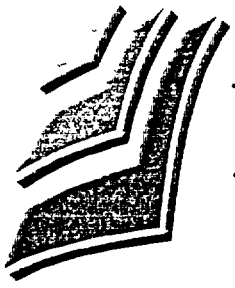
Final Status Survey Report for Buildings 13, 14, 28 and 34 at the Molycorp Site

Washington, PA



MACTEC, Inc.

Revision 0
Dated 3/14/02

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Washington, PA

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Reviews:

MACTEC Radiological Engineer — Date: 3-14-02

MACTEC Radiological Engineering/H&S Manager — Date: 3/14/02

MACTEC Project Manager — Date: 3/14/02

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1.0 BACKGROUND INFORMATION

1.1 GENERAL INFORMATION AND OPERATING HISTORY

Molycorp, Inc.'s (Molycorp) predecessor, the Molybdenum Corporation of America, was formed from the Electric Reduction Company in Washington, Pennsylvania on June 16, 1920. The facility was purchased to manufacture ferroalloys.

Molybdenum manufacturing was begun in the 1920s. Processing of this material was idled in 1991. Although primarily manufacturing molybdenum products, the plant also produced ferrocolumbium (FeCb, 1964 to 1971), as well as other ferroalloys, e.g., tungsten.

In the late 1960s new federal requirements necessitated Molycorp to obtain a Source Material License from the Atomic Energy Commission for possession and use of materials containing 0.05 percent or greater by weight uranium, thorium, or a combination of both. Most of the material that was processed by the corporation for ferrocolumbium contained thorium above the 0.05 percent limit. The slag resulting from this production was in a glass/ceramic form containing an average of 1.2 percent thorium. Almost immediately upon receiving a Source Material License in December 1968, various investigations were undertaken to address the new regulatory requirements.

Applied Health Physics, Inc. was contracted by Molycorp to conduct a series of leaching studies on ferrocolumbium slag during the late 1960s. These studies indicated that radioactive materials were fixed and would not leach into the groundwater in excess of prescribed limits. During this period, Molycorp applied unsuccessfully to the Pennsylvania Department of Health's Industrial Wastes Section and AEC for an onsite burial permit. Ferrocolumbium slag cleanup was concentrated in the early to mid-1970s time frame.

In June 1971, an AEC compliance inspection revealed that thorium-bearing slag had been inadvertently buried onsite in violation of the terms and conditions of their license and AEC regulations. The AEC issued a Notice of Violation and requested Molycorp to take remedial action to excavate these materials and dispose of them in accordance with AEC regulations and guidance documents. Applied Health Physics was contracted to perform a thorough radiological survey of the site and to provide health physics and waste disposal services necessary to comply with AEC's request. Survey measurements indicated exposure levels at 1.2 mR/hr in some areas.

In 1972, thoriated material from the site was disposed of at the West Valley, New York, burial site. The disposal was terminated when New York officials decided that the volume of waste was too large and the contamination level insignificant to use up valuable burial area. Molycorp performed cleanup operations to segregate and stabilize the remaining thoriated material in a capped pile containing about 27,700 cubic yards of slag on the south property. A 1975 Applied Health Physics, Inc. report indicated the average concentration of thorium-232 in the slag pile was 1,250 pCi/g, with exposures within the 0.2 mR/hr Nuclear Regulatory Commission maximum level allowed at the time (AEC was reorganized as the NRC in 1974). This pile was eventually removed and disposed of.

In 1978, one of two molybdenum-roasting furnaces was shut down as part of a consent decree with the Pennsylvania Department of Environmental Resources (PADER) Air Quality Agency due to exceedances of SO_2 standards. All remaining processes continued until 1991.

Oak Ridge Associated Universities, an NRC contractor, conducted a radiological survey of the site in 1985. The survey identified elevated (twice background or greater) levels of thorium in the dikes that separated the surface impoundments, and indicated the potential of subsurface thoriated slags in the western portion of the site.

RSA, Inc. conducted a subsurface survey for Molycorp in 1990 to characterize the thorium contamination across the western portion of the site (i.e., the impoundment area), and the areas immediately to the north, west, and northwest. Thirty-two holes were drilled on the site and radiation measurements were logged at every six inches of depth from the surface down to bedrock, both above and below water table. Radiation levels were also logged in monitoring wells previously drilled on the site. In addition to the subsurface survey, RSA, Inc. conducted a survey of the radiation exposure rates inside the study area. This survey consisted of approximately 400 measurements of the gamma radiation field at a height of one meter above ground level. Findings reveled that; in general, the subsurface concentrations of thorium were above those in the surface soils in almost every hole drilled. A general pattern was that the underground radiation levels decreased to background at a depth of about ten feet. While a majority of the holes exhibited concentrations of greater than 0.01 percent thorium, in only a few holes did the thorium content exceed an average of 0.05 percent at some point below the surface of the ground.

The Molycorp Source Material License (SMB 1393) was renewed in 1992 and included an amendment incorporating a schedule for decommissioning the site. In November 1992, Molycorp submitted a Site Characterization Plan (SCP) to the NRC for approval.

Molycorp submitted the "Decommissioning Plan for the Washington, PA Facility" to the NRC in July 1995. In a letter dated June 1, 1999, (John C. Daniels, Molycorp Project Manager, to John W.N. Hickey, NRC Branch Chief) Molycorp informed the NRC that the Decommissioning Plan would be revised and re-submitted in two parts.

Part 1 Revision of the current Decommissioning Plan was submitted and approved June 30, 1999, and describes the activities required to remediate the site to unrestricted use levels in accordance with the SDMP Action Plan (57 FR 13389). The soil, slag or other material exceeding the SDMP Action Plan criteria will be transported to an NRC approved location for final disposition.

Part 2 Revision of the Decommissioning Plan was to provide for the disposition of the material that exceeded the SDMP Action Plan criteria to a designated on-site impound at the Washington, PA site. The Decommissioning Plan Part 2 Revision was never approved.

1.2 REASON FOR DECOMMISSIONING

Decommissioning of the Molycorp Washington, PA Facility is being performed due to the cessation of molybdenum production at the facility. Several factors, included age of equipment and the production of molybdenum elsewhere in the United States and overseas, have led to the shutdown of the

production process and closure of the facility. In December 2001, all activities were halted and a majority of the workforce was terminated.

1.3 MANAGEMENT APPROACH

This report focuses on the approach taken by management to decommission buildings located at the Molycorp Washington, PA Site. This report does not address the decommissioning activities of soils or subsurface contamination at the site.

The approach taken by management for the decommissioning of buildings includes the characterization and classification of site buildings and areas, performance of radiological surveys to identify and quantify surface radioactive material, identification of elevated dose rates, performance of remedial actions (as required), removal of materials and equipment from buildings, performance of the final surveys to release buildings from radiological controls, and the performance of any remedial action necessary to meet the release criteria of the final status survey.

Once buildings have been surveyed for final status, and the NRC has reviewed and approved the building Final Status Survey Report and completed their verification surveys, the buildings will be demolished and the rubble removed. As identified earlier, subsurface (soil) decommissioning activities are not being performed under the current work scope (decommissioning work.)

Management supported and required the use of all regulatory and approved decommissioning plans and standards for the decommissioning process at Molycorp. The final status survey was conducted in accordance with; NUREG/CR 5849, "Manual for Conducting Radiological Surveys in Support of License Termination," RSI's "Decommission Plan for the Washington, PA Facility, Part 1 Revision," and the requirements of Molycorp's "U.S. Nuclear Regulatory Commission Material License, Amendment No. 5, SMB-1393." Individual requirements of each reference were compiled in MACTEC's "Survey Plan for Determining the Final Status of Buildings at the Molycorp Site" and used as the plan for performing the final status survey.

Approved radiation protection procedures were used during the performance of radiological surveys in support of final status surveys. Qualified radiation protection staff was hired and trained to the requirements of the sampling plan. A radiological engineer (CHP) was assigned to support the project and oversee the day-to-day radiological survey operations. The MACTEC Corporate RSO was involved at all decision making levels, and communicated directly with the NRC, State of Pennsylvania, ORISE Support Personnel and MACTEC Senior Management.

Radiological survey equipment was identified and selected to provide the highest sensitivity for the existing site conditions. Radiological survey equipment selection was based partially on equipment used for earlier final status surveys performed by Radiological Services, Inc. (RSI) in 2001. Additional radiological survey equipment was selected and implemented to what RSI had used in the past. The selection and addition of a hand-held gas-filled proportional instrument and detector package provided a greater sensitivity for the detection of radioactive material, and complemented the previously used selection of instruments used by RSI. All radiological survey equipment used for final surveys was calibrated by an instrument calibration facility using radioactive sources traceable to National Institute of Science and Technology (NIST). When radiological survey instrumentation was due for calibration, or

the instrument malfunctioned, the instrument was removed from service and sent off-site for calibration or repair.

Radiation protection personnel worked closely with decommissioning and construction personnel on the project. The Project Manager interacted closely with the workforce, Radiological Engineer and the HP technicians. The Project Manager was provided weekly HP activity reports detailing the current week's activities and the coming week's goals.

2.0 SITE INFORMATION

2.1 SITE LOCATION

The Molycorp, Inc. project site (the site) is located in southwestern Pennsylvania on the outskirts of Washington County approximately 35 miles southwest of Pittsburgh. The site is separated from the populated City's urbanized are by the ramps and structures associated with Interstate 70 (I-70). The region is generally comprised of towns located close to transportation corridors surrounded by agricultural lands and open areas.

The site consists of approximately 20 acres, which represents the fenced portion of the 59-acre parcel owned by Molycorp Inc. that lies entirely within Canton Township at 300 Caldwell Avenue, Washington, Pennsylvania, 15301. The fenced area is situated between 1,010 and 1,045 feet above mean sea level with relatively flat topography.

Molycorp's property has frontage along two dedicated public streets in Canton Township – Caldwell Avenue and Weirich Avenue. The site is transversed by Chartiers Creek that flows south to north through the property. The property is served by the CSX operated railroad via two lines that were formerly owned by the Tylerdale Connecting Railroad Company and the Baltimore and Ohio Railroad.

Adjacent property owners can be classified into three major categories on the current use of the land – residential, industrial, and public. The residential property lies to the east of the site on Green Street and to the west along Weirich Avenue. The industrial property is located predominately north of the site and includes property under the ownership of the Findlay Refractories Company and Allegheny Ludlum Corporation. Darrt Development Company owns several scattered parcels located to the south and east of the site. Land under public ownership includes the Canton Township Volunteer Fire Company property, the right-of-way for I-70, and other public streets. The Washington Institute of Technology owns a 38-acre parcel with a commercial building adjacent to the southwestern property line. This building was used as a mining education and training facility. However, it has not been used for this purpose for some time and has fallen into a state of disrepair and, therefore, is considered a vacant parcel.

A ten-acre parcel of vacant land under the ownership of L. and C. Cox on Weirich Avenue between Comfort Lane and Point View Drive (behind Allegheny Lundlum) may be the site of future commercial development. The property owner has formally requested that the zoning be changed from R-2 Residential to General Commercial.

2.2 BUILDING STATUS

All buildings/areas did not have the same potential for residual contamination and therefore did not require the same level of survey coverage. For the purposes of establishing the degree of survey effort required, building surfaces were segregated into affected and unaffected buildings/areas. The definitions for the areas:

- Affected area: Accessible areas that have potential radioactive contamination (based on facility operating history) or known radioactive contamination (based on past or preliminary radiological surveillance).

- Unaffected area: All accessible areas not classified as affected. These areas are not expected to contain residual radioactivity, based on knowledge of site history and previous survey information.

All 21 buildings located on site had been characterized (as identified in NRC Material License, Amendment No. 5, SMB-1393) for radiological hazards and classified as either affected or unaffected. 15 buildings had been characterized and classified as unaffected; two (2) buildings had been surveyed for final status; and six (6) buildings had been characterized and classified as affected (or containing affected areas). Building classification and radiological information are described in Table 2.1

TABLE 2.1 - BUILDING CLASSIFICATION AND RADIOLOGICAL INFORMATION

Classification	Building	Radiological Information
A	1	Lab Area, soil samples in the lab and a small source in a lab office. Possible fixed contamination exists on the floor of one of the lab rooms.
A	19	Building contains rad material samples in an individual office. The office has been classified as an affected area.
A	26	Building 26 contains a temporary rad storage area (~20'x30') identified with a rad boundary and radiological postings. The building also contains an above ground 4 section tank (one section being potentially contaminated, internal) and a stainless steel filter (~3 ft. dia. by 4 ft.) that is contaminated.
A	29	Concrete floor with sumps, floor sumps are potentially contaminated and need to be characterized . The rest of the building is identified as unaffected.
A	31	Concrete floor with a steel liner on top. Steel walls and roof, insulated walls. Licensed material mixer was stored in building.

A	33	Concrete floor, steel walls and roof, insulated. Equipment/supplies were originally stored in building. The building was erected in 1979 and is otherwise radiologically clean. Categorized as affected due to the storage of sample containers (contaminated dirt) in the back corner of the building.
U	2	Heat exchange in front of Building 2. Several stories high, mixture of solid and grating floors. Concrete and tin construction.
U	13	Concrete floor, steel and brick walls, some insulation on walls and ceiling.
U	14	Most of the building internals have been removed, brick structure. Roof is rusted and partially disintegrated.
U	21	Concrete floor, steel and cinder block walls, steel ceiling. Maintenance shop in use until March, 2002.
U	22	Concrete floor, metal walls and roof. Equipment/supply storage is the main purpose of this building.
U	23	Concrete floor, steel walls and ceiling.
U	25	Concrete floor, steel walls and ceiling.
U	28	Concrete floor, steel walls and roof, 2 walls insulated, equipment/ supplies located previously stored on shelve located in the building.
U	32	Concrete floor, one wall insulated, steel roof, equipment/supplies previously stored on shelve located in the building, steel front door.
U	34	Concrete floor, steel walls and roof, large conveyor system inside building. Sand pits are located in building.
U	35	Concrete floor, insulated walls and ceiling. Equipment/supplies previously stored in the building. The building was erected in 1988.
U	36	Concrete floor with sumps, double walled construction ½ way up, insulated walls and ceiling.
U	37	Concrete floor, corrugated steel walls and roof. Smaller inside storage building, cinder block construction, roof area was used for storage of additional equipment/supplies.
FS Surveyed	39	Building 39 previously surveyed for final status.
FS Surveyed	42	Building 39 previously surveyed for final status.

2.3 GROUNDS

The Molycorp Washington, PA facility produced a ferrocolumbium alloy from Brazilian ore (pyrochlore) between 1946 and 1970. While the use of pyrochlore was commonplace by that time, this particular ore contained thorium as an accessory metal. The thorium was also in concentrations which required Molycorp to acquire a Source Materials License. This operation resulted in the production of a thorium-bearing slag. A portion of this slag was ball-milled (turned into a granular powder) and used as fill over portions of the site.

While significant amounts of this slag have been removed from the site, remaining slag in soil continued to play a significant role in the survey and release of buildings on site. Building steel walls and concrete floors showed significant readings above "normal" background levels when surveyed by hand-held or portable detectors.

In two instances during the final status survey of buildings 39 and 42, performed by RSI, survey results indicated elevated levels of radioactivity on building walls (even though smears in the same locations indicated that no removable radioactivity existed.) To identify the source of elevated radioactivity, two sections (approximately 2' by 2') of the building's wall were removed from the building by RSI. These wall pieces were resurveyed in areas where background radiation levels were considered "normal" and found to be free of radioactivity (no readings greater than background).

Because this elevated background condition exists at the Molycorp site, MACTEC devised instrument detector windows for some of their instruments and used them in areas where thorium slag in soil created a background nuisance during survey activities.

3.0 DECOMMISSIONING ACTIVITIES

Decommissioning activities of the buildings on site were performed as a "first step" to release the site for unrestricted future use. The scope of work conducted at the site during this phase of work included D and D of all above surface structures and buildings.

All existing structures (buildings, tanks, dryers, bag houses, utilities, etc.) will be removed from the site. Wastes created during the D and D activities will be identified, segregated, and processed for shipment to the appropriate waste facility. Waste will be removed from site in accordance with all applicable federal, state and local regulations and authorities.

3.1 OBJECTIVES

The objectives for this phase of D and D activities included:

- Removal of equipment and surplus supplies from buildings
- Characterization of hazards associated with the buildings (performance of effective radiological surveys)
- Remediation or disposal of hazards identified in the characterization process

- Completion of Final Status Survey
- Unrestricted release of buildings
- Demolition of buildings

3.2 RESULTS OF PREVIOUS SURVEYS

Numerous radiological studies and surveys have been conducted at the Molycorp Washington, PA site. Since the late 1960, regulatory requirements and pressure from local agencies have driven surveys and studies of the hazards associated with the production of various ferroalloys. Recently, RSI has completed and submitted for review the Final Status Survey for buildings 39 and 42. Listed below is a brief history of the previous surveys performed on the Molycorp site:

Applied Health Physics, Inc. was contracted by Molycorp to conduct a series of leaching studies on ferrocolumbium slag during the late 1960s. These studies indicated that radioactive materials were fixed and would not leach into the groundwater in excess of prescribed limits. During this period, Molycorp applied unsuccessfully to the Pennsylvania Department of Health's Industrial Wastes Section and AEC for an onsite burial permit. Ferrocolumbium slag cleanup was concentrated in the early to mid-1970s time frame.

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Foster Wheeler Environmental Corporation conducted a site characterization of the Molycorp Washington, PA site in 1994 and published its report titles "Site Characterization Report for License Termination of the Washington, PA Facility, 1995." This three volume report was conducted to meet the Site Characterization Plan's objectives:

- To determine the extent of the distribution of thoriated residues on the site, in the structures and in the environmental media.
- To determine the rate(s) of migration, if any, of thorium or its daughters through various pathways to man.
- To assess associated non-radiological constituents and determine their affects on the radiological constituents and potential impacts on decommissioning.
- To quantify parameters that affect potential human exposure to existing site radiological materials.
- To support evaluation of alternative decommissioning actions wan detailed planning of a preferred approach for decommissioning, decontamination, and waste disposal.

3.3 DECONTAMINATION PROCEDURES

Most of the above surface buildings have been previously decontaminated and identified as unaffected buildings or areas. These classifications are noted in Molycorp's NRC License, SMB-1393 and identified in Section 2.2. Buildings classified as affected will be surveyed, and where remediation is necessary, decontamination will be performed. It has been estimated that very little radioactive waste will be generated during the entire project scope. Items found to be contaminated above the limits have and will be controlled as radioactive material, temporarily stored on site, and ultimately disposed of as radioactive waste.

MACTEC's "Survey Plan for Determining the Final Status of Buildings at the Molycorp Site" contains the procedures and requirements for the survey of the buildings on site. RSI's Radiation Protection

Procedures (currently the approved procedures used on site) contain the procedural requirements for operational radiation activities on the site.

4.0 FINAL SURVEY PROCEDURES

The basis of the Molycorp radiological survey design conformed to NUREG/CR 5849, "Manual for Conducting Radiological Surveys in Support of License Termination," RSI's "Decommission Plan for the Washington, PA Facility, Part 1 Revision," and the requirements of Molycorp's "U.S. Nuclear Regulatory Commission Material License, Amendment No. 5, SMB-1393." These references provide adequate information and sampling requirements to ensure a proper survey had been planned and performed. The requirements listed in these references were compiled into a sampling plan (MACTEC's "Survey Plan for Determining the Final Status of Buildings at the Molycorp Site") and used as the guidance document for sampling instructions.

4.1 SAMPLING PARAMETERS

Sampling parameters were identified from NUREG/CR 5849, "Manual for Conducting Radiological Surveys in Support of License Termination," RSI's "Decommission Plan for the Washington, PA Facility, Part 1 Revision," and the requirements of Molycorp's "U.S. Nuclear Regulatory Commission Material License, Amendment No. 5, SMB-1393." QC samples were included in the sampling requirements.

Site buildings or areas were classified by contamination potential and grouped into survey units having a common history, contamination potential, or that were naturally distinguishable from other site areas, to assure that the number of survey data points from each survey unit adequately represented the radiological environment of that survey unit. Survey units are subdivisions of the whole area of interest within the sampling plan.

Unaffected survey units identified by direct measurement that exceed 25% of the guideline levels were reclassified as affected areas, gridded as necessary, and resurveyed accordingly.

Representative surveying was accomplished for buildings by using a systematic grid approach to ensure spatial representation of the survey unit of interest. The grid system provided reference locations to aid in proper sample identification and distribution, and ensured that minimum sample surface areas were sampled.

Direct and loose surface measurement locations were identified on the actual surface being surveyed. The physical probe location was traced on the surface being surveyed. When necessary, survey readings were recorded on the physical surface at the location of the survey.

Survey results were obtained and used for comparison against the limits for unrestricted release, as defined in the site's NRC License. These limits are included in MACTEC's "Survey Plan for Determining the Final Status of Buildings at the Molycorp Site" as Appendix A.

Table 4.1 identifies the release limits of the license.

Table 4.1 - Acceptable Surface Contamination Levels (dpm/100cm^2)

Radionuclide [1]	Average	Maximum	Removable
U-nat, U-235, U-238, and associated decay products	5,000 α	15,000α	1,000α
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100	300	20
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000	3,000	200
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above	5,000	15,000	1,000

(1) Where surface contamination by both alpha and beta-gamma emitting nuclides exist, the limits established for alpha and beta-gamma emitting nuclides should apply independently.

Even though limited quantities of natural uranium have been identified at the Washington, PA site, and is included as a part of the site's NRC License, the more restrictive limits for release (for surface activity) are for the natural thorium radionuclide, which is the significant radionuclide of concern.. Therefore, the limits for release are due to the natural thorium radionuclide, and the limits are 1,000 dpm/100cm^2 average, 3,000 dpm/100cm^2 maximum and 200 dpm/100cm^2 removable.

Because both alpha and beta radiations are a product of the decay of natural thorium (in equilibrium), the limits listed above apply independently to both alpha radiation and beta radiation.

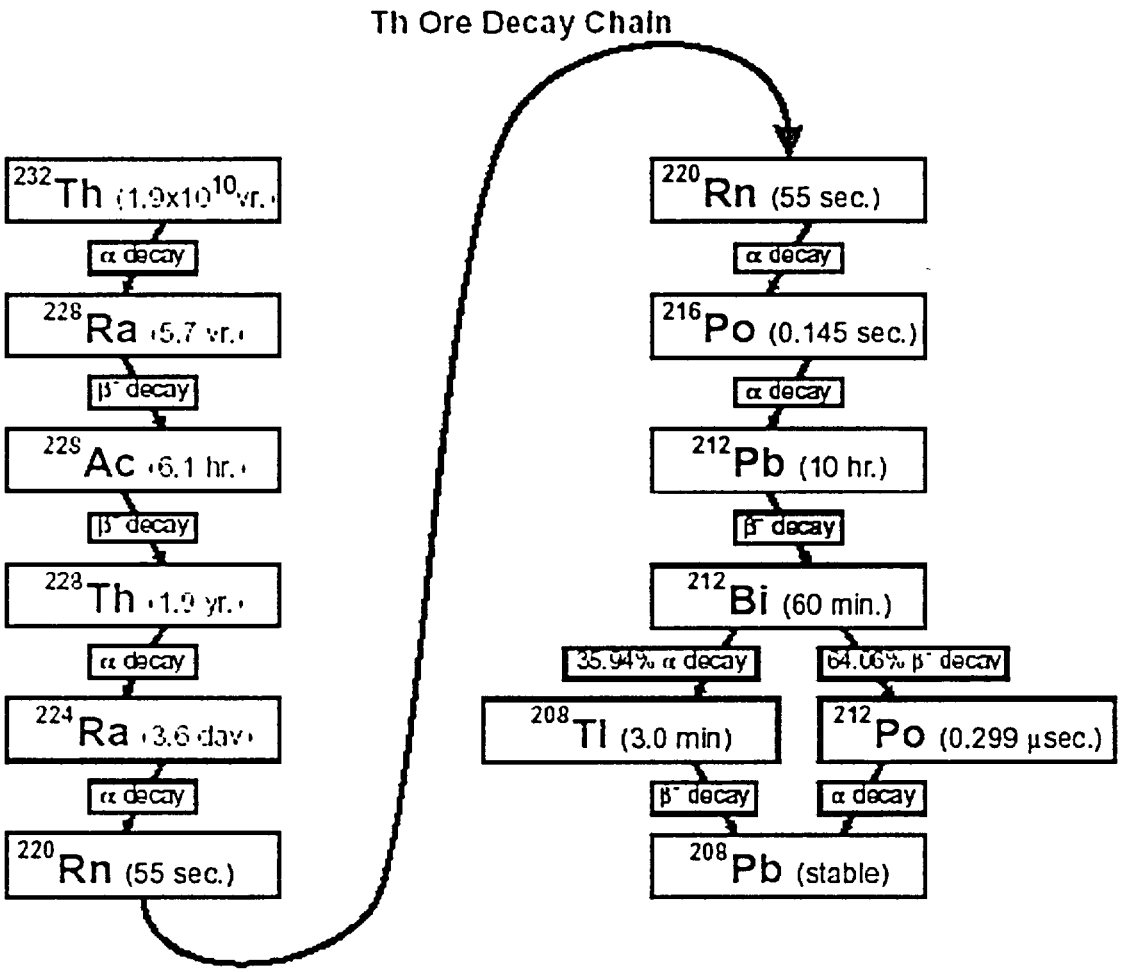
Due to the inherent difficulty of properly quantifying the alpha radiation component during the decay of natural thorium when using a hand-held instrument, a ratio of alpha decays to beta decays was identified and beta radiation was used as a surrogate to quantify the alpha activity. This was not the case for determining removable contamination. The Ludlum 2929 was calibrated and set up for the measurement of both alpha and beta radioactivity.

The detectable ratio of alpha to beta is a 2:1 for natural thorium decay. In actuality, the decay of natural thorium produces 6 alphas and 4 betas to reach stable lead. However, one of the betas emitted during the decay process (from Ra-228) is not detectable (39 keV E-max). The other three betas emitted are detectable and are suitable as a surrogate.

The alpha readings recorded on the various data forms and record sheets were actual instrument readings, obtained from the instrument during the survey, and do not represent this ratio factoring. The use of alpha to beta ratio factoring is incorporated in the data set just prior to statistical analysis and comparison to limit values.

Figure 4.1 is a graphical representation of the decay of natural thorium.

FIGURE 4.1 - NATURAL THORIUM DECAY CHAIN



4.2 SAMPLING SCHEDULE

Scanning of surfaces to identify locations of residual surface activity were performed according to Table 4.2.

TABLE 4.2 - SURFACE SCAN SCHEDULE

Building/ Structure Status	Survey Location	Surface Scan (4.6)
Affected Areas	Building floor and lower walls (<2 m from floor)	100% - Floor and lower walls (<2 m from floor) and other surfaces found to have residual activity in excess of guideline values during characterization surveys.
Affected Areas	Upper surfaces (>2 m from floor) of affected areas found to be non contaminated during the characterization	Limited - Areas found to be non contaminated during the characterization survey, scans in the immediate vicinity of direct measurement.
Affected Areas (4.10.1)	Exterior of piping, ventilation ducting, electrical boxes, conduit, or other interior surfaces that may contain residual contamination	B-G scans, biased, to determine locations that exceed 2x background. *At these locations, and available access points to pipe and duct interiors, direct alpha measurements and smear sample will be obtained.*
All Buildings (4.10.2)	Exterior surface of the roof	Gamma scan only - 1 measurement per 4 m^2 (see Exposure Rates Table)
All Buildings (4.10.2)	Exterior walls	B-G scan, 10% of lower wall surfaces (<2 m from floor).
Unaffected Areas	Building floor and lower wall surfaces (<2 m from floor)	B-G scan, 10% of floor and lower wall surfaces (<2 m from floor)
Equipment/ Structures Located in Affected Areas/Buildings	Equipment/Structure	Free Release Survey - If equipment/structure is identified as being used for processing licensed material. Biased - If equipment/structure was never used for processing licensed material.

Equipment/ Structures Located in Unaffected Areas/Buildings	Equipment/Structure	Biased - If equipment/structure is suspected of being used for processing licensed material. Not Required - If equipment/structure was never used for processing licensed material.
Result Requirements		Locations of surface activity exceeding twice background will be marked for further evaluation.

Building interior surface scans were conducted for alpha and beta-gamma radiations. Scans of exterior building surfaces were for beta and gamma radiations to identify the presence of elevated areas that might indicate residual gross activity.

For hand-held instrumentation, the detector was kept as close as possible to the surface and moved across the surface at a slow speed. Scan surveys were performed by moving the detector over the surface area at a maximum speed of 1-2 inches per second and a distance of approximately 1/2 inch for beta and 1/4 inch for alpha. When the count rate increased, the rate of movement of the detector was decreased or stopped. If the increase in count rate was real (not a random variation in the background count rate), a static 60-second measurement was performed over the area of increased count rate to quantify the activity. Audible indicators (headphones or instrument speaker) were used to identify locations having elevated activity levels. All scanning results were noted on standard survey forms as well as task-specific generated forms.

When elevated levels of surface activity were identified with the Ludlum Model 239-1F floor monitor, the surface was marked and scanned with a hand held unit with a detector size of ~ 100 cm^2 and an appropriate detector efficiency.

Gamma exposure rate measurements (gamma scan) were conducted with the instrument at 1 m above the floor at systematically and randomly selected locations.

Direct measurements were performed according to Table 4.3.

TABLE 4.3 - DIRECT SURFACE MEASUREMENT SCHEDULE

Building/ Structure Status	Survey Location	Direct Measurement (4.7)
Affected Areas	Building floor and lower walls (<2 m from floor)	Floor and lower walls (<2 m from floor) and other surfaces found to have residual activity in excess of guideline values during characterization surveys. (1)

Affected Areas	Upper surfaces (>2 m from floor) of affected areas found to be non contaminated during the characterization	Measurements will be performed at a minimum of 30 locations on both vertical and horizontal surfaces and sufficient additional locations to provide coverage at a minimum of one location per 20 m^2 of surface area. [1]
Affected Areas (4.10.1)	Exterior of piping, ventilation ducting, electrical boxes, conduit, or other interior surfaces that may contain residual contamination	Where B-G scans exceed 2x background - obtain direct alpha measurements. At available access points to pipe and duct interiors - obtain direct alpha measurements.
All Buildings (4.10.2)	Exterior and interior surfaces of air exhaust equipment and at roof drains	Biased
All Buildings (4.10.2)	Exterior walls	A minimum of 30 random direct measurements or an average of at least 1 measurement location per 50 m^2 surface area, whichever is greater, of the survey unit. (4.10.2)
All Buildings (4.10.2)	Exterior surface of the roof	Biased in areas of plausible contamination. (based on gamma scan results)
Unaffected Areas	Building floor and lower walls (<2 m from floor)	A minimum of 30 random direct measurements or an average of at least 1 measurement location per 50 m^2 surface area, whichever is greater. (5849)
Equipment/ Structures Located in Affected Areas/Buildings	Equipment/Structure	Free Release - If equipment/structure is identified as being used for processing licensed material. Biased - If equipment/structure was never used for processing licensed material.
Equipment/ Structures Located in Unaffected Areas/Buildings	Equipment/Structure	Biased - If equipment/structure is identified as being used for processing licensed material. Not Required - If equipment/structure was never used for processing licensed material.
Result Requirements		If scans or measurements indicate residual activity exceeding 25% of the guideline, the area is surveyed per affected area requirements.

[1] If scanning methods are capable of detecting residual Th activity of less than 1,000 dpm/100 cm^2, direct surface activity measurements will be systematically performed at two meter intervals on floors and lower walls and at the same intervals on upper surfaces. If scanning methods produce an MDA that exceeds 1,000 dpm/100 cm^2, measurements will be performed at one meter intervals. On upper surfaces of affected areas that are not scanned for the presence of residual activity, measurements will be performed at a minimum of 30 locations on both vertical and horizontal surfaces. These locations will include surfaces where radioactive material would likely settle and sufficient additional locations to provide coverage at a minimum of one location per 20 m^2 of surface area.

Direct surface measurements were conducted by integrating counts over a 1-minute period.

When scans or measurement exceeds guideline levels, the location was noted for further remediation or resolution. Localized scanning and measurements were repeated after any remediation activities were performed.

Smear surveys were preformed according to Table 4.4.

TABLE 4.4 - LOOSE SURFACE MEASUREMENT SCHEDULE

Building/ Structure Status	Survey Location	Removable Surface Activity
Affected Areas	Building floor and lower walls (<2 m from floor)	Collected from each location where a direct surface activity measurement is made (alpha and beta analysis).
Affected Areas	Upper surfaces (>2 m from floor) of affected areas found to be non contaminated during the characterization.	Collected from each location where a direct surface activity measurement is made (alpha and beta analysis).
Affected Areas (4.10.1)	Exterior of piping, ventilation ducting, electrical boxes, conduit, or other interior surfaces that may contain residual contamination.	Where B-G scans exceed 2x background - obtain alpha smear sample. At available access points to pipe and duct interiors - obtain alpha smear sample.
All Buildings (4.10.2)	Exterior and interior surfaces of air exhaust equipment and at roof drains.	Biased to locations where contamination is most likely.
All Buildings (4.10.2)	Exterior walls	Collected from each location where a direct surface activity measurement is made (alpha and beta analysis).

All Buildings (4.10.2)	Exterior surface of the roof	Samples of roofing material (volumetric) will be obtained where direct measurements indicate contamination is present.
Unaffected Areas	Building and Structure Surfaces	Collected from each location where a direct surface activity measurement is made (alpha and beta analysis).
Equipment/ Structures Located in Affected Areas/Buildings	Equipment/Structure	Collected from each location where a direct surface activity measurement is made (alpha and beta analysis).
Equipment/ Structures Located in Unaffected Areas/Buildings	Equipment/Structure	Collected from each location where a direct surface activity measurement is made (alpha and beta analysis).

A smear for removable contamination was obtained at each location where a direct surface activity measurement was taken, unless otherwise stated in Table 4.3.

Smears were counted for gross alpha and beta with the appropriate instrument.

As a precaution against accidental contamination of the instrumentation used to analyze the smear samples, screening of samples that had a high potential of containing elevated levels of radioactivity was performed.

Exposure rate measurements were performed according to Table 4.5.

TABLE 4.5 - EXPOSURE RATE MEASUREMENT SCHEDULE

Building/ Structure Status	Survey Location	Exposure Rate Measurement (4.8)
Affected Areas	Building Surfaces	Gamma exposure rates measured 1 meter perpendicular to building surfaces at 1 measurement per 4 m^2.
All Buildings	Exterior Roof Surface (gamma scan)	Gamma exposure rates measured 1 meter perpendicular to building surfaces at 1 measurement per 4 m^2. (4.10.2)

Unaffected Areas	Building Surfaces	Gamma exposure rates measured 1 meter perpendicular to building surfaces at 1 measurement per 50 m^2 (calibrated for natural thorium).

Gamma exposure rates were measured at 1 m above ground or floor surfaces using a gamma scintillation instrument.

Where necessary, samples of paint were obtained from 100 cm^2 areas of painted surfaces where direct and removable activity measurements suggest contamination (> surface contamination levels) may have been painted over. These samples were analyzed for beta activity. Direct measurements and smear surveys were made of the underlying surface, after removal of the paint.

Samples of roofing materials (non-metal roofs) were obtained where direct measurements indicate contamination was present in the roofing material. Roof material samples were controlled as volumetric samples and analyzed as such.

Cotton swabs were used for sampling in hard-to-reach areas such as inside wall and floor penetrations, anchor-bolt holes, and floor cracks or expansion joints.

Each piece of equipment that required monitoring was its own entity and was described by name and serial number on survey forms and/or logs. Special attention (increased sample density) was given to areas where there was a high potential for contamination. Equipment previously identified as not affected (not contaminated) was not surveyed unless there was indication that it had become contaminated.

