MACTEC, Inc.

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REGION IV

APPLICATION AND SUPPORTING DOCUMENTS FROM MACTEC DEVELOPMENT CORPORATION FOR A NUCLEAR REGULATORY COMMISSION BROAD SCOPE LICENSE

December 6, 2002

Prepared By: MACTEC Development Corporation
751 Horizon Court, Suite 104
Grand Junction, CO 81506

Prepared For: US Nuclear Regulatory Commission
Region IV
611 Ryan Plaza Drive, Suite 400
Arlington, TX 76011-8064

469435

NRC FORM 313 (8-1999) 10 CFR 30, 32, 33 34, 35, 36, 39 and 40

U. S. NUCLEAR REGULATORY COMMISSION

APPLICATION FOR MATERIAL LICENSE

APPROVED BY OMB: NO. 3150-0120 EXPIRES:08/31/2002

Estimated burden per response to comply with this mandatory information collection request: 7.4 hours. Submittal of the application is necessary to determine that the applicant is qualified and that adequate procedures exist to protect the public health and safety. Send comments regarding burden estimate to the Records Management Branch (T-6 E6), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to bjs1@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202, (3150-0120), Office of Management and Budget, Washington, DC 20503. If a means used to impose an information collection does not display a currently valid OMB control number, NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

INSTRUCTIONS: SEE THE APPROPRIATE LICENSE APPLICATION GUIDE FOR DETAILED INSTRUCTIONS FOR COMPLETING APPLICATION. SEND TWO COPIES OF THE ENTIRE COMPLETED APPLICATION TO THE NRC OFFICE SPECIFIED BELOW.

APPLICATION FOR DISTRIBUTION OF EXEMPT PRODUCTS FILE APPLICATIONS WITH:

DIVISION OF INDUSTRIAL AND MEDICAL NUCLEAR SAFETY
OFFICE OF NUCLEAR MATERIALS SAFETY AND SAFEGUARDS
U.S. NUCLEAR REGULATORY COMMISSION
WASHINGTON, DC 20555-0001

ALL OTHER PERSONS FILE APPLICATIONS AS FOLLOWS:

IF YOU ARE LOCATED IN:

CONNECTICUT, DELAWARE, DISTRICT OF COLUMBIA, MAINE, MARYLAND, MASSACHUSETTS, NEW HAMPSHIRE, NEW JERSEY, NEW YORK, PENNSYLVANIA, RHODE ISLAND, OR VERMONT, SEND APPLICATIONS TO:

LICENSING ASSISTANT SECTION
NUCLEAR MATERIALS SAFETY BRANCH
U.S. NUCLEAR REGULATORY COMMISSION, REGION I
475 ALLENDALE ROAD
KING OF PRUSSIA, PA 19406-1415

ALABAMA, FLORIDA, GEORGIA, KENTUCKY, MISSISSIPPI, NORTH CAROLINA, PUERTO RICO, SOUTH CAROLINA, TENNESSEE, VIRGINIA, VIRGIN ISLANDS, OR WEST VIRGINIA, SEND APPLICATIONS TO:

SAM NUNN ATLANTA FEDERAL CENTER
U. S. NUCLEAR REGULATORY COMMISSION, REGION II
61 FORSYTH STREET, S.W., SUITE 23T85
ATLANTA, GEORGIA 30303-8931

IF YOU ARE LOCATED IN:

ILLINOIS, INDIANA, IOWA, MICHIGAN, MINNESOTA, MISSOURI, OHIO, OR WISCONSIN, SEND APPLICATIONS TO:

MATERIALS LICENSING SECTION
U.S. NUCLEAR REGULATORY COMMISSION, REGION III
801 WARRENVILLE RD.
LISLE, IL 60532-4351

ALASKA, ARIZONA, ARKANSAS, CALIFORNIA, COLORADO, HAWAII, IDAHO, KANSAS, LOUISIANA, MONTANA, NEBRASKA, NEVADA, NEW MEXICO, NORTH DAKOTA, OKLAHOMA, OREGON, PACIFIC TRUST TERRITORIES, SOUTH DAKOTA, TEXAS, UTAH, WASHINGTON, OR WYOMING, SEND APPLICATIONS TO:

NUCLEAR MATERIALS LICENSING SECTION
U.S. NUCLEAR REGULATORY COMMISSION, REGION IV
611 RYAN PLAZA DRIVE, SUITE 400
ARLINGTON, TX 76011-8064

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PERSONS LOCATED IN AGREEMENT STATES SEND APPLICATIONS TO THE U.S. NUCLEAR REGULATORY COMMISSION ONLY IF THEY WISH TO POSSESS AND USE LICENSED MATERIAL IN STATES SUBJECT TO U.S.NUCLEAR REGULATORY COMMISSION JURISDICTIONS.

1. THIS IS AN APPLICATION FOR *(Check appropriate item)*

- [X] A. NEW LICENSE
- [ ] B. AMENDMENT TO LICENSE NUMBER _____
- [ ] C. RENEWAL OF LICENSE NUMBER _____

2. NAME AND MAILING ADDRESS OF APPLICANT *(Include Zip code)*

MACTEC Development Corporation
751 Horizon Court, Suite 104
Grand Junction, CO 81506

3. ADDRESS(ES) WHERE LICENSED MATERIAL WILL BE USED OR POSSESSED

See letter dated December 6, 2002

4. NAME OF PERSON TO BE CONTACTED ABOUT THIS APPLICATION

Steven D. Rima, CHP, CSP

TELEPHONE NUMBER

(970) 243-2861

SUBMIT ITEMS 5 THROUGH 11 ON 8-1/2 X 11" PAPER. THE TYPE AND SCOPE OF INFORMATION TO BE PROVIDED IS DESCRIBED IN THE LICENSE APPLICATION GUIDE.

5. RADIOACTIVE MATERIAL.
a. Element and mass number; b. chemical and/or physical form; and c. maximum amount which will be possessed at any one time.

6. PURPOSE(S) FOR WHICH LICENSED MATERIAL WILL BE USED.

7. INDIVIDUAL(S) RESPONSIBLE FOR RADIATION SAFETY PROGRAM AND THEIR TRAINING EXPERIENCE.

8. TRAINING FOR INDIVIDUALS WORKING IN OR FREQUENTING RESTRICTED AREAS.

9. FACILITIES AND EQUIPMENT.

10. RADIATION SAFETY PROGRAM.

11. WASTE MANAGEMENT.

12. LICENSEE FEES *(See 10 CFR 170 and Section 170.31)*

FEE CATEGORY 1D,2C,3N,4B

AMOUNT ENCLOSED $ 11,000.00

13. CERTIFICATION. *(Must be completed by applicant)* THE APPLICANT UNDERSTANDS THAT ALL STATEMENTS AND REPRESENTATIONS MADE IN THIS APPLICATION ARE BINDING UPON THE APPLICANT.

THE APPLICANT AND ANY OFFICIAL EXECUTING THIS CERTIFICATION ON BEHALF OF THE APPLICANT, NAMED IN ITEM 2, CERTIFY THAT THIS APPLICATION IS PREPARED IN CONFORMITY WITH TITLE 10, CODE OF FEDERAL REGULATIONS, PARTS 30, 32, 33, 34, 35, 36, 39 AND 40, AND THAT ALL INFORMATION CONTAINED HEREIN IS TRUE AND CORRECT TO THE BEST OF THEIR KNOWLEDGE AND BELIEF.

WARNING: 18 U.S.C. SECTION 1001 ACT OF JUNE 25, 1948 62 STAT. 749 MAKES IT A CRIMINAL OFFENSE TO MAKE A WILLFULLY FALSE STATEMENT OR REPRESENTATION TO ANY DEPARTMENT OR AGENCY OF THE UNITED STATES AS TO ANY MATTER WITHIN ITS JURISDICTION.

CERTIFYING OFFICER – TYPED/PRINTED NAME AND TITLE	SIGNATURE	DATE
Dean L. Quamme, Vice President		12/05/02

FOR NRC USE ONLY

TYPE OF FEE	FEE LOG	FEE CATEGORY	AMOUNT RECEIVED	CHECK NUMBER	COMMENTS
			$		
APPROVED BY				DATE	

NRC FORM 313 (8-1999)

PRINTED ON RECYCLED PAPER

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MACTEC, Inc.

MACTEC, Inc.
751 Horizon Court
Suite 104
Grand Junction, CO 81506
Telephone: 970/243-2861
Fax: 970/256-7356
Home Page: www.mactec.com

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December 6, 2002

Nuclear Materials Licensing Section
U.S. Nuclear Regulatory Commission – Region IV
611 Ryan Plaza Drive, Suite 400
Arlington, TX 76011-8064

Subject: Application for an NRC Specific License of Broad Scope for Byproduct Material

This letter forwards MACTEC Development Corporation's (MACTEC's) request for review of the enclosed application for a "Type A Broad Scope Radioactive Materials License." Also enclosed is a check for $11,000 to pay for the application fees associated with fee categories 1D, 2C, 3N, and 4B as defined in 10 CFR 170.31.

The primary document used to prepare this application was "Consolidated Guidance About Material Licenses, Program-Specific Guidance About License of Broad Scope," NUREG-1556, Volume 11. Also used as a guide in the development of the license application, was a copy of the license application submitted by Cabrera Services, Inc., that was approved by NRC Region I (License No. 06-30556-01, Docket No. 030-35316, Feb 20, 2000), which was obtained by MACTEC through the Agency Document Access and Management System (ADAMS) electronic reading room. MACTEC used Cabrera's license application as a guide because it intends to conduct licensed activities that are similar to those performed by Cabrera Services, Inc.

MACTEC is a privately owned corporation founded in 1975 and is organized into three strategic divisions: Consulting Engineering and Sciences, Government Programs and Construction Management. MACTEC provides services within the Construction Management Division that include: Facility Construction and Upgrades, Facility Remediation, Facility Decontamination and Demolition and Facility Redevelopment. Specialty services include Radiation Protection, Health Physics, Safety and Industrial Hygiene. The Construction Management Division specializes in the characterization, remediation and decommissioning of sites contaminated with radioactive material and mixed waste and is currently providing services in these areas to NRC licensees, the Department of Energy and State licensed organizations. The MACTEC staff consists of Health Physicists, Radiological Engineers, Industrial Hygienists and Environmental Engineers. Staff members include Certified Health Physicists, Certified Industrial Hygienists, Certified Safety Professionals, Professional Engineers, as well as Registered Radiation Protection Technologists.

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The primary purpose of this license is to enable MACTEC to provide a comprehensive radioactive materials license package to its clients. These services would be provided to clients and facilities that require work with radioactive materials but do not have access to an approved radioactive materials license that encompasses these activities.

An additional purpose of this license is to provide a legal basis for work involving radioactive material remediation services, which will be performed at client sites. These services may include radiological site characterization and surveillance; radioactive material and mixed waste sampling, handling, and packaging; decontamination and decommissioning of buildings and equipment; and site remediation.

MACTEC's primary guidance documents for decontamination and license termination efforts include, but are not limited to:

U.S. Nuclear Regulatory Commission, U.S. Code of Federal Regulations, Title 10, "Energy," Parts 20, 30, 40, 50, 51, 70, and 72, "Radiological Criteria for License Termination;"

NUREG 1727, "NMSS Decommissioning Standard Review Plan;"

NUREG 1549, "Decision Methods for Dose Assessment to Comply with Radiological Criteria for License Termination;"

NUREG 1505, "A Nonparametric Statistical Methodology for the Design and Analysis of Final Status Decommissioning Surveys;"

NUREG 1507, "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions;"

NUREG 1575, Rev. 1, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) Revision 1;"

Yu, C., et. al., *RESRAD for Windows, Version 6.0,* Computer Modeling Code, Developed by Argonne National Laboratory, Environmental Assessment Division, Argonne, IL under joint sponsorship by the U.S. Department of Energy and the U.S. Nuclear Regulatory Commission, August 2000; and

Applicable EPA and DOE reference guidance material as well as future NRC related guidance, as published in the Federal Register.

This license application is for a Type A Broad Scope License in accordance with 10 CFR 30 and 33. The application also requests possession of source material and less than critical mass quantities of special nuclear material. Our license application includes a Radiation Safety Officer, Steven Rima, CHP, CSP as listed on Form 313. The designated Alternate RSO for the purpose of this license will be Michael McDonald, CHP. The license application is designed for use in all areas of NRC jurisdictions and Agreement States.

MACTEC has no permanent radiological laboratory facility and has entered into various contracts with NRC licensed, qualified laboratories for these needs.

Thank you for your support and guidance in our licensing effort. MACTEC looks forward to a productive relationship with the NRC. As you review this application, please call me for immediate assistance with any questions, concerns, or clarifications.

Sincerely,

Steven D. Rima, CHP, CSP
Radiological Engineering Manager
MACTEC, Inc.

Enclosures

Item No.	Response	Yes	Description Attached
3.	**ADDRESS(ES) WHERE LICENSED MATERIAL WILL BE USED OR POSSESSED** Licensed material may be used or possessed only at job sites of the licensee anywhere in the United States where the U.S. Nuclear Regulatory Commission and/or an Agreement State maintains jurisdiction for regulating the use of licensed material, including areas of exclusive federal jurisdiction within Agreement States, except for calibration sources, reference standards, and/or radioactively contaminated equipment owned by the licensee are not being used at or transported to or from a job site, the calibration sources, reference standards, and/or radioactively contaminated equipment will be located at: MACTEC Development Corporation 751 Horizon Court, Suite 104 Grand Junction, CO 81506 Authorization for use of radioactive materials at job sites in Agreement States not under exclusive federal jurisdiction, shall be obtained from the appropriate state regulatory agency.		

Item No.	Response	Yes	Description Attached
5.	**RADIOACTIVE MATERIAL**		

Unsealed and/or Sealed Byproduct Material

The following radioactive material possession limits are requested for this license:

Byproduct, source, and/or special nuclear material	Chemical and/or physical form	Maximum amount that the licensee may possess at any one time under this license
A. Any byproduct material with atomic numbers 1 through 83	A. Any	100 curies per radionuclide or the curie quantity (per radionuclide) listed in 10 CFR 30.72, which ever is less, and 100 curies total
B. Any byproduct material with atomic numbers 84 through 103	B. Any	1 curie per radionuclide and 1 curie total
C. Uranium and Thorium	C. Any	10,000 kilograms (accept as noted in D below)
D. Any Special Nuclear Material	D. Any	200 grams uranium-233, or 350 grams uranium-235, or 200 grams plutonium, or any combination of these provided that the sum of the ratios does not exceed unity

When Item No. 5 limits are used to cover contract (temporary) work, possession limits for combinations of radioactive materials will be maintained at unity for each category of nuclear material listed (i.e., A, B, C, D) using the sum of the ratios. The unity calculation will be performed over all contract work currently being performed under this license at all jobs. Assurance that limit criteria is met is by maintaining a central inventory of radioactive material being controlled under this license.

The quantity of radioactive material possessed at any one facility will vary with each contract. Therefore, possession limit requirements are requested that will provide the widest range of latitude without provision of an Emergency Response Plan.

Item No.	Response	Yes	Description Attached
5.	**RADIOACTIVE MATERIAL** *(Cont'd)* • Possession of byproduct materials listed under categories A and B, at any work site, will be limited to the lesser of the quantities listed in 10 CFR 30.72 or those categories A and B quantities listed above. The sum of the ratios for combinations of radioactive materials, listed under categories A and B, or listed in 10 CFR 30.72, will be limited to unity. This will be implemented by maintaining an inventory of all radioactive material being controlled under this license for each site. • An Emergency Response Plan is not required under §§40.31 and 40.32 for the requested category C source material possession limits and proposed uses described under Item No. 6 of this application. • Possession of special nuclear material is limited to less than critical mass as defined in §150.11. Based on this possession limit, §70.24 does not require a criticality alarm system, and §70.22 does not require a physical security plan. **Financial Assurance and Recordkeeping for Decommissioning** License material, excluding calibration sources, reference standards, and radioactively contaminated equipment owned by the licensee, will only be used at temporary job locations of the licensee anywhere in the United States where the U.S. NRC maintains jurisdiction for regulating the use of licensed material, including areas of exclusive federal jurisdiction within Agreement States. Calibration sources, reference standards, and radioactively contaminated equipment owned by the licensee, may be used at temporary job locations of the licensee anywhere in the United States where the U.S. NRC maintains jurisdiction for regulating the use of licensed material, including areas of exclusive federal jurisdiction within Agreement States. Except for calibration sources, reference standards, and radioactively contaminated equipment owned by the licensee, possession of licensed material at each temporary job site shall be limited to material originating from each site. This material shall either be transferred to an authorized recipient or remain at the site after licensee activities are completed. • Possession of byproduct material, source material, and special nuclear material in calibration sources, reference standards, and radioactively contaminated equipment owned by the licensee will be limited to less than the quantity described in §§30.35, 40.36, and 70.25 and which require financial assurance and a decommissioning fund plan.		

Item No.	Response	Yes	Description Attached
6.	**PURPOSE(S) FOR WHICH LICENSED MATERIAL WILL BE USED** Receipt, storage, use and/or possession incident to the following activities: 1. Decontamination, decommissioning, and/or remediation of facilities and grounds, equipment and containers; 2. Site characterization; 3. Solidification and/or treatment of wastes; 4. Packaging for transport; 5. Transport in packages or containers approved for use under the provisions of 10 CFR Part 71, for transfer to licensees authorized to receive the materials, in accordance with the terms and conditions of licenses issued by the NRC or an Agreement State; and 6. As calibration sources and reference standards for operational testing of radiation detection and measuring equipment. All activities and services will be performed in accordance with MACTEC, Inc.'s Radiation Protection Program and its accompanying procedures, and all applicable client, State, and federal regulatory requirements.		Yes

Item No.	Response	Yes	Description Attached
7.	**INDIVIDUAL(S) RESPONSIBLE FOR RADIATION SAFETY PROGRAM AND THEIR TRAINING EXPERIENCE** **Executive Management** Mr. Bruce Coles, Chairman and Chief Executive Officer of MACTEC, Inc., resides in Alpharetta, GA at the company's Headquarters office location. Mr. Coles operates MACTEC with a commitment and a broad understanding of radiological issues. Mr. Coles is committed as Chairman and CEO of MACTEC, to enforce its requirements and continue to pursue excellence in all company radiological protection matters. **Radiation Safety Committee** Mr. Jeff Lively, CSP, RRPT is a Health Physicist and Chairman of the MACTEC, Inc. Radiation Safety Committee. His thorough and complete knowledge and understanding of radiation safety issues and health physics fundamentals, as well as his leadership abilities, create a truly effective Radiation Safety Committee Chairman. Given the authority to communicate up and down the organizational structure, Mr. Lively presents radiation safety issues to key people in a timely manner. Throughout his career, Mr. Lively has performed in virtually all positions within a Radiation Protection Program. Mr. Lively has the experience and knowledge appropriate for the role as Chairman of the Radiation Safety Committee. Appendix 3, "Resumes" contains specific information regarding the training and experience of the Radiation Safety Committee Chairman which is relative to the license material requested in this application. Other members of the Radiation Safety Committee may include, but are not limited to: Steven Rima, CHP, CSP Peter Collopy, CHP, CIH Kyle Kleinhans, CHP Michael McDonald, CHP, RRPT Heath Downey, CHP Arthur Samiljan, Health Physicist Jeffrey Thompson, Health Physicist Kris Smith, Health Physicist		Yes

Item No.	Response	Yes	Description Attached
7.	**INDIVIDUAL(S) RESPONSIBLE FOR RADIATION SAFETY PROGRAM AND THEIR TRAINING EXPERIENCE** *(cont'd)* The Radiation Safety Committee, along with management and the Radiation Safety Officer, will review and approve Radiation Protection Program changes and documentation in accordance with criteria developed and approved by the Radiation Safety Committee and delineated in the Radiation Protection Program and related operating procedures. The Radiation Safety Committee is authorized to make Radiation Protection Program changes and changes to operating procedures specifically identified in this license application, without NRC approval, so long as: • The revised Radiation Protection Program is in accordance with regulatory requirements, will not change license conditions, and will not decrease the effectiveness of the Radiation Protection Program. • The Staff is trained in the revised procedure(s) prior to implementation. • The audit program evaluates the effectiveness of the implemented change. **Radiation Safety Officer** The Radiation Safety Officer (RSO) for this license is: Steven D. Rima, CHP, CSP Radiological Engineering Manager MACTEC Development Corporation 751 Horizon Court, Suite 104 Grand Junction, CO 81506 Phone: 970-243-2861 Fax: 970-256-7356 Mobile: 970-260-3848 Email: sdrima@mactec.com		

Item No.	Response	Yes	Description Attached
7.	**INDIVIDUAL(S) RESPONSIBLE FOR RADIATION SAFETY PROGRAM AND THEIR TRAINING EXPERIENCE** *(cont'd)*		
	Appendix 1, "Radiation Protection Program," Section 11.0, Responsibilities, delineates the RSO's responsibilities and duties as the MACTEC, Inc. Corporate RSO and the RSO under this license application.		Yes
	Appendix 2, MACTEC "Organizational Chart" diagrams the management structure, reporting paths, and flow of authority between management, the Radiation Safety Committee Chairman, and the Radiation Safety Officer.		Yes
	Appendix 3, "Resumes" contains specific information regarding the training and experience of the Radiation Safety Officer and Radiation Safety Committee Chairman which are relative to the license material requested in this application.		Yes
	Appendix 4, "Radiation Safety Officer Delegation of Authority," delegates the authority and duty to the RSO.		Yes
	Licensed material may be used by individuals authorized (in writing) by the RSO, or if used by unauthorized individuals, shall be under the supervision of at least one authorized individual while in use.		

Item No.	Response	Yes	Description Attached
8.	**TRAINING FOR INDIVIDUALS WORKING IN OR FREQUENTING RESTRICTED AREAS (INSTRUCTIONS FOR OCCUPATIONAL WORKERS AND ANCILLARY PERSONNEL)** MACTEC's "Radiation Protection Program," Section 9.0 Training, Appendix 1, provides training guidance as an upper-tier document regarding radiological worker training while MACTEC's Radiological Training Procedures (RPT-01, 02, 03, 05, and 06) outline the specifics of radiological worker training and retraining of those workers. The guidance presented in these procedures conform to the requirements of §19.12 regarding training of employees receiving occupational exposure. MACTEC's Radiological Training Procedures are included in Appendix 5.		Yes

Item No.	Response	Yes	Description Attached
9.	**FACILITIES AND EQUIPMENT** MACTEC does not own nor operate a facility for radioactive material handling or processing. If in the future, MACTEC acquires or builds a permanent facility that is used as a radio-laboratory or radioactive material processing facility, this facility shall be designed or modified (as necessary) to protect health, minimize danger to life or property, minimize the possibility of contamination, and keep exposures to workers and the public ALARA. In addition, the license would need to be amended to include this facility and the program(s) that demonstrate compliance with regulatory requirements, prior to use (with radioactive materials). All waste processing functions are contracted by the client/generator or by MACTEC, Inc. for the client/generator. MACTEC owns several different types and models of radiological survey, counting, and analytical laboratory instrumentation and will use these instruments as necessary. MACTEC will rent, lease or purchase additional instrumentation/equipment from other companies/vendors, as needed. MACTEC will ensure radiological instrumentation/equipment used for radiological survey, counting, or analysis is calibrated in accordance with the applicable ANSI Standard(s) and regulatory requirement(s) and is appropriate for the radiation being surveyed. MACTEC will only use NVLAP Certified dosimetry vendors for dosimetry needs. For bioassay services, MACTEC will only use laboratories certified for bioassay sample analysis. MACTEC will only employ the services of laboratories using NIST traceable sources, and EPA and other standard analytical analysis methodologies for specific sample counting analyses.		

Item No.	Response	Yes	Description Attached
10.	**RADIATION SAFETY PROGRAM** MACTEC has performed decontamination and demolition (D & D) as well as remediation work involving radioactive materials and hazardous waste, and has performed these services as a subcontractor for entities/facilities licensed by the NRC and for facilities operated by the Department of Energy. MACTEC has an operational Radiation Protection Program, as described in Appendix 1, "Radiation Protection Program," and includes administrative and operational radiation protection procedures for work preformed. Relevant procedures from MACTEC's Radiation Protection Program are included in Appendix 5 and pertains to the following topics: **Internal Audits** Includes a description of the mechanisms used by management to ensure that adequate oversight of the Radiation Protection Program is exercised. **Radiation Monitoring Instrumentation** Includes the Radiation Protection Operational procedures, RSO approval of these procedures, calibration requirements and frequencies, and NRC licensing of the calibration vendor. **Material Receipt and Accountability** Includes the operating procedures for ordering and receiving radioactive material. **Occupational Dose** Includes descriptions of methods for maintaining compliance with federal regulations concerning occupational dose. **Public Dose** Records concerning public dose will be maintained for review. **Safe Use of Radionuclides and Emergency Procedures** Includes procedures for the safe use of radionuclides, security of radioactive material, and emergencies. **Surveys (including leak test)** Includes procedures to evaluate both external and internal radiological hazards. **Transportation** Records concerning transportation of radioactive material will be maintained for review.		Yes

Item No.	Response	Yes	Description Attached
11.	**WASTE MANAGEMENT** Procedures for waste collection, storage, and disposal are addressed in the MACTEC Radiation Protection Program procedures. Relevant excerpts of the waste management section are included in Appendix 5. Additionally, each particular project work plan will address waste management concerns pertaining to that project (as applicable). All waste shipments will comply with all applicable NRC and DOT requirements.		Yes

MACTEC, Inc.

Appendix 1 - Radiation Protection Program
Appendix 2 - Organizational Chart
Appendix 3 - Resumes
Appendix 4 - Radiation Safety Officer Delegation of Authority
Appendix 5 - Relevant Procedures From MACTEC's Radiation Protection Program

RPP-101	ALARA Program
RPO-101	Radiation Protection Program Overview
RPO-103	Radiation Protection Audits, Assessments and Oversight
RPO-104	Routine Radiation Protection Surveys and Inspections
RPO-106	Radiological Training and Qualification
RPO-107	Radiological Improvement Report
RPO-201	Operation of Portable Radiological Survey Instruments
RPO-202	Operation of the Eberline E-600
RPO-204	Calibration and Quality Control of Portable Radiological Survey Instruments
RPO-208	Operation and Calibration of Air Samplers
RPO-301	Radiological Surveys
RPO-303	Area Air Sampling
RPO-401	Radiation Work Permits
RPO-402	Radiological Posting and Labeling
RPO-403	Access to Radiological Areas
RPO-404	Sealed Source Accountability and Leak Checks
RPO-405	Respiratory Protection
RPO-406	Internal and External Personnel Monitoring
RPO-501	Radiological Incident Response
RPO-601	Shipping and Transportation of Radioactive Materials
RPO-602	Radiological Waste Handling
RPO-603	Environmental Monitoring
RPO-610	Receipt and Control of Licenses Radioactive Material

RPT-01	Training Program Overview
RPT-02	RWT Program
RPT-03	GERT Program
RPT-05	Admin and Control of Examinations
RPT-06	Conducting Radiological Training

MACTEC, Inc.

Appendix 1

Radiation Protection Program

MACTEC, Inc.

RADIATION PROTECTION PROGRAM

Approved by: _____ Date: September 28, 2001
Steven D. Rima, CHP, CSP
Radiological Engineering Mgr.

Approved by: _____ Date: September 28, 2001
Bhaskar Patel
President, MACTEC Constructors, Inc.

Approved by: _____ Date: September 28, 2001
Claude Corvino, P.E.
President, Harding ESE, Inc.

Approved by: _____ Date: September 28, 2001
Terrence A. LiPuma, P.E.
President, Pacific Environmental Services, Inc.

Approved by: _____ Date: September 28, 2001
Scott E. State, P.E.
Chairman and CEO, MACTEC, Inc.

MACTEC, Inc. Radiation Protection Program

1.0 Purpose

The MACTEC, Inc. Corporate Radiation Protection Program (RPP) establishes guidelines and standards for protection against ionizing radiation when developing work site or job-specific Radiation Protection Manuals or Procedures for contract activities conducted for the Department of Energy (DOE), Department of Defense (DoD), U.S. Army Corps of Engineers (USACE), under a license issued by the Nuclear Regulatory Commission (NRC) or an Agreement State. It is intended to control the receipt, possession, use, transfer, and disposal of radioactive material in such a manner that the total dose to an individual is maintained As Low As Reasonably Achievable (ALARA) and does not exceed the standards for protection against radiation prescribed by applicable regulations.

2.0 Scope

This RPP applies to MACTEC, Inc. and its subsidiaries employees and subcontractors that handle radioactive materials or may be exposed to ionizing radiation where their work assignment is controlled by MACTEC. No one may act (or cause others to act) in a manner inconsistent with this RPP. However, nothing in this RPP shall be construed as limiting actions that may be necessary to protect health and safety.

The limits in this RPP do not apply to doses due to:

- background radiation,
- exposure of patients to radiation for the purpose of medical diagnosis or therapy,
- exposure from individuals administered radioactive material and released in accordance with 10 CFR 35.75,
- exposure from voluntary participation in medical research programs,
- consumer products emitting nominal amounts of radiation, or
- activities conducted under the Nuclear Explosives and Weapons Surety Program (relating to the prevention of accidental or unauthorized nuclear detonations).

MACTEC, Inc. management, supervisors, workers and contractors shall comply with the requirements in this document and its supplements when managing or conducting radiological work, either onsite or offsite. Work conducted at another site or location where MACTEC does not have overall management responsibility for radioactive materials work must be conducted in accordance with the site's governing program, RPP or license conditions, as long as the requirements of that program are at least as restrictive as those in this RPP.

3.0 Administration

3.1 Policy

It is the policy of MACTEC, Inc. to conduct its radiological operations in a manner that ensures the health and safety of all its employees, contractors, and the general public. In achieving this objective, MACTEC, Inc. shall ensure that radiation exposures to its workers, general public and releases of radioactivity to the environment are maintained below regulatory limits. Deliberate efforts shall be taken to further reduce exposures and releases As Low As Reasonably Achievable (ALARA). The company is fully committed to implementing a radiological control program of the highest quality that consistently reflects this policy. In meeting this policy, the company shall:

- Establish and implement a Radiation Protection Program that includes plans and procedures reflective of federal and/or state radiation protection standards and recommendations.
- Ensure personnel responsible for performing radiological work activities are appropriately trained. Standards shall be established to ensure the technical competency of the workforce, as appropriate, through implementation of radiological training and professional development programs.
- Ensure the technical competence of personnel responsible for implementing and overseeing the radiological control program. Qualification requirements commensurate with this objective shall be established for technical and professional radiological control program positions and shall, at a minimum, be consistent with applicable industry standards and promote professional development and excellence in radiological performance as goals.
- Establish and maintain, at all levels, management involvement and accountability for radiological performance. The responsibility for compliance with radiological protection requirements, and for minimizing personnel radiation exposure, starts at the worker level and broadens as it progresses upward through the line organization. Managers are fully responsible for radiological performance within their programs and the field activities and sites assigned to them, and shall take necessary actions to ensure requirements are implemented and performance is monitored and corrected as necessary.
- Ensure radiological measurements, analyses, worker monitoring results and estimates of public exposures are accurate and appropriately made.
- Conduct radiological operations in a manner that controls the spread of radioactive materials and reduces exposure to the workforce and the general public and utilize a process that seeks exposure levels that are ALARA.
- Incorporate dose reduction, contamination reduction, and waste minimization features into the design of new facilities and significant modifications to existing facilities in the earliest planning stages. Wherever possible, facility design features shall be directed toward controlling contamination at the source, eliminating airborne radioactivity, maintaining personnel exposure and effluent releases below regulatory limits, and utilizing a process that seeks exposure levels and releases that are ALARA. Radiological design criteria shall reflect

appropriate consensus recommendations of national and international standards setting groups.

- Conduct oversight to ensure all requirements are being complied with and appropriate radiological work practices are being implemented. All company radiological operations shall be conducted in a manner consistent with the above policies and objectives.

3.2 Internal Audits

MACTEC, Inc. shall conduct internal audits of the radiation protection program to identify its strengths and weaknesses, areas of vulnerability, and noncompliance. The audits shall be conducted on every major program element no less frequently than every 36 months and shall include examination of the radiation protection program's content and implementation.

3.3 As Low As Reasonably Achievable (ALARA)

The ALARA philosophy is based on the supposition that radiation dose increases one's risk of cancer—the smaller the dose, the smaller the risk. ALARA is an approach to radiation protection to manage and control individual and collective dose to employees, the public and the environment to levels that are as low as reasonable, taking into account social, technical, economic, practical, and public policy considerations. ALARA is not a dose limit, but a process for maintaining doses as far below the applicable limits as is reasonably achievable. MACTEC, Inc. will use, to the extent practical, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are ALARA. The MACTEC, Inc. ALARA Program contains formal plans and measures for applying the ALARA process to occupational radiation exposure.

3.4 Design Criteria

During routine operations, a combination of physical design features and administrative controls shall be implemented to ensure that any anticipated occupational dose does not exceed allowable dose limits.

3.5 Written Authorizations, Safety Plans and Operating Procedures

Written plans and procedures (e.g., safety plans and operating procedures) shall be developed and implemented as necessary to ensure compliance with this RPP. These plans and procedures shall be commensurate with the radiological hazards created by the activity and consistent with the education, training and skills of the individuals exposed to those hazards. Such written plans and procedures are generally written to apply to one site or activity.

4.0 Radiation Protection Standards

4.1 Occupational Dose Limits

Table 1 contains the dose limits for different categories of people. Doses from background radiation, therapeutic and diagnostic medical exposures, and those resulting from participation as a subject in medical research programs are not included in dose records or when assessing compliance with the occupational dose limits.

Table 1. Annual dose limits

Category	Annual limit (rems)	Dose
General Employees	5 50 15 50	Whole body (internal plus external) Any organ other than eye (internal plus external) Lens of the eye Extremities and skin
Embryo/fetus of a declared pregnant worker	0.5	Internal plus external (evenly distributed throughout gestation)
Occupationally exposed minors	0.1 1.5 5	Whole body (internal plus external) Lens of the eye Extremities and skin
Members of the public	0.1	Whole body (internal plus external)

- Doses received in excess of the annual limits, including doses received during accidents, emergencies, and planned special exposures, must be subtracted from the limits for planned special exposures that the individual may receive during the current year and during the individual's lifetime.
- The assigned deep dose equivalent and shallow dose equivalent must be for the part of the body receiving the highest exposure. The deep dose equivalent, lens dose equivalent, and shallow dose equivalent may be assessed from surveys or other radiation measurements for the purpose of demonstrating compliance with the occupational dose limits, if the individual monitoring device was not in the region of highest potential exposure, or the results of individual monitoring are unavailable.
- In addition to the annual dose limits, soluble uranium intake by an individual shall be limited to 10 milligrams in a week in consideration of chemical toxicity.
- The occupational exposure that an individual may be allowed to receive in the current year shall be reduced by the amount of occupational exposure received while employed by any other company or organization.

4.2 Occupationally Exposed Minors

The MACTEC, Inc. Radiation Safety Officer (RSO) shall evaluate all radiological work that is proposed to be performed by minors.

4.3 Fetal Exposure Minimization Policy

All women working in an environment where exposure to radiation or radioactive materials shall be provided:

- With pregnancy-related information such as NRC Regulatory Guide 8.13, *Instruction Concerning Prenatal Radiation Exposure.*
- An interview with the RSO to ask questions concerning the ramifications of exposure to the embryo/fetus, and determine the potential for occupational exposure to workplace hazards in their current assignment.
- How to declare her pregnancy in writing and limiting radiation exposure to 0.5 rems during the gestation period, and an evaluation of their current work assignment.

All women shall sign a Fetal Exposure Minimization Policy Training Acknowledgement Form that acknowledges that they have received information concerning exposure to the embryo/fetus and the process for declaring a pregnancy.

4.4 Planned Special Exposures (PSE)

Provisions for planned special exposures, which are in addition to and accounted for separately from routine occupational doses, shall be authorized by the MACTEC RSO. Planned Special Exposures should only be authorized in exceptional situations when alternatives which might avoid the higher exposure are unavailable or impractical.

The following conditions apply to all planned special exposures:

1. The individual(s) involved are informed of the purpose of the planned operation.
2. The individual(s) involved are informed of the estimated exposure and special radiation or other conditions that might be involved in performing the task.
3. The individual(s) involved are instructed in the measures to be taken to keep their exposure ALARA considering other risks that may be present.
4. A complete and documented lifetime exposure history for each individual shall be available.
5. A PSE shall not be authorized that would cause an individual to receive a dose from all planned special exposures and doses in excess of the limits to exceed:
    a. The numerical values of any of the federal limits in any year, and
    b. Five times the annual limits during the individual's lifetime

MACTEC shall maintain records of all Planned Special Exposures in accordance with federal regulations and report to the individuals in writing the best estimate of their exposure within 30 days of the exposure.

5.0 Posting Requirements

5.1 General

Posting, deposting, or altering of signs containing the radiation trefoil symbol shall only be done by, or under the direction of, personnel qualified in radiation protection functions in accordance with approved procedures. Applicable implementing procedures contain approved radiological signs and labels as well as guidance for when and where they should be posted.

All radiological postings shall be in accordance with requirements contained in 10 CFR 20, 10 CFR 835, applicable State regulations, or specific license conditions.

When posting access points to an area, the following apply:

- All access doors that can be opened from the outside must be posted, even if the door remains locked. (This posting protects individuals such as security guards, firefighters, and other emergency responders who may enter the area using master keys.) Individuals who allow others to access an area through such doors must ensure those entering the area abide by the access control requirements.
- Doors that cannot be opened from the outside (e.g., highbay rollup doors or emergency exits out of a Plutonium Facility) are only considered access points if they are left open and unattended.
- Side-by-side doors do not have to be individually posted if it is obvious that both doors provide access to the same area and an appropriate sign is clearly and conspicuously posted.

Posting requirements may be waived for periods of less than 8 continuous hours when the area is placed under the continuous observation and control of an individual knowledgeable of and empowered to implement required access and exposure control measures.

6.0 Individual Exposure Monitoring

Individual monitoring of personnel dose shall be done in accordance with the MACTEC, Inc. Dosimetry Manual.

MACTEC shall maintain dose records for all individuals for whom monitoring is required. Records shall include doses received as a result of:

- Routine occupational exposures.
- Planned special exposures.
- Authorized emergency exposures.

Documentation of all previous occupational doses received shall be documented on a NRC Form 4 or equivalent. If an individual's records are estimates or incomplete MACTEC shall make reasonable efforts (at least two written attempts) to obtain complete records of each individual's prior years' occupational dose. If complete records cannot be obtained, a written estimate signed by the individual may be accepted to demonstrate compliance with federal regulations.

Dosimetry records, including detailed information, identified with a specific individual shall be readily available to that individual and to others on a need-to-know basis (e.g., the individual's supervisor, management, and safety personnel). Individuals can request their dosimetry records from the MACTEC RSO.

Upon request, MACTEC, Inc. shall provide dose records to an individual terminating employment as soon as the data is available, but not later than 90 days after termination. If requested, a written estimate of the radiation dose received by that employee (based on available information) shall be provided at the time of termination.

NOTE: **Where MACTEC is the licensee for a site or project, MACTEC will be responsible for the generation, storage, maintenance and transmittal of exposure records. Where MACTEC performs work on a site or project under the license of another entity, that licensee is responsible for such records.**

7.0 Monitoring the Work Environment

Monitoring of work areas is performed to:

- Demonstrate compliance with federal and/or state regulations.
- Document radiological conditions.
- Detect changes in radiological conditions.
- Detect the gradual buildup of radioactive material.
- Verify the effectiveness of engineered and process controls for containing radioactive materials and reducing radiation exposure.
- Identify and control potential sources of individual exposure to radiation and radioactive materials.

Monitoring shall be done in accordance with written procedures.

7.1 Portable Radiation Detection Instruments

Instruments and equipment used for radiological monitoring shall be:

- Periodically maintained and calibrated on an established frequency (typically, annually).
- Appropriate for the types, levels, and energies of the radiation.
- Appropriate for existing environmental conditions.
- Routinely tested for operability.

8.0 Access Controls

Access controls to areas posted with the suitable radiological posting include training (see Section 9.0) and the controls listed in this section.

8.1 Radiological Areas

Personnel entry control shall be maintained for each Radiological Controlled Area. The degree of control shall be commensurate with existing and potential radiological hazards within the area. One or more of the following control methods shall be used:

- Signs and barricades.
- Control devices on entrances.
- Conspicuous visual and/or audible alarms.
- Locked entrance ways.
- Administrative controls.

Controls that would prevent rapid evacuation of personnel under emergency conditions shall not be installed at any Radiological Area exit.

8.2 High Radiation Areas

Access to High Radiation Areas shall be monitored as necessary to determine the exposure rates to individuals in the area. Hand-held radiation detectors should be used in addition to any installed radiation area monitors (RAMs) because the area dose rates may vary significantly. In addition, a supplemental dosimeter is required for access to High Radiation Areas. This dosimeter must be capable of providing an immediate estimate of the individual's integrated deep dose equivalent during the entry. Where a supplemental dosimeter is impractical or ineffective (e.g., when monitoring doses from neutron radiation), other means (e.g., knowledge of the area exposure rate and tracking of individual access times) may be used to provide an immediate estimate of an individual's dose.

