execution Plan, BRAC 93, (Public Law 101-510) requires the closure of the Camp Evans property and its release from US Army control. US Nuclear Regulatory Licenses Numbers 29-01022-06 and 29-01022-14 authorize use of radioactive material at Camp Evans. Title 10, Code of Federal Regulations, Part 30 requires a licensee to provide proof that either no residual radioactive material remains on the site or any radioactive material remaining at the site will not adversely affect the public health or safety. Surveys were conducted under Modern Technologies Corporation's, US Government Omnibus Health Physics Contract, DAAB07-95-D-H008. The survey was performed for the CECOM Directorate of Safety (DS), Fort Monmouth Radiation Protection Officer.

3. PURPOSE. This survey determined the current radiological status of the "Zone 4A" portion of Fort Monmouth, Camp Evans' open land and buildings surveyed. This report is provided to the US Army Communications and Electronics Command's (CECOM) Directorate of Safety (DS) for their review. The report is intended to support CECOM's review of Camp Evans Zone 4A status and eventual request for unrestricted release of this section of Camp Evans for public use through the US Nuclear Regulatory Commission (NRC) and New Jersey Department of Environmental Protection (NJDEP).

4. GENERAL.

a. Camp Evans is located in Wall Township, NJ approximately 10 miles south of Fort Monmouth's main post. The property is 210 acres in size.

b. The section of Camp Evans covered by this report is located within the primary security fence that encloses most of the site's research buildings. The section of Camp Evans surveyed is approximately one and one-half acres in size. The streets that boundary the block that contains Zone 4A are as follows: Avenue B to the North, 6th Street to the East, 7th Street to the South, and 7th Street to the West. Appendix C contains site maps with zone locations identified.

c. The radiological historical review of Camp Evans determined that the area covered by this report contained research and development buildings. The radiological history documents dating from 1950 to the present were reviewed. The historical documents and information from employee interviews gave identification numbers for three buildings in Zone 4A that had a history of utilizing both radioactive materials and ionizing producing devices: buildings 9045, 9401 and 9383.

d. The portions of 6th Street used for temporary storage of radioactive waste will be completed when all radioactive waste is shipped to the disposal site for final disposition. The CECOM Directorate of Safety will provide final survey data for the field for inclusion in an addendum to the Zone 3 and 4 report.

e. All survey field work, sample collection, preparation and analyses were performed by contracted personnel under the direction of Mr. Steven A. Horne, IceSolv, Inc., Nuclear Scientist Consultant to CECOM, Directorate for Safety, from December 7, 1998 until September 10, 1999. Mr. Craig E. Miller, Health Physics Consultant, Modern Technologies Corporation, assumed these responsibilities from October 18, 1999 until completion of the project. Mr. Joseph Santarsiero, the Fort Monmouth Radiation Protection Officer, was CECOM's overseer for the project.

f. Mr. Craig E. Miller, IceSolv, Inc., supervised the fieldwork from December 7, 1998 until September 10, 1999. Field team leaders conducting the surveys were all radiation safety specialists with diverse training and experience in radiological health and safety. The experience and training of the fieldwork supervisor and survey team leaders meets or exceeds the requirements in ANSI 3.1 for a Senior Radiation Technician.

g. Sample analyses were performed at Camp Evans in the CECOM Directorate for Safety Radiological Engineering Laboratory, (REL). Mr. Steven A. Horne, IceSolv, Inc., Nuclear Scientist Consultant to CECOM, DSRM, supervised the laboratory operations from December 7, 1998 until September 10, 1999. Mr. Craig E. Miller, Health Physics Consultant for Modern Technologies Corporation, supervised the REL from October 18, 1999 until the completion of the project. Laboratory technicians completed site-specific procedures, laboratory practices, and occupational health and safety training provided at Camp Evans.

h. Field and laboratory operations were performed using written operating procedures for guidance. Documentation of surveys and laboratory results are on file with the CECOM Directorate of Safety and available for review at Camp Evans. The soil samples and wipes collected during the survey are archived at Camps Evans and will be maintained by the CECOM Directorate of Safety until written releases have been granted by both the US NRC and NJ DEP.

i. Mr. Ken Lamson, Certified Industrial Hygienist and Certified Health Physicist, New World Technology, supervised remediation/excavation operations involving hazardous mixed wastes. Mr. Mark Divoky, Health and Safety Manager, New World Technology, performed health and safety supervision during remediation/excavation operations.

j. The NRC requires the records of site burial or releases of radioactive material to be submitted with any request for unrestricted property release. No site burial of radioactive materials is documented or known to have occurred for the buildings and lands covered in this report.

k. List of abbreviations is found in Appendix B.

5. BACKGROUND.

a. Chronology.

(1) The use of radioactive material for research and development of electronic equipment has been ongoing at Camp Evans since the 1950s. A radiation safety program was instituted in the 1950s to oversee use of radioactive material at Fort Monmouth. The radiation safety program has operated continuously since the 1950s. The Fort Monmouth Radiation Protection Officer and his technical staff execute the radiation safety program. A radiation control committee (RCC), appointed by the Commander Fort Monmouth, oversees the program. This committee meets quarterly to review the radiation safety program's execution. The RCC reviews and approves any new use or changes in the use of radioactive material by researchers. Radiation safety program records going back to the 1950s were used to develop the radiological history of Camp Evans. These documents indicate the R&D operations involving radioactive material were conducted in the portion of Camp Evans that is designated Zone 4A.

