April 20, 2011

Mr. John Hickman
Division of Waste Management
U.S. Nuclear Regulatory Commission
11545 Rockville Pike
MailStop: T-7E18
Rockville, MD 20852

SUBJECT: CONFIRMATORY SURVEY RESULTS FOR PORTIONS OF THE MATERIALS AND EQUIPMENT FROM UNITS 1 AND 2 AT THE HUMBOLDT BAY POWER PLANT, EUREKA, CALIFORNIA [DOCKET NO. 50-00133; RFTA NO. 11-003] DCN: 2029-SR-01-0

Dear Mr. Hickman:

The Oak Ridge Institute for Science and Education (ORISE) performed confirmatory radiological survey activities on portions of the materials and equipment designated for release and/or disposal from Units 1 and 2 at the Humboldt Bay Power Plant in Eureka, California during the period of November 15 through November 19, 2010. These survey activities were requested and approved by the U.S. Nuclear Regulatory Commission (NRC). Enclosed is the final report that summarizes ORISE's survey procedures and provides the results of the ORISE radiological survey activities. The survey activities included beta surface scans and beta direct measurements for surface activity.

If you have any questions, please direct them to me at my information listed below, Erika Bailey at 865.576.6659, or Tim Vitkus at 865.576.5073.

Sincerely,

Wade C. Adams
Health Physicist/Project Manager
Independent Environmental
Assessment and Verification

WCA:fr
Enclosure

c: T. Carter, NRC/FSME/DWMEP/DD/SP T-8F5
R. Evans, NRC Region IV
S. Nesmith, NRC/FSME/TWFN 8A23
G. Schlapper, NRC Region IV
File/2029

Electronic: E. Bailey, ORISE; S. Roberts, ORISE; T. Vitkus, ORISE; D. Herrera, ORISE





CONFIRMATORY SURVEY RESULTS FOR PORTIONS OF THE MATERIALS AND EQUIPMENT FROM UNITS 1 AND 2 AT THE HUMBOLDT BAY POWER PLANT EUREKA, CALIFORNIA

W. C. Adams

Prepared for the
U.S. Nuclear Regulatory Commission

ORISE

Oak Ridge Institute for Science and Education

ORISE
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

CONFIRMATORY SURVEY RESULTS FOR PORTIONS OF THE MATERIALS AND EQUIPMENT FROM UNITS 1 AND 2 AT THE HUMBOLDT BAY POWER PLANT EUREKA, CALIFORNIA

Prepared by

W. C. Adams

ORISE

Independent Environmental Assessment and Verification Program
Oak Ridge Institute for Science and Education
Oak Ridge, Tennessee 37831-0017

Prepared for the
U.S. Nuclear Regulatory Commission

FINAL REPORT

APRIL 2011

This report is based on work performed by the Oak Ridge Institute for Science and Education under contract number DE-AC05-06OR23100 with the Department of Energy.

Prepared by the Oak Ridge Institute for Science and Education, under interagency agreement (NRC FIN No. F1008) between the U.S. Nuclear Regulatory Commission and the U.S. Department of Energy.

ORISE
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

CONFIRMATORY SURVEY RESULTS FOR PORTIONS OF THE MATERIAL AND EQUIPMENT FROM UNITS 1 AND 2 AT THE HUMBOLDT BAY POWER PLANT EUREKA, CALIFORNIA

Prepared by: Wade C. Adams Date: 4/20/2011
W. C. Adams, Health Physicist/Project Manager
Independent Environmental Assessment and Verification

Reviewed by: Timothy J. Vitkus Date: 4/20/2011
T. J. Vitkus, IEAV Survey Operations Director
Independent Environmental Assessment and Verification

Reviewed by: Paige H. Benton Date: 4/20/2011
P. H. Benton, Quality Assurance Specialist
Independent Environmental Assessment and Verification

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS AND ACRONYMS

AEC	Atomic Energy Commission
AL	action level
BSI	Bartlett Services, Inc.
CFR	Code of Federal Regulations
cpm	counts per minute
Cs-137	cesium-137
dpm/100 cm^2	disintegrations per minute per one hundred square centimeters
DS	disposition survey
ESI	Enercon Services, Inc.
HBPP	Humboldt Bay Power Plant
HBRP	Humboldt Bay Repowering Project
IA	initial assessment
IEAV	Independent Environmental Assessment and Verification
ISFSI	Independent Spent Fuel Storage Installation
M&E	materials and equipment
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MARSAME	Multi-Agency Radiation Survey and Assessment of Materials and Equipment
MDC	minimum detectable concentration
MDCR	minimum detectable count rate
NI	non-impacted
NRC	U.S. Nuclear Regulatory Commission
ORAU	Oak Ridge Associated Universities
ORISE	Oak Ridge Institute for Science and Education
PG&E	Pacific Gas & Electric Company
PNL	Pacific Northwest Laboratory
RCA	radiological control area
RCRA	Resource Conservation and Recovery Act
ROC	radionuclides of concern
SAFSTOR	cold shutdown and safety storage
SU	survey unit
USEI	U.S. Ecology Idaho

CONFIRMATORY SURVEY RESULTS FOR PORTIONS OF THE MATERIAL AND EQUIPMENT FROM UNITS 1 AND 2 AT THE HUMBOLDT BAY POWER PLANT EUREKA, CALIFORNIA

1.0 INTRODUCTION AND SITE HISTORY

The Pacific Gas & Electric Company (PG&E) operated the Humboldt Bay Power Plant (HBPP) Unit 3 nuclear reactor near Eureka, California under Atomic Energy Commission (AEC) provisional license number DPR-7. HBPP Unit 3 achieved initial criticality in February 1963 and began commercial operations in August 1963. Unit 3 was a natural circulation boiling water reactor with a direct-cycle design. This design eliminated the need for heat transfer loops and large containment structures. Also, the pressure suppression containment design permitted below-ground construction. Stainless steel fuel claddings were used from startup until cladding failures resulted in plant system contamination—zircaloy-clad fuel was used exclusively starting in 1965 eliminating cladding-related contamination. A number of spills and gaseous releases were reported during operations resulting in a range of mitigative activities (see ESI 2008 for details).

In July 1973, Unit 3 was shut down for annual refueling and seismic modifications. However, by December 1980 it was concluded that completing the required upgrades and restarting Unit 3 would be cost prohibitive. PG&E decided in June 1983 to decommission Unit 3, received a possession-only license amendment, and placed the unit into cold shutdown and safety storage (SAFSTOR). Unit 3 is currently undergoing decommissioning. As part of the Humboldt Bay Repowering Project (HBRP), PG&E has built ten new fossil fuel units (16.3 MWe [megawatt electric] each) on the site in the vicinity of Unit 3.

Decommissioning activities have also begun on the adjacent fossil fuel Units 1 and 2. Currently, PG&E is planning to demolish Units 1 and 2 and seeks to dispose of the materials and equipment (M&E) that is generated during demolition of the Units 1 and 2 structures. The subject waste material consists of concrete, steel, insulation, roofing material, gravel, other metal, wood and soil debris generated during dismantlement activities. PG&E used a *Multi-Agency Radiation Survey and Assessment of Materials and Equipment* (MARSAME)-based method for determining M&E disposal paths (NRC 2009). The method consisted of beta radiation surface scans and limited direct beta activity measurements of M&E from Unit 1 and 2 structures. The preferred disposal method is for recycling if the surfaces of the M&E meet the disposition release criteria (PG&E 2010a). In the event that the M&E does not meet the release criteria for recycling, PG&E has requested approval from the U.S. Nuclear Regulatory Commission (NRC) for alternate disposal of approximately 200,000 cubic feet (ft^3) of hazardous waste containing low-activity radioactive debris, at the U.S. Ecology Idaho (USEI) Resource Conservation and Recovery Act (RCRA) facility in Grand View, Idaho (PG&E 2010b).

At the request of NRC's Headquarters and Region IV Offices, the Independent Environmental Assessment and Verification (IEAV) program of the Oak Ridge Institute for Science and Education (ORISE) performed confirmatory surveys of the M&E from Units 1 and 2 of the HBPP that will be released for recycling or disposed of as low-activity radioactive waste. Specifically, ORISE was tasked with verifying compliance with the licensee's 10 Code of Federal Regulations (CFR) Part 20.2002 exemption request that was approved by the NRC on November 2, 2010 (PG&E 2010b and NRC 2010). The survey activities were to be concurrent with the licensee's surveys and sampling. The NRC also tasked ORISE with reviewing the licensee's MARSAME data packages (BSI 2010).

2.0 SITE DESCRIPTION

The HBPP site, owned by PG&E, consists of 143 acres on the southern edge of Humboldt Bay four miles southwest of the town of Eureka, in Humboldt County, in the State of California (Figure A-1). PG&E maintains ten new operating electric generating units at the HBPP site (in the New Generation Footprint Area) that run on fossil fuels, two non-operating fossil fuel units (Units 1 and 2) and one non-operational nuclear unit (Unit 3). The controlled land that includes Unit 3 encompasses approximately 13 acres. Units 1 and 2 are interconnected with and west of Unit 3 (ESI 2008). The balance of the property includes mostly open areas and protected wetlands (Figure A-2).

An Independent Spent Fuel Storage Installation (ISFSI) has been constructed on-site for dry cask storage of the spent nuclear fuel and greater than Class C wastes. The spent nuclear fuel has been transferred to the ISFSI.

3.0 RADIONUCLIDES OF CONCERN

The radionuclides of concern (ROCs) for the HBRP are consistent with other nuclear reactors that have had fuel cladding failures. Since the reactor has not been in operation for the last 30 plus years, the radionuclides with half lives of 4.3 years or less have decayed to less than 99% of their original activities, as seven or more half-lives have elapsed during the 30-year shutdown period. Table 1 lists the primary ROCs for the site, noting the 1981 quantities are from Pacific Northwest Laboratory (PNL)-4628, *Residual Radionuclide Distribution and Inventory at the Humboldt Bay Nuclear Plant* (PNL 1983), and the projected 2008 levels that were based on radiological decay alone. The overall inventory focuses on the systems and surfaces in Unit 3 and associated buildings and does not focus on quantities in the reactor vessel and environs surrounding the power plant. Site-wide ROCs are therefore condensed in Table 1.

TABLE 1:
DECAY CORRECTED RADIONUCLIDE INVENTORY
HUMBOLDT BAY POWER PLANT
EUREKA, CALIFORNIA

Nuclide	Half-Life (years)	1981 Inventory (millicuries)[a]	2008 Inventory (millicuries)[b]	Soils ROC[c]	Comment[d]
H-3	12.3	unknown	unknown	N	Not a surface soils ROC
Fe-55	2.7	149,000	146	N	Reactor systems ROC only
Co-60	5.27	18,000	517	Y	Surface soil ROC
Cs-137	30.2	2,200	1,180	Y	Surface soil ROC
Ni-63	100	1,400	1,160	Y	Surface soil ROC
Mn-54	0.855	337	1.1 E-07	N	Decayed to de minimus levels
Sr-90	28.5	17.9	9.3	Y	Surface soil ROC
Am-241	432	12.1	11.6[e]	N	Not a surface soils ROC
Pu-238	87.7	7.0	5.7	N	Not a surface soils ROC
Pu-239/240	24,110	6.1	6.1	N	Not a surface soils ROC
Cm-244	18.1	4.9	1.7	N	Reactor systems ROC only

[a]1981 inventory based on data from Table 2-1 of ESI 2007.
[b]2008 inventory calculated by ORISE with time of decay being 27 years.
[c]ROC = radionuclide of concern.
[d]Medium/systems-specific comment based on input from Tables 2-1 and 2-2 of ESI 2007.
[e]The inventory of Am-241 does not account for the decay of Pu-241 to Am-241.

The M&E for Units 1 and 2 are outside the radiological control area (RCA) and most of the M&E are located outdoors where deposition of radioactive gaseous effluent from Unit 3 was a potential source of contamination. Characterization surveys were not performed on Units 1 and 2 M&E; however, volumetric samples during characterization surveys of Unit 3 M&E indicated that radioactivity above background levels was present on surfaces and consisted primarily of cesium-137 (Cs-137). Based on the MARSAME survey contractor's, Bartlett Services Inc. (BSI), initial assessment (IA) for each of the MARSAME data packages [survey units (SUs)] regarding the potential source of contamination, length of time since shutdown, and process knowledge, Cs-137 was selected as the primary ROC for M&E for Units 1 and 2 (BSI 2010).

4.0 CONFIRMATORY SURVEY OBJECTIVE

The objective of the confirmatory survey was to generate independent radiological data for use by the NRC in evaluating the adequacy and accuracy of the licensee's radiological surface activity results from the MARSAME data packages for M&E from Units 1 and 2. Data collected by ORISE and the licensee were reviewed to assess whether MARSAME-based waste lot classifications were appropriate (NRC 2009), and whether the reported surface activity results met the disposition release criteria presented in the MARSAME data packages. ORISE initially reviewed the licensee's MARSAME data packages. ORISE also verified the licensee's compliance with the 10 CFR 20.2002 exemption request (PG&E 2010b and NRC 2010).

