COMPLETE

ENGINEERING CHANGE NOTICE

Page 1 of 21. ECN **No** 617176Proj.
ECN

2. ECN Category (mark one) Supplemental ☐ Direct Revision ☒ Change ECN ☐ Temporary ☐ Standby ☐ Supersedure ☐ Cancel/Void ☐		3. Originator's Name, Organization, MSIN, and Telephone No. T. G. Beam, 16610, S6-70, 372-0019		4. Date November 7, 1994	
		5. Project Title/No./Work Order No. B Plant Complex Hazardous, Mixed and Low Level Waste Certification Plan		6. Bldg./Sys./Fac. No. B Plant Complex	
		8. Document Numbers Changed by this ECN (includes sheet no. and rev.) WHC-SD-HWV-PLN-002, Rev. 4		9. Related ECN No(s). NA	
				10. Related PO No. NA	
11a. Modification Work ☐ Yes (fill out Blk. 11b) ☒ No (NA Blks. 11b, 11c, 11d)		11b. Work Package No. NA	11c. Modification Work Complete NA		11d. Restored to Original Condition (Temp. or Standby ECN only) NA
		Cog. Engineer Signature & Date		Cog. Engineer Signature & Date	
12. Description of Change Rewrite of document to reflect current waste handling practices and regulations. Change of title to include hazardous and mixed waste.					
13a. Justification (mark one) Criteria Change ☒ Design Improvement ☐ Environmental ☐ As-Found ☐ Facilitate Const. ☐ Const. Error/Omission ☐ Design Error/Omission ☐					
13b. Justification Details Administrative change to update information in document to current status of B Plant Complex.					
14. Distribution (include name, MSIN, and no. of copies) T. G. Beam S6-70 (1) Central Files L8-04 (2) J. W. Hasson S6-60 (1) O.S.T.I. L8-07 (2) R. J. Julian S6-65 (1) M. M. Serkowski S6-70 (1) K. D. Strong S6-60 (1) D. W. Wilson S6-70 (1) Regulatory File S6-70 (2)				RELEASE STAMP OFFICIAL RELEASE BY WHC DATE NOV 15 1994 STA. #2	

A-7900-013-3 (06/94) GEF096

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

RELEASE AUTHORIZATION

Document Number: WHC-SD-HWV-PLN-002, REV.5

Document Title: B Plant Complex Hazardous, Mixed and Low Level Waste Certification Plan

Release Date: November 15, 1994

**This document was reviewed following the
procedures described in WHC-CM-3-4 and is:**

APPROVED FOR PUBLIC RELEASE

WHC Information Release Administration Specialist:

Kara M. Broz

November 15, 1994

TRADEMARK DISCLAIMER. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

This report has been reproduced from the best available copy. Available in paper copy and microfiche. Printed in the United States of America. Available to the U.S. Department of Energy and its contractors from:

U.S. Department of Energy
Office of Scientific and Technical Information (OSTI)
P.O. Box 62
Oak Ridge, TN 37831
Telephone: (615) 576-8401

Available to the public from:

U.S. Department of Commerce
National Technical Information Service (NTIS)
5285 Port Royal Road
Springfield, VA 22161
Telephone: (703) 487-4650

SUPPORTING DOCUMENT		1. Total Pages 37
2. Title B Plant Complex Hazardous, Mixed and Low Level Waste Certification Plan	3. Number WHC-SD-HWV-PLN-002	4. Rev No. 5
5. Key Words B Plant Complex Waste Certification Plan Hazardous, Mixed and Low Level Waste <i>Kmb 11/15/94</i>	6. Author Name: T. G. Beam <i>Thomas G Beam 11/15/94</i> Signature Organization/Charge Code 16610/KBE33	
7. Abstract <p>This plan describes the administrative steps and handling methodology for certification of hazardous waste, mixed waste, and low level waste generated at B Plant Complex. The plan also provides the applicable elements of waste reduction and pollution prevention, including up front minimization and end product reduction of volume and/or toxicity. The plan is written to satisfy requirements for Hanford Site waste generators to have a waste certification program in place at their facility. This plan, as described, applies only to waste which is generated at, or is the responsibility of, B Plant Complex. The scope of this plan is derived from the requirements found in WHC-EP-0063, <i>Hanford Site Solid Waste Acceptance Criteria</i>.</p>		
		8. RELEASE STAMP <div style="border: 1px solid black; padding: 5px; margin-top: 10px;"> OFFICIAL RELEASE BY WHC DATE NOV 15 1994 <i>STA. #2</i> </div>

[illegible]