(2) In 1995, a history of the use, storage and disposal of radioactive material at Camp Evans was compiled by CECOM Directorate for Safety personnel. The history was compiled from radiation program records and interviews with past and current Camp Evans employees. Radiological safety historical documents and employee interviews mentioned three buildings in Zone 4A. These buildings were initially classified as affected per NUREG/CR-5849. The land between these buildings was classified as unaffected until April 1999 when "scoping" surveys revealed the presence of licensed radioactive materials in some of the area's soil samples.

(3) Construction of structures in the area occurred during three periods. In the early 1900's, the Marconi Telegraph Operators School built a hotel, gymnasium and one other brick structure on the north end of Zone 3. At the beginning of World War II, in 1940, the US Army built a signal school, motor pool, antenna shelters, towers, and research and development

laboratories, which are located in Zones 3 and 4. The final construction was the Radiation Research Laboratory (RRL) in the early 1950's. The RRL was constructed when it was determined that existing structures could not be used for storage of hazardous radiation sources. The RRL building is included in this survey and designated as building 9401 located in Zone 4A.

(4) The CECOM Directorate for Safety began planning and preparation for performing radiological termination surveys at Camp Evans in 1994. Planning was completed in 1995 and funding for the surveys was made available in June 1996. The first areas surveyed were the portions of Camp Evans that were outside the main building complex. Final survey reports for these areas, designated as Zone 1, 1A, 2 and 3 east (DIANA site) have been reviewed and accepted by the NRC and NJ DEP.

(5) Controlled radioactive material has been removed from all buildings at Camp Evans. Survey of buildings in Zones 3 and 4 began in 1997 as the buildings were vacated. When survey operations were scheduled to begin in a building, administrative controls were used to prevent the return of any radioactive material to the building. After a building was vacant, surveys were started but until the tenant organization turned over control of the building, all entrances were posted with notices stating that no radioactive material was allowed in the building. This practice was in effect as survey operations continued into Zone 4A in December 1998.

(6) Mr. Steve Shaffer, NRC project officer, visited the site in May 1997 and was briefed on the survey scope and activities at Evans Area. Between May 1997 and May 1999, Mr. Shaffer made periodic visits to Fort Monmouth to check on the progress of surveys and source removal operations.

(7) Mr. Shaffer was notified of the contamination in Zone 4A upon his visit in May 1999. He inspected the Zone 4A area with Mr. Richard Lovell, the Directorate for Safety alternate RPO, and Craig E. Miller, IceSolv, Inc, contractor to the Directorate for Safety.

(8) Zones 3 and 4 laboratory analysis and data reviews were completed in June 1999 and submitted to the NRC and NJ DEP in final report format for review. Both the NRC and NJ DEP have provided written acceptance for the release of Zones 3 and 4.

b. Site Condition at Time of Termination Survey.

(1) Zone 4A contains eight structures. Some of these buildings have been remodeled during the 1970's and 1980's and portions were converted from research and development facilities to administrative areas. Carpets installed during renovations were removed so original floors surfaces could be scanned.

(2) Most furniture and equipment was removed from buildings prior to interior surveys. Most of the furniture and equipment had been installed after the buildings were renovated; therefore, the probability of contaminated furniture was considered low. Though the contamination potential was low, all furniture and equipment was screened, by scanning for alpha and beta contamination, before it was removed.

c. Identifying Potential Contaminants.

(1) The area and structures covered by this report are classified as affected. US Nuclear Regulatory License Numbers 29-01022-06 (Broad scope for research and development) and 29-01022-14 (Sealed sources for calibration and operational checking of radiation detection instrumentation) authorized use of radioactive material at Camp Evans. Historical evidence of radioactive materials use in the areas covered by this report indicated several buildings had some radioactive material present in the past. The radioactive material was either research material or US military type classified equipment (compasses, night vision equipment, radiac calibrators, etc.) that contained radioactive components. Due to the history of radioactive material use in Zone 4A, all buildings in this zone were classified as affected to include the storage sheds.

(2) Documented disposal of small quantities of radioactive material into sewage systems was an acceptable practice in the 1950s and 1960s. With the exception of buildings

9045 and 9401, no records of radioactive material releases into drains were found during the historical review. The sewer drains on site were surveyed at the manholes where the major junctions of the sewer connected on site and at the site discharge. Only background radiation was present in the samples taken from the sewers. This information was included in the Zone 3 and 4 final report previously submitted to the NRC and NJ DEP.

(3) The yard areas around buildings in Zone 4A were surveyed as affected. Additional points other than grid locations were surveyed to include areas at entrances and exits to buildings and storage sheds. Due to the limited quantity of tritium used at Camp Evans, soil samples were not tested for tritium. The samples taken from the yard areas for Zone 4A as tested satisfy release guideline values.

(4) Buildings and sheds were given 100% alpha/beta/gamma scans with appropriate survey instruments to detect fixed gamma, alpha and beta up to two meters high on the walls. Only two rooms in building 9045 and building 9383 had ceilings surveyed due to contamination findings. Wipes were taken in all affected structures to detect gross alpha, beta and tritium.

(5) Buildings 9045, 9383 and 9401 had concrete floors removed to exposed piping and/or to remove contamination. The soil below these floors in these areas was alpha/beta/gamma scanned, and the soil was sampled and analyzed for release.