5.0 DOCUMENT REVIEW

ORISE personnel reviewed the HBPP preliminary MARSAME radiological survey data packages prior to these confirmatory survey activities, as well as those data packages that were revised and re-submitted after ORISE demobilized from the site (BSI 2010). The objective of the reviews was to evaluate the technical processes and radiological survey techniques that were used to determine the disposition of M&E from Units 1 and 2. Comments addressing the technical issues within the data packages were submitted via electronic mail to the NRC and HBPP on January 17, 2011 (ORISE 2011a).

6.0 MARSAME CLASSIFICATION

The MARSAME disposition survey (DS) design classification process is similar to the classification in the *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) and is used to determine the level of survey effort for the disposition of the M&E (NRC 2000). However, in regards to MARSAME, the classification is based on estimated radionuclide concentrations or radioactivity relative to the action levels (ALs). The level of survey effort is linked to the potential to exceed a specified AL and a graded approach is used in the survey design. Impacted M&E with the highest potential to exceed ALs (i.e., Class 1) receive the greatest effort for the DS, while M&E with a lower potential to exceed the ALs (Classes 2 or 3) require less survey effort.

Therefore, some knowledge of the radionuclide concentrations is required before M&E can be classified. This information is generated from available historical data or process knowledge or generated by the performance of preliminary surveys. In the absence of information on the radionuclide concentrations, the default assumption is that all M&E is considered Class 1. PG&E is using the following MARSAME classifications:

- **Non-impacted (NI):** M&E that has no reasonable potential for radioactive concentration(s), or residual radioactivity, from site operations.
- **Impacted M&E:** M&E that may contain radioactive concentration(s), or residual radioactivity, from licensed operations. Impacted M&E include Class 1, 2, and 3 M&E.
    - **Class 1:** M&E that have, or had, the following: (1) highest potential for, or known, radionuclide concentration(s) about the AL(s); (2) highest potential for small areas of elevated radionuclide concentrations(s) or radioactivity; and (3) insufficient evidence to support classification as Class 2 or 3 M&E.
    - **Class 2:** M&E that have, or had, the following: (1) low potential for radionuclide concentration(s) or radioactivity above the AL(s); and (2) little or no potential for small areas of elevated radionuclide concentration(s) or radioactivity.
    - **Class 3:** M&E that have, or had, the following: (1) little or no potential for containing radionuclide concentration(s) or residual radioactivity above background; and, (2) insufficient evidence to support classification as non-impacted.

With one exception, the 19 MARSAME Survey Packages [SUs in Table 2] provided to ORISE were designated as either Class 3 or NI. The one exception was for miscellaneous material which may contain Class 1, Class 2, or Class 3 M&E. BSI, the MARSAME survey contractor, provided the following MARSAME Survey Packages (BSI 2010).

TABLE 2: MARSAME SURVEY PACKAGES HUMBOLDT BAY POWER PLANT EUREKA, CALIFORNIA			
Package #	**Class**	**Description**	**Additional Description**
HBPP-GN-001	3	Units 1 and 2 Generators	Units 1 and 2 Generators
			Units 1 and 2 Exciters
HBPP-TB-001	3	Units 1 and 2 Turbines	Turbines
HBPP-CS-001	3	Condensate System	Condensate System
HBPP-DWT-001	3	Distilled Water Tanks	Distilled Water Tanks
			Fire Water Tank
			Light Oil Tank
HBPP-EL-001	3	Electrical Components	Various Electrical Components
HBPP-FOT-001	3	Fuel Oil System	Storage Tank (1)
			Service Tanks (2)
HBPP-FW-001	3	Feedwater System	Feedwater Heaters (10)
			Feedwater Pumps (4)
HBPP-IS-001	3	Intake Structures	Circulating Water Pumps (4)
			Screen Wash Pumps (4)
			Smaller Pumps (6)
HBPP-LO-001	3	Lube Oil Systems	Lube Oil Tanks
HBPP-NG-001	3	Natural Gas Systems	Multiple Gas Lines
HBPP-SA-001	3	Station Air	Receiver Tanks (4)
HBPP-SS-001	3	Structural Steel	Various-Sized Steel
HBPP-PT-001	3	Propane Tank	NA
HBPP-BL-001	3	Boilers	NA
HBPP-MS-001	3	Main/Auxiliary Steam	Main Steam System
			Auxiliary Steam System
HBPP-TF-001	3	Units 1 and 2 Transformers	Transformers (2)
HBPP-VN-001	3	Ventilation System	Stacks (2)
HBPP-MEPP-001	NI	Mobile Electric Power Plants	MEPP Buildings
			Control Buildings
HBPP-MM-001	1, 2, 3	Miscellaneous Materials	Various Classifications

7.0 RADIOLOGICAL SURVEY PROCEDURES

ORISE personnel visited the HBPP property from November 15 through 19, 2010 to perform visual inspections and independent measurements and sampling. The confirmatory radiological survey activities were conducted in accordance with a project-specific plan, the ORISE Survey

Procedures Manual and the Oak Ridge Associated Universities (ORAU) Quality Program Manual (ORISE 2010 and 2008 and ORAU 2009).

ORISE judgmentally selected nine of the partially completed M&E SUs for confirmatory radiological surveys (Table B-1). In addition, the NRC site representative requested that ORISE perform radiological surveys on the concrete reactor shield plug from Unit 3 (Table B-2).

7.1 Reference System

Measurements and sampling locations were referenced to the existing HBPP M&E figures, maps, and/or pictures and documented on the figures and/or ORISE confirmatory survey activity data sheets.

7.2 Background Measurements

ORISE performed five shielded ambient background measurements at each SU location. A shielded background measurement was performed in an effort to simulate the ambient gamma background that would be present during beta surface scans on the M&E surfaces. ORISE also performed unshielded and shielded material-specific background measurements on unaffected metal and concrete surfaces in order to determine an appropriate material-specific beta background for metals and concrete surfaces.

7.3 Surface Scans

ORISE performed medium density (up to 50% scan coverage) beta radiation surface scans on the selected M&E MARSAME SUs focusing on locations where contamination may have concentrated during operations as well as other judgmentally selected locations based on site observations. With two exceptions, ORISE also performed scans on ten 1 m^2 areas within each SU and recorded the highest observed count rate in counts per minute (cpm) within the 1 m^2 areas. The location within each 1 m^2 area exhibiting the maximum count rate was selected for a quantitative direct measurement. ORISE performed scans on nine 1 m^2 areas in SU HBPP-NG-001 and eleven 1 m^2 areas in SU HBPP-MS-001. Beta radiation scans were performed using hand-held gas proportional detectors coupled to ratemeter-scalers with audible indicators. Locations of direct beta radiation that were possibly distinguishable from background were marked for further investigation. At the request of the NRC, ORISE performed alpha and beta scans on two sections of the concrete reactor shield plug which had been cut into eight sections. A total of five 1 m^2 areas were scanned on each of the sections.

7.4 SURFACE ACTIVITY MEASUREMENTS

A one-minute static beta count measurement was performed at the location that exhibited the highest beta scan count rates within each of the 1 m^2 scan areas within each SU. These surface activity measurement locations are indicated on the figures embedded in the data tables for each specific SU (Table B-1) and the reactor shield plug (Table B-2).

7.5 MARSAME DATA COMPARISON

ORISE performed side-by-side direct measurements with PG&E survey personnel within SU HBPP-SA-001. A total of ten surface activity measurements were performed by ORISE and BSI personnel on the Surface Air and Instrument Air tanks within Unit 1 M&E (Table B-3).

8.0 DATA INTERPRETATION

Data were returned to ORISE for interpretation. Beta and alpha surface activity measurement results were reported in units of disintegrations per minute per 100 square centimeters (dpm/100 cm^2). The data generated were compared against MARSAME data package results and the HBPP M&E action levels. Additional information regarding instrumentation and procedures may be found in Appendices C and D.

9.0 FINDINGS AND RESULTS

The results for each radiological survey procedure component are discussed below.

9.1 DOCUMENT REVIEW

HBPP preliminary MARSAME data package survey data were used to determine the statistical variables for calculating scan and static minimum detectable concentrations (MDC). However, per ORISE procedure, ORISE uses an index of sensitivity (*d'*) of 2.32, which represents a true positive detection rate of 95% and a false positive detection rate of 25%. ORISE reviewed the preliminary and several final versions of the MARSAME data packages that were provided for review. Minor comments were submitted either through electronic mail or during the closeout meeting at the end of the survey activities (ORISE 2011a). A remaining open action item is that to date, ORISE has not received requested information regarding the HBPP instrument calibration procedures and direct measurement calculation procedures for confirmatory reviews.

9.2 Surface Scans

ORISE, through the beta radiation surface scans, identified the location within each 1 m^2 area which exhibited the maximum beta radiation level. The maximum beta scan count rate within each 1 m^2 area is provided in the specific SU data table (Table B-1). The maximum beta scan count rate within each 1 m^2 area in each SU was compared with the Scan Action Level (Table B-1) value determined from the calculation of the scan minimum detectable count rate (Scan MDCR) plus the average ambient background for each SU. Results above the calculated Scan Action Level value indicated locations that potentially were above ambient background levels.

A summary of the Max Scan values are presented in Table 3.

TABLE 3:
MAXIMUM SCAN VALUE RANGES PER SURVEY UNIT
HUMBOLDT BAY POWER PLANT
EUREKA, CALIFORNIA

Survey Unit	Max Scan Range (cpm) within 1 m^2		Scan Action Level (cpm)
	Low	High	
HBPP-TB-001	160	380	415
HBPP-GN-001	220	320	415
HBPP-FW-001	210	360	415
HBPP-TF-001	140	430	422
HBPP-NG-001	190	420	486
HBPP-MS-001	210	450	486
HBPP-SA-001	100	300	362
HBPP-BL-001	260	540	416
HBPP-IS-001	250	500	349

9.3 Beta Direct Measurements

The summary data for the net beta activity direct measurements for the nine SUs are presented in Table 4; the individual net beta surface activity measurements for each direct measurement location are provided in Table B-1. At the request of the NRC site representative, ORISE also performed beta (and alpha) direct measurements on two of the reactor shield plug sections (Table B-2).

TABLE 4: NET BETA ACTIVITY VALUE RANGES PER SURVEY UNIT HUMBOLDT BAY POWER PLANT EUREKA, CALIFORNIA			
Survey Unit	Net Beta Activity Range (dpm/100 cm²)		Minimum Detectable Concentration
	Low	High	(dpm/100 cm²)
Confirmatory Survey Unit MARSAME Data Packages			
HBPP-TB-001	97	390	260
HBPP-GN-001	110	390	260
HBPP-FW-001	24	860	260
HBPP-TF-001	17	650	260
HBPP-NG-001	3	580	280
HBPP-MS-001	52	820	280
HBPP-SA-001	-130	130	230
HBPP-BL-001	-66	270	260
HBPP-IS-001	0	720	230
Reactor Shield Plug Beta Measurements			
HBPP-BP-09-081	240	15,000	160
HBPP-BP-09-079	160	17,000	160
Reactor Shield Plug Alpha Measurements			
HBPP-BP-09-081	0	60	64
HBPP-BP-09-079	-9	9	64

9.4 MARSAME DATA COMPARISON

ORISE received the requested comparison measurement data from the licensee's contractor for MARSAME data package HBPP-SA-001 (ORISE 2011b and BSI 2011). A comparison of the surface activity data identified a probable issue in the method that the HBPP uses to determine the appropriate background levels used in calculating net surface activity levels. The surface activity comparison data are presented in Table B-3. BSI collects an ambient background value by positioning their detector one meter from the surface of the SU M&E that was surveyed. However, as indicated in Table B-3, all of the surface activity cpm were less than their ambient background count value, which resulted in all the data being reported as negative values. Provided an appropriate background correction factor is used and the measurement population represents background conditions, then the data should have exhibited both a positive and negative distribution, with a mean approximating zero. The above factor, combined with field observations, determined that HBPP subtracts a background that does not account for the surveyed material shielding the ambient background level. Therefore, the background being subtracted is considered to be too high and results in a systematic measurement error bias.

ORISE took a different approach in determining background levels. Since the majority of the measurements on M&E were on metal surfaces, ORISE performed paired unshielded and shielded direct measurements on metal surfaces at five locations in an area unaffected by Unit 3 effluent releases. The shielded (gamma only) measurement was subtracted from the unshielded (beta and gamma) to yield a beta only measurement for each paired measurement location. The average beta only cpm background value was determined to be 13 cpm for metal surfaces. Likewise, ORISE performed paired unshielded and shielded surface activity measurements on M&E surfaces. Again, the shielded measurement was subtracted from the unshielded measurement to yield a beta only surface activity measurement in cpm. The metal beta background cpm value was then subtracted from the beta only surface activity value providing the beta only surface activity level in cpm. Dividing this value by the total efficiency and geometry yields the beta only surface activity value in units comparable to the HBPP action levels for M&E.

10.0 COMPARISON OF RESULTS WITH GUIDELINES

The detection requirements for release of M&E within the RCA from the HBPP are identified for the primary ROC, Cs-137, as 1,000 dpm/100 cm^2 for removable contamination and 5,000 dpm/100 cm^2 for total (fixed) contamination. ALs, determined for scans and static measurements, were calculated for each SU based on ambient backgrounds determined for each SU. All scans and static measurements for the nine confirmatory SUs met the M&E release criteria. As expected, static measurements for beta activity on the reactor shield plug exceeded the recycling release criteria.