**B PLANT COMPLEX HAZARDOUS, MIXED AND LOW LEVEL WASTE
CERTIFICATION PLAN**

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

B Plant Environmental Engineering

November 1994

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

JP

TABLE OF CONTENTS

1.0	INTRODUCTION	1
1.1	PURPOSE/SCOPE OF PLAN	1
1.2	FACILITY DESCRIPTION	1
1.3	FACILITY WASTE MANAGEMENT STRATEGY	2
1.4	TRAINING	3
2.0	RESPONSIBILITIES	4
2.1	B PLANT COMPLEX OPERATIONS	4
2.2	B PLANT COMPLEX DISPOSAL OPERATIONS	4
2.3	B PLANT ENVIRONMENTAL ENGINEERING	5
2.4	RADIOLOGICAL CONTROL	5
2.5	B PLANT COMPLEX TECHNICAL TRAINING	5
2.6	QUALITY ASSURANCE/QUALITY CONTROL	5
2.7	PRODUCTION CONTROL	6
2.8	B PLANT COMPLEX MAINTENANCE	6
2.9	B PLANT COMPLEX DIRECTOR	6
3.0	WASTE CERTIFICATION	7
3.1	SITEWIDE REQUIREMENTS	7
3.2	B PLANT COMPLEX WASTE CERTIFICATION PROCESS	7
	3.2.1 Waste Identification and Segregation	7
	3.2.2 Low Level Waste Category Determination	8
	3.2.3 Waste Packaging and Shipping	9
3.3	B PLANT COMPLEX WASTE CATEGORIES	9
	3.3.1 Hazardous Waste	9
	3.3.1.1 Mercury Vapor and Sodium Lamps	9
	3.3.1.2 Fluorescent Ballasts	10
	3.3.1.3 Aerosol Cans	10
	3.3.1.4 Paint Related Waste	10
	3.3.1.5 Lead	10
	3.3.1.6 Lead Acid Batteries	10
	3.3.1.7 Dry Cell Batteries	11
	3.3.1.8 Chemical-Contaminated Materials	11
	3.3.1.9 Miscellaneous Waste	11
	3.3.2 Mixed Waste	11
	3.3.2.1 Radioactive Hazardous Waste	11
	3.3.2.2 HEPA Filters	11
	3.3.3 Low Level Waste	12
	3.3.3.1 Compactible Waste	12
	3.3.3.2 Non-compactible Waste	12
	3.3.3.3 HEPA Filters	12
	3.3.3.4 Vegetation	12
	3.3.3.5 Asbestos	12

TABLE OF CONTENTS (CONT.)

4.0	QUALITY ASSURANCE	14
4.1	B PLANT COMPLEX QUALITY ASSURANCE PROGRAM PLAN (QAPP)	14
4.2	QUALITY ASSURANCE PROGRAM INDEX	14
5.0	REFERENCES	15
APPENDIX A: RADIONUCLIDE CHARACTERIZATION METHODOLOGY		A-1
APPENDIX B: B PLANT COMPLEX WASTE COLLECTION AND STORAGE LOCATIONS		B-1
APPENDIX C: MICROSHIELD CALCULATED WASTE PACKAGE CURIE CONTENTS		C-1

1.0 INTRODUCTION

1.1 PURPOSE/SCOPE OF PLAN

This plan describes the administrative steps and handling methodology for certification of hazardous waste (HW), mixed waste (MW), and low level waste (LLW) generated at B Plant Complex. The plan also provides the applicable elements of waste reduction and pollution prevention, including up front minimization and end product reduction of volume and/or toxicity. The plan is written to satisfy requirements for Hanford Site waste generators to have a waste certification program in place at their facility.

The B Plant Complex Hazardous, Mixed and Low Level Waste Certification Plan (WCP), as described herein, applies only to waste which is generated at, or is the responsibility of, B Plant Complex. The scope of this plan is derived from the requirements found in WHC-EP-0063, *Hanford Site Solid Waste Acceptance Criteria*.

1.2 FACILITY DESCRIPTION

B Plant Complex consists of the 221B canyon building and 271B administration building (B Plant), the 225B Waste Encapsulation and Storage Facility (WESF) building, and several surrounding support structures. B Plant was built between 1943 and 1945 and was originally used for plutonium recovery in support of the Manhattan Project. Starting in 1961 extensive modifications were made to B Plant processes to allow for recovery and purification of cesium-137 (Cs) and strontium-90 (Sr) from existing wastes stored at Hanford. Cs/Sr recovery processing was initiated in 1968. The Waste Encapsulation and Storage Facility (WESF) was added to B Plant Complex in 1974 to allow the Cs-137/Sr-90 waste streams to be converted to solid form and placed in stainless steel capsules. These highly radioactive capsules are stored in pool cells inside WESF.

In May 1991, DOE eliminated B Plant from any future processing missions due to difficulties in bringing a 46 year old plant up to current environmental standards. Since that time B Plant has continued to operate, ensuring safe storage and management of approximately 100 megacuries of cesium and strontium capsules in WESF, as well as substantial radioactive contamination and residual inventory from past operations.