(6) Survey release limits (values above background) used for this report are listed in table 1. These values are at or below NRC release guideline values. Release limits lower than NRC guidelines were taken from US Army Regulation (AR) 11-9, Table 4-3, Radioactive Contamination Guides, 28 May 1999. The limits take from AR-11-9 are those listed as maximum levels of contamination acceptable in uncontrolled areas.

Table 1
Survey Release Limits

Isotope	Physical state	Release Limit*
Tritium	Removable, wipe	1000 dpm/100 cm ²
	Fixed	Not measured.
Gross Alpha	Removable, wipe	20 dpm/100 cm ²
	Fixed, direct reading	100 dpm/100 cm ²

Gross Beta	Removable, wipe Fixed, direct reading	1000 dpm/100 cm ² 5000 dpm/100 cm ²
Gamma	Fixed, at 1 meter from surface (soil or structure)	10 microR/hr
Tritium	Soil, Not Sampled	Not measured.
Gross Alpha	Soil, lab analysis	5 pCi/gm
Gross Beta	Soil, Lab analysis	20 pCi/gm
Gamma activity	Soil, Lab analysis	Isotope dependent**

* Activity or instrument reading above background.

**Predicated on NUREG 1500

6. RADIATION SURVEYS AND RESULTS.

a. Instrument/Equipment.

(1) Field survey instrument identification numbers, backgrounds and parameters used for each survey are listed on the "Field Technical Support Data" sheets in Appendix C. All field instruments were calibrated and maintained in accordance with US Army TMDE schedules for "ACTIVE" instruments.

(2) The efficiency for instrument and probe combinations was determined using a source traceable to the National Institute of Standards and Technology (NIST). Survey results are reported in dpm/100 cm² or microR/hr as appropriate. All direct field survey results are corrected for background. Alpha and beta survey instrument LLDs were determined by the following formula:

$$LLD (dpm/100cm^2) = \frac{4.65 \sqrt{\frac{R_b (cpm)}{2\tau (min)}}}{\epsilon (cpm / dpm) \times P_a / 100cm^2}$$

WHERE:

LLD Lower Limit of Detection
R_b Background rate
† Instrument time constant

e Efficiency
P_a Detector area

b. Survey Methods.

(1) Affected Buildings. Floors and the lower two meters of walls were one hundred percent surface scanned for fixed gamma, alpha and beta radiation. Gamma scanning was performed with one-inch NaI crystal scintillation detectors. Alpha and beta scanning was performed with either gas flow proportional counters or scintillation detectors. Scanning MDAs were kept below 25% of the release guidelines and were typically <10% of the release guidelines. Buildings were classified as affected based on historical information so the lower walls and floor survey results were used to determine if ceilings and upper walls would be surveyed. The licensee directed that ceilings and upper walls within Zone 4a should be surveyed consistent with protocols used for Camp Evans Zones 3 and 4. The data taken from these surveys is included. Room #7 and room #9 in building 9045, and building 9383 required surveys to be taken above two meters high on the walls and ceilings. The lower two meters of walls and all floor surfaces were gridded in a one-meter square pattern for data and sample collection. A gamma dose rate was measured at one meter from the surface of each grid. Direct measurements for alpha and beta radiation were taken in the center of each grid location and at each random data point location. Wipes, to detect removable gross alpha, beta and tritium contamination, were taken in the center of each grid and at each random data point location.

(2) Affected Open Land. Open lands were given 100% gamma scan surveys. Gamma scans were performed with one-inch NaI crystal scintillation detectors. Grid patterns were performed using ten-meter equilateral triangles, with sample locations for soil taken at the grid intersections. Additional points other than grid locations were surveyed to include remediated areas, and entrances and exits to buildings and storage sheds. A gamma dose rate was measured at one meter from the surface of each grid sample location. A soil sample was taken at each grid intersection and analyzed for gamma and gross alpha/beta.

(3) Instruments and Techniques.

(a) Sodium Iodide one-inch scintillation detectors were used for fixed and scanning gamma dose rate measurements. Scanning was performed with the detector kept within ten centimeters of the surface being checked and fixed readings were taken one meter above each sample point. Gamma dose rate survey instruments were calibrated over the range of five to five hundred microR per hour.

(b) Gas flow proportional or scintillation alpha and beta probes were used for surface area scanning. The detector's probe was kept within 1 centimeter of the surface during scanning. The scan rate was three seconds per probe width. The majority of scanning was performed using gas flow proportional detectors that simultaneously detected gross alpha and beta radiation. The dual channel detectors were used with audio speakers monitoring for changes in alpha and beta activity while meter deflection was observed for alpha activity changes. The area-scanning objective was 100% of all floor and lower wall surface coverage; this was achieved in all buildings surveyed.

(c) A tritium wipe was taken at each sample point. The sampling method was a metricel, dampened with de-ionized water, wiped over a one hundred square centimeter surface area of the sample point location.

(d) A gross alpha and beta wipe was taken at each sample point location. The wipes were cloth NUCONS. Wipes covered one hundred square centimeters of surface area.

c. Laboratory Counting.

Laboratory records for calibration, quality assurance checks, backgrounds, etc. are available for inspection at the CECOM Directorate for Safety radiological counting laboratory.