One or more of the following controls shall be used for each access point to a High Radiation Area where an individual's whole-body dose could exceed 1 rem in any one hour at 30 cm from the source or from any surface that the radiation penetrates:

- A control device that prevents entry into the area when high-radiation levels exist or that, upon entry, causes the radiation level to be reduced below levels that define a High Radiation Area.
- A device that functions automatically to prevent use or operation of the radiation source or field while individuals are in the area.
- A control device that energizes a conspicuous visible or audible alarm signal so that the individual entering the High Radiation Area and the supervisor of the activity are made aware of the entry. The audible signal shall be of a frequency

(or be capable of producing a sound-pressure level) that can be heard over background noise.

- Entryways that are locked. During periods when access to the area is required, positive control over each entry is maintained.
- Continuous, direct, or electronic surveillance that is capable of preventing unauthorized entry.
- A control device that will automatically generate audible and visual alarm signals to alert personnel in the area of the intended use or operation of the radiation source in sufficient time to either evacuate the area or activate a secondary control device that will prevent use or operation of the source.

8.3 Very High Radiation Areas

In addition to the requirements in Section 8.2, the programmatic organization shall implement additional measures, such as double controlled locks, to ensure individuals are not able to gain unauthorized or inadvertent access to Very High Radiation Areas.

9.0 Training

Radiological training shall be conducted in accordance with established written procedures applicable to the project, location, or level of hazard. Each individual shall complete radiation safety training, commensurate with the hazards in the area and the required controls:

- Before being permitted unescorted access to radiologically controlled areas.
- Before receiving occupational dose during access to radiologically controlled areas.

Furthermore, radiation safety training shall be provided to individuals:

- At intervals not to exceed 24 months.
- When there is a significant change to radiation protection policies and procedures that may affect the individual.

Radiation safety training should include the following topics, as a minimum, to the extent appropriate to each individual's prior training, work assignments, and degree of exposure to potential radiological hazards:

- Risk of exposure to radiation and radioactive materials, including prenatal radiation exposure.
- Basic radiation fundamentals and radiation protection concepts.
- Controls for both routine and emergency actions implemented at the local level to manage and maintain doses as low as reasonably achievable (e.g., physical design features, administrative controls, limits, policies, procedures, alarms, and other measures).
- The individual's rights and responsibilities for implementing the facility's radiological protection program.
- The individual's responsibilities for implementing ALARA measures.
- Reports the individual may request.

If an escort is used in lieu of training, the escort shall have completed the training required for unescorted access to the area and must ensure that all escorted individuals comply with the safety requirements of this document and its supplements.

Records shall be maintained to demonstrate compliance with the training requirements in this section.

10.0 Records

Records that are generated as a result of the requirements of this RPP must be retained until the applicable regulation authorizes their disposition.

11.0 Responsibilities

Organizational responsibilities have been established to ensure an effective implementation of the RPP. The responsibilities of individuals and organizations with regards to occupational radiation protection are specified below.

11.1 MACTEC, Inc. Radiation Safety Officer (RSO)

The MACTEC, Inc. Radiological Engineering Manager is designated as the corporate RSO. The RSO is responsible for the overall content and implementation of this RPP at all company-controlled sites and projects where MACTEC is the licensee or where MACTEC is charged by contract with implementation of a radiation protection program. The RSO provides direction and guidance on the development and implementation of site- or project-specific radiation protection procedures and programs.

11.2 Project/Office Manager

The Project or Office Manager is responsible for the safety and health of MACTEC, employees and for compliance with the requirements of this RPP. To meet this requirement, management shall ensure that appropriate authority, commitment, support, and resources are assigned to all levels of the organization to implement the program and to achieve the desired goals.

11.3 Project- or Site-Specific Radiation Safety Officer

The MACTEC, Inc. RSO may, in some cases, delegate radiation protection management and oversight responsibilities to a person designated as the RSO for a specific site, location, office, or project. This RSO is responsible for the development, maintenance, oversight and implementation of radiation protection programs and procedures specific to the site or project.

11.4 Health Physics Technician (HPT)

The HPT assists program, facility, and service workers with implementing the compliance requirements specified in this document and related implementing procedures, fulfills the posting and monitoring requirements of federal regulations, informs workers and supervisors of actions or operations that are inconsistent with procedures or best management practices, and responds to radiological alarms, spills, accidents, and emergencies.

11.5 Radiological Workers

Radiological Workers shall comply with all written radiation protection program and procedure requirements, minimize personal radiation exposure and the spread of radioactive contamination by adhering to all radiological safety requirements, reporting any radiological problems, and following established good work practices.

12.0 References

USNRC, 10 CFR 20, *Standards for Protection Against Radiation*

USNRC, 10 CFR 19, *Notices, Instructions and Reports to Workers: Inspections and Investigations*

USDOE, 10 CFR 835, *Occupational Radiation Protection, Final Rule*

Appendix A

Terms and Definitions

The terms and definitions provided in this appendix are specific to their use in this document.

As low as reasonably achievable (ALARA)	An approach to radiation protection to manage and control individual and collective dose to the work force and to the general public to as low as is reasonable, taking into account social, technical, economic, practical, and public policy considerations. ALARA is not a dose limit but a process that has the objective of attaining doses as far below the applicable limits as is reasonably achievable.
Background radiation	Radiation from: • Naturally occurring radioactive materials that have not been technologically enhanced. • Cosmic sources. • Global fallout as it exists in the environment (such as from the testing of nuclear explosive devices). • Radon and its progeny in concentrations or levels existing in buildings or the environment that have not been elevated as a result of current or prior activities. • Consumer products containing nominal amounts of radioactive material or producing nominal amounts of radiation.
Calibration	To adjust or determine either: • The response or reading of an instrument relative to a standard (e.g., primary, secondary, or tertiary) or to a series of conventionally true values. • The strength of a radiation source relative to a standard (e.g., primary, secondary, or tertiary) or conventionally true value.
Committed dose equivalent ($H_{T,50}$)	The dose equivalent calculated to be received by a tissue or organ over a 50-year period after intake of a radionuclide into the body. It does not include contributions from radiation sources external to the body. Committed dose equivalent is expressed in units of rem.

Committed effective dose equivalent (CEDE)	The sum of the committed dose equivalent to various tissues in the body ($H_{T,50}$), each multiplied by the appropriate weighting factor (w_T) – that is, $H_{E,50} = \sum w_T H_{T,50}$. Committed effective dose equivalent is expressed in units of rem.
Contamination Area	Any area, accessible to individuals, where removable surface contamination levels exceed or are likely to exceed the removable surface contamination values specified in the site or project's implementing procedures.
Controlled area	Any area where access is managed to protect individuals from exposure to radiation or radioactive material.
Declared pregnant worker	A woman who has voluntarily declared to her employer, in writing, her pregnancy for the purpose of being subject to the occupational dose limits to the embryo/fetus as provided in this RPP. The declared pregnant worker may voluntarily revoke this declaration, in writing, at any time.
Deep dose equivalent	The dose equivalent derived from external radiation at a depth of 1 cm in tissue.
Direct guidance	For the purpose of the CFR, direct guidance requires a fully trained co-worker or supervisor to be in audible or visual contact with the worker who is not fully trained so that guidance and assistance can be readily provided if necessary. The level of supervision must be commensurate with the hazards of the operation and the level of training completed by the worker
Dose	A general term for absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or total effective dose equivalent.
Dose equivalent (H)	The product of absorbed dose (D) in rad in tissue, a quality factor (Q), and other modifying factors (N). Dose equivalent is expressed in units of rem.
Effective dose equivalent (H_E)	The summation of the products of the dose equivalent received by specified tissues of the body (H_T) and the appropriate weighting factor (w_T) – that is, $H_E = w_T H_T$. It includes the dose from radiation sources internal and external to the body. For purposes of compliance with the CFR, deep dose equivalent to the whole body may be used as effective dose equivalent for external exposures. The effective dose equivalent is expressed in units of rem.

External dose or exposure	That portion of the dose equivalent received from radiation sources outside the body (i.e., external sources).
Extremity	Hands and arms (below the elbow) or feet and legs (below the knee).
High Radiation Area	Any area, accessible to individuals, where radiation levels could result in an individual receiving a deep dose equivalent in excess of 0.1 rem in one hour at 30 cm from the radiation source or from any surface that the radiation penetrates.
Internal dose or exposure	That portion of the dose equivalent received from radioactive material taken into the body (i.e., internal sources).
Member of the public	An individual who is not a general employee. An individual is not a member of the public during any period in which he/she receives an occupational dose.
Minor	An individual less than 18 years of age.
Monitoring	The measurement of radiation levels, airborne radioactivity concentrations, radioactive contamination levels, quantities of radioactive material, or individual doses and the use of the results of these measurements to evaluate radiological hazards or potential and actual doses resulting from exposures to ionizing radiation.
Occupational dose	An individual's ionizing radiation dose (external and internal) as a result of his/her work assignment. Occupational dose does not include doses received as a medical patient or doses resulting from background radiation or participation as a subject in medical research programs.
Radiation	Ionizing radiation: alpha particles, beta particles, gamma rays, x rays, neutrons, high-speed electrons, high-speed protons, and other particles capable of producing ions. Radiation, as used in the Rule, does not include nonionizing radiation (e.g., radiowaves, microwaves, or visible, infrared, or ultraviolet light).
Radiation Area	Any area, accessible to individuals, where radiation levels could result in an individual receiving a deep dose equivalent in excess of 0.005 rem (5 mrem) in one hour at 30 centimeters from the source or from any surface that the radiation penetrates.

Radioactive material transportation	The movement of radioactive material by aircraft, rail, vessel, or highway vehicle that is governed by DOT regulations or DOE orders. Radioactive material transportation does not include preparation or packaging of material for transportation, monitoring required by the CFR, storage of material awaiting transportation, or application of markings and labels required for transportation.
Radiological Area	Any area within a controlled area defined as a Radiation Area, High Radiation Area, Very High Radiation Area, Contamination Area, High Contamination Area, or Airborne Radioactivity Area.
Radiological worker	A general employee whose job assignment involves working with radioactive materials, or who is likely to receive a total effective dose equivalent above 0.1 rem per year from routine occupational exposures.
Shallow dose equivalent	The dose equivalent deriving from external radiation at a depth of 0.007 cm in tissue.
Total effective dose equivalent (TEDE)	The sum of the effective dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).
Very High Radiation Area	Any area accessible to individuals where radiation levels could result in an individual receiving an absorbed dose in excess of 500 rads in one hour at 1 m from a radiation source or from any surface that the radiation penetrates.
Weighting factor (w_T)	The fraction of the overall health risk, resulting from uniform, whole-body irradiation, attributable to specific tissue (T). The dose equivalent to tissue (H_T) is multiplied by the appropriate weighting factor to obtain the effective dose equivalent contribution from that tissue. Weighting factors are provided in applicable regulations.
Whole body	For the purposes of external exposure, any exposure to the head, trunk (including male gonads), arms (above and including the elbow), or legs (above and including the knee).

Appendix B

Conducting Internal Audits

Internal audits of the radiation protection program shall be conducted no less frequently than every 36 months. To ensure a comprehensive evaluation, both institutional and facility-specific audits are conducted. Institutional audits may evaluate:

- Management and administration.
- The ALARA Program.
- Radiological training.
- Internal dosimetry.
- External dosimetry.
- Instrument calibration and maintenance.
- Radiation-generating devices.
- Sealed source accountability.

Facility audits focus on how the radiological protection program is implemented in facilities, and include both facility and programmatic implementation of radiological requirements. Facility audits may evaluate:

- Radiation protection written program and procedure documents.
- Implementation of the ALARA Program.
- Individual monitoring, including appropriate use of dosimeters and enrollment and participation in bioassay programs.
- Area monitoring, including air monitoring, contamination monitoring, and radiation monitoring.
- Access controls.
- Radioactive material controls.
- Posting and labeling.
- Training.
- Records.
- Design and control of facility modifications and equipment.

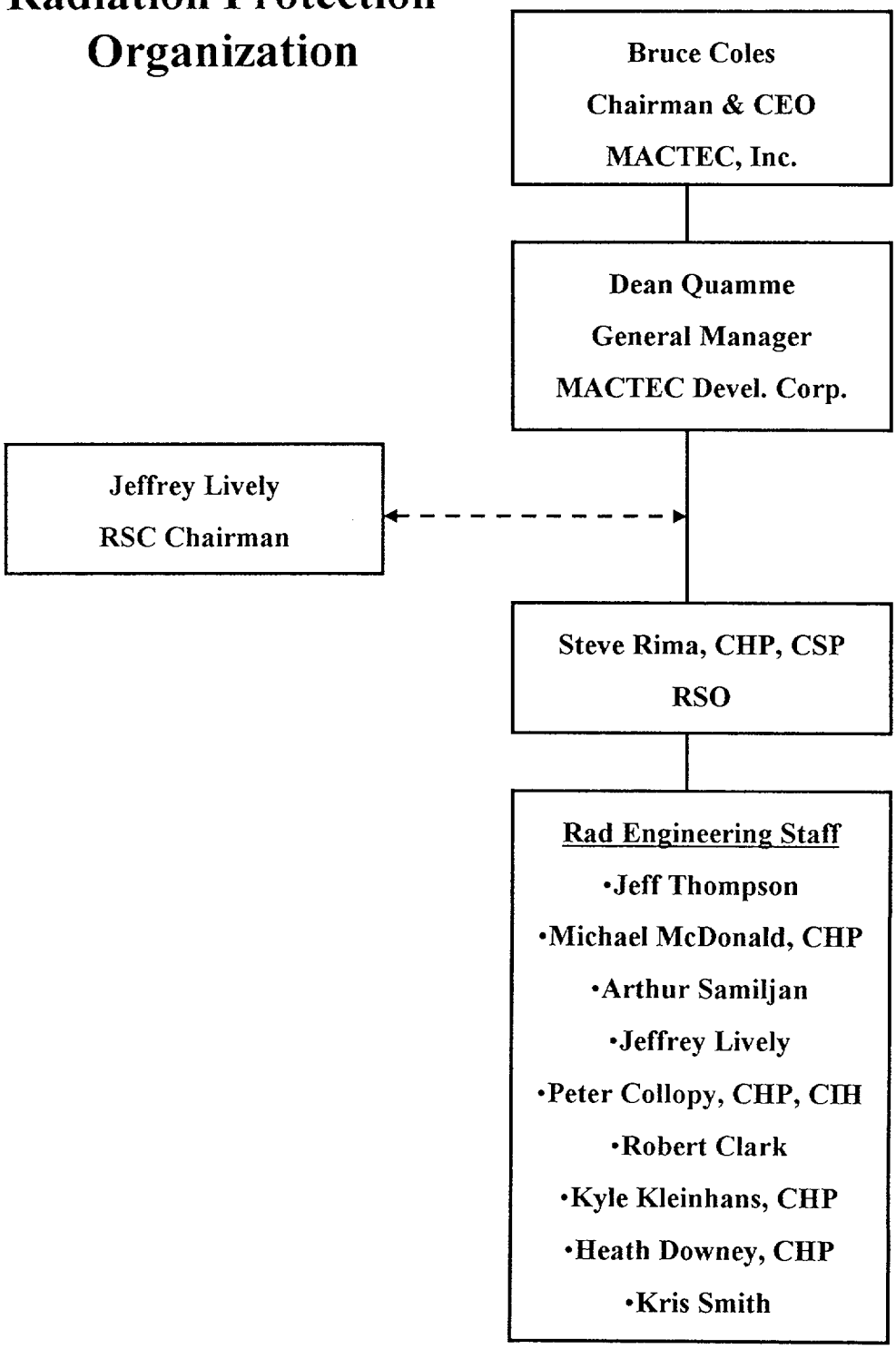
The MACTEC, Inc. RSO or designee is responsible for coordinating and conducting the audits. At the end of each 3-year audit cycle, the RSO presents a comprehensive report to MACTEC, Inc. management.

All audits and assessments shall be documented. Findings or violations shall be recorded and tracked, including corrective actions.

Appendix 2

Organizational Chart

MACTEC, Inc.
Radiation Protection Organization



MACTEC, Inc.

Appendix 3

Resumes

MACTEC, Inc.

Resume of:

STEVEN D. RIMA, CHP, CSP
CERTIFIED HEALTH PHYSICIST
CERTIFIED SAFETY PROFESSIONAL

BACKGROUND

Mr. Rima has over 25 years of diverse experience in the development, implementation, training, and management of Health Physics, Industrial Safety and Industrial Hygiene programs in commercial nuclear power, DOE, DoD, and private industry settings, including large environmental remediation and decontamination and decommissioning projects. He is certified in both Comprehensive Health Physics by the American Board of Health Physics (ABHP) and Comprehensive Practice by the Board of Certified Safety Professionals (BCSP). He is an expert in the development and implementation of programs to meet NRC, DOE, DoD, DOT, EPA, USACE, OSHA, and various state regulations.

EDUCATION/CERTIFICATIONS/MEMBERSHIPS/CLEARANCES

- Bachelor of Science, Applied Science and Technology (B.S.A.S.T.) candidate, Health Physics, Thomas Edison State College, New Jersey
- Certified by the American Board of Health Physics (ABHP) in Comprehensive Health Physics, 1993, recertified 1997, 2001
- Certified by the Board of Certified Safety Professionals (BCSP) in Comprehensive Safety Practice, 1998.
- Registered with the National Registry of Radiation Protection Technologists (NRRPT), 1985
- Plenary member of the Health Physics Society, 1982-present
- Member of the NRRPT Panel of Examiners and Board of Directors, 1988-1992
- Active DOE 'L' security clearance

EXPERIENCE HIGHLIGHTS

- Extensive health physics and industrial safety experience including technician, training development and implementation, management, program and procedure development, environmental restoration and program audits/assessments.
- Management of Health Physics and Industrial Hygiene programs for large environmental restoration projects.

- Helped a major DOE laboratory in developing a program and procedures to comply with 10 CFR 835.

- Managed successful OSHA-based programs and provided consulting in industrial safety and industrial hygiene to a variety of clients.

- Highly successful in managing the ES&H Services Division of a consulting company providing services mainly to DOE sites and clients.

EXPERIENCE

Jan. 1997 to present — MACTEC, Inc.
Radiological Engineering Manager/Construction Health and Safety Manager

As Radiological Engineering Manager, manage all aspects of the company's Radiological Engineering and Health Physics programs. Develop corporate Radiation Protection Program in compliance with NRC, DOE, USACE and Agreement State regulations. Oversee all radiological work activities at D&D and remediation projects in various locations. Recruit and hire staff; serve as the corporate point of contact with regulatory agencies for radiation protection issues; manage the internal and external dosimetry programs; provide field assessments and oversight of work locations; develop radiation protection program and procedure documents; develop and maintain annual budgets; and serve as the corporate Price Anderson Amendments Act coordinator. Perform dose assessment and risk analysis activities for decontamination and decommissioning of buildings and facilities. Expert in the development and implementation of property surveys based on the MARSSIM guidance. Serve as the MACTEC Project Manager for the independent verification of plutonium-contaminated buildings and property at the Rocky Flats Environmental Technology Site, including survey and sampling program design, data collection and data validation.

As Construction Health and Safety Manager, responsible for the development, implementation and oversight of all health and safety programs for MACTEC Constructors, Inc. Select and hire field H&S support staff, provide professional guidance for field operations, maintain performance statistics, investigate incidents and perform field assessments. Maintain compliance with OSHA and other applicable regulations and requirements.

Jan. 1990 to Jul. 1996 — RI-TECH, INCORPORATED
Vice President, ES&H Services

Assisted with company startup. Responsible for all Environmental, Industrial Safety, Industrial Hygiene and Health Physics services for clients nationwide. Identify potential new customers, market, develop proposals, prepare and present best-and- final offer presentations, hire staff and manage all ES&H activities, as well as provide on-site

support to clients by serving as the Project Manager on several projects. Customers included many nuclear power plants, several DOE sites, and private industry. Projects Mr. Rima was personally involved with included:

- Served as the Project Manager for the decontamination and decommissioning of a tritium research laboratory at a DOE site. This five-year project was done under budget and within the original schedule.
- Hired staff and oversaw the development of the original DOE RCT training and qualification program prior to DOE-HQ acceptance.
- Oversaw the development and implementation of programs and procedures to bring a major DOE laboratory into compliance with 10 CFR 835.
- Conducted comprehensive OSHA audits of client facilities to assess regulatory compliance.
- Developed and taught Construction Safety, Confined Space Entry/Rescue, and various OSHA-based programs for clients.
- Developed and presented training courses on 10 CFR 20, NRRPT Exam Preparation, and ABHP Exam preparation to numerous clients.
- Served as the Project Manager for a contract to develop and implement RCT and RadWorker training for a DOE laboratory.
- Provided consulting services in conjunction with a major safety equipment supplier to help clients comply with federal (OSHA) and state industrial safety requirements.

While in this position, the ES&H Division of RI-TECH, Inc. was profitable in every year of operation, and accounted for the majority of corporate income from 1992 through 1996.

1987 to 1990 — GULF STATES UTILITIES
Radiological Training Coordinator

Responsible for the management of all Radiation Protection, Chemistry, Industrial Safety, Industrial Hygiene and related technical training personnel and programs. Obtained initial INPO accreditation of the training programs. Served as the Media Relations Representative for the plant's Emergency Response organization. Provided health physics information to media representatives during real and simulated plant emergencies. Served as member of Plant Management Team for critical path work during refueling outages.

1982 to 1987 — PUBLIC SERVICE COMPANY OF COLORADO
Technical Training Instructor/Radiochemist

As a Technical Training Instructor was responsible for the development, implementation, and evaluation of radiation protection, industrial safety and radiochemistry training programs. Gained initial INPO accreditation of these training programs. Oversaw the selection and managed a number of consultant personnel during program development. Also spoke to schools and civic groups on a variety of

topics on behalf of the company.

As a Radiochemist was responsible for all radiochemical sampling and analysis, including gamma spectroscopy, gross beta-gamma, liquid scintillation, gas chromatography, and operation of related equipment.

1980 to 1982 — FLORIDA POWER CORPORATION
Radiation Control Technician

Responsible for radiation, contamination, and airborne radioactivity surveys, radiochemical sampling and analysis, and providing radiological job coverage. Supervised contract health physics personnel during plant outages.

1978 to 1980 — OMAHA PUBLIC POWER DISTRICT
Health Physics Technician

Responsible for radiation, contamination, and airborne radioactivity surveys, radiochemical sampling and analysis, and providing radiological job coverage. Supervised contract health physics personnel during plant outages. Develop and provide training to non-health physics personnel on radiation safety related topics.

1975 to 1978 — UNITED STATES NAVY
Engineering Laboratory Technician

Trained in all aspects of reactor operation, health physics, and radiochemistry. Performed radiological surveys and radiochemical analysis, and provided training to new personnel in health physics topics.

RELATED SHORT COURSES AND SEMINARS ATTENDED

- On-The-Job Training Instructor, 32 hours, Sandia National Laboratories, 1995
- Radiological Emergency Response, 8 hours, REAC/TS, 1995
- Hazardous Waste and Emergency Response, 40 hours, RE-TECH, Inc., 1995
- Confined Space Entry and Rescue, 8 hours, RI-TECH, Inc., 1994
- ABHP Exam Preparation, 40 hours, Woodson Associates, 1993
- Dale Carnegie Course in Effective Speaking and Public Relations, 1991
- Crisis News Writing, 16 hours, Lewis and Associates, 1988
- ALARA for Design Engineers, 24 hours, General Electric, 1988
- Professional Hot Particle Workshop, 40 hours, San Diego State University, 1988
- Supervisory Skills Workshop, 24 hours, Gulf States Utilities, 1987
- Behavioral Reliability Workshop, 16 hours, Gulf States Utilities, 1987
- The Management Experience, 24 hours, The Training Company, Inc., 1986
- Fundamentals of Gamma Spectroscopy, 40 hours, Canberra, 1985
- Fundamentals of Radiochemistry, 80 hours, Babcock and Wilcox, 1984

PUBLICATIONS

- 'Health Physics Fundamentals and Frontiers,' textbook, copyright 1996, Steven D. Rima, DATUM Enterprises, LLC
- 'NRRPT Exam Preparation,' textbook, 1991, copyright 1991, RI-TECH, Incorporated
- 'The Impact of Changes to 10 CFR 20 for Health Physics Personnel,' 1992, copyright 1992, RI-TECH, Incorporated
- 'Radiological Quantities and Units: A Real World Perspective,' 1996, RSO Magazine, October, 1996, copyright RSA Publications
- 'Radiological Quantities and Units: A Real World Perspective Part II,' 1997, RSO Magazine, January 1997, copyright RSA Publications

MACTEC, Inc.

Resume of:
JEFFREY W. LIVELY, CSP
SENIOR HEALTH PHYSICIST

EXPERIENCE:

- Senior Health Physicist for MACTEC Constructors, Inc. Assigned as a Health Physicist in support of MACTEC's private industry and DOE environmental cleanup, restoration, and monitoring projects, providing supervisory direction to project health and safety teams in the implementation of the industrial safety and radiation protection programs.

- Senior Staff Health Physicist for Chem-Nuclear Geotech, Rust Geotech, and MACTEC-ERS for five years (1996 - 2001). Assigned as a Health Physicist in support of MACTEC-ERS' environmental cleanup, restoration, and monitoring projects at the Grand Junction DOE office, providing supervisory direction to the project health and safety teams in the implementation of the industrial safety and radiation protection programs. Among the projects managed by MACTEC-ERS is the Monticello Mill Tailings Site remediation project (a radiologically contaminated CERCLA cleanup site).

- Successfully implemented new MARSSIM methodology and used computer modeling codes to derive risk-based (dose-based) cleanup criteria, develop statistically significant sampling and analysis plans, and evaluate survey data for compliance with approved cleanup criteria for sites with buildings having low-levels of residual radioactivity at the Monticello Mill Tailings Site.

- Performed human health risk assessments and derived alternative cleanup levels in support of technical justification for applying supplemental cleanup standards in circumstances where it was determined to be impractical or unfeasible to apply default cleanup criteria. Primary experience is with isotopes of uranium and plutonium and their decay progeny.

- Developed and implemented statistic-based radiological survey methodology for demonstrating compliance with operational radiation protection program (10 CFR 835) and the DOE's Radiological Control Manual.

- Designed and implemented pre-demolition verification surveys to demonstrate that buildings used by the University of Utah for radioisotope production and radiochemical research met the criteria for unrestricted release and disposal in the local landfill.

- Established a relationship between bulk radioactivity in soil and the potential to transfer contaminants to a surface in contact with that soil. This relationship allowed the Monticello Project to determine before remedial action began what controls to apply to the work. The result was that many sites were able to be remediated with substantially reduced controls, saving costs, without incurring unacceptable risks.

- Taught health physics in the Radiation Safety Technology degree program at Eastern Idaho Technical College, a nationally recognized program offering Associate Degrees in Applied Science.

- Plant Lead Radiological Controls Technician at a U.S. Naval reactor power plant. Managed the Nuclear Plant Chemistry and Radiological Controls department. Scheduled and coordinated all plant maintenance involving radiological controls. Ensured that all plant operations were completed in compliance with radiological, hazardous materials, and environmental regulations. Nuclear plant coordinator for all hazardous materials, hazardous wastes, and mixed hazardous wastes. Supervised 4 crews of plant radiological controls technicians (50 persons). Earned Navy Achievement Medal for superior performance in this position.

- Qualified as Naval nuclear power plant operator and supervisor.

- Qualified as "Engineering Officer of the Watch." This qualification is comparable to the civilian power plant position of Shift Supervisor.

- Served 11 years in the U.S. Navy in the Naval Nuclear Power Program.

SPECIAL QUALIFICATIONS and TRAINING:

- RESRAD, RESRAD-BUILD, RESRAD-RECYCLE Computer modeling codes
- OSHA 40-hour Hazardous Waste Site Training
- DOE Radiological Controls Technician, and Radiological Worker
- Member of the DOE's region VI Radiological Assistance Program team. Special training to respond to events involving radioactive materials.

PROFESSIONAL REGISTRATIONS, CERTIFICATIONS, AFFILIATIONS:

- Certified Safety Professional, Comprehensive Safety Practice (CSP) (1999)
- Plenary member, Health Physics Society (1994)
- Registered Radiological Protection Technologist (NRRPT-1993)
- Member of the DOE Health Physics Instrument Committee (1996)

EDUCATION:

- Radiological Controls Maintenance Supervisor school (USN).
- Nuclear Plant Chemistry and Radiological Controls school (USN).
- Nuclear Plant Quality Assurance school (USN).
- Naval Nuclear Power Plant School (6th of 483 with 3.74 avg.)
- Radiography Assistant School (USN).
- Radioactive and Hazardous Materials Shipping (DOE).
- High School honor graduate.

Appendix 4

Radiation Safety Officer Delegation of Authority

MACTEC, Inc.

DELEGATION OF AUTHORITY
RADIATION SAFETY OFFICER

Memorandum To: All MACTEC Employees

From: Bruce Coles, Chairman and CEO

Subject: Delegation of Authority for Radiation Safety Officer

Mr. Steven D. Rima, CHP, CSP, has been appointed Radiation Safety Officer and is responsible for ensuring the safe use of byproduct material. The Radiation Safety Officer is responsible for managing the radiation safety program; identifying radiation safety problems; initiating, recommending, or providing corrective actions; verifying implementation of corrective actions; and ensuring compliance with regulations for the use of byproduct material. The Radiation Safety Officer is hereby delegated the authority necessary to meet these responsibilities.

The Radiation Safety Officer has the authority to immediately stop any operations involving the use of byproduct material in which health and safety may be compromised or may result in non-compliance with NRC requirements.

Should you have any questions, concerns, or comments, please do not hesitate to contact me.

Sincerely,

Bruce Coles
Chairman and CEO
MACTEC, Inc.

MACTEC, Inc.

Appendix 5

Relevant Procedures From MACTEC's Radiation Protection Program

MACTEC, Inc.	Procedure No: RPO-101 Revision No: 1 Effective Date: 9-1-02

RADIATION PROTECTION PROGRAM OVERVIEW

Authored By: 4-5-02
Michael P. McDonald — Date
Radiological Engineer

Reviewed By: 8/16/02
Jeffrey W. Lively — Date
Health Physicist

Approved By: 8/16/02
Steven D. Rima — Date
Radiological Engineering Manager

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RADIATION PROTECTION PROGRAM OVERVIEW

1.0 PURPOSE

1.1 The purpose of this procedure is to provide an overview of the MACTEC, Inc. Radiation Protection Program that governs radiological work performed by MACTEC, Inc.

2.0 APPLICABILITY

2.1 This procedure applies to MACTEC, Inc. management, supervisors, individuals, contractors, and subsidiaries employees that handle radioactive materials or may be exposed to ionizing radiation, where their work assignment is controlled by MACTEC, Inc.

2.2 No one may act (or cause others to act) in a manner inconsistent with this procedure. However, nothing in this procedure shall be construed as limiting actions that may be necessary to protect health and safety.

2.3 The limits in this procedure do not apply to doses due to:

- background radiation,
- exposure of patients to radiation for the purpose of medical diagnosis or therapy,
- exposure from individuals administered radioactive material and released in accordance with 10 CFR 35.75,
- exposure from voluntary participation in medical research programs,
- consumer products emitting nominal amounts of radiation, or
- activities conducted under the Nuclear Explosives and Weapons Surety Program (relating to the prevention of accidental or unauthorized nuclear detonations).

3.0 REFERENCES

3.1 MACTEC, Inc., Corporate Radiation Protection Program.

3.2 10 CFR 19, "Notices, Instructions and Reports To Workers: Inspection and Investigations."

3.3 10 CFR 20, "Standards for Protection Against Radiation."

3.4 10 CFR 835, "Occupational Radiation Protection."

3.5 MACTEC, Inc., Radiation Protection Training procedures.

4.0 DEFINITIONS AND ABBREVIATIONS

4.1 See RPO Glossary.

5.0 GENERAL

5.1 EQUIPMENT

Not applicable

5.2 SAFETY CONSIDERATIONS

Not applicable

5.3 RESPONSIBILITIES

5.3.1 The Radiological Engineering Manager, or designee, shall be responsible for the implementation of this procedure.

5.4 PREREQUISITES

Not applicable

5.5 RECORDS

5.5.1 Related documents and/or records shall be stored, arranged, indexed, retained, retrieved, and disposed of in accordance with this procedure and all applicable NRC document regulations and requirements.

5.5.2 Records that are generated as a result of the requirements of federal regulations must be retained until NRC authorizes their disposition.

5.6 PRECAUTIONS AND LIMITATIONS

Not applicable

5.7 REVISIONS

5.7.1 This procedure shall be reviewed at least every two years, with documentation to support the completion of such review.

5.8 OTHER

Not applicable

5.9 ATTACHMENTS

Attachment 1 - RPO Glossary

Attachment 2 - Radiological Engineering Personnel Support Structure

6.0 PROCEDURE

6.1 INTRODUCTION

6.1.1 It is the policy of MACTEC, Inc. to conduct its radiological operations in a manner that ensures the health and safety of all its employees, contractors, and the general public and protect the environment and facilities from the effects of ionizing radiation.

6.1.2 Through the use of MACTEC policies, procedures, and a knowledgeable and experienced workforce, radiation exposures to workers, to the general public and releases of radioactivity to the environment will be maintained below regulatory limits and As Low As Reasonably Achievable (ALARA).

- The ALARA philosophy is based on the supposition that radiation dose increases one's risk of cancer - the smaller the dose, the smaller the risk.
- ALARA is an approach to radiation protection to manage and control individual and collective dose to employees , visitors and public environment to levels that are as low as reasonable, taking into account social, technical, economic, practical, and public policy considerations.
- ALARA is not a dose limit, but a process for maintaining doses as far below the applicable limits as is reasonably achievable.
- MACTEC, Inc. will use, to the extent practical, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are ALARA and ensure that no exposure to workers will occur without the expectation of an overall benefit from the activity.

6.1.3 MACTEC's Radiation Protection Operating Procedures (RPOs) are an integral part of all radiological work activities performed. All company radiological operations shall be conducted in a manner consistent with the RPOs.

6.1.4 MACTEC, Inc. shall prominently post copies of the following documents where licensed material is receive, possess, use, or transferred:

- The regulations of 10 CFR part 19 and part 20;
- The license, license conditions, or documents incorporated into a license by reference, and amendments thereto;
- The operating procedures applicable to licensed activities;

- Any notice of violation involving radiological working conditions, proposed imposition of civil penalty, or order issued; and
- The latest versions of NRC Form 3, "Notice to Employees."

6.1.5 If posting of a document specified above is not practicable, a notice shall be posted which describes the document and states where it may be examined.

6.2 ORGANIZATION AND ADMINISTRATION

6.2.1 Site Project Manager - The Site Project Manager is responsible for the safety and health of MACTEC, Inc.'s employees, compliance with the requirements of 10 CFR 835 or 10 CFR 20, implementation of the MACTEC's Radiation Protection Program (RPP), and implementation of this procedure. The Site Project Manager shall also:

- Interpret federal regulations and DOE Orders.
- Obtain and allocate resources to the RPP projects.
- Coordinate RPP projects to minimize overlap and maximize cost effectiveness.
- Delegate the day-to-day operations of RPP projects to qualified individuals.
- Ensure that appropriate authority, commitment, support, and resources are assigned to all levels of the organization to implement the program and to achieve desired goals.

6.2.2 Environmental Safety and Health (ES&H) Manager - The ES&H Manager is responsible for the management of the project, as it applies to overall project safety.

6.2.3 Corporate Radiation Safety Officer (CRSO) - The CRSO is responsible for the development and implementation of the project's policies and procedures, providing technical advice and assistance to management, and assessing programmatic elements of the program.

6.2.4 Site Radiation Safety Officer (SRSO) - The SRSO is responsible for all aspects of the day-to-day radiological operations and activities conducted at the site, including the implementation of the RPOs.

6.2.5 Certified Health Physicist (CHP) - The CHP evaluates radiological operations, ensures safety plans describe the magnitude of radiological hazards, the physical and administrative controls required for maintaining personnel doses,

effluent discharges, and contamination levels ALARA, responds to radiological spills, accidents, and emergencies, provides radiological safety oversight, provides technical support to program and facility organizations that is consistent with the ALARA process, identifies area monitoring requirements, and conducts workplace evaluations for minors and workers with pregnancy-related medical restrictions.

6.2.6 Health Physics Technician (HPT) - The HPT assists program, facility, and service workers with implementing the compliance requirements specified in the RPOs, fulfills the posting and monitoring requirements of federal regulations, informs workers and supervisors of actions or operations that are inconsistent with procedures or best management practices, and responds to radiological alarms, spills, accidents, and emergencies.

6.2.7 Work Supervisor or Responsible Individual - The Work Supervisor or Responsible Individual ensures requirements and controls specified in this document and its supplements, along with any additional requirements identified by ES&H are integrated into all radiological operations, that workers follow established safety plans and procedures, and that workers are provided appropriate tools and protective equipment.

6.2.8 Radiological Worker - The Radiological Worker performs day-to-day routine radiological work while minimizing personal radiation exposure and the spread of radioactive contamination. This is accomplished by adhering to all radiological safety requirements, reporting any radiological problems, and following established work policies and good work practices.

6.2.9 Training Manager - The training manager develops, presents, and documents institutionally required radiological worker training and trains and qualifies ES&H health and safety technicians (and other specifically identified individuals) to carry out the monitoring requirements.

6.2.10 Records Manager - The Records Manager ensures all records pertaining to the RPO are maintained in accordance with regulatory requirements.

6.2.11 Assurance Review Office - The Assurance Review Office shall verify that corrective actions identified in the internal audits, required by federal regulations, have been addressed by the responsible organization and properly closed out as completed.

6.3 RADIATION PROTECTION PROCEDURES

6.3.1 Activities involving licensed materials shall be conducted in accordance with approved, written RPOs and/or Radiation Work Permits (RWPs).

6.3.2 RPOs shall be developed and implemented as necessary to ensure compliance with this RPO.

- These procedures shall be commensurate with the radiological hazards created by the activity and consistent with the education, training and skills of the individuals exposed to those hazards.

6.3.3 Changes, deletions, or additions to RPOs shall be accomplished under the cognizance of, and with the approval of, the CRSO and SRSO.

6.3.4 All RPOs shall be reviewed and re-approved, at a minimum, biennially.

6.4 LICENSED MATERIAL and ACCOUNTABILITY

6.4.1 Inventory control and accountability is accomplished by documenting receipts and transfers of licensed material in accordance with approved procedures.

- Inventory balances are maintained to ensure that possession limits are not exceeded.

- Purchases of licensed calibration standards shall be from licensed vendors only

6.4.2 A physical inventory of sources and/or devices possessed under the license shall be performed every six months.

6.4.3 Inventory and accountability of Special Nuclear Material shall be performed at least annually, or as required by regulatory requirements (based on the licensed quantity of SNM).

6.5 AUDITS

6.5.1 Audits, inspections and/or assessments shall be performed to determine if radiological operations are being conducted in accordance with applicable license conditions, regulatory requirements and written procedures.

6.5.2 Internal audits of the radiological protection program shall be conducted to identify its strengths and weaknesses, areas of vulnerability, and noncompliance.

6.5.3 Internal audits shall be conducted on every major program element no less frequently than every 36 months and shall include examination of the radiological protection program content and implementation.

6.5.4 Program management shall participate in the facility's internal audits, including supplying an account number, as requested.

6.5.7 Records shall be maintained to document the results of internal audits and other reviews of the radiological protection program content and implementation.

6.6 TRAINING

6.6.1 Each individual shall complete radiation safety training, commensurate with the hazards in the area and the required controls.

6.6.2 Radiation safety training requirements are described in detail in RPO-106 and in MACTEC's Radiation Protection Training procedures.

6.6.3 If an escort is used in lieu of training, the escort shall have completed the training required for unescorted access to the area and must ensure that all escorted individuals comply with the safety requirements.

6.6.4 Records shall be maintained to demonstrate compliance with the training requirements. Documentation of courses and course materials is contained in the MACTEC, Inc. Radiation Protection Training procedures and lesson materials. (GERT/RWT/HP)

6.6.5 Institutionally Required Training

- Programs or facilities may require additional radiological training for access or work in specific facilities.
- The definitive list of institutionally required courses and their alternates is controlled and maintained by the SRSO.
- Except where otherwise stated, retraining is required every 24 months.

6.6.6 General Employee Radiological Training

- All MACTEC, Inc. employees and subcontractors who have access to areas posted with the radiation trefoil symbol shall complete General Employee Radiological Training (GERT).

6.6.7 Radiological Worker Training

- Radiological Worker Training (RWT) is required before performing independent work as a radiological worker and before being permitted unescorted access to Radiological Areas.

6.6.8 Site Specific Required Training

- Additional training (i.e., training beyond that which is provided institutionally) is required where individual ALARA goals are established, area radiation alarms are installed, or safety plans are used to control radiological operations.

6.6.9 The Responsible Individual shall ensure that all site specific training requirements are identified, workers requiring site specific training are identified, and that required training is completed and documented as such.