The legacy of B Plant's radiochemical separation process missions is a substantial quantity of radioactive inventory. The inventory is in the form of stored organics, kilocurie quantities of solid particulate strontium and cesium contained in underground high-efficiency particulate air (HEPA) filters, and a highly contaminated facility structure.

Current maintenance, cleanup and operation efforts are intended to place the B Plant Complex into a safe, cost effective configuration, allowing for long-term surveillance until final decontamination and decommissioning (D&D).

1.3 FACILITY WASTE MANAGEMENT STRATEGY

Pollution prevention is a primary goal at the B Plant Complex. Therefore, all waste is identified and the proper disposal method is specified in advance. Work is performed according to approved work packages or procedures that address waste minimization and waste handling where applicable. Authorization from the Hazardous Waste Coordinator (HWC) is required to introduce chemicals into the canyon and other contaminated areas. The introduction of hazardous chemicals into radiological contamination areas is limited to minimum quantities required for job performance in order to minimize the generation of mixed waste. Administrative controls are also in place to restrict non-regulated waste from being packaged in containers which previously stored a regulated chemical. Pre-job planning and identification of hazardous substances not only minimizes waste, but also reduces the need for sampling in order to characterize the waste. The need for sampling is further reduced by segregating radioactive waste according to its physical and chemical characteristics.

As it is generated, low level waste is segregated by plant operations personnel according to plant operating procedures BO/EO-100-017, "Perform Segregation of Compactible and Non-Compactible Waste". B Plant and WESF operate under separate procedures, so BO-100-017 is for B Plant and EO-100-017 is for WESF. Three plant operating procedures (BO/EO-100-018, "Package and Ship Low-Level Radioactive Waste"; BO/EO-100-019, "Package and Ship Mixed Waste"; and BO/EO-100-020, "Package and Ship Hazardous Waste") are in place to ensure proper identification, packaging, labelling and shipping of HW, MW and LLW. These procedures enable B Plant Complex Disposal Operations to generate their own Packaging and Shipping checklists. Content Inventory Tags are attached to bags of low level waste for content identification.

For low level waste, 55-gallon drums lined with a plastic bag are used as waste collection containers. When the plastic bag is filled, it is removed from the drum, sealed and placed inside a second bag (double bagged). Packaged waste is then stored in an approved location until disposal. An inventory tag is attached to each bag of waste placed in storage. Operating procedures call for a new bag to be placed in the drum to replace the one that was removed.

Operating procedure BO/EO-100-017, "Perform Segregation of Compactible and Non-Compactible Waste", also specifies the final waste package and shipping instructions for compactible and non-compactible low level waste. Compactible low level waste is transported to a waste compaction facility in reusable 4'x 4'x 8' wooden overpacks, while non-compactible low level waste bags are disposed of in 4'x 4'x 8' plywood boxes or 55-gal drums at the Low Level Waste Burial Ground.

Waste generated by contractors is either packaged by plant personnel or packaged by the contractors under the direct supervision of Disposal Operations. B Plant Complex Disposal Operations maintains final responsibility for contractor waste.

1.4 TRAINING

This section provides the requirements to ensure that personnel who handle waste at the B Plant Complex are properly trained. The training may consist of classroom sessions, required reading, on the job training, and/or examination, as appropriate. Requalification requirements vary with training courses. A listing of courses can be found in WHC-SD-WM-TR-024, "B Plant Complex Solid Waste Management Training Plan".

All personnel who handle, package and/or certify HW, MW and LLW are required to be trained to the following documents (as applicable to their job requirements):

- WHC-SD-HWV-PLN-002 B Plant Complex Hazardous, Mixed and Low Level Waste Certification Plan
- WHC-SD-WM-TR-024 B Plant Complex Solid Waste Management Training Plan
- WHC-CM-7-5 Environmental Compliance Manual
- BO/EO-100-017 Perform Segregation of Compactible and Non-Compactible Waste
- BO/EO-100-018 Package and Ship Low Level Radioactive Waste
- BO/EO-100-019 Package and Ship Mixed Waste
- BO/EO-100-020 Package and Ship Hazardous Waste

Personnel who generate HW, MW and LLW will be trained in waste minimization and satellite accumulation area procedures during safety meetings and OJT, as appropriate.

2.0 RESPONSIBILITIES

B Plant Complex Operations is divided into three different operations groups: Disposal Operations, Surveillance Operations and Transition Operations. These groups generate hazardous, mixed, and low level waste. These wastes are segregated and packaged in accordance with established operating procedures and Disposal Operations instructions.