(1) Tritium wipes were counted using a liquid scintillation counting system calibrated with tritium standards traceable to the National Institute of Standards and Technology (NIST). Daily quality assurance tests and background counts validated the

counting systems performance before, during and after each sample run.

(2) Gross alpha and beta wipes were counted in a low background gas flow proportional counting system. The source used to determine the alpha detection efficiency of the system was americium-241. The source used to determine beta detection efficiency was strontium-90. All sources used for efficiency determinations are traceable to the NIST. Daily quality assurance tests and background counts validated the counting systems performance before, during and after each sample run.

(3) Soil samples were analyzed for gamma emitters and gross alpha and beta activity. Gamma spectroscopy analysis was performed using a Canberra Genie System with an intrinsic GeLi detector. Alpha and beta samples were prepared for analysis by chemically digesting two grams of soil; the supernatant of the digestion was transferred to and evaporated on a planchet. Prepared planchets were counted on a low background alpha/beta gas flow proportional counter. Daily quality assurance tests and background counts validated the counting system's performance before, during and after each sample run.

d. Field Survey Results. Gross alpha and beta surface area scanning detected activity that exceeded the release guideline limits in seven of the buildings surveyed. There were no significant readings in other buildings covered by this report. Two areas of soil outside of the buildings were found to have elevated activity.

(1) Building 9401

(a) The two stairways located in the Neutron Generator Room (NGR) were surveyed as affected. However, the stairways were not gridded. Instead, data points were taken at intervals closer than if the stairs had been gridded due to the findings in the basement sump area. This allowed the survey to have almost twice the amount of direct measurements and wipes than would have been the case if the stairways were to have been gridded.

(b) Alpha, beta, and gamma scans were performed in approximately 3% of the areas above two meters in the building. The historical review showed no activities which would have caused airborne contamination or contamination above the normal working area heights. No areas of contamination were detected during scans of the entire building except for the Irradiator Pool Room sump, and the Neutron Generator Room sump.

(c) All of the building's sanitary waste lines were radioactively contaminated. Gamma spectroscopy confirmed the presence of Radium-226 in the Neutron Generator Room (NGR) sink drain line. This two-inch diameter drain line was used as the drain for a sink located on the second floor in Room #11 of the NGR. This sink was dismantled and surveyed for release. This metal two-inch diameter line fed down the West wall of the NGR to the first floor. A sink located on the first floor drained into this line, as well. The sink was dismantled and surveyed for release. The line continued down the West wall into the NGR basement Room #12, where the line ran through a pipe penetration in the West wall and outside of the building. This 2" diameter line made a 90-degree turn to the North, ran under the Ladies bathroom and eventually tied into the 6" diameter terra-cotta line on the North side of building 9401. The drain line was excavated and removed as radioactive waste.

Gamma spectroscopy results indicated the presence of U-238 in Room #9 sink trap. The toilet and sink in the Ladies bathroom were removed, dismantled, and surveyed for release. The drain line coming from the Ladies bathroom was a two-inch diameter metal line. This line tied into the 6" diameter terra-cotta line on the North side of the building. The drain lines coming from the Ladies bathroom were excavated and removed as radioactive waste.

The West-end of room #2 had a 2" diameter drain line that was once the drain for a sink. This line had U-238 present in the line as verified by gamma spectroscopy. The sink had been removed some years prior and could not be located for survey. The 2" diameter drain line tied into a 4" diameter line that fed into the 6" diameter terra-cotta line on the North side of the

building. The 2" diameter line and the 4" diameter drain line were excavated and removed as radioactive waste.

Scoping surveys taken of the Men's bathroom drain lines verified the presence of Cs-137 in the results of the gamma spectroscopy performed on the sample. All of the drain lines in the Men's room fed into a single 4" diameter metal drain line that tied into the 6" terra-cotta sanitary sewer line that serves as the main sanitary sewer line for the building. The 4" diameter line and other metal drain lines from the Men's room were excavated and removed as radioactive waste.

Room #15 had a 2" diameter metal drain line that was once used as a sink drain. The line was contaminated with U-238 and Cs-137, as verified by gamma spectroscopy. The sink was removed some years prior and could not be located for survey. The 2" diameter line fed into a 4" diameter line, located under the heating and air conditioning room HVAC, Room #5, which tied into the 6" diameter terra-cotta line on the North side of the building. The 2" and 4" lines were excavated and removed as radioactive waste. The Co-60 Source Irradiator Pool, located in Room #4, had an overflow drain line contaminated with Co-60, as verified by gamma spectroscopy. This line exited Room #4 on the East side of the building and ran underground where it emptied into the 550-gallon underground holding tank #1, located on the East side of building 9045. This 1" drain line was excavated and removed as radioactive waste.

All of the drain lines in the building were excavated, removed, and disposed of as radioactive waste. The 6" diameter terra-cotta line intersects the post's main 8" terra-cotta sanitary sewer line on the Northside of Avenue B. The 6" terra cotta line was excavated and removed as radioactive waste out to the Zone 4A fence-line; surveys were conducted at this fence-line and the survey results satisfy the unrestricted release guidelines. The 6" diameter line was then sealed with a rubber plug.

Soil samples taken in the trenches created by the excavation and removal of all of the building's drain lines satisfy unrestricted release guidelines as tested. The waste lines and sanitary sewer system for building 9401 were contaminated with elemental mercury

(Hg), so the radioactive waste was designated hazardous mixed waste and coded as D009.