11.0 SUMMARY

During the period of November 15 through 19, 2010, ORISE performed radiological confirmatory survey activities on a portion of the MARSAME M&E available for release at the Humboldt Bay Power Plant in Eureka, California. The confirmatory survey results are in agreement with the licensee's preliminary MARSAME data package survey results as far as demonstrating compliance with the approved release criteria for recycling. The reactor shield plug, which was not approved for recycling, did exhibit elevated beta radiation levels exceeding the recycling levels and is appropriately dispositioned for burial at USEI.

Although the ORISE and BSI surface activity data indicated that the M&E surfaces met the AL release criteria, there were fundamental differences in the determination of appropriate background levels used in the calculation of net total surface activity levels. It is ORISE's opinion that HBPP's contractor should provide technical justification for the use of ambient background measurements in the determination of total net surface activity levels at HBPP.

12.0 REFERENCES

Bartlett Services, Inc. (BSI). Humboldt Bay Power Plant, MARSAME "Survey Packages" (multiple data packages). Plymouth, Massachusetts; October 2010.

BSI. "Electronic Mail; RE: Measurement Data Comparison" from William Barley, (BSI) to Wade Adams (ORISE)." Oak Ridge, Tennessee; February 17, 2011.

Enercon Services, Inc. (ESI). "Site Characterization Plan – Humboldt Bay Power Plant." HBPP-PP-003, Rev. 0; July 16, 2007.

ESI. "Historical Site Assessment," prepared for the Humboldt Bay Power Plant Pacific Gas & Electric Company, Eureka, California, Draft; September 2008.

NRC. "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)," NUREG-1575; Revision 1. Washington, DC; August 2000.

NRC. "Multi-Agency Radiation Survey and Assessment of Materials and Equipment Manual (MARSAME)," NUREG-1575; Supp. 1. Washington, DC; January 2009.

NRC. "Humboldt Bay Power Plant Unit 3 – Request for 10 CFR 20.2002 Alternate Disposal Approval and 10 CFR 30.11 Exemption for Plant Waste Disposal at US Ecology Idaho (TAC No. J00369)." Washington, DC; November 2, 2010.

Oak Ridge Associated Universities (ORAU). "ORAU/ORISE Health & Safety Manual." Oak Ridge, Tennessee; April 2, 2008.

ORAU. "Quality Program Manual for the Independent Environmental Assessment and Verification Program." Oak Ridge, Tennessee; June 30, 2009.

Oak Ridge Institute for Science and Education (ORISE). "Survey Procedures Manual for the Independent Environmental Assessment and Verification Program." Oak Ridge, Tennessee; May 1, 2008.

ORISE. "Project-Specific Plan for the Confirmatory Survey of Materials and Equipment from Units 1, 2 and 3 at the Humboldt Bay Power Plant, Eureka, California." Docket No. 50-00133; RFTA No. 11-003. DCN: 2029-PL-01-0.. Oak Ridge, Tennessee; November 12, 2010.

ORISE. "Electronic Mail; RE: Humboldt Bay MARSAME Data Packages" from Wade Adams (ORISE) to William Barley, et. al.(BSI)". Oak Ridge, Tennessee; January 17, 2011a.

ORISE. "Electronic Mail; RE: Measurement Data Comparison" from Wade Adams (ORISE) to William Barley, et. al.(BSI)". Oak Ridge, Tennessee; February 16, 2011b.

Pacific Gas & Electric Company (PG&E). "MARSAME Disposition of Materials and Equipment"; RCP-6Q, Revision 0. Eureka, California; March 15, 2010a.

PG&E. "Revision to Request for 10 CFR 20.2002 Alternate Disposal Approval and 10 CFR 30.11 Exemption of Humboldt Bay Power Plant Waste for Disposal at US Ecology Idaho." Eureka, California; August 12, 2010b.

Pacific Northwest Laboratory (PNL). "Residual Radionuclide Distribution and Inventory at the Humboldt Bay Nuclear Plant," (PNL-4628); May 1983.

APPENDIX A
FIGURES

Figure A-1: Map Indicating Location of the Humboldt Bay Power Plant in Eureka, California

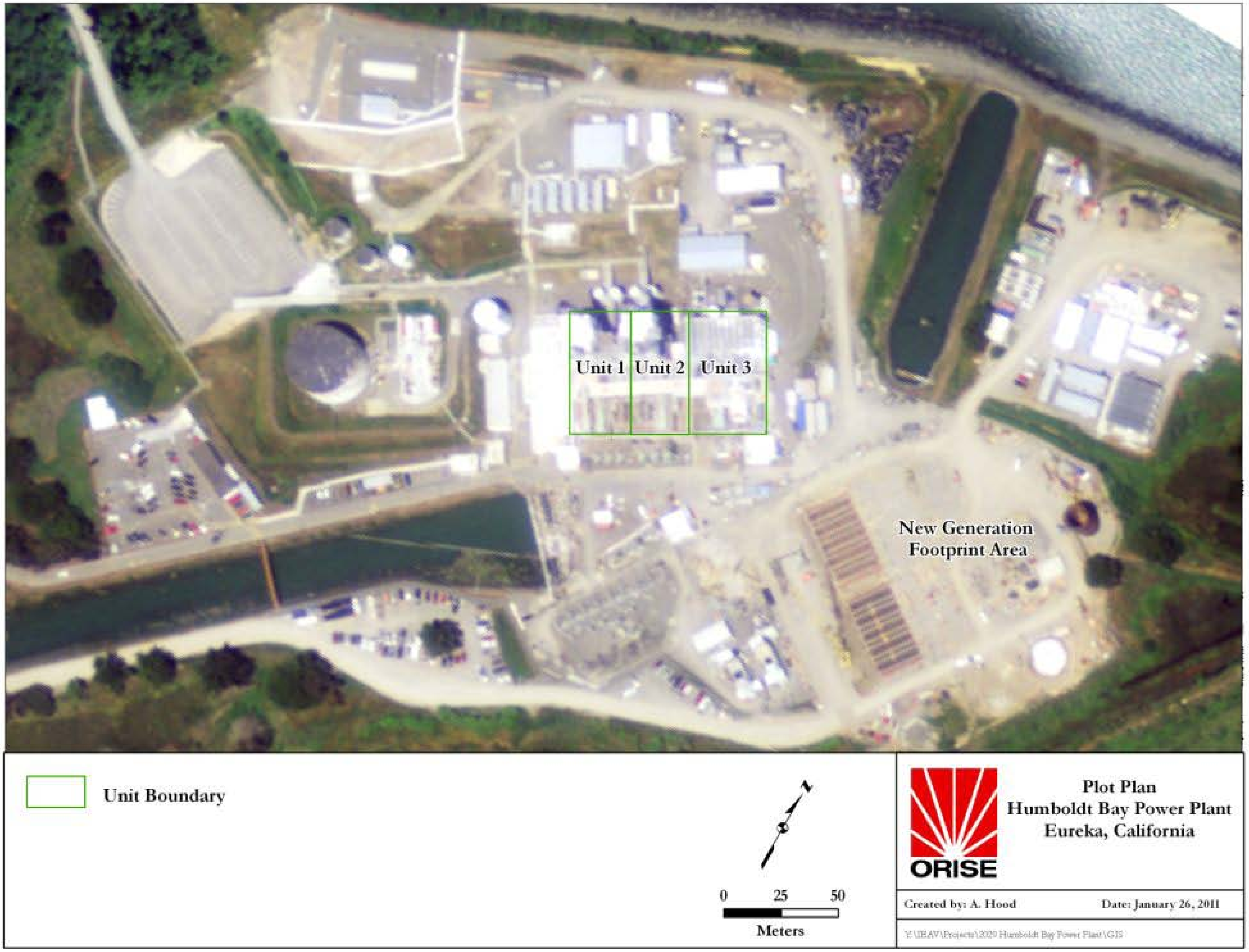


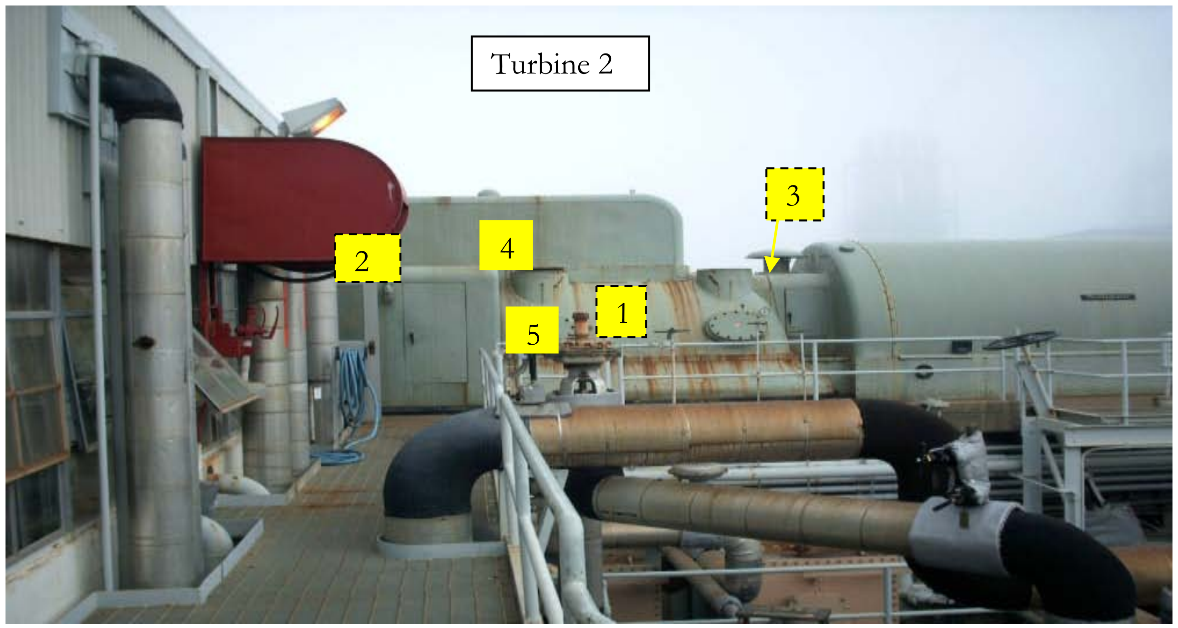
Figure A-2: Plot Plan of the Humboldt Bay Power Plant Indicating Units 1, 2 and 3

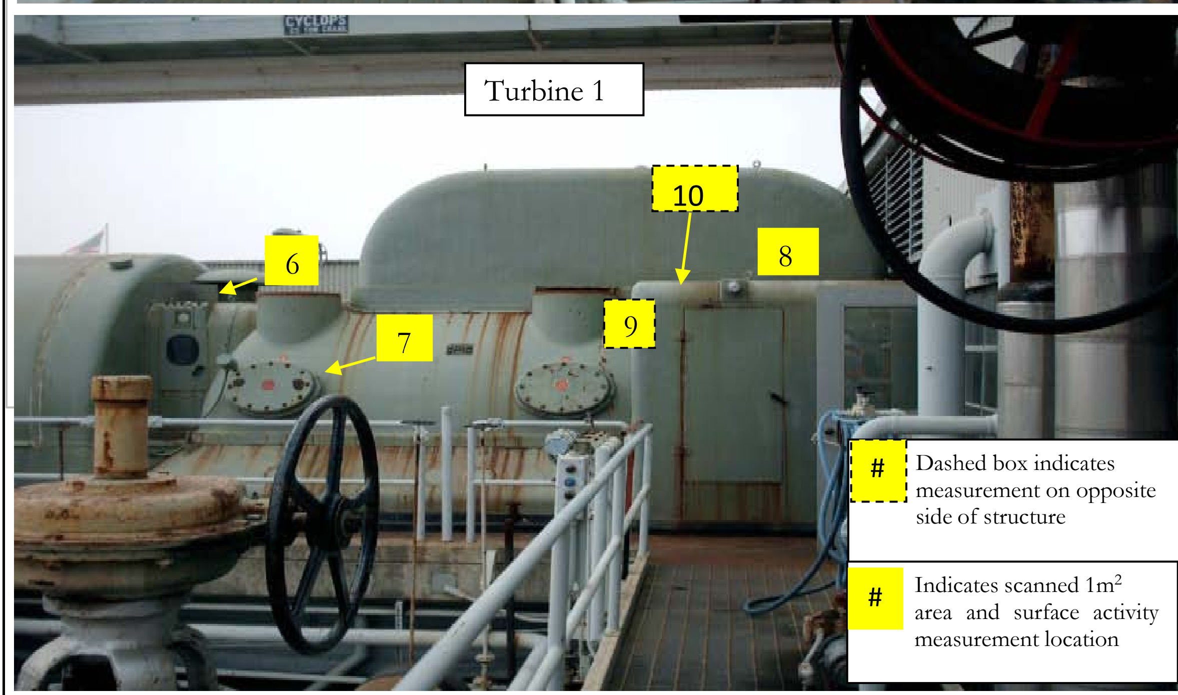
APPENDIX B
TABLES

TABLE B-1:
ORISE CONFIRMATORY SURVEYS OF HBPP MARSAME SURVEY UNITS
HUMBOLDT BAY POWER PLANT, EUREKA, CALIFORNIA

MARSAME Survey Package	HBPP-TB-001
DESCRIPTION	Turbines
SURVEY UNIT	Units 1 and 2 Turbines