In addition to Disposal Operations, there are other groups which lend support to the handling and disposal of waste at the B Plant Complex. Production Control generates work packages, schedules maintenance activities, and ensures that the hazardous material and waste content generated during the job is identified. B Plant Environmental Engineering provides technical support to B Plant Complex Operations and Production Control. Radiological Control provides radiological support to B Plant Complex Operations. B Plant Complex Technical Training provides necessary training to B Plant Complex personnel and maintains the training records. Quality Assurance provides technical support in reviewing required documentation and Quality Control verifies that the requirements are implemented. The following sections detail the duties and responsibilities of the various groups involved in waste handling operations at the B Plant Complex.

2.1 B PLANT COMPLEX OPERATIONS

B Plant Complex Operations is responsible for adhering to all requirements governing activities which affect waste generation. It ensures that its operators have received and are current in the necessary waste handling training areas to maintain compliance with established procedures and this plan. Waste generators are responsible for packaging waste properly, filling out the Contents Inventory Sheets for each low level waste container and the Generator Waste Certification Sheets for each hazardous and mixed waste container.

2.2 B PLANT COMPLEX DISPOSAL OPERATIONS

B Plant Complex Disposal Operations provides waste minimization instructions prior to plant maintenance activities, including limiting the amounts of hazardous chemicals allowed into radiation zones and providing guidance on the proper waste container to be used. Disposal Operations also provides a Packaging and Shipping Instruction Checksheet to B Plant Complex Operations. Disposal Operations is responsible for ensuring that adequate documentation is prepared and maintained for waste shipments.

Disposal Operations is a section within Regulatory Operations and Compliance which provides specific instructions for packaging, labeling and storage of waste, prepares a physical description for each generated waste container, and has ultimate responsibility for the disposal of all waste generated at the B

Plant Complex. They are also responsible for non-Westinghouse contractor generated waste and provide segregation and packaging supervision.

2.3 B PLANT ENVIRONMENTAL ENGINEERING

B Plant Environmental Engineering (BPEE) furnishes Disposal Operations with appropriate instructions and procedures on waste packaging, segregation and shipping. Disposal Operations utilizes these procedures to perform waste handling operations according to federal and state regulations as well as company policies. In turn, Disposal Operations provides appropriate waste content documentation to BPEE. BPEE also provides waste characterization information and requests storage and disposal guidance. These requests are evaluated by WHC Acceptance Services based on the acceptance criteria guidelines in WHC-EP-0063 and packaging instructions are provided via Storage/Disposal Approval Record (SDAR). BPEE maintains the Waste Certification Plan and is responsible for updates and modifications as applicable, as well ensuring that each organization is aware of its responsibilities in meeting the requirements of this plan.

2.4 RADIOLOGICAL CONTROL

Radiological Control Technicians (RCTs) provide radiological support to B Plant Complex Operations. RCTs limit personnel exposure, give specific waste handling instructions pertaining to contamination control, conduct surveys and smears of the waste containers, and record the radiological data on the appropriate documentation. They also assist Disposal Operations in determining the dose rate of waste packages and provide general ALARA policy guidance.

2.5 B PLANT COMPLEX TECHNICAL TRAINING

B Plant Complex Technical Training (BPTT) provides personnel training in waste handling procedures and B Plant Complex pollution prevention practices according to the requirements in the B Plant Complex Solid Waste Management Training Plan (WHC-SD-WM-TR-024). Training records are maintained by BPTT.

2.6 QUALITY ASSURANCE/QUALITY CONTROL

The duties and responsibilities of the Quality Assurance (QA) organization are detailed in the Quality Assurance Program Plan (QAPP) and are briefly discussed in Section 4.0 of this plan. Quality Control audits employee training records, observes waste handling operations and ensures that all appropriate historical records are maintained in accordance with established quality assurance programs.

2.7 PRODUCTION CONTROL

The planner or Person In Charge (PIC) is responsible for making sure that waste segregation and packaging instructions are provided in the J-4 form if the work package generates hazardous, radioactive or mixed waste.

2.8 B PLANT COMPLEX MAINTENANCE

B Plant Complex Maintenance is responsible for ensuring that maintenance personnel are trained in the waste handling methods of this plan and other applicable documentation.

2.9 B PLANT COMPLEX DIRECTOR

The B Plant Complex Director is responsible for ensuring that all waste handling is performed in accordance with applicable state and federal regulations, DOE Orders, and WHC policies. He/She is also responsible for ensuring that each operator or waste generator has successfully completed the appropriate level of technical training and that the training has been documented in the employee's file.

3.0 WASTE CERTIFICATION

This section provides a more detailed description of the B Plant Complex waste streams and waste certification process. Further details on the waste certification process at the B Plant Complex are provided in the appendices.