6.7 RECORDS

6.7.1 Records pertaining to the Radiation Protection Program, unusual occurrences, inspections, audits, ALARA, personnel exposures, radiation and contamination surveys, effluent monitoring, environmental monitoring program, calibrations, and decommissioning are retained and maintained to demonstrate compliance with the conditions of the site's license(s) and with applicable Federal, State and local regulations.

6.7.2 Radiological records must be retained until NRC authorizes their disposition.

6.8 EXPOSURE CONTROL and MONITORING

6.8.1 All MACTEC, Inc. employees and subcontractors who are likely to receive a dose of 100 mrem in one year and/or enter a posted radiation, high radiation, or very high radiation area are required to wear a whole-body dosimeter.

6.8.2 MACTEC, Inc. shall maintain dose records for all individuals for whom monitoring is required.

6.8.3 Documentation of all previous occupational doses received shall be documented on a NRC Form 4 or equivalent.

6.8.4 Dosimetry records, including detailed information, identified with a specific individual shall be readily available to that individual and to others on a need-to-know basis.

6.8.5 Upon request, MACTEC, Inc. shall provide dose records to an individual terminating employment as soon as the data is available, but not later than 90 days after termination.

6.8.6 Air sampling, bioassay sampling, and/or approved dose calculations shall be used to assess and monitor workers' internal dose.

6.8.7 The total effective dose equivalent shall be calculated in accordance with 10 CFR 20 using a combination of personal lapel air sampling data and/or bioassay measurement data, and personnel external monitoring measurements.

6.8.8 Annual dose limits:

Category	Annual Limit (rems)	Dose
General Employees	5	Whole body (internal plus external)
	50	Any organ other than eye (internal plus external)
	15	Lens of the eye
	50	Extremities and skin
Embryo/fetus of a declared pregnant worker	0.5	Internal plus external (evenly distributed throughout gestation)
Occupationally exposed minors	0.1	Whole body (internal plus external)
	1.5	Lens of the eye
	5	Extremities and skin
Members of the public	0.1	Whole body (internal plus external)

- The assigned deep-dose equivalent and shallow-dose equivalent must be for the part of the body receiving the highest exposure. The deep-dose equivalent, lens dose equivalent, and shallow-dose equivalent may be assessed from surveys or other radiation measurements for the purpose of demonstrating compliance with the occupational dose limits, if the individual monitoring device was not in the region of highest potential exposure, or the results of individual monitoring are unavailable.

- In addition to the annual dose limits, soluble uranium intake by an individual shall be limited to 10 milligrams in a week in consideration of chemical toxicity.

- The occupational exposure that an individual may be allowed to receive in the current year shall be reduced by the amount of occupational exposure received while employed by any other company or organization.

6.8.9 Occupationally Exposed Minors

- The CRSO shall evaluate all radiological work that is proposed to be performed by minors.

- Minors shall only be permitted to perform tasks that are unlikely to result in a significant exposure.

6.8.10 Fertile Female General Employee - All women working in an environment where exposure to radiation or radioactive materials is possible or occurring shall be provided with:

- Pregnancy-related information, such as NRC Regulatory Guide 8.13, Instruction Concerning Prenatal Radiation Exposure.

- The opportunity to interview with the Site or Corporate RSO and to ask questions concerning the ramifications of exposure to the embryo/fetus.

- Information on how to declare her pregnancy in writing, information on her new radiation exposure limit during the pregnancy (gestation period), and an evaluation of her workplace to determine the potential for occupational exposure to hazards in her current work assignment.

- A Fertile Female Training Acknowledgement Form that acknowledges she has received information concerning exposure to the embryo/fetus and instructions for declaring her pregnancy.

NOTE: The appropriate members of ES&H will conduct a workplace evaluation when requested. The workplace evaluation, which can be conducted on a confidential basis if requested by the employee, helps ensure the embryo/fetus is afforded maximum protection. At any time, the employee may direct that the medical restriction (and any associated work or workplace modifications) be rescinded by providing written notification to the Site or Corporate RSO.

6.8.11 Provisions for planned special exposures, which are in addition to and accounted for separately from routine occupational doses, shall be authorized by the MACTEC, Inc Corporate CHP.

- Planned Special Exposures should only be authorized in exceptional situations when alternatives which might avoid the higher exposure are unavailable or impractical.

6.9 RADIATION MONITORING INSTRUMENTATION

6.9.1 An adequate number of radiological survey and monitoring instruments of sufficient accuracy and sensitivity and appropriate for the types, levels, and

energies of the radiation shall be available to ensure compliance with monitoring requirements.

6.9.2 Hand-held portable radiation survey instruments utilized for radiation protection purposes shall be calibrated at least annually or following instrument maintenance, repair, or adjustment likely to affect the primary calibration.

6.9.3 Laboratory instruments used for radioactivity measurements shall be evaluated daily, when in use.

6.10 ACCESS CONTROLS and RADIOLOGICAL POSTINGS

6.10.1 Personnel entry control shall be maintained for each radiologically controlled area.

- The degree of control shall be commensurate with existing and potential radiological hazards within the area.

6.10.2 Controls that would prevent rapid evacuation of personnel under emergency conditions **SHALL NOT** be installed at any exit.

6.10.3 Access to High Radiation Areas shall be monitored as necessary to determine the exposure rates to individuals in the area.

- Additional controls shall be used for each access point to a High Radiation Area.

6.10.4 Additional control measures, beyond those used for High Radiation Areas, shall be implemented to ensure individuals are not able to gain unauthorized or inadvertent access to Very High Radiation Areas.

6.10.5 Posting a radiologically controlled area, or altering a radiological posting sign, containing the radiation trefoil symbol, shall only be performed by a qualified individual.

6.10.6 Radiological postings shall be in accordance with the regulatory requirements contained in 10 CFR 20, 10 CFR 835, applicable state regulations, and/or specific license conditions.

6.10.7 When posting access points to a radiologically controlled area, the following requirements apply:

- All access doors that can be opened from the outside must be posted, even if the door remains locked. (This posting protects individuals such as security guards, firefighters, and other emergency responders who may enter the

area using master keys.) Individuals who allow others to access an area through such doors must ensure those entering the area abide by the access control requirements.

- Doors that cannot be opened from the outside (e.g., highbay rollup doors or emergency exits out of a facility) are only considered access points if they are left open and unattended.

- Side-by-side doors do not have to be individually posted if it is obvious that both doors provide access to the same area and an appropriate sign is clearly and conspicuously posted.

6.11 WASTE MANAGEMENT

6.11.1 Collection of radioactive material classified as radioactive waste shall be accomplished using written procedures.

6.11.2 Radioactive waste produced as a result of site operations shall be collected, packaged, surveyed, and stored in a location prescribed by the SRSO.

6.11.3 Radioactive waste shall be transferred to a recipient who is properly licensed to receive such waste in accordance with applicable regulations.

6.11.4 Radioactive waste may be transferred to a licensed broker or shipped directly to an authorized radioactive waste disposal facility or other authorized waste processor.

RPO Glossary

Absorbed dose	The energy imparted by ionizing radiation per unit mass of irradiated material. The units of absorbed dose are the rad and the gray (Gy).
Access hatch	An airtight door system that preserves the pressure integrity of a reactor containment structure while allowing access to personnel and equipment.
Access point	Any location through which an individual could gain access to areas where radioactive materials are located or where radiological hazards exist.
Activation	The process of making a radioisotope by bombarding a stable element with neutrons or protons.
Active fuel length	The end-to-end dimension of fuel material within a fuel element.
Activity	The rate of disintegration (transformation) or decay of radioactive material. The units of activity are the curie (Ci) and the becquerel (Bq).
Agreement State	A state that has signed an agreement with the Nuclear Regulatory Commission under which the state regulates the use of by-product, source and small quantities of special nuclear material within that state.
Air sampling	The collection of samples of air to measure the radioactivity or to detect the presence of radioactive material, particulate matter, or chemical pollutants in the air.
Airborne radioactivity area	A room, enclosure, or area in which airborne radioactive materials, composed wholly or partly of licensed material, exist in concentrations that: (1) Exceed the derived air concentration limits, or (2) Would result in an individual present in the area without respiratory protection exceeding, during the hours the individual is present in the area, 0.6 percent of the annual limit on intake or 12 derived air concentration-hours (see 10 CFR '20.1003 Definitions).

Airborne radioactive material	Radioactive material dispersed in the air in the form of dusts, fumes, particulates, mists, vapors, or gases.
Air-purifying respirator	A respirator with an air-purifying filter, cartridge, or canister that removes specific air contaminants by passing ambient air through the air-purifying element.
ALARA	Acronym for "As Low As Reasonably Achievable," means making every reasonable effort to maintain exposures to ionizing radiation as far below the dose limits as practical, consistent with the purpose for which the licensed activity is undertaken, taking into account the state of technology, the economics of improvements in relation to state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of nuclear energy and licensed materials in the public interest (see 10 CFR 20.1003).
Alpha particle	A positively charged particle ejected spontaneously from the nuclei of some radioactive elements. It is identical to a helium nucleus that has a mass number of 4 and an electrostatic charge of +2. It has low penetrating power and a short range (a few centimeters in air). The most energetic alpha particle will generally fail to penetrate the dead layers of cells covering the skin and can be easily stopped by a sheet of paper. Alpha particles are hazardous when an alpha-emitting isotope is inside the body.
Anion	A negatively charged ion.
Annual limit on intake (ALI)	The derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smaller value of intake of a given radionuclide in a year by the reference man that would result in a committed effective dose equivalent of 5 rems(0.05 sievert) or a committed dose equivalent of 50 rems (0.5 sievert) to any individual organ or tissue. (see 10 CFR 20.1003.)
Assigned protection factor (APF)	The expected workplace level of respiratory protection that would be provided by a properly functioning respirator or a class of respirators to properly fitted and trained users. Operationally, the inhaled concentration can be estimated by dividing the ambient airborne concentration by the APF.

Atmosphere-supplying respirator	A respirator that supplies the respirator user with breathing air from a source independent of the ambient atmosphere, and includes supplied-air respirators (SARs) and self-contained breathing apparatus (SCBA) units.
Atom	The smallest particle of an element that cannot be divided or broken up by chemical means. It consists of a central core of protons and neutrons, called the nucleus. Electrons revolve in orbits in the region surrounding the nucleus.
Atomic energy	Energy released in nuclear reactions. Of particular interest is the energy released when a neutron initiates the breaking up or fissioning of an atom's nucleus into smaller pieces (fission), or when two nuclei are joined together under millions of degrees of heat (fusion). It is more correctly called nuclear energy.
Atomic Energy Commission	Federal agency created in 1946 to manage the development, use, and control of nuclear energy for military and civilian applications. Abolished by the Energy Reorganization Act of 1974 and succeeded by the Energy Research and Development Administration (now part of the U. S. Department of Energy) and the U. S. Nuclear Regulatory Commission.
Atomic number	The number of positively charged protons in the nucleus of an atom.
Attenuation	The process by which the number of particles or photons entering a body of matter is reduced by absorption and scattered radiation.
Audit	An audit is an independent formal review/examination performed to verify that radiological activities are being conducted in accordance with established procedures, protocols, regulations, and NRC License.
Auxiliary feedwater	Backup water supply used during nuclear plant startup and shutdown to supply water to the steam generators during accident conditions for removing decay heat from the reactor.
Average planar linear heat generation rate (APLGHR)	The average value of the linear heat generation rate of all the control rods at any given horizontal plane along a fuel bundle.

Background radiation	Radiation from cosmic sources; naturally occurring radioactive materials, including radon (except as a decay product of source or special nuclear material) and global fallout as it exists in the environment from the testing of nuclear explosive devices. It does not include radiation from source, byproduct, or special nuclear materials regulated by the Nuclear Regulatory Commission. The typically quoted average individual exposure from background radiation is 360 millirems per year.
Barrier	A physical structure separating two areas that cannot be penetrated or bypassed to gain access, except by use of extra ordinary means. Walls, fences, and other structures that go from floor to ceiling meet this definition.
Becquerel (Bq)	The unit of radioactive decay equal to 1 disintegration per second. 37 billion (3.7×10^{10}) becquerels = 1 curie (Ci).
Beta particle	A charged particle emitted from a nucleus during radioactive decay, with a mass equal to 1/1837 that of a proton. A negatively charged beta particle is identical to an electron. A positively charged beta particle is called a positron. Large amounts of beta radiation may cause skin bums, and beta emitters are harmful if they enter the body. Beta particles may be stopped by thin sheets of metal or plastic.
Binding energy	The minimum energy required to separate a nucleus into its component neutrons and protons.
Bioassay	The determination of kinds, quantities or concentrations, and in some cases, the locations, of radioactive material in the human body, whether by direct measurement (in vivo counting) or by analysis and evaluation of materials excreted or removed (in vitro) from the human body.
Biological halflife	The time required for a biological system, such as that of a human, to eliminate, by natural processes, half of the amount of a substance (such as a radioactive material) that has entered it.
Biological shield	A mass of absorbing material placed around a reactor or radioactive source to reduce the radiation to a level safe for humans.

Boiling water reactor (BWR)	A reactor in which water, used as both coolant and moderator, is allowed to boil in the core. The resulting steam can be used directly to drive a turbine and electrical generator, thereby producing electricity.
Bone seeker	A radioisotope that tends to accumulate in the bones when it is introduced into the body. An example is strontium-90, which behaves chemically like calcium.
Boundary	The borders that define the limit of a specific area. Borders may be marked or unmarked and a barrier may be used as a border.
Breeder	A reactor that produces more nuclear fuel than it consumes. A fertile material, such as uranium-238, when bombarded by neutrons, is transformed into a fissile material, such as plutonium-239, which can be used as fuel.
Breathing Zone Air Monitoring	Actions conducted to detect and quantify the radiological conditions of air from the general volume of air breathed by the worker, usually at a height of 1 to 2 meters.
British thermal unit (Btu)	The amount of heat required to change the temperature of one pound of water one degree Fahrenheit at sea level.
Byproduct	Byproduct is (1) any radioactive material (except special nuclear material) yielded in, or made radioactive by, exposure to the radiation incident to the process of producing or using special nuclear material (as in a reactor); and (2) the tailings or wastes produced by the extraction or concentration of uranium or thorium from ore processed primarily for its source material content, including discrete surface wastes resulting from uranium solution extraction processes. Underground ore bodies depleted by these solution extraction operations do not constitute "byproduct material" within this definition. (see 10 CFR 20.1003).
Calibration	The adjustment, as necessary, of a measuring device such that it responds within the required range and accuracy to known values of input.
Capability	The maximum load that a generating station can carry under specified conditions for a given period of time without exceeding approved limits of temperature and stress.

Capacity factor (gross)	The ratio of the gross electricity generated, for the period of time considered, to the energy that could have been generated at continuous full-power operation during the same period.
Capacity factor (net)	The ratio of the net electricity generated, for the period of time considered, to the energy that could have been generated at continuous full-power operation during the same period.
Cask	A heavily shielded container used to store and/or ship radioactive materials. Lead and steel are common materials used in the manufacture of casks.
Cation	A positively charged ion.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act or 1980
Chain reaction	A reaction that initiates its own repetition. In a fission chain reaction, a fissionable nucleus absorbs a neutron and fissions spontaneously, releasing additional neutrons. These, in turn, can be absorbed by other fissionable nuclei, releasing still more neutrons. A fission chain reaction is self-sustaining when the number of neutrons released in a given time equals or exceeds the number of neutrons lost by absorption in nonfissionable material or by escape from the system.
Charged particle	An ion. An elementary particle carrying a positive or negative electric charge.
Chemical description	A description of the principal chemical characteristics of a low-level radioactive waste.
Chemical recombination	Following an ionization event, the positively and negatively charged ion pairs may or may not realign themselves to form the same chemical substance they formed before ionization. Thus, chemical recombination could change the chemical composition of the material bombarded by ionizing radiation.
Cladding	The thin-walled metal tube that forms the outer jacket of a nuclear fuel rod. It prevents corrosion of the fuel by the coolant and the release of fission products into the coolant. Aluminum, stainless steel, and zirconium alloys are common cladding materials.

Class (or lung class or inhalation class)	A classification scheme for inhaled material according to its rate of clearance from the pulmonary region of the lung. Materials are classified as D, W, or Y, which applies to a range of clearance half-times: for Class D (Days) of less than 10 days, for Class W (Weeks) from 10 to 100 days, and for Class Y (Years) of greater than 100 days.
Cleanup system	A system used for continuously filtering and demineralizing a reactor coolant system to reduce contamination levels and to minimize corrosion.
Coastdown	An action that permits the reactor power level to decrease gradually as the fuel in the core is depleted.
Cold shutdown	The term used to define a reactor coolant system at atmospheric pressure and at a temperature below 200 degrees Fahrenheit following a reactor cooldown.
Collective dose	The sum of the individual doses received on a given period of time by a specified population from exposure to a specified source of radiation.
Committed dose equivalent (HT,50)	This is the dose to some specific organ or tissue that is received from an intake of radioactive material by an individual during the 50-year period following the intake (see 10 CFR 20.1003).
Committed effective dose equivalent (HE,50)	Committed effective dose equivalent (HE,50) is the sum of the products of the weighting factors applicable to each of the body organs or tissues that are irradiated and the committed dose equivalent to these organs or tissues (see 10 CFR 20.1003).
Compact	A group of two or more States formed to dispose of low-level radioactive waste on a regional basis. Forty-two States have formed nine compacts.
Compound	A chemical combination of two or more elements combined in a fixed and definite proportion by weight.
Condensate	Water that has been produced by the cooling of steam in a condenser.

Condenser	A large heat exchanger designed to cool exhaust steam from a turbine below the boiling point so that it can be returned to the heat source as water. In a pressurized water reactor, the water is returned to the steam generator. In a boiling water reactor, it returns to the reactor core. The heat removed from the steam by the condenser is transferred to a circulating water system and is exhausted to the environment, either through a cooling tower or directly into a body of water.
Consignee	The designated receiver of the shipment of low-level radioactive waste.
Construction recapture	The maximum number of years that could be added to the license expiration date to recover the period from the construction permit to the date when the operating license was granted. A licensee is required to submit an application for such a change.
Contamination	Undesired radioactive material that is deposited on the surface of or inside structures, areas, objects or people.
Contaminated Area	Any room, enclosure or operating area where there exists loose surface contamination at levels equal to or greater than 10 dpm/100cm^2 (alpha) and/or 200 dpm/100cm^2 (beta, gamma)
Containment structure	A gaslight shell or other enclosure around a nuclear reactor to confine fission products that otherwise might be released to the atmosphere in the event of an accident.
Continuous Air Monitor (CAM)	An instrument that continuously samples and measures the levels of airborne radioactive material on a real-time basis, and has alarm capabilities at preset levels.
Continuous Air Sampling	Air sampling conducted over relatively long periods of time to identify average levels of airborne radioactive materials in a work area. This type of sampling is usually performed by use of a portable CAM or low volume sampler. Long sampling time and the large volume of air collected over that time, gives this type of sampling arrangement the greatest radionuclide concentration sensitivity.

Control rod	A rod, plate, or tube containing a material such as hafnium, boron, etc., used to control the power of a nuclear reactor. By absorbing neutrons, a control rod prevents the neutrons from causing further fissions.
Controlled area	At a nuclear facility, an area outside of a restricted area but within the site boundary, access to which can be limited by the licensee for any reason.
Control room	The area in a nuclear power plant from which most of the plant power production and emergency safety equipment can be operated by remote control.
Coolant	A substance circulated through a nuclear reactor to remove or transfer heat. The most commonly used coolant in the United States is water. Other coolants include heavy water, air, carbon dioxide, helium, liquid sodium, and a sodium-potassium alloy.
Cooldown	The gradual decrease in reactor fuel rod temperature caused by the removal of heat from the reactor coolant system after the reactor has been shutdown.
Cooling tower	A heat exchanger designed to aid in the cooling of water that was used to cool exhaust steam exiting the turbines of a power plant. Cooling towers transfer exhaust heat into the air instead of into a body of water.
Core	The central portion of a nuclear reactor containing the fuel elements, moderator, neutron poisons, and support structures.
Core melt accident	An event or sequence of events that result in the melting of part of the fuel in the reactor core.
Cosmic radiation	Penetrating ionizing radiation, both particulate and electromagnetic, originating in outer space. Secondary cosmic rays, formed by interactions in the earth's atmosphere, account for about 45 to 50 millirem of the 360 millirem background radiation that an average individual receives in a year.
Counter	A general designation applied to radiation detection instruments or survey meters that detect and measure radiation. The signal that announces an ionization event is called a count.

Critical mass	The smallest mass of fissionable material that will support a self-sustaining chain reaction.
Critical organ	That part of the body that is most susceptible to radiation damage under the specific conditions under consideration.
Criticality	A term used in reactor physics to describe the state when the number of neutrons released by fission is exactly balanced by the neutrons being absorbed (by the fuel and poisons) and escaping the reactor core. A reactor is said to be "critical" when it achieves a self-sustaining nuclear chain reaction, as when the reactor is operating.
Crud	A colloquial term for corrosion and wear products (rust particles, etc.) that become radioactive (i.e., activated) when exposed to radiation. The term is actually an acronym for Chalk River Unidentified Deposits, the Canadian plant at which the activated deposits were first discovered.
Cumulative dose	The total dose resulting from repeated exposures of ionizing radiation to an occupationally exposed worker to the same portion of the body, or to the whole body, over a period of time (see 10 CFR 20.1003).
Curie (Ci)	The basic unit used to describe the intensity of radioactivity in a sample of material. The curie is equal to 37 billion ($3.7X10^{10}$) disintegrations per second, which is approximately the activity of 1 gram of radium. A curie is also a quantity of any radionuclide that decays at a rate of 37 billion disintegrations per second. It is named for Marie and Pierre Curie, who discovered radium in 1898.
Daughter products	Isotopes that are formed by the radioactive decay of some other isotope. In the case of radium-226, for example, there are 10 successive daughter products, ending in the stable isotope, lead-206.
Decay heat	The heat produced by the decay of radioactive fission products after a reactor has been shut down.
Decay, radioactive	The decrease in the amount of any radioactive material with the passage of time due to the spontaneous emission from the atomic nuclei of either alpha or beta particles, often accompanied by gamma radiation.

Declared pregnant woman	A woman who is also an occupational radiation worker and has voluntarily informed her employer, in writing, of her pregnancy and the estimated date of conception (see 10 CFR 20.1003, 20.1208).
Decommission	The process of closing down a facility followed by reducing residual radioactivity to a level that permits the release of the property for unrestricted use (see 10 CFR 20.1003).
Decon	A method of decommissioning in which the equipment, structures, and portions of a facility and site containing radioactive contaminants are removed and safety buried in a low-level radioactive waste landfill or decontaminated to a level that permits the property to be released for unrestricted use shortly after cessation of operations.
Decontamination	The reduction or removal of contaminating radioactive material from a structure, area, object, or person. Decontamination may be accomplished by: (1) treating the surface to remove or decrease the contamination, (2) letting the material stand so that the radioactivity is decreased as a result of natural radioactive decay, or (3) covering the contamination to shield or attenuate the radiation emitted (see 10 CFR 20.1003 and '20.1402).
Deep-dose equivalent (Hd)	Applies to external whole-body exposure, is the dose equivalent at a tissue depth of 1 cm (1000 mg/cm^2).
Defense-in-depth	A design and operational philosophy with regard to nuclear facilities that calls for multiple layers of protection to prevent and mitigate accidents. It includes the use of controls, multiple physical barriers to prevent release of radiation, redundant and diverse key safety functions, and emergency response measures.
Demand respirator	An atmosphere-supplying respirator that admits breathing air to the facepiece only when a negative pressure is created inside the facepiece by inhalation.
Departure from nucleate boiling (DNB)	The point at which the heat transfer from a fuel rod rapidly decreases due to the insulating effect of a steam blanket that forms on the rod surface when the temperature continues to increase.
Departure From Nuclear Boiling Ratio (DNBR)	The ratio of the heat flux to cause departure from nucleate boiling to the actual local heat flux or a fuel rod.

Depleted uranium	Uranium having a percentage of uranium-235 smaller than the 0.7 percent found in natural uranium. It is obtained from spent (used) fuel elements or as byproduct tails, or residues, from uranium isotope separation.
Derived air concentration (DAC)	The concentration of radioactive material in air and the time of exposure to that radionuclide, in hours. An NRC licensee may take 2,000 hours to represent one ALI, equivalent to a committed effective dose equivalent of 5 rems (0.05 sievert). Also, the concentration of a given radionuclide in air which, if breathed by the reference man for a working year of 2,000 hours under conditions of light work (inhalation rate 1.2 cubic meters of air per hour), results in an intake of one Annual Limit of Intake (ALI). DAC values are given in Table 1, Column 3, of Appendix B to Section 20.1001 through 20.2401.
Design-basis accident	A postulated accident that a nuclear facility must be designed and built to withstand without loss to the systems, structures, and components necessary to assure public health and safety.
Design-basis phenomena	Earthquakes, tornadoes, hurricanes, floods, etc., that a nuclear facility must be designed and built to withstand without loss of systems, structures, and components necessary to assure public health and safety.
Detector	A material or device that is sensitive to radiation and can produce a response signal suitable for measurement or analysis. A radiation detection instrument.
Deterministic effect	The health effects, the severity of which varies with the dose and for which a threshold is believed to exist. Radiation-induced cataract formation is an example of a deterministic effect (also called a non-stochastic effect) (see 10 CFR 20.1003).
Deuterium	An isotope of hydrogen with one proton and one neutron in the nucleus.
Deuteron	The nucleus of deuterium. It contains one proton and one neutron. See also heavy water.
Differential pressure (dp or ΔP)	The difference in pressure between two points of a system, such as between the inlet and outlet of a pump.

Disposal container	A container principally used to confine low-level radioactive waste during disposal operations at a land disposal facility (also see "high integrity container").
Distinguishable from background	The detectable concentration of a radionuclide is statistically different from the background concentration of that radionuclide in the vicinity of the site or, in the case of structures, in similar materials using adequate measurement technology, survey, and statistical techniques.
Doppler coefficient	Another name used for the fuel temperature coefficient of reactivity.
Dose	The absorbed dose, given in rads (or the international system of units, grays), that represents the energy absorbed from the radiation in a gram of any material. Furthermore, the biological dose or dose equivalent, given in rem or sieverts, is a measure of the biological damage to living tissue from the radiation exposure.
Dose equivalent (HT)	The product of absorbed dose in tissue multiplied by a quality factor, and then sometimes multiplied by other necessary modifying factors at the location of interest. It is expressed numerically in rems or sieverts (see 10 CFR 20.1003).
Dosimeter	A small portable instrument (such as a film badge, thermoluminescent or pocket dosimeter) for measuring and recording the total accumulated personnel dose of ionizing radiation.
Dosimetry	The theory and application of the principles and techniques involved in the measurement and recording of ionizing radiation doses.
Dose rate	The ionizing radiation dose delivered per unit time. For example, rem or sieverts per hour.
Drywell	The containment structure enclosing a boiling water reactor vessel and its recirculation system. The drywell provides both a pressure suppression system and a fission product barrier under accident conditions.
Earthquake, operating basis	An earthquake that could be expected to affect the reactor plant site, but for which the plant power production equipment is designed to remain functional without undue risk to public health and safety.

Effective halflife	The time required for the amount of a radioactive element deposited in a living organism to be diminished 50% as a result of the combined action of radioactive decay and biological elimination.
Efficiency, plant	The percentage of the total energy content of a power plant's fuel that is converted into electricity. The remaining energy is lost to the environment as heat.
Electrical generator	An electromagnetic device that converts mechanical (rotational) energy into electrical energy. Most large electrical generators are driven by steam or water turbine systems.
Electromagnetic radiation	A traveling wave motion resulting from changing electric or magnetic fields. Familiar electromagnetic radiation range from x-rays (and gamma rays) of short wavelength, through the ultraviolet, visible, and infrared regions, to radar and radio waves of relatively long wave length.
Electron	An elementary particle with a negative charge and a mass 1/1837 that of the proton. Electrons surround the positively charged nucleus and determine the chemical properties of the atom.
Element	One of the 103 known chemical substances that cannot be broken down further without changing its chemical properties. Some examples include, hydrogen, nitrogen, gold, lead, and uranium. See the periodic table of elements.
Embryo/fetus	The developing human organism from conception until the time of birth.
Emergency classifications	Response by an offsite organization is required to protect local citizens near the site. A request for assistance from offsite emergency response organizations may be required.
Emergency core cooling systems (ECCS)	Reactor system components (pumps, valves, heat exchangers, tanks, and piping) that are specifically designed to remove residual heat from the reactor fuel rods should the normal core cooling system (reactor coolant system) fail.
Emergency feedwater	Another name that may be used for auxiliary feedwater.

Entomb	A method of decommissioning in which radioactive contaminants are encased in a structurally long-lived material, such as concrete. The entombment structure is appropriately maintained, and continued surveillance is carried out until the radioactivity decays to a level permitting decommissioning and ultimate unrestricted release of the property.
Entrance or access point	Any location through which an individual could gain access to radiation areas or to radioactive materials. This includes entry or exit portals of sufficient size to permit human entry, irrespective of their intended use.
Exclusion area	That area surrounding the reactor, in which the reactor licensee has the authority to determine all activities, including exclusion or removal of personnel and property from the area.
Excursion	A sudden, very rapid rise in the power level of a reactor caused by supercriticality. Excursions are usually quickly suppressed by the negative temperature coefficient, the fuel temperature coefficient or the void coefficient (depending upon reactor design), or by rapid insertion of control rods.
Exposure	Being exposed to ionizing radiation or to radioactive material.
External dose	That portion of the dose equivalent received from radiation sources outside the body.
External radiation	Exposure to ionizing radiation when the radiation source is located outside the body.
Extremities	The hands, forearms, elbows, feet, knee, leg below the knee, and ankles (permissible radiation exposures in these regions are generally greater than in the whole body because they contain less blood forming organs and have smaller volumes for energy absorption) (see 10 CFR 20.1003).
Eye dose equivalent	The dose equivalent that applies to the external exposure of the lens of the eye and is taken as the dose equivalent at a tissue depth of 0.3 centimeter (300 mg/cm^2).

Fast fission	Fission of a heavy atom (such as uranium-238) when it absorbs a high energy (fast) neutron. Most fissionable materials need thermal (slow) neutrons in order to fission.
Fast neutron	A neutron with kinetic energy greater than its surroundings when released during fission.
Feedwater	Water supplied to the reactor pressure vessel (in a BWR) or the steam generator (in a PWR) that removes heat from the reactor fuel rods by boiling and becoming steam. The steam becomes the driving force for the plant turbine generator.
Fertile material	A material, which is not itself fissile(fissionable by thermal neutrons), that can be converted into a fissile material by irradiation in a reactor. There are two basic fertile materials, uranium-238 and thorium-232. When these fertile materials capture neutrons, they are converted into fissile plutonium-239 and uranium-233, respectively.
Film badge	Photographic film used for measurement of ionizing radiation exposure for personnel monitoring purposes. The film badge may contain two or three films of differing sensitivities, and it may also contain a filter that shields part of the film from certain types of radiation.
Filtering facepiece (dust mask)	A negative pressure particulate respirator with a filter as an integral part of the facepiece or with the entire facepiece composed of the filtering medium, not equipped with elastomeric sealing surfaces and adjustable straps.
Fissile material	Although sometimes used as a synonym for fissionable material, this term has acquired a more restricted meaning. Namely, any material fissionable by thermal (slow) neutrons. The three primary fissile materials are uranium-233, uranium-235, and plutonium-239.
Fission (fissioning)	The splitting of a nucleus into at least two other nuclei and the release of a relatively large amount of energy. Two or three neutrons are usually released during this type of transformation.
Fission gases	Those fission products that exist in the gaseous state. In nuclear power reactors, this includes primarily the noble gases, such as krypton and xenon.

Fission products	The nuclei (fission fragments) formed by the fission of heavy elements, plus the nuclide formed by the fission fragments' radioactive decay.
Fissionable material	Commonly used as a synonym for fissile material, the meaning of this term has been extended to include material that can be fissioned by fast neutrons, such as uranium-238.
Fit factor	A quantitative estimate of the fit of a particular respirator to a specific individual, and typically estimates the ratio of the concentration of a substance in ambient air to its concentration inside the respirator when worn.
Fit test	The use of a protocol to qualitatively or quantitatively evaluate the fit of a respirator on an individual.
Flux	A term applied to the amount of some type of particle (neutrons, alpha radiation, etc.) or energy (photons, heat, etc.) crossing a unit area per unit time. The unit of flux is the number of particles, energy, etc., per square centimeter per second.
Fuel assembly	A cluster of fuel rods (or plates). Also called a fuel element. Many fuel assemblies make up a reactor core.
Fuel cycle	The series of steps involved in supplying fuel for nuclear power reactors. It can include mining, milling, isotopic enrichment, fabrication of fuel elements, use in a reactor, chemical reprocessing to recover the fissionable material remaining in the spent fuel, reenrichment of the fuel material, refabrication into new fuel elements, and waste disposal.
Fuel reprocessing	The processing of reactor fuel to separate the unused fissionable material from waste material.
Fuel rod	A long, slender tube that holds fissionable material (fuel) for nuclear reactor use. Fuel rods are assembled into bundles called fuel elements or fuel assemblies, which are loaded individually into the reactor core.

Fuel temperature coefficient of reactivity	The change in reactivity per degree change in the fuel temperature. The physical property of fuel pellet material (uranium-238) that causes the uranium to absorb more neutrons away from the fission process as fuel pellet temperature increases. This acts to stabilize power reactor operations. This coefficient is also known as the Doppler coefficient.
Fusion reaction	A reaction in which at least one heavier, more stable nucleus is produced from two lighter, less stable nuclei. Reactions of this type are responsible for enormous release of energy, as in the energy of stars, for example.
FUSRAP	Formerly Utilized Sites Remedial Action Program
Gap	The space inside a reactor fuel rod that exists between the fuel pellet and the fuel rod cladding.
Gamma radiation	High-energy, short wavelength, electromagnetic radiation emitted from the nucleus. Gamma radiation frequently accompanies alpha and beta emissions and always accompanies fission. Gamma rays are very penetrating and are best stopped or shielded by dense materials, such as lead or depleted uranium. Gamma rays are similar to x-rays.
Gas-cooled reactor	A nuclear reactor in which a gas is the coolant.
Gases	Normally, formless fluids that completely fill the space, and take the shape of, their container.
Gaseous Diffusion Plant	A facility where uranium hexafluoride gas is filtered, uranium-235 is separated from uranium-238, increasing the percentage of uranium-235 from 1 to about 3 percent. The process requires enormous amounts of electric power.

Geiger-Mueller counter	A radiation detection and measuring instrument. It consists of a gas-filled tube containing electrodes, between which there is an electrical voltage, but no current flowing. When ionizing radiation passes through the tube, a short, intense pulse of current passes from the negative electrode to the positive electrode and is measured or counted. The number of pulses per second measures the intensity of the radiation field. It was named for Hans Geiger and W. Mueller, who invented it in the 1920s. It is sometimes called simply a Geiger counter or a G-M counter, and is the most commonly used portable radiation instrument.
General Area Air Sampling	Actions conducted to detect and quantify the radiological conditions of air from the general work area. This type of sampling differs from breathing zone sampling in that the sample result may not be representative of the air an individual is breathing unless the airborne contamination is homogeneous throughout the work area. This type of monitoring is typically performed by low volume samplers or high volume samplers.
Generation (gross)	The total amount of electric energy produced by a generating station as measured at the generator terminals.
Generation (net)	The gross amount of electric energy produced less the electric energy consumed at a generating station for station use.
Generation (net)	The gross amount of electric energy produced less the electric energy consumed at a generating station for station use.
Generator	A licensee operating under a Commission or Agreement State license who (1) is a waste generator as defined in 10 CFR 20, or (2) is the licensee to whom waste can be attributed within the context of the Low-Level Radioactive Waste Policy Amendments Act of 1985.

Grab Sampling	A single sample collected from the workplace air over a short time interval, typically less than one hour. Grab sampling should be used for temporary or non-routine situations, determining current conditions in the air to establish posting and personal protection requirements, and/or as a backup for other types of air sampling in the event of equipment failure. This type of sampling is also useful for identifying the concentration of airborne radionuclides with very restrictive DAC allowances in a short period of time. The larger volume of air collected in the short time period provides a lower minimum detectable concentration (MDC) for the radionuclide of interest. Grab sampling may also be referred to as intermittent sampling.
Graphite	A form of carbon, similar to the lead used in pencils, used as a moderator in some nuclear reactors.
Gigawatt	One billion (10^9) watts.
Gigawatthour	One billion (10^9) watt-hours.
Gray (Gy)	The new international system (SI) unit of radiation dose expressed in terms of absorbed energy per unit mass of tissue. The gray is the unit of absorbed dose and replaces the rad. 1 gray = 1 Joule/kilogram and also equals 100 rad.
Halflife	The time in which one half of the atoms of a particular radioactive substance disintegrates into another nuclear form. Measured halflives vary from millionths of a second to billions of years. Also called physical or radiological halflife
Halflife, biological	The time required for the body to eliminate one half of the material taken in by natural biological means.
Halflife, effective	The time required for a radionuclide contained in a biological system, such as a human or an animal, to reduce its activity by one-half as a combined result of radioactive decay and biological elimination.
Half-thickness	The thickness of any given absorber that will reduce the intensity of its original beam of ionizing radiation to one-half of its initial value.

Head, reactor vessel	The removable top section of a reactor pressure vessel. It is bolted in place during power operation and removed during refueling to permit access of fuel handling equipment to the core.
Health physics	The science concerned with the recognition, evaluation, and control of health hazards which may arise from the use and application of ionizing radiation.
Heat exchanger	Any device that transfers heat from one fluid (liquid or gas) to another fluid or to the environment.
Heat sink	Anything that absorbs heat. It is usually part of the environment, such as the air, a river, or a lake.
Heatup	The rise in temperature of the reactor fuel rods resulting from an increase in the rate of fission in the core.
Heavy water (D_20)	Water containing significantly more than the natural proportions (one in 6,500) of heavy hydrogen (deuterium, D) atoms to ordinary hydrogen atoms. Heavy water is used as a moderator in some reactors because it slows down neutrons effectively and also has a low probability of absorption of neutrons.
Heavy water moderated reactor	A reactor that uses heavy water as its moderator. Heavy water is an excellent moderator and thus permits the use of unenriched uranium as a fuel.
Helmet	A rigid respiratory inlet covering that also provides head protection against impact and penetration.
High-enriched uranium	Uranium enriched to 20 percent or greater in the isotope uranium-235.
High-level waste	High-level radioactive waste (HLW) means (1) irradiated (spent) reactor fuel; (2) liquid waste resulting from the operation of the first cycle solvent extraction system, and the concentrated wastes from subsequent extraction cycles, in a facility for reprocessing irradiated reactor fuel; and (3) solids into which such liquid wastes have been converted. HLW is primarily in the form of spent fuel discharged from commercial nuclear power reactors. It also includes some reprocessed HLW from defense activities, and a small quantity of reprocessed commercial HLW (see 10 CFR Part 60).

High integrity container (HIC)	A container commonly designed to meet the structural stability requirements of 10 CFR 61.56, and to meet Department of Transportation requirements for a Type A package.
High Radiation Area	Any area with dose rates greater than 100 millirems (1 millisievert) in one hour 30 centimeters from the source or from any surface through which the ionizing radiation penetrates. Areas at licensee facilities must be posted as "high radiation areas" and access into these areas is maintained under strict control.
Hood	A respiratory inlet covering that completely covers the head and neck and may also cover portions of the shoulders and torso.
Hot	A colloquial term meaning highly radioactive.
Hot spot	The region in a radiation/contamination area in which the level of radiation/contamination is significantly greater than in neighboring regions in the area.
Individual	Any human being.
Individual monitoring	(1) The assessment of dose equivalent by the use of devices designed to be worn by an individual; (2) The assessment of committed effective dose equivalent by bioassay (see Bioassay) or by determination of the time-weighted air concentrations to which an individual has been exposed, i.e., DAC-hours; or (3) The assessment of dose equivalent by the use of survey data.
Individual monitoring devices (individual monitoring equipment)	Devices designed to be worn by a single individual for the assessment of dose equivalent such as film badges, thermoluminescence dosimeters (TLDs), pocket ionization chambers, and personal ("lapel") air sampling devices.
Internal dose	That portion of the dose equivalent received from radioactive material taken into the body.
Kilo-	A prefix that multiplies a basic unit by 1,000 or 10^3.
Kilovolt	The unit of electrical potential equal to 1,000 volts.
Kinetic energy	The energy that a body possesses by virtue of its mass and velocity. Also called the energy of motion.