(d) The Neutron Generator Room Basement (NGRB) equipment loading enclosure had a floor drain contaminated with Cs-137. This 12"x12" grated floor drain kept the loading entrance from flooding and kept water from entering under the exterior doors when it rained. The rainwater would run through a one and one-half inch diameter metal pipe into a 24" in diameter vitreous clay sump, located inside of the NGRB approximately 24 feet away.

An electric pump would send the water to a 2" diameter drain line located under the sub floor of Room #2. This 2" line is the line discussed in paragraph c. The sump, outside drain line, and the 2" line were removed and disposed of as radioactive waste. The electric pump was dismantled, surveyed, and released. The concrete floor and walls of the loading area enclosure were given 100% alpha, beta and gamma scans with no findings above background. Soil samples taken from the area where the piping was removed satisfy unrestricted release guidelines as tested.

(e) Two return duct entrances for the HVAC system were found to be contaminated with Cs-137, Co-60, and Ra-226. Loose surface activities in the ducts were up to 3000 dpm/100cm² beta-gamma, with no fixed activities found. The contamination was dust and debris, which had fallen down into the floor grate covering the return duct entrances in Room #3 and Room #2. The ducts were located beneath the floors of the first floor. The contamination was limited to the entrances to the return ducts and was not found further than one foot into the return duct entrances. The contamination was easily removed. Surveys were taken inside of the return ducts after remediation operations revealed no activity above background as tested. These surveys included alpha, beta, gamma scans and wipes. Surveys taken inside of the supply ducts revealed no activity above background as tested. Survey results show that all samples taken in the return ducts satisfy unrestricted release guidelines as tested.

(f) The Co-60 Stainless Steel Irradiator Pool was surveyed. The original filtering system consisted of a diatomaceous earth filter and pump, an activated charcoal filter, and a resin filter. All of the filter mediums were sampled and analyzed by

gamma spectroscopy. All filter mediums were contaminated with Co-60. All filters were removed and disposed of as radioactive waste. The water in the pool was analyzed for gross gamma, alpha, and beta. The water was below release criteria; however, sediment located in the bottom of the pool was contaminated with Co-60 and Ra-226. The sediment and debris were vacuumed through a new diatomaceous earth filter and circulated back to the pool.

The water was circulated through the diatomaceous earth filter for three days before it was sampled. The water was sampled and analyzed for gross gamma, alpha, and beta and found to be below release criteria and pumped to the sanitary sewer downstream of Zone 4A. The filter medium was disposed of as radioactive waste.

The pump was taken apart and the pump internals and filter housing were surveyed with no detectable activity above background. The pool walls and floor were given 100% alpha, beta, and gamma scans with no activity above background found. Wipes were taken with no activity found above the release criterion. The pool walls and floor were surveyed as affected along with the inside of the source storage recess located at the bottom of the pool. Survey results show that all samples taken in the pool satisfy unrestricted release guidelines as tested.

(g) The Irradiator Pool overflow line ran through a concrete penetration and down into the ground outside of 9401 on the Southeast corner. The concrete penetration was a 6" x 6" square opening which allowed the piping to come from the concrete sump where the original pool filters were once located. The sump had sands contaminated with Co-60 from the pool filter spread across the floor of the sump. The sand was vacuumed and disposed of as radioactive waste. The soil on the ground just outside of the sump pipe penetration was also contaminated with Co-60. The soil activity was up to 20 pico-curies per gram (pCi/g). This area of soil was removed and disposed of as radioactive waste. Survey results show that all samples taken from the sump area and soils outside of the pipe penetration satisfy unrestricted release guidelines as tested.

(h) The concrete pad located on the South side of building 9401 was contaminated with Ra-226. Fixed activities were approximately 6000 dpm/100cm² of beta-gamma. The area

contaminated covered approximately 100 square feet. A small portion of the top layer of the pad was removed and disposed of as radioactive waste. Surveys on the concrete pad did not indicate any activities above background levels. The concrete pad was surveyed as affected. Survey results of the pad show that samples taken from the pad itself satisfy unrestricted release guidelines as tested. Surveys were not conducted of the soil beneath the concrete pad.

(2) Building 9345

Scientists working in buildings 9401 and 9045 used building 9345 as a machine shop. Scoping surveys indicated loose surface activity on two areas of the floor and three workbenches located in the building. Gamma spectroscopy results showed Th-232 and Co-60 to be the contaminant. The levels of contamination were in excess of 5,000dpm/100cm² beta-gamma. The areas of contamination were remediated. All of the equipment located in the building was surveyed prior to allowing it to be moved to storage locations. No contamination was found on walls or ceiling areas that were scanned for alpha, beta, and gamma radiation. Survey results show that all samples taken in building 9345 satisfy unrestricted release guidelines as tested.

(3) Building 9383

Alpha, beta, and gamma scan surveys revealed contamination in excess of 200,000dpm/100cm² fixed beta-gamma activity on the concrete floor in the Northeast corner of the building. Gamma spectroscopy verified the nuclide to be Co-60. A concrete rack for source storage was contaminated with Cs-137. The beta-gamma activities were in excess of 100,000dpm/100cm². Spotty fixed contamination of Ra-226 was across the building floor from 1000 to 10,000dpm/100cm². All of the concrete floor and the concrete source rack were removed as radioactive waste. The building received 100% alpha, beta, and gamma scans. The ceiling was given 100% scans as well. Scoping surveys were taken of the soil around the perimeter of the building with no activity above release guideline values. The interior was surveyed as affected to include many direct measurements taken of the ceiling. More direct measurements were taken of the ceiling than if it had been

gridded as affected. This was done since building construction and ceiling rafters made it difficult to grid. Survey results show that all samples taken in building 9383 satisfy unrestricted release guidelines as tested.