3.1 SITEWIDE REQUIREMENTS

This Waste Certification Plan is designed to ensure that all waste from the B Plant Complex meets the waste acceptance criteria for the Hanford Site Storage and Disposal Facilities. These criteria are presented in WHC-EP-0063, *Hanford Site Solid Waste Acceptance Criteria*. The certification process will address the following areas:

- Waste reduction (minimization and source reduction) plans and procedures that affect certification.
- Methods used to identify and segregate hazardous materials from low level and non-hazardous waste.
- Characterization methods used (e.g. assay, material balance, etc.) to determine radioactive material content of the waste.
- Characterization methods used to determine the physical and chemical properties of the waste.
- Waste handling and packaging activities from waste generation through shipment.

The process of certification remains an integral part of the waste management program at Hanford. To ensure that these five areas are properly addressed, an analysis of the waste streams at the B Plant Complex is necessary. This allows the wastes to be identified and dispositioned in a controlled manner.

3.2 B PLANT COMPLEX WASTE CERTIFICATION PROCESS

The following sections provide a description of the process which is in place at the B Plant Complex to ensure that all waste generated meets the acceptance criteria required for disposal on the Hanford Site.

3.2.1 Waste Identification and Segregation

Personnel are trained to identify hazardous waste, mixed waste, compactible low level waste, and non-compactible low level waste. Much of B Plant Complex's waste is generated from routine activities, making identification a simple matter. When additional identification is necessary, Disposal Operations coordinates the required efforts. Such efforts may consist of characterization sampling, radiological surveys, process research, and/or

other activities. Results of such identification efforts are documented in the waste files maintained by Disposal Operations.

Individual waste generators are responsible for the proper segregation of waste. Waste generators are instructed on the proper use of waste segregation procedures and satellite accumulation areas. Low level waste must be segregated into compactible and non-compactible waste per operating procedures BO/EO-100-017, while hazardous and mixed waste must be maintained in separate containers. Waste is segregated by providing multiple waste collection drums at work areas for different waste streams. A list of the current B Plant Complex waste collection locations is shown in Appendix B. All waste receptacles are labeled and content inventories must be maintained for the benefit of Disposal Operations and shipping/disposal purposes.

3.2.2 Low Level Waste Category Determination

Disposal requirements make it necessary to further classify low level waste (LLW) according to its radionuclide distribution and curie content. Activity limits are set in WHC-EP-0063 for each radionuclide, making it possible for LLW to be considered a category 1, category 3 or greater than category 3 waste.

The Content Inventory Tags which are filled out by the operator collecting and segregating the waste provide some of the information necessary to make this determination. The Content Inventory Tag must contain the following information:

- waste content description
- date
- dose rate reading from waste (mR/hr)

The dose rate reading is the piece of important information which is needed to help make a category determination.

The other piece of information which is necessary to make a LLW category determination is the radionuclide distribution of the waste. B Plant Complex uses a standard distribution for all of its LLW. This distribution was determined from characterization sampling efforts performed at the facility. Additional details are provided in Appendix A.

Two worksheets, "Radionuclide Curie Content Calculation Worksheet" and "Waste Category Determination Worksheet" (both shown in Appendix) can then be used to determine what category the LLW belongs in. Currently, B Plant Complex is using Microshield or Isoshield (radiation dose software), and a Lotus-based spreadsheet developed by Disposal Operations to make this determination. For routine LLW shipments in 55-gallon drums and 4'x4'x8' plywood boxes, Microshield calculations showing waste package curie content as a function of waste package density and waste package dose rate are provided in Appendix C. Copies of this documentation is included in the shipping records maintained by Disposal Operations.

3.2.3 Waste Packaging and Shipping

Following waste identification, segregation and LLW category determination, the waste is ready to be packaged for shipment. The waste is handled, packaged, and shipped according to the appropriate operating procedure. In addition, shipments must meet the requirements of the applicable SDAR or waste disposal letter from Acceptance Services. The following is a list of the pertinent operating procedures.

- BO/EO-100-017 Perform Segregation of Compactible and Non-Compactible Waste
- BO/EO-100-018 Package and Ship Low Level Waste
- BO/EO-100-019 Package and Ship Mixed Waste
- BO/EO-100-020 Package and Ship Hazardous Waste

3.3 B PLANT COMPLEX WASTE CATEGORIES

B Plant Complex generates hazardous, mixed and low level waste. Each category of waste consists of several waste stream types. B Plant Complex, on occasion, also generates asbestos and PCB waste. These wastes are not considered to be a hazardous waste as defined in the regulations, but instead are regulated under the Toxic Substances Control Act (TSCA). Asbestos and PCB waste are handled in accordance with established WHC policy. The following sections provide a more detailed description of the waste generated at B Plant Complex.