4.3 BACKGROUND LEVELS IDENTIFIED

Material-specific background levels were established by RSI in late 2001 for each type of instrument used for total surface contamination measurements during their final status surveys of buildings 39 and 42. Similar instrumentation was selected for use by MACTEC to take advantage of this previously available information.

Background measurements were collected on surfaces of similar construction as the buildings at the site and having no possibility of being impacted by site operations. Measurements to establish background for a specific material were collected from multiple locations to provide an estimate of the variability or uncertainty. Background determination was performed using the same instrumentation that was used for final status survey data collection. An average background value was determined for each material surveyed and this value was subtracted from each measurement to determine a net count or count rate. Background determinations were required and performed for concrete and a class of material designated a generic material.

The required number of background measurements per material type is as follows:

- Concrete - minimum of 20 measurements
- Cinderblock - minimum of 20 measurements

- Generic Material - minimum of 10 measurements for each type of material surveyed (i.e., wood, insulation, corrugated steel, etc.)

It was previously identified in the final status survey report for buildings 39 and 42, submitted by RSI, that significant background radiation levels existed at the Molycorp site, primarily due to gamma radiation from the thorium slag in the soil. RSI had reported levels as high as 30 micro-R per hour.

During survey activities performed by MACTEC at the site, a significant component of the measured activity was indeed identified to be from the elevated gamma background coming from the slag in the soil. A method was devised to minimize the interference of this background radiation when using the hand-held detectors, and produce more accurate results of beta activity, the primary indicator used for the detection and quantification of natural thorium. A shield, or "beta window" was used to eliminate the beta component of a measurement made in areas where background levels proved to be a nuisance. A second measurement was taken without the shield in place. This measurement process produced two readings, one containing a beta-gamma interaction with the detector, and one containing only a gamma interaction with the detector. The difference between the two readings provided a beta-only component of the measurement, with the gamma background removed. This reading was then compared against the materials background that was determined at the off-site location and a net beta reading was obtained.

The material used to shield the beta radiation was a thin piece of aluminum (approximately 3/16 inch think). A test was performed to validate the aluminum's ability to shield the beta radiation. A beta source was counted without the shield, and then the shield was put in place. The source was again counted. Results of the tests indicated that in all cases, when the shield was in place , the instrument indicated background values and completely shielded out any beta radiation.

4.4 Major Contaminates Identified

The major contaminate (significant radionuclide of concern) at the Molycorp Washington, PA site was identified to be natural thorium. Trace amounts of natural uranium were also identified as a contaminate. Both of these materials are identified in the site's NRC License.

No other licensed material has been brought on site, based on the site Facility Superintendent's knowledge of process and site operations.

Results of preliminary assessment and characterization survey support the conclusion and identify the significant radiological contaminant to be thorium-232, from the processing of certain types of ore concentrates in the production of ferrocolumbium. Most of the material Molycorp processed for ferrocolumbium was a pyrochlore, which contained thorium above the 0.05 percent limit. It is possible that buildings and structures involved with the processing of pyrochlore and production of ferrocolumbium may have been contaminated with thorium-232. The average activity ratio of Th-228 and Th-230 to Th-232 found in slag/soil samples are:

Th-228:Th-232	1.03%
Th-230:Th-232	0.16 %

4.5 GUIDELINES ESTABLISHED

All final status survey measurements were compared to the values listed in the Site's NRC License. The criteria specified in the guideline for natural thorium are more conservative than natural uranium, and were applied at the site for final status survey.

4.6 EQUIPMENT AND PROCEDURES SELECTED

Instrument and procedure selection was based on several criteria. The first criteria that was considered was the use of instruments and procedures that had been previously used on site for final status surveys. Since RSI had just completed the final status survey of two buildings at the site, prior to MACTEC's arrival, using similar procedures and instruments made sense. Because MACTEC's radiation protection operating procedures had not yet been approved for use at the site, RSI's radiation protection procedures were used. RSI's radiation protection procedures had previously been approved for use on site by the NRC. Verbal approval was given by the NRC to allow MACTEC to continue work using RSI's radiation protection procedures until their procedures were approved.

4.7 INSTRUMENT MDA

The detection sensitivity of a measurement system refers to the statistically determined quantity of radioactive material or radiation that can be measured or detected at a preselected confidence level. This sensitivity is a factor of both the instrumentation and the technique or procedure being used. Typically, detection sensitivity has been defined (EPA 1980) as the level above which there is less than a 5% probability that radioactivity will be reported present when it is really absent (Type I error) or reported absent when it is really present (Type II error).

Minimum detectable activity (MDA) is an *a priori* estimate of the minimum activity level which is practically measurable with a specific instrument, and sampling and/or measurement technique. The basic equation for determining field instrument MDA (NUREG/CR-5849) is:

$$MDA = \frac{2.71 + 4.65\sqrt{B_R * t}}{t * E * \frac{A}{100}}$$

Where:

B_R = background count rate
t = sample count time (min)
E = efficiency
A = area of probe

Instrument MDAs were calculated on a daily basis and recorded on the applicable survey forms. Where instrument MDAs did not meet criteria (25% of the release limit value,) instrument background count times and sample count times were increased until MDA values became acceptable.

4.8 INSTRUMENT SELECTION

Instrument and equipment selection was made based on previous use and the criteria of NUREG/CR-5849, for MDA sensitivity. In addition to the previous use criteria, instruments were selected based on the ability to detect the desired radiation and at a desired level, ease of use, availability and cost.

- For dose rate measurements, the Ludlum Micro-R meter was selected and used. It was selected due to it's relatively flat energy response curve and because it had been used on site previously for final status surveys.

- For surface scans of large areas (floor and walls), the Ludlum Floor Monitor (239-1F/2350-1) with the 582 cm^2 detector (43-37) was selected. The MDA for the instrument was considered acceptable until an area of elevated activity was detected by the instrument. During surveys with the floor monitor, when an area of elevated activity was detected, the probe size was theoretically reduced from 582 cm^2 to a size of 100 cm^2 (a postulated physical size of elevated activity). The MDA of the instrument with it's newly reduced probe size (100 cm^2 probe size) became unacceptable for scanning. For areas where the floor monitor detected elevated activity, the area was identified and resurveyed with a 100 cm^2 hand-held gas proportional detector. Instrument MDA was calculated and recorded at the start of the job, at the job site. If the instrument was relocated to a different location during the same day of work, the MDA was again calculated and recorded for the new location. The floor monitor was set up and calibrated to detect both alpha and beta radiations.

- For surface scans of areas with elevated readings, the Ludlum 2350-1 with the 43-68 or 43-106 was selected. Due to the detector's relative size (compared to the 43-37) the MDA for the detector was acceptable. However, using a hand-held instrument to survey large surface areas is not efficient in either cost or time. The primary duty of the large area hand-held gas-flow proportional detector was scanning areas where elevated levels of activity had been identified by the floor monitor. When required to be used, the instrument's MDA was calculated and recorded at the start of the job, at the job site. If the instrument was relocated to a different location during the same day of work, the MDA was again calculated and recorded for the new location. This instrument was not used for static measurements due to the added effort of the surveyor (moving the gas bottle around with the instrument) and the added cost to use the instrument. The instrument's lower MDA allowed for the sample population density of other sample mediums (for affected area surveys units) to be less dense. When the MDA of the scanning instrument could not reach 25% of the release limit, the sample population density increased for the other sample mediums (direct and loose surface measurements) and a greater number of samples were required to be obtained. The instrument was set up and calibrated to detect both alpha and beta radiations.

- For static (direct) surface measurements, the Ludlum 2360 with the 43-89 detector was selected. The MDA was acceptable. Instrument MDA was calculated and recorded at the start of the job, at the job site. If the instrument was relocated to a different location during the same day of work, the MDA was again calculated and recorded for the new location. When background radiation created an unacceptable MDA for this instrument, the instrument was reconfigured to count with a longer count time. Background count times were also increased to lower instrument MDA to acceptable levels. Durability, ease of use and cost were a consideration in the selection of this instrument. The instrument was set up and calibrated to detect both alpha and beta radiations.

- For counting samples (smears and air samples), the Ludlum 2929 with 43-10-1 detector was selected. Instrument MDA was calculated and recorded daily, and found to be acceptable.

Durability, ease of use, familiarity and cost were a consideration in the selection of this instrument. The instrument was set up and calibrated to detect both alpha and beta radiations.

Table 4.6 provides information on the instruments selected to be used for final status surveys at the Molycorp Washington, PA site. Information on MDA calculations can be found in "Survey Plan for Determining the Final Status of Buildings at the Molycorp Site," Appendix B.

TABLE 4.6 - INSTRUMENT SELECTION

Instruments	Probe	Radiation	MDA ($dpm/100\ cm^2$)	Use
Ludlum, Model 2360	43-89	Alpha	67	Static Surveys
Ludlum, Model 2360	43-89	Beta	520	Static Surveys
Ludlum, Model 2929	43-10-1	Alpha	29	Counter Scaler
Ludlum, Model 2929	43-10-1	Beta	182	Counter Scaler
Ludlum, Model 2350-1	43-68/43-106	Alpha	105	Scan Surveys
Ludlum, Model 2350-1	43-68/43-106	Beta	625	Scan Surveys
Ludlum, Model 239-1F	43-37	Alpha	64	Floor Monitor
Ludlum, Model 239-1F	43-37	Beta	1186	Floor Monitor
Ludlum, Model 19	Internal	Gamma		Exposure Rates

4.9 INSTRUMENT USE TECHNIQUES

Instruments selected for performing final status surveys were provided by GTS Duratek, Field Engineering and Field Services group, Kingston, TN. Prior to delivery, instrument calibrations and operations were verified by the vendor, and shipped to Washington, PA. Upon arrival, the instruments were inspected and verified operational. Instrument backgrounds were preformed. QC check control limits were established and Chi-squared tests were performed.

Prior to daily use, instruments were response checked and compared against their two and three sigma warning and control limit values. For scaler instruments, daily backgrounds were determined and MDCs were calculated in addition to their response checks. After daily use, hand-held instruments were once again source response checked to ensure that the instrument did not fail during the day's work. All instrument "daily checks" data was logged in the appropriate data log record.

Qualified HP technicians were trained on the use of the instruments, and provided access to the instrument's User Manuals. Surveys were performed in accordance with approved radiological survey procedures on site. Survey results were reviewed by the Radiological Engineer for accuracy and completeness.

4.10 PROCEDURES FOLLOWED

The requirements of NUREG/CR 5849, "Manual for Conducting Radiological Surveys in Support of License Termination" were followed for most statistical methodologies used during the performance of surveys and testing of data for the final status survey. In one instance, the methodology found in "Multi-Agency Radiation Survey and Site Investigation Manual" (MARSSIM) was used for determining the scanning MDA of those instruments used for scanning. This methodology provided a more accurate MDA result than would have been calculated from the guidance found in NUREG/CR-5849.

4.11 SURVEYING ORGANIZATION

Characterization and final status surveys were performed by a team composed of qualified personnel currently employed or subcontracted by MACTEC.

The team was operated under the supervision of the Project Manager, Mr. Vern Taylor, of MACTEC, Inc who has overall authority of the project.

The day to day operations of the site were the responsibility of the Site Superintendent, Mr. John Peek of MACTEC, Inc.

Radiological field measurements and sample collection were the responsibility of Mr. Michael McDonald of MACTEC, Inc. Mike is a Board Certified Health Physicist (CHP) in comprehensive practice and a Registered Radiation Protection Technologist (RRPT).

Radiological surveys were performed by a team of HP technicians. One Senior HP Technician was assigned as the Lead Technician and was given the responsibility of the team.

5.0 SURVEY FINDINGS

Detailed data reports for each survey unit sampled are provided as an appendix to this report. Field data collection forms, survey report forms, instrumentation information (background, QC, MDA, and source response data forms), statistical test results, and comparisons to release limits are all provided as a single package. Each package also contains a summary of the final status survey for that survey unit and includes information on anomalies discovered during the survey process. Where significant differences existed between final status survey results and results of previous surveys for the survey unit, explanations are provided.

Raw survey data was compiled into survey data tables, where appropriate, and presented with calculational results and comparisons, and are presented in the appropriate appendix.

5.1 TECHNIQUES FOR REDUCING/EVALUATING DATA

Survey information was obtained from the instrument's meter face used at the time of the survey. This data was recorded on a Radiological Survey Location Indicator data sheet, in the instrument's units. For scans and static measurements, the units were in counts per minute (cpm). Smear data was recorded

after counting, subtracting background, and conversion to units of disintegrations per minute per 100 square centimeters (dpm/100cm^2). Dose rate measurements were recorded in units of micro-Roentgen per hour (uR/hr) and taken directly from the instruments meter face. Information used in the conversion from cpm to dpm (instrument efficiencies) was recorded on both the Radiological Survey Location Indicator data sheet and the Radiation Protection Survey Report form. For scans, the highest reading for the given immediate scan area was recorded in cpm.

Where "hot spots" needed to be evaluated, additional readings were taken and the average hot spot activity was calculated in accordance with NUREG/CR-5849, Section 8.5.2 - Elevated Areas of Activity.

5.2 Statistical Evaluation and Comparison Tables

The statistical methodology used to provide the true representation of the data in relationship to the applicable limits is found in Sections 2.0 and 8.0 of NUREG/CR-5849. Comparison tables and tests used in the analysis are presented as part of each survey unit's data package, as an appendix to this report.

6.0 SUMMARY

Final status survey of the buildings located at the Molycorp Washington, PA site were performed in accordance with the requirements listed in NUREG/CR 5849, "Manual for Conducting Radiological Surveys in Support of License Termination," RSI's "Decommission Plan for the Washington, PA Facility, Part 1 Revision," Molycorp's "U.S. Nuclear Regulatory Commission Material License, Amendment No. 5, SMB-1393," and MACTEC's "Survey Plan for Determining the Final Status of Buildings at the Molycorp Site."

According to the findings of the final status surveys performed at the Molycorp Washington, PA site, all release criteria have been met. Results of the final status survey demonstrate that the residual radioactivity in Buildings 13, 14, 28 and 34 is below the unrestricted use criteria and confirm that the buildings are suitable for unrestricted use.

7.0 REFERENCES

1) *Manual for Conducting Radiological Surveys in Support of License Termination*, NUREG/CR-5849, Draft, December 1993.

2) *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) Revision 1*, NUREG-1575, Rev. 1, US Nuclear Regulatory Commission, Office of Nuclear Regulatory Research, Washington, DC, August 2000.

3) *Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs*, American National Standard, ANSI/ASQC E4-1994.

4) *Quality Assurance for Radiological Monitoring Program - Effluent Streams and the Environment*, NRC Regulatory Guide 4.15, 1979.

5) *Termination of Operating Licenses for Nuclear Reactors*, Nuclear Regulatory Commission, Regulatory Guide 1.86, 1974.

6) *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions*, NUREG/CR-1507, Final, 1997.

7) *Statistical Methods for Evaluating the Attainment of Cleanup Standards*, Pacific Northwest Laboratory,.Richland, WA, December 1992.

8) *Radiation Detection and Measurement*, Knoll, 1979.

9) *Washing, PA Facility, Decommissioning Plan, Part 1 Revision*, June 30, 1999, Radiological Services Inc.

10) *Radiation Protection Program, Health Physics Procedures*, June 1999, Radiological Services Inc.

11) *Site Characterization Report for License Termination of the Washington, PA Facility*, January 1995, Radiological Services Inc.

12) *U.S. Nuclear Regulatory Commission Materials License*, Molycorp, Inc, SMB-1393, Docket No. 040-08778, Amendment 5.

Appendix A

Building 13 Data Package

Molycorp Washington, PA

Building 13 Data Package

This data package contains final status survey information for Building 13, Molycorp, Washington, PA site.

Field data collection forms, survey report forms, statistical test results, and comparisons to release limits are provided.

Summary

No anomalies were reported during the survey of Building 13. Elevated levels of background radiation, from soil radioactivity, continued to be a presence during survey activities.

Results from the final status survey of Building 13 provides evidence that release criteria have been met, demonstrates that residual radioactivity is below the unrestricted use criteria, and confirms that Building 13 is suitable for unrestricted use.

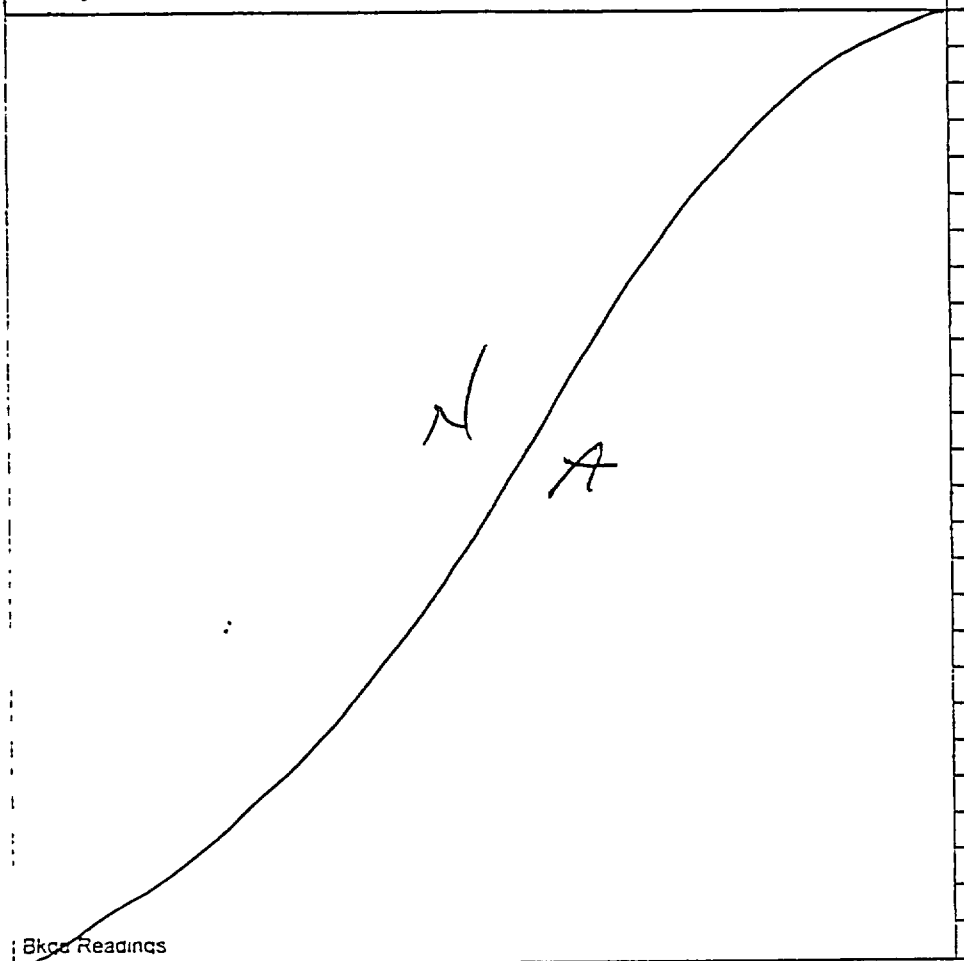
DDO-138 Radiation Protection Survey Report	Site: Molycorp / Washington, PA

Section 1: Survey Information Building 13 unaffected, 100% survey

Date	Time	Location	Survey Issue Log Number:
3-7-02	1100	Building 13	02-0046

RWP Number	Purpose of Survey:	Page 1 of 4
N/A	☐ RWP ☐ Routine Survey ☐ Unconditional Release ☑ Other	

Survey Title:



Bkgd Readings

Smear Number	Beta dpm/100cm²	Alpha dpm/100cm²
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13	N	
14		A
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		

Legend

00 = mRem/h gamma | 00 C = mRem/h gamma contact | ① = Smear Location | 7 = Air Sample Location | -X-X-X- = Rope, Boundary, or Barrier

00 β = mRem/h beta | 00 βC = mRem/h beta contact | —①— = Large Area Wipe | = Bulk Material Sample

Section 2: Instrument Used

Instrument Model/SN	Cal Due Date	Probe Model/SN	Cal Due Date.	Detector Eff.. (cpm/dpm)	MDA α	MDA β	Other α	Other β	
2350-1 95359	8-16-02	43-37 092503	8-16-02	α .207	14.6	205	BKg ~~1.04~~	349	
2350-1 117566	8-16-02	43-106 128912	8-16-02	.212	.257	16.6	690	BKg 2.2	336
2929 152202	2-6-03	42-10 156519	2-6-03	.344	.165	11.6α	206β'	β'=45	α=.14
2224-1 129462	8-6-02	43-89 169230	8-6-02	α .154	β' .092	64.3α	475β'	β'=78	α=2.4 Floor
2224-1 129462	8-6-02	43-89 169230	8-6-02	α .154	β' .092	75.6α	172β'	β'=8	α=3.7 wall

Section 3: Review and Approval

Survey Performed By (Sign): Mark Blanciak	Area Posted and/or Barricaded.	Date and Time.
	☐ Yes ☐ No ☒ Not Required	3-7-02 1100
Radiation Safety Officer (Print Name & Sign) Mike McDonald		Date and Time 3-14-02 9:30

Radiological Survey Results - Survey Location Indicator

Survey # 02-0046

Survey Area Information:

	Instrument Model/SN	Cal Due	Probe Model/SN	Cal Due	α Scan MDA	β Scan MDA	α Static MDA	β Static MDA
Instrument Data	2350-1 / 95359	8-6-02	43-37 / 092503	8-6-02	15	295	N	
	2350-1 / 117566	8-6-02	43-106 / 128912	8-6-02	66	690		A
	2929 / 152202	2-6-03	43-10 / 156519	2-6-02	N		12	306
	2224-1 / 129462	8-6-02	43-89 / 169230	8-6-02		A	64	475
	19 / 22526	8-6-02	N/A	N/A			N/A	N/A

	Print Name	Signature	Date
Performed By:	MARK BLANCIAK	Mark Blanciak	3-7-02
	DENNIS Whitlock	Dennis Whitlock	3-7-02

Location	β Scan (cpm)	α Scan (cpm)	β Static (unsh) (cpm)	β Static (sh) (cpm)	α Static (cpm)	ER (μrem/hr)	Smears (dpm/100 cm²) α	Smears (dpm/100 cm²) β
F-1	1700	9	—	—	0	12	-.4	-24
F-2	—	—	—	—	2	12	-.4	-12
F-3	324	1	—	—	2	12	-.4	-42
F-4	—	—	—	—	1	12	-.4	-18
F-5	—	—	—	—	4	12	-.4	-55
F-6	1600	8	—	—	1	12	-.4	0
F-7	—	—	—	—	1	12	-.4	115
F-8	—	—	—	—	2	12	2.5	91
F-9	—	—	—	—	0	12	5.4	103
F-10	—	—	—	—	4	12	-.4	18
F-11	—	—	—	—	3	12	-.4	-30
F-12	—	—	—	—	1	12	-.4	-12
F-13	—	—	—	—	3	12	-.4	24
F-14	—	—	—	—	2	12	2.5	-12
F-15	—	—	—	—	6	12	2.5	55
F-15 QC	—	—	—	—	4	12	-.4	18
W-1	—	—	—	—	1	11	5.4	5.6
W-2	400	15	—	—	2	10	-.4	-30
W-3	—	—	—	—	2	12	2.5	24
W-4	400	2	—	—	1	12	-.4	-79
W-5	—	—	—	—	0	12	-.4	-42
W-6	—	—	—	—	4	12	-.4	-67
W-7	360	1	—	—	1	12	-.4	42
W-9	—	—	—	—	1	12	2.5	48
W-8 QC	—	—	—	—	1	12	-.4	36
W-9	520	2	—	—	1	12	-.4	48
—	—	—	—	—	—	—	—	—

Radiological Survey Results - Calculational Sheet

SURVEY # 02-0046

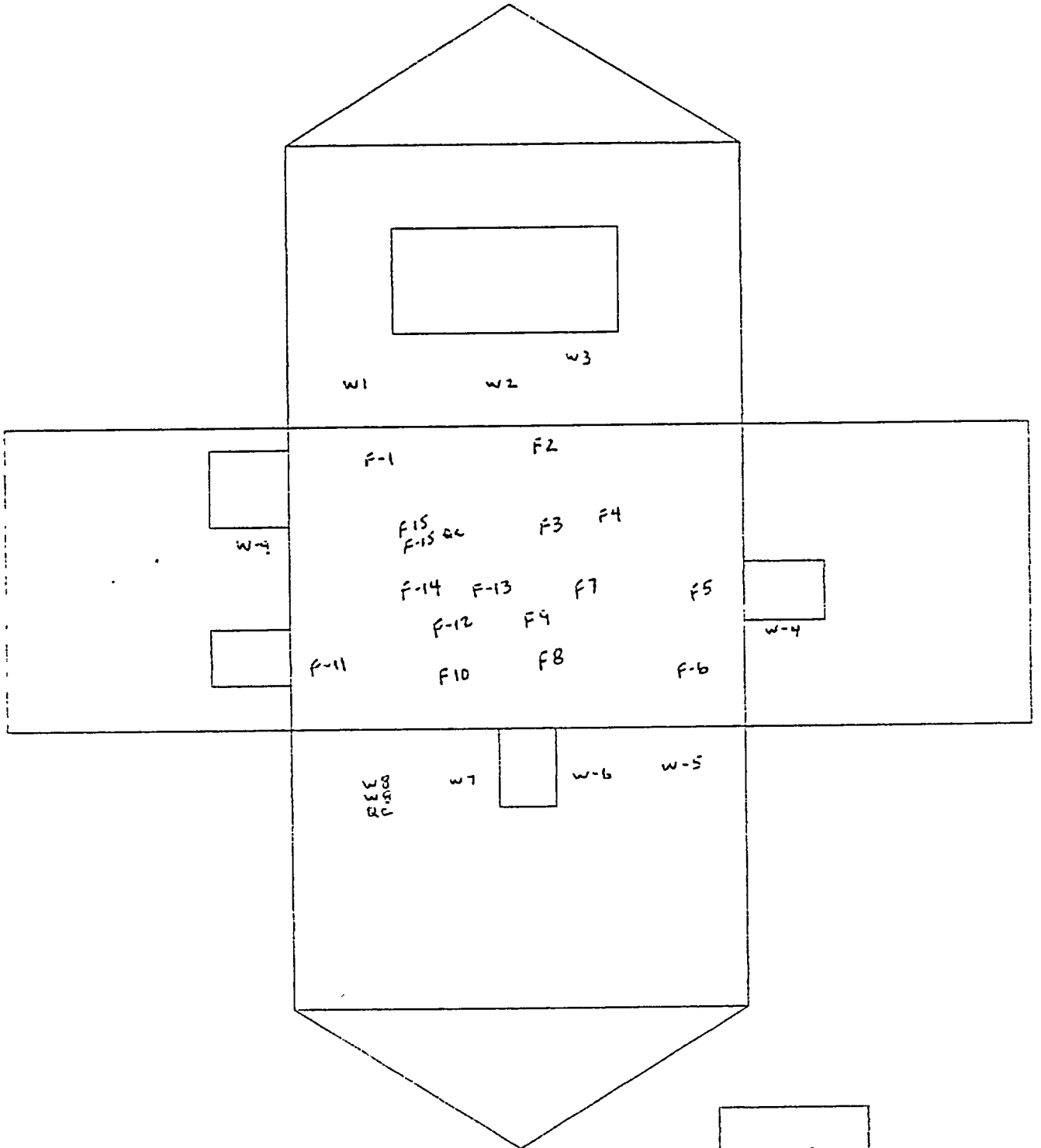
Location	β Static (unsh) (cpm)	β Static (sh) (cpm)	Gross β	Minus Bkgd = (Net β)	Net β dpm/100 cm²
F-1	310	299	11	-67	-728
F-2	305	305	0	-78	-847
F-3	397	305	92	14	152
F-4	362	261	101	23	250
F-5	376	268	108	30	326
F-6	328	290	116	38	413
F-7	347	290	57	-21	-228
F-8	325	288	37	-41	-445
F-9	346	303	43	-35	-380
F-10	289	269	20	-58	-630
F-11	319	294	25	-53	-576
F-12	361	251	110	32	347
F-13	332	269	63	-15	-163
F-14	334	302	32	-46	-500
F-15	327	306	21	-57	-619
F-15 QC	359	268	91	13	141
W-1	341	285	56	48	522
W-2	293	281	12	4	43
W-3	314	248	66	58	630
W-4	304	305	-1	-9	-97
W-5	309	254	55	47	511
W-6	281	276	5	-3	-32
W-7	266	244	22	14	152
W-8	310	284	26	18	195
W-8 QC	330	279	51	43	467
W-9	333	261	72	64	696
		N			
		A			

Instrument Model/SN:	Probe Model/SN:	Detector Eff.: (cpm/dpm)
2224-1 / 129463	43-89 / 169230	β=.092 / α=.154
	N	
	A	

Material	Bkgd
Floor	78
wall	8
N	
A	

Survey # 02-0046

Building 13
North



Scale:
4m x 4m

Interior

DDO-138 Radiation Protection Survey Report	Site: Molycorp / Washington, PA

Section 1: Survey Information

Date:	Time:	Location:	Survey Issue Log Number
3-7-02	1030	9/5 Bldg 13	02-0047
RWP Number	Purpose of Survey: ☐ RWP ☐ Routine Survey ☐ Unconditional Release ☒ Other:		Page 1 of 4

Survey Title:

NO ROOF SURVEY.

DUE TO UNSAFE

CONDITIONS

Smear Number	Beta dpm/100cm²	Alpha dpm/100cm²
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13	N	
14		A
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		

2360 α 3.7 β⁻ 8 model 19 10 mR/HR

Bkgd Readings 2350-1 α 1 β⁻ 280 2929 α .16 β⁻ 69

Legend

00 = mRem/h gamma | 00 C = mRem/h gamma contact | ① = Smear Location | 7 = Air Sample Location | -X-X-X- = Rope, Boundary, or Barrier

00 β = mRem/h beta | 00 βC = mRem/h beta contact | —①— = Large Area Wipe | = Bulk Material Sample

Section 2: Instrument Used

Instrument Model/SN	Cal Due Date.	Probe Model/SN	Cal Due Date	Detector Eff (cpm/dpm)	MDA	Other
2350-1 / 117014	8-13-02	43-106 / 133866	8-6-02	α .211 β⁻ .248	α 45 β⁻ 637	
2929 / 115563	6-19-02	43-10 / 127216	6-19-02	α .352 β⁻ .239	α 14 β⁻ 176	
2360 / 156371	8-15-02	43-89 / 164832	8-5-02	α .153 β⁻ .088	α 76 β⁻ 180	N / A
19 / 22526	8-6-02	N		N		
N/A	N/A	A			A	

Section 3: Review and Approval

Survey Performed By (Sign).	Area Posted and/or Barricaded: ☐ Yes ☐ No ☒ Not Required	Date and Time
		3-7-03 1030
Radiation Safety Officer (Print Name & Sign) Mike McDonald		Date and Time 3-14-02 9:30

Survey # 02-0047

Radiological Survey Results - Survey Location Indicator

Survey Area Information:

	Instrument Model/SN	Cal Due	Probe Model/SN	Cal Due	α Scan MDA	β Scan MDA	α Static MDA	β Static MDA
Instrument Data	2350-1 / 117014	8-13-02	43-106 / 135866	8-6-02	45	637	N/A	N/A
	2929 / 115563	6-19-02	43-10 / 127216	6-19-02			14	176
	2360 / 156371	8-15-02	43-89 / 164832	8-5-02	N		76	180
	19 / 22526	8-6-02	N			A	N	
	N/A	N/A	A					A

	Print Name	Signature	Date
Performed By:	DENNIS Whitcock		3-7-03

Location	β Scan (cpm)	α Scan (cpm)	β Static (unsh) (cpm)	β Static (sh) (cpm)	α Static (cpm)	ER (µrem/hr)	Smears (dpm/100 cm²) α	Smears (dpm/100 cm²) β
ω-1	—	—	—	—	0	10	2	-21
ω-2	290	2	—	—	2	12	-.5	-33
ω-3	—	—	—	—	2	11	-.5	-8
ω-3 QC	—	—	—	—	2	11	-.5	4
ω-4	340	5	—	—	2	10	-.5	-17
ω-5	—	—	—	—	2	10	2	-46
ω-6	310	6	—	—	2	10	2	29
				N				
				A				

SURVEY #02-0047

Radiological Survey Results - Calculational Sheet

Bldg #13

Location	β Static (unsh) (cpm)	β Static (sh) (cpm)	Gross β	Minus Bkgd = (Net β)	Net β dpm/100 cm²
W-1	275	286	-11	-19	-215
W-2	273	274	-2	-10	-114
W-3	313	294	19	11	125
W-3 QC	341	288	53	45	511
W-4	341	268	73	65	739
W-5	315	269	46	38	432
W-6	287	250	37	29	330

N

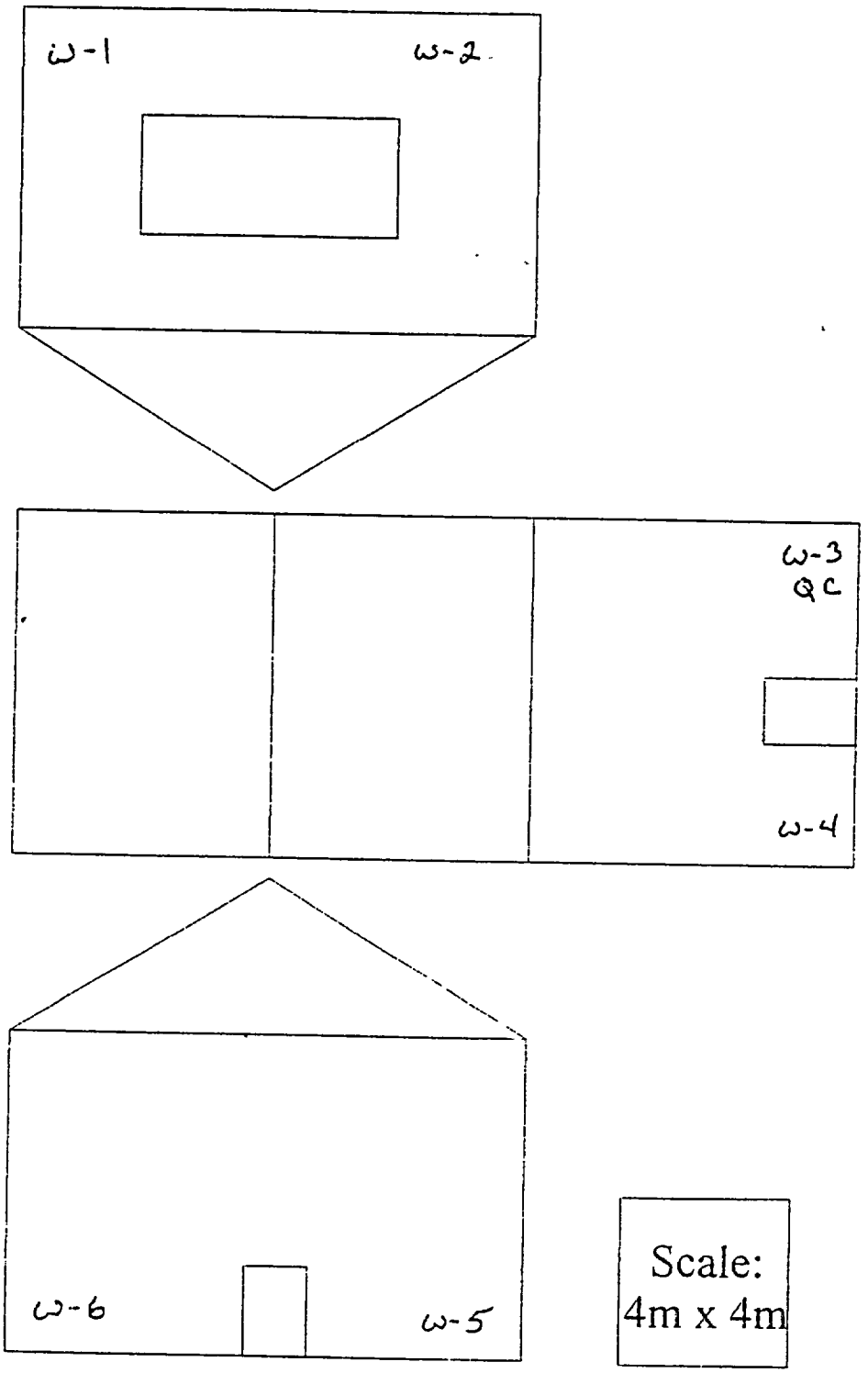
A

Instrument Model/SN:	Probe Model/SN:	Detector Eff.. (cpm/dpm)
2360 / 156371	43-89 / 164832	B: .088 / α: .153
	N	
	A	

Material	Bkgd
Wall	B: 8 α: 3.7
N	
A	

Survey # 02-0047

Building 13
North



Exterior

RPP-OP-019

DDO-138 Radiation Protection Survey Report	Site: Molycorp / Washington, PA

Section 1: Survey Information Verification of status for building 13 INSIDE/outside #2 meter verification

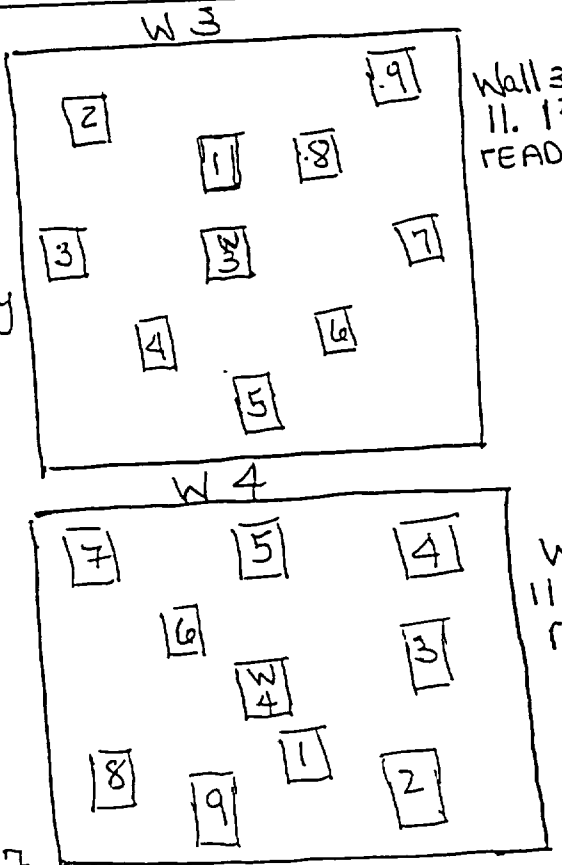
Date:	Time:	Location:	Survey Issue Log Number:
3-12-02	1300	Building 13	02-00064

RWP Number:	Purpose of Survey:	Page 1 of 5
N/A	☐ RWP ☐ Routine Survey ☐ Unconditional Release ☑ Other:	

Survey Title

Outside AREA
building 13
Walls 3 & 4

Each Squared area is 40 in. by 40 in.