Action Levels				
Recycling Action Level (dpm/100 cm^2)			Burial Action Level	
Cs-137	Total	5,000	(pCi/g)	(dpm/100 cm^2)
	Removable	1,000	15	16,600





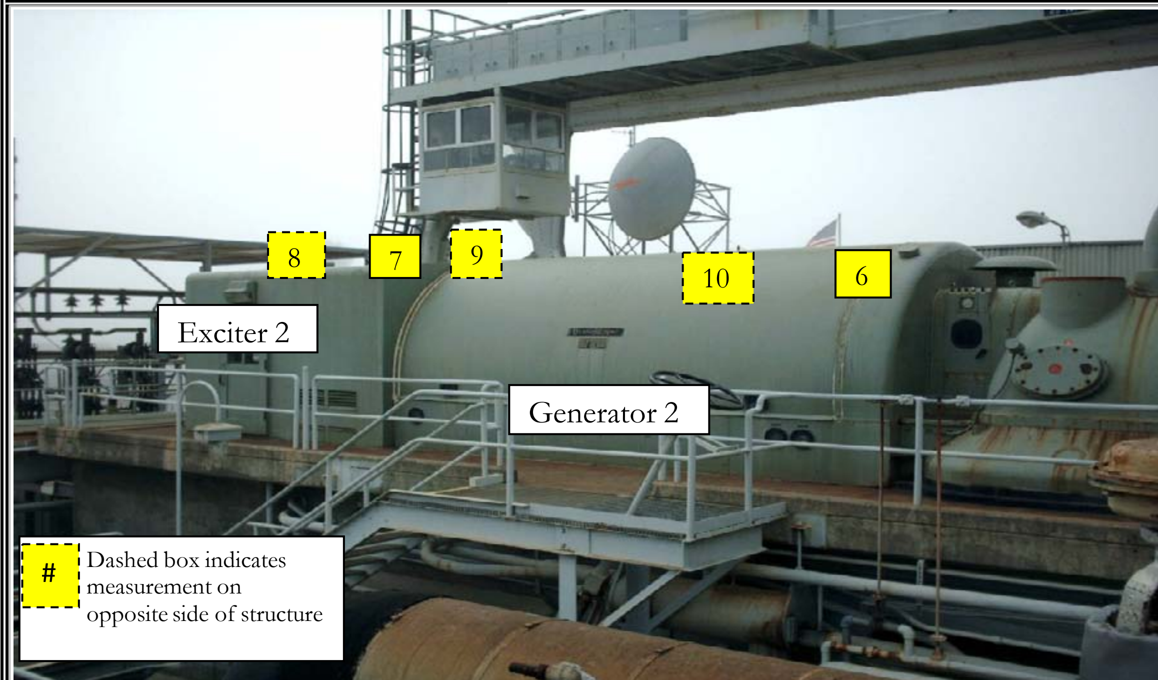
#	Dashed box indicates measurement on opposite side of structure
#	Indicates scanned 1m^2 area and surface activity measurement location

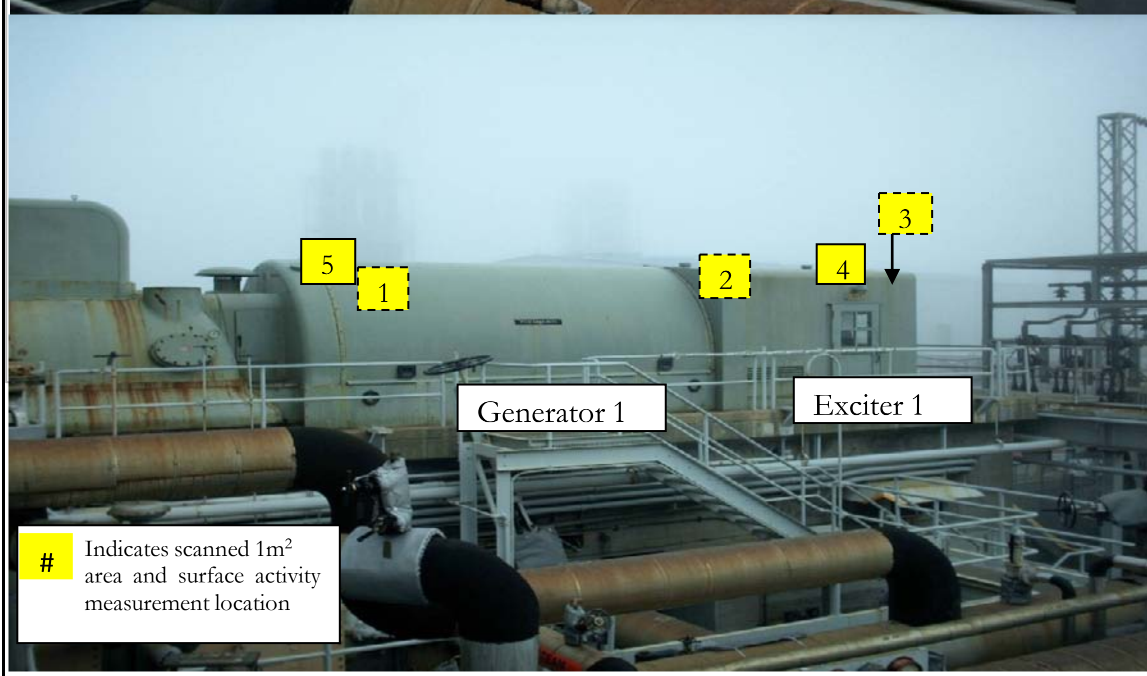
Scan Location (1 m^2)	Max Scan (cpm)	Unshielded (cpm)	Shielded (cpm)	Net Beta Activity (dpm/100 cm2)
Turbine 2				
1	160	211	157	140
2	190	283	178	320
3	250	231	151	230
4	380	331	204	390
5	240	226	153	210
Turbine 1				
6	250	215	129	250
7	210	175	114	170
8	330	265	192	210
9	310	241	182	160
10	280	218	177	97

Ambient BKG Measurements		Instrument Efficiency		Other Data
Location:	Shielded	Static Efficiency		Mat.-Spec.Beta BKG
Count	cpm	ε_i =	0.46	13
1	228	ε_s =	0.5	**Scan MDCR**
2	196	ε_t =	0.23	181 cpm
3	233	**Scan Efficiency**		**Scan Action Level**
4	233	ε_i =	0.3	415 cpm
5	279	ε_s =	0.5	**Scan MDC**
Average	234	ε_t =	0.15	1708 dpm/100 cm^2

TABLE B-1:
ORISE CONFIRMATORY SURVEYS OF HBPP MARSAME SURVEY UNITS
HUMBOLDT BAY POWER PLANT, EUREKA, CALIFORNIA

MARSAME Survey Package	**HBPP-GN-001**
DESCRIPTION	Generators and Exciters
SURVEY UNIT	Units 1 and 2 Generators



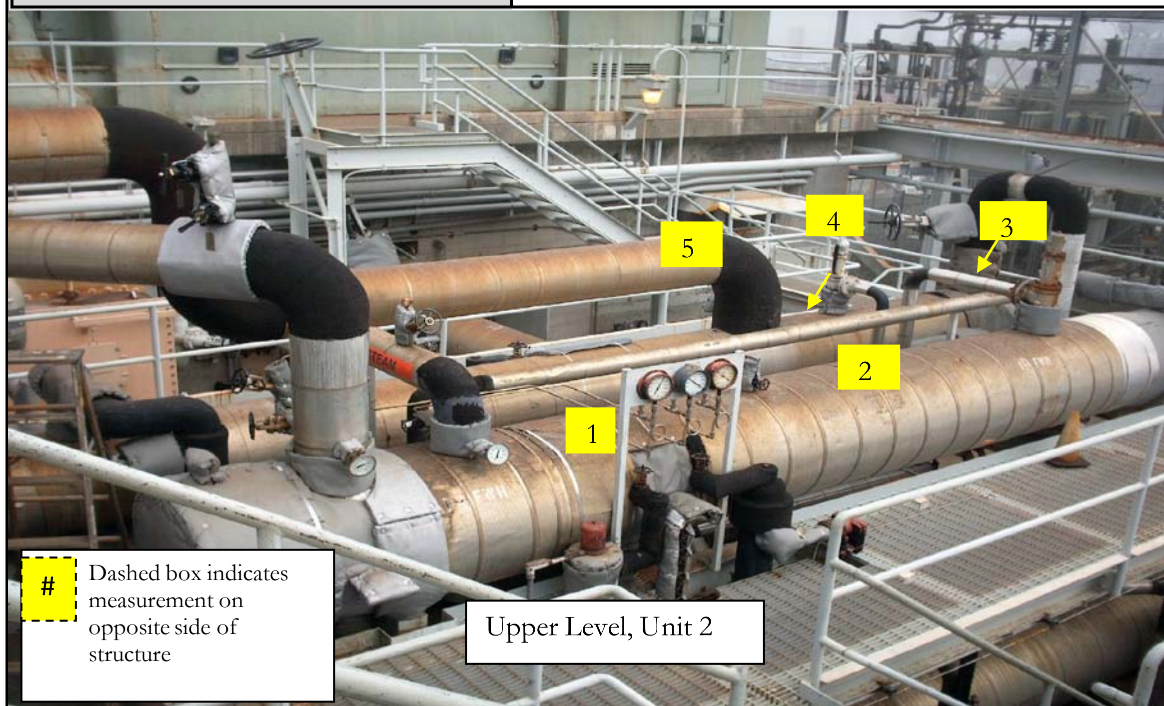


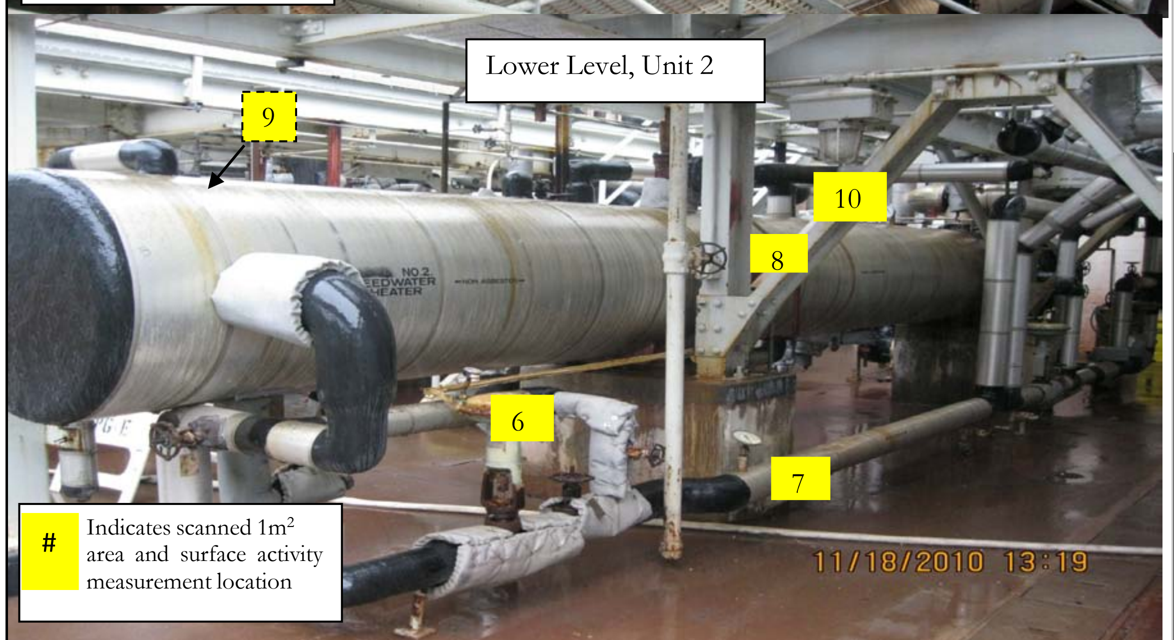
Action Levels				
Recycling Action Level (dpm/100 cm^2)			**Burial Action Level**	
Cs-137	Total	5,000	(pCi/g)	(dpm/100 cm^2)
	Removable	1,000	15	16,600
Scan Location (1 m^2)	**Max Scan (cpm)**	**Unshielded (cpm)**	**Shielded (cpm)**	**Net Beta Activity (dpm/100 cm2)**
Unit 2 Generator and Exciter				
1	220	198	134	180
2	260	253	183	200
3	230	278	162	360
4	270	238	192	110
5	240	218	171	120
Unit 1 Generator and Exciter				
6	320	230	184	110
7	320	260	185	210
8	250	269	143	390
9	250	238	165	210
10	230	217	155	170

Ambient BKG Measurements		**Instrument Efficiency**		**Other Data**
Location:	**Shielded**	**Static Efficiency**		**Mat.-Spec.Beta BKG**
Count	**cpm**	ε_i =	0.46	13
1	228	ε_s =	0.5	**Scan MDCR**
2	196	ε_t =	0.23	181 cpm
3	233	**Scan Efficiency**		**Scan Action Level**
4	233	ε_i =	0.3	415 cpm
5	279	ε_s =	0.5	**Scan MDC**
Average	234	ε_t =	0.15	1708 dpm/100 cm^2

TABLE B-1:
ORISE CONFIRMATORY SURVEYS OF HBPP MARSAME SURVEY UNITS
HUMBOLDT BAY POWER PLANT, EUREKA, CALIFORNIA

MARSAME Survey Package	HBPP-FW-001
DESCRIPTION	Feedwater System, Unit 2
SURVEY UNIT	Feedwater System