3.3.1 Hazardous Waste

The hazardous waste stream generated at the B Plant Complex consists of waste lamps, fluorescent ballasts, aerosol cans, paint related waste, lead, lead acid batteries, dry cell batteries, chemical-contaminated materials and miscellaneous wastes.

3.3.1.1 Mercury Vapor and Sodium Lamps

Mercury Vapor and Sodium lamps are used in various areas around the B Plant Complex. Mercury vapor and high pressure sodium lamps are considered hazardous because of the lead solder in them. Low pressure sodium lamps are considered hazardous because of their reactive, corrosive and ignitability characteristics. Radiological Control surveys for contamination and unconditionally releases this waste stream if no contamination is found. Lamps that have been unconditionally released are treated as hazardous waste and handled in accordance with the WAC 173-303.

Lamps that are determined to be radiologically contaminated are decontaminated when possible. Lamps that cannot be decontaminated are treated as mixed waste and handled according to appropriate operating procedures. This is usually the case since lamp moldings are rough, allowing airborne radioactivity to settle into the cracks of the bulb;

the radiation control technicians (RCTs) will not sign an unconditional release for such solid materials.

3.3.1.2 Fluorescent Ballasts

Fluorescent lamp ballasts are an integral part of the fluorescent lighting used at the B Plant Complex. They are surveyed for contamination and if released by Radiological Control, they are designated as hazardous or polychlorinated biphenyl (PCB) waste, depending on whether the ballast contains PCBs or dioctylphthalate (DOP). Ballasts which are not released are treated as mixed waste.

3.3.1.3 Aerosol Cans

A container which holds or previously held an aerosol propellant is treated as an aerosol can. Waste is characterized according to the appropriate Material Safety Data Sheet (MSDS). Aerosol cans are segregated from other waste by generators prior to being placed in the waste collection drums.

3.3.1.4 Paint Related Waste

Paint related waste consists of paint chips, dry paint cans, brushes, rollers, rags and plastic. Paint used to stabilize contamination is assumed to contain lead and/or lead chromate. Chemical constituents of other paints are determined by the use of MSDSs. This waste stream is segregated by the generators using process knowledge.

3.3.1.5 Lead

Lead waste generated at the B Plant Complex comes from:

- Lead shot and lead sheets used for shielding to control radiation dose rates.
- Lead used for counter weight on the canyon jumpers.
- Equipment containing lead either for shielding or as soldered connections.

If possible, the lead sheets and shot are either excessed for someone else to use or recycled. This avoids the need to dispose of them as hazardous waste.

3.3.1.6 Lead Acid Batteries

Lead acid batteries are generated from the boom truck in the 221B canyon. They contain lead and sulfuric acid. When batteries are removed from the canyon, sulfuric acid is drained from the battery and the interior is neutralized. The battery is treated as lead would be treated. An acid sample is sent out for total activity. If the sample is not contaminated, it is unconditionally released and treated as hazardous waste. If it cannot be released, it is placed in a container apart from other waste types and treated as mixed waste. Currently, the

B Plant Complex is recycling its lead acid batteries through an established WHC program.

3.3.1.7 Dry Cell Batteries

Dry cell batteries are generated by the use of flashlights and lanterns in all areas of the B Plant Complex. This waste stream is regulated as an oxidizing material. Dry cell batteries are placed in separate waste containers specifically designated for this waste stream. Dry cell battery waste containers are kept separate from containers holding corrosive liquids, poisonous liquids or gases.

3.3.1.8 Chemical-Contaminated Materials

This waste stream consists of rags, paper, sponges, plastic, rubber and other materials that have been contaminated with a chemical which is regulated as a hazardous waste. Many of these chemicals are solvents and/or cleaning agents of some sort.

3.3.1.9 Miscellaneous Waste

Miscellaneous waste consists of waste which is discovered with unknown characteristics, waste which are generated by unusual or nono-routine activities, or any other waste which might be generated at B Plant which is not specifically mentioned in this plan.

3.3.2 Mixed Waste

The mixed waste stream generated at the B Plant Complex consists of all the same items which comprise the hazardous waste stream. In addition, High Efficiency Particulate Air (HEPA) filters comprise a portion of the mixed waste stream.

3.3.2.1 Radioactive Hazardous Waste

Any of the hazardous waste types previously mentioned which are used or present in a radiologically contaminated area may become part of the mixed waste stream. In particular, lead, waste lamps and cleaning solvents often wind up as mixed waste. The mixed waste stream is handled according to applicable operating procedures and regulations.

3.3.2.2 HEPA Filters

HEPA filters are used to trap radioactively contaminated particles and prevent them from being released to the environment. HEPA filters consist of a plywood or stainless steel frame, fiberglass, aluminum separators, neoprene strip gaskets and stainless steel wire cloth.