Wall 3
11. 12
READINGS

Wall 4
11 12
READINGS

Set for Block
Bkgd B-8 α 3.7

Smear Number	Beta dpm/100cm²	Alpha dpm/100cm²
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13	N	
14		A
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		

Legend.
00 = mRem/h gamma | 00 C = mRem/h gamma contact | ① = Smear Location | 7 = Air Sample Location | -X-X-X- = Rope, Boundary, or Barrier
00 β = mRem/h beta | 00 βC = mRem/h beta contact | —①— = Large Area Wipe | = Bulk Material Sample

Section 2: Instrument Used

Instrument Name	Model Number:	Serial/ID Number	Calibration Due Date	MDA.
2224-1/43-89	129463/169230	A	8-6-02/8-6-02	B-172 α 76
		N		
		A		

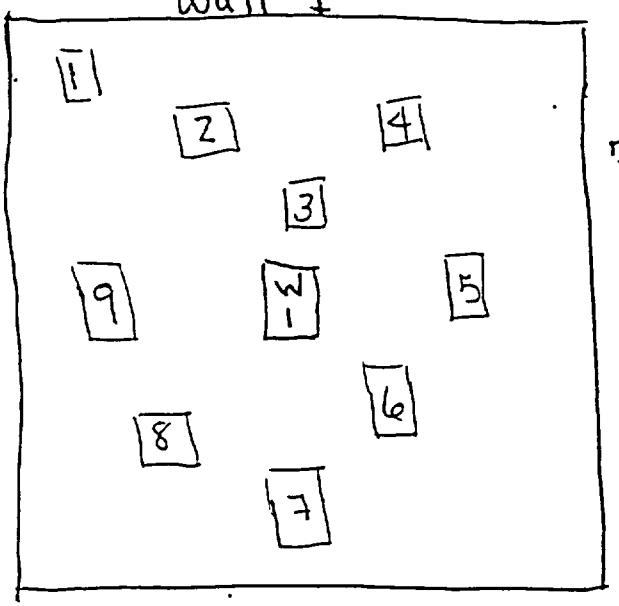
Section 3: Review and Approval

Survey Performed By (Sign)	Area Posted and/or Barricaded: ☐ Yes ☐ No ☑ Not Required	Date and Time: 3-12-02/1300
Radiation Safety Officer (Print Name & Sign). Mike McDonald		Date and Time: 3-14-02 9:30

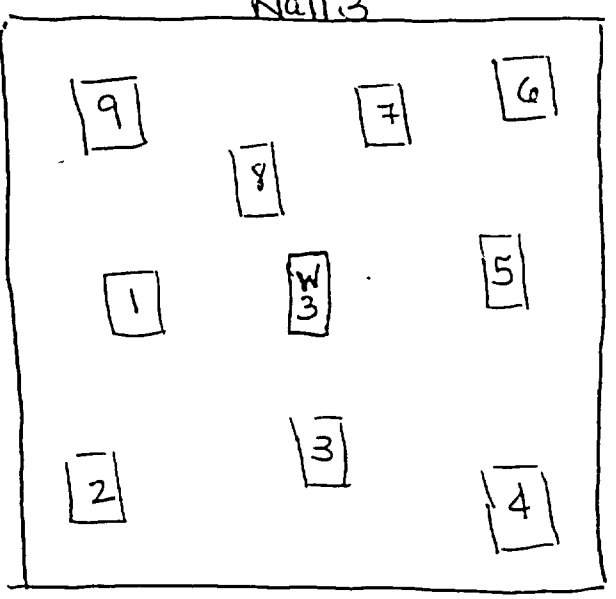
Survey # 02-0064

Building 13 INSIDE AREA Walls 1, 3, 5, 9.
1² squared meter verification survey

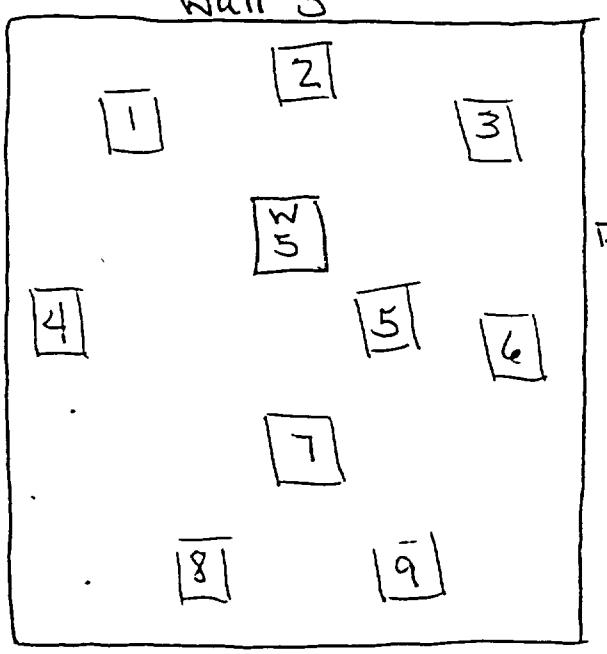
Wall 1
7 1² READINGS



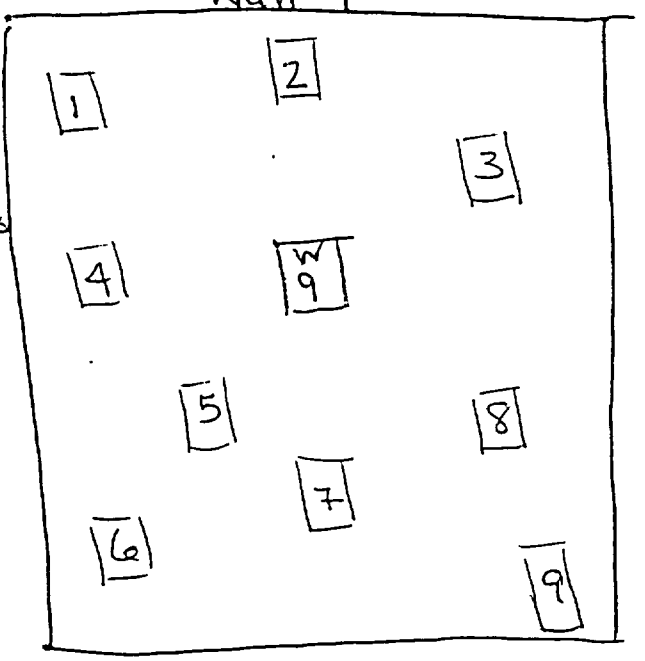
Wall 3
7 1² READINGS



Wall 5
28 1² READINGS



Wall 9
1 1² READINGS



SET Bkgd for Block
B-8 ∝ 3.7
HDA 172 B
76 ∝
2224-1

Radiological Survey Results - Calculational Sheet

Survey # 02-0064

Location	β Static (unsh) (cpm)	β Static (sh) (cpm)	Gross β	Minus Bkgd = (Net β)	Net β dpm/100 cm²	
Bldg 13 W1 I/S	362	314	48	40	434	
	355	333	22	14	152	
	368	344	24	16	174	
	346	348	-2	-10	-109	
	360	306	54	46	500	
	362	316	46	38	413	
	388	320	18	10	108	
	325	330	-5	-13	-141	
	352	318	34	26	283	
					1814/9	202
W3 I/S	330	310	20	12	130	
	334	376	-42	-50	-543	
	300	264	36	28	304	
	310	320	-10	-18	-196	
	326	349	-23	-31	-337	
	330	336	-6	-14	-152	
	274	268	6	-2	-22	
	310	304	6	-2	-22	
	348	320	28	20	217	
					-621/9	-69
W5 I/S	348	310	38	30	326	
	312	282	30	22	239	
	380	326	54	46	500	
	390	324	66	58	630	
	334	314	20	12	130	
	402	332	70	62	674	
	332	290	42	34	370	
	318	264	54	46	500	
	292	290	2	-6	-65	
					3304/9	367

Instrument Model/SN:	Probe Model/SN:	Detector Eff.: (cpm/dpm)
2224/129463	43-89/169230	α .154 β⁻ .092
	N	
	A	

Material	Bkgd
WALL	α 3.7 β⁻ 8
N	A

Radiological Survey Results - Calculational Sheet

SURVEY # 02-0064

Location	β Static (unsh) (cpm)	β Static (sh) (cpm)	Gross β	Minus Bkgd = (Net β)	Net β dpm/100 cm²	
Bldg 13 W9 I/S	371	307	64	56	609	
	307	313	-6	-14	-152	
	331	315	16	8	87	
	361	350	11	3	33	
	442	366	76	68	740	
	358	283	75	67	728	
	330	280	50	42	457	
	343	286	57	49	533	
	341	316	25	17	185	
					3220 / 9	358
Bldg 13 W3 O/S	232	271	-39	-47	-511	
	300	298	2	-6	-65	
	338	290	48	40	435	
	336	330	6	-2	22	
	360	301	59	51	554	
	320	286	34	26	283	
	280	242	38	30	326	
	340	316	24	16	174	
	264	278	-14	-22	-239	
					979 / 9	109
W4 O/S	300	252	48	40	435	
	282	265	17	9	98	
	326	257	69	61	663	
	341	265	76	68	739	
	313	263	50	42	457	
	304	272	32	24	261	
	295	287	8	0	0	
	319	357	62	54	587	
	300	253	47	39	424	
					3664 / 9	407

Instrument Model/SN:	Probe Model/SN:	Detector Eff.: (cpm/dpm)
2224/129463	43-89/169230	α .154 β .092
	N	
	A	

Material	Bkgd
WALL	α 3.7 β 8
	N
	A

Bldg 13

IS W1 $522\left(\frac{900}{10,000}\right) + 202\left(1-\frac{900}{10,000}\right)$ $46.98 + 183.8 = 231$ dpm β^- ; 462 dpm α

W3 $630\left(\frac{700}{10,000}\right) + -69\left(1-\frac{700}{10000}\right)$ $44.1 + -64.17 = -20$ dpm β^- ; 0 dpm α

W5 $511\left(\frac{2800}{10,000}\right) + 367\left(1-\frac{2800}{10000}\right)$ $143 + 264 =$ 407 β^- ; 814 α

W9 $696\left(\frac{200}{10000}\right) + 358\left(1-\frac{200}{1000}\right) = 13.92 + 350.8 = 365$ β^- ; 730 α

3/5

W3 $511\left(\frac{1000}{10000}\right) + 109\left(1-\frac{1000}{10000}\right) = 51.1 + 98.1 =$ 149 β^- ; 298 α

W4 $739\left(\frac{1100}{10000}\right) + 407\left(1-\frac{1100}{10000}\right)$ $81.29 + 362 = 443$ β^- ; 886 α

Results of Surface Scans

Molycorp - Building 13 Survey Unit (Unaffected Area)

Building Interior

Location (see map)	Beta Scan gross cpm	Beta Scan net cpm	Alpha Scan gross cpm	Alpha Scan net cpm	
F1	1700	1351	9	8	All floor scans performed with Ludlum 239-1F (2350-1 No 95359 with 43-37 No 92503)
F2					Floor Monitor Info
F3	324	-25	1	0	Scan MDA Beta - 205 dpm/detector area
F4					Scan MDA Alpha - 14 6 dpm/detector area
F5					Scan background Beta - 349 cpm
F6	1600	1251	8	7	Scan background Alpha - 1 cpm
F7					10% scan of floor and 2 meters up walls
F8					
F9					
F10					
F11					
F12					
F13					
F14					
F15					
W1					
W2	400	64	15	12.8	All interior wall scans performed with Ludlum 2350-1 No.117566 with 43-106 No 128921
W3					43-106 Info
W4	400	64	2	-0 2	Scan MDA Beta - 690 dpm/detector area
W5					Scan MDA Alpha - 66 dpm/detector area
W6					Scan background Beta - 336 cpm
W7	380	44	1	-1 2	Scan background Alpha - 2 2 cpm
W8					
W9	520	184	2	-0 2	

Building Exterior

Location (see map)	Beta Scan gross cpm	Beta Scan net cpm	Alpha Scan gross cpm	Alpha Scan net cpm	
W1					All external wall scans performed with Ludlum 2350-1 No 117014 with 43-106 No 133866
W2	290	10	2	1	43-106 Info.
W3					Scan MDA Beta - 637 dpm/detector area
W4	340	60	5	4	Scan MDA Alpha - 45 dpm/detector area
W5					Scan background Beta - 280 cpm
W6	310	30	6	5	Scan background Alpha - 1 cpm

F = floor, W = wall, C = ceiling

Elevated Scan Readings

Molycorp - Building 13 Survey Unit (Unaffected Area)

Building Interior

Locations F1 and F6 indicated elevated readings by scan with floor monitor as shown below.

Location	Beta Scan net cpm
F1	1351
F6	1251

Locations F1 and F6 were re-scanned with hand-held 43-106, results indicated background levels. Direct measurements in locations F1 and F6 indicate background values.

Building Exterior

No elevated scan results were reported during exterior scans.

Direct Measurements (Total Activity)

Molycorp - Building 13 Survey Unit (Unaffected Area)

Building Interior

Location	Unshield Beta cpm	Shield Beta cpm	Gross Beta cpm	Bkgd cpm	Net cpm	Direct Beta (dpm/100cm^2)	Uncertainty 95% CL	MDA (dpm/100cm^2)	Direct Alpha [1] (dpm/100cm^2)
F1	310	299	11	78	-67	-728	201	475	-1457
F2	305	305	0	78	-78	-848	188	475	-1696
F3	397	305	92	78	14	152	278	475	304
F4	362	261	101	78	23	250	285	475	500
F5	376	268	108	78	30	326	291	475	652
F6	328	290	38	78	-40	-435	229	475	-870
F7	347	290	57	78	-21	-228	248	475	-457
F8	325	288	37	78	-41	-446	228	475	-891
F9	346	303	43	78	-35	-380	234	475	-761
F10	389	269	120	78	42	457	300	475	913
F11	319	294	25	78	-53	-576	216	475	-1152
F12	361	251	110	78	32	348	292	475	696
F13	332	269	63	78	-15	-163	253	475	-326
F14	334	302	32	78	-46	-500	223	475	-1000
F15	327	306	21	78	-57	-620	212	475	-1239
W1	341	285	56	8	48	522	170	172	1043
W2	293	281	12	8	4	43	95	172	87
W3	314	248	66	8	58	630	183	172	1261
W4	304	305	-1	8	-9	-98	56	172	-196
W5	309	254	55	8	47	511	169	172	1022
W6	281	276	5	8	-3	-33	77	172	-65
W7	266	244	22	8	14	152	117	172	304
W8	310	284	26	8	18	196	124	172	391
W9	333	261	72	8	64	696	191	172	1391

All building interior direct measurements were performed with 43-89 No 169230	Beta	Alpha
Efficiency	0 092	0 154
Floor Background (cpm)	78	.2 4
Wall Background (cpm)	8	3 7
Floor MDA (dpm/100 cm^2)	475	64 3
Wall MDA (dpm/100 cm^2)	172	75 6

Building Exterior

Location	Unshield Beta cpm	Shield Beta cpm	Gross Beta cpm	Bkgd cpm	Net cpm	Direct Beta (dpm/100cm^2)	Uncertainty 95% CL	MDA (dpm/100cm^2)	Direct Alpha [1] (dpm/100cm^2)
W1	275	276	-1	8	-9	-102	59	180	-205
W2	273	274	-1	8	-9	-102	59	180	-205
W3	313	294	19	8	11	125	116	180	250
W4	341	268	73	8	65	739	200	180	1477
W5	315	269	46	8	38	432	164	180	864
W6	287	250	37	8	29	330	149	180	659

All building exterior direct measurements were performed with 43-89 No 164832	Beta	Alpha
Efficiency	0 088	0 153
Background (cpm)	8	3 7
MDA (dpm/100 cm^2)	180	76

(1) - A beta to alpha ratio factoring (1 2, beta to alpha) was used to provide a more accurate alpha activity determination then sampling

Elevated Direct Readings (Total Activity) and Averaging Results
Molycorp - Building 13 Survey Unit (Unaffected Area)

Building Interior

Location	Direct Alpha (dpm/100cm^2)	Over Area (cm^2)	Exceeds Limits Maximum	Exceeds Limits Average
W1	1044	900	No	Yes
W3	1261	700	No	Yes
W5	1022	2800	No	Yes
W9	1391	200	No	Yes

Averaged Value (over 1 m^2)		Within Limit?
W1	462	Yes
W3	0	Yes
W5	814	Yes
W9	730	Yes

Building Exterior

Location	Direct Alpha (dpm/100cm^2)	Over Area (cm^2)	Exceeds Limits Maximum	Exceeds Limits Average
W4	1447	1100	No	Yes

Averaged Value (over 1 m^2)		Within Limit?
W4	886	Yes

Removable Surface Activity Measurements
Molycorp - Building 13 Survey Unit (Unaffected Area)

Building Interior

Location (see map)	Removable Beta (dpm/100cm^2)	Uncertainty 95% CL	MDA	Removable Alpha (dpm/100cm^2)	Uncertainty 95% CL	MDA
F1	-24	26 2	206	-0 4	2.1	11 6
F2	-12	20 2	206	-0 4	2.1	11 6
F3	-42	33 2	206	-0 4	2 1	11 6
F4	-18	23 4	206	-0 4	2 1	11 6
F5	-55	37.5	206	-0 4	2.1	11 6
F6	0	11 3	206	-0 4	2 1	11.6
F7	115	53 0	206	-0 4	2 1	11.6
F8	91	47 4	206	2 5	5 3	11 6
F9	103	50 3	206	5 4	7 8	11.6
F10	18	23 4	206	-0 4	2 1	11 6
F11	-30	28 7	206	-0.4	2.1	11.6
F12	-12	20 2	206	-0.4	2.1	11.6
F13	24	26 2	206	-0 4	2 1	11.6
F14	-12	20 2	206	2.5	5 3	11.6
F15	55	37 5	206	2.5	5 3	11.6
W1	5 6	16.0	206	5.4	7.8	11.6
W2	-30	28.7	206	-0 4	2.1	11.6
W3	24	26 2	206	2.5	5.3	11 6
W4	-79	44 3	206	-0 4	2.1	11 6
W5	-42	33 2	206	-0 4	2.1	11 6
W6	-67	41.1	206	-0 4	2.1	11 6
W7	42	33 2	206	-0 4	2.1	11.6
W8	48	35 3	206	2.5	5 3	11 6
W9	48	35 3	206	-0 4	2 1	11.6

Ludlum 2929 No. 152202 with 43-10 No 156519 Info

	Beta	Alpha
Background (cpm)	45	0.14
Bkgd ct time	50	50
Sample ct time	1	1
Efficiency	0 165	0 344
MDA	206	11 6

Building Exterior

Location (see map)	Removable Beta (dpm/100cm^2)	Uncertainty 95% CL	MDA	Removable Alpha (dpm/100cm^2)	Uncertainty 95% CL	MDA
W1	-21	20 7	176	2	4.7	14
W2	-33	25 0	176	-0 5	2 4	14
W3	-8	14 9	176	-0 5	2 4	14
W4	-17	19 1	176	-0 5	2 4	14
W5	-46	28 8	176	2	4.7	14
W6	29	23 6	176	2	4 7	14

Ludlum 2929 No 115563 with 43-10 No 127216 Info

	Beta	Alpha
Background (cpm)	69	0 16
Bkgd ct time	50	50
Sample ct time	1	1
Efficiency	0 239	0 35
MDA	176	14

F = floor, W = wall, C = ceiling

Removable Surface Activity Measurements
Molycorp - Building 13 Survey Unit (Unaffected Area)

No elevated removable surface activity was reported.

Exposure Rate Measurements
Molycorp - Building 13 Survey Unit (Unaffected Area)

Building Interior

Location	Exposure Rate uR/hr
F1	12
F2	12
F3	12
F4	12
F5	12
F6	12
F7	12
F8	12
F9	12
F10	12
F11	12
F12	12
F13	12
F14	12
F15	12
W1	11
W2	10
W3	12
W4	12
W5	12
W6	12
W7	12
W8	12
W9	12

Background dose rate: 11-12 uR/hr with Model 19, No.22526

Building Exterior

Location	Exposure Rate uR/hr
W1	10
W2	12
W3	11
W4	10
W5	10
W6	10

Background dose rate: 10 uR/hr with Model 19, No 22526

Summary of Building Surface Direct Reading (Total Activity) Results

Molycorp - Building 13 Survey Unit (Unaffected Area)

Building Interior

Location	Average Total Activity (dpm/100cm^2) Direct Beta (dpm/100cm^2)	Correlated Alpha (dpm/100cm^2)
F1	-728	-1456 5
F2	-848	-1695 7
F3	152	304 3
F4	250	500.0
F5	326	652 2
F6	-435	-869 6
F7	-228	-456 5
F8	-446	-891 3
F9	-380	-760.9
F10	457	913 0
F11	-576	-1152 2
F12	348	695.7
F13	-163	-326 1
F14	-500	-1000.0
F15	-620	-1239 1
W1	231	462 0
W2	43	87.0
W3	-20	-40 0
W4	-98	-195 7
W5	407	814.0
W6	-33	-65 2
W7	152	304.3
W8	196	391 3
W9	365	730 0

	Beta				Alpha			
	n	$\bar{x}$	s	μ_α	n	$\bar{x}$	s	μ_α
	30	-34	383 6	84.8	30	-68 2	767 2	169 5
		$t_{1-\alpha}$	1.697					

Guidelines/Conditions Satisfied	
Beta	Alpha
Yes	Yes

Building Exterior

Location	Direct Beta (dpm/100cm^2)	Correlated Alpha (dpm/100cm^2)
W1	-102	-205
W2	-102	-205
W3	125	250
W4	443	886
W5	432	864
W6	330	659

Summary of Exposure Rate Measurements
Molycorp - Building 13 Survey Unit (Unaffected Area)

Building Interior

Location	Exposure Rate uR/hr	Exposure Rate Background	Exposure Rate Net
F1	12	11	1
F2	12	11	1
F3	12	11	1
F4	12	11	1
F5	12	11	1
F6	12	11	1
F7	12	11	1
F8	12	11	1
F9	12	11	1
F10	12	11	1
F11	12	11	1
F12	12	11	1
F13	12	11	1
F14	12	11	1
F15	12	11	1
W1	11	11	0
W2	10	11	-1
W3	12	11	1
W4	12	11	1
W5	12	11	1
W6	12	11	1
W7	12	11	1
W8	12	11	1
W9	12	11	1

Exposure Rate (uR/hr)

n	$\bar{x}$	s	μ_α
30	0 8	0 5508614	1.0

$t_{1-\alpha}$ 1.697

Guidelines/Conditions Satisfied: Yes

Building Exterior

Location	Exposure Rate uR/hr	Exposure Rate Background	Exposure Rate Net
W1	10	10	0
W2	12	10	2
W3	11	10	1
W4	10	10	0
W5	10	10	0
W6	10	10	0

Appendix B

Building 14 Data Package

Molycorp Washington, PA

Building 14 Data Package

This data package contains final status survey information for Building 14, Molycorp, Washington, PA site.

Field data collection forms, survey report forms, statistical test results, and comparisons to release limits are provided.

Summary

No anomalies were reported during the survey of Building 14. Elevated levels of background radiation, from soil radioactivity, continued to be a presence during survey activities.

Results from the final status survey of Building 14 provides evidence that release criteria have been met, demonstrates that residual radioactivity is below the unrestricted use criteria, and confirms that Building 14 is suitable for unrestricted use.

RPP-OP-019

DDO-138 Radiation Protection Survey Report | Site: Molycorp / Washington, PA

Section 1: Survey Information Building 14, unaffected, 10% SURVEY

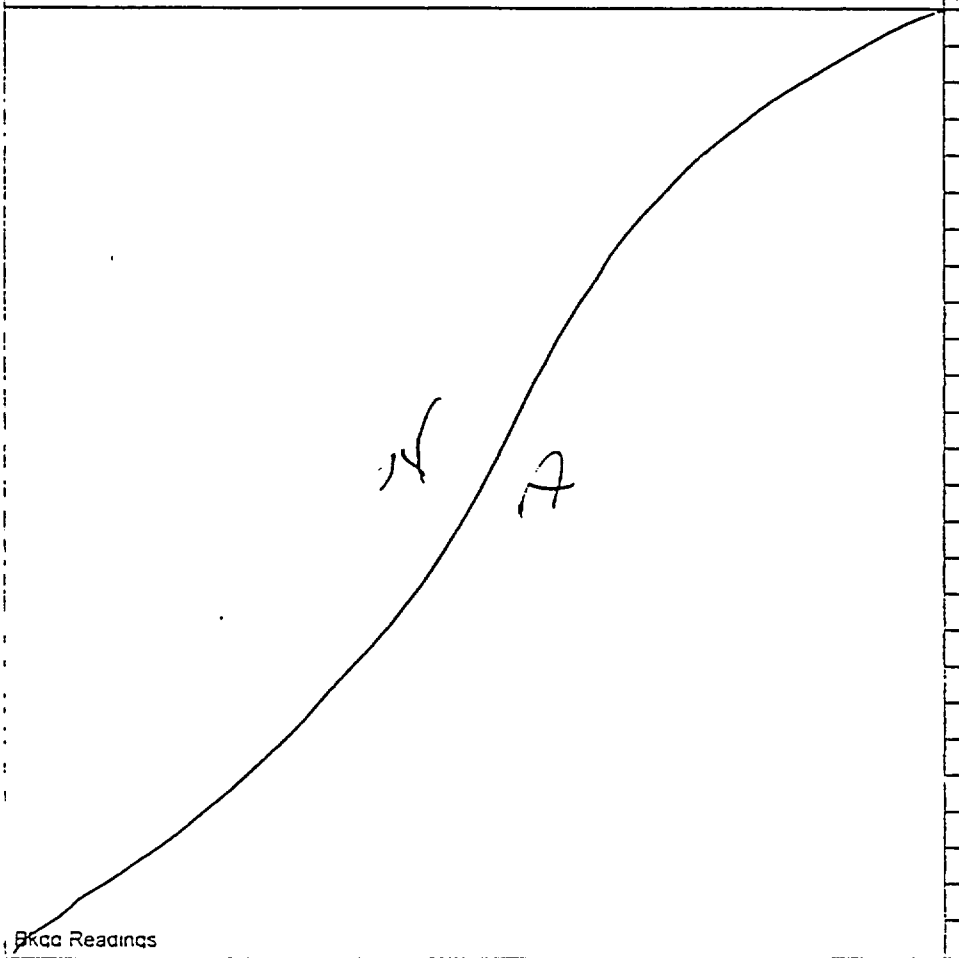
Date	Time	Location	Survey Issue Log Number
3-7-02	0800	Building 14	02-0048

RWP Number: N/A

Purpose of Survey: ☐ RWP ☐ Routine Survey ☐ Unconditional Release ☒ Other:

Page 1 of 4

Survey Title:



BKGD Readings

Smear Number	Beta dpm/100cm²	Alpha dpm/100cm²
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13	N	
14		A
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		

Legend

00 = mRem/h gamma | 00 C = mRem/h gamma contact | ⓘ = Smear Location | 7 = Air Sample Location | -X-X-X- = Rope Boundary, or Barrier

00 β = mRem/h beta | 00 βC = mRem/h beta contact | —ⓘ— = Large Area Wipe | = Bulk Material Sample

Section 2: Instrument Used

Instrument Model/SN	Cal Due Date	Probe Model/SN	Cal Due Date	Detector Eff (cpm/dpm)	MDA	Other
2350-1 95359	8-6-02	43-37 092503	8-6-02	α .207 .24	14.6α 205β	BKground 5.2α 1744β
2350-1 117566	8-6-02	43-100 128912	8-6-02	α .212 .251	16.0α 690β	Bkg. 7.2α 336β
2929 152202	2-6-03	43-10 151519	2-6-03	α .344 .165	11.6α 206β	β=45 α=.14
2224-1 129462	8-6-02	43-89 169230	8-6-02	α=.154 β=.092	64.3α 475β	β=78 α=2.7 floor
2224-1 129462	8-6-02	43-89 169230	8-6-02	α=.154 .092	75.6α 172β	β=8 α=3.7 wall

Section 3: Review and Approval

Survey Performed By (Sign)	Area Posted and/or Barricaded	Date and Time
Mark Blaucik	☐ Yes ☐ No ☒ Not Required	3-7-02 0800

Radiation Safety Official (Print Name & Sign)	Date and Time
Mike McGuire MACTEC	3-14-02 9:30

Survey # 02-0048

Radiological Survey Results - Survey Location Indicator

Survey Area Information:

	Instrument Model/SN	Cal Due	Probe Model/SN	Cal Due	α Scan MDA	β Scan MDA	α Static MDA	β Static MDA
Instrument Data	2350-1 / 95359	8-6-02	43-37 / 092503	8-6-02	15	205	N	
	2350-1 / 117566	8-6-02	43-106 / 128912	8-6-02	66	690		A
	2929 / 152202	2-6-03	43-10 / 156519	2-6-03		N	12	206
	2224-1 / 129462	8-6-02	43-89 / 169230	8-6-02		A	64	475
	#9 / 22526	8-6-02	N/A	N/A			N/A	N/A

	Print Name	Signature	Date
Performed By:	MARK BLANCIAK	Mark Blanciak	3-7-02
	DENNIS Whitlock	[illegible]	3-7-02

Location	β Scan (cpm)	α Scan (cpm)	β Static (unsh) (cpm)	β Static (sh) (cpm)	α Static (cpm)	ER (μrem/hr)	Smears (dpm/100 cm²) α	Smears (dpm/100 cm²) β
F-1	1600	2	—	—	0	9	-.4	-24
F-2	—	—	—	—	2	9	2.5	36
F-3	—	—	—	—	1	9	-.4	48
F-4	1600	7	—	—	2	9	-.4	6
F-5	—	—	—	—	14	12	-.4	-6
F-6	—	—	—	—	7	10	2.5	-30
F-7	—	—	—	—	2	10	-.4	48
F-8	—	—	—	—	2	10	-.4	0
F-9	—	—	—	—	7	10	2.5	55
F-10	—	—	—	—	8	10	-.4	67
F-11	1900	12	—	—	5	11	-.4	-6
F-11 QC	1900	12	—	—	4	10	-.4	12
F-12	1700	10	—	—	5	10	2.5	6
F-13	—	—	—	—	2	10	-.4	-12
F-14	2100	14	—	—	2	9	2.5	-42
W-1	320	1	—	—	3	8	-.4	0
W-2	350	1	—	—	2	8	-.4	-24
W-3	306	1	—	—	1	8	-.4	-12
W-4	410	4	—	—	4	9	-.4	-18
W-5	320	1	—	—	2	9	-.4	67
W-6	—	—	—	—	2	9	-.4	30
W-7	350	2	—	—	5	10	-.4	0
W-8	350	2	—	—	7	10	-.4	-55
W-8 QC	—	—	—	—	5	10	-.4	-30
W-9	—	—	—	—	3	10	-.4	-61
W-10	—	—	—	—	3	10	-.4	-36
—	—	—	—	—	—	—	—	—

Radiological Survey Results - Calculational Sheet

Location	β Static (unsh) (cpm)	β Static (sh) (cpm)	Gross β	Minus Bkgd = (Net β)	Net β dpm/100 cm²
F-1	349	279	70	-8	-86
F-2	338	272	66	-12	-130
F-3	308	255	53	-25	-271
F-4	306	279	27	-51	-554
F-5	418	318	100	22	239
F-6	390	290	100	22	239
F-7	344	300	44	-34	-369
F-8	354	287	67	-11	-119
F-9	398	304	94	16	173
F-10	341	290	51	-27	-293
F-11	388	274	114	36	391
F-11QC	374	374	0	-78	-847
F-12	352	281	71	-7	-76
F-13	358	274	84	6	65
F-14	420	326	94	16	173
W-1	272	237	35	27	293
W-2	293	267	26	18	196
W-3	230	209	21	13	141
W-4	307	271	36	28	304
W-5	282	254	28	20	217
W-6	262	226	36	28	304
W-7	280	247	33	25	271
W-8	289	223	66	58	630
W-8 QC	290	233	57	49	533
W-9	241	205	36	28	304
W-10	258	240	18	10	108
		N			
			A		

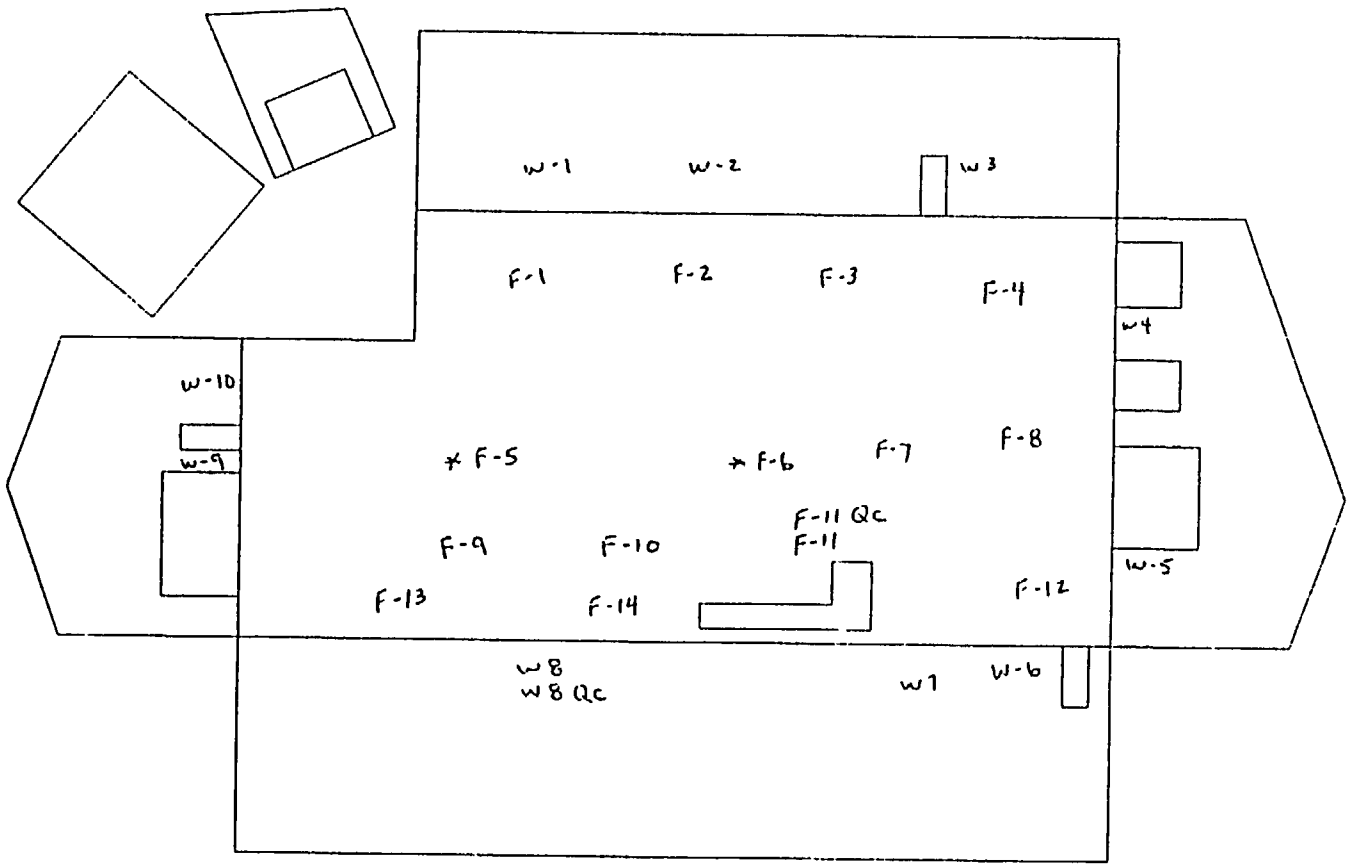
Instrument Model/SN:	Probe Model/SN:	Detector Eff.: (cpm/dpm)
2224-1/129463	43-89/169230	β: .092/α: .154
	N	
	A	

Material	Bkgd
Floor	78
Wall	8
N	
	A

Survey # 02-0048

Page 32 of 44

Building 14
North



Interior

Scale:
4m x 4m

* In Trench

DDO-138 Radiation Protection Survey Report

Site: Molycorp / Washington, PA

Section 1: Survey Information

Date	Time	Location	Survey Issue Log Number
3-7-02	0900	S/S Bldg 14	02-0049

RWP Number:

Purpose of Survey: ☐ RWP ☐ Routine Survey ☐ Unconditional Release ☒ Other

Page 1 of 4

Survey Title:

No Roof Survey Due to Unsafe Conditions

Smear Number	Beta dpm/100cm²	Alpha dpm/100cm²
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13	N	
14		A
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		

2360 α 3.7 β 8 Model 19 8 mr/hr

Bkgd Readings. 2350-1 α 1.2 β 250 2929 α .16 β 69.