Lethal dose	(Lethal dose 50/30) The dose of radiation expected to cause death to an exposed population within 30 days to 50 percent (LD 50/30) of those exposed. Typically, the LD 50/30 is in the range from 400 to 450 rem (4 to 5 sieverts) received over a very short period of time.
Lens dose equivalent (LDE)	Applies to the external exposure of the lens of the eye and is taken as the dose equivalent at a tissue depth of 0.3 centimeter (300 mg/cm^2).
License	A license issued under the regulations in parts 30 through 36, 39, 40, 50, 60, 61, 70, or 72 of chapter 10.
Licensed Material (Radioactive Material)	Source material, special nuclear material, or byproduct material received, possessed, used, transferred, or disposed of under a general or specific license issued by the Nuclear Regulatory Commission.
Licensee	The holder of a license.
Light water	Ordinary water (H_20) as distinguished from heavy water (D_20).
Light water reactor	A term used to describe reactors using ordinary water as coolant, including boiling water reactors (BWRs) and pressurized water reactors (PWRs), the most common types used in the United States.
Limiting condition for operation	The section of Technical Specifications that identifies the lowest functional capability or performance level of equipment required for safe operation of the facility.
Limiting safety system settings	Settings for automatic protective devices related to those variables having significant safety functions. Where a limiting safety system setting is specified for a variable on which a safety limit has been placed, the setting will assure that automatic protective action will correct the abnormal situation before a safety limit is exceeded.
Limits (dose limits)	The permissible upper bounds of radiation doses.
Linear heat generation rate	The heat generation rate per unit length of fuel rod, commonly expressed in kilowatts per foot of fuel rod (kw/ft).

Loop	In a pressurized water reactor, the coolant flow path through piping from the reactor pressure vessel to the steam generator, to the reactor coolant pump, and back to the reactor pressure vessel. Large PWRs may have as many as four separate loops.
Loose-fitting facepiece	A respiratory inlet covering that is designed to form a partial seal with the face.
Loss of coolant accident (LOCA)	Those postulated accidents that result in a loss of reactor coolant at a rate in excess of the capability of the reactor makeup system from breaks in the reactor coolant pressure boundary, up to and including a break equivalent in size to the double-ended rupture of the largest pipe of the reactor coolant system.
Low-level waste	Low-level radioactive waste (LLW) is a general term for a wide range of wastes. Industries, hospitals and medical, educational, or research institutions; private or government laboratories; and nuclear fuel cycle facilities (e.g., nuclear power reactors and fuel fabrication plants) using radioactive materials generate low-level wastes as part of their normal operations. These wastes are generated in many physical and chemical forms and levels of contamination (see 10 CFR Part 61).
Low population zone (LPZ)	An area of low population density often required around a nuclear installation before being built. The number and density of residents is of concern in emergency planning so that certain protective measures (such as notification and instructions to residents) can be accomplished in a timely manner.
Mass-energy equation	The equation developed by Albert Einstein, which is usually given as $E = mc^2$, showing that, when the energy of a body changes by an amount E (no matter what form the energy takes), the mass, m, of the body will change by an amount equal to E/c^2. The factor c^2, the square of the speed of light in a vacuum ($3x10^8$ meters/second), may be regarded as the conversion factor relating units of mass and energy. The equation predicted the possibility of releasing enormous amounts of energy by the conversion of mass to energy. It is also called the Einstein Equation.
Mass number	The number of nucleons (neutrons and protons) in the nucleus of an atom. Also known as the atomic weight of an atom.

Material Balance Area (MBA)	Designated use and/or storage location(s) on the Windsor Site for licensed Special Nuclear Material. Each MBA maintains a separated set of accountability books.
Maximum dependable capacity (gross)	Dependable main-unit gross generating capacity, winter or summer, whichever is smaller. The dependable capacity varies because the unit efficiency varies during the year due to temperature variations in cooling water. It is the gross electrical output as measured at the output terminals of the turbine generator during the most restrictive seasonal conditions (usually summer).
Maximum dependable capacity (net)	Gross maximum dependable generating capacity less the normal station service loads.
Mega-	A prefix that multiplies a basic unit by 1,000,000 or 10^6.
Megacurie	One million (10^6) curies.
Megawatt (MW)	One million (10^6) watts.
Megawatt hour (MWh)	One million (10^6) watt-hours.
Member of the public	Any individual except when that individual is receiving an occupational dose.
Metric ton	Approximately 2,200 pounds in the English system of measurements (Note: in the international system of measurements, 1 metric ton = 1000 kg.)
Micro-	A prefix that divides a basic unit into one million parts (10^{-6}).
Microcurie	One millionth (10^{-6}) of a curie.
Mill tailings	Naturally radioactive residue from the processing of uranium ore into yellowcake in a mill. Although the milling process recovers about 93 percent of the uranium, the residues, or tailings, contain several naturally-occurring radioactive elements, including uranium, thorium, radium, polonium, and radon.
Milli-	A prefix that divides a basic unit by 1,000.
Millirem	One thousandth of a rem. (1 mrem = 10^{-3} rem)

Milliroentgen	One thousandth of a roentgen, R. (1 mR = 10^{-3}R)
Minor	An individual less than 18 years of age.
Mixed oxide fuel	A mixture of uranium oxide and plutonium oxide used to fuel a reactor. Often it is abbreviated as "MOX." Conventional fuel is made of pure uranium oxide.
Moderator	A material, such as ordinary water, heavy water, or graphite, that is used in a reactor to slow down high-velocity neutrons, thus increasing the likelihood of fission.
Moderator temperature coefficient of reactivity	The change in reactivity per degree change in moderator temperature due to the property of the reactor moderator to slow down fewer neutrons as its temperature increases. This acts to stabilize power reactor operations.
Molecule	A group of atoms held together by chemical forces. A molecule is the smallest unit of a compound that can exist by itself and retain all of its chemical properties.
Monitoring	Periodic or continuous determination of the amount of ionizing radiation or radioactive contamination present in an occupied region, as a safety measure, for the purpose of health protection.
Nano-	A prefix that divides a basic unit by one billion (10^{-9}).
Nanocurie	One billionth (10^{-9}) of a curie.
Natural circulation	The circulation of the coolant in the reactor coolant system without the use of the reactor coolant pumps. The circulation is due to the natural convection resulting from the different densities of relative cold and heated portions of the system.
Natural uranium	Uranium as found in nature. It contains 0.7 percent uranium-235, 99.3 percent uranium-238, and a trace of uranium-234.
Negative pressure respirator (tight fitting)	A respirator in which the air pressure inside the facepiece is negative during inhalation with respect to the ambient air pressure outside the respirator.

Net summer capability	The steady hourly output that generating equipment is expected to supply to system load exclusive of auxiliary power, as demonstrated by tests at the time of summer peak demand.
Neutron	An uncharged elementary particle with a mass slightly greater than that of the proton, and found in the nucleus of every atom heavier than hydrogen.
Neutron capture	The process in which an atomic nucleus absorbs or captures a neutron.
Neutron chain reaction or Neutron flux	A process in which some of the neutrons released in one fission event cause other fissions to occur. There are three types of chain reactions: (1) Nonsustaining chain reaction--An average of less than one fission is produced by the neutrons released by each previous fission (reactor subcriticality). (2) Sustaining chain reaction--An average of exactly one fission is produced by the neutrons released by each previous fission (reactor criticality). (3) Multiplying chain reaction--An average of more than one fission is produced by the neutrons released by precious fission (reactor supercriticality).
Neutron generation	The release, thermalization, and absorption of fission neutrons by a fissile material and the fission of that material producing a second generation of neutrons. In a typical nuclear power reactor system, there are about 40,000 generations of neutrons every second.
Neutron leakage	Neutrons that escape from the vicinity of the fissionable material in a reactor core. Neutrons that leak out of the fuel region are no longer available to cause fission and must be absorbed by shielding placed around the reactor pressure vessel for that purpose.
Neutron source	A radioactive material (decays by neutron emission) that can be inserted into a reactor to ensure that a sufficient quantity of neutrons are available to register on neutron detection equipment for power level indication.
Neutron, thermal	A neutron that has (by collision with other particles) reached an energy state equal to that of its surroundings, typically on the order of 0.025 eV (electron volts).

Noble gas	A gaseous chemical element that does not readily enter into chemical combination with other elements. An inert gas. Examples are helium, argon, krypton, xenon and radon.
Nonpower reactor	Reactors used for research, training, and test purposes, and for the production of radioisotopes for medical and industrial uses.
Non-stochastic effect	The health effects, the severity of which vary with the dose and for which a threshold is believed to exist. Radiation-induced cataract formation is an example of a deterministic effect (also called a deterministic effect) (see 10 CFR 20.1003).
Non-vital plant systems	Systems at a nuclear facility that may or may not be necessary for the operation of the facility (i.e., power production), but that would have little or no effect on public health and safety should they fail. These systems are not safety related.
Nozzle	As used in PWRs and BWRs, the interface for fluid (inlet and outlet) between reactor plant components (pressure vessel, coolant pumps, steam generators, etc.) and their associated piping systems.
NRC	An acronym for the Nuclear Regulatory Commission or its duly authorized representatives.
Nuclear Materials Management and Safeguards System (NMMSS)	A national database used by DOE and NRC for tracking nuclear material.
Nuclear energy	The energy liberated by a nuclear reaction (fission or fusion) or by radioactive decay.
Nuclear force	A powerful short-ranged attractive force that holds together the particles inside an atomic nucleus.
Nuclear power plant	An electrical generating facility using a nuclear reactor as its power (heat) source.
Nuclear steam supply system	The reactor and the reactor coolant pumps (and steam generators for a pressurized water reactor) and associated piping in a nuclear power plant used to generate the steam needed to drive the turbine generator unit.

Nuclear waste	see High-level waste and Low-level waste.
Nucleon	Common name for a constituent particle of the atomic nucleus. At present, applied to protons and neutrons, but may include any other particles found to exist in the nucleus.
Nucleus	The small, central, positively charged region of an atom that carries the atom's nuclei. Except for the nucleus of ordinary (light) hydrogen, which has a single proton, all atomic nuclei contain both protons and neutrons. The number of protons determines the total positive charge, or atomic number. This is the same for all the atomic nuclei of a given chemical element. The total number of neutrons and protons is called the mass number.
Nuclide	A general term referring to all known isotopes, both stable (279) and unstable (about 5,000), of the chemical elements.
Occupational dose	The dose received by an individual in the course of employment in which the individual's assigned duties involve exposure to radiation or to radioactive material from licensed and unlicensed sources of radiation, whether in the possession of the licensee or other person. Occupational dose does not include dose received from background radiation, from any medical administration the individual has received, from exposure to individuals administered radioactive material and released in accordance with §35.75, from voluntary participation in medical research programs, or as a member of the public.
Operable	A system, subsystem, train, component, or device is operable or has operability when it is capable of performing its specified functions, and when all necessary attendant instrumentation, controls, electrical power, cooling or seal water, lubrication or other auxiliary equipment that are required for the system, subsystem, train, component or device to perform its functions are also capable of performing their related support functions.
Operational mode	An operational mode corresponds to any one inclusive combination of core reactivity condition, power level, and average reactor coolant temperature.

Package	The assembly of components necessary to ensure compliance with the packaging requirements of DOT regulations, together with its radioactive contents, as presented for transport.
Parent	A radionuclide that upon radioactive decay or disintegration yields a specific nuclide (the daughter).
Parts per million (ppm)	Parts (molecules) of a substance contained in a million parts of another substance (or water).
Pellet, fuel	As used in pressurized water reactors and boiling water reactors, a pellet is a small cylinder approximately 3/8-inch in diameter and 5/8-inch in length, consisting of uranium fuel in a ceramic form - uranium dioxide, UO2. Typical fuel pellet enrichments in nuclear power reactors range from 2.0 percent to 3.5 percent uranium-235.
Performance-based Regulation	Required results or outcome of performance rather than a prescriptive process, technique, or procedure.
Periodic Table	An arrangement of chemical elements in order of increasing atomic number. Elements of similar properties are placed one under the other, yielding groups or families of elements. Within each group, there is a variation of chemical and physical properties, but in general, there is a similarity of chemical behavior within each group. See an online periodic table.
Permanent Radiological Posting	Any area intended or expected to be posted for a period of greater than 90 days.

Person	(1) Any individual, corporation, partnership, firm, association, trust, estate, public or private institution, group, Government agency other than the Commission or the Department of Energy (except that the Department shall be considered a person within the meaning of the regulations in 10 CFR chapter I to the extent that its facilities and activities are subject to the licensing and related regulatory authority of the Commission under section 202 of the Energy Reorganization Act of 1974 (88 Stat. 1244), the Uranium Mill Tailings Radiation Control Act of 1978 (92 Stat. 3021), the Nuclear Waste Policy Act of 1982 (96 Stat. 2201), and section 3(b)(2) of the Low-Level Radioactive Waste Policy Amendments Act of 1985 (99 Stat. 1842)), any State or any political subdivision of or any political entity within a State, any foreign government or nation or any political subdivision of any such government or nation, or other entity; and (2) Any legal successor, representative, agent, or agency of the foregoing.
Personal Air Sampling	The sampling of air for radioactive particles in the immediate vicinity of an individual worker's nose and mouth, usually by a portable sampling pump and collection tube worn on the body with the filter holder worn on or near the shirt collar, such as a lapel sampler. This is the most representative method for estimating breathing zone concentrations due to the proximity of the collection media to the worker's nose and mouth.
Personnel monitoring	The use of portable survey meters to determine the amount of radioactive contamination on an individual, or the use of dosimetry to determine an individual's occupational radiation dose.
Photon	A quantum (or packet) of energy emitted in the form of electromagnetic radiation. Gamma rays and x-rays are examples of photons.
Physical description	The items called for on NRC Form 541 to describe a low-level radioactive waste.
Pico-	A prefix that divides a basic unit by one trillion (10^{-12}).
Picocurie	One trillionth (10^{-12}) of a curie.

Pig	A colloquial term describing a container (usually lead or depleted uranium) used to ship or store radioactive materials. The thick walls of this shielding device protect the person handling the container from radiation. Large containers used for spent fuel storage are commonly called casks.
Pile	A colloquial term describing the first nuclear reactors. It is called a pile because the earliest reactors were "piles" of graphite and uranium blocks.
Planned special exposure	An infrequent exposure to radiation, separate from and in addition to, the annual dose limits (see 10 CFR 20.1003 and '20.1206).
Plutonium (Pu)	A heavy, radioactive, manmade metallic element with atomic number 94. Its most important isotope is fissile plutonium-239, which is produced by neutron irradiation of uranium-238. It exists in only trace amounts in nature.
Pocket dosimeter	A small ionization detection instrument that indicates ionizing radiation exposure directly. An auxiliary charging device is usually necessary.
Poison, neutron	In reactor physics, a material other than fissionable material, in the vicinity of the reactor core that will absorb neutrons. The addition of poisons, such as control rods or boron, into the reactor is said to be an addition of negative reactivity.
Pool reactor	A reactor in which the fuel elements are suspended in a pool of water that serves as the reflector, moderator, and coolant. Popularly called a "swimming pool reactor," it is used for research and training, not for electrical generation.
Positive pressure respirator	A respirator in which the pressure inside the respiratory inlet covering exceeds the ambient air pressure outside the respirator.
Positron	Particle equal in mass, but opposite in charge, to the electron (a positive electron).
Power coefficient of reactivity	The change in reactivity per percent change in power. The power coefficient is the summation of the moderator temperature coefficient of reactivity, the fuel temperature coefficient of reactivity, and the void coefficient of reactivity.

Power defect	The total amount of reactivity added due to a given change in power. It can also be expressed as the integrated power coefficient over the range of the power change.
Power reactor	A reactor designed to produce heat for electric generation, as distinguished from reactors used for research, for producing radiation or fissionable materials, or for reactor component testing.
Powered air-purifying respirator (PAPR)	An air-purifying respirator that uses a blower to force the ambient air through air-purifying elements to the inlet covering.
Pressure demand respirator	A positive pressure atmosphere-supplying respirator that admits breathing air to the facepiece when the positive pressure is reduced inside the facepiece by inhalation.
Pressure vessel	A strong-walled container housing the core of most types of power reactors. It usually also contains the moderator, neutron reflector, thermal shield, and control rods.
Pressurized water reactor (PWR)	A power reactor in which heat is transferred from the core to an exchanger by high temperature water kept under high pressure in the primary system. Steam is generated in a secondary circuit. Many reactors producing electric power are pressurized water reactors.
Pressurizer	A tank or vessel that acts as a head tank (or surge volume) to control the pressure in a pressurized water reactor.
Primary system	A term that may be used for referring to the reactor coolant system.
Proportional counter	A radiation instrument in which an electronic detection system receives pulses that are proportional to the number of ions formed in a gas-filled tube by ionizing radiation.
Proton	An elementary nuclear particle with a positive electric charge located in the nucleus of an atom.

Public dose	The dose received by a member of the public from exposure to radiation or radioactive material released by a licensee, or to any other source of radiation under the control of a licensee. Public dose does not include occupational dose or doses received from background radiation, from any medical administration the individual has received, from exposure to individuals administered radioactive material and released in accordance with §35.75, or from voluntary participation in medical research programs.
Qualitative fit test (QLFT)	A pass/fail fit test to assess the adequacy of respirator fit that relies on the individual's response to the test agent.
Quality factor	The factor by which the absorbed dose (rad or gray) is to be multiplied to obtain a quantity that expresses, on a common scale for all ionizing radiation, the biological damage (rem or sievert) to an exposed individual. It is used because some types of radiation, such as alpha particles, are more biologically damaging internally than other types.
Quantitative fit test (QNFT)	An assessment of the adequacy of respirator fit by numerically measuring the amount of leakage into the respirator.
Quantum theory	The concept that energy is radiated intermittently in units of definite magnitude, called quanta, and absorbed in a like manner.
Quarter	A period of time equal to one-fourth of the year observed by the licensee (approximately 13 consecutive weeks), providing that the beginning of the first quarter in a year coincides with the starting date of the year and that no day is omitted or duplicated in consecutive quarters.
Rad	The special unit for radiation absorbed dose, which is the amount of energy from any type of ionizing radiation (e.g., alpha, beta, gamma, neutrons, etc.) deposited in any medium (e.g., water, tissue, air). A dose of one rad means the absorption of 100 ergs (a small but measurable amount of energy) per gram of absorbing tissue (100 rad = 1 gray).
Radiation, nuclear	Particles (alpha, beta, neutrons) or photons(gamma) emitted from the nucleus of unstable radioactive atoms as a result of radioactive decay.

Radiation area	Any area with radiation levels greater than 5 millirems (0.05 millisievert) in one hour at 30 centimeters from the source or from any surface through which the radiation penetrates.
Radiation detection instrument	A device that detects and displays the characteristics of ionizing radiation.
Radiation Safety Officer (RSO)	A health physics professional who meets the experience and qualification requirements delineated in the applicable NRC license
Radiation shielding	Reduction of radiation by interposing a shield of absorbing material between any radioactive source and a person, work area, or radiation-sensitive device.
Radiation sickness (syndrome)	The complex of symptoms characterizing the disease known as radiation injury, resulting from excessive exposure (greater than 200 rads or 2 gray) of the whole body (or large part) to ionizing radiation. The earliest of these symptoms are nausea, fatigue, vomiting, and diarrhea, which may be followed by loss of hair (epilation), hemorrhage, inflammation of the mouth and throat, and general loss of energy. In severe cases, where the radiation exposure has been approximately 1,000 rad (10 gray) or more, death may occur within two to four weeks. Those who survive 6 weeks after the receipt of a single large dose of radiation to the whole body may generally be expected to recover.
Radiation source	Usually a sealed source of radiation used in teletherapy and industrial radiography, as a power source for batteries (as in use in space craft), or in various types of industrial gauges. Machines, such as accelerators and radioisotope generators, and natural radionuclides may be considered sources.
Radiation standards	Exposure standards, permissible concentrations, rules for safe handling, regulations for transportation, regulations for industrial control of radiation, and control of radioactive material by legislative means.

Radiation warning symbol	An officially prescribed symbol (a magenta or black trefoil) on a yellow background that must be displayed where certain quantities of radioactive materials are present or where certain doses of radiation could be received. The symbol shall be the conventional three-bladed design as described in 10CFR20.1901
Radioactive contamination	Deposition of radioactive material in any place where it may harm persons or equipment.
Radioactive Material Area	Any area or room in which there is used or stored an amount of licensed material exceeding 10x the amount specified in Appendix C of 10 CFR 20.
Radioactive series	A succession of nuclides, each of which transforms by radioactive disintegration into the next until a stable nuclide results. The first member is called the parent, the intermediate members are called daughters, and the final stable member is called the end product.
Radioactivity	The spontaneous emission of radiation, generally alpha or beta particles, often accompanied by gamma rays, from the nucleus of an unstable isotope. Also, the rate at which radioactive material emits radiation. Measured in units of becquerels or disintegrations per second.
Radiography	The making of a shadow image on photographic film by the action of ionizing radiation.
Radioisotope	An unstable isotope of an element that decays or disintegrates spontaneously, emitting radiation. Approximately 5,000 natural and artificial radioisotopes have been identified.
Radiological Area	Any area, inside a Restricted Area, posted as a Radiation Area, High Radiation Area, Very High Radiation Area, Contamination Area, Airborne Radioactivity Area, or any other radiologically posted area.
Radiological sabotage	Any deliberate act directed against a nuclear facility licensed by the NRC or against a component of such a facility which could endanger the public health and safety by exposure to radiation.
Radiological Safety Engineer (RSE)	A health physics professional with knowledge and experience sufficient to develop, implement, and audit a Radiation Protection Program at a work site.

Radiological survey	The evaluation of the radiation hazards accompanying the production, use, or existence of radioactive materials under a specific set of conditions. Such evaluation customarily includes a physical survey of the disposition of materials and equipment, measurements or estimates of the levels of radiation that may be involved, and a sufficient knowledge of processes affecting these materials to predict hazards resulting from expected or possible changes in materials or equipment.
Radiologically controlled area	Any area to which access is controlled for the protection of individuals from exposure to radiation and radioactive materials.
Radiology	That branch of medicine dealing with the diagnostic and therapeutic applications of radiant energy, including x-rays and radioisotopes.
Radionuclide	A radioisotope.
Radiosensitivity	The relative susceptibility of cells, tissues, organs, organisms, or other substances to the injurious action of radiation.
Radium (Ra)	A radioactive metallic element with atomic number 88. As found in nature, the most common isotope has a mass number of 226. It occurs in minute quantities associated with uranium in pitchblende, camotite, and other minerals.
Radon (Rn)	A radioactive element that is one of the heaviest gases known. Its atomic number is 86. It is a daughter of radium.
Reaction	Any process involving a chemical or nuclear change.
Reactivity	A term expressing the departure of a reactor system from criticality. A positive reactivity addition indicates a move toward supercriticality (power increase). A negative reactivity addition indicates a move toward subcriticality (power decrease).
Reactor coolant system	The system used to remove energy from the reactor core and transfer that energy either directly or indirectly to the steam turbine.

Reactor, nuclear	A device in which nuclear fission may be sustained and controlled in a self-supporting nuclear reaction. The varieties are many, but all incorporate certain features, including fissionable material or fuel, a moderating material (unless the reactor is operated on fast neutrons), a reflector to conserve escaping neutrons, provisions of removal of heat, measuring and controlling instruments, and protective devices. The reactor is the heart of a nuclear power plant.
Reference man	A person with the anatomical and physiological characteristics of an average individual which is used in calculations assessing internal dose (also may be called "Standard Man").
Reflector	A layer of material immediately surrounding a reactor core that scatters back (or reflects) into the core many neutrons that would otherwise escape. The returned neutrons can then cause more fissions and improve the neutron economy of the reactor. Common reflector materials are graphite, beryllium, water, and natural uranium.
REM	(Roentgen Equivalent Man) - a standard unit that measures the effects of ionizing radiation on humans.
Restricted Area	Any area to which access is controlled for the protection of individuals from exposure to radiation and radioactive materials.
Residual radioactivity	Radioactivity in structures, materials, soils, groundwater, and other media at a site resulting from activities under the licensee's control. This includes radioactivity from all licensed and unlicensed sources used by the licensee, but excludes background radiation. It also includes radioactive materials remaining at the site as a result of routine or accidental releases of radioactive material at the site and previous burials at the site, even if those burials were made in accordance with the provisions of 10 CFR part 20.
Residual waste	Low-level radioactive waste resulting from processing or decontamination activities that cannot be easily separated into distinct batches attributable to specific waste generators.
Respiratory protective device	An apparatus, such as a respirator, used to reduce the individual's intake of airborne radioactive materials.

"Health Physics" Restricted Area	An area, access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials. Also an area where a member of the general public could receive a dose of greater than 100 mR TEDE in a year. Restricted area does not include areas used as residential quarters, but separate rooms in a residential building may be set apart as a restricted area.
Risk-informed regulation	Incorporating an assessment of safety significance or relative risk in NRC regulatory actions. Making sure that the regulatory burden imposed by individual regulations or processes is commensurate with the importance of that regulation or process to protecting public health and safety and the environment.
Roentgen (R)	A unit of exposure to ionizing radiation. It is the amount of gamma or x-rays required to produce ions resulting in a charge of 0.000258 coulombs/kilogram of air under standard conditions. Named after Wilhelm Roentgen, the German scientist who discovered x-rays in 1895.
Rubblization	A decommissioning technique involving demolition and burial of formerly operating nuclear facilities. All equipment from buildings is removed and the surfaces are decontaminated. Above-grade structures are demolished into rubble and buried in the structure's foundation below ground. The site surface is then covered, graded and landscaped for unrestricted use.
Safeguards	The protection of special nuclear material (SNM) to prevent its theft, loss, or sabotage.
Safe shutdown earthquake	A design-basis earthquake.
Safety injection	The rapid insertion of a chemically soluble neutron poison (such as boric acid) into the reactor coolant system to ensure reactor shutdown.
Safety limit	A limit placed upon important process variables which are found to be necessary to reasonably protect the integrity of the physical barriers which guard against the uncontrolled release of radioactivity.

Safety related	The managerial controls, administrative documents, operating procedures, systems, structures, and components that have been designed to mitigate the consequences of postulated accidents that could cause undue risk to public health and safety.
SAFSTOR	A method of decommissioning in which the nuclear facility is placed and maintained in such condition that the nuclear facility can be safely stored and subsequently decontaminated to levels that permit release for unrestricted use.
Sanitary sewerage	A system of public sewers for carrying off waste water and refuse, but excluding sewage treatment facilities, septic tanks, and leach fields owned or operated by the licensee.
SAP	Sampling and Analysis Plan
Scattered radiation	Radiation that, during its passage through a substance, has been changed in direction. It may also have been modified by a decrease in energy. It is one form of secondary radiation.
Scintillation detector	The combination of phosphor, photomultiplier tube and associated electronic circuits for counting light emissions produced in the phosphor by ionizing radiation.
Scram	The term used to mean the sudden shutting down of a nuclear reactor, usually by rapid insertion of control rods, either automatically or manually by the reactor operator. May also be called a reactor trip. It is actually an acronym for "safety control rod axe man," the man assigned to insert the emergency rod on the first reactor (the Chicago pile) in the U.S.
Sealed source	Any special nuclear material or byproduct encased in a capsule designed to prevent leakage or escape of the material.
Secondary radiation	Radiation originating as the result of absorption of other radiation in matter. It may be either electromagnetic or particulate in nature.
Secondary system	The steam generator tubes, steam turbine, condenser, and associated pipes, pumps, and heaters used to convert the heat energy of the reactor coolant system into mechanical energy for electrical generation. Most commonly used in reference to pressurized water reactors.

Seismic category I	A term used to define structures, systems, and components that are designed and built to withstand the maximum potential earthquake stresses for the particular region where a nuclear plant is sited.
Self-contained breathing apparatus (SCBA)	An atmosphere-supplying respirator for which the breathing air source is designed to be carried by the user.
Shallow-dose equivalent (HS)	Applies to the external exposure of the skin or an extremity, is taken as the dose equivalent at a tissue depth of 0.007 centimeter (7 mg/cm^2) averaged over an area of 1 square centimeter.
Shielding	Any material or obstruction that absorbs radiation and thus tends to protect personnel or materials from the effects of ionizing radiation.
Shipper	The licensed entity (i.e., the waste generator, waste collector, or waste processor) who offers low-level radioactive waste for transportation, typically consigning this type of waste to a licensed waste collector, waste processor, or land disposal facility operator.
Shipping paper	NRC Form 540 and, if required, NRC Form 540A which includes the information required by DOT in 49 CFR part 172.
Shutdown	A decrease in the rate of fission (and heat production) in a reactor (usually by the insertion of control rods into the core).
Shutdown margin	The instantaneous amount of reactivity by which the reactor is subcritical or would be subcritical from its present condition assuming all full-length rod cluster assemblies (shutdown and control) are fully inserted except for the single rod cluster assembly of highest reactivity worth which is assumed to be fully withdrawn.
Sievert (Sv)	The new international system (SI) unit for dose equivalent equal to 1 Joule/kilogram. 1 sievert = 100 rem.
Smear sample	A sample collected by wiping the surface of the sample location with a semi-absorbent sample media disc while applying moderate pressure to transfer removable radioactivity from the surface to the sample media. (also know as a swipe or wipe sample)
Somatic effects of radiation	Effects of radiation limited to the exposed individual, as distinguished from genetic effects, which may also affect subsequent unexposed generations.

Source material	Uranium or thorium, or any combination thereof, in any physical or chemical form or ores which contain by weight one-twentieth of one percent (0.05%) or more of: (1) uranium, (2) thorium or (3) any combination thereof. Source material does not include special nuclear material.
Special Nuclear Material (SNM)	(1) Means plutonium, uranium 233, uranium enriched in the isotope 233 or in the isotope 235, and any other material which the Commission, pursuant to the provisions of section 51 of the act, determines to be special nuclear material, but does not include source material; or (2) any material artificially enriched by any of the foregoing but does not include source material.
Spent (depleted) fuel	Nuclear reactor fuel that has been used to the extent that it can no longer effectively sustain a chain reaction.
Spent fuel pool	An underwater storage and cooling facility for fuel elements that have been removed from a reactor.
Spent nuclear fuel	Fuel that has been removed from a nuclear reactor because it can no longer sustain power production for economic or other reasons.
Stable isotope	An isotope that does not undergo radioactive decay.
Standard Technical Specifications	NRC staff guidance on model technical specifications for an operating license. (See also Technical Specifications.)
Startup	An increase in the rate of fission (and heat production) in a reactor (usually by the removal of control rods from the core).
Stay time	The period during which personnel may remain in a restricted area in a reactor before accumulating some permissible occupational dose.
Steam generator	The heat exchanger used in some reactor designs to transfer heat from the primary (reactor coolant) system to the secondary (steam) system. This design permits heat exchange with little or no contamination of the secondary system equipment.

Stochastic effects	Effects that occur by chance, generally occurring without a threshold level of dose, whose probability is proportional to the dose and whose severity is independent of the dose. In the context of radiation protection, the main stochastic effects are cancer and genetic effects.
Subcriticality	The condition of a nuclear reactor system when the rate of production of fission neutrons is lower than the rate of production in the previous generation due to increased neutron leakage and poisons.
Supercritical reactor	A reactor in which the power level is increasing with time.
Supercriticality	The condition for increasing the level of operation of a reactor. The rate of fission neutron production exceeds all neutron losses, and the overall neutron population increases.
Supercritical reactor	A reactor in which the power level is increasing with time.
Superheating	The heating of a vapor, particularly steam, to a temperature much higher than the boiling point at the existing pressure. This is done in some power plants to improve efficiency and to reduce water damage to the turbine.
Supplied-air respirator (SAR) or airline respirator	An atmosphere-supplying respirator for which the source of breathing air is not designed to be carried by the user.
Survey	An evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or presence of radioactive material or other sources of radiation. When appropriate, such an evaluation includes a physical survey of the location of radioactive material and measurements or calculations of levels of radiation, or concentrations or quantities of radioactive material present.
Survey meter	Any portable radiation detection instrument especially adapted for inspecting an area or individual to establish the existence and amount of radioactive material present.

Swipe sample	A sample collected by wiping the surface of the sample location with a semi-absorbent sample media disc while applying moderate pressure to transfer removable radioactivity from the surface to the sample media. (also know as a wipe or smear sample)
Technical Specifications	Part of an NRC license authorizing the operation of a nuclear production or utilization facility. A Technical Specification establishes requirements for items such as safety limits, limiting safety system settings, limiting control settings, limiting conditions for operation, surveillance requirements, design features, and administrative controls. (See also Standard Technical Specifications.)
Terrestrial radiation	The portion of the natural background radiation that is emitted by naturally occurring radioactive materials, such as uranium, thorium, and radon in the earth.
Thermal breeder reactor	A breeder reactor in which the fission chain reaction is sustained by thermal neutrons.
Thermalization	The process undergone by high-energy (fast) neutrons as they lose energy by collision.
Thermal power	The total core heat transfer rate to the reactor coolant.
Thermal reactor	A reactor in which the fission chain reaction is sustained primarily by thermal neutrons. Most current reactors are thermal reactors.
Thermal shield	A layer, or layers, of high-density material located within a reactor pressure vessel or between the vessel and the biological shield to reduce radiation heating in the vessel and the biological shield.
Thermoluminescent dosimeter	A small device used to measure radiation by measuring the amount of visible light emitted from a crystal in the detector when exposed to ionizing radiation.
Thermonuclear	An adjective referring to the process in which very high temperatures are used to bring about the fusion of light nuclei, such as those of the hydrogen isotopes deuterium and tritium, with the accompanying liberation of energy.
Tight-fitting facepiece	A respiratory inlet covering that forms a complete seal with the face.

Total effective dose equivalent (TEDE)	The sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).
Transient	A change in the reactor coolant system temperature and/or pressure due to a change in power output of the reactor. Transients can be caused by adding or removing neutron poisons, by increasing or decreasing electrical load on the turbine generator, or by accident conditions.
Trip, reactor	The term used to mean the sudden shutting down of a nuclear reactor, usually by rapid insertion of control rods, either automatically or manually by the reactor operator. May also be called a reactor scram.
Tritium	A radioactive isotope of hydrogen (one proton, two neutrons). Because it is chemically identical to natural hydrogen, tritium can easily be taken into the body by any ingestion path. It decays by beta emission. It has a radioactive halflife of about 12.5 years.
Turbine	A rotary engine made with a series of curved vanes on a rotating shaft, usually turned by water or steam. Turbines are considered the most economical means to turn large electrical generators.
Turbine generator (TG)	A steam (or water) turbine directly coupled to an electrical generator. The two devices are often referred to as one unit.
Ultraviolet	Electromagnetic radiation of a wavelength between the shortest visible violet and low energy x-rays.
Unrestricted area	The area outside the owner-controlled portion of a nuclear facility (usually the site boundary). An area in which a person could not be exposed to radiation levels in excess of 2 millirems in any one hour from external sources (see 10 CFR 20.1003).
Unstable isotope	A radioactive isotope.
Uranium	A radioactive element with the atomic number 92 and, as found in natural ores, an atomic weight of approximately 238. The two principal natural isotopes are uranium-235 (0.7 percent of natural uranium), which is fissile, and uranium-238 (99.3 percent of natural uranium), which is fissionable by fast neutrons and is fertile. Natural uranium also includes a minute amount of uranium-234.

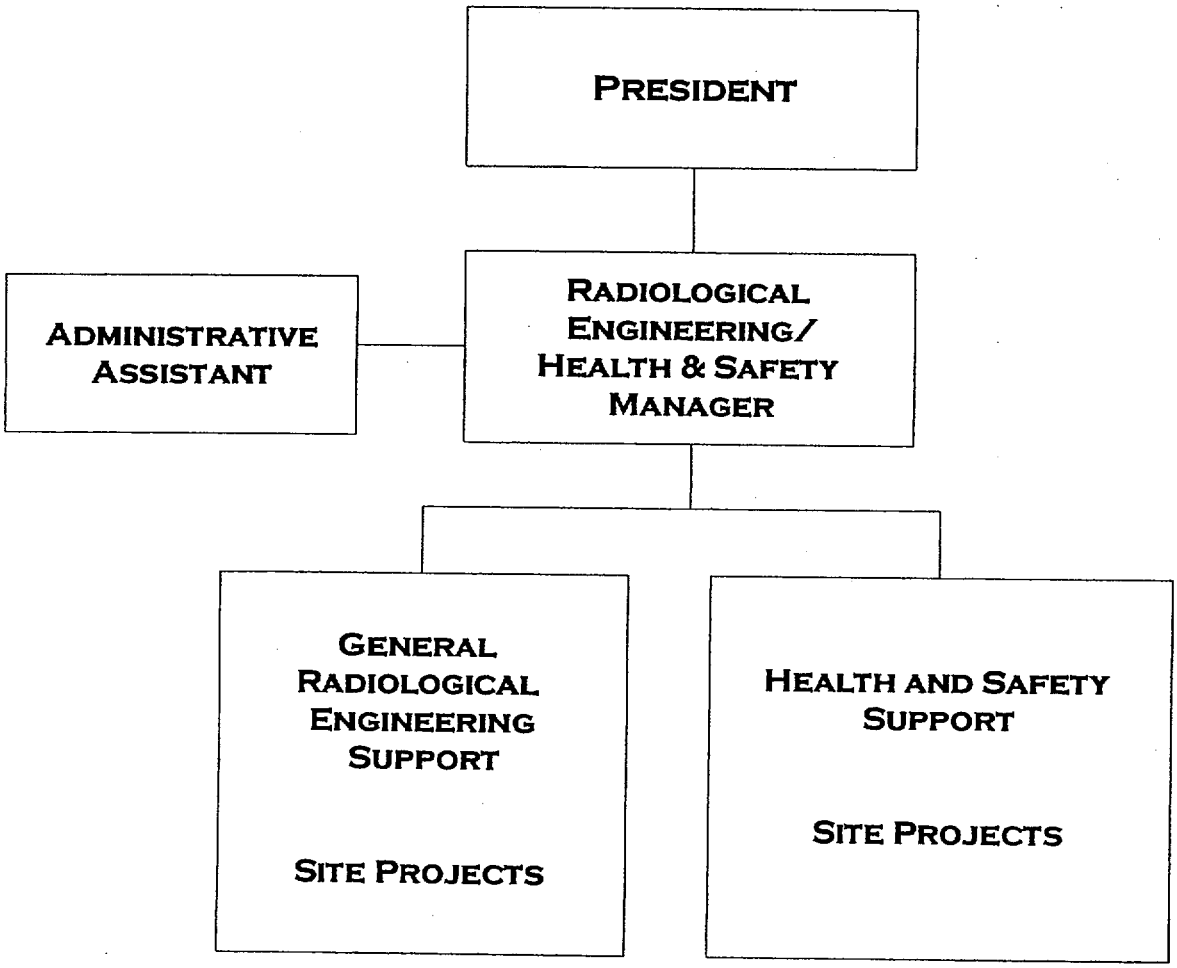
Uranium fuel cycle	The operations of milling of uranium ore, chemical conversion of uranium, isotopic enrichment of uranium, fabrication of uranium fuel, generation of electricity by a light-water-cooled nuclear power plant using uranium fuel, and reprocessing of spent uranium fuel to the extent that these activities directly support the production of electrical power for public use. Uranium fuel cycle does not include mining operations, operations at waste disposal sites, transportation of radioactive material in support of these operations, and the reuse of recovered non-uranium special nuclear and byproduct materials from the cycle.
Uranium fuel fabrication facility	A facility that (1) manufactures reactor fuel containing uranium for any of the following (i) preparation of fuel materials; (ii) formation of fuel materials into desired shapes; (iii) application of protective cladding; (iv) recovery of scrap material; and (v) storage associated with such operations; or (2) conducts research and development activities.
Uranium hexafluoride production facility	A facility that receives natural uranium in the form of ore concentrate; enriches it, either by gaseous diffusion or gas centrifuge methods; and converts it into uranium hexafluoride (UF6).
User seal check (fit check)	An action conducted by the respirator user to determine if the respirator is properly seated to the face. Examples include negative pressure check, positive pressure check, irritant smoke check, or isoamyl acetate check.
Vapor	The gaseous form of substances that are normally in liquid or solid form.
Void	An area of lower density in a moderating system (such as steam bubbles in water) that allows more neutron leakage than does the more dense material around it.
Very high radiation area	An area in which radiation levels exceed 500 rad (5 gray) in one hour at 1 meter from the source or from any surface that the radiation penetrates (see 10 CFR 20.1003).

Viability assessment	A Department of Energy decision making process to judge the prospects for geologic disposal of high-level radioactive wastes at Yucca Mountain based on (1) specific design work on the critical elements of the repository and waste package, (2) a total system performance assessment that will describe the probable behavior of the repository, (3) a plan and cost estimate for the work required to complete a license application, and (4) an estimate of the costs to construct and operate the repository (see 10 CFR Part 60).
Void coefficient of reactivity	The change in reactivity per percent change in void content due to an increase in the neutron leakage as the density of the moderator decreases with an increasing void content.
Waste, radioactive	Solid, liquid, and gaseous materials from nuclear operations that are radioactive or become radioactive and for which there is no further use. Wastes are generally classified as high-level (having radioactivity concentrations of hundreds of thousands of curies per gallon or foot), low-level (in the range of 1 microcurie per gallon or foot), or intermediate level (between these extremes) (see 10 CFR Parts 60 and 61).
Waste collector	An entity, operating under a Commission or Agreement State license, whose principal purpose is to collect and consolidate waste generated by others, and to transfer this waste, without processing or repackaging the collected waste, to another licensed waste collector, licensed waste processor, or licensed land disposal facility.
Waste description	The physical, chemical and radiological description of a low-level radioactive waste as called for on NRC Form 541.
Waste generator	An entity, operating under a Commission or Agreement State license, who (1) possesses any material or component that contains radioactivity or is radioactively contaminated for which the licensee foresees no further use, and (2) transfers this material or component to a licensed land disposal facility or to a licensed waste collector or processor for handling or treatment prior to disposal. A licensee performing processing or decontamination services may be a "waste generator" if the transfer of low-level radioactive waste from its facility is defined as "residual waste."