Many of the HEPA filters in use at the B Plant Complex were efficiency tested with DOP, which is a hazardous material. This makes the HEPA filters mixed waste. Spent HEPA filters are removed from the system per instructions that are provided on a work package. During removal, testing information to support the waste designation is compiled. The information is then evaluated per the latest regulatory guidance and if

the filter is determined to be mixed waste, it is disposed of per mixed waste guidelines.

3.3.3 Low Level Waste

The low level waste stream generated at the B Plant Complex consists of compactible waste, non-compactible waste, HEPA filters, vegetation and radiologically contaminated asbestos.

3.3.3.1 **Compactible Waste**

B Plant Complex compactible low level waste is generated from processing, maintenance, construction and housekeeping activities. B Plant Complex compactible low level waste consists of paper, plastic, dry rags, gloves, clothing, rubber, tape, cardboard, empty plastic bottles, and other dry, low density compactible waste.

3.3.3.2 **Non-compactible Waste**

Non-compactible waste is generated from general processing, housekeeping, construction, and maintenance activities. Non-compactible waste at the B Plant Complex consists of concrete, piping, metal, wood, filters, tools, hard plastic, glass, soil, rock, and other high density non-hazardous materials. Free liquids cannot be disposed of as non-compactible waste.

3.3.3.3 **HEPA Filters**

HEPA filters are used to trap radioactively contaminated particles and prevent them from being released to the environment. HEPA filters consist of a plywood or stainless steel frame, fiberglass, aluminum separators, neoprene strip gaskets and stainless steel wire cloth.

Spent HEPA filters are removed from the system per instructions that are provided on a work package. If they have not been efficiency tested with a regulated material, then they may be disposed of a low level waste instead of mixed waste.

3.3.3.4 **Vegetation**

Vegetative waste consists primarily of dead plant material deposited in the vicinity of the B Plant Complex by the wind. The vegetation is composed of organic material and fibrous cellulose. Whenever the B Plant Complex personnel encounter vegetative waste that is potentially contaminated, supervision or Disposal Operations is contacted. Waste disposal will be handled on a case by case basis. Vegetation that is found in a radiation zone or that is determined to be contaminated is loaded into the tumble weed compaction truck. Vegetation found to be free of radiological contamination is taken to the sanitary landfill.

3.3.3.5 **Asbestos**

Asbestos has been used as insulation on steam lines in 221B and in the transite used as a wall and a floor material in the office areas of

271B. Radiologically contaminated asbestos is disposed of as low level waste once it is wetted down and bagged separately.

4.0 QUALITY ASSURANCE

This section addresses the quality assurance program which is in place at B Plant Complex and how it interfaces with the waste certification program.

4.1 B PLANT COMPLEX QUALITY ASSURANCE PROGRAM PLAN (QAPP)

The B Plant Complex QAPP is presented in WHC-CM-5-6, B Plant Administration, Section 10.0. The implementing requirements for the elements of Quality Assurance Program Requirements for Nuclear Facilities (ASME NQA-1) are presented in this plan.

The B Plant Complex QAPP has been modified to include the following documents that relate to the certification of waste:

- BO-020-025 Store WESF Waste Drums in Cell 4
- BO/EO-100-017 Perform Segregation of Compactible and Non-Compactible Waste
- BO/EO-100-018 Package and Ship Low Level Waste
- BO/EO-100-019 Package and Ship Mixed Waste
- BO/EO-100-020 Package and Ship Hazardous Waste
- EO-100-021 Prepare the K-3 Burial Box for Disposal
- EO-100-022 Prepare and Dispose of K-3 Filter Cover Blocks
- EO-902-003 Prepare and Package WESF A Cell Waste
- EO-912-014 Transport Waste Cask

4.2 QUALITY ASSURANCE PROGRAM INDEX

The B Plant Complex QAPP contains the Quality Assurance (QA) Program Index. The above mentioned documents (section 4.1) have been added to the following NQA-1 QA Elements in the QA Program Index:

- 2.0 Quality Assurance
- 6.0 Document Control
- 8.0 Identification and Control of Items
- 9.0 Control of Processes
- 10.0 Inspections
- 13.0 Handling, Storage, and Shipping
- 17.0 Quality Assurance Records
- 18.0 Audits

Those NQA-1 elements not supplemented by the B Plant Complex QAPP adequately address requirements necessary for the certification of radiologically contaminated wastes.

5.0 REFERENCES

WHC-EP-0063, *Hanford Site Solid Waste Acceptance Criteria*, Revision 4, Westinghouse Hanford Company, 1993.

WHC-CM-5-6, *B Plant Administration*, Westinghouse Hanford Company.

WHC-SD-WM-EV-025, *B Plant Complex Pollution Prevention Plan*, Revision 1, Westinghouse Hanford Company, 1994.