(4) Building 9302

Alpha, beta, and gamma scans revealed a wooden shelf located on the South wall of the storage building to be contaminated. Gamma spectroscopy indicated the presence of U-238. The contamination was fixed to the shelf, the shelf stand leg, and a small section of concrete floor at the base of the shelf leg. Activities ranged from <100 to 50,000dpm/100cm² beta-gamma. The contaminated sections of shelf, stand leg, and concrete floor were removed and disposed of as radioactive waste. The building received 100% alpha, beta, and gamma scans, to include the ceiling. Survey results show that all samples taken in building 9302 satisfy unrestricted release guidelines as tested.

(5) Shed 1

Affected status surveys were performed. Survey results show that all samples taken in Shed 1 satisfy unrestricted release guidelines as tested.

(6) Shed 2

Alpha, beta, and gamma scans on wall grid WA10B revealed a localized area of fixed alpha activity of approximately 200dpm/100cm². Storage shelves rested against this area of the wall; however, no activity was found on the shelves. Gamma spectroscopy indicated the activity to be Ra-226. The section of wall was <100cm² and was easily removed as radioactive waste. Surveys included 100% alpha, beta, and gamma scans of the ceiling. Survey results show that all samples taken in Shed 2 satisfy unrestricted release guidelines as tested.

(7) Nitrogen Shack (9401 gas shack)

Alpha, beta, and gamma surveys located a 500cm² area on the concrete floor contaminated with Cs-137, as verified by gamma spectroscopy. Activities were <1000 to 5000dpm/100cm² fixed beta-gamma. The concrete was chipped up and disposed of as radioactive waste. Surveys included 100% alpha, beta, and gamma scans taken of the ceilings. Survey results show that all samples taken in the 9401 gas shack building satisfy unrestricted release guidelines as tested.

(8) Building 9045

(a) Scoping surveys taken of the Men's downstairs bathroom (room #6) revealed that the floor drain had Cs-137 contamination. Gamma spectroscopy verified the activity to be 237pCi/gm. A bathroom located directly above on the second floor was investigated. No activity was found in the samples taken from the upstairs bathroom drain lines. The room #6 floor drain went directly to a 6" terra-cotta sanitary sewer line for the building. The 6" terra-cotta line runs East under room #10 and then outside of the building. The line then takes a 90-degree turn to the North and runs under room #9. The line continues under the fence line and out across B Avenue where it intersects with the Camp Evans main post 8" sanitary sewer line. The 6" terra-cotta line was excavated and removed from the Men's room (room #6) to the Zone 4A fence line. The interior of the terra-cotta line was surveyed at the fence line and sealed with a rubber plug. Samples taken inside of the 6" terra-cotta line satisfy unrestricted release guidelines. Samples taken in the trenches from the line excavation satisfy unrestricted release guidelines as tested.

(b) Room #2 contained two 2" metal drain lines that were contaminated with Ra-226, U-235, U-238, Co-60, and Cs-137, as verified by gamma spectroscopy. The drain lines had been abandoned and did not exist on the building schematics or drawings. One of the two drain lines had been capped closed where the West wall and floor meet. This line was probably used as a drain for a sink in past years of research operations, but a sink was not present or accounted for. The second drain line was found in the West wall where the South wall and West wall meet. This drain line ran up through the West wall to the second floor,

where it was capped closed inside of the wall. This line most probably was used as a sink drain line as well. However, a sink was not present in either of the two rooms upstairs that bordered the wall containing the capped line. Both 2" diameter metal lines exited the building approximately 10 feet apart on the West of building 9045. Both lines ran West under a concrete pad for approximately eight feet where they both tied into a 4" metal drain line. The 4" pot-metal drain line ran North to the 8" terra-cotta main sanitary sewer line on the North side of B Avenue. Sediment samples taken from the connection to the 8" sanitary sewer were above the release guideline values. However, sediment samples taken from the 8" sanitary sewer line satisfied unrestricted release guidelines. All of the 2" and 4" diameter drain lines were excavated and removed as radioactive waste. Twelve linear feet of the 8" terra-cotta main sanitary sewer line was removed, even though surveys did not indicate any activity above the release guidelines in the 8" sanitary sewer line. Six linear feet on the upstream side of the 4" connection and six linear feet on the downstream side of the 4" connection were removed. Samples of the soil in the trenches, after remediation operations, satisfy unrestricted release guidelines as tested.

(c) Two 550-gallon stainless steel holding tanks, Tank #1 and Tank #2, located underground on the East of building 9045, were contaminated. Samples taken from the tanks were sent to Teledyne Brown Analytical laboratory for analyses. This was done due to the limitations of the REL. Sr-90 testing needed to be performed and the REL could not provide this analysis. The tanks were contaminated with Cs-137, Ra-226, Th-232, Co-60, and U-238.