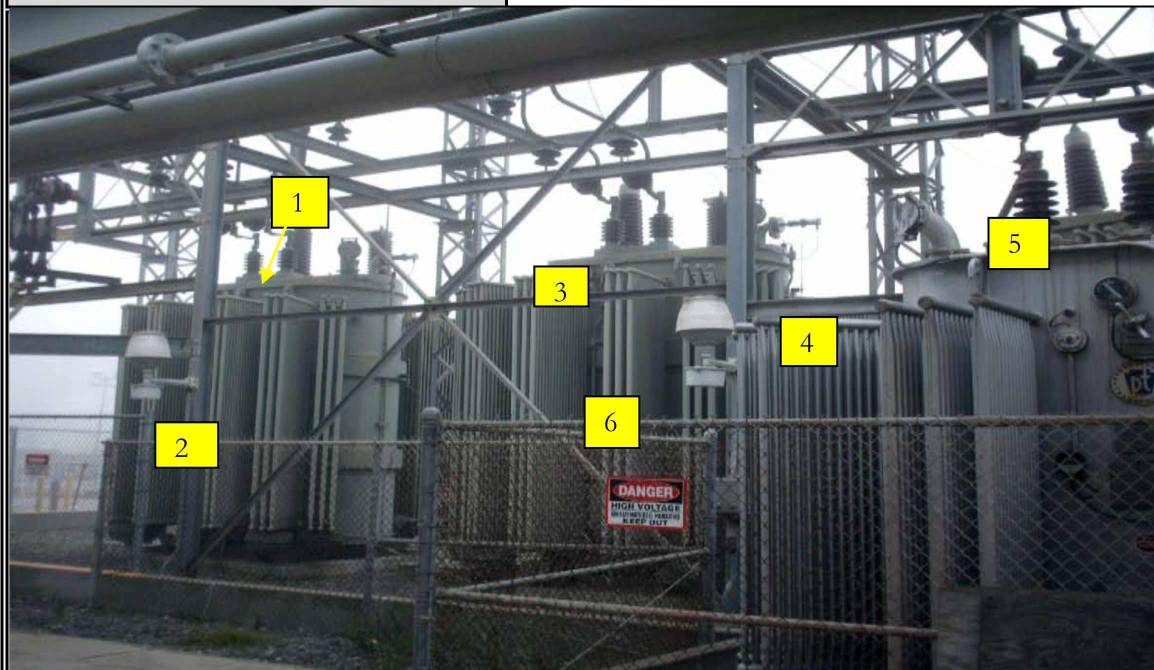
Action Levels				
Recycling Action Level (dpm/100 cm^2)			Burial Action Level	
Cs-137	Total	5,000	(pCi/g)	(dpm/100 cm^2)
	Removable	1,000	15	16,600

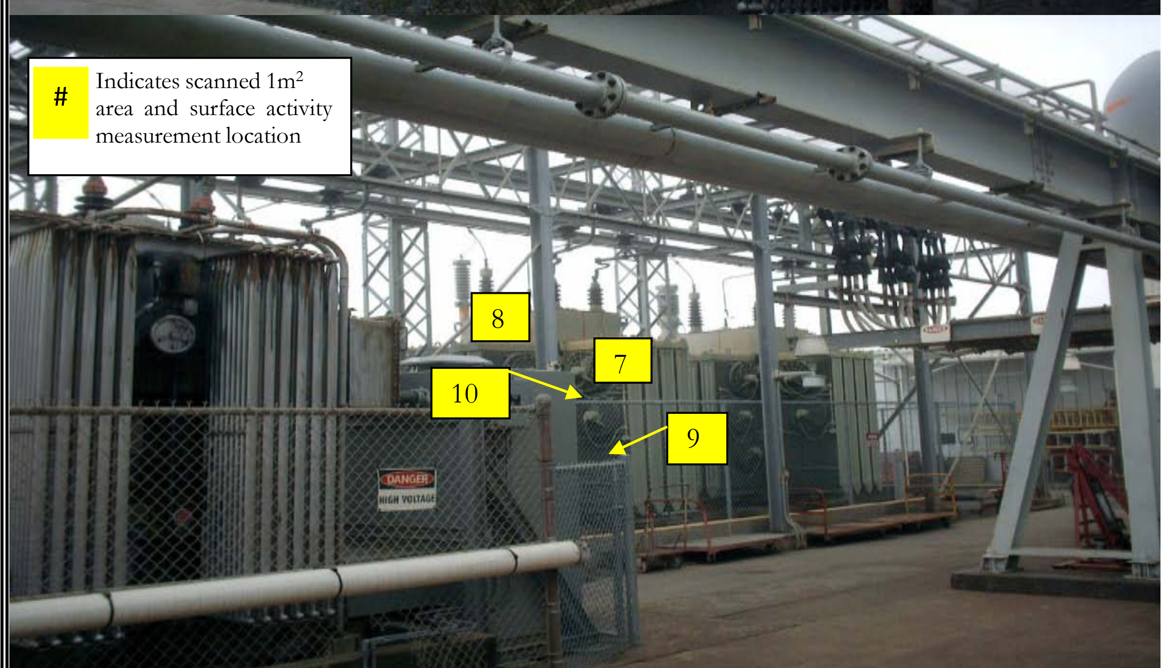
Scan Location (1 m^2)	Max Scan (cpm)	Unshielded (cpm)	Shielded (cpm)	Net Beta Activity (dpm/100 cm2)
Upper Level, Unit 2				
1	240	249	135	350
2	300	285	139	460
3	240	165	145	24
4	360	426	173	830
5	350	437	174	860
Lower Level, Unit 2				
6	240	275	176	300
7	210	245	174	200
8	260	264	197	190
9	230	255	138	360
10	210	170	142	52

Ambient BKG Measurements		Instrument Efficiency		Other Data
Location:	Shielded	Static Efficiency		Mat.-Spec.Beta BKG
Count	cpm	ε_i =	0.46	13
1	228	ε_s =	0.5	**Scan MDCR**
2	196	ε_t =	0.23	181 cpm
3	233	Scan Efficiency		**Scan Action Level**
4	233	ε_i =	0.3	415 cpm
5	279	ε_s =	0.5	**Scan MDC**
Average	234	ε_t =	0.15	1708 dpm/100 cm^2

TABLE B-1:
ORISE CONFIRMATORY SURVEYS OF HBPP MARSAME SURVEY UNITS
HUMBOLDT BAY POWER PLANT, EUREKA, CALIFORNIA

MARSAME Survey Package	HBPP-TF-001
DESCRIPTION	Transformers and Control Breakers
SURVEY UNIT	Units 1 and 2 Transformers





Action Levels				
Recycling Action Level (dpm/100 cm²)			Burial Action Level	
Cs-137	Total	5,000	(pCi/g)	(dpm/100 cm²)
	Removable	1,000	15	16,600
Scan Location (1 m²)	**Max Scan (cpm)**	**Unshielded (cpm)**	**Shielded (cpm)**	**Net Beta Activity (dpm/100 cm2)**
1	430	294	164	400
2 Elec box	180	203	152	130
3	270	263	154	330
4	210	152	123	55
5	260	288	173	350
6 fin	200	245	181	180
7 fin	280	245	204	97
8 top	290	305	103	650
9	240	137	119	17
10	140	149	102	120

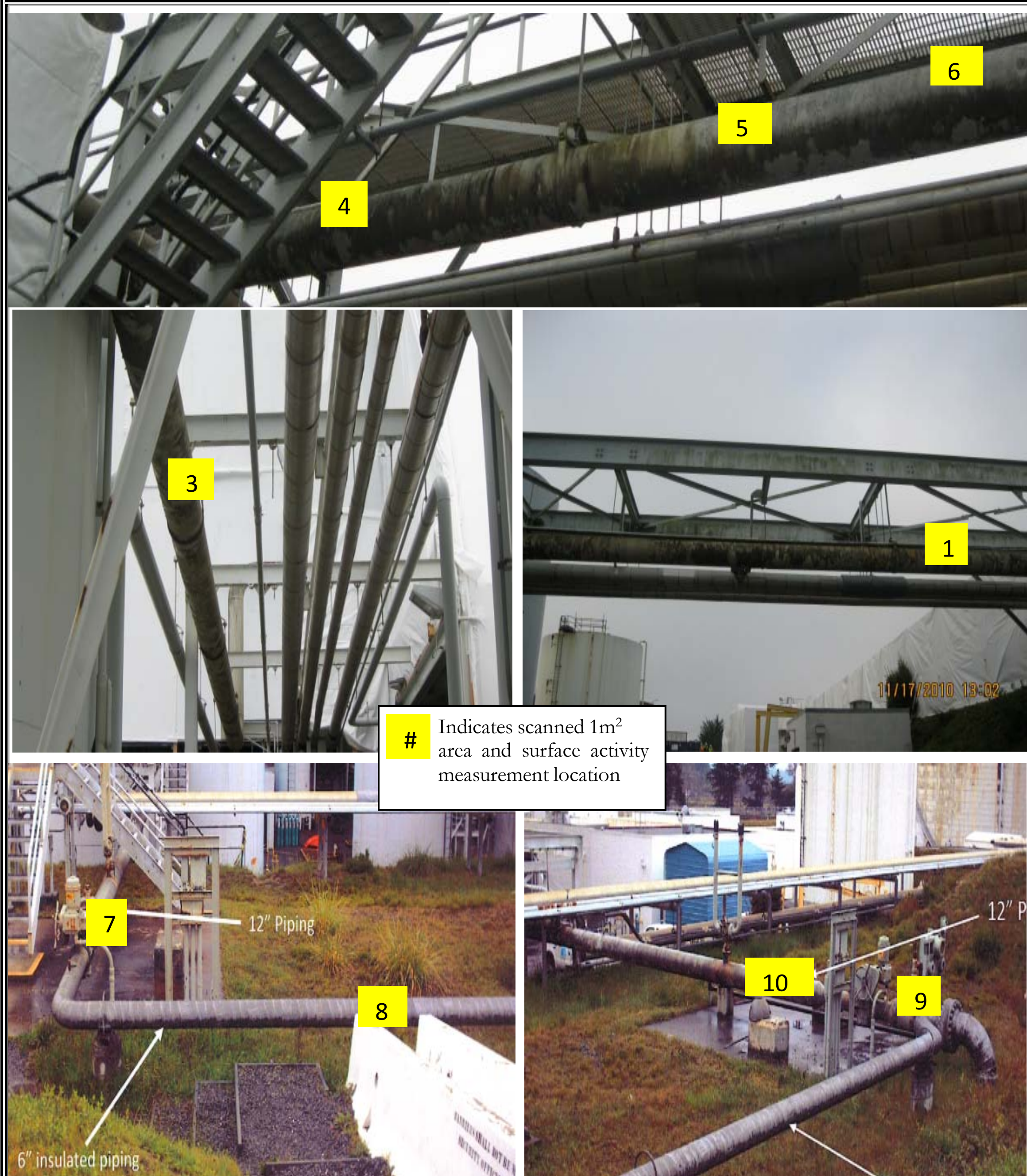
Ambient BKG Measurements		Instrument Efficiency		Other Data
Location:	**Shielded**	**Static Efficiency**		**Mat.-Spec.Beta BKG**
Count	**cpm**	$\varepsilon_i =$	0.46	13
1	236	$\varepsilon_s =$	0.5	**Scan MDCR**
2	240	$\varepsilon_t =$	0.23	183 cpm
3	222	**Scan Efficiency**		**Scan Action Level**
4	265	$\varepsilon_i =$	0.3	422 cpm
5	233	$\varepsilon_s =$	0.5	**Scan MDC**
Average	239	$\varepsilon_t =$	0.15	1728 dpm/100 cm²

TABLE B-1:
ORISE CONFIRMATORY SURVEYS OF HBPP MARSAME SURVEY UNITS
HUMBOLDT BAY POWER PLANT, EUREKA, CALIFORNIA

MARSAME Survey Package	**HBPP-NG-001**
DESCRIPTION	Natural Gas Systems
SURVEY UNIT	Units 1 and 2

Action Levels				
Recycling Action Level (dpm/100 cm²)			**Burial Action Level**	
Cs-137	Total	5,000	(pCi/g)	(dpm/100 cm²)
	Removable	1,000	15	16,600