Waste processor	An entity, operating under a Commission or Agreement State license, whose principal purpose is to process, repackage, or otherwise treat low-level radioactive material or waste generated by others prior to eventual transfer of waste to a licensed low-level radioactive waste land disposal facility.
Waste type	A waste within a disposal container having a unique physical description (i.e., a specific waste descriptor code or description; or a waste sorbed on or solidified in a specifically defined media).
Watt	An electrical unit of power. 1 watt = 1 Joule/second.
Watt-hour	An electrical energy unit of measure equal to 1 watt of power supplied to, or taken from, an electrical circuit steadily for 1 hour.
Week	7 consecutive days starting on Sunday.
Weighting factor (WT)	Multipliers of the equivalent dose to an organ or tissue used for radiation protection purposes to account for different sensitivities of different organs and tissues to the induction of stochastic effects of radiation (see 10 CFR 20.1003).
Well-logging	A technique used in oil and gas exploration to help predict the commercial viability of new or existing wells. It involves lowering a well-logging tool, including a sealed source of radioactive material, into a well on a wire. This device sends data on the well's underground characteristics to the surface, where it is plotted on a chart.
Wheeling Service	The movement of electricity from one system to another over transmission facilities of intervening systems. Wheeling service contracts can be established between two or more systems.
Whole-body counter	A device used to identify and measure the radioactive material in the body of human beings and animals. It uses heavy shielding to keep out naturally existing background radiation and ultrasensitive radiation detectors and electronic counting equipment.

Whole-body exposure	An exposure of the body to radiation, in which the entire body, rather than an isolated part, is irradiated. Where a radioisotope is uniformly distributed throughout the body tissues, rather than being concentrated in certain parts, the irradiation can be considered as whole-body exposure.
Wipe sample	A sample collected by wiping the surface of the sample location with a semi-absorbent sample media disc while applying moderate pressure to transfer removable radioactivity from the surface to the sample media. (also know as a swipe or smear sample)
Working level (WL)	Any combination of short-lived radon daughters (for radon-222: polonium-218, lead-214, bismuth-214, and polonium-214; and for radon-220: polonium-216, lead-212, bismuth-212, and polonium-212) in 1 liter of air that will result in the ultimate emission of 1.3×10^5 MeV of potential alpha particle energy.
Working level month (WLM)	An exposure to 1 working level for 170 hours (2,000 working hours per year/12 months per year = approximately 170 hours per month).
X-rays	Penetrating electromagnetic radiation (photon) having a wavelength that is much shorter than that of visible light. These rays are usually produced by excitation of the electron field around certain nuclei. In nuclear reactions, it is customary to refer to photons originating in the nucleus as x-rays.
Year	The period of time beginning in January used to determine compliance with the provisions of this part. The licensee may change the starting date of the year used to determine compliance by the licensee provided that the change is made at the beginning of the year and that no day is omitted or duplicated in consecutive years.
Yellowcake	A solid uranium-oxygen compound (U_3O_8) that takes its name from its color and texture. It is a product of the uranium milling process and is the feed material used for fuel enrichment and fuel pellet fabrication.

Radiological Engineering Support Structure



MACTEC, Inc.	Procedure No: RPO-103 Revision No: 1 Effective Date: 9-1-02

RADIATION PROTECTION AUDITS, ASSESSMENTS AND OVERSIGHT

Authored By: _____ 4-5-02
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Reviewed By: _____ 8/16/02
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RADIATION PROTECTION AUDITS, ASSESSMENTS AND OVERSIGHT

1.0 PURPOSE

1.1 The purpose of this procedure is to establishes requirements for, and provide instruction during, the performance of audits and assessments performed on the MACTEC, Inc. Radiological Protection Program. This procedure also applies to audits and assessments performed in support of radiological work activities.

2.0 APPLICABILITY

2.1 This procedure applies to MACTEC, Inc. management, supervisors, individuals and contractors where their work assignment is controlled by MACTEC, Inc.

3.0 REFERENCES

3.1 10 CFR 20, "Standards for Protection Against Radiation."

3.2 10 CFR 835, "Occupational Radiation Protection."

3.3 RPO-101, "Radiation Protection Program Overview."

3.4 RPO-106, "Radiological Training and Qualification."

3.5 RPO-201, "Operation of Portable Radiological Survey Instruments."

4.0 DEFINITIONS AND ABBREVIATIONS

4.1 See RPO Glossary.

4.2 Audit - An independent formal review/examination performed to verify that radiological activities are being conducted in accordance with established procedures, protocols, regulations, and regulatory requirements.

5.0 GENERAL

5.1 EQUIPMENT

Not applicable

5.2 SAFETY CONSIDERATIONS

Not applicable

5.3 RESPONSIBILITIES

5.3.1 RSO (or designee):

- Develop and maintain a Radiation Protection/Health Physics Audit & Assessment Plan that complies with NRC license requirements (as applicable) and all other applicable regulatory requirements.
- Coordinate and conduct internal institutional and facility-specific audits.
- Assist auditors/assessors during the performance of their audit/assessment.
- Schedule independent audits as necessary.
- Ensure audit/assessor personnel have the proper training, qualifications, dosimetry, PPE, etc. prior to entering radiologically controlled areas in the performance of their audits and assessments.
- Respond to audit/assessment non-compliance issues and findings, as appropriate.
- Keep MACTEC, Inc. Executive Management informed of the status of the audit program including audit schedules, findings, and corrective actions required and performed.

5.4 PREREQUISITES

5.4.1 A written audit plan shall be established to identify the scope and areas to be audited prior to the performance of an internal audit.

5.5 RECORDS

5.5.1 Audit/assessment related documents and/or records shall be stored, arranged, indexed, retained, retrieved, and disposed of in accordance with this procedure and all applicable document regulations and requirements.

5.6 PRECAUTIONS AND LIMITATIONS

Not applicable

5.7 REVISIONS

5.7.1 This procedure shall be reviewed at least every two years, with documentation to support the completion of such review.

5.8 OTHER

Not applicable

5.9 ATTACHMENTS

Attachment 1 - Audit/Assessment Tracking Log

6.0 PROCEDURE

6.1 GENERAL

6.1.1 Audits/assessments shall be performed to determine if radiological operations are being conducted in accordance with applicable license conditions, federal regulations, and written procedures.

6.1.2 To ensure a comprehensive evaluation, both institutional and facility-specific audits shall be conducted

6.1.3 Audits of the radiological protection program shall be conducted no less frequently than every 36 months.

6.1.4 Additional Radiation Protection Program audits/assessments shall be conducted as required by the RSO.

6.1.5 Radiation Protection Program audits, assessments, inspections, and independent assessments may be conducted at any time by an outside agency of regulatory agency, where work is being performed under the jurisdiction of that regulatory agency (e.g., NRC or DOE).

6.2 INTERNAL AUDITS and ASSESSMENTS

6.2.1 MACTEC, Inc. shall conduct internal audits of their Radiation Protection Program to identify its strengths and weaknesses, areas of vulnerability, and noncompliance.

6.2.2 Internal audits shall be conducted on every major program element no less frequently than every 36 months and shall include examination of the radiation protection program's content and implementation.

6.2.3 To ensure a comprehensive evaluation, both institutional and facility-specific audits shall be conducted during an audit cycle (no less frequently than every 36 months).

6.2.4 Institutional audits shall focus on (but are not limited to) the following program elements:

- Management and administration.
- The ALARA Program.

- Radiological training.
- Internal dosimetry.
- External dosimetry.
- Instrument calibration and maintenance.
- Radiation-generating devices.
- Sealed source accountability.

6.2.5 Facility audits shall focus on (but are not limited to) the following program elements:

- Radiation protection written program and procedure documents.
- Implementation of the ALARA Program.
- Individual monitoring, including appropriate use of dosimeters and enrollment and participation in bioassay programs.
- Area monitoring, including air monitoring, contamination monitoring, and radiation monitoring.
- Access controls.
- Radioactive material controls.
- Posting and labeling.
- Training.
- Records.
- Design and control of facility modifications and equipment.

6.2.6 The RSO shall schedule a pre-audit meeting with the audit team and appropriate members of the Health Physics Staff prior to the audit/assessment.

6.2.7 The RSO shall ensure the audit team is knowledgeable and qualified to conduct a radiation protection audit/assessment.

- The RSO shall allow the audit team to familiarize themselves with the site's license requirements and operational procedures prior to conducting the audit/assessment.

6.2.8 The RSO and audit team shall develop a specific audit/assessment plan, focusing on the primary intent of the audit/assessment, as described in steps 6.2.4 and 6.2.5 above.

6.2.9 The RSO and health physics staff shall provide support to the audit team, as necessary.

6.2.10 The RSO shall schedule an exit meeting with the audit team, select member of the Health Physics Staff upon completion of the audit/assessment.

6.2.11 Upon completion of the exit meeting, a written report shall be generated by the RSO.

- The report shall present the results of the audit/assessment, if available, including all non-compliances and pertinent comments made by the audit/assessment team.

6.2.12 A written Corrective Action Plan shall be prepared to address any non-compliance issues discovered by the audit team.

6.2.13 All corrective actions shall be tracked to completion in accordance with Section 6.4.

6.3 EXTERNAL AUDITS and ASSESSMENTS

6.3.1 The RSO shall request an entrance meeting with the audit team prior to the audit/assessment.

6.3.2 The RSO and staff shall provide support to the audit team, as necessary.

6.3.3 The RSO shall request an exit meeting with the audit team upon completion of the audit.

6.3.4 Upon completion of the exit meeting, a written report shall be generated by the RSO. The report shall present the results of the audit/assessment, including all non-compliances and pertinent comments made by the audit/assessment team.

6.3.5 A written Corrective Action Plan shall be prepared to address any non-compliance issues discovered by the audit team.

6.3.6 All corrective actions shall be tracked to completion in accordance with Section 6.4.

6.4 AUDIT RESULTS and TRACKING

6.4.1 All audits and assessments shall be documented.

- Findings or non-compliance issues shall be recorded and tracked, including corrective actions.

6.4.2 A permanent tracking system (i.e., electronic database, paper log, etc.), for the performance of audit/assessment and their results, shall be generated and maintained by the RSO (Attachment 1).

6.4.3 If the Audit/Assessment Tracking Log (Attachment 1) is not used for audit tracking purposes, the tracking system used shall include (as a minimum) the following information:

- A sequential tracking number
- Date(s) of the audit/assessment
- Audit/assessment number
- Type of audit/assessment (i.e., Internal, Independent, NRC, INPO, etc.)
- Corrective Action Plan number
- Date Corrective Action Plan was written
- Closure Report number
- Date Closure Report was written
- Comments

6.4.4 The audit and inspection database shall be reviewed monthly by the RSO.

6.4.5 Once all corrective actions listed in the Corrective Action Plan have been completed, a written Closure Report shall be prepared and distributed to management documenting the completion of the corrective actions.

6.4.6 Management shall respond to findings or non-compliance issues and, as necessary, report non-compliance issues to the appropriate regulatory agency.

6.4.7 At the end of each 3-year audit cycle, the RSO shall prepare and present a comprehensive audit report to MACTEC, Inc. management.

7.0 QUALITY ASSURANCE

7.1 The RSO shall review the Audit/Assessment Tracking Log monthly. Open entries remaining on the Audit/Assessment Tracking Log for a period greater than three months shall be brought to the attention of management for review.

AUDIT/ASSESSMENT TRACKING LOG

Page _____ of _____

Tracking No.	Audit Date	Audit No.	Audit Type[1]	Corrective Action Plan No.	Corrective Action Plan Written Date	Written Closure Report No.	Written Closure Report Date	Comments

Notes:

1 - Internal, Independent, NRC, DEP, OSHA, etc.

Form RPO-103-01-1

MACTEC, Inc.	Procedure No: RPO-104 Revision No: 0 Effective Date: 1/02/02

ROUTINE RADIATION PROTECTION SURVEYS & INSPECTIONS

Authored By: _____ 12-13-01
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Jeffrey W. Lively — Date
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Approved By: _____ CHP 12/21/01
Steven D. Rima — Date
Radiological Engineering Manager

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ROUTINE RADIATION PROTECTION INSPECTIONS

1.0 PURPOSE

1.1 The purpose of this procedure is to establishes requirements for, and provide guidance during, the performance of routine radiation protection surveys, inspections and operational checks. This procedure also provides guidance on the performance and schedule of routine activities (routines) conducted in support of radiological work activities.

2.0 APPLICABILITY

2.1 This procedure applies to MACTEC, Inc. management, supervisors, individuals and contractors that conduct inspections and surveys, where their work assignment is controlled by MACTEC, Inc.

3.0 REFERENCES

3.1 10 CFR 20, "Standards for Protection Against Radiation."

3.2 10 CFR 835, "Occupational Radiation Protection."

3.3 Various RPOs.

4.0 DEFINITIONS AND ABBREVIATIONS

4.1 See RPO Glossary.

4.2 Inspection - An inspection is a routine review performed to assure that operations and activities are conducted in compliance with regulatory and procedural requirements.

5.0 GENERAL

5.1 EQUIPMENT

Not applicable

5.2 SAFETY CONSIDERATIONS

Not applicable

5.3 RESPONSIBILITIES

5.3.1 RSO (or designee):

- Implement this procedure.
- Develop and maintain a radiation protection inspection plan/schedule that is in compliance with the site's license(s) and applicable regulations.
- Assist inspectors/surveyors during the performance of their inspection.
- Ensure inspector/surveyor personnel have the correct training, qualifications, dosimetry, and PPE to enter health physics Restricted Areas and/or radiological areas.
- Respond to inspection findings, as appropriate.
- Complete scheduled reviews/inspections.
- Notify MACTEC, Inc. management of any unusual or non-compliance items identified during routine inspection, surveys, or other operations.

5.3.2 Health Physics Staff:

- Comply with this procedure.
- Conduct surveys, inspection, and quality control checks in accordance with applicable procedures and good health physics/safety practices.
- Exercise appropriate contamination control techniques in the performance of radiological surveys.
- Comply with entry requirements for the areas to be surveyed.
- Operate radiological survey instrumentation in accordance with approved operating procedures.
- Notify the RSO of abnormal radiological conditions or safety issues

5.4 PREREQUISITES

Not applicable

5.5 RECORDS

5.5.1 Inspection records/checklists shall be stored, arranged, indexed, retained, retrieved, and disposed of in accordance with this procedure and all applicable document regulations and requirements.

5.6 PRECAUTIONS AND LIMITATIONS

Not applicable

5.7 REVISIONS

5.7.1 This procedure shall be reviewed at least every two years, with documentation to support the completion of such review.

5.8 OTHER

Not applicable

5.9 ATTACHMENTS

Attachment 1 - Inspection Checklist - Daily Routines

Attachment 2 - Inspection Checklist - Weekly Routines

Attachment 3 - Inspection Checklist - Monthly Routines

Attachment 4 - Inspection Checklist - Quarterly Routines

Attachment 5 - Health Physics Routine Inspection Tracking Log

6.0 PROCEDURE

6.1 ROUTINE INSPECTIONS

6.1.1 Routine inspections shall be conducted in and around radiologically controlled areas.

6.1.2 Individuals conducting the inspection(s) shall indicate the completion of each inspection task by initialing the initials' block on the appropriate inspection checklist (Attachments 1-4).

6.1.3 The RSO shall be immediately notified of any inspection deficiency or identified safety hazard discovered during the inspection process.

6.1.4 All inspection deficiencies, or identified safety hazards, shall be noted on the appropriate inspection checklist.

6.1.5 Any easily repaired deficiency shall be corrected (repaired) on the spot, and an entry made on the inspection checklist noting the deficiency and the repair performed.

6.1.6 Any safety hazard(s), identified during an inspection (that are not immediately corrected), shall be controlled by preventing unauthorized access (e.g., using rope, safety tape barricades, or any other appropriate means) to the hazard area(s).

6.1.7 Daily inspections shall be conducted in accordance with Attachment 1.

6.1.8 Weekly inspections shall be conducted in all outdoor areas containing licensed or FUSRAP radioactive material. The inspection results shall be documented on the Inspection Checklist - Weekly Routines, Attachment 2. The inspection shall include, as a minimum:

- Inspecting perimeter fencing, gates and ropes around posted areas.

6.1.9 A monthly inspection shall be conducted to verify that all radiological postings are present and in good physical condition. The inspection results shall be documented in accordance with RPO-402, Attachment 8, Radiological Posting Inspection.

6.2 ROUTINE RADIOLOGICAL SURVEYS

6.2.1 Routine radiological surveys shall be performed to determine general radiological conditions of work areas and areas accessible to members of the general public.

6.2.2 As a minimum, routine radiological survey shall be performed to identify loose surface contamination. Additional surveys may be required, as determined by the RSO, to identify fixed contamination activity or general area dose rates.

6.2.3 Radiological survey results shall be documented in accordance with RPO-301 and documented on the appropriate Inspection Checklist.

6.2.4 Daily contamination surveys shall be performed in buffer zone type areas.

- These areas are generally access/egress areas that workers utilize as transition points between radiologically controlled areas and clean areas.
- Buffer zone survey locations are identified on the appropriate Inspection Checklist.

NOTE: Additional daily surveys may be performed to support site operations. Scheduling and documentation of those surveys are beyond the scope of this procedure.

6.2.5 Weekly surveys shall be performed in areas where active work with radioactive material is being performed.

- Typical areas requiring weekly surveys may include, but are not limited to; health physics labs, environmental sampling labs, etc.
- Weekly survey locations are identified on the appropriate Inspection Checklist.

6.2.6 Monthly radiological surveys shall be performed in areas where access is restricted to occupational workers or in (or around) areas where loose surface contamination is known to be located.

- Monthly survey locations are identified on the appropriate Inspection Checklist.

6.2.7 Quarterly surveys shall be performed in areas generally accepted to be clean areas, but may contain low levels of contamination in discrete locations. Contamination surveys shall also be performed in secured laboratories that are not in use.

- Quarterly survey locations are identified on the appropriate Inspection Checklist.

6.2.8 Quarterly source leak checks are required for sealed sources that emit alpha radiation. Leak checks are to be performed and documented in accordance with RPO-404.

6.3 OTHER INSPECTIONS/CHECKS

6.3.1 Other health physics operations are required to comply with the Radiation Protection Program, as well as license and regulatory requirements. This section identifies (but is not limited to) routine checks that may be required.

6.3.2 Daily routine checks:

- Quality control check of the alpha/beta counting system (when in use).
- Quality control check of the gamma spectroscopy system (when in use).
- Operational checks of stack and general area air samplers.
- Change out of stack and general area air samplers (when required).
- Personnel frisker response checks (when in use).
- Review of Lapel air sampler results.

6.3.3 Weekly routine checks:

- Review instrument calibration list .
- Verify and record SNM inventory (U-235), verify quantity is within license limits (if applicable).
- Perform background count for gamma spectroscopy system(s) when in use.
- Fill gamma spectroscopy cryostats (dewars) with liquid nitrogen.
- Change general area and stack air sampler filters.

6.3.4 Monthly routine checks:

- Review SNM accountability logs (if applicable).

- Review active and terminated RWPs.
- Review open items from the audit and inspection lists.
- Review radiological training list.
- Inspect respiratory protection equipment.

6.3.5 Quarterly routine checks:

- Environmental TLD change out.
- Personnel monitoring TLD change out.
- Leak check of alpha emitting sealed sources.
- Semi-annually leak check of beta-gamma emitting sealed sources.

6.4 GENERAL REQUIREMENTS

6.4.1 Perform health physics routines in accordance with Attachments 1 through 4, and as required by the RSO.

- Initial the appropriate area of the inspection checklist to indicate inspection/performance of the area/item completed satisfactory.
- Record "NA" to indicate an inspection/performance was not applicable and not performed.
- If other than "satisfactory" or "NA" is recorded, note the condition/action taken in the Comments Section of the checklist and notify the RSO immediately.
- Add or delete inspection areas/items to the checklist as site conditions warrant, or as procedural requirements dictate. This can be a pen and ink change and does not require a formal procedure revision.

NOTE: Additions or deletions to any Attachment, 1 through 4 of this procedure, must be approved by the RSO, but does NOT require a formal procedure revision. When a formal revision to this procedure is made, pen and ink additions or deletions to the attachments shall be updated at that time, as a part of the formal procedure revision.

6.4.2 Any findings identified during the health physics routines shall be recorded and the RSO immediately notified.

6.5 INSPECTION RESULTS and TRACKING

6.5.1 Document the completion of various health physics inspections/routines on Attachments 1 through 4.

6.5.2 Track all health physics routine inspection findings (Attachment 5) until the recommended corrective actions have been completed. This tracking system (log) shall be created and maintained by the RSO. The tracking system shall include the following minimum information:

- A sequential tracking number.
- Date of the health physics routine inspection.
- Description of finding.
- Description of the corrective action planned and tentative correction date.
- Date corrective action completed.
- Comments.

7.0 QUALITY ASSURANCE

7.1 The RSO shall review the various Inspection Checklists when completed and the Inspection Tracking Log monthly. Open findings remaining on the Inspection Tracking Log for a period greater than three months shall be brought to the attention of MACTEC, Inc. management for review.

7.2 This procedure and all related documents shall be made available as part of the annual Health Physics audit program

Inspection Checklist - Daily Routines

For The Week Beginning: _____

Facility Daily Checks	Sun	Mon	Tue	Wed	Thr	Fri	Sat
General Area Safety and Radiological Inspection							
Sample Counter QC Check							
General Area and Stack Air Sampler Checks							
Frisker Response Checks							
Calculate and Review Lapel Air Sampler Results							
Waste Storage Areas							

For HP instrumentation, the check includes visual for damage, current calibration sticker, battery and source response check performed (as required).

Inspection Checklist - Daily Routines

Buffer Zone Contamination Survey	Sun	Mon	Tue	Wed	Thr	Fri	Sat
Building X							

Inspection Checklist - Daily Routines

Site Daily Checks	Sun	Mon	Tue	Wed	Thr	Fri	Sat
Remove and Analyze Daily General Area/Stack Air Sample Monitors (as required)							
Check HP Equipment/Areas When Work Is In Progress							
Review the various Inspection Checklists when completed							

HPT initials indicate a completed inspection with satisfactory results of the item checked.

Comments: _____

_____

_____

_____

Reviewed by: _____ Date: _____

Inspection Checklist - Weekly Routines

For The Week Of: _____

Weekly Contamination Survey	Initials
Health Physics Office	
Temporary Work Areas	

Weekly Air Sample Filter Change Out	Initials
Air Sampler Filter Media Change*	

* Weekly when in use, for non-moving filter media. Weekly source checks required on CAMS with automatic alarms systems to verify proper operation.

Weekly Site Checks	Initials
Weekly Outdoors Inspection	
Instrument Calibration List Update	
SNM Inventory	
Fill Gamma Spec. Cryostat	
Gamma spectroscopy system background count (when in use)	

Inspection Checklist - Weekly Routines

Weekly Site Checks (cont.)	**Initials**
Air Sampler Filter Change	

HPT initials indicate a completed inspection with satisfactory results of the item checked.

Comments: _____

_____

_____

_____

Reviewed by: _____ Date: _____

Inspection Checklist - Monthly Routines

For The Month Of: _____ , _____

(year)

Reference	Location/Item	Inspection Type	Initials
RPO-301	Building X General Area	Radiological Survey	
RPO-301	R.M.S.A	Radiological Survey	
RPO-402	Radiological Postings Inspection	Visual - Complete Radiological Posting Inspection Sheet	
RPO-401	Monthly RWP Review	List Active RWPs:	
RPO-103, Attachment 1	Audit/ Assessment Tracking Log	Review and List Open Audit Numbers:	
RPO-104, Attachment 5	Inspection Tracking Log	Review	
RPO-405	Respirator Facepieces That Are Routinely Available For Issue	Inspect	

(cont.)

Inspection Checklist - Monthly Routines

Reference	Location/Item	Inspection Type	Initials
RPO-405	"Escape-Only" Respiratory Protection Devices	Visually Inspect	
RPO-405	Emergency Respiratory Protection Equipment	Visually Inspect	
RPO-106	Radiological Training List	Review Current	

HPT initials indicate a completed inspection with satisfactory results of the item checked.

Comments: _____

_____

_____

_____

Reviewed by: _____ Date: _____

Inspection Checklist - Quarterly Routines

For the 1st 2nd 3rd 4th Quarter of: _____
(circle one) (year)

Reference	Location/Item	Inspection Type	Initials
RPO-301	Building X General Area	Radiological Survey	
RPO-406	Personnel TLD Exchange	Exchange	
RPO-103, Attachment 1	Open Audit Items	List Audit ID Number(s) Open > 3 Months:	
RPO-405	Emergency Respiratory Protection Equipment	Operationally Test	
RPO-405 (periodically or prior to use)	Equipment Used In Conjunction With Facepiece Respirators	Inventory and Functionally Test	
RPO-603	Environmental TLD	Change-out	

Inspection Checklist - Quarterly Routines

(cont.)

Reference	Location/Item	Inspection Type	Initials
RPO-404	Alpha Source Leak Checks	Perform Source Leak Checks	
RPO-404	Beta-gamma Source Leak Checks Every Six Months - June and Dec.	Perform Source Leak Check	

HPT initials indicate a completed inspection with satisfactory results of the item checked.

Comments: _____

_____

_____

_____

Reviewed by: _____ Date: _____

HEALTH PHYSICS ROUTINE INSPECTION TRACKING LOG

Page _____ of _____

Tracking No.	Inspection Date	Description of Finding	Description of Corrective Action Planned	Corrective Action Due Date	Corrective Action Completion Date	Comments

Reviewed by: _____ Date: _____

MACTEC, Inc.	Procedure No: RPO-106 Revision No: 1 Effective Date: 9-1-02

TRAINING and QUALIFICATION

Authored By: _____ 4-5-02
Michael P. McDonald — Date
Radiological Engineer

Reviewed By: _____ 8/16/02
Jeffrey W. Lively — Date
Health Physicist

Approved By: _____ 8/16/02
Steven D. Rima — Date
Radiological Engineering Manager

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TRAINING AND QUALIFICATION

1.0 PURPOSE

1.1 The purpose of this procedure is to define the radiological training requirements necessary for radiological workers to perform unescorted work in the various radiologically controlled areas.

2.0 APPLICABILITY

2.1 This procedure applies to MACTEC, Inc. management, supervisors, individuals and contractors that work in radiologically controlled areas (Restricted Areas and radiological areas) where their work assignment is controlled by MACTEC, Inc.

3.0 REFERENCES

3.1 10 CFR 20, "Standards for Protection Against Radiation."

3.2 10 CFR 835, "Occupational Radiation Protection."

3.3 RPO-101, "Radiation Protection Program Overview."

3.4 RPO-405, "Respiratory Protection."

4.0 DEFINITIONS AND ABBREVIATIONS

4.1 See RPO Glossary.

5.0 GENERAL

5.1 EQUIPMENT

Not applicable

5.2 SAFETY CONSIDERATIONS

Not applicable

5.3 RESPONSIBILITIES

5.3.1 RSO (or designee):

- Implement this procedure.

- Ensure individuals are qualified to perform this procedure.
- Ensure that non-radiological workers complete General Employee Radiological Training (GERT), as applicable.
- Ensure that radiological workers complete Radiological Worker Training (RWT).
- Ensure that radiological workers and members of the Health Physics Staff receive appropriate job-specific radiological training, as applicable.

5.3.2 Radiological Workers:

- Complete required radiological worker training as prescribed by this procedure and the RSO.
- Have a current radiological worker qualification to access and perform work in radiologically controlled areas.

5.3.4 Non-radiological Workers:

- Complete GERT, as applicable.

5.4 PREREQUISITES

Not applicable

5.5 RECORDS

5.5.1 Related documents and/or records shall be stored, arranged, indexed, retained, retrieved, and disposed of in accordance with this procedure and all applicable document regulations and requirements.

5.6 PRECAUTIONS AND LIMITATIONS

5.6.1 Radiological workers who are required to use respiratory protection devices for protection against airborne radiological hazards, shall be trained in accordance with the company respiratory protection training program, as required by Reference 3.4, and as required by the RSO.

5.7 REVISIONS

5.7.1 This procedure shall be reviewed at least every two years, with documentation to support the completion of such review.

5.8 OTHER

Not applicable

5.9 ATTACHMENTS

Attachment 1 - Radiological Training Requirements List

6.0 PROCEDURE

6.1 RADIOLOGICAL TRAINING - MINIMUM REQUIREMENTS

6.1.1 Personnel shall complete the appropriate radiation safety training, in accordance with Attachment 1, before being:

- Permitted access to any radiologically controlled area.
- Occupationally exposed to ionizing radiation.

6.1.2 All radiological training requirements, commensurate with the hazards, shall be completed before personnel are allowed access to radiologically posted areas.

6.1.3 Workers shall complete the appropriate level of radiological worker training prior to:

- Unescorted access to radiologically controlled area.
- Occupational exposure to ionizing radiation.
- Performing unescorted assignments as radiological workers.

NOTE: The level of radiological worker training required, as well as job-specific radiological training, depends upon the types of radiological hazards or radiological areas that individuals may encounter while performing assigned activities.

6.1.4 Radiological worker training qualifications shall be valid for a period not to exceed 24 months.

6.1.5 Radiological workers shall have access to their radiological qualification cards, and be available to present their qualifications (as requested by radiation protection staff) prior to gaining access and performing work in radiologically controlled areas.

6.1.6 Personnel who have completed comparable radiological worker training may apply for training equivalency. For determination of training equivalency, contact the RSO.

6.1.7 Contract personnel or visitors, being brought on site for their expertise in the field of health physics and radiation protection (e.g., experience, education, or certification), may apply for a training equivalency waiver from the RSO. Site specific training shall be administered by the RSO, or designee, prior to taking the appropriate radiation worker examination.

6.1.8 Current qualification as a Health Physics Technician (HPT) satisfy the requirements for RWT as well as GERT.

6.2 RADIOLOGICAL TRAINING FOR NON-RADIOLOGICAL WORKERS

6.2.1 Non-radiological workers, who require unescorted access to radiologically controlled areas shall complete GERT.

6.2.2 RSO may authorize non-radiological workers, who have completed GERT, access to Radioactive Material Areas, Fixed Contamination Areas (without disturbing the fixed contamination), and certain Radiation Areas.

6.2.3 Non-radiological workers who have completed GERT may be authorized to:

- Operate/use devices, equipment, etc., that contain inaccessible radioactive material.

6.3 RADIOLOGICAL TRAINING FOR RADIOLOGICAL WORKERS

6.3.1 Personnel whose job assignments require routine, unescorted access to radiologically controlled area shall complete RWT.

6.3.2 RWT is required for personnel:

- that use, or work with, radioactive material;
- that operate or use of devices, equipment, etc., that contain accessible radioactive material;
- whose job assignments involve the transport of radioactive material;
- whose job assignments require receiving more than 100 mrem in a year from occupational exposure;
- directly involved with the modification of, or invasive maintenance on, equipment containing normally inaccessible radioactive material;
- whose work involves direct contact with radioactive material that could result in contamination of the worker or property; and/or
- whose job assignments require unescorted access to radiologically controlled areas.

6.4 JOB-SPECIFIC RADIOLOGICAL WORKER TRAINING

6.4.1 Radiological workers shall complete appropriate job-specific radiological training.

- This training shall include, as a minimum, reading and understanding all technical work documents applicable to their work assignments.
- This training should also include appropriate on-the-job training (OJT), such as mentoring and/or vendor-provided training.
- Based upon the complexity of the task(s) and/or the experience of the worker, the manager/supervisor (with RSO approval) may exempt an individual worker from job-specific radiological training requirements.

6.4.2 Managers/supervisors of radiological workers shall be responsible for providing training on job-specific technical work documents (i.e., operating procedures, operating instructions, etc.), and for providing any additional training (i.e., equipment manufactures' training, specialized radiological training), as necessary, to qualify their personnel for the assigned radiological work.

6.4.3 Managers/supervisors, in conjunction with the RSO, shall be responsible for the following, for each radiological worker in their organization:

- Determining appropriate job-specific radiological training.
- Documenting completion of job-specific radiological training and forwarding such documentation to the RSO.

6.5 RADIOLOGICAL WORKER RETRAINING

6.5.1 Radiological workers shall complete radiation safety retraining (i.e., RWT) at intervals not to exceed 24 months and when there are significant changes to radiation protection policies and procedures that may affect them.

6.6 HEALTH PHYSICS TECHNICIAN TRAINING

6.6.1 HPTs are responsible for all radiological surveys of record (i.e., release surveys, surveys performed in support of evaluating radiological hazards and establishing radiological control requirements). Surveys of record (i.e., legal records) shall be performed only by personnel who are trained and qualified as HPTs.

6.6.2 An industry accepted health physics and radiation protection qualification standard shall be used to define the requirements for satisfactory HPT training and qualification. HPTs shall be trained to the level of knowledge and skills commensurate with their job duties and responsibilities.

6.6.3 HPTs shall complete training on procedures specific to their job assignment and facilities they assist. The level of training shall be commensurate with the HPTs' assignments.

6.6.4 HPTs shall complete health physics retraining at intervals not to exceed 24 months and when there are significant changes to radiation protection policies and procedures that may affect them.

6.7 HEALTH PHYSICS STAFF FUNDAMENTAL TRAINING

6.7.1 The Radiological Engineer shall obtain and maintain (when required by site or facility procedures) the following minimum training qualifications:

- GERT
- RWT
- Specialized health physics training commensurate with their duties and professional development curriculum.

6.8 OTHER TRAINING

6.8.1 Managers/supervisors who are responsible for tours (or visitors) shall be responsible for:

- Being familiar with the current radiological conditions of the areas to be visited.
- Awareness of current work activities for the areas to be entered and required safety equipment (e.g., hardhats, safety shoes, etc.)
- The applicable training requirements for areas to be entered.
- Obtaining approval from the RSO, or designee, for any tour in any radiological type area.

7.0 QUALITY ASSURANCE

7.1 The RSO shall review the Radiological Training Program and training materials on an annual basis. If discrepancies are noted in the training material or in the training programs, the RSO shall update the training material(s) or program(s) to correct the noted discrepancies.

RADIOLOGICAL TRAINING REQUIREMENTS LIST

Affected Personnel/Activity	Minimum Training Required
Access to Radiologically Controlled Areas	GERT
Access to Radioactive Material Areas	GERT
Access to Radiation Areas	RWT
Access to High Radiation and Very High Radiation Areas	RWT
Access to Contamination Areas	RWT
Access to Airborne Radioactivity Areas	RWT
Access to Fixed Contamination Areas to perform work that disturbs fixed contamination	RWT
Radiological emergency response team members	RWT
Users of radioactive sources or material: • Accessible radioactive material • Inaccessible radioactive material	 RWT GERT
Personnel who transport radioactive material	RWT

MACTEC, Inc.	Procedure No: RPO-107 Revision No: 0 Effective Date: 9-1-02

RADIOLOGICAL IMPROVEMENT REPORT

Authored By: _____ 4-5-02
Michael P. McDonald — Date
Radiological Engineer

Reviewed By: _____ 8/16/02
Jeffrey W. Lively — Date
Health Physicist

Approved By: _____ 8/16/02
Steven D. Rima — Date
Radiological Engineering Manager

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RADIOLOGICAL IMPROVEMENT REPORT

1.0 PURPOSE

1.1 The purpose of this procedure is to provide instruction in the preparation and distribution of Radiological Improvement Reports (RIR).

2.0 APPLICABILITY

2.1 This procedure applies to MACTEC, Inc. management, supervisors, individuals and contractors that respond to radiological incidents, where their work assignment is controlled by MACTEC, Inc.

3.0 REFERENCES

3.1 10 CFR 20, "Standards for Protection Against Radiation."

3.2 10 CFR 835, "Occupational Radiation Protection."

3.3 RPO-101, "Radiation Protection Program Overview."

3.4 RPO-103, "Radiation Protection Audits, Assessments and Oversight."

4.0 DEFINITIONS AND ABBREVIATIONS

4.1 See RPO Glossary.

5.0 GENERAL

5.1 EQUIPMENT

Not applicable

5.2 SAFETY CONSIDERATIONS

Not applicable

5.3 RESPONSIBILITIES

5.3.1 RSO (or designee):

- Implement this procedure.
- Ensure individuals are qualified to perform this procedure.

- Maintain the Radiological Improvement Report log.

5.3.2 Health Physics Staff:

- Comply with this procedure.

5.4 PREREQUISITES

Not applicable

5.5 RECORDS

5.5.1 Related documents and/or records shall be stored, arranged, indexed, retained, retrieved, and disposed of in accordance with this procedure and all applicable document regulations and requirements.

5.6 PRECAUTIONS AND LIMITATIONS

Not applicable

5.7 REVISIONS

5.7.1 This procedure shall be reviewed at least every two years, with documentation to support the completion of such review.

5.8 OTHER

Not applicable

5.9 ATTACHMENTS

Attachment 1 - Radiological Improvement Report Log

Attachment 2 - Radiological Improvement Report Criteria

Attachment 3 - Radiological Improvement Report

6.0 PROCEDURE

6.1 GENERAL INFORMATION

6.1.1 If a member of the Radiological Engineering organization is involved with, observes, or is informed of a radiological type incident, event, activity, or process that could be improved, a Radiological Improvement Report shall be initiated.

6.1.2 Attachment 2 lists examples of events that would cause a Radiological Improvement Report to be generated.

6.1.3 When an incident, event, activity, or process is identified that is not listed in Attachment 2, the preparer (usually a member of the Radiological Engineering organization) should discusses the event with their supervisor/manager to determine if the event warrants documentation by a Radiological Improvement Report.

6.1.4 All Radiological Improvement Reports shall be sequentially numbered (RIR-YY-XXX) where:

- RIR is acronym for Radiological Improvement Report.
- YY is the last two digits of the current year.
- XXX is a sequential number beginning at 001 on January 1 of each calendar year.

6.1.5 A Radiological Improvement Report log shall be maintained by the Corporate RSO (or designee). Attachment 1 illustrates the suggested format and minimum information required on the log.

6.2 GENERATING A RADIOLOGICAL IMPROVEMENT REPORT

6.2.1 Obtain a blank Radiological Improvement Report form (Attachment 3).

6.2.2 Obtain the next Radiological Improvement Report number from the Corporate RSO (or designee) and record this number on all pages of the Radiological Improvement Report.

6.2.3 Date the Radiological Improvement Report in the designated areas.

6.2.4 Indicate the reason for generating the report, in the appropriate area.

6.2.5 Describe the event(s) in the space provided on page 1 of the Radiological Improvement Report. As necessary;

- Include sufficient detail of the event.
- DO NOT use individuals names in the description of events. Instead, indicate individuals by Worker A, Worker B, etc.

6.2.6 Indicate the radiological condition(s) and posting(s) of the area at the time of the event.

6.2.7 Record all applicable survey data.

6.2.8 List any applicable supporting documentation and attach to the report.

6.2.9 On page 2 of the report, record the work location, the building, the room number, the manager and the RWP number, if applicable.

6.2.10 Provide the name of the worker(s) and associated title used on page 1 of the report (i.e., Worker A = John Doe) the worker's Radiological Training level, and any Self Reading Dosimeter (SRD) data that is available for all individuals involved.

6.2.11 If additional space is required during the preparation of the report, use additional blank paper and include the RIR number, date, and page number.

6.2.12 Sign and date the Radiological Improvement Report and submit it to the Site RSO or Lead Radiological Engineer on site.

NOTE: The report shall be completed as soon as possible, but should not interfere with any immediate response activities that are required to stabilize the situation. The report should be completed as soon as enough data is available to ensure that conditions are reported accurately. All data gathering does not have to be completed, but enough data must be available to ensure that appropriate reporting requirements can be determined.

6.3 RIR APPROVAL AND DISTRIBUTION

6.3.1 The Site RSO or Radiological Engineer shall review the report. If clarification or additional information is deemed necessary, the report shall be returned to the author for clarification and/or revision.

6.3.2 The completed report shall be forwarded to the Corporate RSO for review.

6.3.3 The Corporate RSO shall evaluate the completed report for pertinent and applicable information regarding:

- Lessons Learned
- Regulatory infractions
- Regulatory required notification
- Personnel exposure
- Root Cause Analysis

6.3.4 The Corporate RSO shall implement/initiate any required corrective actions or steps identified. Corrective actions not previously completed shall be tracked in accordance with Reference 3.4, Radiation Protection Audits, Assessments and Oversight.

7.0 QUALITY ASSURANCE

7.1 Documents generated during the performance of this procedure shall be audited in accordance with Reference 3.4.

RADIOLOGICAL IMPROVEMENT REPORT LOG

Report No.	Report Date	Author	Remarks

Form RPO-107-01-0

RADIOLOGICAL IMPROVEMENT REPORT CRITERIA

A Radiological Improvement Report should be initiated when any of the following occur:

Facility Abnormalities

- Poor facility design.
- Inadequate/ineffective shielding.
- Inadequate/ineffective ventilation.
- Failure of ventilation, shielding or other items used for engineering controls.