Legend

00 = mRem/h gamma | 00 C = mRem/h gamma contact | ① = Smear Location | 7 = Air Sample Location | -X-X-X- = Room Boundary, or Barrier

00 β = mRem/h beta | 00 βC = mRem/h beta contact | —①— = Large Area Wipe | = Bulk Material Sample

Section 2: Instrument Used

Instrument Model/SN	Cal Due Date	Probe Model/SN	Cal Due Date	Detector Eff (cpm/dpm)	MDA.	Other
2350-1 / 117014	8-13-02	43-10α / 133866	8-6-02	α .28 β .28	α 42 β 707	
2929 / 115563	6-19-02	43-10 / 127216	6-19-02	α .35 β .239	α 14 β 176	
2360 / 156371	8-15-02	43-89 / 164832	8-5-02	α .153 β .188	α 76 β 180	N/A
19 / 22526	8-6-02	N		N		
N/A	N/A	A			A	

Section 3: Review and Approval

Survey Performed By (Sign)	Area Posted and/or Barricaded	Date and Time
	☐ Yes ☐ No ☒ Not Required	3-7-02 0900
Radiation Safety Officer (Print Name & Sign)		Date and Time
Mike McDonald		3-14-02 9:30

Survey #02-0049

Radiological Survey Results - Survey Location Indicator

Survey Area Information:

	Instrument Model/SN	Cal Due	Probe Model/SN	Cal Due	α Scan MDA	β Scan MDA	α Static MDA	β Static MDA
Instrument Data	2350-1 / 117014	8-13-02	43-106 / 133866	8-6-02	42	707	N/A	N/A
	2929 / 115563	6-19-02	43-10 / 127216	6-19-02			14	176
	2360 / 156371	8-15-02	43-89 / 16-4532	8-5-02	N		76	180
	19 / 22526	8-6-02	N			A	N	
	N/A	N/A	A					A

	Print Name	Signature	Date
Performed By:	DENNIS whitLock		3-7-02

Location	β Scan (cpm)	α Scan (cpm)	β Static (unsh) (cpm)	β Static (sh) (cpm)	α Static (cpm)	ER (μrem/hr)	Smears (dpm/100 cm²) α	Smears (dpm/100 cm²) β
W-1	270	4	—	—	2	9	-.5	29
W-2	300	6	—	—	0	10	-.5	-29
W-3	315	6	—	—	6	11	2	8
W-4	270	1	—	—	2	10	-.5	-4
W-5	290	5	—	—	3	9	5	17
W-5 QC	285	5	—	—	3	8	-.5	-33
W-6	310	4	—	—	6	11	5	-67
				N				
					A			

Survey # 02-0049

Radiological Survey Results - Calculational Sheet

Bldg # 14

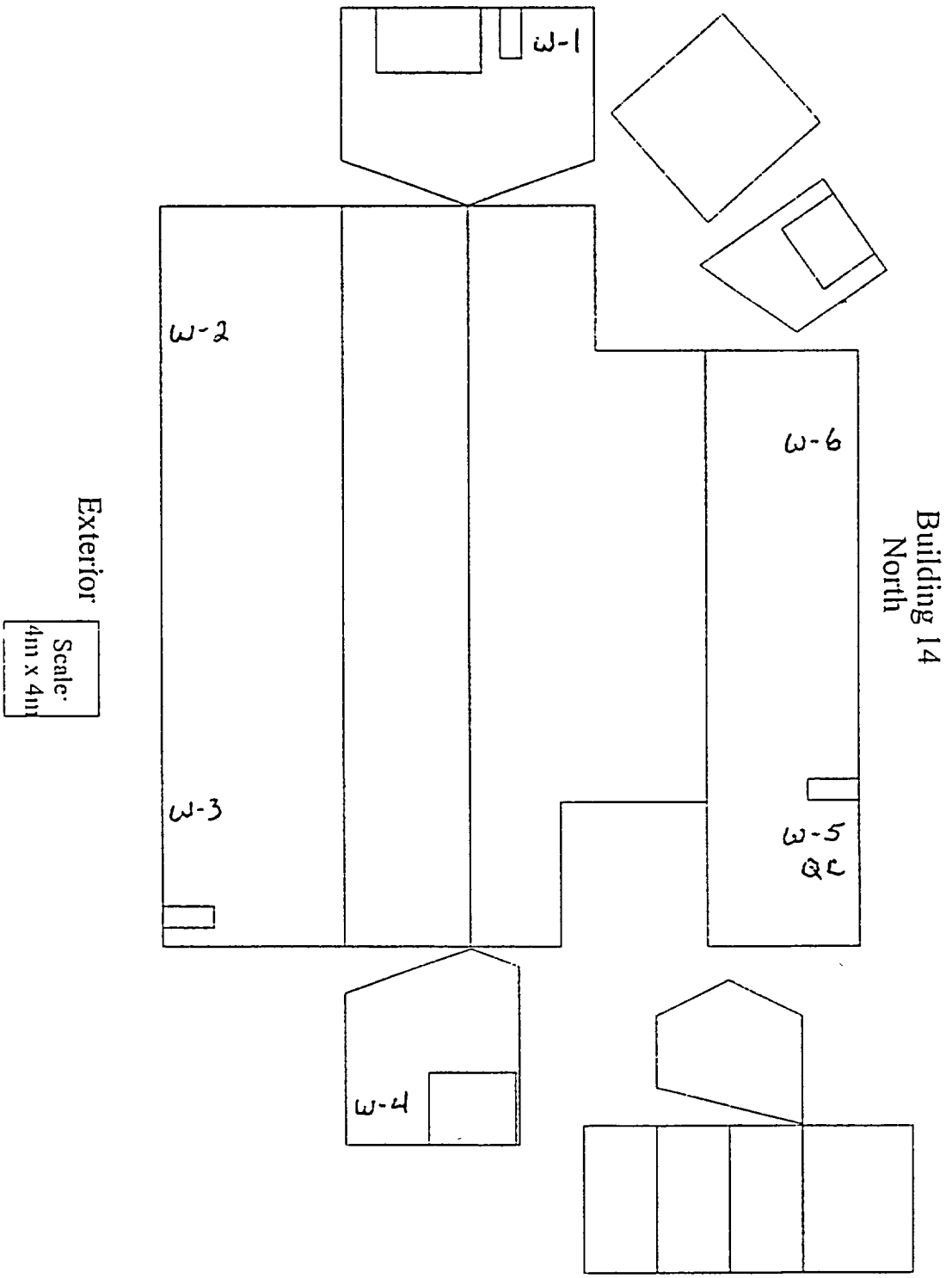
Location	β Static (unsh) (cpm)	β Static (sh) (cpm)	Gross β	Minus Bkgd = (Net β)	Net β dpm/100 cm²
W-1	255	255	0	-8	-91
* W-2	260	209	51	43	489
* W-3	248	244	4	-4	-45
* W-4	247	221	26	18	205
W-5	208	222	-14	-22	-250
W-5 QC	208	214	-6	-14	-159
W-6	228	173	55	47	534

N

A

Instrument Model/SN:	Probe Model/SN:	Detector Eff.: (cpm/dpm)
2360/15637	43-89/164832	β=.088/α=.153

Material	Bkgd
Wall	β=8/α=3.7
* Concrete	β=78/α=2.7


W-1
W-2
W-6
W-3
W-5
QC
W-4
Building 14
North
Exterior
Scale:
4m x 4m

DDO-138 Radiation Protection Survey Report

Site: Molycorp / Washington, PA

Section 1: Survey Information

Date	Time:	Location:	Survey Issue Log Number:
3-12-02	1400	I/S & W/S Bldg 14	02-0061

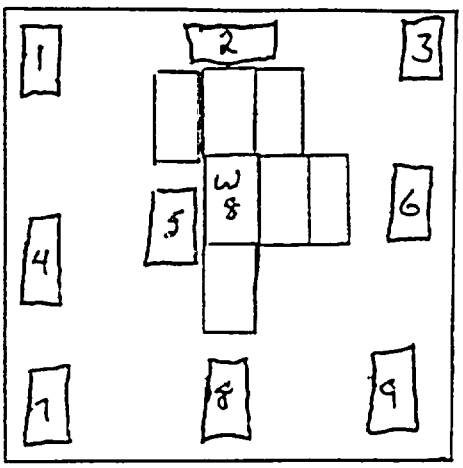
RWP Number:

Purpose of Survey: ☐ RWP ☐ Routine Survey ☐ Unconditional Release ☒ Other

Page 1 of 2

Survey Title: $1m^2$ VERIFICATION SURVEY

Bldg 14 W8 I/S



$630\left(\frac{700}{10,000}\right) + 417\left(1-\frac{700}{10,000}\right)$

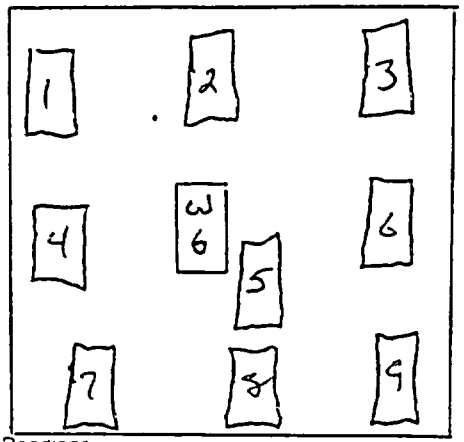
$44.1 + 387.8$

$432 dpm/100cm^2\ \beta^-$

$864 dpm/100cm^2\ \alpha$

W8 Reading $630 dpm/100cm^2$

Bldg 14 W6 O/S



$534\left(\frac{100}{10,000}\right) + 139\left(1-\frac{100}{10,000}\right)$

$5.34 + 137.6$

$143 dpm/100cm^2\ \beta^-$

$286 dpm/100cm^2\ \alpha$

W6 Reading $534 dpm/100cm^2$

Smear Number	Beta dpm/100cm²	Alpha dpm/100cm²
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13	N	
14		A
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		

Bkgd Readings

Legend

00 = mRem/h gamma | 00 C = mRem/h gamma contact | ① = Smear Location | ▽ = Air Sample Location | -X-X-X- = Rope Boundary, or Barrier

00 β = mRem/h beta | 00 βC = mRem/h beta contact | –①– = Large Area Wipe | = Bulk Material Sample

Section 2: Instrument Used

Instrument Model/SN	Cal Due Date	Probe Model/SN	Cal Due Date	Detector Eff (cpm/dpm)	MDA	Other
236c/16468c	7-9-02	43B9/#B534A	8-6-02	α, 164 β, 113	α, 71 β 140	α 3.7 β⁻ ✓
	N			N		
	A				A	

Section 3: Review and Approval

Survey Performed By (Sign):	Area Posted and/or Barricaded. ☐ Yes ☐ No ☒ Not Required	Date and Time: 3-12-02 1400
Radiation Safety Officer (Print Name & Sign): Mike McDonald		Date and Time: 3-14-02 9:30

Radiological Survey Results - Calculational Sheet

Survey # 02-0061

Location	β Static (unsh) (cpm)	β Static (sh) (cpm)	Gross β	Minus Bkgd = (Net β)	Net β dpm/100 cm²
Bldg 14 W8 F/s	376	287	89	81	717
	258	204	54	46	407
	224	188	36	28	248
	272	204	68	60	531
	262	187	75	67	593
	253	206	47	39	345
	272	239	33	25	221
	273	215	58	50	442
	253	217	36	28	248
					3752 / 9
					417 dpm/100cm 2
Bldg 14 W6 °/s	207	198	9	1	9
	200	180	20	12	106
	183	191	-8	-16	-142
	192	207	-15	-23	-204
	176	178	-2	-10	-88
	211	153	58	50	442
	267	215	52	44	389
	316	224	92	84	743
	191	183	8	0	0
					1255 / 9
					139 dpm/100cm²

Instrument Model/SN:	Probe Model/SN:	Detector Eff.: (cpm/dpm)
2360 / 164860	43-89 / 119-544	α .164 β .113
	N	
	A	

Material	Bkgd
WALL	β 8 x 3.7
N	
A	

Results of Surface Scans

Molycorp - Building 14 Survey Unit (Unaffected Area)

Building Interior

Location (see map)	Beta Scan gross cpm	Beta Scan net cpm	Alpha Scan gross cpm	Alpha Scan net cpm	
F1	1600	-144	2	-3	All floor scans performed with Ludlum 239-1F (2350-1 No 95359 with 43-37 No 92503)
F2					Floor Monitor Info.
F3					Scan MDA Beta - 205 dpm/detector area
F4	1600	-144	7	2	Scan MDA Alpha - 15 dpm/detector area
F5					Scan background Beta - 1744 cpm
F6					Scan background Alpha - 5 cpm
F7					10% scan of floor and 2 meters up walls
F8					
F9					
F10					
F11	1900	156	12	7	
F12	1700	-44	10	5	
F13					
F14	2100		14		
W1	320	-46	1	-1 2	
W2	350	-16	7	4 8	All interior wall scans performed with Ludlum 2350-1 No.128912 with 43-106 No 128921
W3	300	-66	1	-1.2	43-106 Info·
W4	410	44	4	1 8	Scan MDA Beta - 690 dpm/detector area
W5	320	-46	1	-1 2	Scan MDA Alpha - 66 dpm/detector area
W6					Scan background Beta - 336 cpm
W7	350	-16	2	-0 2	Scan background Alpha - 2 2 cpm
W8	350	-16	2	-0 2	
W9					
W10					

Building Exterior

Location (see map)	Beta Scan gross cpm	Beta Scan net cpm	Alpha Scan gross cpm	Alpha Scan net cpm	
W1	270	20	4	3	All external wall scans performed with Ludlum 2350-1 No 117014 with 43-106 No. 133866
W2	300	50	6	5	43-106 Info
W3	315	65	6	5	Scan MDA Beta - 707 dpm/detector area
W4	270	20	1	0	Scan MDA Alpha - 42 dpm/detector area
W5	290	40	5	4	Scan background Beta - 250 cpm
W6	310	60	4	3	Scan background Alpha - 1 cpm

F = floor, W = wall

Elevated Scan Readings

Molycorp - Building 14 Survey Unit (Unaffected Area)

No elevated scan results were reported during interior or exterior scans.

Direct Measurements (Total Activity)

Molycorp - Building 14 Survey Unit (Unaffected Area)

Building Interior

Location	Unshield Beta cpm	Shield Beta cpm	Gross Beta cpm	Bkgd cpm	Net cpm	Direct Beta (dpm/100cm^2)	Uncertainty 95% CL	MDA (dpm/100cm^2)	Direct Alpha [1] (dpm/100cm^2)
F1	349	279	70	78	-8	-87	259	475	-174
F2	338	272	66	78	-12	-130	256	475	-261
F3	308	255	53	78	-25	-272	244	475	-543
F4	306	279	27	78	-51	-554	218	475	-1109
F5	418	318	100	78	22	239	284	475	478
F6	390	290	100	78	22	239	284	475	478
F7	344	300	44	78	-34	-370	235	475	-739
F8	354	287	67	78	-11	-120	257	475	-239
F9	398	304	94	78	16	174	279	475	348
F10	341	290	51	78	-27	-293	242	475	-587
F11	388	274	114	78	36	391	295	475	783
F12	352	281	71	78	-7	-76	260	475	-152
F13	358	274	84	78	6	65	271	475	130
F14	420	326	94	78	16	174	279	475	348
W1	272	237	35	8	27	293	140	172	587
W2	293	267	26	8	18	196	124	172	391
W3	230	209	21	8	13	141	115	172	283
W4	307	271	36	8	28	304	141	172	609
W5	282	254	28	8	20	217	128	172	435
W6	262	226	36	8	28	304	141	172	609
W7	280	247	33	8	25	272	136	172	543
W8	289	223	66	8	58	630	183	172	1261
W9	241	205	36	8	28	304	141	172	609
W10	258	240	18	8	10	109	109	172	217

All building interior direct measurements were performed with 43-89 No 169230

	Beta	Alpha
Floor Efficiency	0 092	0 154
Wall Efficiency	0 092	0 154
Floor Background (cpm)	78	2 4
Wall Background (cpm)	8	3 7
Floor MDA (dpm/100 cm^2)	475	64 3
Wall MDA (dpm/100 cm^2)	172	75 6

Building Exterior

Location	Unshield Beta cpm	Shield Beta cpm	Gross Beta cpm	Bkgd cpm	Net cpm	Direct Beta (dpm/100cm^2)	Uncertainty 95% CL	MDA (dpm/100cm^2)	Direct Alpha [1] (dpm/100cm^2)
W1	255	255	0	8	-8	-91	63	180	-182
W2	260	209	51	8	43	489	171	180	977
W3	248	244	4	8	-4	-45	77	180	-91
W4	247	221	26	8	18	205	130	180	409
W5	208	222	-14	8	-22	-250	55	180	-500
W6	228	173	55	8	47	534	177	180	1068

All building exterior direct measurements were performed with 43-89 No. 164832

	Beta	Alpha
Efficiency	0 088	0.153
Background (cpm)	8	3.7
MDA (dpm/100 cm^2)	180	76

(1) - A beta to alpha ratio factoring (1 2, beta to alpha) was used to provide a more accurate alpha activity determination then sampling

Elevated Direct Readings (Total Activity) and Averaging Results

Molycorp - Building 14 Survey Unit (Unaffected Area)

Building Interior

Location	Direct Alpha (dpm/100cm^2)	Over Area (cm^2)	Exceeds Limits Maximum	Average
W8	1261	700	No	Yes

Averaged Value (over 1 m^2)		Within Limit?
W1	864	Yes

Building Exterior

Location	Direct Alpha (dpm/100cm^2)	Over Area (cm^2)	Exceeds Limits Maximum	Average
W6	1068	100	No	Yes

Averaged Value (over 1 m^2)		Within Limit?
W4	286	Yes

Removable Surface Activity Measurements

Molycorp - Building 14 Survey Unit (Unaffected Area)

Building Interior

Location (see map)	Removable Beta (dpm/100cm^2)	Uncertainty 95% CL	MDA	Removable Alpha (dpm/100cm^2)	Uncertainty 95% CL	MDA
F1	-24	26 2	206	-0 4	2 1	11.6
F2	36	31 1	206	2 5	5.3	11 6
F3	48	35 3	206	-0 4	2 1	11 6
F4	6	16 3	206	-0 4	2.1	11 6
F5	-6	16 3	206	-0.4	2.1	11 6
F6	-30	28 7	206	2.5	5 3	11 6
F7	48	35 3	206	-0.4	2.1	11 6
F8	0	11.3	206	-0 4	2.1	11 6
F9	55	37.5	206	2.5	5 3	11 6
F10	67	41.1	206	-0 4	2 1	11.6
F11	-6	16 3	206	-0.4	2.1	11 6
F12	6	16 3	206	2 5	5 3	11 6
F13	-12	20 2	206	-0 4	2.1	11 6
F14	-42	33 2	206	2.5	5 3	11 6
W1	0	11.3	206	-0 4	2.1	11 6
W2	-24	26 2	206	-0 4	2.1	11.6
W3	-12	20.2	206	-0 4	2 1	11 6
W4	-18	23 4	206	-0 4	2 1	11 6
W5	67	41.1	206	-0 4	2 1	11 6
W6	30	28 7	206	-0 4	2 1	11 6
W7	0	11.3	206	-0 4	2 1	11 6
W8	-55	37.5	206	-0 4	2 1	11 6
W9	-61	39 3	206	-0 4	2 1	11 6
W10	-36	31 1	206	-0 4	2 1	11.6

Ludlum 2929 No 152202 with 43-10 No. 156519 Info

	Beta	Alpha
Background (cpm)	45	0 14
Bkgd ct time	50	50
Sample ct time	1	1
Efficiency	0 165	0 344
MDA	206	11 6

Building Exterior

Location (see map)	Removable Beta (dpm/100cm^2)	Uncertainty 95% CL	MDA	Removable Alpha (dpm/100cm^2)	Uncertainty 95% CL	MDA
W1	29	23 6	176	-0 5	2.4	14
W2	-29	23 6	176	-0 5	2 4	14
W3	8	14 9	176	2	4 7	14
W4	-4	12.5	176	-0 5	2 4	14
W5	17	19 1	176	5	7 4	14
W6	-67	34.2	176	5	7 4	14

Ludlum 2929 No. 115563 with 43-10 No 127216 Info

	Beta	Alpha
Background (cpm)	69	0.16
Bkgd ct time	50	50
Sample ct time	1	1
Efficiency	0 239	0.35
MDA	176	14

F = floor, W = wall

Removable Surface Activity Measurements
Molycorp - Building 14 Survey Unit (Unaffected Area)

No elevated removable surface activity was reported.

Exposure Rate Measurements

Molycorp - Building 14 Survey Unit (Unaffected Area)

Building Interior

Location	Exposure Rate uR/hr
F1	9
F2	9
F3	9
F4	9
F5	10
F6	10
F7	10
F8	10
F9	10
F10	10
F11	11
F12	10
F13	10
F14	9
W1	8
W2	8
W3	8
W4	9
W5	9
W6	9
W7	10
W8	10
W9	10
W10	10

Background dose rate 8-10 uR/hr with Model 19, No 22526

Building Exterior

Location	Exposure Rate uR/hr
W1	9
W2	10
W3	11
W4	10
W5	9
W6	11

Background dose rate: 8 uR/hr with Model 19, No 22526

Gamma scans of roof not performed The roof is rusting away and is not safe to access

Summary of Building Surface Direct Reading (Total Activity) Results

Molycorp - Building 14 Survey Unit (Unaffected Area)

Building Interior

Location	Unshield Beta cpm	Shield Beta cpm	Gross Beta cpm	Bkgd cpm	Net cpm	Average Total Activity Direct Beta (dpm/100cm^2)	Correlated Alpha (dpm/100cm^2)
F1	349	279	70	78	-8	-87	-174
F2	338	272	66	78	-12	-130	-261
F3	308	255	53	78	-25	-272	-543
F4	306	279	27	78	-51	-554	-1109
F5	418	318	100	78	22	239	478
F6	390	290	100	78	22	239	478
F7	344	300	44	78	-34	-370	-739
F8	354	287	67	78	-11	-120	-239
F9	398	304	94	78	16	174	348
F10	341	290	51	78	-27	-293	-587
F11	388	274	114	78	36	391	783
F12	352	281	71	78	-7	-76	-152
F13	358	274	84	78	6	65	130
F14	420	326	94	78	16	174	348
W1	272	237	35	8	27	293	587
W2	293	267	26	8	18	196	391
W3	230	209	21	8	13	141	283
W4	307	271	36	8	28	304	609
W5	282	254	28	8	20	217	435
W6	262	226	36	8	28	304	609
W7	280	247	33	8	25	272	543
W8	289	223	66	8	58	630	864
W9	241	205	36	8	28	304	609
W10	258	240	18	8	10	109	217

	Beta			Alpha			
	n	$\bar{x}$	s	μ_α	n	$\bar{x}$	s	μ_α
	30	108	286 4	196 4	30	176 1	527.6	339 6
		$t_{1-\alpha}$	1 697					

Guidelines/Conditions Satisfied	
Beta	Alpha
Yes	Yes

Building Exterior

Location	Unshield Beta cpm	Shield Beta cpm	Gross Beta cpm	Bkgd cpm	Net cpm	Direct Beta (dpm/100cm^2)	Correlated Alpha (dpm/100cm^2)
W1	255	255	0	8	-8	-91	-182
W2	260	209	51	8	43	489	977
W3	248	244	4	8	-4	-45	-91
W4	247	221	26	8	18	443	886
W5	208	222	-14	8	-22	-250	-500
W6	228	173	55	8	47	534	286

Summary of Exposure Rate Measurements
Molycorp - Building 14 Survey Unit (Unaffected Area)

Building Interior

Location	Exposure Rate uR/hr	Exposure Rate Background	Exposure Rate Net
F1	9	8	1
F2	9	8	1
F3	9	8	1
F4	9	8	1
F5	10	8	2
F6	10	8	2
F7	10	8	2
F8	10	8	2
F9	10	8	2
F10	10	8	2
F11	11	8	3
F12	10	8	2
F13	10	8	2
F14	9	8	1
W1	8	8	0
W2	8	8	0
W3	8	8	0
W4	9	8	1
W5	9	8	1
W6	9	8	1
W7	10	8	2
W8	10	8	2
W9	10	8	2
W10	10	8	2

Exposure Rate (uR/hr)

n	$\bar{x}$	s	μ_α
30	1.6	0.8	1.8

$t_{1-\alpha}$ 1.697

Guidelines/Conditions Satisfied: Yes

Building Exterior

Location	Exposure Rate uR/hr	Exposure Rate Background	Exposure Rate Net
W1	9	8	1
W2	10	8	2
W3	11	8	3
W4	10	8	2
W5	9	8	1
W6	11	8	3

Appendix C

Building 28 Data Package

Molycorp Washington, PA

Building 28 Data Package

This data package contains final status survey information for Building 28, Molycorp, Washington, PA site.

Field data collection forms, survey report forms, statistical test results, and comparisons to release limits are provided.

Summary

No anomalies were reported during the survey of Building 28. Elevated levels of background radiation, from soil radioactivity, continued to be a presence during survey activities.

Results from the final status survey of Building 28 provides evidence that release criteria have been met, demonstrates that residual radioactivity is below the unrestricted use criteria, and confirms that Building 28 is suitable for unrestricted use.

DDO-138 Radiation Protection Survey Report	Site: Molycorp / Washington, PA

Section 1: Survey Information Bldg # 28

Date	Time:	Location:	Survey Issue Log Number
3-1-02	1000	Bldg # 28	02-0040

RWP Number:	Purpose of Survey:	Page
N/A	☐ RWP ☐ Routine Survey ☐ Unconditional Release ☒ Other	1 of 4

Survey Title: Bldg # 28 UNAFFECTED

Smear Number	Beta dpm/100cm²	Alpha dpm/100cm²
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		

STATIC MDA FLOOR β^- 447 α 64

WALL β^- 162 α 75

N/A

Bkgd Readings 2929 α .18 β^- 45 EFF. α.344 β^-.165

Legend

00 = mRem/h gamma | 00 C = mRem/h gamma contact | ⓓ = Smear Location | ▽ = Air Sample Location | -X-X-X- = Rope, Boundary, or Barrier

00 β = mRem/h beta | 00 βC = mRem/h beta contact | —ⓓ— = Large Area Wipe | = Bulk Material Sample

Section 2: Instrument Used

Instrument Model/SN	Cal Due Date	Probe Model/SN	Cal Due Date	Detector Eff (cpm/dpm)	MDA	Other
2360/145469	1-10-02	43-89/145391	1-14-02	β^-=.098 α=.15	β^- 447 α 64	BKG FLOOR=78 WALL=8
2350-1/117566	8-10-02	43-106/128912	8-10-02	α .212 β .251	α 56 β 673	BKG α 1.6 β 320
2350-1/95359	8-6-02	43-37/092503	8-6-03	α .307 β .27	α 19 β 179	β^-=1730 α=9
			N/A			

Section 3: Review and Approval

Survey Performed By (Sign).	Area Posted and/or Barricaded.	Date and Time.
Mark Blaucoak Health Tech	☐ Yes ☐ No ☒ Not Required	3-1-02 / 1000
Radiation Safety Officer (Print Name & Sign)		Date and Time
Mike McDonald		3-14-02 9:30

Radiological Survey Results - Survey Location Indicator

Survey Area Information: Bldg #28 UNAFFECTED Survey # 02-00-40

	Instrument Model/SN	Cal Due	Probe Model/SN	Cal Due	α Scan MDA	β Scan MDA	α Static MDA	β Static MDA
Instrument Data	2360/145469	1-10-03	43-89/145391	1-14-03	—	—	64	447
	2350-1/117566	8-10-02	43-106/128912	8-10-02	56	673	—	—
	2929/152202	2-6-03	43-10/156519	2-6-03	—	—	~~15~~	~~206~~
	19/115870	8-602	—	—	—	—	—	—

	Print Name	Signature	Date
Performed By:	MARK BLANCIAK	Mark Blanciak	3-1-02
	Steve Filo	Steve Filo	3-1-02

Location	β Scan (cpm)	α Scan (cpm)	β Static (unsh) (cpm)	β Static (sh) (cpm)	α Static (cpm)	ER (μrem/hr)	Smears (dpm/100 cm²) α	Smears (dpm/100 cm²) β
W-1	270	1.6	N/A	N/A	2	6	-5	-12
W-2	240	1.0			1	9	-5	12
W-3	N/A	N/A			2	9	-5	6
W-4	↓	↓			2	10	-5	0
W-5	N/A	N/A			2	10	-5	-6
W-6	290	1.2			1	11	-5	-42
W-7	N/A	N/A			2	11	-5	6
W-8	310	0			2	11	-5	-36
W-9	N/A	N/A			2	11	-5	60
W-10	N/A	N/A			3	11	-5	6
W-11	280	1.0			3	11	-5	36
W-11 QC	N/A	N/A			1	11	-5	36
W-12	↓	↓			2	11	-5	12
W-13	N/A	N/A			2	11	-5	-18
W-14	290	1.2			2	11	-5	18
F-1	N/A	N/A			1	10	-5	-6
F-2	N/A	N/A			1	11	-5	42
F-3	1550	22			2	11	-5	-18
F-4	N/A	N/A			4	10	-5	18
F-5	1630	12			5	11	-5	-12
F-6	1480	8			6	9	-5	-12
F-7	1700	10			7	10	-5	-42
F-7 QC	N/A	N/A			5	11	-5	-12
F-8	↓	↓			9	11	-5	60
F-9	↓	↓	↓	↓	3	11	-5	24
F-10	N/A	N/A	N/A	N/A	9	10	-5	36
N/A								→ N/A

Radiological Survey Results - Calculational Sheet

Bldg #28 UNAFFECTED

SURVEY # 02-0040

Location	β Static (unsh) (cpm)	β Static (sh) (cpm)	Gross β	Minus Bkgd = (Net β)	Net β dpm/100 cm²
W-1	233	196	37	29	296
W-2	207	201	6	-2	-20
W-3	227	212	15	7	71
W-4	205	240	-35	-43	-438
W-5	251	211	40	32	327
W-6	218	229	~~-19~~ -11	-19	-194
W-7	224	228	-4	-12	-122
W-8	238	234	4	-4	-41
W-9	238	215	23	15	153
W-10	283	266	17	9	92
W-11	279	269	10	2	20
W-11 QC	266	279	-13	-21	-214
W-12	267	263	4	-4	-41
W-13	245	237	8	0	
W-14	230	244	-14	-22	-224
~~W-15~~ NU I-192		~~N~~ A			
F-1	268	234	34	-44	-449
F-2	386	343	43	-35	-357
F-3	296	253	43	-35	-357
F-4	288	281	7	-71	-724
F-5	288	214	74	-4	-41
F-6	257	232	25	-53	-541
F-7	317	235	82	4	-41
F-7 QC	322	249	73	-5	-51
F-8	296	235	61	-17	-173
F-9	289	232	57	-21	-214
F-10	350	289	61	-17	-173

Instrument Model/SN:	Probe Model/SN:	Detector Eff.: (cpm/dpm)
2360/145469	43-89/145391	β⁻ .098 α .155
	N	
	A	

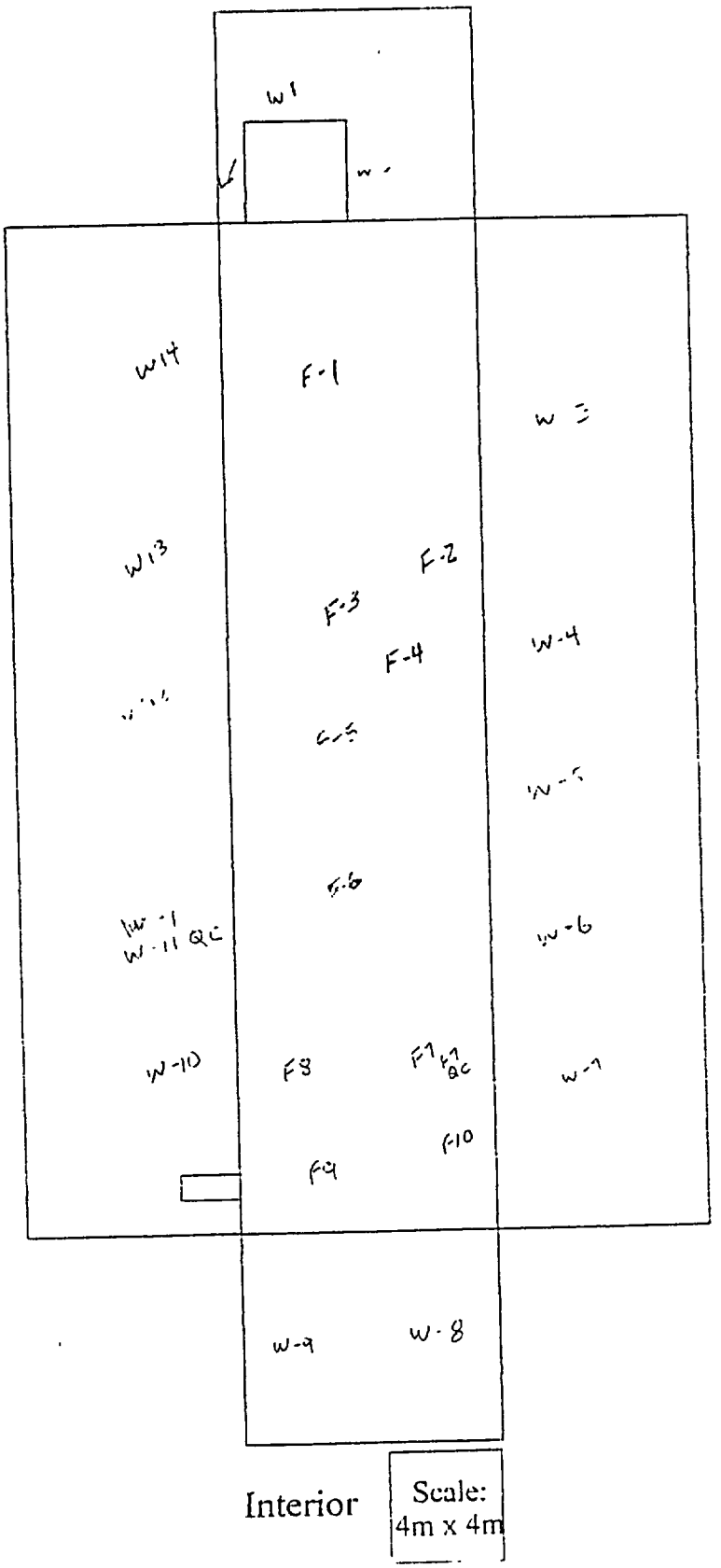
Material	Bkgd
Wall	β 8 α 3.7
Floor	β 7.8 α 2.4
	N
	A

Mark Blemmik 3-1-02 1000

Building 28

SURVEY # 02-0040

North



Interior

Scale: 4m x 4m

Mark Blaauw 3-1-02 1:000

DDO-138 Radiation Protection Survey Report			Site: Molycorp / Washington, PA
Section 1: Survey Information: Building 28 Survey			
Date: 3-1-02	Time: 0900	Location: Bldg 28	Survey Issue Log Number: 02-0036
RWP Number: N/A	Purpose of Survey: ☐ RWP ☐ Routine Survey ☐ Unconditional Release ☑ Other		Page 1 of 4

Survey Title: Unaffected, exterior.