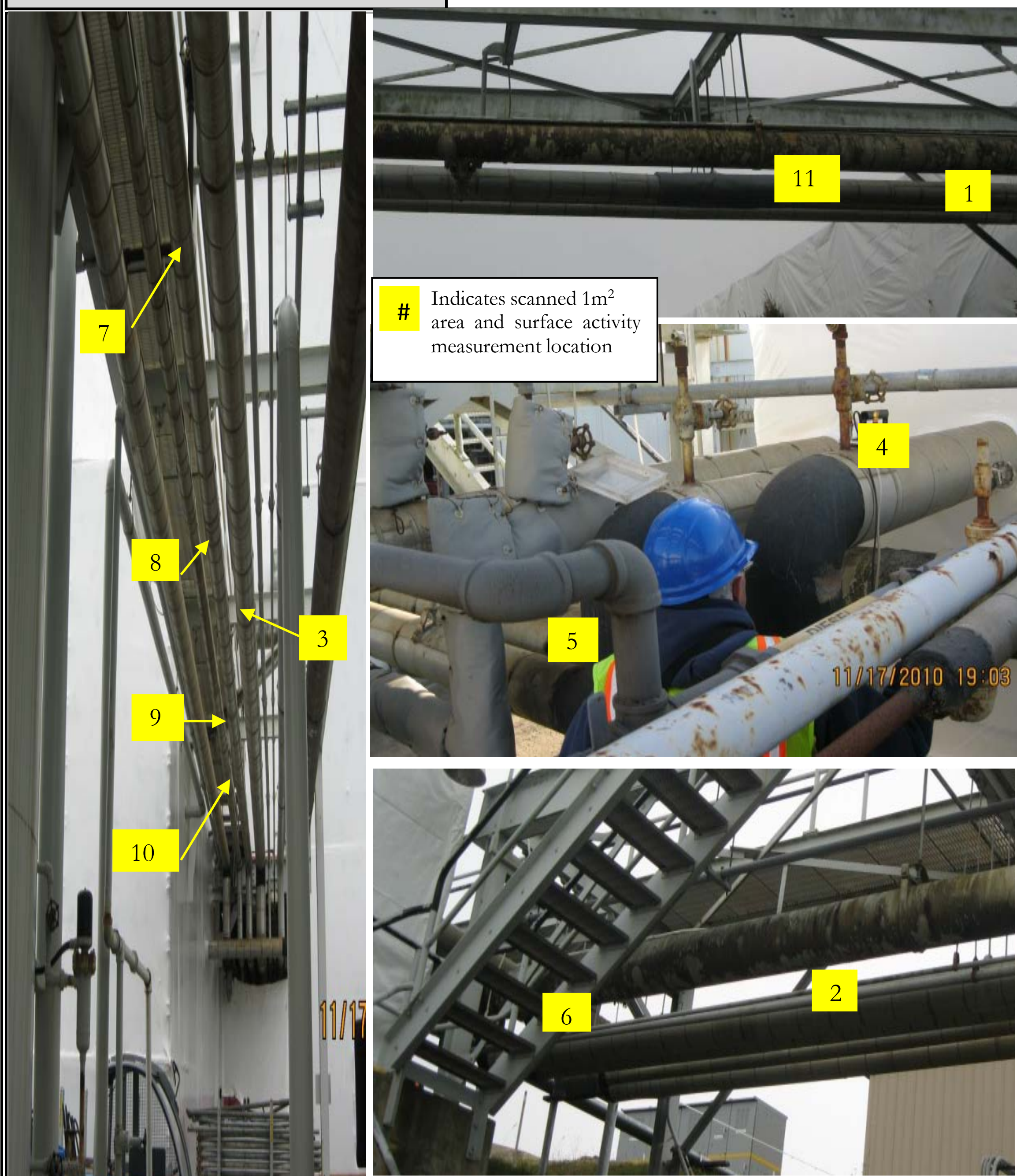
Scan Location (1 m²)	**Max Scan (cpm)**	**Unshielded (cpm)**	**Shielded (cpm)**	**Net Beta Activity (dpm/100 cm2)**
1	370	328	228	300
2 NA	Location 2 was actually on Main/Auxillary System for #11			
3	240	179	152	48
4	350	343	265	220
5	370	300	286	3
6	420	497	317	580
7	340	275	221	140
8	280	299	242	150
9	190	253	237	10
10	400	312	249	170



Ambient BKG Measurements		**Instrument Efficiency**		**Other Data**
Location:	**Shielded**	**Static Efficiency**		**Mat.-Spec.Beta BKG**
Count	**cpm**	ε_i =	0.46	13
1	314	ε_s =	0.5	**Scan MDCR**
2	309	ε_t =	0.23	200 cpm
3	238	**Scan Efficiency**		**Scan Action Level**
4	240	ε_i =	0.3	486 cpm
5	329	ε_s =	0.5	**Scan MDC**
Average	286	ε_t =	0.15	1889 dpm/100 cm²

TABLE B-1:
ORISE CONFIRMATORY SURVEYS OF HBPP MARSAME SURVEY UNITS
HUMBOLDT BAY POWER PLANT, EUREKA, CALIFORNIA

MARSAME Survey Package	HBPP-MS-001
DESCRIPTION	Main/Auxiliary Steam
SURVEY UNIT	Units 1 and 2

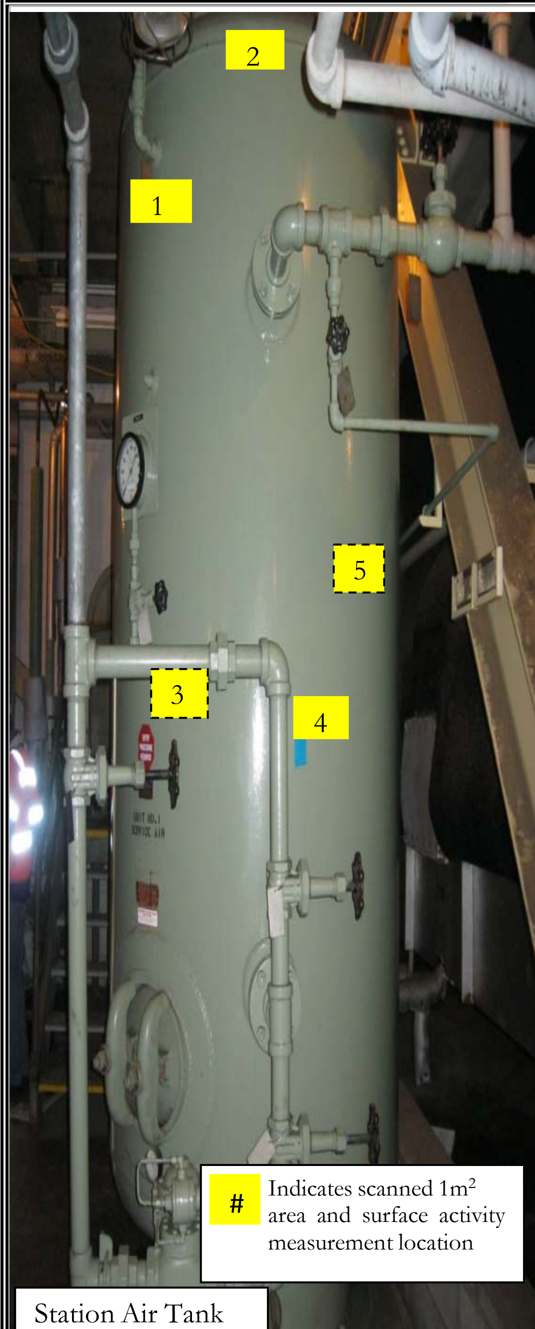


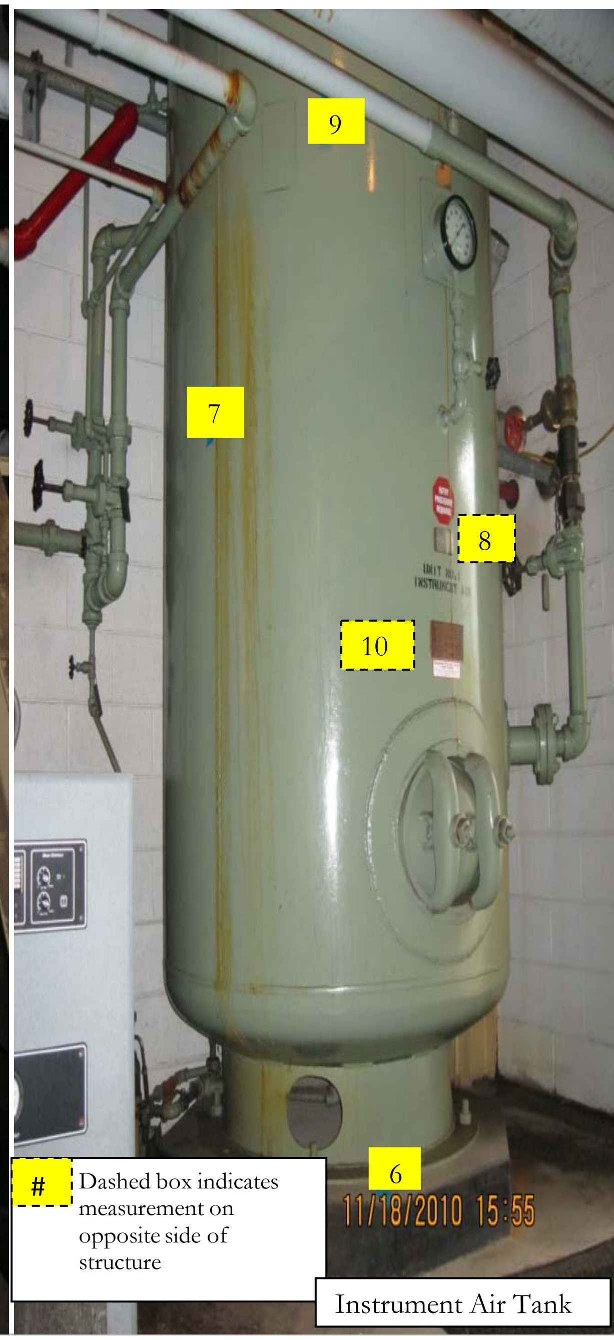
Action Levels				
Recycling Action Level (dpm/100 cm^2)			Burial Action Level	
Cs-137	Total	5,000	(pCi/g)	(dpm/100 cm^2)
	Removable	1,000	15	16,600
Scan Location	**Max Scan**	**Unshielded**	**Shielded**	**Net Beta Activity**
(1 m^2)	**(cpm)**	**(cpm)**	**(cpm)**	**(dpm/100 cm2)**
1	210	155	127	52
2	420	523	321	650
3	400	395	268	390
4	430	420	301	370
5	230	337	231	320
6	350	459	270	610
7	360	386	243	450
8	380	472	220	820
9	350	463	234	750
10	410	282	220	170
11	450	443	259	590

Ambient BKG Measurements		Instrument Efficiency		Other Data
Location:	**Shielded**	**Static Efficiency**		**Mat.-Spec.Beta BKG**
Count	**cpm**	ε_i =	0.46	13
1	314	ε_s =	0.5	**Scan MDCR**
2	309	ε_t =	0.23	200 cpm
3	238	**Scan Efficiency**		**Scan Action Level**
4	240	ε_i =	0.3	486 cpm
5	329	ε_s =	0.5	**Scan MDC**
Average	286	ε_t =	0.15	1889 dpm/100 cm^2

TABLE B-1:
ORISE CONFIRMATORY SURVEYS OF HBPP MARSAME SURVEY UNITS
HUMBOLDT BAY POWER PLANT, EUREKA, CALIFORNIA

MARSAME Survey Package	**HBPP-SA-001**
DESCRIPTION	Station Air and Instrument Air Tanks
SURVEY UNIT	Unit 1 Station Air





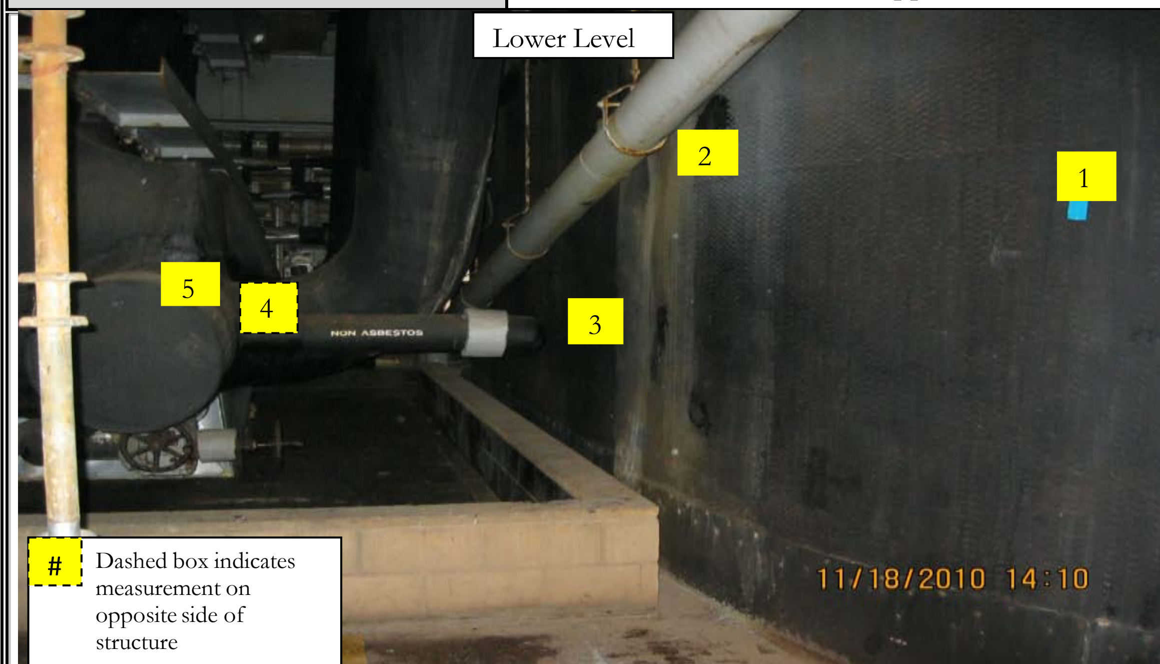
Action Levels				
Recycling Action Level (dpm/100 cm^2)			**Burial Action Level**	
Cs-137	Total	5,000	(pCi/g)	(dpm/100 cm^2)
	Removable	1,000	15	16,600
Scan Location (1 m^2)	**Max Scan (cpm)**	**Unshielded (cpm)**	**Shielded (cpm)**	**Net Beta Activity (dpm/100 cm2)**
Station Air				
1	230	170	130	93
2	300	216	185	62
3	200	162	138	38
4	280	140	165	-130
5	250	173	151	31
Instrument Air				
6	280	207	180	48
7	300	154	144	-10
8	100	169	148	28
9	300	183	175	-17
10	250	208	158	130