Potential Personnel Exposure

- Unplanned/unmonitored exposure exceeding the appropriate limit for monitoring (this is dependent upon how the person is classified: visitor, rad. worker, minor, etc.)
- Unplanned intake.
- Nasal swipes or swipes from the inside of a respirator following use that indicate detectable contamination.
- ALARA Person-rem limit for a job exceeded.
- Detectable personnel contamination of the skin or personal clothing (excluding Radon).
- Actual dose to an individual (from planned work) exceeds the estimated dose by more than 50 mrem.
- Work being performed in a non-uniform radiation field without the appropriate multiple dosimetry.
- Exceeding an established administrative control level.

Abnormal Events

- Spill involving radioactive material.
- Unattended and uncontrolled radioactive material.

RADIOLOGICAL IMPROVEMENT REPORT CRITERIA

- Lost, stolen or unaccounted radioactive material.
- Damaged or leaking radioactive source.
- Unanticipated airborne radioactivity.
- Unanticipated radiation levels.
- A fire involving radioactive material.
- Unanticipated alarm of area monitoring equipment that cannot be attributed to system faults or variations in Radon levels.
- Malfunction of radiological safety equipment.
- Radiation detection equipment used after expiration of calibration.
- Use of a radiation detection instrument that failed the operational check.
- Discovery of an unknown condition which could cause a radiological instrument to give a false reading (e.g., RF, EM or microwave fields).
- Significant discrepancy between different instruments of the same type.
- Change in radiological conditions that results in current controls not being adequate.

Loss of Administrative Controls

- Radiological work requiring a RWP, performed without one.
- Radiation/contamination levels exceeding the posting.
- Use of postings that do not meet the requirements of regulations.
- Unauthorized altering of postings.
- Inadequate access controls.
- Level of access controls does not meet the requirements for the type of area.
- Access controls are violated.

RADIOLOGICAL IMPROVEMENT REPORT CRITERIA

- Interlocks overridden or bypassed.
- Required locks not in place.
- Failure to obey radiological requirements.
- Failure to meet the entry requirements for a posted area.
- Failure to wear prescribed dosimetry.
- Failure to perform self-monitoring when required.

RADIOLOGICAL IMPROVEMENT REPORT

Report Date/Time: _____ RIR No: _____

Preparer: _____

Reason for Report: ☐ Lessons Learned ☐ Abnormal Event ☐ Administrative Control Failure
☐ Engineering Control Failure ☐ Personnel Exposure ☐ Other: _____

Event Description: _____

_____

_____

_____

_____

_____

_____

Radiological Posting: ☐ VHRA ☐ HRA ☐ RA ☐ CA ☐ ARA ☐ RMA ☐ None
☐ Controlled/Restricted Area ☐ Other: _____

Radiation Level: (Survey #: _____ - _____ - _____) ☐ NA

Dose Rates: _____ mrem/hr ☐ General Area ☐ Contact Reading

Contamination Level: (Survey #: _____ - _____ - _____) ☐ NA

β-γ Total: _____ dpm/100 cm^2 α Total: _____ dpm/100 cm^2

β-γ Loose: _____ dpm/100 cm^2 α Loose: _____ dpm/100 cm^2

Personnel Contamination: (Survey #: _____ - _____ - _____) ☐ NA

☐ Personal Clothing ☐ PPE ☐ Skin Activity: _____ cpm dpm
(circle one)

Airborne Radioactivity: (Survey #: _____ - _____ - _____) ☐ NA

☐ False CAM alarm ☐ True CAM Alarm CAM Results: _____ μCi/ml

☐ Air Sample Results: _____ μCi/ml

Other: _____

Form RPO-107-03-0

RADIOLOGICAL IMPROVEMENT REPORT

Date: _____ **RIR No:** _____

Supporting Documentation (list attachments)

_____

_____

_____

_____

Location of Incident: _____

_____

_____

_____

_____

Personnel Involved:

Name:	Job Description:	Monitoring Results:

Review & Approval

Preparer: _____ Date: _____
Signature

Supervisor: _____ Date: _____
Signature

Corp. RSO: _____ Date: _____
Signature

Form RPO-107-03-0

MACTEC, Inc.	Procedure No: RPO-201 Revision No: 1 Effective Date: 9-1-02

OPERATION OF PORTABLE RADIOLOGICAL SURVEY INSTRUMENTS

Authored By: _____ 5-22-02
Michael P. McDonald — Date
Radiological Engineer

Reviewed By: _____ 8/16/02
Jeffrey W. Lively — Date
Health Physicist

Approved By: _____ 8/16/02
Steven D. Rima — Date
Radiological Engineering Manager

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OPERATION OF PORTABLE RADIOLOGICAL SURVEY INSTRUMENTS

1.0 PURPOSE

1.1 The purpose of this procedure is to provide instruction for the operation of portable radiological survey instruments.

2.0 APPLICABILITY

2.1 This procedure applies to MACTEC, Inc. management, supervisors, individuals and contractors that operate portable radiological survey instruments where their work assignment is controlled by MACTEC, Inc.

3.0 REFERENCES

3.1 10 CFR 20, "Standards for Protection Against Radiation."

3.2 10 CFR 835, "Occupational Radiation Protection."

3.3 ANSI N323A, "Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments," 1997.

3.4 RPO-101, "Radiation Protection Program Overview."

3.5 RPO-103, "Radiation Protection Audits, Assessments and Oversight."

3.6 RPO-106, "Radiological Training and Qualification."

3.7 RPO-201, "Operation of Portable Radiological Survey Instruments."

3.8 RPO-204, "Calibration and Quality Control of Portable Radiological Survey Instruments."

3.9 RPO-301, "Radiological Surveys."

4.0 DEFINITIONS AND ABBREVIATIONS

4.1 See RPO Glossary.

5.0 GENERAL

5.1 EQUIPMENT

5.1.1 Various portable radiation and contamination survey instruments

5.1.2 Various radioactive sources and source jigs

5.2 SAFETY CONSIDERATIONS

Not applicable

5.3 RESPONSIBILITIES

5.3.1 RSO (or designee):

- Implement this procedure.
- Ensure individuals are qualified to perform this procedure.
- Ensure an adequate number of radiological survey and monitoring instruments of sufficient accuracy and sensitivity are available for use.

5.3.2 Health Physics Staff:

- Comply with this procedure.
- Exercise appropriate contamination control techniques in the performance of radiological surveys and while handling sample media.
- Comply with entry requirements for the areas to be surveyed.
- Operate radiological survey instrumentation in accordance with this procedure and the instrument's operating manual.

5.4 PREREQUISITES

5.4.1 HPT shall ensure that the portable radiation monitoring instrument being used is current in regard to calibration.

5.4.2 HPT shall ensure that the instrument is operated with the probe it was calibrated with, or that the instrument is designed to be operated with a variety of other calibrated "smart" type probes.

5.4.3 HPT shall be properly qualified to operate the portable survey instrument prior to use.

5.5 RECORDS

5.5.1 Portable survey instrument and instrument calibration/QC documents and/or records shall be stored, arranged, indexed, retained, retrieved, and disposed of

in accordance with this procedure and all applicable document regulations and requirements.

5.6 PRECAUTIONS AND LIMITATIONS

5.6.1 Direct probe contact with the radioactive check source surface can damage or disturb the protective coating and/or radioactive material of the radioactive check source surface and/or spread radioactive material to the detector/probe.

5.6.2 Unexplainable or out of character changes in background count or dose rates may be the result of a damaged or contaminated detector/probe or unidentified radiation interference.

5.6.3 Instruments that are out of calibration may function improperly or respond falsely. Do not use an instrument that is out of calibration. Contact the RSO if an instrument is used that is out of calibration.

5.6.4 If maintenance is performed on a survey meter (except battery change out), an instrument calibration shall be performed prior to use.

5.7 REVISIONS

5.7.1 This procedure shall be reviewed at least every two years, with documentation to support the completion of such review.

5.8 OTHER

Not applicable

5.9 ATTACHMENTS

Attachment 1 - Portable Instrument Response Check Sheet

Attachment 2 - Operation Of Sealed Gas Detectors

Attachment 3 - Operation Of NaI Detectors

6.0 PROCEDURE

6.1 PRE-OPERATIONAL CHECK

6.1.1 If at any time an instrument is damaged during use, fails any of the steps listed in this procedure, or is recalled by the RSO:

- Stop using the instrument
- Return the instrument to the Instrument Lab immediately.

6.1.2 Prior to using a portable survey instrument, verify that the instrument's calibration is current and the instrument is properly suited for the survey type (i.e., type, level, and energies of radiation encountered).

6.1.3 Inspect the instrument for physical damage. Look for areas of damage to include (as a minimum):

- Damage to the body of instrument.
- Damage to the meter face.
- Damage to the detector cable.
- Damage to the detector surface (i.e., broken detector window covering, scratches in the detector window covering, dents in the detector, etc.)
- Broken or loose fasteners, handles, switches.

6.1.4 Verify that instruments with analog meter indications read zero (with the instrument turned off).

6.1.5 Verify all instrument electrical features are acceptable and in proper working order. Check for (if installed):

- Battery self-test or battery OK indication.
- Instrument high voltage self-test indication.
- Automatic adjustment of electronic zero.

6.1.6 Inform the RSO of any problems found that can not be corrected by the user.

6.2 INSTRUMENT OPERATION

6.2.1 Ensure that all peripheral equipment (i.e., instrument's detector/probe, gas supply system, external speaker, data cable, etc.) is properly attached or connected, as required.

6.2.2 Turn the instrument on.

- If the instrument performs automatic start up checks (i.e., battery check, high voltage check, etc.) during the start up process, verify that automatic checks are performed and the results are acceptable.

- If the instrument is manufactured such that the battery and/or detector high voltage check is performed during the manual start up process of the instrument (i.e., rotating the On/Off/Range Selector switch towards the On position), manually perform the required checks as described below and verify that the results are acceptable.

6.2.3 Perform a battery check (if not previously performed).

6.2.4 If required for the instrument, perform a detector high voltage check and adjust as necessary (if not previously performed).

6.2.5 Initiate and adjust gas flow to the detector, if required.

NOTE: Gas flow detectors must be purged with counting gas to ensure proper response. Check the manufactures technical manual or Attachment 2 of this procedure to determine appropriate purge times.

6.2.6 If any other pre-operational checks are required by the instrument manufacturer or operating procedure, perform those checks at this time.

6.3 GENERAL BACKGROUND CHECK

6.3.1 Perform an instrument background check in the same area where the instrument will be source response checked (i.e., the instrument lab). For count rate type instruments, an area with minimal background radiation interference is preferred.

NOTE: Job specific instrument background determinations may be required during radiological surveys. The site-specific survey plan will indicated requirements for additional background checks.

6.3.2 Select the lowest scale (as applicable) on the instrument which will allow a response from a normal background reading.

6.3.3 Obtain background reading for the instrument.

NOTE: The background for instruments with only ratemeter mode may be estimated by the user based on the continuous observation of the meter needle over a 20 to 30 second observation. For instruments that operate in a scaler mode, count the background for 1.0 minute.

NOTE: The background for dose rate instruments which do not have a scale low enough to read an actual background should be written as less than (<) the lowest reading obtainable by the instrument (i.e., < 0.1 mrem).

6.3.4 Record the instrument's background reading on the Portable Instrument Response Check Sheet assigned to that instrument.

6.4 SOURCE RESPONSE CHECK

6.4.1 Perform the instrument source response check in the same area where the instrument's background reading and QC check was performed (i.e., instrument lab).

6.4.2 Obtain the Portable Instrument Response Check Sheet assigned to the instrument/probe to be used.

6.4.3 If the Portable Instrument Response Check Sheet is to be continued to another response check sheet, obtain a blank check sheet and write "Continuation" in the comments section of the sheet.

- Indicate the correct page of page number.
- Transfer applicable information to the new sheet.

6.4.4 Record the date and time of the source response check in the applicable block on the next available line.

6.4.5 Obtain the source(s) identified on the Portable Instrument Response Check Sheet. Use of a source jig system (if available) is preferred over a non-jigged source.

6.4.6 If applicable, select the desired scale on the instrument.

6.4.7 Place the detector next to the source (or source jig). Detector to source alignment (geometry of the detector to source) is critical, and shall duplicate the alignment used during the initial QC check of the instrument.

6.4.8 Obtain a source reading.

6.4.9 Record the source reading in the correct "Reading" box.

6.4.10 Move the detector away from the source.

6.4.11 If the instrument's source reading is outside of the Acceptable Range:

- Record "unsat" in the remarks section of the form.
- Notify the RSO.

6.4.12 Sign your initials under the "Initials" block for each row of readings you have recorded on the form.

6.4.13 Return source(s) to their proper storage location.

6.5 INSTRUMENT USE

6.5.1 Operate the instrument in accordance with the manufacturer's operation manual, applicable RPOs, and Attachments 2 and 3.

6.5.2 If the instrument is damaged during use, appears to be functioning improperly, or is being used while out of calibration:

- Leave the area where the survey is being preformed.
- Stop using the instrument.
- Notify the RSO immediately.
- Return the instrument to the instrument lab.

6.5.3 When finished using the instrument (for the shift):

- Verify the instrument is radiologically clean.
- Perform a source response check. If the instrument fails the "post-operational" source response check, contact the RSO immediately.
- Ensure the instrument is turned off and return it to its proper storage location.

6.6 INSTRUMENT FAILURE

6.6.1 If a portable radiological survey instruments fails to pass any pre-operational check, post-operational check, or fails during use:

- Do NOT use the instrument.
- Place a tag on the instrument identifying it as out-of-service.
- Report the out of service condition to the RSO.

6.6.2 Return the instrument to the Instrument Lab.

6.6.3 Terminate the Portable Instrument Response Check Sheet for that instrument by drawing a diagonal line through the remaining blank lines on the form. Sign and date the diagonal line.

7.0 QUALITY ASSURANCE

7.1 The RSO shall review Portable Instrument Response Check Sheets at least monthly. Any errors found shall be brought to the attention of the HPT making the entry and corrected.

PORTABLE INSTRUMENT RESPONSE CHECK SHEET

Instrument: _____ Serial No: _____ Probe: _____ Serial No: _____

Cal. Preformed Date: _____ Cal. Due Date: _____

Response Check Location: _____

Source ID: _____ Source Jig ID: _____

Source Reference Reading (α): _____ +20% _____ -20% _____

Source Reference Reading (βγ): _____ +20% _____ -20% _____

Date/Time	α Bkg.	βγ Bkg.	α Reading	βγ Reading	Remarks	Initials

Comments:

_____

RSO Review: _____ Date: _____

Form RPO-201-01-1

OPERATION OF SEALED GAS DETECTORS

OPERATION

Instrument/detector use shall be operated in accordance with the manufacturer's operating manuals, this procedure, and with the following additional instructions:

1. The Eberline HP-100B shall not be used in a sealed-gas mode. However, the detector may be used in a flow-through mode.

2. The Eberline HP-100A was converted to a sealed-gas unit and can only be used for a period of 2 hours between gas charges.

3. The Ludlum 43-86 detector can only be used for a period of 2 hours between gas charges.

4. Both the HP-100A and the Ludlum 43-86 detectors may only be used with the Ludlum 2224 scaler/ratemeter.

5. Any required calculations shall be performed using the detector's stated efficiency value as indicated on the detector's efficiency tag.

6. Prior to use of any sealed-gas detector:

   - Purge the detector at the appropriate flow rate for a period of at least one hour.

   - Perform a background and source response check.

   - Log the source response and background count results on Attachment 1 of this procedure. Indicate that checks are pre-use checks.

   - Only one repeat attempt of the source response check is allowed. If the second attempt results in a failure, remove the detector from service and contact the RSO.

7. After use of any sealed-gas detector:

   - Perform a one minute background and one minute source response check.

   - Log the post-use source response and post-use background count results on Attachment 1 of this procedure. Indicate that checks are post-use checks.

   - Only one repeat attempt of the source response check is allowed. If the second attempt results in a failure, remove the detector from service, contact the RSO, and hold all data accumulated from this detector suspect until reviewed and approved by the RSO.

OPERATION OF NaI DETECTORS

PRE-OPERATION

Instrument/detector use shall be operated in accordance with the manufacturer's operating manuals, this procedure, and with the following additional instructions:

1. Position the meter "in/out" switch on the Ludlum 16 to "out" unless otherwise instructed by the RSO.

2. Position the meter fast/slow ("F/S") switch to "S" unless otherwise instructed by the RSE or Cognizant Engineer or Technician.

3. Position the meter switch to the appropriate range scale.

SOURCE RESPONSE CHECK

1. Place the end of the NaI detector into the 2" opening on the designated QC jig. Place the designated gamma QC check source into the 1" opening on the opposite end of the QC jig.

2. Allow the instrument reading to stabilize. Compare the reading to the response check criteria on the QC label.

3. The response check reading must fall within +/- 20% of the value on the QC label, or within the range specified on the QC label. The response check shall be documented by recording the appropriate data on Attachment 1 of this procedure.

4. If the response reading falls outside of +/- 20% of the designated reading or outside the designated range, tag the instrument "Out of Service, and notify the RSO.

OPERATION

1. Begin operation by placing the meter switch to the highest range scale (X 1000), and working down the ranges to the lowest range scale that does not read off scale.

2. The instrument reading is obtained by multiplying the meter reading in counts/minute by the range multiplier corresponding to the position of the meter switch.

3. Battery changes do not require instrument re-calibration, and can be performed by the user of the instrument.

MACTEC, Inc.	Procedure No: RPO-202 Revision No: 0 Effective Date: 10-8-01

OPERATION OF THE EBERLINE E-600

Authored By: _____ 10-8-01
Michael P. McDonald — Date
Radiological Engineer

Reviewed By: _____ 10/08/01
Jeffrey W. Lively — Date
Health Physicist

Approved By: _____ 10/8/01
Steven D. Rima — Date
Radiological Engineering Manager

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OPERATION OF THE EBERLINE E-600

1.0 PURPOSE

1.1 The purpose of this procedure is to provide instruction for the operation of the Eberline E-600 survey meter.

2.0 APPLICABILITY

2.1 This procedure applies to MACTEC, Inc. management, supervisors, individuals and contractors that perform radiological surveys using the Eberline E-600 where their work assignment is controlled by MACTEC, Inc.

3.0 REFERENCES

3.1 10 CFR 20, "Standards for Protection Against Radiation."

3.2 10 CFR 835, "Occupational Radiation Protection."

3.3 RPO-101, "Radiation Protection Program Overview."

3.4 RPO-103, "Radiation Protection Audits, Assessments and Oversight."

3.5 RPO-106, "Radiological Training and Qualification."

3.6 RPO-201, "Operation of Portable Radiological Survey Instruments."

3.7 RPO-204, "Calibration and Quality Control of Portable Radiological Survey Instruments."

4.0 DEFINITIONS AND ABBREVIATIONS

4.1 See RPO Glossary.

5.0 GENERAL

5.1 EQUIPMENT

5.1.1 E-600 Instrument

5.1.2 SHP 330 α\ β probe

5.1.3 SHP 360 β probe

5.1.4 SHP 380 AB α\ β probe

5.1.5 Probe connector cable

5.1.6 Appropriate radioactive check source(s)

5.2 SAFETY CONSIDERATIONS

5.2.1 All radiological surveys shall be performed in accordance with ALARA policies and practices, governing work documents, and contamination control practices.

5.2.2 If work area hazards are unknown, or may have changed, obtain current work area hazard information prior to initiation of radiological surveys.

5.2.3 Depending on the type of probe used with the E-600, potentials in excess of 2000 volts may be present on the probe connector. The voltage may remain for up to one (1) minute after the probe is disconnected or the unit is turned off.

5.3 RESPONSIBILITIES

5.3.1 RSO (or designee):

- Implement this procedure.
- Ensure individuals are qualified to perform this procedure.
- Ensure that all survey documentation is reviewed in a timely manner.

5.3.2 Health Physics Staff:

- Comply with this procedure.
- Exercise appropriate contamination control techniques in the performance of radiological surveys and while handling sample media.
- Comply with entry requirements for the areas to be surveyed.

5.4 PREREQUISITES

5.4.1 Review available survey data if unfamiliar with the facility or area you intend to survey.

5.5 RECORDS

5.5.1 Related documents and/or records shall be stored, arranged, indexed, retained, retrieved, and disposed of in accordance with this procedure and all applicable document regulations and requirements.

5.6 PRECAUTIONS AND LIMITATIONS

5.6.1 Ensure that instruments and equipment used for quantitative radiation measurements (i.e., dose rate and effluent monitoring) are properly calibrated and quality control checked for the radiation being measured.

5.6.2 When entering areas of unknown radiation levels, select the highest scale available on the survey instrument prior to entry.

5.6.3 If needed for protection against contamination, instruments may be placed in plastic bags or similar devices. For alpha/beta frisking or beta dose rates surveys, insure the plastic protective cover doesn't interfere with the instrument detector or window.

5.6.4 Only individuals qualified in accordance with Reference 3.5 shall be allowed to perform radiological surveys of record.

5.6.5 Wear appropriate protective clothing when performing surveys in known or suspected Contaminated Areas or when handling potentially contaminated samples or materials.

5.6.6 Surfaces containing significant amounts of dirt, dust or moisture may result in erroneous survey results. Alpha emitting isotopes present under dirty or painted surfaces will not be detected using standard frisking techniques. Consult with the RSO or Radiological Engineer when there is a potential for these conditions to occur.

5.6.7 Immediately reported any abnormal radiological conditions encountered to the RSO.

5.7 REVISIONS

5.7.1 This procedure shall be reviewed at least every two years, with documentation to support the completion of such review.

5.8 OTHER

Not applicable

5.9 ATTACHMENTS

Attachment 1 - E-600 Instrument

Attachment 2 - SHP 330 α\ β probe

Attachment 3 - SHP 360 β probe

Attachment 4 - SHP 380 AB α\ β probe

Attachment 5 - Detector Information

6.0 PROCEDURE

6.1 EQUIPMENT SETUP AND PRE-OPERATIONAL CHECKS

6.1.1 Select the proper probe for the type of activity expected. Attachment 6, "Probes Used with E-600 Portable Radiation Monitor" can be used to assist in selecting the proper probe.

NOTE: The SHP 330 probe in either Beta mode (beta or alpha plus beta) is light sensitive and will respond to bright lights such as the sun. The use of this probe in bright light, especially sunlight should be avoided. If surveying for beta activity, consider using the SHP 360 or SHP 380AB probes

6.1.2 To remove a probe from the cable:

- Turn the instrument off for at least one minute.
- Squeeze the grooved area of the cord and pull apart.

6.1.3 Attach the appropriate probe to the E-600 using the appropriate cable and smart probe connector if required.

NOTE: The probe efficiency(s) and detector voltage will be posted on each probe.

6.1.4 Turn the selector switch to the "Check" position. If an OUT OF CAL, FAIL, or PROBE OUT OF CAL message is displayed:

- Do NOT use the instrument
- Notify the RSO
- Return the instrument so it may be calibrated.

6.1.5 Verify that the probe type displayed is the correct probe attached to the instrument.

- The probe serial number will be displayed first, then the type of probe connected.
- The probe serial number and type of probe connected to the instrument will be displayed any time the instrument is turned on.
- This information scrolls across the bottom of the display screen, right corner, from right to left.

6.1.6 After the type of probe is displayed, verify battery condition.

- The condition will be displayed as a percentage of full charge.
- This is for indication only and should not be used to determine if the batteries should be changed.

6.1.7 After the probe information has been displayed, press the "Chnl" key one time to get to the Alarm set point mode.

- The probe operating voltage will be displayed in the lower right hand corner.
- See Section 6.2, Setting Alarm Set Points, for additional information on setting alarms.

6.1.8 Press the "Chnl" key after setting the alarm set point(s) to display the address number for the last Logged reading. (No data will be displayed).

- Press the "Log" key at this point to display the last numbered data point used.
- If this number is not one(1), data has been stored and may need retrieving (see Section 6.5, Data Logging And Retrieval, for additional information on stored data).

6.1.9 Press the "Chnl" key again to place the instrument in the screen display mode.

6.1.10 Switch the Selector switch instrument to the Ratemeter mode. If the battery icon in the lower left-hand portion of the display is flashing, turn off the E-600, change the batteries, and return to step 6.1.6.

6.1.11 Complete the preoperational checks in accordance with Reference 3.6.

6.1.12 Turn the selector switch to the appropriate operating position. See Attachment 7 for selector switch position descriptions.

6.1.13 When using a probe that is capable of monitoring beta, alpha, and both beta plus alpha, use the "Chnl" key to select the type of activity being monitored. (i.e., beta only, press the "Chnl" key once, now in beta and alpha mode.)

- The appropriate symbol for the type of activity will be displayed below the analog display.

6.2 SETTING ALARM SET POINTS

NOTE: Alarm set points are not required to use this instrument.

6.2.1 Turn (verify) the selector switch to "Check."

6.2.2 After the instrument completes the display of probe information, press the "Chnl" key until the symbol for the desired type of radiation is displayed.

6.2.3 Press the "Range" key to change the alarm setting.

- The up arrow increases the alarm setting while the down arrow will decrease the alarm setting.
- Setting the alarm setting at zero "0" will disable the alarm for the selected type of radiation.

6.2.4 Press the "Chnl" key to select the next alarm setting to be set.

6.2.5 After setting the alarms, turn the selector switch to the appropriate operating position. See Attachment 7.

6.3 SETTING BACKGROUND SUBTRACTION

6.3.1 To capture a background count rate, select the "Backgd" position using the selector switch.

- The count rate will be displayed as in normal operation with the precision of the count displayed in the lower right hand corner of the display.

6.3.2 When the proper precision has been reached (wait at least 60 seconds), press the "Star" key.

- For probes capable of detecting more than one type of radiation, background will be simultaneously counted and saved as long as the high voltage is the same in each mode.

6.3.3 Use the "Chnl" key to display each type of activity (i.e., beta, alpha, beta & alpha).

6.3.4 The background value will remain in the instrument memory until updated or the probe is changed.

6.4 OPERATING IN THE BACKGROUND SUBTRACTION MODE.

6.4.1 Set the background subtraction count rate. See Section 6.3.

6.4.2 While in the required operating mode, press the "Gross\Net " key on the body of the instrument to the left of the handle.

- Net will be displayed to the left of the large digital reading.

6.4.3 To turn the background subtraction feature off, press the "Gross\Net" key.

6.5 DATA LOGGING AND RETRIEVAL

NOTE: Saved data can only be retrieved by connecting the E-600 to a computer and running the interface software.

6.5.1 To log data in any of the four operating modes, press the "Log" key.

- At this point, the reading will be frozen on the display and a Log # will appear in the lower right portion of the display.

6.5.2 To change the Log #, use the range "up\down" keys to change the log #.

6.5.3 When the reading and the Log # are acceptable, press the "Log" key again.

- The date, time, instrument and probe serial number, reading, and location code will be saved.

6.5.4 Press the "Star" key or wait for 15 seconds to return the instrument to normal operation.

6.5.5 To retrieve stored data, connect the E-600 to a computer and follow the software program instructions.

6.6 INSTRUMENT MAINTENANCE

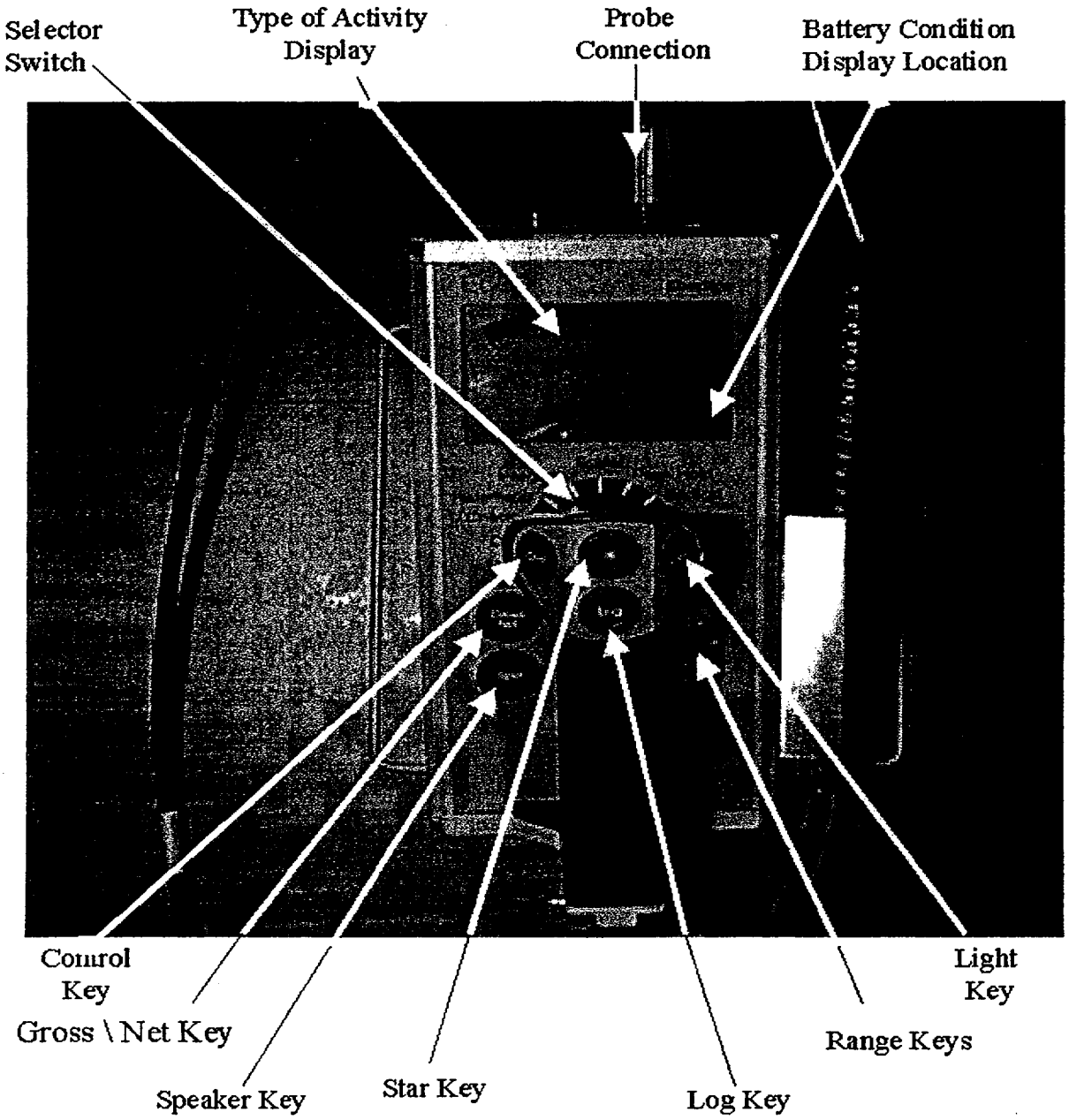
6.6.1 If an E-600 requires any repairs or maintenance:

- Do NOT use the instrument
- Notify the RSO
- Return the instrument so it may be calibrated/repaired.

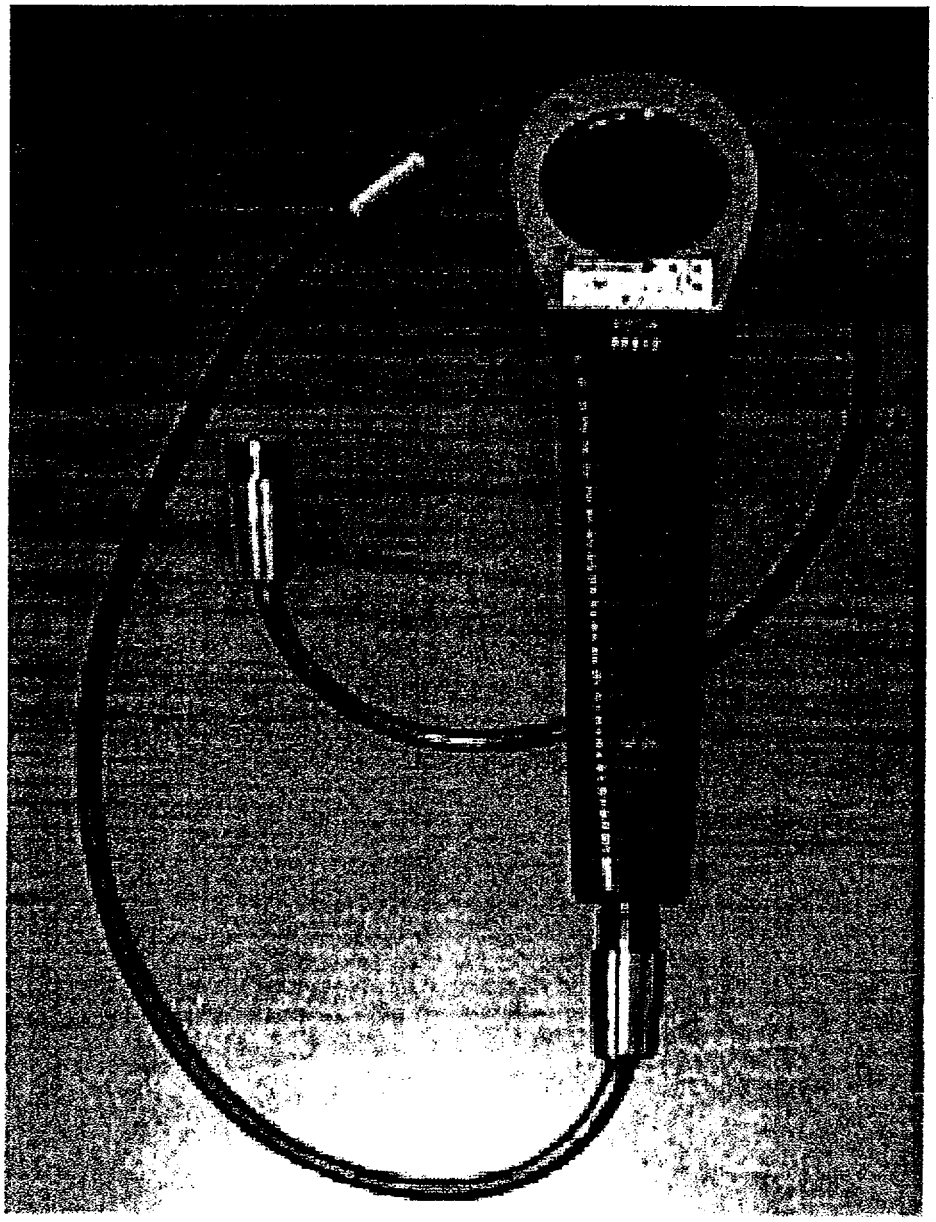
7.0 QUALITY ASSURANCE

7.1 Documents generated during the performance of this procedure shall be audited in accordance with Reference 3.4.

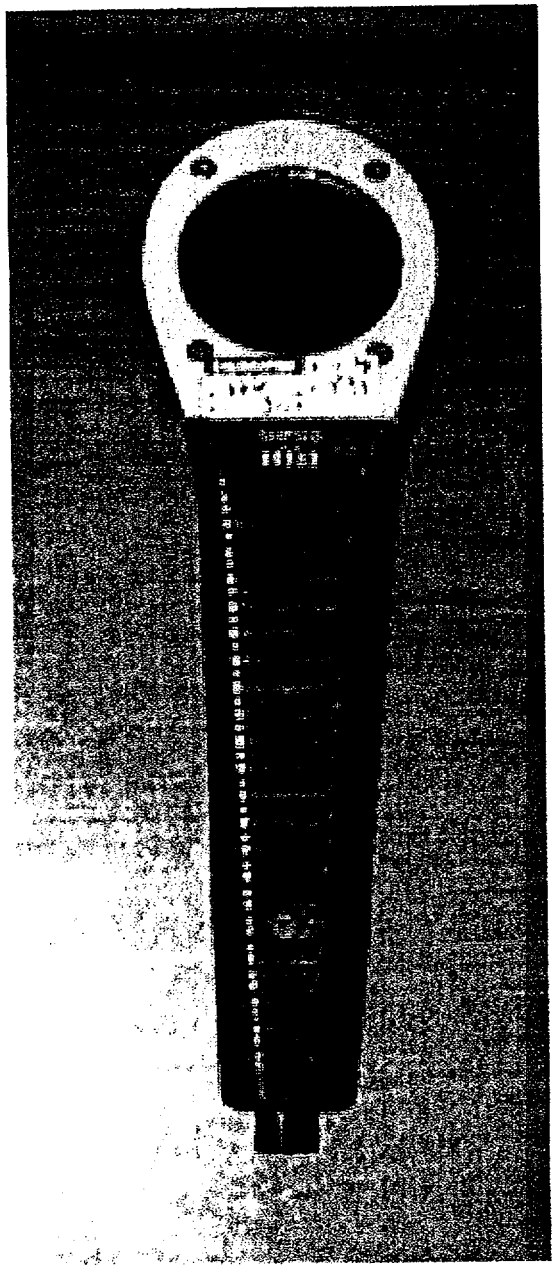
E-600 PORTABLE RADIATION MONITOR WITH SHP 330 PROBE



SHP 330 PROBE WITH CONNECTING CABLE



SHP 360 PROBE



SHP 380 AB PROBE

DETECTOR INFORMATION

Probe Model Number	Type of Probe	Type of Radiation Detected	Probe Area in cm^2
SHP 330	Sealed gas proportional	Alpha, Beta, Alpha plus Beta	15
SHP 360	Pancake GM	Beta	15
SHP 380 AB	Scintillation	Alpha, Beta, Alpha plus Beta	100
NRD *	BF3	Neutron	N\A
SPA-3 *	NaI(Tl)	Gamma	N\A

* Requires a smart probe connector to be added before the probe. This will be supplied with the detector.

MACTEC, Inc.	Procedure No: RPO-204 Revision No: 1 Effective Date: 9-1-02

CALIBRATION AND QUALITY CONTROL OF PORTABLE RADIOLOGICAL SURVEY INSTRUMENTS

Authored By: _____ 5-29-02
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Reviewed By: _____ 8/16/02
Jeffrey W. Lively — Date
Health Physicist

Approved By: _____ 8/16/02
Steven D. Rima — Date
Radiological Engineering Manager

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CALIBRATION AND QUALITY CONTROL OF PORTABLE RADIOLOGICAL SURVEY INSTRUMENTS

1.0 PURPOSE

1.1 The purpose of this procedure is to provide instruction for the calibration and quality control of portable radiological survey instruments.

2.0 APPLICABILITY

2.1 This procedure applies to MACTEC, Inc. management, supervisors, individuals and contractors that perform calibration or Quality Control (QC) checks of portable radiological survey instruments where their work assignment is controlled by MACTEC, Inc.

3.0 REFERENCES

3.1 10 CFR 20, "Standards for Protection Against Radiation."

3.2 10 CFR 835, "Occupational Radiation Protection."

3.3 RPO-101, "Radiation Protection Program Overview."

3.4 RPO-103, "Radiation Protection Audits, Assessments and Oversight."

3.5 RPO-201, "Operation of Portable Radiological Survey Instruments."

3.6 RPO-301, "Radiological Surveys."

3.7 ANSI N323A-1997, "Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments."

3.8 Regulatory Guide 8.21 "Health Physics Surveys for Byproduct Material at NRC Licensed Processing and Manufacturing Plants."

4.0 DEFINITIONS AND ABBREVIATIONS

4.1 See RPO Glossary.

5.0 GENERAL

5.1 EQUIPMENT

5.1.1 Various portable radiation and contamination survey instruments

5.1.2 Various radioactive sources and source jigs

5.2 SAFETY CONSIDERATIONS

Not applicable

5.3 RESPONSIBILITIES

5.3.1 RSO (or designee):

- Implement this procedure.
- Ensure individuals are qualified to perform this procedure.
- Ensure portable survey instruments are calibrated per this procedure and the manufacturer's operating manual.
- Ensure that quality control limits are accurately calculated and documented.

5.3.2 Health Physics Staff:

- Comply with this procedure.
- Exercise appropriate ALARA techniques when using radioactive sources.
- Not use portable survey instruments that fail calibration or do not meet QC check requirements.

5.4 PREREQUISITES

5.4.1 Portable radiation monitoring instrument being QC checked shall be in calibration.

5.4.2 HPT shall ensure that the instrument is operated with the probe it was calibrated with, or that the instrument is designed to be operated with a variety of other calibrated "smart" type probes.

5.5 RECORDS

5.5.1 Instrument calibration/QC or related documents and/or records shall be stored, arranged, indexed, retained, retrieved, and disposed of in accordance with this procedure and all applicable document regulations and requirements.

5.6 PRECAUTIONS AND LIMITATIONS

5.6.1 Direct probe contact with the radioactive check source surface can damage or disturb the protective coating and/or radioactive material of the radioactive check source surface and/or spread radioactive material to the detector/probe.

5.6.2 Unexplainable or out of character changes in background count or dose rates may be the result of a damaged or contaminated detector/probe or unidentified radiation interference.

5.6.3 Instruments that are out of calibration may function improperly or respond falsely. Do not use an instrument or detector that is out of calibration.

5.6.4 Radioactive sources that are not permanently attached to the instrument shall be removed prior to shipment.

5.6.5 Disconnect the battery or secure the power switch in the off position prior to shipment.

5.6.6 Upon receipt of new instruments, after instrument repair or calibration; new quality control limits shall be established in accordance with Section 6.3 of this procedure.