Background reading for 2350-1

β - 296

α .6

Background reading for 2360

β 8 α 3.7

Background for 19 in Micro R/hr

15-20

Bkgd Readings 2929 α .18 β 69

Smear Number	Beta dpm/100cm²	Alpha dpm/100cm²
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13	N/A	
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		

Legend

00 = mRem/h gamma | 00 C = mRem/h gamma contact | ⊙ = Smear Location | T = Air Sample Location | -X-X-X- = Rope Boundary, or Barrier

00 β = mRem/h beta | 00 βC = mRem/h beta contact | —⊙— = Large Area Wipe | = Bulk Material Sample

Section 2: Instrument Used

Instrument Model/SN	Cal Due Date	Probe Model/SN	Cal Due Date	Detector Eff (cpm/dpm)	MDA	Other
2350-1 953516	8-16-02	43-106 133816	8-16-02	β .48 α .211	9532.34	
2360 151637	8-15-02	43-89 164832	8-5-02	β .089 α .153	β 180 α 78	
2929 115563	6-19-02	43-10 127212	6-14-02	β .239 α .353	1762 ± 14	
19 22526	5-16-02	←	N/A			→
←			N/A			→

Section 3: Review and Approval

Survey Performed By: (Sign)	Area Posted and/or Barricaded	Date and Time
	☐ Yes ☐ No ☑ Not Required	3-1-02 0900
Radiation Safety Officer (Print Name & Sign)		Date and Time
Mike McDonald		3-14-02 9:30

Radiological Survey Results - Survey Location Indicator

Survey Area Information: Bldg 28 EXTERIOR — Survey # 02-0056

	Instrument Model/SN	Cal Due	Probe Model/SN	Cal Due	α Scan MDA	β Scan MDA	α Static MDA	β Static MDA
Instrument Data	Ludlum 2350-1 95356	8-6-01	43-68 133816	8-6-02	34	6.53	← NA →	
	Ludlum 2360 151637-1	8-15-02	43-89 114832	8-5-02	← NA →		76	150
	Ludlum 2929 115563	6-19-02	43-10 127216	6-19-02	14	176	← NA →	
	Ludlum 19 22526	8-6-01	← NA →					
	← N/A →							

	Print Name	Signature	Date
Performed By:	Tommie Sue Darby		3-1-02
	Dennis Whitebeck		3-1-02

Location	β Scan (cpm)	α Scan (cpm)	β Static (unsh) (cpm)	β Static (sh) (cpm)	α Static (cpm)	ER (μrem/hr)	Smears (dpm/100 cm²) α	Smears (dpm/100 cm²) β
W 1	224	3.76	258	217	1	7	2	38
W 2	283	1.97	347	302	6	17	-.5	0
W 3	← N/A →		336	307	4	17	2	-13
W 4	3.11	.97	255	241	5	17	-.5	-29
W 4 QC	← N/A →		271	269	4	17	-.5	96
W 5	← N/A →		275	250	6	17	-.5	-4
W 6	320	.93	271	222	6	9	-.5	-33
				N A				

Radiological Survey Results - Calculational Sheet

SURVEY #02-0036

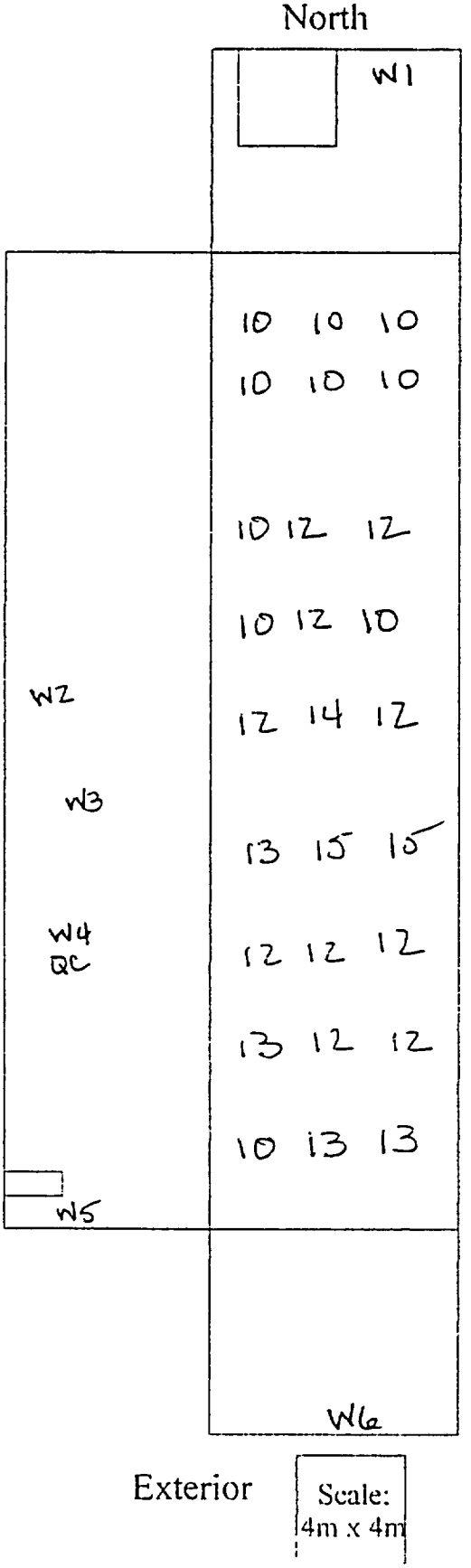
Location	β Static (unsh) (cpm)	β Static (sh) (cpm)	Gross β	Minus Bkgd = (Net β)	Net β dpm/100 cm²
W 1	258	217	41	33	375
W 2	347	302	45	37	420
W 3	336	307	29	21	238
W 4	255	241	14	6	68
W 4 QC	271	269	2	-6	-68
W 5	275	250	25	17	193
W 6	271	222	49	41	465
	"				
		D			
			A		

Instrument Model/SN.	Probe Model/SN:	Detector Eff.: (cpm/dpm)
2360 153371	43-89 164832	B: .083 α .153
	D	
	A	

Material	Bkgd
Lead	β & α 3.7
D	
	A

Survey #02-0036

Building 28



Bkgd for model 19
10-12 uR/hr

Dose rates on roof
all MicroR/hr.

Results of Surface Scans

Molycorp - Building 28 Survey Unit (Unaffected Building)

Building Interior

Location (see map)	Beta Scan gross cpm	Beta Scan net cpm	Alpha Scan gross cpm	Alpha Scan net cpm
F1				
F2				
F3	1550	220	22	13
F4				
F5	1630	300	12	3
F6	1480	150	8	-1
F7	1700	370	10	1
F8				
F9				
F10				
W1	270	-50	1 6	0
W2	240	-80	1	-0 6
W3				
W4				
W5				
W6	290	-30	1.2	-0 4
W7				
W8	310	-10	0	-1 6
W9				
W10	320	0	1	-0.6
W11	280	-40		
W12				
W13				
W14	290	-30	1 2	-0.4

All floor scans performed with Ludlum 239-1F (2350-1 No 95359 with 43-37 No 92503)
Floor Monitor Info
Scan MDA Beta - 179 dpm/detector area
Scan MDA Alpha - 19 dpm/detector area
Scan background Beta - 1330 cpm
Scan background Alpha - 9 cpm
100% scan of floor and 2 meters up walls

All wall and ceiling scans performed with Ludlum 2350-1 No 117566 with 43-106 No 128921
43-106 Info
Scan MDA Beta - 673 dpm/detector area
Scan MDA Alpha - 56 dpm/detector area
Scan background Beta - 320 cpm
Scan background Alpha - 1 6 cpm

Building Exterior

Location (see map)	Beta Scan gross cpm	Beta Scan net cpm	Alpha Scan gross cpm	Alpha Scan net cpm
W1	224	-72	3.8	3 2
W2	283	-13	2	1.4
W3				
W4	311	15	1	0 4
W5				
W6	320	24	0 9	0 3

All external wall scans performed with Ludlum 2350-1 No 195356 with 43-106 No. 133866
43-106 Info.
Scan MDA Beta - 653 dpm/detector area
Scan MDA Alpha - 34 dpm/detector area
Scan background Beta - 296 cpm
Scan background Alpha - .6 cpm

Elevated Scan Readings

Molycorp - Building 28 Survey Unit (Unaffected Building)

Three locations (F3, F5, and F7) were identified with scans results greater than MDA values. All other measurement techniques (direct and removable) results indicated levels at or below background values

Direct Measurements (Total Activity)

Molycorp - Building 28 Survey Unit (Unaffected Building)

Building Interior

Location	Gross Beta cpm	Bkgd cpm	Net cpm	Direct Beta (dpm/100cm^2)	Uncertainty 95% CL	MDA (dpm/100cm^2)	Direct Alpha [1] (dpm/100cm^2)
F1	34	78	-44	-449	212	447	-898
F2	43	78	-35	-357	220	447	-714
F3	43	78	-35	-357	220	447	-714
F4	7	78	-71	-724	184	447	-1449
F5	74	78	-4	-41	247	447	-82
F6	25	78	-53	-541	203	447	-1082
F7	82	78	4	41	253	447	82
F8	61	78	-17	-173	236	447	-347
F9	57	78	-21	-214	232	447	-429
F10	61	78	-17	-173	236	447	-347
W1	37	8	29	296	134	447	592
W2	6	8	-2	-20	75	447	-41
W3	15	8	7	71	96	447	143
W4	-35	8	-43	-439	104	447	-878
W5	40	8	32	327	139	447	653
W6	-11	8	-19	-194	35	447	-388
W7	-4	8	-12	-122	40	447	-245
W8	4	8	-4	-41	69	447	-82
W9	23	8	15	153	111	447	306
W10	17	8	9	92	100	447	184
W11	10	8	2	20	85	447	41
W12	4	8	-4	-41	69	447	-82
W13	8	8	0	0	80	447	0
W14	-14	8	-22	-224	49	447	-449

	43-89 Info
Beta Efficiency	0 098
Beta Background - Concrete Floor (cpm)	78
Beta Background - Steel Wall (cpm)	8
Beta MDA (dpm/100 cm^2)	447

Building Exterior

Location	Gross Beta cpm	Bkgd cpm	Net cpm	Direct Beta (dpm/100cm^2)	Uncertainty 95% CL	MDA (dpm/100cm^2)	Direct Alpha [1] (dpm/100cm^2)
W1	41	8	33	375	156	180	750
W2	45	8	37	420	162	180	841
W3	29	8	21	239	135	180	477
W4	14	8	6	68	104	180	136
W5	25	8	17	193	128	180	386
W6	49	8	17	193	168	180	386

	43-89 Info
Beta Efficiency	0.088
Beta Background - Concrete Floor (cpm)	78
Beta Background - Steel Wall (cpm)	8
Beta MDA (dpm/100 cm^2)	180

(1) - Alpha measurements (direct) were obtained with the 43-89 operated in the alpha mode and were recorded on the Radiation Protection Survey Report form However, actual results were not used as part of the comparison process A beta to alpha ratio factoring (1:2, beta to alpha) was used to provide a more accurate alpha activity determination

Elevated Direct Readings and Remediation Results
Molycorp - Building 28 Survey Unit (Unaffected Building)

No elevated direct measurements were reported.

Removable Surface Activity Measurements

Molycorp - Building 28 Survey Unit (Unaffected Building)

Building Interior

Location (see map)	Removable Beta (dpm/100cm^2)	Uncertainty 95% CL	MDA	Removable Alpha (dpm/100cm^2)	Uncertainty 95% CL	MDA
F1	-6	16	206	-5	7	0 18
F2	42	33	206	-5	7	0.18
F3	-18	23	206	-5	7	0 18
F4	18	23	206	-5	7	0 18
F5	-12	20	206	-5	7	0.18
F6	-12	20	206	-5	7	0 18
F7	-42	33	206	-5	7	0 18
F8	60	39	206	-5	7	0 18
F9	24	26	206	-5	7	0 18
F10	36	31	206	-5	7	0 18
W1	-12	20	206	-5	7	0 18
W2	12	20	206	-5	7	0 18
W3	6	16	206	-5	7	0 18
W4	0	11	206	-5	7	0 18
W5	-6	16	206	-5	7	0 18
W6	-42	33	206	-5	7	0.18
W7	6	16	206	-5	7	0.18
W8	-36	31	206	-5	7	0.18
W9	60	39	206	-5	7	0.18
W10	6	16	206	-5	7	0.18
W11	36	31	206	-5	7	0.18
W12	12	20	206	-5	7	0.18
W13	-18	23	206	-5	7	0.18
W14	18	23	206	-5	7	0 18

Ludlum 2929 No 152202 with 43-10 No. 156519 Info

	Beta	Alpha
Background (cpm	45	0 18
Bkgd ct time	50	50
Sample ct time	1	1
Efficiency	0 165	0 344
MDA	206	15

Building Exterior

Location (see map)	Removable Beta (dpm/100cm^2)	Uncertainty 95% CL	MDA	Removable Alpha (dpm/100cm^2)	Uncertainty 95% CL	MDA
W1	38	26	176	2	5	14
W2	0	8	176	-0 5	2	14
W3	-13	16	176	2	5	14
W4	-29	23	176	-0 5	2	14
W5	-4	11	176	-0 5	2	14
W6	-33	24	176	-0 5	2	14

Ludlum 2929 No. 152202 with 43-10 No 156519 Info.

	Beta	Alpha
Background (cpm	45	0 18
Bkgd ct. time	50	50
Sample ct. time	1	1
Efficiency	0.239	0 35
MDA	176	14

F = floor, W = wall

Removable Surface Activity Measurements

Molycorp - Building 28 Survey Unit (Unaffected Building)

No elevated removable surface activity was reported.

Exposure Rate Measurements

Molycorp - Building 28 Survey Unit (Unaffected Building)

Building Interior

Location	Exposure Rate uR/hr
F1	10
F2	11
F3	11
F4	10
F5	11
F6	9
F7	10
F8	11
F9	11
F10	10
W1	6
W2	9
W3	9
W4	10
W5	10
W6	11
W7	11
W8	11
W9	11
W10	11
W11	11
W12	11
W13	11
W14	11

Interior background dose rate 9-10 uR/hr with Model 19, No 115870

Building Exterior

Location	Exposure Rate uR/hr
W1	7
W2	17
W3	17
W4	17
W5	17
W6	9

Exterior background dose rates varied widely (7-20 uR/hr) based on soil activity for building area surveyed (instrument location) Based on direct and loose surface surveys results, elevated dose rates are due to background gamma rates and not building surface activity

Building Roof Gamma Scan

Location (See map)	Exposure Rate uR/hr	Exposure Rate Background	Exposure Rate Net
R1	10	10	0
R2	10	10	0
R3	10	10	0
R4	10	10	0
R5	10	10	0
R6	10	10	0
R7	10	10	0
R8	12	12	0
R9	12	12	0
R10	10	10	0
R11	12	10	2
R12	10	10	0
R13	12	12	0
R14	14	12	2
R15	12	12	0
R16	13	12	1
R17	15	12	3
R18	15	12	3
R19	12	12	0
R20	12	12	0
R21	12	12	0
R22	13	12	1
R23	12	12	0
R24	12	12	0
R25	10	12	-2
R26	13	12	1
R27	13	12	1

Building roof background gamma exposure rates varied based on reading locations
Background levels were reported as 10-12 uR/hr when held away from the roof surface (over the side)

Summary of Building Surface Direct Reading (Total Activity) Results

Molycorp - Building 28 Survey Unit (Unaffected Building)

Building Interior

Location	Direct Beta (dpm/100cm^2)	Correlated Alpha (dpm/100cm^2)
F1	-449	-898
F2	-357	-714
F3	-357	-714
F4	-724	-1449
F5	-41	-82
F6	-541	-1082
F7	41	82
F8	-173	-347
F9	-214	-429
F10	-173	-347
W1	296	592
W2	-20	-41
W3	71	143
W4	-439	-878
W5	327	653
W6	-194	-388
W7	-122	-245
W8	-41	-82
W9	153	306
W10	92	184
W11	20	41
W12	-41	-82
W13	0	0
W14	-224	-449

Average Total Activity (dpm/100cm^2)

	Beta				Alpha			
	n	$\bar{x}$	s	μ_α	n	$\bar{x}$	s	μ_α
	30	-45	292 8	45 7	30	-90 1	585 7	91 4

$t_{1-\alpha}$ 1 697

Guidelines/Conditions Satisfied

Beta	Alpha
Yes	Yes

	43-89 Info
Beta Efficiency	0 098
Beta Background - Concrete Floor (cpm)	78
Beta Background - Steel Wall (cpm)	8
Beta MDA (dpm/100 cm^2)	447

Building Exterior

Location	Direct Beta (dpm/100cm^2)	Correlated Alpha (dpm/100cm^2)
W1	375	750
W2	420	841
W3	239	477
W4	68	136
W5	193	386
W6	466	932

	43-89 Info
Beta Efficiency	0 088
Beta Background - Concrete Floor (cpm)	78
Beta Background - Steel Wall (cpm)	8
Beta MDA (dpm/100 cm^2)	180

Summary of Exposure Rate Measurements

Molycorp - Building 28 Survey Unit (Unaffected Building)

Building Interior

Location	Exposure Rate uR/hr	Exposure Rate Background	Exposure Rate Net
F1	10	9	1
F2	11	9	2
F3	11	9	2
F4	10	9	1
F5	11	9	2
F6	9	9	0
F7	10	9	1
F8	11	9	2
F9	11	9	2
F10	10	9	1
W1	6	9	-3
W2	9	9	0
W3	9	9	0
W4	10	9	1
W5	10	9	1
W6	11	9	2
W7	11	9	2
W8	11	9	2
W9	11	9	2
W10	11	9	2
W11	11	9	2
W12	11	9	2
W13	11	9	2
W14	11	9	2

Exposure Rate (uR/hr)

n	$\bar{x}$	s	μ_α
30	1.1	1.1357817	1.5

$t_{1-\alpha}$ 1.697

Guidelines/Conditions Satisfied: Yes

Building Exterior

Location	Exposure Rate uR/hr	Exposure Rate Background	Exposure Rate Net
W1	7	7	0
W2	17	17	0
W3	17	17	0
W4	17	17	0
W5	17	17	0
W6	9	7	2

Appendix D

Building 34 Data Package

Molycorp Washington, PA

Building 34 Data Package

This data package contains final status survey information for Building 34, Molycorp, Washington, PA site.

Field data collection forms, survey report forms, statistical test results, and comparisons to release limits are provided.

Summary

No anomalies were reported during the survey of Building 34. Elevated levels of background radiation, from soil radioactivity, continued to be a presence during survey activities.

Results from the final status survey of Building 34 provides evidence that release criteria have been met, demonstrates that residual radioactivity is below the unrestricted use criteria, and confirms that Building 34 is suitable for unrestricted use.

	DDO-138 Radiation Protection Survey Report	Site: Molycorp / Washington, PA

Section 1: Survey Information

Date	Time:	Location	Survey Issue Log Number:
3-8-02	1430	Bldg 37	02-0051

RWP Number	Purpose of Survey	Page
N/A	☐ RWP ☐ Routine Survey ☐ Unconditional Release ☒ Other	1 of 2

Survey Title: UNAFFECTED Bldg

Smear Number	Beta dpm/100cm²	Alpha dpm/100cm²
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13	N	
14		A
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		

Model # 19 115870 8-6-02 Ckgd 11mr/HR

Bkgd Readings

Legend

00 = mRem/h gamma | 00 C = mRem/h gamma contact | ① = Smear Location | 7 = Air Sample Location | -X-X-X- = Room, Boundary, or Barrier

00 β = mRem/h beta | 00 βC = mRem/h beta contact | —①— = Large Area Wipe | = Bulk Material Sample

Section 2: Instrument Used

Instrument Model/SN	Cal Due Date.	Probe Model/SN	Cal Due Date	Detector Eff (cpm/dpm)	MDA:	Other B⁻ BKG α
2929/152202	2/6/03	43-10/156519	2-6-03	B⁻ .165 / .344	B⁻ 212 / 145	B⁻ 46 α .16
2350-1/117014	8-13-02	43-106/13396	8-6-02	B⁻ .248 / .211	B⁻ 600 / 49	B⁻ 248 / 1.2
2350-1/117566	8-6-02	43-106/128912	8-6-02	B⁻ .251 / .212	B⁻ 643 / 45	B⁻ 292 / 1
2350-1/95359	8-6-02	43-37/092503	8-6-02	B⁻ .27 / .207	B⁻ 185 / 14	B⁻ 1430 / 4.8
2360/164680	7-9-02	43-89/118544	8-6-02	B⁻ .113 / .164	B⁻ 398 / 60 α .140 / .71	B⁻ Floor wet 74 / 8 Floor dry 2.4 / 3.7

Section 3: Review and Approval

Survey Performed By (Sign)	Area Posted and/or Barricaded:	Date and Time.
MARK BLUBAUGH	☐ Yes ☐ No ☒ Not Required	3-8-02 / 1430

Radiation Safety Officer (Print Name & Sign)	Date and Time
Mike McDonald	3-14-02 / 9:30

Radiological Survey Results - Survey Location Indicator

SURVEY # 02-0051

Survey Area Information:

Instrument Data	Instrument Model/SN	Cal Due	Probe Model/SN	Cal Due	α Scan MDA	β Scan MDA	α Static MDA	β Static MDA
			N					
			A					

Performed By:	Print Name	Signature	Date
	MARK BLANCIAK	Mark Blanciak	3-8-02
	Justin Trenidad	Justin Trenidad	3-8-02
	Steve Filo	Steve Filo	3-8-02

Location i/s	β Scan (cpm)	α Scan (cpm)	β Static (unsh) (cpm)	β Static (sh) (cpm)	α Static (cpm)	ER (μrem/hr)	Smears (dpm/100 cm²) α	Smears (dpm/100 cm²) β
W-1	640	2	498	477	5	16	-.46	-289
W-2	480	2	253	237	8	10	2.4	-55
W-3			325	340	5	15	-.46	-18
W-4			277	238	8	15	-.46	-18
W-5	450	1.2	276	276	6	17	2.4	-42
W-6			219	228	4	12	-.46	0
W-7	280	1	196	213	0	11	-.46	-12
W-8	270	.8	187	205	2	10	-.46	36
W-8 QC			192	215	1	10	-.46	48
W-9	580	1	418	379	3	12	-.46	-36
E-1			342	288	3	10	-.46	-85
E-2	1600	16	317	244	6	9	-.46	-48
E-3	1700	15	360	277	5	12	-.46	30
E-4	3400	2	707	646	2	22	-.46	12
E-5	1800	9	396	310	1	12	-.46	6
E-6	1600	10	360	310	1	10	-.46	-18
E-7	1800	12	433	335	4	14	2.4	18
E-8	2000	10	476	384	2	18	-.46	-48
E-9	2600	14	553	569	0	22	-.46	12
E-10			276	264	2	11	-.46	-18
E-11	1700	11	387	354	5	14	-.46	-18
E-12	2800	10	589	534	4	20	-.46	55
E13			353	286	1	12	2.4	-24
E-13 QC	1700	12	377	292	2	12	-.46	-18
			N					
				A				

Radiological Survey Results - Calculational Sheet

Survey # 62-0051

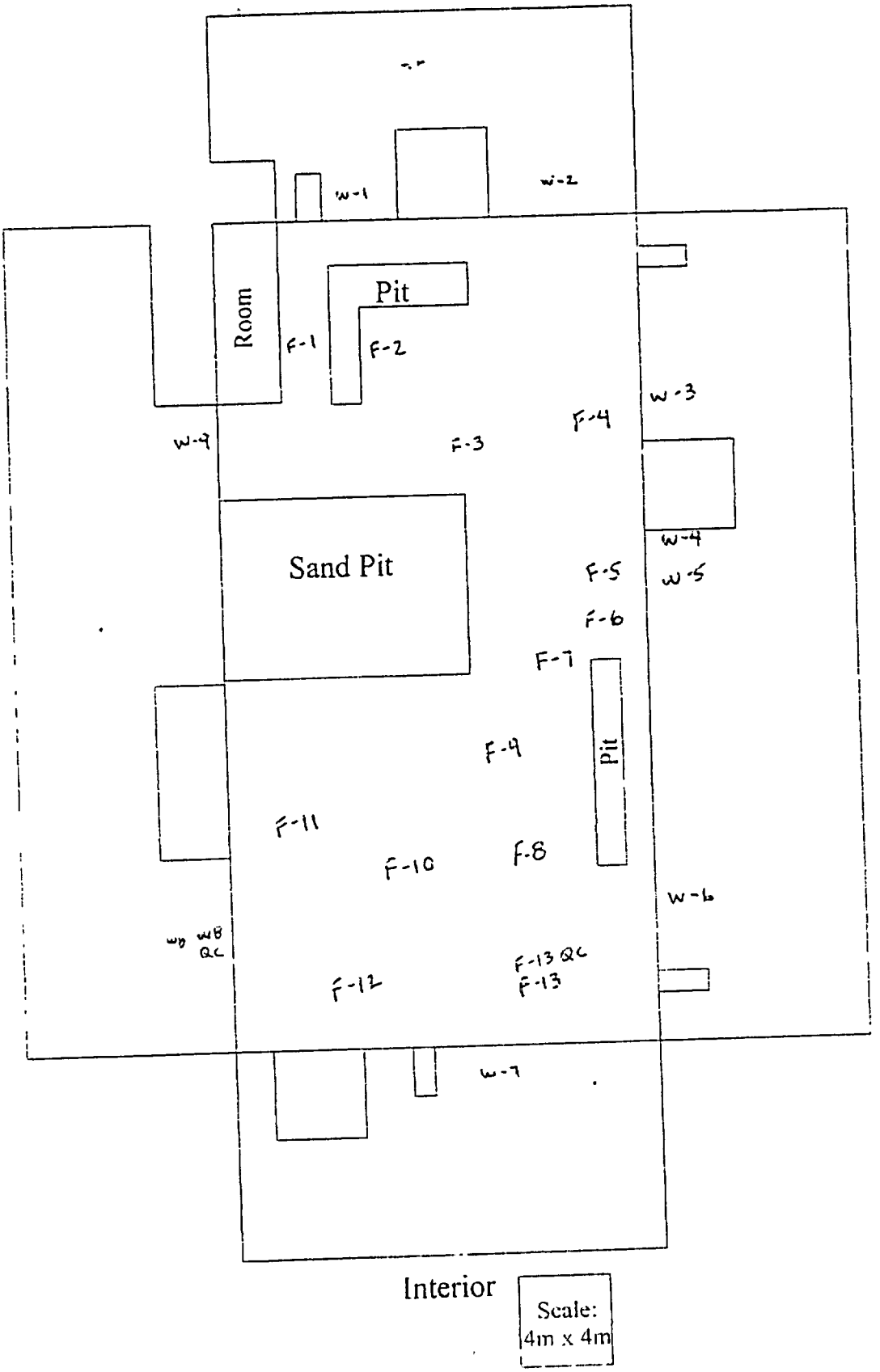
Location	β Static (unsh) (cpm)	β Static (sh) (cpm)	Gross β	Minus Bkgd = (Net β)	Net β dpm/100 cm²
CW-1	498	477	21	13	115
CW-2	253	237	16	8	71
CW-3	325	340	-15	-23	-204
CW-4	277	238	39	31	274
CW-5	276	276	0	-8	-71
CW-6	219	228	-9	-17	-150
CW-7	196	213	-17	-25	-221
CW-8	187	205	-18	-26	-230
CW-8 QC	192	215	-23	-31	-274
CW-9	418	379	39	31	274
F-1	342	288	54	-24	-212
F-2	317	244	73	-5	-44
F-3	360	277	83	5	44
F-4	707	646	61	-17	-150
F-5	396	310	86	8	71
F-6	360	310	50	-28	-248
F-7	433	335	98	20	177
F-8	476	384	92	14	124
F-9	553	569	-16	-94	-832
F-10	276	264	12	-66	-584
F-11	387	354	33	-45	-398
F-12	589	534	55	-23	-204
F-13	353	286	67	-11	-97
F-13 QC	377	292	85	7	62
		N			
			A		

Instrument Model/SN:	Probe Model/SN:	Detector Eff.: (cpm/dpm)
2360 / 164680	43-89 / 118544	B: .113 α: .164
	N	
		A

Material	Bkgd
Wall	8
Floor	78
N	
	A

SURVEY # 02-0051

Building 34
North



Radiological Survey Results - Survey Location Indicator

Survey # 02-0051

Survey Area Information:

Instrument Data	Instrument Model/SN	Cal Due	Probe Model/SN	Cal Due	α Scan MDA	β Scan MDA	α Static MDA	β Static MDA
			N					
				A				

Performed By:	Print Name	Signature	Date
	MARK BLANCIAK	Mark Blanciak	3-8-02
	Justin Trenidad	Justin Trenidad	3-8-02
	STeve Filo	Steve Filo	3-8-02

Location	β Scan (cpm)	α Scan (cpm)	β Static (unsh) (cpm)	β Static (sh) (cpm)	α Static (cpm)	ER (μrem/hr)	Smears (dpm/100 cm²) α	Smears (dpm/100 cm²) β
W-1	650	2	529	449	1	22	-.46	0
W-2			337	324	5	22	-.46	-6
W-3	320	4	300	277	1	14	-.46	-67
W-4	353	2	318	269	1	16	-.46	-12
W-4 ac			297	280	3	16	-.46	30
W-5			222	217	6	13	1.0	-18
W-6	300	3	188	228	4	10	5.3	-36
W-7	240	4.9	197	208	5	9	2.4	0
W-8	377	6	299	276	2	12	-.46	0
				N				
					A			

SURVEY # 02-0051

Radiological Survey Results - Calculational Sheet

Location	β Static (unsh) (cpm)	β Static (sh) (cpm)	Gross β	Minus Bkgd = (Net β)	Net β dpm/100 cm²
LW-1	529	449	80	72	637
LW-2	353	324	29	21	186
LW-3	300	277	23	15	133
LW-4	318	269	49	41	363
LW-4 QC	297	280	17	9	80
LW-5	222	217	5	-3	-27
LW-6	188	228	-40	-48	-424
LW-7	197	208	-11	-19	-168
LW-8	299	276	23	15	132
		N	A		

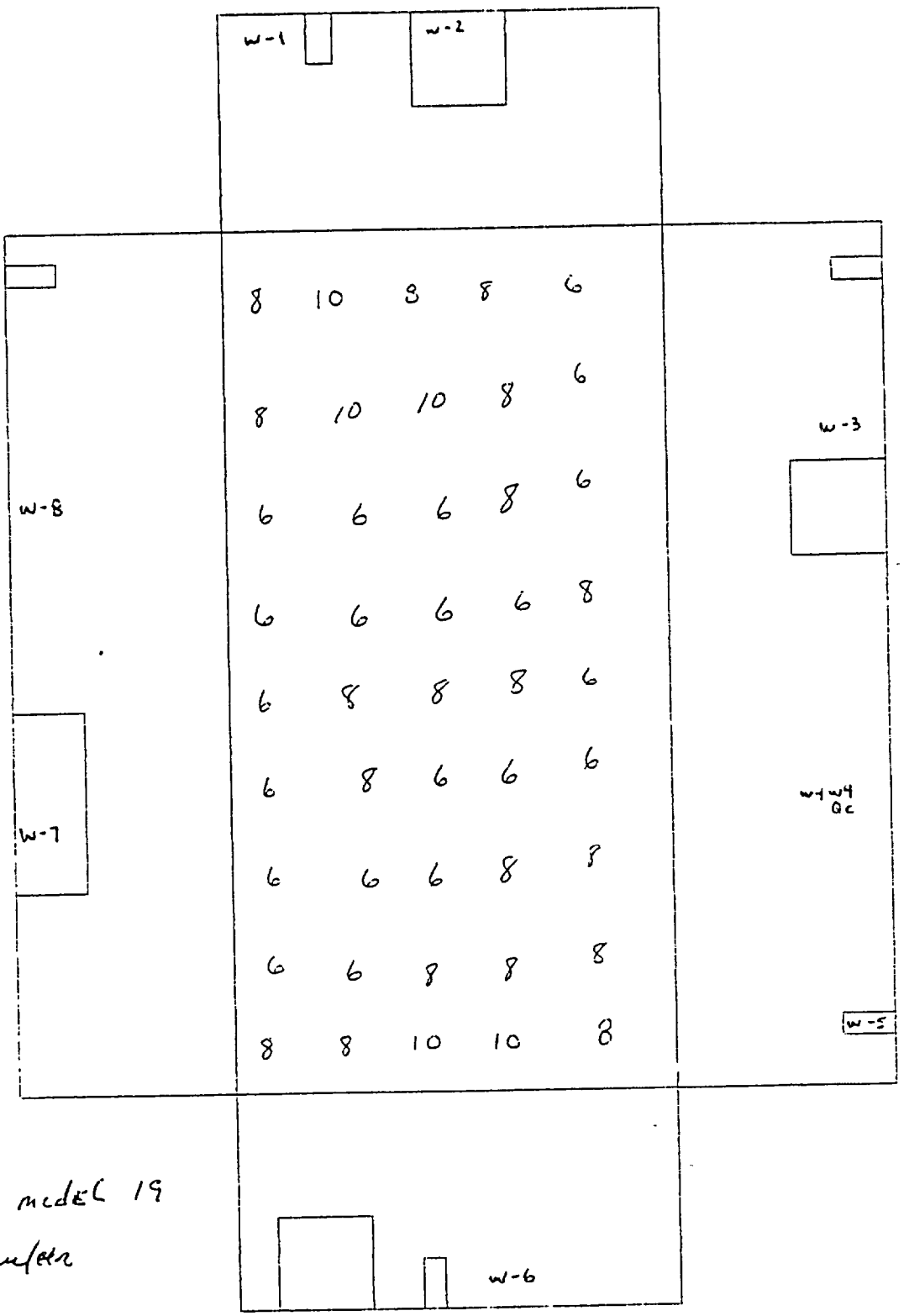
Duncan 7-9-02 8-6-02

Instrument Model/SN:	Probe Model/SN:	Detector Eff.: (cpm/dpm)
2360/164680	43-89/118544	B=.113 α=.164
	N	
	A	