Sr-90 was the largest contributor of contamination. The remaining water and sediment in the tanks were drained into 55-gallon drums for radioactive waste disposal. All drain, water, and pump lines were disconnected and disposed of as radioactive waste. The tanks were removed from the ground, placed into a containment tent, wiped out, and cut into small pieces for disposal as radioactive waste. Samples taken from the tank excavation areas satisfy unrestricted release guidelines as tested.

(d) Rooms located on the Eastern side of building had drain lines that emptied into Tank #1. These drain lines were

contaminated with Cs-137, Ra-226, Th-232, Co-60, and U-238. Most of the drain lines were found easily using schematics of the tank drain system; however, technicians found a one and one half inch in diameter metal drain line located in the wall between rooms #7 and #9. This drain line was contaminated and fed into the same piping system. Since there was a possibility of drain lines being located inside of the walls that were not on building drawings or schematics, holes were torn in the walls throughout the building to ensure no contaminated piping remained. No other lines were found.

(e) Two contaminated pumps used for moving water from Tank #1 and Tank #2 were located in the Northeast corner of room #9. The following is a basic review of the system: The pumps were located in a concrete block sump that was also contaminated with Sr-90. Tank #1 received all of the contaminated water from the laboratories on the East side of building 9045 and any excess water that came from the overflow drain line of the Irradiator Pool in building 9401. Pump #1 removed the water in Tank #1 and sent it to Tank #2, where the wastewater would be diluted by adding clean water. Pump #2 would pump the diluted water from Tank #2 to the 6" terra-cotta sanitary sewer line downstream of building 9045.

100% alpha, beta, gamma scans were performed on the floors in room 49 and room #7 prior to excavating the drain lines and sump. Beta activities were detected only in the sump area. However during the excavation of the floors to remove the drain lines, Sr-90 contamination was found throughout the sub-floors of room #9 and the bordering areas of room #7. Beta activities were detected in the soils in excess of 100,000dpm/100cm². Room #9 was originally two rooms, room #8, and room #9. During remediation efforts, however, a wall was removed that separated the two rooms, and thus it became one single room, as survey data shows in Appendix C. Room #7 had two thirds of the asbestos floor tiles removed in order to excavate piping below the floors. Surveys detected no activity above background on the removed asbestos tiles and on the floor tiles prior to removal. However, fixed beta activities in excess of 10,000 dpm/100cm² were found throughout the areas of the floor where the tiles had been

removed. The areas of contamination were remediated using a "concrete-scabbler." The remaining floor tiles of room #7 were not removed to enable surveys of the floor below the tiles per the direction of the licensee. The data taken from the surveys of the surrounding area are included.

Up to four feet of the soil under portions of the floor of room #9 was contaminated and removed as radioactive waste along with the entire concrete floor. A concrete footer between room #9 and room #7 was partially contaminated and the contaminated areas were removed. A small portion of the sub floor and soil was removed in room #7 that bordered room #9, also due to contamination. All of the contaminated drain lines, concrete floor, sump, tank pumps, and soils were removed and disposed of as radioactive waste. Room #7 had fixed beta contamination on the concrete below the floor tiles located in the Northern and Northeastern sections of the floor. These areas were removed as radioactive waste. Samples as tested revealed no activities above background on the tiles removed from the floor.

Surveys taken in room #7 and room #9 included soil sample analyses, wipe test analyses, and 100% alpha, beta, and gamma scans of the concrete and dirt floors, walls, and ceilings. Soil samples were taken at one sample per square meter in the areas where the concrete floors were removed in room #7 and room #9. The samples taken satisfy unrestricted release guidelines as tested.

Preliminary soil samples taken around the perimeter of the concrete pad located West of building 9045 had elevated levels of Th-232 and Ra-226 above guideline values. The concrete pad was removed and surveyed for unrestricted use. The soil was sampled from where the pad was located and Ra-226 and Th-232 were detected above the release guideline levels. The top twelve inches of soil was removed from the 180 square meter area and disposed of as radioactive waste. Samples taken from the area satisfy unrestricted release guidelines as tested.

(f) The concrete pad located East of building 9045 was contaminated with Cs-137. Contamination was fixed activity

approximately 10,000 dpm/100cm². The area contaminated was approximately two square meters. The contamination was found during beta-gamma scans during characterization surveys. The contamination was fixed in the surface of the concrete and was easily removed by "scabbling." The pad was surveyed as affected and subsequent samples from the pad satisfy unrestricted release guidelines as tested.

(9) Open Lands of Zone 4A

(a) An area of soil covering approximately one hundred square feet was contaminated with Cs-137 and Th-232 along the West side of the Zone 4A fence line approximately 70 feet North of building 9345. This contamination was detected during 100% gamma scan surveys of the Zone 4A open land areas. Gamma spectroscopy confirmed the presence of Cs-137 at levels up to 3000 pCi/g. Soil was removed up to three feet in depth during the remediation effort. The highest gamma reading taken on contact with the soil prior to remediation was 100 μ R/hr over background. The 7th Street asphalt road runs parallel along the outside of the West fence-line. Portions of the asphalt butt up against the area that was remediated. No samples were taken under the asphalt road of 7th Street. The data taken from the surveys of the surrounding area are included. Remediated soils were removed and disposed of as radioactive waste.