5.7 REVISIONS

5.7.1 This procedure shall be reviewed at least every two years, with documentation to support the completion of such review.

5.8 OTHER

Not applicable

5.9 ATTACHMENTS

Attachment 1 - Instrument QC Check Sheet

Attachment 2 - Portable Instrument Response Check Sheet

6.0 PROCEDURE

6.1 GENERAL INFORMATION

6.1.1 Calibrate portable survey instruments, utilized for radiation protection purposes, at least annually or following instrument maintenance, repair, or adjustment likely to affect the primary calibration.

6.1.2 Perform instrument calibration and QC checks according to this procedures and instructions or other guidance documents reviewed and approved by the RSO.

6.1.3 Perform instrument calibrations using standard sources traceable to NIST.

6.1.4 A list of all portable survey instruments shall be maintained. The list shall contain the following information, as a minimum:

- Instrument Manufacturer
- Instrument Model
- Instrument Type
- Instrument Serial No.
- Calibration Due Date
- Instrument Status
- Comments

6.2 CALIBRATION OF PORTABLE SURVEY INSTRUMENTS

6.2.1 Return portable survey instruments due for calibration to the instrument lab/locker for calibration.

6.2.2 Perform a contamination survey on all portable survey instruments that will be sent off site if there is a potential for the instrument to be contaminated.

6.2.3 Send portable survey instruments to a commercial calibration service, or perform calibration in accordance with approved procedures.

6.2.4 Upon return of calibrated portable survey instrument, establish QC limits in accordance with Section 6.3 of this procedure.

6.3 QUALITY CONTROL LIMITS

6.3.1 Complete the upper section of the Instrument QC Check Sheet (Attachment 1).

6.3.2 Select an appropriate counting source and place it in the proper geometry for counting.

NOTE: For certain instruments, a jig must be utilized. If a jig is utilized, indicate it use on the QC check sheet.

6.3.3 For instruments with scaler counting features, place the instrument probe over the QC source and initiate the counting cycle (minimum of 1 minute). Record the results on the Instrument QC Check Sheet. Repeat the count for a total of five readings.

6.3.4 For instruments with an analog readout, place the instrument probe over the QC source, allow the meter reading to stabilize, and record the reading on the QC Check Sheet. Repeat the count for a total of five readings.

6.3.5 Obtain an average of the five readings and record on the Instrument QC Check Sheet.

6.3.6 Establish an upper and lower QC response value by multiplying the average by 20%. Add the results to the average to obtain an upper QC limit and subtract the value from the average to obtain the lower QC limits.

6.3.7 Record the QC values and the source used on the Portable Instrument Response Check Sheet (Attachment 2).

6.3.8 Record the QC values on an indelible label and attach the label to the instrument.

6.3.9 Attach the instrument QC Check Sheet to the calibration certificate and place in the appropriate instrument file.

6.3.10 Complete all other required information on the Portable Instrument Response Check Sheet:

- Instrument Model
- Instrument Serial Number

- Probe Type
- Probe Serial Number
- Instrument Calibration Date
- Instrument Calibration Expiration (Due) Date
- Response Check Location
- Check Source(s) Identification Number

6.3.11 Place the Portable Instrument Response Check Sheet in the Response Check Logbook.

6.3.12 Perform the QC check with the source that will be used during source response checks. For guidance on source selection, contact the RSO.

6.3.13 If more than one source is required to be used for an instrument, repeat step 6.3.2 through 6.3.9 for each source used.

6.3.14 Return source(s) to their proper storage location.

7.0 QUALITY ASSURANCE

7.1 The RSO shall review QC Instrument Check Sheets. Any errors found shall be brought to the attention of the HPT making the entry and corrected.

7.2 The RSO shall review the instrument list quarterly to verify all instruments in use are calibrated.

INSTRUMENT QC CHECK SHEET

Date: _____ Time: _____

Instrument: _____ Serial No: _____

Probe: _____ Serial No: _____

Cal. Preformed Date: _____ Cal. Due Date: _____

Source Isotope: _____ Source #: _____

QC Check Location: _____

Jig Used: Yes No (circle one) Jig ID# _____

QC Counting Results	
Count No.	Count Result
1	
2	
3	
4	
5	
	Add results, list in Total
Total	
	Divide the total by 5
Source Reference Reading (Average)	

Range Calculation

Source Ref. Reading: _____ X 20% = _____

Avg. + 20% = _____

Avg. - 20% = _____

Acceptable Range:

From _____ to _____
(Avg. - 20%) (Avg. + 20%)

Comments: _____

Performed By: _____ Date: _____

RSO Review: _____ Date: _____

Form RPO-204-01-1

PORTABLE INSTRUMENT RESPONSE CHECK SHEET

Instrument: _____ Serial No: _____ Probe: _____ Serial No: _____

Cal. Preformed Date: _____ Cal. Due Date: _____

Response Check Location: _____

Source ID: _____ Source Reference Reading: _____
(list unit of measure)

Acceptable Range: +20% _____ -20% _____

Acceptable Range: +20% _____ -20% _____

Date/Time	JIG ID	Bkg.	Reading	Reading	Remarks	Initials

Comments: _____

RSO Review: _____ Date: _____

Form RPO-204-02-1

MACTEC, Inc.	Procedure No: RPO-208 Revision No: 0 Effective Date: 1/07/02

OPERATION and CALIBRATION OF LOW VOLUME AIR SAMPLERS

Authored By: _____ 12-27-01
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Approved By: _____ 1/4/02
Steven D. Rima
Radiological Engineering Manager
Date

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OPERATION and CALIBRATION OF LOW VOLUME AIR SAMPLERS

1.0 PURPOSE

1.1 The purpose of this procedure is to provide instruction for the operation and calibration of the low volume air sampler.

2.0 APPLICABILITY

2.1 This procedure applies to MACTEC, Inc. management, supervisors, individuals and contractors that calibrating and operating low volume air samplers where their work assignment is controlled by MACTEC, Inc.

3.0 REFERENCES

3.1 10 CFR 20, "Standards for Protection Against Radiation."

3.2 10 CFR 835, "Occupational Radiation Protection."

3.3 RPO-101, "Radiation Protection Program Overview."

3.4 NRC Regulatory Guide 8.25 "Air Sampling In The Workplace."

3.5 F&J Technical Manual for Calibrator Model D-812.

4.0 DEFINITIONS AND ABBREVIATIONS

4.1 See RPO Glossary.

5.0 GENERAL

5.1 EQUIPMENT

5.1.1 Low volume air sampling instrumentation

5.1.2 Air sampler filter material

5.1.3 F&J Calibrator Model D-812

5.2 SAFETY CONSIDERATIONS

Not applicable

5.3 RESPONSIBILITIES

5.3.1 RSO (or designee):

- Implement this procedure.
- Ensure individuals are qualified to perform this procedure.
- Ensure low volume air samplers are calibrated at a frequency not to exceed six months.
- Review the Low Volume Air Sampler Certificate of Calibration as they are completed.

5.3.2 Health Physics Staff:

- Comply with this procedure.
- Exercise appropriate contamination control techniques in the calibration of internally contaminated air samplers.

5.4 PREREQUISITES

Not applicable

5.5 RECORDS

5.5.1 Air sampler calibration documents and/or records shall be stored, arranged, indexed, retained, retrieved, and disposed of in accordance with this procedure and all applicable document regulations and requirements.

5.6 PRECAUTIONS AND LIMITATIONS

5.6.1 Air monitoring and sampling equipment that has the potential for being contaminated internally shall be properly labeled (e.g., "Caution: Internal Contamination" or "Potential Internal Contamination") and treated/handled with caution, using good contamination control techniques.

5.7 REVISIONS

5.7.1 This procedure shall be reviewed at least every two years, with documentation to support the completion of such review.

5.8 OTHER

Not applicable

5.9 ATTACHMENTS

Attachment 1 - Low Volume Air Sampler Certificate of Calibration

Attachment 2 - Low Volume Air Sampler Inspection Log

6.0 PROCEDURE

6.1 LOW VOLUME AIR SAMPLER GENERAL INFORMATION

6.1.1 If using the low volume sampler for breathing zone coverage, ensure the filter/cartridge location will be in an area which is representative of the breathable air in the work location. Contact the RSO for guidance.

6.1.2 Obtain approval from the RSO if an extension sampling tubing is to be used when sampling.

6.1.3 For general area sampling, the sampler may run using the same filter for several days as needed. If used for breathing zone sampling, the sampler is to run only when work is being performed and not to exceed one shift.

6.1.4 For all sampling operations, the sample flow rate shall not drop below 50% of the initial sampling value. If the sampling flow rate drops below 50% of initial sampling flow rate, stop the sampler and investigate the cause.

- If the sampler filter medium is loaded, change the sampler filter and verify correct flow rate after restart.
- If the cause is unknown or can not be corrected, discontinue use of the sampler and notify the RSO immediately.

6.1.5 Ensure the job duration and flow rate of the pump will be adequate to meet the required sampling volume for the radionuclide(s) of concern.

6.1.6 When a building's effluent exhaust stack is being monitored by a low volume air sampler, that sampler shall be operated and adjusted, as necessary, so that it is sampling in an isokinetic mode.

- Air flow measurements and calculations shall be performed periodically to verify the air sampler's isokinetic operating condition.

6.1.7 When in use, air samplers shall be inspected daily and the inspection shall be recorded on the Low Volume Air Sampler Inspection Log (Attachment 2).

6.2 LOW VOLUME AIR SAMPLING OPERATION

6.2.1 Obtain needed equipment.

6.2.2 Perform a pre-operational check of the air sampler.

- Inspect the sampler, including power cord for physical damage. If damage is found, DO NOT use the sampler.
- Verify current calibration from the attached calibration sticker. If the sticker is missing or is beyond the indicated expiration date, DO NOT use the sampler.
- Inspect the rubber O-rings on the sampler. If damaged or missing, DO NOT use the sampler.
- Inspect the sampler head filter backing screen for damage. If damaged excessively, replace the sampler head.
- If the sampler does not pass the pre-operational checks for any reason, place it out-of-service and return it to the instrument lab.
- Log completed checks in the Low Volume Air Sampler Inspection Log.

6.2.3 Install the appropriate filter media in the sampler head. Contact the RSO for guidance, as necessary.

6.2.4 Connect the sampler to power supply if AC operated.

6.2.5 Turn the power switch ON.

6.2.6 Verify proper flow through the filter media.

6.2.7 Check for air in-leakage into sampling lines by momentarily blocking the sampler inlet immediately after starting the unit.

- Flow indication should drop towards "zero." If flow does not drop, investigate for source of air in-leakage and correct.
- If air in-leakage can not be corrected, place the unit out of service and inform the RSO.

6.2.8 Document completed checks on the Low Volume Air Sampler Inspection Log.

6.2.9 Obtain required air sample.

6.2.10 When finished sampling, turn the power switch OFF.

6.2.11 Remove the filter media and process.

6.2.12 Document air sample information and results.

6.2.13 Return equipment.

6.3 LOW VOLUME AIR SAMPLER CALIBRATION USING THE F&J AIRFLOW CALIBRATOR

6.3.1 Obtain a Low Volume Air Sampler Certificate of Calibration Sheet (Attachment 1). Record pre-calibration information on the form.

6.3.2 Remove the filter holder from the air sampler being calibrated and connect the F&J airflow calibrator to it.

6.3.3 Turn on the calibrator.

6.3.4 Press the select button to read temperature (F) and barometric pressure (mmHg). Record these readings on the Certificate of Calibration (Attachment 1).

NOTE: Accurate temperature and pressure readings can only be obtained if there is no airflow going through the calibrator.

NOTE: This instrument reads correctly only at 70 (+/-5) deg. F and 760 (+/-5) mmHg. Corrections to the actual airflow must be made to adjust for varying temperatures and pressures outside the acceptable range (see Section 6.4)

6.3.5 Select the appropriate flow units (lpm/cfm) on the calibrator.

6.3.6 Start the air sample pump.

NOTE: Calibration of the air sample flow meter is performed by comparing three flow rate points to the calibrator's three reference flow rate points.

6.3.7 To determine the high, midrange, and low flow rate points:

- Adjust the airflow on the air sampler pump to its maximum flow rate.
- Observe the air sampler flow rate on the calibrator and choose the next lower whole number as the high flow rate calibration point (i.e., if max. flow is 4.8 cfm, choose 4.0 cfm as the high flow rate calibration point).
- Record on the Certificate of Calibration sheet.

- Determine the low flow rate calibration point by choosing the lowest positive (i.e., not zero) value clearly readable on the air sample flow meter. Record on the Certificate of Calibration sheet.

- Determine the midrange flow rate calibration point by subtracting the low flow rate calibration point value from the high flow rate calibration point value, divide by two (2), then add to the low flow rate calibration point value. Record on the Certificate of Calibration sheet.

NOTE: Due to flow meter fluctuations at low flow conditions, it may be necessary to select a higher low flow rate calibration point value to obtain a more accurate calibration. Contact the RSO for guidance if necessary.

6.3.8 Adjust the air sampler pump until the calibrator reads the high flow rate calibration point selected in 6.3.7. Record the flow reading from the air sampler's flow meter on the Certificate of Calibration in the as-found column.

6.3.9 Adjust the air sampler pump until the calibrator reads the midrange flow rate calibration point selected in 6.3.7. Record the flow reading from the air sampler's flow meter on the Certificate of Calibration in the as-found column.

6.3.10 Adjust the air sampler pump until the calibrator reads the low flow rate calibration point selected in 6.3.7. Record the flow reading from the air sampler's flow meter on the Certificate of Calibration in the as-found column.

6.3.11 Compare the recorded as-found flow rates to the calibrator flow rate standards.

- The as-found flow rates must be +/- 20% of the calibrator flow rate standards.

- Notify the RSO if the as-found values are outside of the +/-20% calibrator flow rate standards.

6.3.12 If the as-found values are acceptable and no adjustments are necessary, record the as-found values in the as-left column of the Certificate of Calibration form and complete the form. Attach a calibration label to the air sampler's flow meter indicating the date of calibration and the new calibration due date.

6.3.13 If the air sampler's flow meter has a mechanical adjustment, and the calibration as-found values are outside the +/-20% of the calibrator flow rate standards (or if as found value is acceptable but adjustment to the flow meter would provide a more accurate reading), adjust the air sampler's flow meter to its most accurate setting. Record these new flow rates in the as-left column of the Certificate of Calibration.

6.3.14 If you are unable to adjust the air sampler's flow meter to within +/- 20% of the calibrator flow rate standard standards, replace the air sampler's flow meter and recalibrate or remove the instrument from service.

6.3.15 Update the master instrument calibration spreadsheet to reflect the new calibration date.

6.3.16 Complete the Certificate of Calibration and forward to the RSO for review.

6.3.17 Attach a calibration label to the side of the flow meter indicating the air sampler number, date of calibration, and calibration due date (6 mos.)

6.4 TEMPERATURE AND PRESSURE CALCULATIONS

6.4.1 If calibration must be performed and the temperature and/or pressure criteria cannot be met, calculate the actual calibrator setting using the following equation:

$$\text{Flow actual} = (\text{Flow display}) \times \frac{ActualTemp + 460}{530} \times \frac{760mm}{actualP}$$

6.4.2 Note any temperature/pressure corrections made on the Certificate of Calibration.

7.0 QUALITY ASSURANCE

7.1 The RSO shall review the Low Volume Air Sampler Certificate of Calibration as they are completed.

LOW VOLUME AIR SAMPLER CERTIFICATE OF CALIBRATION

Calibration Date: _____ Calibration Due Date: _____

Air Sampler Data	Calibrator Data
Manufacturer: _____	Manufacturer: _____
Model Number: _____	Model Number: _____
Serial Number: _____	Serial Number: _____
CE ID Number: _____	Calibration Due Date: _____
	Temperature (°F): _____
	Pressure (mm Hg): _____

Calibration Results

Range Point	Calibrator Flow Rate Standard	Air Sampler Flow Rate As-Found	Air Sampler Flow Rate As-Left
High			
Midrange			
Low			

Calibration: (check one) ❑ ACCEPTED ❑ REJECTED

Remarks: _____

_____

_____

_____

Calibration by: _____ Date: _____

Reviewed by: _____ Date: _____

LOW VOLUME AIR SAMPLER INSPECTION LOG

Date	Time	A/S #	Sampler Location	Calibration Date	Physical Condition	Filter Condition	Air In-leakage Check	Flow Rate	Filter Changed Y/N	Initial

Note: Not all fields of the inspection log need to be completed for every inspection. Some inspections are performed at sampler start-up, while others are performed daily when the sampler is in operation. Consult with the RSO if necessary

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RADIOLOGICAL SURVEYS

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RADIOLOGICAL SURVEYS

1.0 PURPOSE

1.1 The purpose of this procedure is to provide instruction for the performance of radiological surveys. These surveys include both radiation and contamination surveys, either routine or special, performed before, during and after radiological work. This procedure also describes the methodology used to document the results of radiological surveys.

2.0 APPLICABILITY

2.1 This procedure applies to MACTEC, Inc. management, supervisors, individuals and contractors that perform radiological surveys where their work assignment is controlled by MACTEC, Inc.

3.0 REFERENCES

3.1 10 CFR 20, "Standards for Protection Against Radiation."

3.2 10 CFR 835, "Occupational Radiation Protection."

3.3 RPO-101, "Radiation Protection Program Overview."

3.4 RPO-103, "Radiation Protection Audits, Assessments and Oversight."

3.5 RPO-106, "Radiological Training and Qualification."

3.6 RPO-201, "Operation of Portable Radiological Survey Instruments."

3.7 RPO-204, "Calibration and Quality Control of Portable Radiological Survey Instruments."

3.8 Regulatory Guide 8.21 "Health Physics Surveys for Byproduct Material at NRC Licensed Processing and Manufacturing Plants."

4.0 DEFINITIONS AND ABBREVIATIONS

4.1 See RPO Glossary.

5.0 GENERAL

5.1 EQUIPMENT

5.1.1 Portable and laboratory radiological survey and counting equipment.

5.1.2 Smear/wipe media.

5.1.3 Various anti-contamination clothing used for protection from contamination while performing surveys.

5.2 SAFETY CONSIDERATIONS

5.2.1 All radiological surveys shall be performed in accordance with ALARA policies and practices, governing work documents, and contamination control practices.

5.2.2 If work area hazards are unknown, or may have changed, obtain current work area hazard information prior to initiation of radiological surveys.

5.3 RESPONSIBILITIES

5.3.1 RSO (or designee):

- Implement this procedure.
- Ensure individuals are qualified to perform this procedure.
- Ensure that all survey documentation is reviewed in a timely manner.
- Determine the radiological instrumentation to be utilized to perform radiological surveys, if necessary.

5.3.2 Health Physics Staff:

- Comply with this procedure.
- Exercise appropriate contamination control techniques in the performance of radiological surveys and while handling sample media.
- Comply with entry requirements for the areas to be surveyed.
- Operate radiological survey instrumentation in accordance with approved operating procedures.

5.4 PREREQUISITES

5.4.1 Review available survey data if unfamiliar with the facility or area you intend to survey.

5.4.2 Select and operate portable radiation survey instruments in accordance with applicable RPOs and manufacturer's operating manuals.

5.5 RECORDS

5.5.1 Related documents and/or records shall be stored, arranged, indexed, retained, retrieved, and disposed of in accordance with this procedure and all applicable document regulations and requirements.

5.5.2 Related documents and/or records, showing the results of radiological surveys and instrument calibrations, shall be maintained as required by 10 CFR 20 or 10 CFR 835. These documents/records include, as a minimum:

- Records of all surveys for radiation dose rates, area and equipment contamination levels, unconditional release of materials, and any other surveys as designated by the RSO.
- Records of the results of measurements and calculations used to determine individual intakes of radioactive material and used in the assessment of internal dose.
- Records showing the results of air sampling, surveys, and bioassays sampling.
- Records of the results of measurements and calculations used to evaluate the release of radioactive effluents to the environment.

5.6 PRECAUTIONS AND LIMITATIONS

5.6.1 Ensure that instruments and equipment used for quantitative radiation measurements (i.e., dose rate and effluent monitoring) are properly calibrated and quality control checked for the radiation being measured.

5.6.2 When entering areas of unknown radiation levels, select the highest scale available on the survey instrument prior to entry.

5.6.3 If needed for protection against contamination, instruments may be placed in plastic bags or similar devices. For alpha/beta frisking or beta dose rates surveys, insure the plastic protective cover doesn't interfere with the instrument detector or window.

5.6.4 Only individuals qualified in accordance with Reference 3.5 shall be allowed to perform radiological surveys of record.

5.6.5 Wear appropriate protective clothing when performing surveys in known or suspected Contaminated Areas or when handling potentially contaminated samples or materials.

5.6.6 Obtain a sufficient number of radiological survey points to adequately characterize the radiological conditions of the area or item. Inaccessible surfaces shall be considered potentially contaminated until proven otherwise. Contact the RSO or Radiological Engineer for clarification, as needed.

5.6.7 Surfaces containing significant amounts of dirt, dust or moisture may result in erroneous survey results. Alpha emitting isotopes present under dirty or painted surfaces will not be detected using standard frisking techniques. Consult with the RSO or Radiological Engineer when there is a potential for these conditions to occur.

5.6.8 Immediately reported any abnormal radiological conditions encountered to the RSO.

5.6.9 To make corrections on radiological survey maps, forms, or logs; use a single line strikeout with an initial and date. Enter the correct information beside the strikeout.

NOTE: The use of white-out or other similar material to make corrections on survey forms is not authorized.

5.7 REVISIONS

5.7.1 This procedure shall be reviewed at least every two years, with documentation to support the completion of such review.

5.8 OTHER

Not applicable

5.9 ATTACHMENTS

Attachment 1 - Radiological Survey Form

Attachment 2 - Radiological Survey Map

Attachment 3 - Radiological Survey Remarks

Attachment 4 - Radiological Survey Form Continuation

Attachment 5 - Radiochemistry Analytical Results

Attachment 6 - Personnel Frisking Instructions

6.0 PROCEDURE

6.1 RADIOLOGICAL SURVEY TECHNIQUES

6.1.1 Perform general area radiation surveys with the instrument's detector held at waist level.

6.1.2 Perform on-contact radiation surveys with the instrument's detector held as close as possible to the item being surveyed, without touching the instrument or detector to the item or surface.

6.1.3 When performing radiation surveys, do not make corrections or subtractions for background radiation levels.

6.1.4 Allow sufficient time for the instrument to respond while conducting radiological surveys.

6.1.5 For fixed surface contamination surveys; hold the alpha frisking probe within ¼ inch of the surface and moved at a rate of no greater than one inch per second, and the beta/gamma frisking probe within ½ inch of the surface and moved at a rate of no greater than two inches per second.

6.1.6 Whenever possible, select an instrument with an audible response.

6.1.7 Perform environmental dose rate monitoring using an appropriate dose rate survey meter, reporting dose rate values in microrem per hour (μrem/hr).

6.1.8 Report/record radiation dose rate survey results (except as otherwise stated) in millirem per hour (mrem/hr).

6.1.9 Use an instrument with an audible response when performing monitoring of personnel.

6.1.10 Smears containing significant amounts of dirt, dust or moisture may result in erroneous survey results. Consult with the RSO or Radiological Engineer when there is a potential for these conditions to occur.

6.2 RADIATION SURVEYS

6.2.1 General Area Dose Rate (Beta/Gamma)

- Select the appropriate survey instrument(s) necessary to perform the survey.
- Obtain radiation levels (dose rates) for each anticipated type of radiation in the area(s) of interest. Dose gradient measurements may need to be

obtained to determine special dosimetry requirements or to characterize the work area(s).

- Document survey results in accordance with Section 6.9.

6.2.2 Contact Dose Rate (Beta, Gamma)

- Select the appropriate survey instrument(s) necessary to perform the survey.
- Obtain contact dose rate measurements for each item of interest. Repeat dose rate measurements to characterize the item, as necessary.
- If radiation levels are found to be above background levels, obtain dose rate measurements at the distance(s) indicated by the governing procedure or the distance(s) that is/are determined by the RSO/RSE.
- To determine the beta dose rate in a mixed beta-gamma radiation field, obtain an open window (OW) dose rate measurement and a closed window (CW) dose rate measurement for each item or area of interest. Readings shall be obtained at approximately 1 inch from the surface at the location of the highest reading. If calculation corrections are necessary to determine a true beta dose rate, make corrections in accordance with manufactures operating instructions, calibration values, or contact the RSO or Radiological Engineer for guidance.
- Document survey results in accordance with Section 6.9.

6.2.3 Low-energy Photon Radiation Field

- Select the appropriate low-energy photon radiation survey instrument(s) necessary to perform the survey.
- Obtain low-energy photon radiation measurements for each item or area of interest. Repeat dose rate measurements to characterize the item or area, as necessary.
- Document survey results in accordance with Section 6.9.

6.3 REMOVABLE SURFACE CONTAMINATION SURVEY

6.3.1 Select the appropriate type of smear media necessary to perform a removable contamination survey. If necessary, consult the RSO or Radiological Engineer for guidance on the proper selection of smear media.

6.3.2 Label each smear container with a unique number to provide accountability. This number shall also be used to identify (on the radiological survey map) the location of where the smear is taken.

6.3.3 Swipe the surface with the smear. Apply moderate pressure to the smear media to ensure proper transfer of radioactive material. Unless otherwise specified, the area sampled shall be 100 square centimeters (cm^2). For items with an accessible surface area of less than 100 cm^2, swipe the entire accessible surface.

6.3.4 Place smear in a clean coin envelope or other suitable container.

NOTE: Take precautions to prevent cross contamination of individual smears or loss of sample activity while handling and processing.

6.3.5 Repeat the previous steps, as necessary, to characterize the area or item.

NOTE: If contamination levels in excess of 10,000 cpm are suspect or identified, field count the smear(s) and consult with the counting laboratory personnel or the RSO on methods for analyzing the smear(s). Do not bring these smears into the counting laboratory without permission from lab personnel. This does not apply to samples in closed containers prepared for analysis by liquid scintillation or gamma spectroscopy counting.

6.3.6 Deliver smear(s) to the counting laboratory for analysis, or analyze smear(s) using the appropriate counting instrument. Field counting may be performed for work area indications.

6.3.7 Document survey results in accordance with Section 6.9.

6.4 LARGE AREA WIPE (LAW) SURVEY

6.4.1 Select the appropriate type(s) of media (e.g., Masslinn®) for performing large area wipe surveys.

6.4.2 Wipe an area with the selected media, applying moderate pressure.

6.4.3 Monitor the wipe using the appropriate contamination monitoring instrument.

6.4.4 If any unexpected contamination is detected, determine removable surface contamination levels in accordance with Section 6.3.

NOTE: Unconditional release of items or material shall NOT be made using a large area wipe survey.

6.4.6 Document wipe results in accordance with Section 6.9.

6.5 FIXED SURFACE CONTAMINATION SURVEY

6.5.1 Use large surface area (100 cm^2) detectors, capable of detecting the radiation(s) of concern, to perform fixed surface contamination surveys (if available). If larger surface areas (>100 cm^2) or multi-detector instruments are used, seek operational guidance from the RSO or Radiological Engineer.

6.5.2 Obtain instrument background reading, in appropriate units, for each instrument used prior to performing surveys. To maximize the detection capabilities of the instrument, perform contamination surveys in areas where the background radiation is as low as feasible.

6.5.3 Scan the surface of the item or area of interest for each potential type of radiation. For optimum detection sensitivity, use the instrument's audible response rather than observing meter fluctuations. Avoid contact of the instrument's detector with the surface being monitored.

6.5.4 If an increased count rate is observed, reposition the probe over the area of increased activity and perform a static one minute count.

6.5.5 Repeat the previous steps, as necessary, to characterize the item or area.

6.5.6 As necessary, determine the "Total" activity level in dpm by subtracting the background count rate from the fixed surface contamination count rate and dividing by the detector efficiency:

$$\text{Total activity (dpm)} = \frac{\text{Surface activity (cpm)} - \text{Background activity (cpm)}}{\text{Detector efficiency (counts/disintegration)}}$$

6.5.7 If a 100 cm^2 surface area probe is not used during the survey, correct the survey results to a 100 cm^2 surface area result as follows:

- For an area of contamination $\geq$ 100 cm^2:

  a) Determine the maximum measurement within a representative area of 100 cm^2.

  b) Correct the measurement to 100 cm^2 by multiplying by the appropriate correction factor: 6.5 (for the standard 15.5 cm^2 GM pancake probe).

  c) Record as dpm/100 cm^2.

NOTE: If using a probe other than the standard 15.5 cm^2 GM pancake probe, determine the appropriate correction by dividing 100 by the effective area of the probe.

- For an area of contamination < 100 cm^2 but > the area of the probe:

  a) Determine the maximum measurement within the contaminated area.

  b) Record as dpm/probe area and indicate the area of contamination (i.e., 700 dpm/probe over 45 cm^2).

- For an area of contamination ≤ the area of the probe:

  a) Determine the measurement.

  b) Record as dpm over probe area (i.e., 700 dpm/15.5 cm^2).

6.5.8 To obtain fixed surface activity levels, subtract the removable surface activity (dpm/100 cm^2) from the total surface activity (dpm/100 cm^2).

6.5.9 Record total surface activity in units of dpm/100 cm^2 alpha or beta.

6.5.10 Document survey results in accordance with Section 6.9.

6.6 VOLUMETRIC SAMPLING

6.6.1 Perform volumetric sampling to determine activity levels when there is a potential for contamination to be present under dirty or painted surfaces, or absorbed in insulating materials.

6.6.2 Collect volumetric samples using appropriate methods to remove the surface materials (chemical or mechanical striping). Remove a sufficient amount of material to meet the laboratories analytical requirements. Contact the RSO or Radiological Engineer for additional guidance, as necessary.

6.6.3 Accurately measure the area from which the sample is obtained. Determine the number of square centimeters sampled. Based on laboratory analysis, calculate the activity and report in units of dpm/100 cm^2 alpha or beta.

6.6.4 Volumetric samples obtained to quantify the activity of soil or other similar media shall be determined by project procedures, protocols, or by the RSO. To the extent possible, ensure that the media being sampled is homogeneously mixed prior to loading into the sampling container.

6.6.5 Document survey results in accordance with Section 6.9 and Attachment 5.

NOTE: Standard radiological protection practices shall be followed when sampling known or suspected contaminated materials. Care must be taken to ensure that the external surfaces of the sampling containers are free of radiological and other contaminates.

6.7 UNCONDITIONAL RELEASE SURVEYS

6.7.1 Perform both a removable and fixed surface contamination survey on items requiring unconditional release, in accordance with Sections 6.3 and 6.4.

NOTE: Isotopic identification must be performed to determine free release criteria.

6.7.2 Compare the survey results with the applicable regulatory release limits or contractual release limits. If the survey results are greater than the release limits, DO NOT release the item.

6.7.4 Document survey results in accordance with Section 6.9.

6.8 PERSONNEL MONITORING

6.8.1 Personnel shall perform a whole-body frisk when exiting a Contamination or Airborne Radiological Area, and as directed by the RWP and/or the RSO, in accordance with Attachment 6 or as directed by the posted RWP.

6.8.2 Inform individuals to notify the HPT or RSO if the instrument reading is greater than background and/or the instrument alarms.

6.9 RADIOLOGICAL SURVEY DOCUMENTATION

6.9.1 Document all radiological surveys (except airborne radiological surveys and personnel frisking) in accordance with this procedure, using standard radiological survey forms (Attachments 1, 2, and 3).

NOTE: Radiological Survey Maps are not required for every survey, but should be used to add clarity to a survey or help record exact locations where surveys are performed.

6.9.2 Assign a unique survey number to each survey performed. If a site-specific numbering system is not used, use the following format, YY-MMDD-XX where:

YY = Last two digits of the current year

MM = The numerical equivalent of the current month (i.e., April = 04)

DD = The day of the month (i.e., 04, 15, 28)

XX = Sequential survey number (i.e., 01, 02, 03, etc.)

6.9.3 Document all radiological surveys with sufficient information and clarity to provide a clear understand of the scope, contents, and results of the survey.

6.9.4 Maintain a survey log (database) to document all radiological surveys. At a minimum, the log shall contain:

- Survey Number.
- Location of survey.
- Date and time of survey.
- Purpose of survey.
- Name of individual(s) performing the survey.

6.9.5 Enter the following information on all Radiological Survey Form(s) used:

- Survey number.
- Survey location. Be as specific as possible. Use building and room numbers if applicable.
- Requester's name. If the survey is in support of HP routines, write 'N/A' in the space.
- Date and time that the survey was begun.
- Purpose of the survey. If the survey is in support of HP routines, list the routine survey being performed.
- RWP number, if used.
- Model, probe type(s), and serial number(s) for the instrument(s) used in the performance of any survey.
- Any applicable remarks in the appropriate section on the Radiological Survey Form or the Radiological Survey Remarks sheet (Attachment 3).

NOTE: Count lab instrument information need not be included provided the lab report of the counting data is attached.

6.9.6 For radiation surveys, enter the following information on the Radiological Survey Form, if a Radiological Survey Map is not used:

- A unique number used to identify each item, if multiple items are surveyed.
- The measured dose rate. Units are assumed to be mrem/hr for gamma dose rate surveys, unless otherwise noted. For beta dose rate surveys, the units shall be listed as mrad/hr.
- Any specific distance (not already mentioned in this procedure) at which the measurement was taken.

6.9.7 For contamination surveys, enter the following information on the Radiological Survey Form(s):

- A unique number used to identify each item, if multiple items are surveyed.
- Item(s) description and location.
- Radionuclide of concern, if known, and the instrument's efficiency.
- The resultant cpm for each smear, background count rate, corrected dpm/100 cm^2 value, and indicate whether the results are for total, removable or fixed contamination.
- Count lab results of removable contamination levels in units of dpm per 100 cm^2 (or indicate other appropriate area).

6.9.8 Use the following symbols and descriptors to present information on the Radiological Survey Map, as necessary:

- Written number (e.g., 2.5) indicates a general area dose rate reading in mrem/hr. If the survey is <u>not</u> for gamma/photon radiation, indicate the type of radiation next to the measurement.
- Written number with asterisk beside it (e.g., 1.5 *) indicates contact dose rate reading in mrem/hr. If the survey is not for gamma/photon, indicate the type of radiation next to the measurement.
- Number in circle (e.g., ①) indicates smear number and location taken. Removable surface activity shall be recorded on the Radiological Survey Form.

- Written number with pound sign beside it (e.g., 1 #) indicates direct frisk reading in dpm/100 cm^2. Total/fixed surface activity shall be recorded on the Radiological Survey Form.

- Number in triangle (e.g., △1) indicates volumetric sample and location taken.

- Number beside LAW (e.g., LAW-2) indicates large area wipe number and location taken. LAW activity shall be recorded on the Radiological Survey Form.

NOTE: Additional symbols may be utilized by the surveyor provided they are defined in the comment section of the survey form.

6.9.9 If using a Radiological Survey Map:

- Illustrate the item or area surveyed. Be as detailed as necessary.

- Indicate the location of step-off pads used by illustrating a small rectangle with the letters 'SOP' written inside the rectangle.

6.9.10 Use the Radiological Survey Form Continuation sheet (Attachment 4) as necessary to document survey information. Do NOT use blank paper to record radiological survey results or information.

6.9.11 To complete survey documentation:

- Print name and sign the Radiological Survey Form in the spaces provided.

- Number all pages in sequential order and ensure that the survey number is on each page.

- Attach all survey documentation and transmit to the RSO (or designee) for review and storage.

7.0 QUALITY ASSURANCE

7.1 Documents generated during the performance of this procedure shall be audited in accordance with Reference 3.4.

RADIOLOGICAL SURVEY FORM

Survey Number: _____ Page _____ of _____

Location	Requester	Date	Time
Purpose			RWP #

Instrument and Probe Type and Serial Number		Surveyor(s) Printed Name	Surveyor(s) Signature

#	ITEM DESCRIPTION/LOCATION	BETA-GAMMA ACTIVITY Counting Data Attached ☐Yes ☐No % Eff._____ /Radionuclide _____				ALPHA ACTIVITY Counting Data Attached ☐Yes ☐No % Eff._____ /Radionuclide _____				RADIATION SURVEY	
		cpm	Bkg. cpm	dpm / 100 cm² (1)	T/R/F(2)	cpm	Bkg. cpm	dpm / 100 cm² (1)	T/R/F(2)	mrem/hr (3)	Distance

(1) If area other than 100 cm², record as dpm/probe, or dpm/LAW. (2) Total/Removable/Fixed. (3) Indicate type, if other than gamma (i.e., n or β).

Remarks:

Reviewed by: Date:

Form RPO-301-01-1

RADIOLOGICAL SURVEY MAP

Survey Number: _____ Page _____ of _____

O indicates smear location * indicates contact radiation reading △ indicates volumetric sample location LAW indicates large area wipe

All radiation readings are gamma in mrem/h unless noted.

Form RPO-301-02-1

RADIOLOGICAL SURVEY REMARKS

Survey Number: _____ Page _____ of _____

Remarks:

Form RPO-301-03-1

PROCEDURE NO: RP0-301	REVISION NO: 1	ATTACHMENT 3 PAGE NO: 1 OF 1

RADIOLOGICAL SURVEY FORM CONTINUATION

Survey Number: _____ Page ____ of ____

#	Item Description/Location	BETA-GAMMA ACTIVITY				ALPHA ACTIVITY				RADIATION SURVEY	
		cpm	Bkg. cpm	$\frac{dpm}{100\ cm^2}$ (1)	T/R/F(2)	cpm	Bkg. cpm	$\frac{dpm}{100\ cm^2}$ (1)	T/R/F(2)	mrem/hr (3)	Distance

Form RPO-301-04-1

RADIOCHEMISTRY ANALYTICAL RESULTS

Page ____ of ____

Sample Number	Sample Matrix [1]	Sample Size / Area	Activity [2] U-235	Activity [2] Total U	Activity [2] Co-60	Activity [2] Cs-137	Activity [2] Other	Total Activity [3] dpm/100 cm^2 α ß

Form RPO-301-05-1

Matrix [1]: S - Soil, P - Paint, I – Insulation, L- Liquid, D - Dust, C - Concrete, O - Other

Activity [2]: All activity to be reported in pico-curies per gram (pCi/g)

Total Activity [3]: For surface samples activity is reported in dpm/100 cm^2. Circle Alpha or Beta

Comments: _____

_____

Prepared By: _____ Date: _____

Reviewed By: _____ Date: _____

Personnel Frisking Instructions

Personnel monitoring with portable frisking instruments shall perform the following:

1. Visually inspect frisker to verify that the:
   - Instrument is on
   - Instrument is on lowest scale
   - Audio output can be heard
2. Prior to picking up probe, frisk one hand by moving hand across active area of probe. The detector (frisking probe) shall be held within ½ inch of the skin or clothing and moved at a rate of no faster than 2 inches per minute. If alpha contamination is suspected or present, the detector shall be held as close as possible (without touching) to the surface and moved at a rate of no faster that 1 inch per second.
3. If the instrument's audible output increases, hold the probe over the area for 10-15 seconds to provide adequate time for instrument response.
4. After frisking the first hand, frisk the other hand.
5. If the frisk of the second hand does not indicate the presence of contamination, complete a whole body frisk as indicated below:
   - Head and face - pause at mouth and nose
   - Neck and shoulders
   - Arms
   - Chest and abdomen
   - Back, hips, and seat of pants
   - Legs
   - Shoe tops and sides
   - Bottoms of shoes
   - Personal equipment
6. Return probe to holder and leave the area. Be sure to position the probe so that the next person can frisk one hand without touching the probe.
7. Notify Health Physics personnel or the RSO of any instrument reading above background or if the instrument alarms, and remain at the frisking station unless directed otherwise.

MACTEC, Inc.	Procedure No: RPO-303 Revision No: 1 Effective Date: 9-1-02

AREA AIR SAMPLING

Authored By: _____ 5-30-02
Michael P. McDonald
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Date

Reviewed By: _____ 8/16/02
Jeffrey W. Lively
Health Physicist
Date

Approved By: _____ CHP 8/16/02
Steven D. Rima
Radiological Engineering Manager
Date

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AREA AIR SAMPLING

1.0 PURPOSE

1.1 The purpose of this procedure is to provide instruction for the sampling of airborne radioactive materials in the workplace.

2.0 APPLICABILITY

2.1 This procedure applies to MACTEC, Inc. management, supervisors, individuals and contractors that perform airborne radioactive material sampling and/or operate airborne radioactive material sampling or monitoring equipment.

3.0 REFERENCES

3.1 10 CFR 20, "Standards for Protection Against Radiation."

3.2 10 CFR 835, "Occupational Radiation Protection."

3.3 RPO-101, "Radiation Protection Program Overview."

3.4 RPO-209, "Operation and Calibration of Lapel Air Samplers."

3.5 NRC Regulatory Guide 8.25, "Air Sampling in the Workplace."

4.0 DEFINITIONS AND ABBREVIATIONS

4.1 See RPO Glossary.

5.0 GENERAL

5.1 EQUIPMENT

5.1.1 Various air sampling equipment (includes but is not limited to, general area high volume and low volume air samplers, lapel air samplers, continuous air monitors, etc.)