Material	Bkgd
WALL	B=8 α=3.7
FLOOR	B=.78 α=2.4
N	
	A

SURVEY # 02-0051

Building 34
North



Bkgd for model 19
6-8 meter

Exterior

Scale:
4m x 4m

RPP-OP-019

	DDO-138 Radiation Protection Survey Report	Site: Molycorp / Washington, PA

Section 1: Survey Information

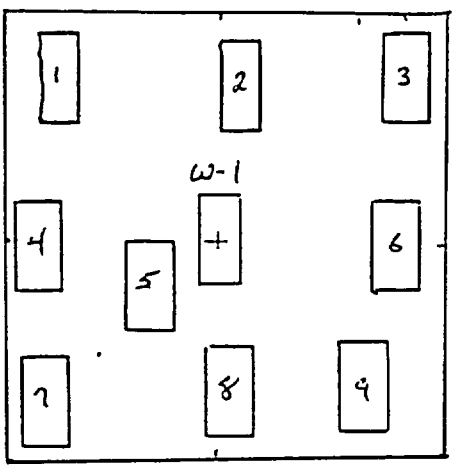
Date	Time:	Location:	Survey Issue Log Number
3-12-02	1130	O/S Bldg 34	02-0060

RWP Number:	Purpose of Survey:	Page of
N/A	☐ RWP ☐ Routine Survey ☐ Unconditional Release ☒ Other	Page 1 of 1

Survey Title:

1 m² Survey on O/S Wall #1 Reading 637

Dpm/100cm² β⁻



Loc	UN sh	wash	NB	DPM
1	483	483	-8	-71
2	396	402	-14	-124
3	422	431	-17	-150
4	504	486	10	88
5	497	477	12	106
6	457	466	-17	-150
7	533	527	-2	18
8	525	516	1	9
9	464	464	-8	-71
				-345

$\frac{-345}{9} = -38$

$637\left(\frac{100}{10,000}\right) + -38\left(1 - \frac{100}{10,000}\right)$

$6.37 + -37.62$

-31.2 dpm/100cm² β⁻ 0 dpm/100cm² α

Smear Number	Beta dpm/100cm²	Alpha dpm/100cm²
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13	N	
14		A
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		

Bkgd Readings

Legend

00 = mRem/h gamma | 00 C = mRem/h gamma contact | ① = Smear Location | 7 = Air Sample Location | -X-X-X- = Rope Boundary, or Barrier

00 β = mRem/h beta | 00 βC = mRem/h beta contact | —①— = Large Area Wipe | = Bulk Material Sample

Section 2: Instrument Used

Instrument Model/SN	Cal Due Date.	Probe Model/SN	Cal Due Date	Detector Eff (cpm/dpm)	MDA	Other Bkgd
2360/164680	7-9-02	43-89/118544	8-6-02	α .164 β⁻ .113	α .71 β⁻ 140	β⁻ 8 α 3.7
	N			N		
	A				A	

Section 3: Review and Approval

Survey Performed By (Sign)	Area Posted and/or Barricaded:	Date and Time
	☐ Yes ☐ No ☒ Not Required	3-12-02 1130
Radiation Safety Officer (Print Name & Sign)		Date and Time
Mike McDonald		3-14-02 9:30

Results of Surface Scans

Molycorp - Building 34 Survey Unit (Unaffected Area)

Building Interior

Location (see map)	Beta Scan gross cpm	Beta Scan net cpm	Alpha Scan gross cpm	Alpha Scan net cpm	
F1					All floor scans performed with Ludlum 239-1F (2350-1 No 95359 with 43-37 No 92503)
F2	1600	170	16	11	Floor Monitor Info
F3	1700	270	15	10	Scan MDA Beta - 185 dpm/detector area
F4	3400	1970	2	-3	Scan MDA Alpha - 14 dpm/detector area
F5	1800	370	9	4	Scan background Beta - 1430 cpm
F6	1600	170	10	5	Scan background Alpha - 5 cpm
F7	1800	370	12	7	10% scan of floor and 2 meters up walls
F8	2000	570	10	5	
F9	2600	1170	14	9	
F10					
F11	1700	270	11	6	
F12	2800	1370	10	5	
F13					
W1	640	-3	2	1	
W2	480	-163	2	1	All interior wall scans performed with Ludlum 2350-1 No.117566 with 43-106 No 128921
W3					43-106 Info:
W4					Scan MDA Beta - 643 dpm/detector area
W5	450	-193	2	1	Scan MDA Alpha - 45 dpm/detector area
W6					Scan background Beta - 292 cpm
W7	280	-363	1	0	Scan background Alpha -1 cpm
W8	270	-373	1	0	
W9					

Building Exterior

Location (see map)	Beta Scan gross cpm	Beta Scan net cpm	Alpha Scan gross cpm	Alpha Scan net cpm	
W1	650	402	2	1	All external wall scans performed with Ludlum 2350-1 No.117014 with 43-106 No 133866
W2					43-106 Info
W3	320	72	4	3	Scan MDA Beta - 600 dpm/detector area
W4	353	105	2	1	Scan MDA Alpha - 49 dpm/detector area
W5					Scan background Beta - 248 cpm
W6	300	52	3	2	Scan background Alpha - 1 cpm
W7	240	-8	5	4	
W8	377	129	6	5	

F = floor, W = wall

Elevated Scan Readings

Molycorp - Building 34 Survey Unit (Unaffected Area)

Building Interior

Locations F4, F9 and F12 indicated elevated readings by scan with floor monitor as shown below.

Location	Beta Scan net cpm
F4	1970
F9	1170
F12	1370

Elevated locations were re-scanned with hand-held 43-106, results indicated background levels
Direct and removable measurement results in locations F4, F9 and F12 indicate background values.

Building Exterior

Location W1 indicated elevated reading by scan with floor monitor as shown below.

Location	Beta Scan net cpm
W1	402

Direct measurement in locationW1 indicate background values

Direct Measurements (Total Activity)

Molycorp - Building 34 Survey Unit (Unaffected Area)

Building Interior

Location	Unshield Beta cpm	Shield Beta cpm	Gross Beta cpm	Bkgd cpm	Net cpm	Direct Beta (dpm/100cm^2)	Uncertainty 95% CL	MDA (dpm/100cm^2)	Direct Alpha [1] (dpm/100cm^2)
F1	342	288	54	78	-24	-261	199	387	-522
F2	317	244	73	78	-5	-54	213	387	-109
F3	360	277	83	78	5	54	220	387	109
F4	707	646	61	78	-17	-185	204	387	-370
F5	396	310	86	78	8	87	222	387	174
F6	360	310	50	78	-28	-304	196	387	-609
F7	433	335	98	78	20	217	230	387	435
F8	476	384	92	78	14	152	226	387	304
F9	553	569	-16	78	-94	-1022	137	387	-2043
F10	276	264	12	78	-66	-717	165	387	-1435
F11	387	354	33	78	-45	-489	183	387	-978
F12	589	534	55	78	-23	-250	200	387	-500
F13	353	286	67	78	-11	-120	209	387	-239
W1	498	477	21	8	13	141	93	140	283
W2	253	237	16	8	8	87	85	140	174
W3	325	340	-15	8	-23	-250	46	140	-500
W4	277	238	39	8	31	337	119	140	674
W5	276	276	0	8	-8	-87	49	140	-174
W6	219	228	-9	8	-17	-185	17	140	-370
W7	196	213	-17	8	-25	-272	52	140	-543
W8	187	205	-18	8	-26	-283	55	140	-565
W9	418	379	39	8	31	337	119	140	674

All building interior direct measurements were performed with 43-89 No 118544	Beta	Alpha
Floor Efficiency	0 113	0 164
Wall Efficiency	0.113	0 164
Floor Background (cpm)	78	2.4
Wall Background (cpm)	8	3 7
Floor MDA (dpm/100 cm^2)	387	60
Wall MDA (dpm/100 cm^2)	140	71

Building Exterior

Location	Unshield Beta cpm	Shield Beta cpm	Gross Beta cpm	Bkgd cpm	Net cpm	Direct Beta (dpm/100cm^2)	Uncertainty 95% CL	MDA (dpm/100cm^2)	Direct Alpha [1] (dpm/100cm^2)
W1	529	449	80	8	72	637	163	140	1274
W2	353	324	29	8	21	186	106	140	372
W3	300	277	23	8	15	133	97	140	265
W4	318	269	49	8	41	363	131	140	726
W5	222	217	5	8	-3	-27	63	140	-53
W6	188	228	-40	8	-48	-425	98	140	-850
W7	197	208	-11	8	-19	-168	30	140	-336
W8	299	276	23	8	15	133	97	140	265

All building exterior direct measurements were performed with 43-89 No 118544	Beta	Alpha
Efficiency	0 113	0 164
Background (cpm)	8	3 7
MDA (dpm/100 cm^2)	140	71

(1) - A beta to alpha ratio factoring (1 2, beta to alpha) was used to provide a more accurate alpha activity determination then sampling

Elevated Direct Readings (Total Activity) and Averaging Results
Molycorp - Building 34 Survey Unit (Unaffected Area)

Building Interior

No interior elevated direct measurements were reported

Building Exterior

Location	Direct Alpha (dpm/100cm^2)	Over Area (cm^2)	Exceeds Limits Maximum	Average
W1	1274	100	No	Yes

Averaged Value (over 1 m^2)		Within Limit?
W1	0	Yes

Removable Surface Activity Measurements

Molycorp - Building 34 Survey Unit (Unaffected Area)

Building Interior

Location (see map)	Removable Beta (dpm/100cm^2)	Uncertainty 95% CL	MDA	Removable Alpha (dpm/100cm^2)	Uncertainty 95% CL	MDA
F1	-85	45 9	212	-0 46	2.3	14 5
F2	-48	35 3	212	-0 46	2.3	14 5
F3	30	28 8	212	-0.46	2.3	14 5
F4	12	20 2	212	-0 46	2 3	14 5
F5	6	16 4	212	-0 46	2.3	14 5
F6	-18	23 4	212	-0 46	2.3	14 5
F7	18	23 4	212	2 4	5 2	14 5
F8	-48	35 3	212	-0 46	2.3	14 5
F9	12	20 2	212	-0 46	2.3	14 5
F10	-18	23 4	212	-0 46	2 3	14 5
F11	-18	23 4	212	-0 46	2.3	14 5
F12	55	37.6	212	-0 46	2 3	14 5
F13	-24	26 2	212	2 4	5.2	14 5
W1	-29	28 4	212	-0 46	2.3	14 5
W2	-55	37.6	212	2 4	5 2	14 5
W3	-18	23 4	212	-0 46	2.3	14 5
W4	-18	23 4	212	-0 46	2.3	14 5
W5	-42	33 3	212	2 4	5.2	14 5
W6	0	11 4	212	-0 46	2.3	14 5
W7	-12	20 2	212	-0 46	2.3	14 5
W8	36	31 1	212	-0 46	2.3	14 5
W9	-39	32.2	212	-0 46	2.3	14 5

Ludlum 2929 No 152202 with 43-10 No 156519 Info:

	Beta	Alpha
Background (cpm)	46	0 16
Bkgd ct. time	50	50
Sample ct. time	1	1
Efficiency	0.165	0 344
MDA	212	14.5

Building Exterior

Location (see map)	Removable Beta (dpm/100cm^2)	Uncertainty 95% CL	MDA	Removable Alpha (dpm/100cm^2)	Uncertainty 95% CL	MDA
W1	0	11.4	176	-0 46	2.3	14 5
W2	-6	16 4	176	-0 46	2.3	14 5
W3	-67	41.1	176	-0 46	2.3	14 5
W4	-12	20 2	176	-0 46	2.3	14 5
W5	-18	23 4	176	10	10 6	14 5
W6	-36	31.1	176	5 3	7.7	14 5
W7	0	11 4	176	2.4	5.2	14 5
W8	0	11.4	176	-0 46	2 3	14 5

	Beta	Alpha
Background (cpm)	46	0 16
Bkgd ct. time	50	50
Sample ct time	1	1
Efficiency	0.165	0 344
MDA	212	14.5

F = floor, W = wall

Removable Surface Activity Measurements
Molycorp - Building 34 Survey Unit (Unaffected Area)

No elevated removable surface activity was reported.

Exposure Rate Measurements

Molycorp - Building 34 Survey Unit (Unaffected Area)

Building Interior

Location	Exposure Rate uR/hr
F1	10
F2	9
F3	12
F4	22
F5	12
F6	10
F7	14
F8	18
F9	22
F10	11
F11	14
F12	20
F13	12
W1	16
W2	10
W3	15
W4	15
W5	17
W6	12
W7	11
W8	10
W9	12

Building Roof Gamma Scan

Location (see map)	Exposure Rate uR/hr	Location (see map)	Exposure Rate uR/hr
R1	8	R24	8
R2	10	R25	6
R3	8	R26	6
R4	8	R27	8
R5	6	R28	6
R6	8	R29	6
R7	10	R30	6
R8	10	R31	6
R9	8	R32	6
R10	6	R33	6
R11	6	R34	8
R12	6	R35	8
R13	6	R36	6
R14	8	R37	6
R15	6	R38	8
R16	6	R39	8
R17	6	R40	8
R18	6	R41	8
R19	6	R42	8
R20	8	R43	10
R21	6	R44	10
R22	8	R45	8
R23	8		

Building Exterior

Location	Exposure Rate uR/hr
W1	22
W2	22
W3	14
W4	16
W5	13
W6	10
W7	9
W8	12

Building roof background gamma exposure rates varied based on reading locations. Background levels were reported as 6-8 uR/hr when held away from the roof surface (over the side).

Exterior and interior background dose rates varied widely (9-22 uR/hr) based on soil activity for building area surveyed (instrument location) Based on direct and loose surface surveys results, elevated dose rates are due to background gamma rates and not building surface activity

Summary of Building Surface Direct Reading (Total Activity) Results

Molycorp - Building 34 Survey Unit (Unaffected Area)

Building Interior

Location	Unshield Beta cpm	Shield Beta cpm	Gross Beta cpm	Bkgd cpm	Net cpm	Average Total Activity (dpm/100cm^2) Direct Beta (dpm/100cm^2)	Correlated Alpha (dpm/100cm^2)
F1	342	288	54	78	-24	-212	-424.8
F2	317	244	73	78	-5	-44	-88 5
F3	360	277	83	78	5	44	88 5
F4	707	646	61	78	-17	-150	-300 9
F5	396	310	86	78	8	71	141.6
F6	360	310	50	78	-28	-248	-495 6
F7	433	335	98	78	20	177	354 0
F8	476	384	92	78	14	124	247.8
F9	553	569	-16	78	-94	-832	-1663 7
F10	276	264	12	78	-66	-584	-1168.1
F11	387	354	33	78	-45	-398	-796 5
F12	589	534	55	78	-23	-204	-407 1
F13	353	286	67	78	-11	-97	-194 7
W1	498	477	21	78	-57	-504	-1008 8
W2	253	237	16	78	-62	-549	-1097.3
W3	325	340	-15	8	-23	-204	-407,1
W4	277	238	39	8	31	274	548 7
W5	276	276	0	8	-8	-71	-141.6
W6	219	228	-9	8	-17	-150	-300 9
W7	196	213	-17	8	-25	-221	-442 5
W8	187	205	-18	8	-26	-230	-460 2
W9	418	379	39	8	31	274	548 7

	Beta				Alpha			
	n	$\bar{x}$	s	μ_α	n	$\bar{x}$	s	μ_α
	30	-97	313 0	0 2	30	-236 0	562 9	-61 6
		$t_{1-\alpha}$	1 697					

Guidelines/Conditions Satisfied	
Beta	Alpha
Yes	Yes

Building Exterior

Location	Unshield Beta cpm	Shield Beta cpm	Gross Beta cpm	Bkgd cpm	Net cpm	Direct Beta (dpm/100cm^2)	Correlated Alpha (dpm/100cm^2)
W1	529	449	80	8	72	637	0
W2	353	324	29	8	21	186	372
W3	300	277	23	8	15	133	265
W4	318	269	49	8	41	363	726
W5	222	217	5	8	-3	-27	-53
W6	188	228	-40	8	-48	-425	-850
W7	197	208	-11	8	-19	-168	-336
W8	299	276	23	8	15	133	265

Summary of Exposure Rate Measurements
Molycorp - Building 34 Survey Unit (Unaffected Area)

Building Interior

Location	Exposure Rate uR/hr	Exposure Rate Background	Exposure Rate Net
F1	10	10	0
F2	9	10	-1
F3	12	10	2
F4	22	20	2
F5	12	10	2
F6	10	10	0
F7	14	10	4
F8	18	20	-2
F9	22	20	2
F10	11	10	1
F11	14	10	4
F12	20	20	0
F13	12	10	2
W1	16	10	6
W2	10	10	0
W3	15	15	0
W4	15	15	0
W5	17	15	2
W6	12	10	2
W7	11	10	1
W8	10	10	0
W9	12	10	2

Exposure Rate (uR/hr)

n	$\bar{x}$	s	μ_α
30	1.3	1.7	1.8

$t_{1-\alpha}$ 1.697

Guidelines/Conditions Satisfied: Yes

Building Exterior

Location	Exposure Rate uR/hr	Exposure Rate Background	Exposure Rate Net
W1	22	20	2
W2	22	20	2
W3	14	13	1
W4	16	13	3
W5	13	13	0
W6	10	10	0
W7	9	10	-1
W8	12	10	2

Appendix E

Background Assessment Data

Molycorp Washington, PA

Background Assessment

Material-specific background levels were established by RSI in late 2001 for each type of instrument used for total surface contamination measurements during their final status surveys of buildings 39 and 42. Similar instrumentation was selected for use by MACTEC to take advantage of this previously available information.

Background measurements were collected by RSI on surfaces of similar construction as the buildings at the site and having no possibility of being impacted by site operations. Measurements to establish background for a specific material were collected from multiple locations to provide an estimate of the variability or uncertainty. Background determination was performed using the same instrumentation that was used for final status survey data collection. An average background value was determined for each material surveyed. Background determinations were required and performed for concrete and a class of material designated a generic material.

The number of background measurements obtained per material type:

- Concrete - minimum of 20 measurements
- Cinderblock - minimum of 20 measurements
- Generic Material - minimum of 10 measurements for each type of material surveyed (i.e., wood, insulation, corrugated steel, etc.)

MACTEC performed material-specific backgrounds for poured concrete with it's four large-area scintillator instruments. Results of the backgrounds matched those of RSI, and gave confidence that other material-specific background information established by RSI was valid for use. The most conservative backgrounds values were selected and used for all background subtracts for direct (static) type surveys performed.

Background measurements for poured concrete were calculated from surveys obtained at the Canton Volunteer Fire Department Station 52-1, Canton Township, PA on their poured concrete surfaces. A mean value for each instrument was calculated. The most conservative background value was selected and used by the Health Physics technicians for all instrument background subtractions.

Included in this appendix are the results of MACTEC's background assessment data.

Concrete Background Assessment
Molycorp Washington, PA

Poured Concrete Surfaces

Ludlum Model 2224-1 (129463) with 43-89 (169230)

Beta - Direct Measurements (cpm)

Unshield	Shield	Net
360	301	59
318	267	51
379	287	92
344	269	75
342	290	52
396	266	130
336	273	63
328	272	56
358	314	44
351	256	95
347	272	75
405	276	129
350	284	66
388	299	89
354	292	62
349	257	92
395	277	118
359	302	57
326	287	39
393	270	123

Mean (cpm)	78
Stand Deviation	28.8
n_b	10

Readings taken at the Canton Volunteer Fire Department Station 52-1, Canton Township, PA on their poured concrete surfaces

Concrete Background Assessment
Molycorp Washington, PA

Poured Concrete Surfaces

Ludlum Model 2360 (156371) with 43-89 (164832)

Beta - Direct Measurements (cpm)

Unshield	Shield	Net
349	273	76
329	268	61
368	248	120
326	293	33
338	289	49
289	257	32
324	254	70
345	310	35
353	281	72
369	261	108
418	269	149
364	280	84
377	266	111
317	249	68
350	294	56
366	273	93
343	251	92
368	260	108
362	294	68
356	267	89

Mean (cpm)	79
Stand Deviation	30.9
n_b	11

Readings taken at the Canton Volunteer Fire Department Station 52-1, Canton Township, PA on their poured concrete surfaces.

Concrete Background Assessment
Molycorp Washington, PA

Poured Concrete Surfaces

Ludlum Model 2360 (164680) with 43-89 (118544)

Beta - Direct Measurements (cpm)

Unshield	Shield	Net
308	255	53
309	264	45
349	239	110
356	254	102
360	281	79
370	245	125
343	242	101
354	243	111
354	256	98
345	252	93
329	254	75
345	232	113
363	232	131
330	241	89
319	236	83
310	230	80
343	262	81
338	255	83
322	260	62
358	263	95

Mean (cpm)	90
Stand Deviation	22.3
n_b	5

Readings taken at the Canton Volunteer Fire Department Station 52-1, Canton Township, PA on their poured concrete surfaces

Concrete Background Assessment
Molycorp Washington, PA

Poured Concrete Surfaces

Ludlum Model 2360 (145465) with 43-89 (145391)

Beta - Direct Measurements (cpm)

Unshield	Shield	Net
348	272	76
321	260	61
345	282	63
418	271	147
377	269	108
361	273	88
318	266	52
359	302	57
405	281	124
354	263	91
310	231	79
390	299	91
308	256	52
360	261	99
340	253	87
359	292	67
356	266	90
352	280	72
336	282	54
390	275	115

Mean (cpm)	84
Stand Deviation	25 8
n_b	7

Readings taken at the Canton Volunteer Fire Department Station 52-1, Canton Township, PA on their poured concrete surfaces

Appendix F

Instrumentation Data

Molycorp Washington, PA

Instrumentation Data

This data package contains instrumentation information (background, QC, and source response data forms) for the instruments used during the final status survey of Buildings 13, 14, 28, and 34.

Ludlum Model 19 Micro-Rem

Routine Performance and Background Data Form

Instrument ID #: 115870	Cal. Due: 8-6-02	Source ID #: Cs 137 #1610
Mean Source Value: 204	Mean plus + 20% Value: 245	Mean plus - 20% Value: 163

Date	Time	Meter Scale				Background Reading	Sat/Unsat
		25 µrem (sat/unsat)	50 µrem (sat/unsat)	250 µrem +/-20% value	500 µrem +/-20% value		
3-12-02	0615			220		13	~~Sat~~
3-13-02	0615			220		13	~~Sat~~
3-14-02	0618			220		13	~~Sat~~
					N		
		N			A		
			A				

Ludlum Model 19 Micro-Rem

Routine Performance and Background Data Form

Instrument ID #: 115870	Cal. Due: 8-6-02	Source ID #: Cs 137 # 1610
Mean Source Value: 204	Mean plus + 20% Value: 245	Mean plus - 20% Value: 163

Date	Time	Meter Scale				Background Reading	Sat/Unsat
		25 µrem (sat/unsat)	50 µrem (sat/unsat)	250 µrem +/-20% value	500 µrem +/-20% value		
2-13-02	0700			210		9	S
2-14-02	0605			200		12	S
2-15-02	0600			240		11	S
2-18-02	0605			220		10	S
2-19-02	0605			200		10	S
2-20-02	0620			190		12	S
2-21-02	0610			220		12	S
2-22-02	0615			220		13	S
2-25-02	0630	N		210	N	13	S
2-26-02	0607		A	220	A	13	S
2-27-02	0612			220		12	S
2-28-02	0610			220		13	S
3-1-02	0615			220		12	S
3-4-02	0603			240		13	S
3-5-02	0608			240		13	S
3-6-02	0625			220		13	S
3-7-02	0603			200		13	S
3-8-02	0625			220		12	S
3-11-02	0619			220		12	S

Ludlum Model 19 Micro-Rem

QC Check Control Limits

Instrument: Model-19 Micro-R ID: 115870 Date: 2-12-02

20 Source-Count: Gamma			
Source ID: Cs 137 16 ic Scale: 250			
Count	Reading (x_i)	$(x_i)-(\bar{x})$	$[(x_i)-(\bar{x})]^2$
1	200		
2	200		
3	220		
4	210		
5	200		
6	210		
7	190		
8	200		
9	210		
10	200		
11	200		
12	200		
13	210		
14	220		
15	190		
16	200		
17	200		
18	200		
19	210		
20	200		
Total	4070		

20 Source-Count: Background			
Scale:			
Count	Reading (x_i)	$(x_i)-(\bar{x})$	$[(x_i)-(\bar{x})]^2$
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
Total			

Mean

$$\bar{x} = \frac{\sum x_i}{20}$$

Where:
$\bar{x}$ = mean
x_i = each individual measurement

Gamma Values			
$\bar{x}$ =	204	20% =	41
+20% =	245	-20% =	163

Background Values			
$\bar{x}$ =		20% =	
+20% =		-20% =	

Reviewed: [signature] Date: 3-14-02

Ludlum Model 19 Micro-Rem

Routine Performance and Background Data Form

Instrument ID #: 22526	Cal. Due: 8-6-02	Source ID #: Cs 137 #1610
Mean Source Value: 208	Mean plus + 20% Value: 250	Mean plus - 20% Value: 167

Date	Time	Meter Scale				Background Reading	Sat/Unsat
		25 µrem (sat/unsat)	50 µrem (sat/unsat)	250 µrem +/-20% value	500 µrem +/-20% value		
3-11-02	0618			200		12	S
3-12-02	0715			210		12	S
3-13-02	0615			190		13	SAT
3-14-02	0619			200		12	SAT
		N	A		N	A	

Ludlum Model 19 Micro-Rem

Routine Performance and Background Data Form

Instrument ID #: 22526	Cal. Due: 8/6/02	Source ID #: Cs 137 1610
Mean Source Value: 208	Mean plus + 20% Value: 250	Mean plus - 20% Value: 167

Date	Time	Meter Scale				Background Reading	Sat/Unsat
		25 µrem (sat/unsat)	50 µrem (sat/unsat)	250 µrem +/-20% value	500 µrem +/-20% value		
2-12-02	0800			200		10	Sat.
2-13-02	0700			180		9	Sat
2-14-02	0606			200		12	Sat
2-15-02	0600			200		11	Sat
2-18-02	0605			190		10	Sat
2-19-02	0605			200		10	Sat
2-20-02	0620			200		12	Sat
2-21-02	0610	N		200	N A	12	Sat
2-22-02	0615		A	220		13	Sat
2-25-02	0610			200		12	Sat
2-26-02	0607			200		12	Sat
2-27-02	0612			200		13	Sat
2-28-02	0610			180		13	Sat
3-1-02	0615			200		12	Sat
3-4-02	0603			200		13	Sat
3-5-02	0604			200		13	Sat
3-6-02	0626			200		13	Sat
3-7-02	0603			180		13	Sat
3-8-02	0625			200		13	Sat

Ludlum Model 19 Micro-Rem

QC Check Control Limits

Instrument: Model 19 Micro R ID: 22526 Date: 2-12-02

20 Source-Count: Gamma			
Source ID: Cs 137 #610 Scale: 250			
Count	Reading (x_i)	$(x_i)-(\bar{x})$	$[(x_i)-(\bar{x})]^2$
1	200		
2	200		
3	220		
4	210		
5	210		
6	200		
7	220		
8	220		
9	200		
10	210		
11	210		
12	200		
13	220		
14	220		
15	200		
16	210		
17	200		
18	200		
19	210		
20	210		
Total	4170		

20 Source-Count: Background			
Scale:			
Count	Reading (x_i)	$(x_i)-(\bar{x})$	$[(x_i)-(\bar{x})]^2$
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
Total			

Mean

$$\bar{x} = \frac{\sum x_i}{20}$$

Where:
$\bar{x}$ = mean
x_i = each individual measurement

Gamma Values			
$\bar{x}$ =	208.5	20% =	41.7
+20% =	250.2	-20% =	166.8

Background Values			
$\bar{x}$ =		20% =	
+20% =		-20% =	

Reviewed: _____ Date: 3-14-02

EFF. 251

Daily Instrumentation Operational Check Sheet

Instrument: 2350-1 #117566 Probe: 43-106 #128912

Cal Due: 8-6-02 Cal Due: 8-6-02

Source ID:	Tc 99 3935	Mean Source Count Rate:	5144	Mean +2 σ Value:	5282	Mean -2 σ Value:	5006
Radiation Type:	β⁻	Sigma Value:	69	Mean +3 σ Value:	5351	Mean -3 σ Value:	5937

Background					Source Check				Results	
Date	Time	Count Time (min)	Gross Counts	BKGD CPM	Count Time (min)	Gross Counts	W/I 2 σ Value	W/I 3 σ Value	LLD	SAT/ UNSAT
3-7-02	1729	—	—	—	1	5146	—	—	—	Sat
3-8-02	0625	5	1679	~~336~~1679	1	5028	✓	✓	96	~~Sat~~
3-9-02	1400	—	—	—	1	5053	✓	✓	—	Sat
3-11-02	0642	5	1884	378	1	5029	✓	✓	102	~~Sat~~
3-12-02	0630	5	1894	379	1	5014	✓	✓	102	~~Sat~~

EFF. 212

Daily Instrumentation Operational Check Sheet

Instrument: 2350-1 # 117566 Probe: 43-106 # 128912

Cal Due: 8-6-02 Cal Due: 8-6-02

Source ID:	Mean Source Count Rate:	Mean +2 σ Value:	Mean -2 σ Value:
Th230 3937	735	785	685

Radiation Type:	Sigma Value:	Mean +3 σ Value:	Mean -3 σ Value:
α	25	810	660

Background					Source Check				Results	
Date	Time	Count Time (min)	Gross Counts	BKGD CPM	Count Time (min)	Gross Counts	W/I 2 σ Value	W/I 3 σ Value	LLD	SAT/ UNSAT
3-7-02	1726	—	—	—	1 —	762	—	—	—	Sat
3-8-02	0635	5	7	1.4	1	741	✓	✓	9	Sat
3-8-02	1400	—	—	—	1	745	—	—	—	Sat
3-11-02	0642	5	8	1.6	1	748	✓	✓	9	Sat
3-12-02	0630	5	7	1.4	1	776	✓	✓	9	Sat

EFF. .251

Daily Instrumentation Operational Check Sheet

Instrument: 2350-1 # 117566 Probe: 43-106 # 128912

Cal Due: 8-6-02 Cal Due: 8-6-02

Source ID:	Mean Source Count Rate:	Mean +2 σ Value:	Mean -2 σ Value:
Tc 99 3935	5144	5282	5006
Radiation Type:	**Sigma Value:**	**Mean +3 σ Value:**	**Mean -3 σ Value:**
β⁻	69	5351	4937

Background					Source Check				Results	
Date	Time	Count Time (min)	Gross Counts	BKGD CPM	Count Time (min)	Gross Counts	W/I 2 σ Value	W/I 3 σ Value	LLD	SAT/ UNSAT
2-23-02	1430	5	1847	369	1	5013	✓	✓	101	SAT
2-25-02	0640	5	1678	336	1	5140	✓	✓	96	SAT
2-25-02	1710	~~5~~	~~1487~~	—	1	5026	✓	✓	—	SAT
2-26-02	0610	5	1987	397	1	5012	✓	✓	104	SAT
2-26-02	1225	—	—	—	1	5270	—	—	—	SAT
2-27-02	0609	5	1772	354	1	5168	✓	✓	99	SAT
2-28-02	0607	5	1693	339	1	5149	✓	✓	96	SAT
3-1-02	0630	5	1760	352	1	5022	✓	✓	99	SAT
3-1-02	1705	—	—	—	1	5242	—	—	—	SAT.
3-4-02	0626	5	1748	350	1	5096	✓	✓	98	SAT
3-4-02	1720	—	—	—	1	5130	—	—	—	SAT.
3-5-02	0630	5	1669	334	1	5018	✓	✓	96	SAT
3-5-02	1700	—	—	—	1	5236	—	—	—	SAT.
3-6-02	0610	5	1636	327	1	5040	✓	✓	95	SAT
3-6-02	1730	—	—	—	1	5092	—	—	—	SAT.
3-7-02	0630	5	1712	342	1	5105	✓	✓	97	SAT

EFF .212

Daily Instrumentation Operational Check Sheet

Instrument: 2350-1 # 117566 Probe: 43-106 # 128912

Cal Due: 8-6-02 Cal Due: 8-6-02

Source ID:	Mean Source Count Rate:	Mean +2 σ Value:	Mean -2 σ Value:
Th230 3937	735	785	685
Radiation Type:	**Sigma Value:**	**Mean +3 σ Value:**	**Mean -3 σ Value:**
∝	25	810	660

Background					Source Check				Results	
Date	Time	Count Time (min)	Gross Counts	BKGD CPM	Count Time (min)	Gross Counts	W/I 2 σ Value	W/I 3 σ Value	LLD	SAT/ UNSAT
2-23-02	1430	5	5	1	1	740	✓	✓	8	~~SAT~~
2-25-02	0640	5	10	2	1	688	✓	✓	10	~~SAT~~
2-25-02	1715	—	—	—	1		—	—	—	~~SAT~~
2-26-02	0610	5	9	1.8	1	715	✓	—	10	~~SAT~~
2-26-02	1715	—	—	—	1	729	—	—	—	Sat
2-27-02	0609	5	4	.8	1	776	✓	✓	7	~~SAT~~
2-28-02	0601	5	13	2.6	1	769	✓	✓	11	~~SAT~~
3-1-02	0630	5	10	2	1	750	✓	✓	10	~~SAT~~
3-1-02	1700	—	—	—	1	762	—	—	—	~~SAT~~
3-4-02	0626	5	16	3.2	1	753	✓	✓	12	~~SAT~~
3-4-02	1730	—	—	—	1	707	—	—	—	~~SAT~~
3-5-02	0630	5	12	2.4	1	718	✓	✓	11	~~SAT~~
3-5-02	1700	—	—	—	1	733	—	—	—	~~SAT~~
3-6-02	0610	5	9		1	704	✓	✓		
3-6-02	1730	—	—	—	1	733	—	—	—	~~SAT~~
3-7-02	0630	5	11	2.2	1	738	✓	✓	10	~~SAT~~

DETERMINATION OF SOURCE QC LIMITS

Instrument: 2350-1 ID: 117566 Date: 2-22-02

Detector: 43-106 ID: 128912 Operating Voltage: 1460α/1850β

20 Source-Count: Alpha

Source ID: Th-230 3937

Count	Gross Cts (x_i)	$(x_i)-(\bar{x})$	$[(x_i)-(\bar{x})]^2$
1	724	-11	121
2	749	14	196
3	702	-33	1089
4	731	-4	16
5	717	-18	324
6	774	39	1521
7	719	-16	256
8	765	30	900
9	721	-14	196
10	714	-21	441
11	739	4	16
12	726	-9	81
13	680	-55	3025
14	736	1	1
15	765	30	900
16	755	20	400
17	720	-15	225
18	758	23	529
19	772	37	1369
20	742	7	49