Ambient BKG Measurements		**Instrument Efficiency**		**Other Data**
Location:	**Shielded**	**Static Efficiency**		**Mat.-Spec.Beta BKG**
Count	**cpm**	ε_i =	0.46	13
1	198	ε_s =	0.5	**Scan MDCR**
2	205	ε_t =	0.23	166 cpm
3	212	**Scan Efficiency**		**Scan Action Level**
4	182	ε_i =	0.3	362 cpm
5	185	ε_s =	0.5	**Scan MDC**
Average	196	ε_t =	0.15	1566 dpm/100 cm^2

TABLE B-1:
ORISE CONFIRMATORY SURVEYS OF HBPP MARSAME SURVEY UNITS
HUMBOLDT BAY POWER PLANT, EUREKA, CALIFORNIA

MARSAME Survey Package	HBPP-BL-001
DESCRIPTION	Boilers
SURVEY UNIT	Unit 2 Lower and Upper Levels

Action Levels				
Recycling Action Level (dpm/100 cm^2)			Burial Action Level	
Cs-137	Total	5,000	(pCi/g)	(dpm/100 cm^2)
	Removable	1,000	15	16,600

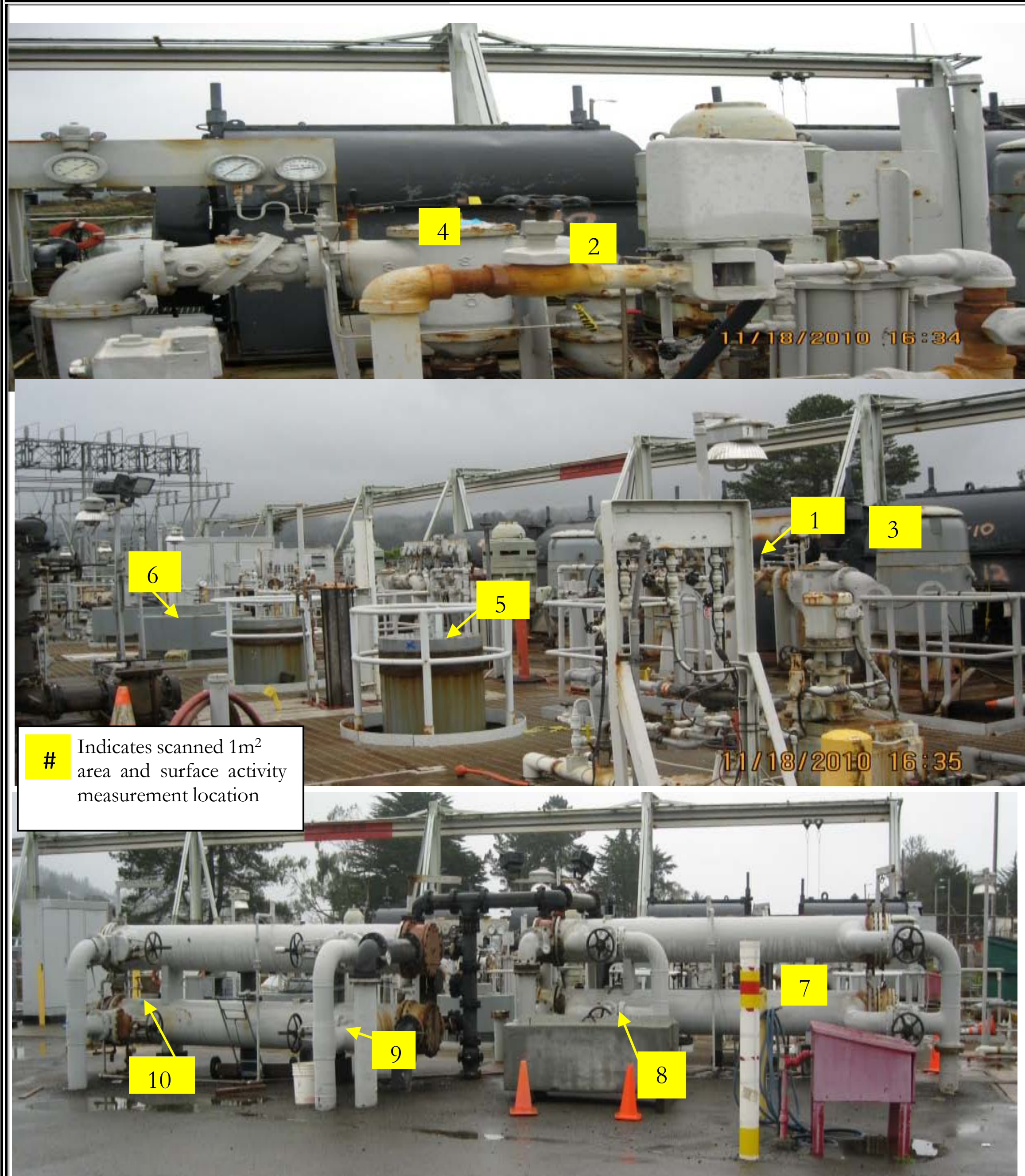


Scan Location (1 m^2)	Max Scan (cpm)	Unshielded (cpm)	Shielded (cpm)	Net Beta Activity (dpm/100 cm2)
Lower Level				
1	270	217	214	-35
2	300	223	198	41
3	340	230	183	120
4	310	243	202	97
5	260	264	235	55
Upper Level				
6	540	446	452	-66
7	480	246	228	17
8	330	281	218	170
9	410	302	212	270
10	430	281	194	260

Ambient BKG Measurements		Instrument Efficiency		Other Data
Location:	Shielded	Static Efficiency		Mat.-Spec.Beta BKG
Count	cpm	ε_i =	0.46	13
1	215	ε_s =	0.5	**Scan MDCR**
2	220	ε_t =	0.23	181 cpm
3	326	Scan Efficiency		**Scan Action Level**
4	224	ε_i =	0.3	416 cpm
5	187	ε_s =	0.5	**Scan MDC**
Average	234	ε_t =	0.15	1710 dpm/100 cm^2

TABLE B-1:
ORISE CONFIRMATORY SURVEYS OF HBPP MARSAME SURVEY UNITS
HUMBOLDT BAY POWER PLANT, EUREKA, CALIFORNIA

MARSAME Survey Package	**HBPP-IS-001**	**Action Levels**				
		Recycling Action Level (dpm/100 cm^2)			**Burial Action Level**	
DESCRIPTION	Intake Structures and Piping	Cs-137	Total	5,000	(pCi/g)	(dpm/100 cm^2)
SURVEY UNIT	Intake Structures		Removable	1,000	15	16,600



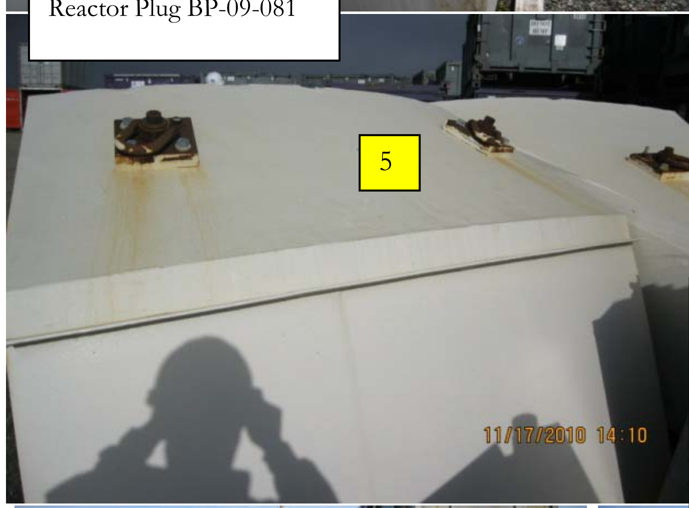
Scan Location (1 m^2)	**Max Scan (cpm)**	**Unshielded (cpm)**	**Shielded (cpm)**	**Net Beta Activity (dpm/100 cm2)**
1	360	291	156	420
2	250	174	150	38
3	260	187	127	160
4	330	408	186	720
5	490	388	216	550
6	500	370	239	410
7	330	238	165	210
8	330	245	174	200
9	420	301	191	330
10	340	194	181	0

Ambient BKG Measurements		**Instrument Efficiency**		**Other Data**
Location:	**Shielded**	**Static Efficiency**		**Mat.-Spec.Beta BKG**
Count	**cpm**	ε_i =	0.46	13
1	180	ε_s =	0.5	**Scan MDCR**
2	186	ε_t =	0.23	162 cpm
3	182	**Scan Efficiency**		**Scan Action Level**
4	198	ε_i =	0.3	349 cpm
5	190	ε_s =	0.5	**Scan MDC**
Average	187	ε_t =	0.15	1529 dpm/100 cm^2

TABLE B-2:
ORISE CONFIRMATORY SURVEYS OF HBPP MARSAME SURVEY UNITS
HUMBOLDT BAY POWER PLANT, EUREKA, CALIFORNIA

		Action Levels				
MARSAME Survey Package	**HBPP-BP-09**	Recycling Action Level (dpm/100 cm^2)			Burial Action Level	
DESCRIPTION	Reactor Shield Plug Cut Into 8 Sections	Cs-137	Total	5,000	(pCi/g)	(dpm/100 cm^2)
SURVEY UNIT	Reactor Shield Plug		Removable	1,000	15	16,600

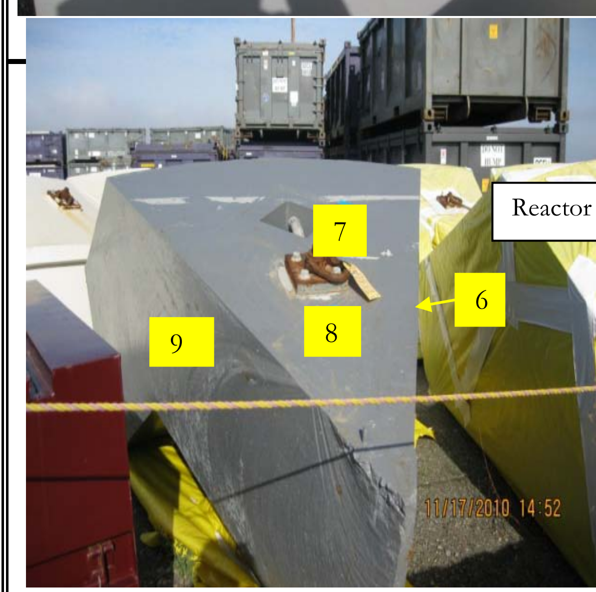
Reactor Plug BP-09-081



Scan Location (1 m^2)	Max Scan (cpm)	Unshielded (cpm)	Shielded (cpm)	Net Beta Activity (dpm/100 cm^2)	Alpha (cpm)	Net Alpha (dpm/100 cm^2)
BP-09-081						
1 top	920	945	528	1700	8	60
2 top	3600	3879	440	15000	8	60
3 side	380	341	243	240	1	0
4 side	360	313	145	560	5	34
5 back top	550	545	194	1400	6	43
BP-09-079						
6 side	510	446	179	1000	1	0
7 top	2500	2931	317	12000	2	9
8 top	570	461	316	450	2	9
9 side	350	352	272	160	2	9
10 top ledge	3000	4358	532	17000	0	-9

# Indicates scanned 1m^2 area and surface activity measurement location

Instrument Efficiency				**Material Background**	
Static β Efficiency		**Static α Efficiency**		Material	Concrete
ε_i =	0.44	ε_i =	0.47	Shielded BKG =	45
ε_s =	0.5	ε_s =	0.25	Alpha BKG =	1
ε_t =	0.22	ε_t =	0.12		
G =	1	G =	1		
MDC =	155	MDC	64		



Reactor Plug BP-09-079

TABLE B-3:
ORISE AND BSI COMPARISON SURVEY DATA
HUMBOLDT BAY POWER PLANT, EUREKA, CALIFORNIA

MARSAME Survey Package	HBPP-SA-001			Action Levels		
				Recycling Action Level (dpm/100 cm^2)		
DESCRIPTION	Station Air and Instrument Air Tanks			Cs-137	Total	5,000
SURVEY UNIT	Unit 1 Station Air				Removable	1,000
ORISE Comfirmatory Surface Activity Measurements				BSI Surface Activity Measurements		
Surface Activity Location (1 m^2)	Unshielded (cpm)	Shielded (cpm)	Net Beta Activity (dpm/100 cm2)	Unshielded (cpm)	Ambient BKG (cpm)	Net Beta Activity (dpm/100 cm2)
Station Air						
1	170	130	93	134	154	-66
2	216	185	62	124	154	-98
3	162	138	38	137	154	-56
4	140	165	-130	93	154	-200
5	173	151	31	131	154	-75
Instrument Air						
6	207	180	48	128	157	-95
7	154	144	-10	128	157	-95
8	169	148	28	114	157	-140
9	183	175	-17	148	157	-30
10	208	158	130	126	157	-100

ORISE Instument Data				
Ambient BKG Measurements		Instrument Efficiency		Other Data
Location:	Shielded	ORISE Static Efficiency		Surface Material
Count	cpm	ε_i =	0.46	Metal
1	198	ε_s =	0.5	
2	205	ε_t =	0.23	Mat.-Spec.Beta BKG
3	212	BSI Static Efficiency		13
4	182	ε_i =	NA	
5	185	ε_s =	NA	Detector Geometry
Average	196	ε_t =	0.2418	1.26

APPENDIX C
MAJOR INSTRUMENTATION

APPENDIX C
MAJOR INSTRUMENTATION

The display of a specific product is not to be construed as an endorsement of the product or its manufacturer by the author or his employer.