(b) An area of soil covering approximately one hundred square feet was contaminated with Cs-137 located approximately seventy feet South of building 9383 and butted up against the East side of the East Concrete Pad. This area of soil was contaminated with Cs-137 and covered an area of approximately one hundred square feet. The gamma reading taken at the surface was 30 μ R/hr when originally detected during characterization survey scans, but increased to 106 μ R/hr down in the soil at the one foot depth during remediation. Gamma spectroscopy confirmed the presence of Cs-137. Soil was remediated and disposed of as radioactive waste; however, no samples were taken underneath the East Concrete Pad at the direction of the licensee. The data taken from the surveys of the surrounding area are included. The

All field instrumentation has a QC check performed on it each morning prior to use, and at the end of the day after use.

Gamma probe rate meters are checked against a NIST traceable source of Cs-137. The probes must show readings within $\pm 20\%$ of the mean. If the instrument does not fall into the parameters, it is checked three additional times. If the instrument falls outside of parameters during any of the three additional counts, it is taken out of service and sent for repair and/or calibration. Any data taken with that instrument for that day is disregarded and re-taken, and the instrument is taken out of service and sent for repair and/or calibration.

Alpha/beta probe rate meters are checked against two different NIST traceable sources, a Cs-137 source for beta, and an Am-241 source for alpha. Every instrument has each channel (alpha and beta) checked following the same criteria as the gamma probes. Even if only one channel falls outside of the control parameters, (e.g. alpha is outside of parameters but beta falls within parameters), both alpha and beta data for that day are disregarded and re-taken and the instrument is taken out of service and sent for repair and/or calibration.

Alpha/beta integrating instruments are checked against two different NIST traceable sources, a Cs-137 source for beta, and an Am-241 source for alpha. Every instrument has each channel (alpha and beta) checked and both channels must fall inside of $\pm 5\%$. If either channel falls outside of $\pm 5\%$, it is counted three additional times. All readings must fall inside the parameters all of the three additional times. If not, both alpha and beta data taken with that instrument for that day are disregarded and re-taken, and the instrument is taken out of service and sent for repair and/or calibration. If control checks are inside of $\pm 5\%$ but not inside of $\pm 3\sigma$, then it is noted on the instrument's chart. If this occurs any three consecutive days in a row, the instrument is taken out of service and sent for repair and/or calibration. All data for those three days is disregarded and re-taken.

If any field instruments are found to fall outside of control check parameters or have had repairs/calibrations which may have

changed the instrument's operating parameters, new control parameters are assigned by taking 20 source check readings on each instrument's respective control parameters source(s) and calculating the new parameters.

c. Survey Data

The Field Operations Supervisor reviews all field readings on a daily basis. The Field Operations Supervisor (FOS) investigates any readings that are at or above flag values to ensure the integrity of the data. The FOS performs daily visual internal audits to ensure that the surveys are taken properly and in strict adherence to any local, state, and federal guidelines. All data and surveys performed by the field technicians are strictly monitored for deficiencies so that improvements can be made to assure data accuracy. The same is performed by the Laboratory Manager for all laboratory operations, and ultimately by the Project Manager throughout the survey process from data collection to report.

All data collected from the field instrumentation and from the laboratory are maintained in a secure database with limited access given only to those individuals required to review or process. Any hard copies are kept in secure location at Modern Technologies Corporation NJ Operations.

An outside auditor provided Quality Assurance audits for all phases and processes of the survey with results given to the Project Manager. QA findings and corrective action statements were placed in report form and given to the Project Manager to aid in quality assurance and improvement of the survey process. The Project Manager reviewed the laboratory findings with the laboratory technicians and the Laboratory Manager for corrective actions. The same was performed for the field survey findings with the Field Operations Supervisor. The Project Manager has an "open door policy" in order for any site personnel to be able to make comments for improvement of operations.

SURVEY RESULTS (APPENDIX C) ORGANIZATION.

a. Raw Data Reduced For Report.

Field survey and laboratory raw data compiled on each sample point has been reviewed and organized for presentation. Each building or area report starts with a survey map, followed by the survey results report and Field Technical Support Data Sheets. The report data has been converted into appropriate units of activity to match release criteria. Field readings for alpha, beta, and gamma radiation have the daily field background subtracted. Laboratory wipe results have only the counting system "blank" background subtracted. Soil samples results have the Charles Wood Area (CWA) background soil sample analyses averages of gross alpha, beta, and gamma subtracted from them. The CWA gross alpha, beta, and gamma results are non-impacted area results and therefore the average values should be subtracted from survey area results before the results were compared to release guidelines. All detected gamma activities are listed by isotopic symbol and atomic number.

b. The report's field survey readings have all been adjusted for background. Backgrounds for gamma, alpha, and beta were measured daily. The backgrounds were measured in a known clean area, physically similar to the survey area.

c. Laboratory results from the low background alpha/beta counting system and the Liquid Scintillation counting system have only had the counting system background subtracted. Count results of wipes taken to detect removable contamination are reported in disintegrations per minute per one hundred centimeters squared after subtracting counting system background.

9. CONCLUSION. Evaluation of the samples and laboratory analysis indicate that radiation for the samples taken is at or near background levels. That is, based upon initial review of the results of this survey, the samples covered in this report do not appear to have radiation contamination present that is distinguishable from background radiation as tested.

10. RECOMMENDATION: CECOM Directorate of Safety should review the results of this report to determine if a request for unrestricted release for public use of the buildings and land

covered by this survey should be submitted to the NRC and NJ DEP.