$\bar{x}$ =	735	σ =	25
2σ =	50	3σ =	75

20 Source-Count: Beta

Source ID: Tc-99 3935

Count	Gross Cts (x_i)	$(x_i)-(\bar{x})$	$[(x_i)-(\bar{x})]^2$
1	5154	10	100
2	5084	-60	3600
3	5097	-47	2209
4	5064	-80	6400
5	5203	59	3481
6	5127	-17	289
7	5038	-106	11236
8	5290	146	21316
9	5060	-84	7056
10	5096	-48	2304
11	5189	45	2025
12	5131	13	169
13	5102	-42	1764
14	5237	93	8649
15	5221	77	5929
16	5182	38	1444
17	5154	10	100
18	5232	88	7744
19	5141	-3	9
20	5080	-64	4096

$\bar{x}$ =	5144	σ =	69
2σ =	138	3σ =	207

Mean

$$\bar{x} = \frac{\sum x_i}{20}$$

Sigma

$$\sigma = \sqrt{\frac{\Sigma(x_i - \bar{x})^2}{(n-1)}}$$

Where:
- σ = standard deviation
- $\bar{x}$ = mean count
- x_i = each individual measurement
- n = number of measurements

Chi-squared

$$X^2 = \frac{\sum(n-\bar{n})^2}{\bar{n}}$$

Where:
- n = data for individual counts
- $\bar{n}$ = average of the twenty data points

Alpha Values

mean +2 σ =	785	mean -2 σ =	685
mean +3 σ =	810	mean -3 σ =	660
X^2 = 16			

Beta Values

mean +3 σ =	5351	mean -2 σ =	5006
mean +2 σ =	5282	mean -3 σ =	4937
X^2 = 17			

Reviewed: _____ Date: 3-14-02

EFF. 248

Daily Instrumentation Operational Check Sheet

Instrument: 2350-1 # 117014 Probe: 43-106 # 133866

Cal Due: 8-13-02 Cal Due: 8-6-02

Source ID:	Tc99 3935	Mean Source Count Rate:	4720	Mean +2 σ Value:	4832	Mean -2 σ Value:	4608
Radiation Type:	β⁻	Sigma Value:	56	Mean +3 σ Value:	4888	Mean -3 σ Value:	4552

Background					Source Check				Results	
Date	Time	Count Time (min)	Gross Counts	BKGD CPM	Count Time (min)	Gross Counts	W/I 2 σ Value	W/I 3 σ Value	LLD	SAT/ UNSAT
3-7-02	0627	5	1587	317	1	4773	✓	✓	93	~~SAT~~
3-7-02	1720	—	—	—	1	4659	—	—	—	~~SAT~~
3-8-02	0638	5	1582	316	1	4831	✓	✓	93	~~SAT~~
3-8-02	1415	—	—	—	1	4672	—	—	—	~~SAT~~
3-11-02	0637	5	1556	311	1	4708	✓	✓	92	~~SAT~~
3-12-02	0625	5	1604	321	1	4723	✓	✓	94	~~SAT~~

EFF .211 ~~.248~~

Daily Instrumentation Operational Check Sheet

Instrument: 2350-1 # 117014 Probe: 43-106 # 133866

Cal Due: 8-13-02 Cal Due: 8-6-02

Source ID:	Th230 3437	Mean Source Count Rate:	723	Mean +2 σ Value:	775	Mean -2 σ Value:	671
Radiation Type:	α	Sigma Value:	26	Mean +3 σ Value:	801	Mean -3 σ Value:	645

Background					Source Check				Results	
Date	Time	Count Time (min)	Gross Counts	BKGD CPM	Count Time (min)	Gross Counts	W/I 2 σ Value	W/I 3 σ Value	LLD	SAT/ UNSAT
3-7-02	0627	5	12	2.4	1	743	✓	✓	11	~~SAT~~
3-7-02	1719	—	—	—	1	677	—	—	—	~~SAT~~
3-8-02	0638	5	4	.8	1	747	✓	✓	7	~~SAT~~
3-8-02	1415	—	—	—	1	723	—	—	—	~~SAT~~
3-11-02	0637	5	7	1.4	1	712	✓	✓	9	~~SAT~~
3-12-02	0625	5	11	2.2	1	757	✓	✓	10	~~SAT~~

DETERMINATION OF SOURCE QC LIMITS

Instrument: 2350-1 ID: 117014 Date: 3-6-02

Detector: 43-106 ID: 133866 Operating Voltage: α 1350 β 1800

20 Source-Count: Alpha

Source ID: Th-230 3937

Count	Gross Cts (x_i)	$(x_i)-(\bar{x})$	$[(x_i)-(\bar{x})]^2$
1	710	-13	169
2	719	-4	16
3	736	13	169
4	696	-17	289
5	783	60	3600
6	744	21	441
7	687	-36	1296
8	741	18	324
9	732	9	81
10	728	5	25
11	733	10	100
12	742	19	361
13	656	-67	4489
14	737	14	196
15	721	-2	4
16	717	-6	36
17	736	13	169
18	707	-16	256
19	737	14	196
20	707	-16	256

$\bar{x}$ =	723	σ =	26
2σ =	52	3σ =	78

20 Source-Count: Beta

Source ID: Tc 99 3935

Count	Gross Cts (x_i)	$(x_i)-(\bar{x})$	$[(x_i)-(\bar{x})]^2$
1	4683	-37	1369
2	4741	21	441
3	4826	106	11236
4	4718	-2	4
5	4775	55	3025
6	4751	31	961
7	4661	-59	3481
8	4677	-43	1849
9	4809	89	7921
10	4741	21	441
11	4736	16	256
12	4701	-19	361
13	4721	1	1
14	4686	-34	1156
15	4700	-20	400
16	4612	-108	11664
17	4767	47	2209
18	4623	-97	9409
19	4700	-20	400
20	4770	50	2500

$\bar{x}$ =	4720	σ =	56
2σ =	112	3σ =	168

Mean

$$\bar{x} = \frac{\sum x_i}{20}$$

Sigma

$$\sigma = \sqrt{\frac{\Sigma(x_i - \bar{x})^2}{(n-1)}}$$

Where:
- σ = standard deviation
- $\bar{x}$ = mean count
- x_i = each individual measurement
- n = number of measurements

Chi-squared

$$X^2 = \frac{\sum(n-\bar{n})^2}{\bar{n}}$$

Where
- n = data for individual counts
- $\bar{n}$ = average of the twenty data points

Alpha Values

mean +2 σ = 775	mean -2 σ = 671
mean +3 σ = 801	mean -3 σ = 645
X^2 = 17.2	

Beta Values

mean +3 σ = 4888	mean -2 σ = 4608
mean +2 σ = 4832	mean -3 σ = 4552
X^2 = 12.5	

Reviewed: _____ Date: 3-14-02

EFF.27

Daily Instrumentation Operational Check Sheet

Instrument: 2350-1 # 95359 Probe: 43-37 # 092503

Cal Due: 8-6-02 Cal Due: 8-6-02

Source ID: Tc99 3935 Mean Source Count Rate: 5308 Mean +2 σ Value: 5464 Mean -2 σ Value: 5152

Radiation Type: β⁻ Sigma Value: 78 Mean +3 σ Value: 5542 Mean -3 σ Value: 5076

Background					Source Check				Results	
Date	Time	Count Time (min)	Gross Counts	BKGD CPM	Count Time (min)	Gross Counts	W/I 2 σ Value	W/I 3 σ Value	LLD	SAT/ UNSAT
3-7-02	1724	—	—	—	1	5266	—	—	—	Sat.
3-8-02	1405	—	—	—	1	5292	—	—	—	Sat
3-11-02	0635	5	6137	1245	1	5346	✓	✓	186	Sat
3-12-02	0625	5	6303	1261	1	5282	✓	✓	184	Sat

EFF.207

Daily Instrumentation Operational Check Sheet

Instrument: 2350-1 # 95359 Probe: 43-37 # 092503

Cal Due: 8-6-02 Cal Due: 8-6-02

Source ID:	Mean Source Count Rate:	Mean +2 σ Value:	Mean -2 σ Value:
Th230 3937	729	783	675

Radiation Type:	Sigma Value:	Mean +3 σ Value:	Mean -3 σ Value:
α	27	810	648

Background					Source Check				Results	
Date	Time	Count Time (min)	Gross Counts	BKGD CPM	Count Time (min)	Gross Counts	W/I 2 σ Value	W/I 3 σ Value	LLD	SAT/ UNSAT
3-7-02	1722	—	—	—	1	759	—	—	—	Sat
3-8-02	1400	—	—	—	1	749	—	—	—	Sat
3-11-02	0635	5	82	16	1	774	✓	✓	23	sat
3-12-02	0625	5	49	10	1	776	✓	✓	19	sat

Daily Instrumentation Operational Check Sheet

EFF .27

Instrument: 2350-1 #95359 Probe: 43-37 # 092503

Cal Due: 8-6-02 Cal Due: 8-6-02

Source ID:	Mean Source Count Rate:	Mean +2 σ Value:	Mean -2 σ Value:
Tc 99 3935	5308	5464	5152 ~~5076~~ DW 2-23-02

Radiation Type:	Sigma Value:	Mean +3 σ Value:	Mean -3 σ Value:
β⁻	78	5542	5076

Background					Source Check				Results	
Date	Time	Count Time (min)	Gross Counts	BKGD CPM	Count Time (min)	Gross Counts	W/I 2 σ Value	W/I 3 σ Value	LLD	SAT/ UNSAT
2-25-02	0638	5	6317	1263	1	5328	✓	✓	184	~~SAT~~
2-25-02	1725	—	—	—	1	5342	✓	✓	—	Sat
2-26-02	0606	5	6433	1287	1	5306	✓	✓	185	~~SAT~~
2-26-02	1715	—	—	—	1	5404	—	—	—	WB
2-27-02	0605	5	6614	1323	1	5400	✓	✓	188	~~SAT~~
2-27-02	1700	✓	—	—	1	5403	—	—	—	Sat
2-28-02	0603	5	6409	1282	1	5313	✓	✓	185	~~SAT~~
3-1-02	0605	5	6586	1317	1	5396	✓	✓	188	~~SAT~~
3-1-02	1715	—	—	—	1	5307	—	—	—	Sat.
3-4-02	0620	5	6459	1292	1	5316	✓	✓	186	~~SAT~~
3-4-02	1715	—	—	—	1	5401	—	—	—	Sat.
3-5-02	0620	5	6483	1297	1	5360	✓	✓	186	~~SAT~~
3-6-02	0608	5	6249	1250	1	5361	✓	✓	183	~~SAT~~
3-6-02	1720	—	—	—	1	5243	—	—	—	Sat.
3-7-02	0625	5	6490	1294	1	5224	✓	✓	186	~~SAT~~
3-8-02	0644	5	6232	1246	1	5418	✓	✓	183	~~SAT~~

EFF .207

Daily Instrumentation Operational Check Sheet

Instrument: 2350-1 # 95359 Probe: 43-37 # 092503

Cal Due: 8-6-02 Cal Due: 8-6-02

Source ID:	Th230 3937	Mean Source Count Rate:	729	Mean +2 σ Value:	783	Mean -2 σ Value:	675
Radiation Type:	α	Sigma Value:	27	Mean +3 σ Value:	810	Mean -3 σ Value:	648

Background					Source Check				Results	
Date	Time	Count Time (min)	Gross Counts	BKGD CPM	Count Time (min)	Gross Counts	W/I 2 σ Value	W/I 3 σ Value	LLD	SAT/ UNSAT
2-25-02	0630	5	41	8	1	684	✓	✓	17	~~sat~~
2-25-02	1729	—	—	—	1	695	—	—	—	~~Sat~~
2-26-02	0606	5	52	10	1	720	✓	✓	19	~~sat~~
2-26-02	1720	—	—	—	1	#6716	—	—	—	~~Sat~~
2-27-02	0605	5	41	8	1	778	✓	✓	17	~~sat~~
2-27-02	1705	—	—	—	1	752	—	—	—	~~Sat~~
2-28-02	0603	5	55	11	1	714	✓	✓	20	~~sat~~
3-1-02	0605	5	50	10	1	777	✓	✓	19	~~sat~~
3-1-02	1715	—	—	—	1	777	—	—	—	~~sat.~~
3-4-02	0620	5	73	15	1	769	✓	✓	22	~~sat~~
3-4-02	1710	—	—	—	1	744	✓	✓	—	~~sat.~~
3-5-02	0620	5	59	12	1	762	✓	✓	20	~~sat~~
3-6-02	0608	5	53	11	1	763	✓	✓	20	~~sat~~
3-6-02	1720	—	—	—	1	741	—	—	—	~~sat.~~
3-7-02	0625	5	46	9.2	1	712	✓	✓	18	~~sat~~
3-8-02	0644	5	46	9.2	1	747	✓	✓	18	~~sat~~

DETERMINATION OF SOURCE QC LIMITS

Instrument: 2350-1 ID: 95359 Date: 2-23-02

Detector: 43-37 ID: 092503 Operating Voltage: 1350v/1800v

20 Source-Count: Alpha

Source ID: Th230 3937

Count	Gross Cts (x_i)	$(x_i)-(\bar{x})$	$[(x_i)-(\bar{x})]^2$
1	722	-7	49
2	745	16	256
3	739	10	100
4	800	71	5041
5	722	-7	49
6	689	-40	1600
7	768	39	1521
8	735	6	36
9	752	23	529
10	754	25	625
11	693	-36	1296
12	690	-39	1521
13	721	-8	64
14	711	-18	324
15	723	-6	36
16	729	0	0
17	723	-6	36
18	697	-32	1024
19	736	7	49
20	722	-7	49

$\bar{x}$ =	729	σ =	27
2σ =	54	3σ =	54

20 Source-Count: Beta

Source ID: Tc 99 3935

Count	Gross Cts (x_i)	$(x_i)-(\bar{x})$	$[(x_i)-(\bar{x})]^2$
1	5383	75	5625
2	5330	22	484
3	5376	68	4624
4	5370	62	3844
5	5400	92	8464
6	5292	-16	256
7	5421	113	12769
8	5293	-15	225
9	5280	-28	784
10	5243	-65	4225
11	5385	77	5929
12	5270	-38	1444
13	5268	-40	1600
14	5307	-1	1
15	5151	-157	24649
16	5299	-9	81
17	5291	-17	289
18	5122	-186	34596
19	5293	-15	225
20	5378	70	4900

$\bar{x}$ =	5308	σ =	78
2σ =	156	3σ =	234

Mean

$$\bar{x} = \frac{\sum x_i}{20}$$

Sigma

$$\sigma = \sqrt{\frac{\sum (x_i - \bar{x})^2}{(n-1)}}$$

Where.
- σ = standard deviation
- $\bar{x}$ = mean count
- x_i = each individual measurement
- n = number of measurements

Chi-squared

$$X^2 = \frac{\sum (n - \bar{n})^2}{\bar{n}}$$

Where.
- n = data for individual counts
- $\bar{n}$ = average of the twenty data points

Alpha Values

mean +2 σ =	783	mean -2 σ =	675
mean +3 σ =	810	mean -3 σ =	648
X^2 =	19		

Beta Values

5152

mean +3 σ =	5542	mean -2 σ =	~~5076~~ 5076 2-23-02
mean +2 σ =	5464	mean -3 σ =	~~5152~~ 5076 DW
X^2 =	22		

Reviewed: _____ Date: 3-14-02

EFF. 165

Daily Instrumentation Operational Check Sheet

Instrument: 2929 # 152202 Probe: 43-10 # 156519

Cal Due: 2-6-03 Cal Due: 2-6-03

Source ID: Tc99 3937 Mean Source Count Rate: 2630 Mean +2 σ Value: 2720 Mean -2 σ Value: 2540

Radiation Type: β^- Sigma Value: 45 Mean +3 σ Value: 2765 Mean -3 σ Value: 2495

Background					Source Check				Results	
Date	Time	Count Time (min)	Gross Counts	BKGD CPM	Count Time (min)	Gross Counts	W/I 2 σ Value	W/I 3 σ Value	LLD	SAT/ UNSAT
2-23-02	1310	50	2266	45	1	2656	✓	✓	34	SAT
2-25-02	0600	↑	2331	47	↑	2660	✓	✓	35	SAT
2-26-02	0603		2388	48		2621	✓	✓	35	SAT
2-27-02	0600		2212	44		2636	✓	✓	34	SAT
2-28-02	0600		2299	46		2562	✓	✓	35	SAT
3-1-02	0600		2251	45		2592	✓	✓	34	SAT
3-4-02	0600		2288	46		2652	✓	✓	35	SAT
3-5-02	0605		2143	44		2571	✓	✓	34	SAT
3-6-02	0605		2207	44		2581	✓	✓	34	SAT
3-7-02	0600		2247	45		2577	✓	✓	34	SAT
3-8-02	0615		2279	46		2564	✓	✓	35	SAT
3-11-02	0615		2245	45		2571	✓	✓	34	SAT
3-12-02	0812		2166	43		2559	✓	✓	34	SAT
3-13-02	0610		2278	46		2548	✓	✓	35	SAT
3-14-02	0615	↓	2250	45	↓	2680	✓	✓	34	SAT
		50			1					

EFF-344

Daily Instrumentation Operational Check Sheet

Instrument: 2929 # 152202 Probe: 43-10 # 156519

Cal Due: 2-6-03 Cal Due: 2-6-03

Source ID:	Th230 3435	Mean Source Count Rate:	1220	Mean +2 σ Value:	1304	Mean -2 σ Value:	1136
Radiation Type:	α	Sigma Value:	42	Mean +3 σ Value:	1346	Mean -3 σ Value:	1094

Background					Source Check				Results	
Date	Time	Count Time (min)	Gross Counts	BKGD CPM	Count Time (min)	Gross Counts	W/I 2 σ Value	W/I 3 σ Value	LLD	SAT/ UNSAT
2-23-02	1350	50	7	.14	1	1224	✓	✓	4	~~SAT~~
2-25-02	0600	↑	8	.16	↑	1273	✓	✓	5	~~SAT~~
2-26-02	0603		7	.14		1193	✓	✓	4	~~SAT~~
2-27-02	0600		9	.18		1202	✓	✓	5	~~SAT~~
2-28-02	0600		16	.32		1217	✓	✓	5	~~SAT~~
3-1-02	0600		9	.18		1195	✓	✓	5	~~SAT~~
3-4-02	0600		8	.16		1232	✓	✓	5	~~SAT~~
3-5-02	0605		7	.14		1206	✓	✓	4	~~SAT~~
3-6-02	0605		13	.26		1212	✓	✓	5	~~SAT~~
3-7-02	0600		7	.14		1176	✓	✓	4	~~SAT~~
3-8-02	0615		8	.16		1247	✓	✓	5	~~SAT~~
3-11-02	0615		6	.12		1282	✓	✓	4	~~SAT~~
3-12-02	0612		3	.06		1196	✓	✓	4	~~SAT~~
3-13-02	0610		14	.28		1229	✓	✓	5	~~SAT~~
3-14-02	0615	↓	8	.16	↓	1233	✓	✓	5	~~SAT~~
		50			1					

EFF .165

Daily Instrumentation Operational Check Sheet

Instrument: 2929 # 152202 Probe: 43-10-1 # 156519

Cal Due: 2-6-03 Cal Due: 2-6-03

Source ID:	Tc 99 3935	Mean Source Count Rate:	2688	Mean +2 σ Value:	2810.6	Mean -2 σ Value:	2565.4
Radiation Type:	β⁻	Sigma Value:	61.3	Mean +3 σ Value:	2871.9	Mean -3 σ Value:	2504.1

Background					Source Check				Results	
Date	Time	Count Time (min)	Gross Counts	BKGD CPM	Count Time (min)	Gross Counts	W/I 2 σ Value	W/I 3 σ Value	LLD	SAT/ UNSAT
2-13-02	0650	50	2203	44	1	2605	✓	✓	33	SAT
2-14-02	0604	50	2399	48	1	2668	✓	✓	35	SAT
2-15-02	0607	50	2345	48	1	2674	✓	✓	35	SAT
2-19-02	0600	50	2313	46	1	2668	✓	✓	35	SAT
2-19-02	0602	50	2371	47	1	2576	✓	✓	35	SAT
2-20-02	0610	50	2388	48	1	2728	✓	✓	35	SAT
2-21-02	0605	50	2404	48	1	2718	✓	✓	35	SAT
2-22-02	0600	50	2306	46	1	2579	✓	✓	35	SAT

EFF .344

Daily Instrumentation Operational Check Sheet

Instrument: 2929 # 152202 Probe: 43-10-1 # 156519

Cal Due: 2-6-03 Cal Due: 2-6-03

Source ID:	Mean Source Count Rate:	Mean +2 σ Value:	Mean -2 σ Value:
Th 230 3937	1258	1348	1168

Radiation Type:	Sigma Value:	Mean +3 σ Value:	Mean -3 σ Value:
∝	45	1393	1123

Background					Source Check				Results	
Date	Time	Count Time (min)	Gross Counts	BKGD CPM	Count Time (min)	Gross Counts	W/I 2 σ Value	W/I 3 σ Value	LLD	SAT/ UNSAT
2-13-02	0650	50	3	.06	1	1275	✓	✓	4	Sat
2-14-02	0604	50	9	.18	1	1255	✓	✓	4.7	Sat
2-15-02	0607	50	9	.18	1	1202	✓	✓	5	Sat
2-18-02	0604	50	8	.16	1	1187	✓	✓	5	Sat
2-19-02	0602	50	26	.5	1	1231	✓	✓	6	Sat
2-20-02	0610	50	6	.12	1	1205	✓	✓	4	Sat
2-21-02	0605	50	6	.12	1	1252	✓	✓	4	Sat
2-22-02	0606	50	7	.14	1	1222	✓	✓	4	Sat

DETERMINATION OF SOURCE QC LIMITS

Instrument: 2929 ID: 152202 Date: 2-22-02

Detector: 43-10 ID: 156519 Operating Voltage: 750

20 Source-Count: Alpha

Source ID: Th 230 3437

Count	Gross Cts (x_i)	$(x_i)-(\bar{x})$	$[(x_i)-(\bar{x})]^2$
1	1187	-33	1089
2	1206	-14	196
3	1296	76	5776
4	1299	27	729
5	1246	26	676
6	1212	-8	64
7	1175	-45	2025
8	1197	-23	529
9	1276	56	3136
10	1172	-48	2304
11	1308	88	7744
12	1197	-23	529
13	1219	-1	1
14	1217	-3	9
15	1205	-15	225
16	1196	-24	576
17	1267	47	2209
18	1225	5	25
19	1157	-63	3969
20	1185	-32	1024

$\bar{x}$ =	1220	σ =	42
2σ =	84	3σ =	126

20 Source-Count: Beta

Source ID: Tc 99 3935

Count	Gross Cts (x_i)	$(x_i)-(\bar{x})$	$[(x_i)-(\bar{x})]^2$
1	2627	-3	9
2	2614	-16	256
3	2660	30	900
4	2673	43	1849
5	2608	-22	484
6	2723	93	8649
7	2577	-53	2809
8	2616	-14	196
9	2610	-20	400
10	2680	50	2500
11	2542	-88	7744
12	2616	-14	196
13	2562	-68	4624
14	2627	-3	9
15	2595	-35	1225
16	2682	52	2704
17	2684	54	2916
18	2623	-7	49
19	2657	27	729
20	2635	5	25

$\bar{x}$ =	2630	σ =	45
2σ =	90	3σ =	135

Mean

$$\bar{x} = \frac{\sum x_i}{20}$$

Sigma

$$\sigma = \sqrt{\frac{\Sigma (x_i - \bar{x})^2}{(n-1)}}$$

Where
- σ = standard deviation
- $\bar{x}$ = mean count
- x_i = each individual measurement
- n = number of measurements

Chi-squared

$$X^2 = \frac{\sum (n-\bar{n})^2}{\bar{n}}$$

Where:
- n = data for individual counts
- $\bar{n}$ = average of the twenty data points

Alpha Values

mean +2 σ =	1304	mean -2 σ =	1136
mean +3 σ =	1346	mean -3 σ =	1094
X^2 =	26.9		

Beta Values

mean +3 σ =	2765	mean -2 σ =	2540
mean +2 σ =	2720	mean -3 σ =	2495
X^2 =	14.5		

Reviewed: _____ Date: 3-14-02

Daily Instrumentation Operational Check Sheet

, 134

Instrument: 2929 #115563 Probe: 43-10 #127216

Cal Due: 6-19-02 Cal Due: 6-19-02

Source ID:	Mean Source Count Rate:	Mean +2 σ Value:	Mean -2 σ Value:
Tc 99 3935	3872	3994	3750

Radiation Type:	Sigma Value:	Mean +3 σ Value:	Mean -3 σ Value:
β⁻	61	4055	3689

Background					Source Check				Results	
Date	Time	Count Time (min)	Gross Counts	BKGD CPM	Count Time (min)	Gross Counts	W/I 2 σ Value	W/I 3 σ Value	LLD	SAT/ UNSAT
1-23-02	1310	50	3503	70	1	3855	✓	✓	42	SAT
1-25-02	0600	↑	3542	71	↑	3750	✓	✓	42	SAT
1-26-02	0603		3505	70		3785	✓	✓	42	SAT
1-27-02	0600		3465	69		3754	✓	✓	42	SAT
1-28-02	0600		3500	70		3823	✓	✓	42	SAT
3-1-02	0600		3474	69		3774	✓	✓	42	SAT
3-4-02	0600		3433	69		3886	✓	✓	42	SAT
3-5-02	0605		3479	70		3815	✓	✓	42	SAT
3-6-02	0605		3533	71		3835	✓	✓	42	SAT
3-7-02	0600		3463	69		3780	✓	✓	42	SAT
3-8-02	0615		3534	71		3839	✓	✓	42	SAT
3-11-02	0615		3412	69		3783	✓	✓	42	SAT
3-12-02	0610		3433	69		3766	✓	✓	42	SAT
3-13-02	0610		3468	69		3794	✓	✓	42	SAT
3-14-02	0615	↓	3509	70	↓	3794	✓	✓	42	SAT
		50			1					

Daily Instrumentation Operational Check Sheet

.35

Instrument: 2929 SN 115563 Probe: 43-10 # 127216

Cal Due: 6-19-02 Cal Due: 6-19-02

Source ID: Th 230 3935 Mean Source Count Rate: 1411 Mean +2 σ Value: 1485 Mean -2 σ Value: 1337

Radiation Type: α Sigma Value: 37 Mean +3 σ Value: 1522 Mean -3 σ Value: 1300

Background					Source Check				Results	
Date	Time	Count Time (min)	Gross Counts	BKGD CPM	Count Time (min)	Gross Counts	W/I 2 σ Value	W/I 3 σ Value	LLD	SAT/ UNSAT
2-23-02	1310	50	8	.16	1	1377	✓	✓	5	~~SAT~~
2-25-02	0600	↑	9	.18	↑	1369	✓	✓	5	~~SAT~~
2-26-02	0603		5	.1		1457	✓	✓	4	~~SAT~~
2-27-02	0600		9	.18		1451	✓	✓	5	~~SAT~~
2-28-02	0600		7	.14		1435	✓	✓	4	~~SAT~~
3-1-02	0600		9	.18		1423	✓	✓	5	~~SAT~~
3-4-02	0600		11	.22		1395	✓	✓	5	~~SAT~~
3-5-02	0605		7	.14		1477	✓	✓	4	~~SAT~~
3-6-02	0605		11	.22		1408	✓	✓	5	~~SAT~~
3-7-02	0600		8	.16		1399	✓	✓	5	~~SAT~~
3-8-02	0615		7	.14		1365	✓	✓	4	~~SAT~~
3-11-02	0615		6	.12		1409	✓	✓	4	~~SAT~~
3-12-02	0610		9	.18		1407	✓	✓	5	~~SAT~~
3-13-02	0610		10	.2		1446	✓	✓	5	~~SAT~~
3-14-02	0615	↓	11	.22	↓	1453	✓	✓	5	~~SAT~~
		50			1					

EFF .239

Daily Instrumentation Operational Check Sheet

Instrument: 2929 # 115563 Probe: 43-10-1 # 127216

Cal Due: 6/19/02 Cal Due: 6/19/02

Source ID:	Tc 99 3935	Mean Source Count Rate:	3711	Mean +2 σ Value:	3826	Mean -2 σ Value:	3596
Radiation Type:	β⁻	Sigma Value:	57.5	Mean +3 σ Value:	3883.5	Mean -3 σ Value:	3538.5

Background					Source Check				Results	
Date	Time	Count Time (min)	Gross Counts	BKGD CPM	Count Time (min)	Gross Counts	W/I 2 σ Value	W/I 3 σ Value	~~LLD~~ LCD ~~MDA~~ DL	SAT/ UNSAT
2-13-02	0650	50	3370	67	1	3815	✓	✓	41	S
2-14-02	0602	50	3591	72	1	3696	✓	✓	43	S
2-15-02	0605	50	3570	71	1	3678	✓	✓	42	S
2-18-02	0600	50	3502	70	1	3637	✓	✓	42	S
2-19-02	0600	50	3519	70	1	3721	✓	✓	42	S
2-20-02	0610	50	3477	70	1	3758	✓	✓	42	S
2-21-02	0605	50	3463	69	1	3814	✓	✓	42	S

EFF .3508

Daily Instrumentation Operational Check Sheet

Instrument: 2929 # 115563 Probe: 43-10-1 # 127216

Cal Due: 6/19/02 Cal Due: 6-19-02

Source ID:	Mean Source Count Rate:	Mean +2 σ Value:	Mean -2 σ Value:
Th230 3937	1467	1562	1372

Radiation Type:	Sigma Value:	Mean +3 σ Value:	Mean -3 σ Value:
α	47	1609	1325

Background					Source Check				Results	
Date	Time	Count Time (min)	Gross Counts	BKGD CPM	Count Time (min)	Gross Counts	W/I 2 σ Value	W/I 3 σ Value	~~LLD~~ LLD ~~MDA~~	SAT/ UNSAT
2-13-02	0650	50	13	.26	1	1492	✓	✓	5	S
2-14-02	0602	50	10	.2	1	1415	✓	✓	5	S
2-15-02	0605	50	11	.2	1	1415	✓	✓	5	S
2-18-02	0600	50	9	.18	1	1505	✓	✓	5	S
2-19-02	0600	50	13	.26	1	1433	✓	✓	5	S
2-20-02	0610	50	12	.24	1	1490	✓	✓	5	S
2-21-02	0605	50	10	.2	1	1383	✓	✓	5	S

DETERMINATION OF SOURCE QC LIMITS

Instrument: 2929 ID: 115563 Date: 2-22-02

Detector: 43-10 ID: 127216 Operating Voltage: 1045

20 Source-Count: Alpha

Source ID: Th230 3937

Count	Gross Cts (x_i)	$(x_i)-(\bar{x})$	$[(x_i)-(\bar{x})]^2$
1	1424	13	169
2	1351	-60	3600
3	1426	15	225
4	1385	-26	676
5	1419	8	64
6	1423	12	144
7	1442	31	961
8	1420	9	81
9	1402	-9	81
10	1345	-66	4356
11	1447	36	1296
12	1367	-44	1936
13	1414	3	9
14	1439	28	784
15	1452	41	1681
16	1340	-71	5041
17	1438	27	729
18	1389	-22	484
19	1419	8	64
20	1476	65	4225

$\bar{x}$ =	1411	σ =	37
2σ =	74	3σ =	111

20 Source-Count: Beta

Source ID: Tc99 3935

Count	Gross Cts (x_i)	$(x_i)-(\bar{x})$	$[(x_i)-(\bar{x})]^2$
1	4045	173	29929
2	3853	-19	361
3	3909	37	1369
4	3900	28	784
5	3838	-34	1156
6	3870	-2	4
7	3862	-10	100
8	3904	32	1024
9	3796	-76	5776
10	3962	90	8100
11	3905	33	1089
12	3851	-21	441
13	3870	-2	4
14	3862	-10	100
15	3804	-68	4624
16	3850	-22	484
17	3910	38	1444
18	3835	-37	1369
19	3881	9	81
20	3958	114	12996

$\bar{x}$ =	3872	σ =	61
2σ =	122	3σ =	183

Mean

$$\bar{x} = \frac{\sum x_i}{20}$$

Sigma

$$\sigma = \sqrt{\frac{\Sigma(x_i - \bar{x})^2}{(n-1)}}$$

Where.
- σ = standard deviation
- $\bar{x}$ = mean count
- x_i = each individual measurement
- n = number of measurements

Chi-squared

$$X^2 = \frac{\sum(n-\bar{n})^2}{\bar{n}}$$

Where.
- n = data for individual counts
- $\bar{n}$ = average of the twenty data points

Alpha Values

mean +2 σ =	1485	mean -2 σ =	1337
mean +3 σ =	1522	mean -3 σ =	1300
X^2 =	18.8		

Beta Values

mean +3 σ =	4055	mean -2 σ =	3750
mean +2 σ =	3994	mean -3 σ =	3689
X^2 =	18.3		

Reviewed: _____ Date: 3.14.02

EFF. .248

Daily Instrumentation Operational Check Sheet

Instrument: 2350-1 #95356 Probe: 43-106 #133866

Cal Due: 8-6-02 Cal Due: 8-6-02

Source ID:	Tc99 3935	Mean Source Count Rate:	4972	Mean +2 σ Value:	5124	Mean -2 σ Value:	4820
Radiation Type:	β⁻	Sigma Value:	76	Mean +3 σ Value:	5200	Mean -3 σ Value:	4744

Background					Source Check				Results	
Date	Time	Count Time (min)	Gross Counts	BKGD CPM	Count Time (min)	Gross Counts	W/I 2 σ Value	W/I 3 σ Value	LLD	SAT/ UNSAT
2-23-02	1430	5	1822	364	1	4897	✓	✓	100	~~SAT~~
2-25-02	0635	5	1535	307	1	4832	✓	✓	92	~~SAT~~
2-26-02	0608	5	1636	327	1	4824	✓	✓	95	~~SAT~~
2-27-02	0607	5	1543	309	1	4830	✓	✓	92	~~SAT~~
2-27-02	1655	—	—	—	1	4911	✓	✓	—	Sat
2-28-02	0605	5	1582	316	1	4873	✓	✓	93	~~SAT~~
3-1-02	0607	5	1417	283	1	4902	✓	✓	88	~~SAT~~
3-1-02	1715	—	—	—	1	4846	—	—	—	Sat.
3-4-02	0624	5	1517	303	1	4832	✓	✓	91	~~SAT~~
3-4-02	1710	—	—	—	1	5050	—	—	—	Sat.
DW 3-5-02	~~0623~~	~~5~~	~~1494~~		1					
3-6-02			1695							

Daily Instrumentation Operational Check Sheet

EFF. .211

Instrument: 2350-1 #95356 Probe: 43-106 #133866

Cal Due: 8-6-02 Cal Due: 8-6-02

Source ID:	Mean Source Count Rate:	Mean +2 σ Value:	Mean -2 σ Value:
Th 230 3937	769	829	739

Radiation Type:	Sigma Value:	Mean +3 σ Value:	Mean -3 σ Value:
α	30	859	709

Background					Source Check				Results	
Date	Time	Count Time (min)	Gross Counts	BKGD CPM	Count Time (min)	Gross Counts	W/I 2 σ Value	W/I 3 σ Value	LLD	SAT/ UNSAT
2-23-02	1430	5	9	1.8	1	760	✓	✓	10	~~SAT~~
2-25-02	0635	5	11	2.2	1	760	✓	✓	10	~~SAT~~
2-26-02	0608	5	9	1.8	1	741	✓	✓	10	~~SAT~~
2-27-02	0607	5	5	1	1	742	✓	✓	8	~~SAT~~
2-27-02	1645	—	—	—	1	752	✓	✓	—	~~Sat~~
2-28-02	0608	5	1	.2	1	740	✓	✓	5	~~SAT~~
3-1-02	0607	5	7	1.4	1	744	✓	✓	9	~~SAT~~
3-1-02	1710	—	—	—	1	759	—	—	—	~~Sat~~
3-4-02	0624	5	12	2.4	1	752	✓	✓	10	~~SAT~~
3-4-02	1725	—	—	—	1	765	—	—	—	~~Sat.~~
~~3-5-02~~ PM 3-6-02	~~0623~~	~~5~~	~~2~~		1	744	✓	✓		
3-6-02	1430	5	14		1					