C.1 SCANNING AND MEASUREMENT INSTRUMENT/DETECTOR COMBINATIONS

C.1.1 Beta

Ludlum Ratemeter-Scaler Model 2221
coupled to
Ludlum Gas Proportional Detector Model 43-68, Physical Area: 126 cm^2
(Ludlum Measurements, Inc., Sweetwater, TX)
Calibration Due Date: 04/06/2011

Ludlum Ratemeter-Scaler Model 2221
coupled to
Ludlum Plastic Scintillation Detector Model 44-142, Physical Area: 100 cm^2
(Ludlum Measurements, Inc., Sweetwater, TX)
Calibration Due Date: 02/27/2011

C.1.2 Alpha

Ludlum Ratemeter-Scaler Model 2221
(Ludlum Measurements, Inc., Sweetwater, TX)
coupled to
Ludlum Alpha Scintillation Detector Model 43-92, Physical Area: 100 cm^2
(Ludlum Measurements, Inc., Sweetwater, TX)
Calibration Due Date: 04/20/2011

APPENDIX D
SURVEY PROCEDURES

D.1 PROJECT HEALTH AND SAFETY

The proposed survey and sampling procedures were evaluated to ensure that any hazards inherent to the procedures themselves were addressed in current Job Hazard Analyses (JHA). All survey and laboratory activities were conducted in accordance with Oak Ridge Associated Universities (ORAU) health and safety procedures (ORAU 2008)[1].

Pre-survey activities included the evaluation and identification of potential health and safety issues. Survey work was performed per the Oak Ridge Institute for Science and Education (ORISE) generic health and safety plans and a site-specific Integrated Safety Management (ISM) pre-job hazard checklist. Humboldt Bay Power Plant (HBPP) personnel provided site-specific safety awareness training. ORISE personnel also performed a safety walk down of the site to check for unexpected hazards.

D.2 CALIBRATION AND QUALITY ASSURANCE

Calibration of all field instrumentation was based on sources/standards, traceable to the National Institute of Standards and Technology (NIST).

Field survey activities were conducted in accordance with procedures from the following ORAU and ORISE documents:

- Survey Procedures Manual (ORISE 2008)[2]
- Quality Program Manual (ORAU 2009)[3]

The procedures contained in these manuals were developed to meet the requirements of 10 Code of Federal Regulations (CFR) 830 Subpart A, *Quality Assurance Requirements*, Department of Energy Order 414.1C *Quality Assurance*, and the U.S. Nuclear Regulatory Commission *Quality Assurance Manual for the Office of Nuclear Material Safety and Safeguards*[4] and contain measures to assess processes during their performance.

---

[1] ORAU. "ORAU/ORISE Health & Safety Manual." Oak Ridge, Tennessee; April 2, 2008.

[2] ORISE. "Survey Procedures Manual for the Independent Environmental Assessment and Verification Program." Oak Ridge, Tennessee; May 1, 2008.

[3] ORAU. "Quality Program Manual for the Independent Environmental Assessment and Verification Program." Oak Ridge, Tennessee; June 30, 2009.

[4] U.S. Nuclear Regulatory Commission (NRC). "Minimum Detectable Concentrations With Typical Radiation Survey Instruments for Various Contaminants and Field Conditions," NUREG-1507; Washington, DC; June 1998.

Quality control procedures include:

- Daily instrument background and check-source measurements to confirm that equipment operation is within acceptable statistical fluctuations.
- Training and certification of all individuals performing procedures.

D.3 SURVEY PROCEDURES

These procedures provide guidance on the terms used by ORISE on the data spreadsheets (Appendix B) during the confirmatory survey activities to determine HBPP's compliance with approved *Multi-Agency Radiation Survey and Assessment of Materials and Equipment* (MARSAME) survey procedures and action levels.

D.3.1 AMBIENT BACKGROUND DETERMINATIONS

For scanning measurements, ORISE performed five ambient background measurements within the vicinity of the Survey Unit (SU) that was being investigated. The average of the ambient background measurements was calculated and that value was used in the determination of the scan minimum detectable concentration (Scan MDC) measurements.

ORISE performed metal and concrete material-specific background measurements at five locations each within unaffected areas. At each location, an unshielded and shielded measurement was performed. The average shielded measurement was subtracted from the average unshielded measurement to determine the net material-specific beta background.

$$R_m = R_u - R_s$$

where:

R_m = reference material background beta count rate (ambient background subtracted out)
R_u = unshielded (gross) background count rate (gamma + beta)
R_s = shielded background count rate (gamma only)

The respective reference material-specific background was used for the surface activity calculations.

D.3.2 SCANNING MEASUREMENTS

A hand-held gas proportional detector was used to scan for elevated beta radiation. Identification of elevated radiation levels was based on increases in the audible signal from the recording and/or indicating instrument. ORISE Survey Procedures (ORISE 2008) require a minimum scan speed of 0.5 to 1 meter per second (m/s) based on the site contaminant and the Derived Concentration Guideline Level (DCGL) for the primary contaminant of concern.

D.3.2.1 Scan MDCR

For beta activity scans, ORISE determined Scan MDCs per NUREG-1507 guidance. Some of the factors for determining Scan MDCs are as follows: the intrinsic characteristics of the detector (efficiency, window area, etc.); the nature (energy of the beta emissions) and the relative distribution of the potential contamination (point versus distributed source and depth of contamination); the scan rate; background levels; and surveyor vigilance. Many of the factors used to determine Scan MDCs have already been estimated for typical field situations and contaminants. Therefore, Scan MDCs can be determined by using the calculational approach described in Chapter 6 of NUREG-1507 (NRC 1998).

To compare the actual surveyor's performance to that of the *ideal observer* within acceptable performance parameters (in terms of true and false positive rates), decision errors—Type I error (α) and Type II error (β)—must be determined. ORISE uses a 95% true positive rate (1-β) and a 25% false positive rate (α), to determine the index of sensitivity (*d'*) which is 2.32 (from NUREG-1507, Table 6.1).

The selection of the Scan MDC is based on the ability of the *ideal observer* (without typical human deficiencies) to make optimal use of the available survey information to make a correct determination of actual activity/concentration for the survey measurement. Therefore, the minimum detectable count rate (MDCR) for the ideal observer can be calculated as follows:

$$MDCR = d' * \sqrt{b_i} * (\frac{60}{i})$$

For a less than ideal observer, the MDCR is increased by dividing by the default efficiency of the human surveyor (*p*):

$$MDCR_{surveyor} = \frac{d' * \sqrt{b_i} * (\frac{60}{i})}{\sqrt{p}}$$

where:

MDCR = minimum detectable (net) count rate in counts per minute

d' = index of sensitivity (ORISE uses 2.32)

b_i = background counts in observation interval

i = observation interval (in seconds), based on the scan speed, detector size, and the area extent of the contamination (size of hot spot).

p = surveyor efficiency (ORISE assumes a surveyor efficiency value at the lower end of the observed range (i.e., 0.5) when making Scan MDC determinations.

NOTE: The term MDCR (without subscript) refers to the performance of the ideal observer, and the $MDCR_{surveyor}$ relates to the performance of the surveyor. In the data tables for this report (Appendix B), Scan MDCR relates to the $MDCR_{surveyor}$.

D.3.2.2 Scan Action Level

The scan results were compared against the Scan Action Level calculation for each SU to determine if contamination above background levels was present on the M&E surfaces. The Scan Action Level was calculated as follows:

$$Scan\ Action\ Level\ (cpm) = Scan\ MDCR + BKG$$

The maximum scan count rate (Max Scan) was compared with the Scan Action Level to determine if residual contamination, greater than background levels, was present on the scanned surfaces.

D.3.2.3 Scan MDC

Scan minimum detectable concentrations (Scan MDCs) were then determined from the Scan MDCR by applying appropriate conversion factors to obtain results in terms of measurable surface activities. These conversion factors account for the detector and surface characteristics, as well as surveyor efficiency. The MDCR accounts for the background level, performance criteria [(*d'*) index of sensitivity], and the observation interval (*i*) which is the actual time that the detector can respond to the contamination source (depending on the scan speed, detector size in direction of scan, and size of the hot spot).

The Scan MDC for a structure surface was determined as follows:

$$Scan\ MDC = \frac{MDCR}{\sqrt{p} * \varepsilon_i \varepsilon_s}$$

where,

ε_i = the instrument efficiency for scanning (ORISE has determined both static and scan instrument efficiencies for Cs-137 for gas proportional detectors. The static $\varepsilon_i = 0.46$ and the scan $\varepsilon_i = 0.3$ from Table 9.3 (Abelquist 2001)[5]

ε_s = the source efficiency ($\varepsilon_s = 0.25$ for $\beta_{max} \leq 400$ keV and $\varepsilon_s = 0.5$ for $\beta_{max} > 400$ keV); for Cs-137, the $\varepsilon_s = 0.5$

NOTE: ORISE determines the Scan MDC without the probe area correction factor in the above equation. This is contrary to the Static MDC equation, as well as for the calculation of net surface activity. The reason is that in order to calculate Scan MDC one must postulate a certain hot spot size. As long as this postulated hot spot measures 100 cm^2 the Scan MDC will be determined in the appropriate units (dpm/100 cm^2) (Abelquist 2001). HBPP determined their Scan MDC using a probe area correction factor.

The Scan MDCs for the hand-held gas proportional detector for each SU ranged from 1,529 to 1,889 dpm/100 cm^2. Any audible increase in radiation levels were investigated by ORISE. It is standard procedure for the ORISE staff to pause and investigate any locations where surface scan radiation levels are distinguishable from background levels.

D.3.3 STATIC MEASUREMENTS

Detection limits, referred to as MDCs, were based on 3 plus 4.65 times the standard deviation of the background count [3 + (4.65 $(BKG)^{1/2}$)]. Because of variations in background levels, measurement

[5] Abelquist, Eric W. (Abelquist). "Decommissioning Health Physics: A Handbook for MARSSIM Users." Institute of Physics. 2001.

efficiencies, and contributions from other radionuclides in measurement locations, the detection limits differ from measurement to measurement and instrument to instrument.

D.3.3.1 Static MDC

For static measurements, ORISE performed five ambient background measurements within the vicinity of each SU that was being surveyed. The average of the ambient background measurements was calculated and that value was used in the determination of the Static Minimum Detectable Concentration (Static MDC or MDC) measurements. The MDCs shown in Table D-1 were calculated as follows:

$$MDC\ (dpm/100\ cm^2) = \frac{3 + 4.65\sqrt{BKG}}{\varepsilon_{Tot} * T * G}$$

where:

MDC = minimum detectable concentration level in dpm/100 cm^2.

BKG = background total counts in time interval, T (SU specific ambient background was used)

T = count time (min) used in field measurements

ε_{Tot} = total efficiency = $\varepsilon_i * \varepsilon_s$

ε_i = instrument efficiency

ε_s = source efficiency

G = geometry = Physical Detector Area cm^2/100 (Ludlum 43-68 physical area is 126 cm^2)

TABLE D-1
MINIMUM DETECTABLE CONCENTRATIONS
HUMBOLDT BAY POWER PLANT, EUREKA, CALIFORNIA

MARSAME Survey Package	MDC (dpm)	Adjusted MDC (dpm/100 cm^2)
HBPP-TB-001	322	256
HBPP-GN-001	322	256
HBPP-FW-001	322	256
HBPP-TF-001	326	259
HBPP-NG-001	355	282
HBPP-MS-001	355	282
HBPP-SA-001	296	235
HBPP-BL-001	323	256
HBPP-IS-001	290	230

D.3.3.2 Surface Activity Measurements

Surface activity measurements (unshielded and shielded pairs) were performed at ten locations within each SU. The determination of the net beta surface activity at each location was calculated as follows:

$$Net\ Beta\ Activity\ \left(\frac{dpm}{100\ cm^2}\right) = \frac{U - S - R_m}{\varepsilon_{Tot} * G * T}$$

where:

U	= unshielded (gross) surface activity count rate (gamma + beta)
S	= shielded surface activity count rate (gamma only)
R_m	= reference material background beta count rate (ambient reference material gamma background subtracted out)
ε_{Tot}	= total efficiency = $\varepsilon_i * \varepsilon_s$
ε_i	= instrument efficiency
ε_s	= source efficiency
G	= geometry = Physical Detector Area cm^2/100 (Ludlum 43-68 physical area is 126 cm^2)

The Net Beta Activity was compared against the Total and Removable Action Levels as provided by HBPP (refer to Appendix B data tables).