5.1.2 Laboratory counting equipment.

5.1.3 Various sample filter media.

5.2 SAFETY CONSIDERATIONS

Not applicable

5.3 RESPONSIBILITIES

5.3.1 RSO (or designee):

- Implement this procedure.
- Ensure individuals are qualified to perform this procedure.
- Ensure that all air sampling documentation is reviewed in a timely manner.
- Determine the air sampling instrumentation to be utilized to perform airborne radiological surveys, if necessary.

5.3.2 Health Physics Staff:

- Comply with this procedure, exercising appropriate contamination control techniques in the performance of radiological surveys and while handling sample media, and complying with entry requirements for the areas to be surveyed.
- Ensure that individuals have completed, and are current in, Radiation Worker Training qualifications prior to issuance of a lapel air sampler.
- Operate airborne radiological survey instrumentation in accordance with approved operating procedures.

5.4 PREREQUISITES

Not applicable

5.5 RECORDS

5.5.1 Airborne radiological survey documents and/or records are generated during the performance of this procedure and shall be stored, arranged, indexed, retained, retrieved, and disposed of in accordance with all applicable NRC document regulations and requirements.

5.6 PRECAUTIONS AND LIMITATIONS

5.6.1 The presence of radon daughters, which are naturally occurring, can give a false indication of high airborne radioactivity.

5.6.2 If sample lines are used for collecting airborne particulates, the lines shall be as short as possible and shall be made of a material that is not subject to significant static charge effects.

5.7 REVISIONS

5.7.1 This procedure shall be reviewed at least every two years, with documentation to support the completion of such review.

5.8 OTHER

Not applicable

5.9 ATTACHMENTS

Attachment 1 - Airborne Radiological Survey

Attachment 2 - CAM Inspection

Attachment 3 - Sample Activity Calculation Examples

6.0 PROCEDURE

6.1 GENERAL AREA AIR SAMPLING

6.1.1 Perform workplace air sampling for any of the following conditions:

- When work activities or radiological conditions could result in an intake to occupational workers in excess of 10% of the regulatory limit.
- When work activities or condition of facilities could result in potential exposure to members of the general public in excess of the limit specified in regulatory requirements (10 CFR 20.1301 and 1302).
- If a potential pathway exist for unmonitored discharges from radiologically controlled areas to the environment in excess of the regulatory limits (10 CFR 20.1302 (b)(2)(i)).
- When workplace conditions affect the air flow for the area, potentially causing airborne radiological concerns.
- When respiratory protection equipment is used for the purpose of limiting intakes of radioactive material.
- When performing work in an existing Airborne Radioactivity Area, if applicable.
- As required by the RWP and/or RSO.

6.1.2 Determine airborne radioactivity levels using either low volume air samplers(<150 LPM), high volume air samplers (>150 LPM), or continuous air monitors.

- High volume air samplers are generally not designed to operate over an extended period of time.
- The more restrictive the DAC for a radionuclide, the more difficult it is to measure the concentration for that DAC. Longer counting times, sampling times, and larger volumes of air are necessary to provide sufficient data to analyze for these radionuclides.

6.1.3 Protect sampling equipment from becoming externally contaminated to the extent possible (i.e., placing plastic between a sampling pump and contaminated surface).

6.2 CONTINUOUS AIR MONITORING

6.2.1 Use continuous air monitoring (CAM) for any of the following conditions:

- Airborne concentrations are likely to exceed 0.1 DAC averaged over 40 hours or longer.
- There is a potential for intakes to exceed 40 DAC-hours in one day.

6.2.2 Operate the CAM in accordance with the manufacture's operating instructions and recommendations, and in accordance with applicable RPOs.

6.2.3 In areas where there is a potential for intakes to exceed 40 DAC-hours in one week, analyze CAM filter media on a daily basis. CAM units with installed detector(s) and moving filter media are exempt from filter media daily analysis.

6.2.4 Inspect CAMs on a daily basis (excluding non-work days), when in operation. The "CAM Inspection" sheet (Attachment 2) shall be completed for each inspection performed.

6.2.5 Collect CAM system sample filters at least weekly, when in operation. A more frequent collection may be required if filter loading significantly reduces sample flow rate. CAM units that have a moving filter media need not be collected weekly, but shall be collected when the filter media is spent.

- Filter media <u>shall</u> be changed if filter loading reduces the sample flow rate by > 50% of the initial flow rate, filter media becomes wet, or if the filter media is found to be damaged.

6.2.6 Remove filter media from the CAM and analyze the filter media in accordance with Section 6.6.

6.2.7 Perform weekly source checks on CAMS (if applicable) with automatic alarms systems to verify proper operation.

6.3 LOW VOLUME/HIGH VOLUME AIR SAMPLING

6.3.1 Place the recommended sample filter media on the appropriate filter holder of the sampler.

6.3.2 Place the air sampler (if not permanently installed) in the desired location to obtain the best representation of air the worker will be breathing during the job.

- Contact the RSO or Radiological Engineer for guidance on determining where air samplers/monitors are to be placed.

6.3.3 Operate the air sampler equipment in accordance with the manufacture's operating instructions and recommendations, and in accordance with applicable RPOs.

- Check for air in-leakage into sampling lines by momentarily blocking the sampler inlet immediately after starting the unit. Flow indication should drop towards "zero" flow rate. If flow does not drop, investigate for source of air in-leakage and correct. If air in-leakage can not be corrected, tag the unit out of service and immediately inform the RSO.

6.3.4 Collect required airborne radioactive sample (contact the RSO for guidance, as necessary).

6.3.5 Remove the filter media from the filter holder and analyze the filter media in accordance with Section 6.6.

CAUTION: While handling used filter media, take care not to disturb the radioactive material collected on the media. Inappropriate handling will result in inaccurate sample results and the potential or actual spread of radioactive contamination.

6.4 STACK MONITORING

6.4.1 Exhaust stacks from contaminated areas shall be monitored whenever the exhaust system is in operation.

6.4.2 Isokinetic sampling rates shall be calculated for each stack sampled if not automatically performed by the unit.

6.4.3 Stack sampler filter media shall be changed-out on a weekly basis and sample activity calculated in accordance with Section 6.6

6.4.4 The RSO shall be notified of any calculated stack activity exceed 10% of the isotope appropriate value specified in 10 CFR 20 Appendix B table 2 column 1 or the appropriate regulatory guidance.

6.5 LAPEL AIR SAMPLING

6.5.1 Lapel air samplers shall be used when:

- Airborne concentrations exceed, or have the potential to exceed 10% of DAC and the occupational worker is subject to >100 mrem (TEDE) for the year.
- Working in an environment where the potential for an intake of four (4) DAC-hours could be received in one 40 hour work week.
- Individuals are wearing respiratory protection used for the purpose of limiting intakes of radioactive material.
- Required by the RWP.

6.5.2 Instruct the wearer to operate the sampler only during the time the wearer is in the work area.

NOTE: Multiple entries may be made during a shift without changing the filter media. Perform a contamination survey of the lapel sampler head and filter prior to removing from the airborne or contamination area.

6.5.3 If anti-contamination clothing is worn, locate the pump under the clothing (if possible) to protect it from external contamination, with the filter head protruding outside in the lapel. If work conditions are such that the HPT determines it is not feasible to physically protect the pump from external contamination, then the pump must be surveyed and proven radiologically clean externally before leaving the work area.

6.5.4 Ensure lapel air sampler heads are not covered by any protective equipment or clothing (i.e., respirators, bubble hoods, coveralls, etc) when in use.

6.5.5 Operate the lapel air sampler in accordance with Reference 3.4.

6.5.6 Complete the general information section of the Airborne Radiological Survey Form, as well as parts of the lapel sampler section that are applicable to the beginning of the job.

6.5.7 Record sample start and stop times each time they occur during the work for each sample.

6.5.8 When the wearer is finished using the lapel air sampler, remove the filter media from the filter holder and analyze the filter media in accordance with Section 6.6.

CAUTION: While handling used filter media, take care not to disturb the radioactive material collected on the media. Inappropriate handling will result in inaccurate sample results and the potential or actual spread of radioactive contamination.

6.5.9 Count lapel air sampler media the following workday. If sample activity indicates a potential intake of ≥ 10 DAC-hours, restrict the individual from work involving potential airborne exposure.

NOTE: Notify the RSO of any individual whose lapel sample indicates an intake of ≥ 1 DAC-hour after the initial sample analysis.

6.5.10 When calculating DAC-hours for users of respiratory protection equipment, obtain RSO approval to apply respiratory protection factors.

- With approval, DAC-hours calculated shall be reduced by the assigned respiratory protection factor (10 CFR 20 Appendix A).

6.5.11 A record of the individual's intake and accumulated DAC hours shall be maintained. DAC hour calculations and resulting exposures shall be included in the individual's dose history file, if applicable.

6.6 PREPARING, TRANSPORTING AND COUNTING SAMPLE(S)

6.6.1 Remove filter media from filter holder, if not previously done.

NOTE: Use tweezers or equivalent apparatus to remove the filter media from the air sampler. If removing sample with hands, use gloves for removal. Change gloves as needed to avoid cross contamination of filter media.

6.6.2 Place filter media in an air sample filter media collection container (i.e., coin envelop, counting planchet, etc.)

NOTE: Handle filter media and containers with care to reduce potential loss of activity from the media.

NOTE: If activity levels in excess of 10,000 cpm are suspect or identified, field count the filter media and consult with the counting laboratory personnel or the RSO on methods for analyzing the filter media. Do not bring these samples into the counting laboratory without permission. This does not apply to samples in closed containers prepared for analysis by liquid scintillation counting (LSC).

6.6.3 Record the following information on the air sample filter media collection container: air sample number, sampler start time and date, stop time and date, beginning and ending flow rate, total volume of air sampled, lapel sampler information and HP's initials.

NOTE: If a copy of the Airborne Radiological Survey form is provided to the count lab with all the information listed above, the filter media container need only have the sample number and HPT's initials.

6.6.4 Record applicable information in the appropriate sections of the Airborne Radiological Survey form (Attachment 1) and/or the CAM Inspection form (Attachment 2), as applicable.

6.6.5 Deliver sample(s) to count lab as soon as practicable, if used, but at least within one working day.

NOTE: Results of air samples taken which could provide indications of personnel intakes should be available no later than the beginning of the next working day. If positive results are obtained, but radon daughters are suspected, an allowance for radon decay may be assumed (i.e., three day decay time for thoron daughters).

6.6.6 Count samples within three working days of collection.

6.6.7 Perform sample analysis for all suspect isotopes. Work area characterizations, past radiological surveys, known work area profiles, and/or as determined by the RSO may be used to identify suspect isotopes.

6.6.8 Samples shall be analyzed for a sufficient length of time such that the calculated Minimum Detectable Concentration (MDC) value is less than or equal to one-tenth (1/10) the isotope specific concentrations identified in the applicable regulatory guidance.

- MDC values shall be calculated and documented for each counting instrument.

6.6.9 If the analyzed sample activity is less than the counting systems MDA value, then the counting systems MDA value will be utilized to calculate the sample's activity. Contact the RSO for guidance, as necessary.

6.6.10 Calculate sample activity manually or through the use of computer programs.

6.6.11 Retain all samples submitted for laboratory analysis until disposal is authorized by the RSO.

7.0 QUALITY ASSURANCE

7.1 The RSO or Radiological Engineer shall review lapel air sample results as soon as practical, but at least daily when lapel samples are obtained.

7.2 The RSO shall annually review the past year's air sampling program and components to determine:

- Whether the measurements were accurate and reliable.
- Whether changes should be made to improve the measurements.
- Whether the air sampling was appropriate for the intended purpose.
- Whether the air sampler/monitor was located properly during sampling.

7.3 Computer programs used to calculate general area airborne activity and DAC hours shall be QA checked prior to initial use.

- This check will involve inputting known values and verifying that the computer generated results match the results that are independently calculated.
- If computer generated results do not agree with the independently calculated results the RSO shall be notified, and all sample calculations shall be considered invalid until the source of the discrepancy is identified and corrected.

AIRBORNE RADIOLOGICAL SURVEY

Page: _____ of _____

Building/Location: _____ Requester: _____

Purpose of Survey: _____ Radionuclide(s): _____

RWP #: _____ Date of Survey: _____

Sample Type(s): ☐ Lapel ☐ General Area

Sample #	Remarks	ALPHA ACTIVITY Instrument Eff.: _____% MDC: _____				BETA-GAMMA ACTIVITY Instrument Eff.: _____% MDC: _____			
		cpm	Bkg. cpm	Sample dpm	Activity	cpm	Bkg. cpm	Sample dpm	Activity

Remarks:

HPT Signature: _____ Date: _____

RSO Signature: _____ Date: _____

Form RPO-303-01-1

LOW VOLUME/HIGH VOLUME AIR SAMPLING

Air Sample Number: _____ Sampler Model: _____ Sampler Serial #: _____ Cal Due Date: _____

Sample Location: _____

Respirator Type: ☐ Air Purifying ☐ Air Line ☐ SCBA ☐ None ☐ Other: _____

☐ Low Volume Sampler (Long Duration Sampler) ☐ High Volume Sampler (Short Duration Sampler)

Sample Start Date/Time: _____ Sample End Date/Time: _____ Total Sampling Time (Minutes): _____

Beginning Air Flow: _____ Ending Flow: _____ Total Volume Sampled: _____ ☐LPM ☐ CFM ☐CCM

Remarks:

LOW VOLUME/HIGH VOLUME AIR SAMPLING

Air Sample Number: _____ Sampler Model: _____ Sampler Serial #: _____ Cal Due Date: _____

Sample Location: _____

Respirator Type: ☐ Air Purifying ☐ Air Line ☐ SCBA ☐ None ☐ Other: _____

☐ Low Volume Sampler (Long Duration Sampler) ☐ High Volume Sampler (Short Duration Sampler)

Sample Start Date/Time: _____ Sample End Date/Time: _____ Total Sampling Time (Minutes): _____

Beginning Air Flow: _____ Ending Flow: _____ Total Volume Sampled: _____ ☐LPM ☐ CFM ☐CCM

Remarks:

Form RPO-303-01-1

LAPEL SAMPLING

Air Sample Number: _____ Sampler Model: _____ **NOTE:** 1 cc = 1 ml, 1000 ml=1 liter

Wearer's Name: _____ S.S.#: _____ RWP #: _____

Sampler Serial #: _____ Respirator Type: ☐ Air Purifying ☐ Air Line ☐ SCBA ☐ None ☐ Other: _____

	RUN 1	RUN 2	RUN 3	RUN 4	RUN 5	RUN 6
Sampler Start Time	____ : ____	____ : ____	____ : ____	____ : ____	____ : ____	____ : ____
Sampler End Time	____ : ____	____ : ____	____ : ____	____ : ____	____ : ____	____ : ____
Sampler Air Volume Register Start Number	_____	_____	_____	_____	_____	_____
Sampler Air Volume Register End Number	_____	_____	_____	_____	_____	_____
Total Sampler Air Volume Register Number	_____	_____	_____	_____	_____	_____
Cumulative Sample Air Volume Register Number	_____	_____	_____	_____	_____	_____

Total Run Time: _____ (minutes) Beginning Flow Rate: _____ (LPM) Ending Flow Rate: _____ (LPM) Average Flow Rate: _____ (LPM)

Total Run Time X Average Flow Rate = Total Volume: _____ liters Sampler Air Volume Register Number Conversion Factor: _____ (ml/digit) Cumulative Sample Air Volume Register Number X Conversion Factor (ml/digit) X 1000 = Total Volume: _____ liters

Remarks:

Form RPO-303-01-1

CAM INSPECTION

Model: _____ Serial Number: _____

Date / Time	CAM #	Location	Flow Rate	Filter Cond. SAT/UNSAT	Filter Changed Date	HPT Int.

HPT Signature: _____ Date: _____

RSO Signature: _____ Date: _____

Form RPO-303-02-1

SAMPLE ACTIVITY CALCULATIONS EXAMPLES

1) Sample volume:
   (Sample Rate [LPM]) x (# minutes sampled) x (1000 ml/L) = Sample volume in ml's.

2) DAC-hour calculation from Lapel Air Sampler:

   $$\text{DAC-hours} = \text{Hours Worked} \times \frac{\text{Sample Activity (uCi/ml)}}{\text{DAC value (uCi/ml)}}$$

3) Air Activity concentration from gamma spectroscopy results:

   $$\text{Air Activity} = \frac{\text{Sample Activity (pCi)} \times 1\text{x } 10^{-6}\text{ uCi/pCi}}{\text{Sample Volume (ml)}} = \text{uCi/ml}$$

4) Air Activity concentration from gross alpha/beta counting:

   $$\text{Air Activity Concentration} = \frac{\text{Sample Activity (dpm)} \times 4.5 \times 10^{-7}\text{ uCi/dpm}}{\text{Sample Volume (ml)}} = \text{uCi/ml}$$

5) Air Activity from Victoreen Model 08-430 Personnel Air Monitor:

   Sample Volume = Digit Stop* - Digit Start X Conversion Factor (ml/digit)

   * Victoreen Model 08-430 has a mechanical digital readout with a maximum reading of 99,999. When the sampler continues to operate past 99,999 the digit counter resets to 0. For sample volume calculations a one must be added as the first digit to the digit stop total when the sampler digit readout resets to zero during operation.

   Example
   Digit start: 95,000
   Digit stop: 01000
   Sample Volume = (101000 - 95,000) x (Conversion Factor [ml/digit])

   $$\text{Air Activity Concentration} = \frac{\text{Net dpm} \times 4.5 \times 10^{-7}\text{ uCi/dpm}}{\text{Sample volume (ml)}} = \text{uCi/ml}$$

   $$\text{DAC-hours} = \text{Hours Worked} \times \frac{\text{Sample Activity (uCi/ml)}}{\text{DAC value (uCi/ml)}}$$

MACTEC, Inc.	Procedure No: RPO-401 Revision No: 1 Effective Date: 9-1-02

RADIATION WORK PERMITS

Authored By: _____ 5-30-02
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Date

Reviewed By: _____ 8/16/02
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Health Physicist
Date

Approved By: _____ 8/16/02
Steven D. Rima
Radiological Engineering Manager
Date

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RADIATION WORK PERMITS

1.0 PURPOSE

1.1 The purpose of this procedure is to provide instruction in the preparation, distribution, utilization, administration, revision, and termination of Radiation Work Permits (RWPs).

2.0 APPLICABILITY

2.1 This procedure applies to MACTEC, Inc. management, supervisors, individuals and contractors that prepare, review, approve, distribute, utilize, and/or cancel RWPs, where their work assignment is controlled by MACTEC, Inc.

2.2 This procedure applies to radiological work activities that have the potential for personnel exposure and/or the spread of radioactive contamination to personnel, the site, or the environment.

3.0 REFERENCES

3.1 RPO-101, "Radiation Protection Program Overview."

3.2 10 CFR 20, "Standards for Protection Against Radiation."

3.3 10 CFR 835, "Occupational Radiation Protection."

4.0 DEFINITIONS AND ABBREVIATIONS

4.1 See RPO Glossary.

5.0 GENERAL

5.1 EQUIPMENT

Not applicable

5.2 SAFETY CONSIDERATIONS

Not applicable

5.3 RESPONSIBILITIES

5.3.1 RSO (or designee):

- Implement this procedure.

- Ensure that individuals are qualified and trained to perform this procedure.
- Review and approve RWPs and revisions to RWPs.
- Review completed RWP package.
- Approve RWP Termination Packages.
- Review, on a monthly basis active RWPs.

5.3.2 Health Physics Technician:

- Comply with this procedure.
- Compose RWPs in accordance with this procedure or as required by the RSO.
- Review terminated RWPs for completeness and accuracy.

5.3.3 Radiation Workers

- Read and understand the RWP controlling the work.
- Agree to abide by the requirements of the RWP as written.
- Agree to ask questions about the RWP when the RWP is not understood.

5.4 PREREQUISITES

Not applicable

5.5 RECORDS

5.5.1 Records that may be generated during the performance of this procedure include the following:

- Radiation Work Permit
- RWP Request
- RWP Log
- Radiation Work Permit Sign-In Sheet
- Record of pre job meetings or briefings

- Radiation and contamination surveys
- RWP Termination Checklist

5.5.2 RWP documents and/or records shall be stored, arranged, indexed, retained, retrieved, and disposed of in accordance with this procedure and all applicable NRC document regulations and requirements.

5.5.3 Records that are generated as a result of the requirements of federal regulations must be retained until NRC authorizes their disposition.

5.6 PRECAUTIONS AND LIMITATIONS

5.6.1 RWPs developed for radiological work shall be in compliance with the conditions of the applicable NRC Licenses and any other appropriate regulatory requirement that is in effect.

5.6.2 It is critical that the Health Physics Technician has a through understanding of the work activities to be performed. Failure to have a complete understanding of the work activities to be performed could result in unnecessary personnel exposure and/or the spread of radiological contamination.

5.6.3 During the job evaluation phase of writing the RWP, emphasis should be placed on determining any administrative or engineering techniques/methods to help keep personnel exposure ALARA.

5.7 REVISIONS

5.7.1 This procedure shall be reviewed at least every two years, with documentation to support the completion of such review.

5.8 OTHER

Not applicable

5.9 ATTACHMENTS

Attachment 1 - RWP Request

Attachment 2 - RWP

Attachment 3 - RWP Continuation Sheet

Attachment 4 - RWP Sign-In Sheet

Attachment 5 - RWP Termination Checklist

Attachment 6 – RWP Tracking Log Sheet

6.0 PROCEDURE

6.1 RWP INITIATION

6.1.1 The RWP process shall be initiated upon the receipt of an RWP Request (Attachment 1) or when deemed necessary by a Health Physics Technician or Health Physics staff.

6.1.2 The Health Physics Technician shall assess the radiological condition(s) of the proposed work area and complete the applicable sections of the RWP, based on:

- Information provided in the RWP Request.
- Additional information obtained from the RWP requester.
- Current radiological survey data of the proposed work area.
- Discussion with the requesting personnel and/or other Health Physics staff members.
- Related RPOs or other regulatory guidance.

6.1.3 If current radiological survey data is not available, perform pre-job radiological survey(s) of the work area in accordance with appropriate RPOs.

6.1.4 If pre-job radiological surveys cannot be performed prior to initiating work, the necessary surveys shall be performed after RWP approval and concurrent with work activities.

- Radiological hold points shall be established (on the RWP) to stop work and allow for the performance of survey activity when the area or item becomes available to survey.
- Increased HP work coverage shall be provided when performing work where a radiological survey is not practical or possible prior to work start.
- The work shall be stopped and the RWP revised if radiological conditions are significantly different then estimated.

6.1.5 Previous survey data may be used in place of a pre-job survey when either:

- Performing a survey would present an unnecessary safety hazard (e.g. confined space) or be contrary to ALARA practices, or

- The latest radiological survey performed in the area of question is less than three calendar months old AND activities performed in the area have not changed the radiological conditions since this last survey.

6.1.6 The pre-job survey shall include the following, as applicable:

- A map of the work area detailing boundaries, postings, entrance and exit points, step-off pad locations, and any other physical hazards present in the work area.

- An assessment of all radiological hazards (known and potential) associated with the work area.

6.1.7 If the potential for other hazards (e.g., physical hazards, confined spaces, etc.) are identified, contact the appropriate safety personnel for guidance to determine whether or not radiological controls will be impacted.

6.2 RWP DEVELOPMENT

6.2.1 On the RWP (Attachment 2), indicate whether this will be a job-specific or general RWP.

- A job-specific RWP is issued for performance of a specific job in a specific area where the work may affect or change the radiological conditions, as well as any work or task that does not meet the requirements for a general RWP. Job-specific RWPs are issued for the duration of the job, not to exceed a period of one month.

- A general RWP is issued for work of a routine nature, such as routine sampling, surveys, calibrations, tours, inspections, or other repetitive tasks that do not change the radiological protection requirements for a system or area and/or do not result in significant radiation exposure. General RWPs can be issued for an extended period of time, not to exceed a period of one year.

6.2.2 Enter the unique RWP number obtained from the RWP Tracking Log (Attachment 6).

- An RWP Tracking log shall be maintained for the tracking and issuance of RWP numbers and shall be controlled by the RSO.

- The numbering format shall be YY-XXX where YY = the last two digits of the current year and XXX = the sequential numbering starting with 001 (e.g. 02-010 would be the tenth RWP issued during 2002).

6.2.3 Enter the start and end dates on the RWP and the RWP Tracking Log.

6.2.4 Enter the job location on the RWP and the RWP Tracking Log.

6.2.5 Provide a describe of work on the RWP and the RWP Tracking Log.

- The work description should include enough detail to adequately explain the job and associated radiological hazards.

6.2.6 Radiological Source(s): Indicate the radiological hazards of concern for the work area by marking any appropriate box(es).

6.2.7 Airborne Radioactivity:

- Indicate the contaminates of concern and record the airborne activity concentration (μCi/ml) for each.
- If airborne radioactivity is not a concern, mark the 'N/A' box.

6.2.8 Surface Contamination:

- If contamination is not a radiological hazard for the work, mark the 'N/A' box.
- If contamination is not detected, mark the 'None Detected' box.
- If the contamination levels are unknown, mark the 'Unknown Levels' box and establish hold points, as necessary, to determine the radiological conditions.
- Enter the fixed and removable surface contamination levels for the work area and the radionuclide(s), as applicable.

NOTE: Typically, the highest removable and fixed contamination levels present in the work area should be recorded.

- If it is expected that contamination levels will change during the duration of work, mark the 'See Latest Survey' box.

6.2.9 Radiation Levels

- Enter applicable radiation levels in the space(s) provided. Clearly include the appropriate units.
- If radiation levels do not apply, record 'N/A' in the spaces provided.

6.2.10 Pre-Job Survey Information:

- Record pre-job survey number(s).
- If radiological conditions are to be determined concurrent with work activities, enter 'TBD.' A TBD notation shall be related to a radiological hold point.
- If pre-job surveys are not applicable, enter 'N/A.'

6.2.11 Protective Clothing (PCs)

- Indicate the appropriate type of PCs that are required for the work.
- Use the blank spaces as needed to specify the type of PCs or to reference a radiological hold point or a special instruction.
- If PCs are not required, mark the 'None Required' box.

6.2.12 Respiratory Protection

- Indicate the type of respiratory protection required.
- If respiratory protection is not required, mark the 'None Required' box.

6.2.13 Dosimetry

- Indicate the type(s) of dosimetry required.
- If 'Additional TLD(s)' or 'Extremity' dosimetry is needed, indicate the placement of the dosimetry, and describe the proper use and placement of multiple or self-reading dosimetry in the Special Instructions section of the RWP.
- Consult with RSO or Radiological Engineer regarding bioassay requirements, if needed.
- If bioassay sampling is required, mark the type of bioassay (pre-job, post-job, or frequency). Indicate any frequency requirements in the space provided.
- If dosimetry is not required, mark the 'None Required' box.

6.2.14 Training

- Indicate the type(s) of training required.
- Consult with the RSO or Radiological Engineer, as needed, to determine if additional training is required prior to the commencement of the work activity.

6.2.15 Monitoring:

- Indicate all appropriate requirements for monitoring radiological conditions.

6.2.16 Complete the Radiological Hold Points section of the RWP form as follows:

- List and explain any radiological hold points.

NOTE: A radiological hold point should include the criteria that must be met, or action the must be taken, to satisfy the hold point prior to continuing with subsequent steps in the planned activity.

NOTE: The following activities and potential conditions should be considered when determining the need for radiological hold points.

- Action needed to assess changing radiological conditions and ensure implementation of required controls.
- Potential for radiation doses in excess of the applicable limit.
- Potential for elevated airborne radioactivity levels.
- Potential for elevated or changing removable surface contamination levels on accessible surfaces.
- Potential for unplanned or uncontrolled release of radioactive material to the environment.

6.2.17 Complete the Special Instructions section of the RWP form as follows:

- Present instructions in short, easy-to-follow steps.
- Start each step with an action verb; avoid passive statements. For example, write, "Secure the area" instead of "The area should be secured."
- Include only one action per step, unless multiple actions are performed simultaneously within a step.
- If actions need to be performed sequentially, label steps with numbers or letters to indicate the order in which steps are to be performed.
- Use "if" or "when" to introduce a step in which certain conditions must be met before the step is performed.
- Be specific and detailed enough so that the worker can perform the task(s) without direct supervision.

- If practical, use sketches or photographs to clarify topics, such as work area boundaries, radiological hazards, worker positions, and access controls.
- If practical, make checklists for critical tasks.

6.2.18 Use an RWP Continuation Sheet (Attachment 3) if more space is needed to list radiological hold points or special instructions. Indicate that an RWP Continuation Sheet is used by marking the 'Continuation Sheet(s) Attached' box.

6.2.19 Authorized Personnel

- Only personnel identified on the RWP Request form and/or approved by health physics shall be allowed to perform work activities under the approved RWP.
- The sign-in sheet shall be posted with the job site RWP.
- Prior to entry into the work area to perform tasks under the RWP, individuals shall review the requirements of the RWP, print their name on the RWP Sign In Sheet, and record their initials in the appropriate spot.

6.2.20 RWP Sign In/Out:

- Indicate the RWP sign in/out requirements.

6.2.21 Personnel Contamination Frisk:

- Indicate the type of frisk required upon exiting the work area.
- If needed, provide additional instruction in the appropriate space.
- If frisking is not required, mark the 'None' box.

6.2.22 Sign and date the RWP form.

6.2.23 Generate an RWP Sign-In Sheet.

6.2.24 Retain the RWP Request (if one was generated) for inclusion in the original RWP package.

6.2.25 Route the RWP package for review and approval to the RSO or designee.

6.2.26 After RWP approval, ensure:

- The RWP number has been recorded on each page of the RWP and the RWP Sign-In Sheet.

- All pages of the RWP package are numbered.

6.2.27 Make a copy of the RWP and store the original RWP, along with the RWP Request, in the Active RWP Folder.

6.3 RWP ISSUANCE

6.3.1 Insert a copy of the Radiation Work Permit into the RWP Work Package Folder.

- This copy is considered the work-area copy and shall be posted at the work area while work is in progress.

6.3.2 Insert a copy of the Radiation Work Permit Sign-in Sheet (Attachment 4) into the RWP Work Package Folder.

6.3.3 Insert any additional information into the RWP Work Package Folder deemed necessary to convey radiological information to the work force. (e.g. radiological survey maps, radiological survey results, B-Z sign-in forms, diagrams or drawings, etc.)

6.3.4 Issue the RWP Work Package Folder to the individual requesting the RWP.

6.3.5 Review radiological protection requirements, radiological hold points, and special instructions with the individual, as required. If survey maps are supplied with the RWP Package Folder, instruct the individual to post the maps at the entrance to the area.

6.3.6 If a pre-job meeting is required, assemble all authorized individuals and conduct the briefing. Individuals who do not receive the briefing will not be allowed to perform work under the RWP until properly briefed.

6.4 RWP TERMINATION

6.4.1 Remove the posted work area copy RWP from the work area.

6.4.2 Remove the original RWP from the Active RWP Folder.

6.4.3 Cancel the original RWP by signing and dating the RWP in the Termination Signature section of the RWP.

6.4.4 Retrieve or obtain the following items for inclusion in the RWP Termination Packet:

- The original terminated RWP.

- Any documentation associated with the RWP (e.g., RWP Sign-In Sheets, RWP ALARA Review attendance records, RWP Request form, etc.)
- An RWP Termination Checklist (Attachment 5).

6.4.5 Enter the RWP number on the RWP Termination Checklist.

6.4.6 Complete the Post-Job Conditions/Analysis section of the RWP Termination Checklist as follows:

- Indicate the reason for termination.
- Indicate whether Post-Job radiological surveys were performed to support this RWP. If yes, list the corresponding radiological survey numbers.
- Indicate whether other surveys were performed to support this RWP. If yes, list corresponding survey numbers.

6.4.7 Complete the Termination Packet section of the RWP Termination Checklist as follows:

- Indicate if the RWP Request is in the Termination Packet by marking the appropriate box.
- Indicate if all pages of the original RWP are in the Termination Packet by marking the appropriate box.
- Indicate if all RWP Sign-In Sheets are in the Termination Packet by marking the appropriate box.
- Indicate if any pre-job briefing and associated Attendance Records are in the Termination Packet by marking the appropriate box.
- Indicate if data from supplemental self-reading dosimeters (SRD) or Breathing Zone sampling is provided by marking the appropriate box. If supplemental sign-in sheets were not required, mark the 'N/A' box.
- List any additional documentation that is included in the packet.
- Indicate that the RWP Tracking Log has been updated.

6.4.8 Destroy the work area copy RWP.

6.4.9 Contact the RSO if any items known to have been completed are marked as not being included (i.e., are missing). The Original RWP and all RWP Sign-in Sheets are the minimum records required for each RWP Termination Package.

6.4.10 In the Verification/Approval section of the RWP Termination Checklist, the individual completing the Termination Package shall print his/her name on the line provided, then sign and date the form.

6.4.11 Place all items marked as being attached in the Termination Packet folder, including the RWP Termination Checklist.

6.4.12 Route the Termination Package to the RSO for review and approval.

6.4.13 The RSO (or designee) shall:

- Review the RWP package for completeness.
- Obtain corrections to the information, as applicable.
- Sign and date the RWP Termination Checklist.
- Route the complete RWP Termination Package for storage.

7.0 QUALITY ASSURANCE

7.1 The RSO or Radiological Engineer shall review active RWPs on a monthly basis.

7.2 The RWP program shall be evaluated as part of the annual audit of the health physics program.

RADIATION WORK PERMIT REQUEST

(1) WORK LOCATION	This section to be completed by the HPT:
Organization: _____	RWP Number: _____
Bldg.: _____ Room: _____ Area: _____	
Other Info: _____	

(2) WORK DESCRIPTION
(3) Title and Number of Related Work Documents:

INFORMATION	
(4) Authorized Users(s):	Attached List? ☐Yes ☐No
(5) Job Start Date:	(6) Estimated Job End Date:

(7) RADIOLOGICAL HAZARDS ASSOCIATED WITH THE WORK ACTIVITY/LOCATION	
a. Will any radioactive material/equipment be moved to another location?	☐Yes ☐No
b. Will any grinding, burning, cutting, or welding be done?	☐Yes ☐No
c. Will any vacuuming or sweeping be done?	☐Yes ☐No
d. Will any compressed gas or air powered tools be used?	☐Yes ☐No
e. Will any volatile solvents or fluids be used?	☐Yes ☐No
f. Will any radiological work be done in a confined space?	☐Yes ☐No
g. Will any intrusive work be done? (panels moved or voids entered)	☐Yes ☐No
(8) Other possible hazards:	
(9) Remarks: (Explain any Yes answers above; supply additional information as needed.)	

(10) Requestor (Print)	Requestor (Signature)	Phone	Date

Form RPO-401-01-1

RADIATION WORK PERMIT REQUEST

INSTRUCTIONS

Complete the Radiation Work Permit (RWP) Request prior to returning it to Health Physics (HP). All blanks, except for those in the shaded section, must be completed. HP will complete this section after they assign a number to the RWP.

(1) Complete all requested information about the work location. If any information does not apply, write 'N/A' in that space.

(2) Provide a description of the work to be performed. Give sufficient detail to adequately describe radiological control required. Use another sheet of paper if necessary. The more detailed you are, the easier and quicker it will be for HP to write your RWP, and the more accurate it will be.

(3) If any documents are applicable to this work, write this information in the space. These documents should be provided to HP for review. If not applicable, write 'N/A' in the space.

(4) Indicate the individuals who will be authorized to work under this RWP. If you want to have a users list, check the **'YES'** box, and attach a list of authorized users, else check the **'NO'** box.

(5) Enter the Job Start Date. This is when the radiation work is scheduled to begin and the RWP becomes active.

(6) Enter the estimated Job End Date.

(7) Answer the following radiological hazard-related questions. If you are unsure whether any of the hazards are, or will be, present, discuss it with HP. Every question must be answered. NOTE: **'Yes'** answers may require other permits or documents in addition to the RWP.

(8) Indicate any other hazards that you think HP should know about, list them in this space. Use extra paper if necessary.

(9) Write any remarks or extra information here that you think HP may want to know. Use extra paper if necessary. Any **'Yes'** answer in (7) must have an explanation here.

(10) Print and sign your name, indicate your phone number and date of request.

After all information is completed, print your name and phone number, sign and date the form. Turn the completed form in to HP.

RADIATION WORK PERMIT

Page _____ of _____

☐ General ☐ Job Specific RWP No.:_____

Start Date: _____ Location: _____

End Date: _____

Description of Work:

RADIOLOGICAL CONDITIONS

* indicates an estimated value

Radiological Source(s)

☐ Alpha Emitting
☐ Beta/Gamma Emitting
☐ Other: _____

Airborne Radioactivity

Source (b/g or alpha)	Concentration
_____	_____ µCi/ml
_____	_____ µCi/ml

☐ N/A

Surface Contamination

☐ N/A ☐ None Detectable ☐ Unknown Levels

Fixed: _____dpm/____cm^2 Alpha
Fixed: _____dpm/____cm^2 Beta/Gamma
Removable: _____dpm/____cm^2 Alpha
Removable: _____dpm/____cm^2 Beta/Gamma
Radionuclide(s):_____ ☐ See Latest Survey

Radiation Levels

General Area: _____
Contact: _____
Other: _____

Pre-Job Survey Information

Detailed survey information contained in the following:

RADIOLOGICAL PROTECTION REQUIREMENTS

Protective Clothing

☐ None Required
☐ Lab Coat _____
☐ Surgeon-Style Gloves _____
☐ Coveralls/Tyvek _____
☐ Shoe Covers _____
☐ Plastic Suit _____
☐ Plastic Shoe Covers _____
☐ Rubber Boots _____
☐ Hood _____
☐ Work Gloves _____
☐ Other: _____

Respiratory Protection

☐ None Required
☐ Full Face Air Purifying (APR)
☐ SCBA
☐ Airline (Supplied Air)
☐ Other: _____

Training

☐ GERT
☐ Radiation Worker (RWT)
☐ Respiratory Protection
☐ Confined Space Safety
☐ Other: _____

Dosimetry

☐ None Required
☐ Whole Body TLD
☐ Additional TLD(s): _____
☐ Extremity: _____
☐ Self-Reading Dosimeter
☐ Lapel Air Sampling
☐ Bioassay:
☐ Pre-job ☐ Post-job
☐ Frequency: _____
☐ Other: _____

Monitoring

☐ Notify HPT at Job Start
☐ Intermittent
☐ Continuous
☐ Notify HPT at Job Completion
☐ HPT required at Control Point
☐ Undress by HPT
☐ Portable CAM
☐ Portable Air Sampling During Job
☐ Other: _____

RADIOLOGICAL HOLD POINTS and SPECIAL INSTRUCTIONS

Use RWP Continuation Sheet (if necessary) ☐ Continuation Sheet(s) Attached

RWP Sign-In/Out

☐ Initial Entry ☐ Daily ☐ Each Entry
☐ Other: _____
(List other sheet if used for access control)

Personnel Contamination Frisk

☐ None ☐ On Exiting Area ☐ Hands & Feet ☐ Whole Body
☐ Other: _____

REVIEW/APPROVAL SIGNATURES

Prepared by: Date:

Approved by (RSO): Date:

TERMINATION SIGNATURE

RWP Termination By: Date:

Form RPO-401-02-1

RWP CONTINUATION SHEET

Page _____ of _____

RWP No.:_____

RADIOLOGICAL HOLD POINTS and SPECIAL INSTRUCTIONS

Form RPO-401-03-1

RADIATION WORK ERMIT SIGN-IN SHEET

Page ____ ____

RWP No.: _____

Work Area Location: _____ Date: _____

Name and ID Number	Initials	Resp. Pro. (Y or N)	Dose In	PAS ID #	Digit/Flow Start #	Time In	Time Out	Dose Out	Digit/Flow Stop #

Form RPO-401-04-1

PAS Air Sample Media Collected By: _____

* By my initials, I verify that I understand and will comply with the requirements of the RWP.
Record NA for spaces not used or not applicable.

RWP TERMINATION CHECKLIST

RWP No. _____

POST-JOB CONDITIONS/ANALYSIS			
Reason for Termination:	☐ Job Completed	☐ Change in Scope of Work	
	☐ Change in Job Site	☐ RWP Expired	
	☐ Other: _____		
Post-Job Survey(s) Performed?	☐ Yes	☐ No	Survey Number(s): _____
Other Survey(s) Performed?	☐ Yes	☐ No	Survey Number(s): _____

TERMINATION PACKET (information attached)			
RWP Request	☐ Yes	☐ No	☐ N/A
RWP (including all RWP Continuation Sheets)	☐ Yes	☐ No*	# of sheets _____
RWP Sign-In Sheet(s)	☐ Yes	☐ No*	# of sheets _____
Pre Job Meeting Attendance Record	☐ Yes	☐ No	☐ N/A
RWP Tracking Log Updated	☐ Yes	☐ No	
Additional Documentation: _____			

Form RPO-401-05-1

VERIFICATION/APPROVAL

Name: _____
(Print)

Signature: _____ Date: _____

RSO Signature: _____ Date: _____

* Contact RSO for guidance

RWP Tracking Log

RWP Number	Date Issued	Date Closed	Job Location and Description of Work	Initials

Form RPO-401-06-1