DETERMINATION OF SOURCE QC LIMITS

Instrument: 2350-1 ID: 95356 Date: 2-22-02

Detector: 43-106 ID: 133866 Operating Voltage: 1350α / 1800 β-

20 Source-Count: Alpha

Source ID: Th230 3937

Count	Gross Cts (x_i)	$(x_i)-(\bar{x})$	$[(x_i)-(\bar{x})]^2$
1	799	30	900
2	773	4	16
3	766	-3	9
4	747	-22	484
5	779	10	100
6	794	25	625
7	779	10	100
8	721	-48	2304
9	788	19	361
10	780	11	121
11	712	-57	3249
12	800	31	961
13	721	-48	2304
14	757	-12	144
15	795	26	676
16	803	34	1156
17	792	23	529
18	767	-2	4
19	782	13	169
20	716	-53	2809

$\bar{x}$ =	769	σ =	30
2σ =	60	3σ =	90

20 Source-Count: Beta

Source ID: Tc 99 3935

Count	Gross Cts (x_i)	$(x_i)-(\bar{x})$	$[(x_i)-(\bar{x})]^2$
1	4902	-70	4900
2	5006	34	1156
3	5033	61	3721
4	4982	10	100
5	4901	-71	5041
6	5065	93	8649
7	4995	23	529
8	4954	-18	324
9	4911	-61	3721
10	5160	188	35344
11	4832	-140	19600
12	4890	-82	6724
13	4948	-24	576
14	4966	-6	36
15	4934	-38	1444
16	4966	-6	36
17	4929	-43	1849
18	5094	122	14884
19	4961	-11	121
20	5019	47	2209

$\bar{x}$ =	4972	σ =	76
2σ =	152	3σ =	228

Mean	Sigma
$\bar{x} = \frac{\sum x_i}{20}$	$\sigma = \sqrt{\frac{\Sigma(x_i - \bar{x})^2}{(n-1)}}$

Where.
- σ = standard deviation
- $\bar{x}$ = mean count
- x_i = each individual measurement
- n = number of measurements

Chi-squared

$$X^2 = \frac{\sum(n-\bar{n})^2}{\bar{n}}$$

Where.
- n = data for individual counts
- $\bar{n}$ = average of the twenty data points

Alpha Values

mean +2 σ =	829	mean -2 σ =	739
mean +3 σ =	859	mean -3 σ =	709
X^2 =	22		

Beta Values

mean +3 σ =	5200	mean -2 σ =	4820
mean +2 σ =	5124	mean -3 σ =	4744
X^2 =	22.3		

Reviewed: _____ Date: 3-14-02

EFF .048

Daily Instrumentation Operational Check Sheet

Instrument: 2360 #145469 Probe: ~~43-40~~ 43-89 #145391
3-13-01

Cal Due: 7-10-02 Cal Due: 7-10-02

Source ID:	Mean Source Count Rate:	Mean +2 σ Value:	Mean -2 σ Value:
Tc 99 3935	1998	2104	1892

Radiation Type:	Sigma Value:	Mean +3 σ Value:	Mean -3 σ Value:
β⁻	53	2157	1839

Background					Source Check				Results	
Date	Time	Count Time (min)	Gross Counts	BKGD CPM	Count Time (min)	Gross Counts	W/I 2 σ Value	W/I 3 σ Value	LLD	SAT/ UNSAT
2-25-02	0611	5	1268	254	1	1962	✓	✓	84	~~SAT~~
2-25-02	1705	—	—	—	1	2031	—	←	—	Sat
2-26-02	0626	5	1133	227	1	2080	✓	✓	79	~~SAT~~
2-26-02	1655	—	—	—	1	1932	—	—	—	Sat
2-27-02	0635	5	1104	222	1	2033	✓	✓	79	~~SAT~~
2-27-02	1715	✓	—	—	1	2030	✓	—	✓	Sat
2-28-02	0630	5	1118	224	1	2024	✓	✓	79	~~SAT~~
2-28-02	1700	—	—	—	1	2044	✓	✓	—	Sat
3-1-02	0626	5	1015	219	1	1994	✓	✓	78	~~SAT~~
3-1-02	1700	—	—	—	1	1926	—	—	—	~~SAT~~
3-4-02	0614	5	1202	240	1	2066	✓	✓	82	~~SAT~~
3-5-02	0616	5	1229	246	1	2043	✓	✓	83	~~SAT~~
~~3-6-02~~	~~0622~~	~~5~~	~~1281~~		1					
			1281			1968				

RW 3-6-02

EFF .155

Daily Instrumentation Operational Check Sheet

Instrument: 2360 # 145469

Probe: ~~DP43-10~~ 43-89 # 145391
2-12-02

Cal Due: 7-10-02

Cal Due: 7-10-02

Source ID:	Mean Source Count Rate:	Mean +2 σ Value:	Mean -2 σ Value:
Th230 3937	684	740	628

Radiation Type:	Sigma Value:	Mean +3 σ Value:	Mean -3 σ Value:
α	28	768	600

Background					Source Check				Results	
Date	Time	Count Time (min)	Gross Counts	BKGD CPM	Count Time (min)	Gross Counts	W/I 2 σ Value	W/I 3 σ Value	LLD	SAT/ UNSAT
2-25-02	0611	5	9	1.8	1	734	✓	✓	10	~~SAT~~
2-25-02	1410	—	—	—	1	656	—	—	—	Sat
2-26-02	0626	5	12	2.4	1	652	✓	✓	11	~~SAT~~
2-26-02	1700	—	—	—	1	707	—	—	—	Sat
2-27-02	0635	5	10	2	1	637	✓	✓	10	~~SAT~~
2-27-02	1725	—	—	—	1	661	—	—	—	Sat
2-28-02	0630	5	7	1.4	1	614	✓	✓	9	~~SAT~~
2-28-02	1700	—	—	—	1	675	✓	✓	—	Sat
3-1-02	0626	5	17	3.4	1	715	✓	✓	12	~~SAT~~
3-1-02	1710	—	—	—	1	659	—	—	—	~~SAT~~
3-4-02	0614	5	24	4.8	1	661	✓	✓	14	~~SAT~~
3-5-02	0616	5	5	1	1	632	✓	✓	8	SAT
3-6-02	0622	5	2		1					
			8							

DETERMINATION OF SOURCE QC LIMITS

Instrument: 2360 ID: 145469 Date: 2-22-02

Detector: 43-89 ID: 145391 Operating Voltage: 675

20 Source-Count: Alpha

Source ID: Th230 3937

Count	Gross Cts (x_i)	$(x_i)-(\bar{x})$	$[(x_i)-(\bar{x})]^2$
1	655	-29	841
2	713	29	841
3	683	-1	1
4	668	-16	256
5	638	-46	2116
6	657	-27	729
7	694	10	100
8	696	12	144
9	706	22	484
10	706	22	484
11	657	-27	729
12	723	39	1521
13	637	-47	2209
14	688	4	16
15	715	31	961
16	653	-31	961
17	698	14	196
18	670	-14	196
19	723	39	1521
20	709	25	625

$\bar{x}$ =	684	σ =	28
2σ =	56	3σ =	84

20 Source-Count: Beta

Source ID: Tc 99 3935

Count	Gross Cts (x_i)	$(x_i)-(\bar{x})$	$[(x_i)-(\bar{x})]^2$
1	2014	16	256
2	1930	-68	4624
3	1952	-46	2116
4	2003	5	25
5	1985	-13	169
6	2025	27	729
7	1931	-67	4489
8	1973	-25	625
9	2093	95	9025
10	1985	-13	169
11	2071	73	5329
12	2002	4	16
13	1979	-19	361
14	1928	70	4900
15	2013	15	225
16	1962	-36	1296
17	2012	14	196
18	1988	-10	100
19	2132	134	17956
20	1986	-12	144

$\bar{x}$ =	1998	σ =	53
2σ =	106	3σ =	159

Mean

$$\bar{x} = \frac{\sum x_i}{20}$$

Sigma

$$\sigma = \sqrt{\frac{\Sigma(x_i - \bar{x})^2}{(n-1)}}$$

Where.
- σ = standard deviation
- $\bar{x}$ = mean count
- x_i = each individual measurement
- n = number of measurements

Chi-squared

$$X^2 = \frac{\sum(n-\bar{n})^2}{\bar{n}}$$

Where
- n = data for individual counts
- $\bar{n}$ = average of the twenty data points

Alpha Values

mean +2 σ = 740	mean -2 σ = 628
mean +3 σ = 768	mean -3 σ = 600
X^2 = 21.8	

Beta Values

mean +3 σ = 2157	mean -2 σ = 1892
mean +2 σ = 2104	mean -3 σ = 1839
X^2 = 26.4	

Reviewed: _____ Date 3-14-02

EFF .092

Daily Instrumentation Operational Check Sheet

Instrument: 2224-1 # 129463 Probe: 43-89 # 169230

Cal Due: 8-6-02 Cal Due: 8-6-02

Source ID:	Mean Source Count Rate:	Mean +2 σ Value:	Mean -2 σ Value:
Tc99 3935	1862	1958	1766

Radiation Type:	Sigma Value:	Mean +3 σ Value:	Mean -3 σ Value:
β-	48	2006	1718

Background					Source Check				Results	
Date	Time	Count Time (min)	Gross Counts	BKGD CPM	Count Time (min)	Gross Counts	W/I 2 σ Value	W/I 3 σ Value	LLD	SAT/ UNSAT
3-7-02	1710	—	—	—	1	1884	—	—	—	SAT
3-8-02	0622	5	1356	271	1	1881	✓	✓	87	SAT
3-11-02	0634	5	1387	277	1	1903	✓	✓	87	SAT
3-11-02	1710	—	—	—	1	1945	—	—	—	Sat
3-12-02	0618	5	1350	270	1	1910	✓	✓	87	SAT
3-12-02	1700	—	—	—	1	1905	—	—	—	Sat
3-13-02	0624	5	1328	266	1	1869	✓	✓	86	SAT
3-14-02	0624	5	1365	273	1	1926	✓	✓	87	SAT

EFF .154

Daily Instrumentation Operational Check Sheet

Instrument: 2224-1 # 129463 Probe: 43-89 # 169230

Cal Due: 5-6-02 Cal Due: 5-6-02

Source ID:	Mean Source Count Rate:	Mean +2 σ Value:	Mean -2 σ Value:
Th230 3537	705	751	659

Radiation Type:	Sigma Value:	Mean +3 σ Value:	Mean -3 σ Value:
α	23	774	636

Background					Source Check				Results	
Date	Time	Count Time (min)	Gross Counts	BKGD CPM	Count Time (min)	Gross Counts	W/I 2 σ Value	W/I 3 σ Value	LLD	SAT/ UNSAT
3-7-02	1708	—	—	—	1	687	—	—	—	Sat
3-8-02	0628	5	2	.4	1	694	✓	✓	6	~~Sat~~
3-11-02	0634	5	12	2.4	1	680	✓	✓	11	~~Sat~~
3-11-02	1210	—	—	—	1	695	—	—	—	Sat
3-12-02	0615	5	4	.8	1	616	✓	✓	7	~~Sat~~
3-12-02	1200	—	—	—	1	685	—	—	—	Sat
3-13-02	0624	5	4	.8	1	645	✓	✓	7	~~Sat~~
3-14-02	0624	5	8	1.6		703	✓	✓	9	~~Sat~~

EFF .092

Daily Instrumentation Operational Check Sheet

Instrument: 2224-1 # 129463 Probe: 43-89 # 169230

Cal Due: 8/6/02 Cal Due: 8/6/02

Source ID:	Mean Source Count Rate:	Mean +2 σ Value:	Mean -2 σ Value:
Tc 99 3935	1862	1957.2	1766.8

Radiation Type:	Sigma Value:	Mean +3 σ Value:	Mean -3 σ Value:
β	47.6	2004.8	1719.2

Background					Source Check				Results	
Date	Time	Count Time (min)	Gross Counts	BKGD CPM	Count Time (min)	Gross Counts	W/I 2 σ Value	W/I 3 σ Value	LLD	SAT/ UNSAT
2-14-02	0620	5	1390	278	1	1821	✓	✓	87	S
2-15-02	0615	5	1323	265	1	1846	✓	✓	86	S
2-15-02	1710	—	—	—	1	1916	✓	✓	—	Sat
2-18-02	0615	5	1350	270	1	1880	✓	✓	86	Sat
2-18-02	1710	—	—	—	1	1868	✓	—	—	Sat
2-19-02	0614	5	1247	249	1	1843	✓	✓	83	Sat
2-22-02	0610	5	1563	313	1	1837	✓	✓	70	Sat
2-25-02	0609	5	1346	269	1	1947	✓	✓	86	Sat
2-26-02	0624	5	1334	268	1	1912	—	✓	86	Sat
2-27-02	0631	5	1408	282	1	1900	✓	—	85	Sat
2-28-02	0617	5	1313	263	1	1861	✓	✓	95	Sat
3-1-02	0624	5	1268	254	1	1794	✓	✓	84	Sat
3-4-02	0612	5	1384	277	1	1957	✓	✓	87	Sat
3-5-02	0614	5	1305	261	1	1833	✓	✓	85	Sat
3-6-02	0630	5	1384	278	1	1946	✓	✓	87	Sat
3-7-02	0614	5	1367	273	1	1898	✓	✓	87	Sat

Daily Instrumentation Operational Check Sheet

EFF .154

Instrument: 2224-1 #129463 Probe: 43-89 169230

Cal Due: 8/6/02 Cal Due: 8/6/02

Source ID:	Mean Source Count Rate:	Mean +2 σ Value:	Mean -2 σ Value:
Th230 3937	705	750.6	659.4

Radiation Type:	Sigma Value:	Mean +3 σ Value:	Mean -3 σ Value:
α	22.8	773.4	636.6

Background					Source Check				Results	
Date	Time	Count Time (min)	Gross Counts	BKGD CPM	Count Time (min)	Gross Counts	W/I 2 σ Value	W/I 3 σ Value	LLD	SAT/ UNSAT
2-14-02	0610	5	18 ~~134~~	3.6	1	701	✓	✓	12	S
2-15-02	0615	5	2	.4	1	684	✓	✓	6	S
2-15-02	1715	—	—	—	1	727	✓	✓	—	Sat
2-18-02	0615	5	9	1.8	1	662	✓	✓	10	~~SAT~~
2-18-02	1705	—	—	—	1	714	✓	✓	—	Sat
2-19-02	0614	5	3	.6	1	667	✓	✓	7	~~SAT~~
2-22-02	0612	5	16	3.2	1	706	✓	✓	12	~~SAT~~
2-25-02	0609	5	3	.6	1	734	✓	✓	7	~~SAT~~
2-26-02	0624	5	1	.2	1	729	✓	✓	5	~~SAT~~
2-27-02	0631	5	8	1.6	1	701	✓	✓	9	~~SAT~~
2-28-02	0620	5	8	1.6	1	677	✓	✓	9	~~SAT~~
3-1-02	0614	5	6	1.2	1	696	✓	✓	8	~~SAT~~
3-4-02	0612	5	21	4.2	1	667	✓	✓	13	~~SAT~~
3-5-02	0614	5	8	1.6	1	692	✓	✓	9	~~SAT~~
3-6-02	0620	5	17	3.4	1	669	✓	✓	12	~~SAT~~
3-7-02	0614	5	7	1.4	1	671	✓	✓	9	~~SAT~~

DETERMINATION OF SOURCE QC LIMITS

Instrument: 2224-1 ID: 129463 Date: 2-12-02

Detector: 43-89 ID: 169230 Operating Voltage: 800

20 Source-Count: Alpha

Source ID: Th 230 3937

Count	Gross Cts (x_i)	$(x_i)-(\bar{x})$	$[(x_i)-(\bar{x})]^2$
1	714	9	81
2	737	32	1024
3	710	5	25
4	684	-21	441
5	717	12	144
6	705	0	0
7	725	20	400
8	677	-28	784
9	729	24	576
10	724	19	361
11	736	31	961
12	688	-17	289
13	650	-55	3025
14	723	18	324
15	685	-20	400
16	712	7	49
17	687	-18	324
18	713	8	64
19	701	-4	16
20	681	-24	576

$\bar{x}$ =	705	σ =	22.8
2σ =	45.6	3σ =	68.4

20 Source-Count: Beta

Source ID: Tc 99 3935

Count	Gross Cts (x_i)	$(x_i)-(\bar{x})$	$[(x_i)-(\bar{x})]^2$
1	1849	-13	169
2	1920	58	3364
3	1862	0	0
4	1869	7	49
5	1931	69	4761
6	1880	18	324
7	1818	-44	1936
8	1939	77	5929
9	1914	52	2704
10	1845	-17	289
11	1954	92	8464
12	1865	3	9
13	1812	-50	2500
14	1855	-7	49
15	1839	-23	529
16	1819	-43	1849
17	1829	-33	1089
18	1800	-62	3844
19	1846	-16	256
20	1792	-70	4900

$\bar{x}$ =	1862	σ =	47.6
2σ =	95.2	3σ =	142.8

Mean

$$\bar{x} = \frac{\sum x_i}{20}$$

Sigma

$$\sigma = \sqrt{\frac{\Sigma(x_i - \bar{x})^2}{(n-1)}}$$

Where
- σ = standard deviation
- $\bar{x}$ = mean count
- x_i = each individual measurement
- n = number of measurements

Chi-squared

$$X^2 = \frac{\sum(n-\bar{n})^2}{\bar{n}}$$

Where
- n = data for individual counts
- $\bar{n}$ = average of the twenty data points

Alpha Values

mean +2 σ =	750.6	mean -2 σ =	659.4
mean +3 σ =	773.4	mean -3 σ =	636.6
X^2 =	13.9		

Beta Values

mean +3 σ =	2004.8	mean -2 σ =	1766.8
mean +2 σ =	1957.2	mean -3 σ =	1719.2
X^2 =	23.1		

Reviewed: _____ Date: 3-14-02

EFF. 113

Daily Instrumentation Operational Check Sheet

Instrument: 13-60 # 164650 Probe: 43-89 # 1185-14

Cal Due: 7-9-02 Cal Due: 8-6-02

Source ID:	Mean Source Count Rate	Mean +2 σ Value	Mean -2 σ Value:
Tc 99 3935	2447	2535	2359

Radiation Type:	Sigma Value:	Mean +3 σ Value:	Mean -3 σ Value:
β⁻	44	2579	2315

Background					Source Check				Results	
Date	Time	Count Time (min)	Gross Counts	BKGD CPM	Count Time (min)	Gross Counts	W/I 2 σ Value	W/I 3 σ Value	LLD	SAT/ UNSAT
3-7-02	0617	5	1337	267	1	2518	✓	✓	86	~~SAT~~
3-7-02	1715	—	—	—	1	2489	—	—	—	SAT
3-8-02	0620	5	1359	272	1	2504	✓	✓	87	~~SAT~~
3-8-02	1425	—	—	—	1	2525	—	—	—	SAT
3-11-02	0630	5	1379	276	1	2528	✓	✓	87	SAT
3-12-02	0620	5	1354	271	1	2482	✓	✓	87	SAT
3-12-02	1706	—	—	—	1	2452	—	—	—	SAT
3-13-02	0622	5	1377	275	1	2499	✓	✓	87	SAT
3-14-02	0622	5	1386	277	1	2464	✓	✓	87	SAT

EFF. 164

Daily Instrumentation Operational Check Sheet

Instrument 2360 # 164680 Probe: 43-89 # 118544

Cal Due: 7-9-02 Cal Due: 8-6-02

Source ID: Th230 3437 Mean Source Count Rate: 731 Mean +2 σ Value: 789 Mean -2 σ Value: 673

Radiation Type: α Sigma Value: 29 Mean +3 σ Value: 818 Mean -3 σ Value: 644

Background					Source Check				Results	
Date	Time	Count Time (min)	Gross Counts	BKGD CPM	Count Time (min)	Gross Counts	W/I 2 σ Value	W/I 3 σ Value	LLD	SAT/ UNSAT
3-7-02	0612	5	11	2.2	1	721	✓	✓	10	SAT
3.7-02	1718	—	—	—	1	693	—	—	—	Sat.
3-8-02	0620	5	7	1.4	1	706	✓	✓	9	SAT
3-8-02	1425	—	—	—	1	760	—	—	—	SAT
3-11-02	0630	5	7	1.4	1	733	✓	✓	9	SAT
3-12-02	0620	5	9	1.8	1	775	✓	✓	10	SAT
3-12-02	1200	—	—	—	1	744	—	—	—	SAT
3-13-02	0632	5	16	3.2	1	774	✓	✓	12	SAT
3-14-02	0622	5	10	2	1	693	✓	✓	10	SAT

EFF .113

Daily Instrumentation Operational Check Sheet

Instrument: 23-60 ~~2929~~ DW #164680 Probe: 43-89 #115544

Cal Due. 7-9-02 Cal Due: 8-6-02

Source ID:	Mean Source Count Rate:	Mean +2 σ Value:	Mean -2 σ Value:
Tc 99 3935	2447	2535	2359

Radiation Type:	Sigma Value:	Mean +3 σ Value:	Mean -3 σ Value:
β⁻	44	2579	2315

Background					Source Check				Results	
Date	Time	Count Time (min)	Gross Counts	BKGD CPM	Count Time (min)	Gross Counts	W/I 2 σ Value	W/I 3 σ Value	LLD	SAT/ UNSAT
2-19-02	1145	5	1401	280	1	2423	✓	✓	89	~~SAT~~
2-20-02	0615	5	1294	259	1	2454	✓	✓	85	~~SAT~~
2-21-02	0615	5	1305	261	1	2465	✓	✓	85	~~SAT~~
2-22-02	0608	5	1403	281	1	2432	✓	✓	89	~~SAT~~
2-23-02	1700	—	—	—	1	2513	✓	✓	✓	~~SAT~~
2-25-02	0607	5	1405	281	1	2454	✓	✓	89	~~SAT~~
2-26-02	0620	5	1447	289	1	2470	✓	✓	89	~~SAT~~
2-26-02	1645	—	—	—	1	2474	✓	✓	✓	Sat
2-27-02	0627	5	1411	282	1	2517	✓	✓	89	~~SAT~~
2-28-02	0622	5	1358	272	1	2436	✓	✓	87	~~SAT~~
2-28-02	1700	—	[illegible]	—	1	2486	✓	✓	—	Sat
3-1-02	0621	5	1365	273	1	2429	✓	✓	87	~~SAT~~
3-4-02	0610	5	1476	295	1	2497	✓	✓	90	~~SAT~~
3-5-02	0612	5	1325	266	1	2475	✓	✓	86	~~SAT~~
3-5-02	1715	—	—	—	1	~~2490~~	—	—	—	
3-6-02	0617	5	1375	275	1	2398	✓	✓	87	~~SAT~~

EFF-164

Daily Instrumentation Operational Check Sheet

Instrument: 23-60 #16468c Probe: 43-54 #118.544

Cal Due: 7-9-02 Cal Due: 8-6-02

Source ID:	Mean Source Count Rate:	Mean +2 σ Value:	Mean -2 σ Value:
Th 230 3937	731	789	673

Radiation Type:	Sigma Value:	Mean +3 σ Value:	Mean -3 σ Value:
α	29	818	644

Background					Source Check				Results	
Date	Time	Count Time (min)	Gross Counts	BKGD CPM	Count Time (min)	Gross Counts	W/I 2 σ Value	W/I 3 σ Value	LLD	SAT/ UNSAT
2-19-02	1145	5	3	.6	1	772	✓	✓	7	~~SAT~~
2-20-02	0615	5	7	1.4	1	707	✓	✓	9	~~SAT~~
2-21-02	0615	5	6	1.2	1	706	✓	✓	8	~~SAT~~
2-22-02	0645	5	20	4	1	694	✓	✓	13	~~SAT~~
2-23-02	1700	—	—	—	1	706	✓	✓	✓	SAT
2-25-02	0607	5	5	1	1	736	✓	✓	8	~~SAT~~
2-26-02	0620	5	8	1.6	1	703	✓	✓	9	~~SAT~~
2-26-02	1649	—	—	—	1	691	—	—	—	Sat
2-27-02	0627	5	14	2.8	1	706	✓	✓	11	~~SAT~~
2-28-02	0622	5	13	2.6	1	770	✓	✓	11	~~SAT~~
2-28-02	1700	—	—	—	1	693	✓	✓	—	Sat
3-1-02	0621	5	10	2	1	734	✓	✓	10	~~SAT~~
3-4-02	0610	5	14	2.8	1	680	✓	✓	11	~~SAT~~
3-5-02	0612	5	16	3.2	1	719	✓	✓	12	~~SAT~~
3-5-02	1715	—	—	—	1	684	—	—	—	~~Sat~~
3-6-02	0617	5	11	2.2	1	710	✓	✓	10	~~SAT~~

DETERMINATION OF SOURCE QC LIMITS

Instrument: 23-60 ID: 164680 Date: 2-19-02

Detector: 43-89 ID: 118544 Operating Voltage: 900

20 Source-Count: Alpha			
Source ID. Th 230 3937			
Count	Gross Cts (x_i)	$(x_i)-(\bar{x})$	$[(x_i)-(\bar{x})]^2$
1	746	15	225
2	721	-10	100
3	681	-50	2500
4	727	-4	16
5	778	47	2209
6	726	-5	25
7	714	-17	289
8	685	-46	2116
9	678	-53	2809
10	723	-8	64
11	764	33	1089
12	753	22	484
13	759	28	784
14	700	-31	961
15	745	14	196
16	755	24	576
17	749	18	324
18	717	-14	196
19	770	39	1521
20	727	-4	16

$\bar{x}$ =	731	σ =	29
2σ =	58	3σ =	87

20 Source-Count: Beta			
Source ID: Tc 99 3935			
Count	Gross Cts (x_i)	$(x_i)-(\bar{x})$	$[(x_i)-(\bar{x})]^2$
1	2416	-31	961
2	2507	60	3600
3	2476	29	841
4	2424	-23	529
5	2481	34	1156
6	2496	49	2401
7	2502	55	3025
8	2440	-7	49
9	2462	15	225
10	2435	-12	144
11	2447	0	0
12	2460	13	169
13	2404	-43	1849
14	2375	-72	5184
15	2436	-11	121
16	2481	34	1156
17	2465	18	324
18	2499	52	2704
19	2392	-55	3025
20	2348	-99	9801

$\bar{x}$ =	2447	σ =	44
2σ =	88	3σ =	132

Mean

$$\bar{x} = \frac{\sum x_i}{20}$$

Sigma

$$\sigma = \sqrt{\frac{\Sigma(x_i - \bar{x})^2}{(n-1)}}$$

Where
- σ = standard deviation
- $\bar{x}$ = mean count
- x_i = each individual measurement
- n = number of measurements

Chi-squared

$$X^2 = \frac{\sum(n-\bar{n})^2}{\bar{n}}$$

Where
- n = data for individual counts
- $\bar{n}$ = average of the twenty data points

Alpha Values			
mean +2 σ =	789	mean -2 σ =	673
mean +3 σ =	818	mean -3 σ =	644
X^2 =	2.3		

Beta Values			
mean +3 σ =	2579	mean -2 σ =	2359
mean +2 σ =	2535	mean -3 σ =	2315
X^2 =	15		

Reviewed _____ Date. 3-14-02

EFF . 084

Daily Instrumentation Operational Check Sheet

Instrument: 2360 # 152321 Probe. 43-89 # 164832

Cal Due 8-15-02 Cal Due: 8-5-02

Source ID:	Mean Source Count Rate:	Mean +2 σ Value:	Mean -2 σ Value:
Tc 99 3935	2101	2171	2031

Radiation Type:	Sigma Value:	Mean +3 σ Value:	Mean -3 σ Value:
B⁻	35	2206	1996

Background					Source Check				Results	
Date	Time	Count Time (min)	Gross Counts	BKGD CPM	Count Time (min)	Gross Counts	W/I 2 σ Value	W/I 3 σ Value	LLD	SAT/ UNSAT
3-12-02	1200	—	—	—	1	2038	—	—	—	S
3-13-02	0620	5	1486	297	1	2051	✓	✓	91	S
3-13-02	1200	—	—	—	1	2073	✓	✓	✓	S
3-14-02	0620	5	1451	290	1	2088	✓	✓	89	S

EFF. 153

Daily Instrumentation Operational Check Sheet

Instrument: 2360 # 156371 Probe. 43-89 # 164832

Cal Due: 8-15-02 Cal Due: 8-5-02

Source ID:	Mean Source Count Rate:	Mean +2 σ Value:	Mean -2 σ Value:
TH 230 3932	695	753	637

Radiation Type:	Sigma Value:	Mean +3 σ Value:	Mean -3 σ Value:
α	29	782	608

Background					Source Check				Results	
Date	Time	Count Time (min)	Gross Counts	BKGD CPM	Count Time (min)	Gross Counts	W/I 2 σ Value	W/I 3 σ Value	LLD	SAT/ UNSAT
3-12-02	1200	—	—	—	1	652	✓	✓	—	~~SAT~~
3-13-02	0620	5	5	1	1	698	✓	✓	8	~~SAT~~
3-13-02	1720	"	—	—	1	735	"	"	"	Sat
3-14-02	0620	5	1	.2	1	730	✓	✓	5	~~SAT~~

EFF .153

Daily Instrumentation Operational Check Sheet

Instrument 2360 # 156371 Probe: 43-89 # 164832

Cal Due: 8-15-02 Cal Due: 8-5-02

Source ID:	Mean Source Count Rate.	Mean +2 σ Value:	Mean -2 σ Value:
Th 230 3937	695	753	637

Radiation Type:	Sigma Value:	Mean +3 σ Value:	Mean -3 σ Value:
α	29	782	608

Background					Source Check				Results	
Date	Time	Count Time (min)	Gross Counts	BKGD CPM	Count Time (min)	Gross Counts	W/I 2 σ Value	W/I 3 σ Value	LLD	SAT/ UNSAT
2-26-02	0930	5	1	.2	1	697	✓	✓	5	~~SAT~~
2-27-02	0625	5	8	1.6	1	708	✓	✓	5	~~SAT~~
2-28-02	0625	5	20	4	1	719	✓	✓	D.L.L 13	~~SAT~~
3-1-02	0610	5	7	1.4	1	640	✓	✓	5	~~SAT~~
3-1-02	1700	—	—	—	1	658	—	—	—	~~SAT~~
3-4-02	0605	5	14	2.8	1	714	✓	✓	11	~~SAT~~
3-5-02	0610	5	15	3	1	731	✓	✓	12	~~SAT~~
3-5-02	1700	—	—	—	1	739	—	—	—	~~SAT~~
3-6-02	0615	5	8	1.6	1	692	✓	✓	5	~~SAT~~
3-6-02	1730	—	—	—	1	640	—	—	—	~~SAT~~
3-7-02	0610	5	11	2.2	1	708	✓	✓	10	~~SAT~~
3-7-02	1705	—	—	—	1	675	—	—	—	Sat.
3-8-02	0618	5	5	1	1	681	✓	✓	8	~~SAT~~
3-8-02	1500	—	—	—	1	648	—	—	—	~~SAT~~
3-11-02	0630	5	12	2.4	1	720	✓	✓	11	~~SAT~~
3-12-02	0617	5	5	1	1	639	✓	✓	8	~~SAT~~

.FF .088

Daily Instrumentation Operational Check Sheet

Instrument: 2360 * 156371 Probe: 43-89 # 164832

Cal Due: 8-15-02 Cal Due: 8-5-02

Source ID:	Tc 99 3935	Mean Source Count Rate	2101	Mean +2 σ Value:	2171	Mean -2 σ Value:	2031
Radiation Type:	β⁻	Sigma Value.	35	Mean +3 σ Value:	2206	Mean -3 σ Value:	1996

Background					Source Check				Results	
Date	Time	Count Time (min)	Gross Counts	BKGD CPM	Count Time (min)	Gross Counts	W/I 2 σ Value	W/I 3 σ Value	LLD	SAT/ UNSAT
2-26-02	0930	5	1452	296	1	2150	✓	✓	90	SAT
2-27-02	0625	5	1190	298	1	2105	✓	✓	91	SAT
2-28-02	0620	5	1426	285	1	2087	✓	✓	89	SAT
3-1-02	0620	5	1418	284	1	2116	✓	✓	89	SAT
3-4-02	0608	5	1458	292	1	2057	✓	✓	90	SAT
3-5-02	0610	5	1477	295	1	2088	✓	✓	90	SAT
3-5-02	1700	—	—	—	1	2112	—	—	—	pat.
3-6-02	0615	5	1436	287	1	2084	✓	✓	89	SAT
3-6-02	1730	—	—	—	1	2189	—	—	—	pat.
3-7-02	0610	5	1449	290	1	2071	✓	✓	90	SAT
3-7-02	1700	—	—	—	1	2051	—	—	—	SAT
3-8-02	0615	5	1451	290	1	2056	✓	✓	89	SAT
3-8-02	1500	—	—	—	1	2035	—	—	—	pat.
3-11-02	0630	5	1473	295	1	2107	✓	✓	90	SAT
3-12-02	0617	5	1484	297	1	2071	✓	✓	90	SAT

DETERMINATION OF SOURCE QC LIMITS

Instrument: 2360 ID: 156371 Date: 2-26-02

Detector: 43-89 ID: 164832 Operating Voltage: 825

20 Source-Count: Alpha

Source ID: Th230 3937

Count	Gross Cts (x_i)	$(x_i)-(\bar{x})$	$[(x_i)-(\bar{x})]^2$
1	719	24	576
2	743	48	2304
3	643	-52	2704
4	716	21	441
5	713	18	324
6	689	-6	36
7	709	14	196
8	722	27	729
9	721	26	676
10	692	-3	9
11	672	-23	529
12	706	11	121
13	630	-65	4225
14	724	29	841
15	673	-22	484
16	652	-43	1849
17	699	4	16
18	688	-7	49
19	682	-13	169
20	700	5	25

$\bar{x}$ =	695	σ =	29
2σ =	58	3σ =	87

20 Source-Count: Beta

Source ID Tc 99 3935

Count	Gross Cts (x_i)	$(x_i)-(\bar{x})$	$[(x_i)-(\bar{x})]^2$
1	2111	10	100
2	2084	-17	289
3	2057	-44	1936
4	2076	-25	625
5	2116	15	225
6	2101	0	0
7	2053	-48	2304
8	2068	-33	1089
9	2118	17	289
10	2126	25	625
11	2172	71	5041
12	2115	14	196
13	2138	37	1369
14	2129	28	784
15	2078	-23	529
16	2089	-12	144
17	2144	43	1849
18	2064	37	1369
19	2024	-77	5929
20	2153	52	2704

$\bar{x}$ =	2101	σ =	35
2σ =	70	3σ =	105

Mean

$$\bar{x} = \frac{\sum x_i}{20}$$

Sigma

$$\sigma = \sqrt{\frac{\sum (x_i - \bar{x})^2}{(n-1)}}$$

Where
- σ = standard deviation
- $\bar{x}$ = mean count
- x_i = each individual measurement
- n = number of measurements

Chi-squared

$$X^2 = \frac{\sum (n-\bar{n})^2}{\bar{n}}$$

Where.
- n = data for individual counts
- $\bar{n}$ = average of the twenty data points

Alpha Values

mean +2 σ = 753	mean -2 σ = 637
mean +3 σ = 782	mean -3 σ = 608
X^2 = 23	

Beta Values

mean +3 σ = 2206	mean -2 σ = 2031
mean +2 σ = 2171	mean -3 σ = 1996
X^2 = 13	

Reviewed _____ Date: 3-14-02