WHC-SD-WM-TR-024, *B Plant Complex Solid Waste Management Training Plan*, Revision 1, Westinghouse Hanford Company, 1994.

Internal Memo 85151-92-JAK-038, "Radionuclide Content of B Plant Canyon Waste", J. A. Koerner to N. P. Willis, dated March 17, 1992, Westinghouse Hanford Company.

Internal Memo 7E141-92-JAK-068, "Radionuclide Content of B Plant Waste", J. A. Koerner to Distribution, dated June 26, 1992, Westinghouse Hanford Company.

Internal Memo 16410-93-JAK-012, "Radionuclide Content of Low Level Radioactive Solid Waste Generated at WESF", J. A. Koerner to Distribution, dated February 17, 1993, Westinghouse Hanford Company.

APPENDIX A
RADIONUCLIDE CHARACTERIZATION METHODOLOGY

The requirements for radionuclide characterization are contained in WHC-EP-0063-4, *Hanford Site Solid Waste Acceptance Criteria*. The requirement can be summarized as follows:

Characterization data must include all radionuclides that contribute greater than 1% (by curie) of the total activity of the waste matrix and any of the following radionuclides even if they contribute <1% of the total activity: H-3, C-14, Co-60, Ni-59, Ni-63, Sr-90, Nb-94, Tc-99, I-129, Cs-137, Pu-241, Cm-242, Se-79 and alpha emitting nuclides with half lives >5 years.

The curie content of each waste container is calculated based on:

- Radionuclide distribution of the waste.
- Density of the waste package.
- Dose rate of the waste package.

A.1 RADIONUCLIDE DISTRIBUTION

An comprehensive sampling plan was developed to obtain the information necessary to perform the required characterization of B Plant Complex low level waste. The characterization plan consisted of 117 smear samples analyzed for total alpha, beta, and gamma energy analysis (GEA). The total alpha, beta, and GEA were combined into 5 samples representing zones of collection from the B Plant canyon deck. The collection zones were selected based on past operation campaigns. Each sample was analyzed for a list of specific radionuclides based upon "process knowledge". A similar characterization sampling plan was implemented for WESF using 35 smear samples representing 3 zones of collection.

Once concentration levels for each of the radionuclides were determined for each collection zone, a weighted average distribution was calculated using the following ratio:

number of smear samples per zone / total number of smear samples

Based on the results of the both sample characterization efforts, the following radionuclide distribution will be used for the characterization of LLW generated at B Plant Complex:

80% ¹³⁷Cs in equilibrium with ^{137m}Ba
20% ⁹⁰Sr in equilibrium with ⁹⁰Y

Sample results indicated less than 1% alpha-emitters for all samples, which is 0.45% of the radioactivity in B Plant Complex low level waste. These concentration levels are below the values necessary to affect waste classification and will not be considered in the characterization of B Plant Complex LLW.

All LLW generated at B Plant will be characterized using the above radionuclide distribution. The exceptions to this will be waste which has been contaminated by sources other than those currently known to be present in the B Plant canyon which are being disposed of by B Plant Complex Disposal Operations for some reason and radioactive sources which are being disposed of for the Radiological Control group. Such waste not falling under the standard B Plant Complex radionuclide distribution will be sampled and sent to the lab for analysis.

A.2 DENSITY

To calculate the density of the waste package, it is necessary to know the densities of the waste items which make up the package. Waste package density is then determined by either weighted averages or by taking the total weight of the package and dividing by the total volume. Table A.1 shows the densities of items often found in LLW generated at B Plant Complex.

Table A.1 B Plant Complex LLW Items and Densities

Item	Density (g/cc)		Item	Density (g/cc)
Plastic	0.9		Paper	1.1
Air	0.001		Cloth	1.5
Rubber	1.5		Pumice	0.385
Steel	7.86		Wood	0.9
Dirt/Soil	2.0		Lead	11.3
Glass	2.6		Aluminum	2.7
Copper	8.8		Concrete	3.2
Loose Fiber Asbestos	0.001		Pyrofoam	0.2
Transite Asbestos	2.45		Insulation	1.0
Mask Filter Canisters	0.5		Cleanup 4 Sweeping Compound	1.0

A.3 DOSE RATE

The dose rates from the waste packages are measured in units of either $\mu\text{R/hr}$ or mR/hr and are determined by the radiological control technician when requested to do so by Disposal Operations.

A.4 MISCELLANEOUS LOW LEVEL WASTE PACKAGES

B Plant Complex uses the Microshield or Isoshield program to calculate the curie content of individual low level waste packages when requested to do so by Disposal Operations. The following are examples of containers which may require individual curie content computations:

- Non-uniform surface dose rate containers
- Non-standard size (not 55-gallon drum or 4'x4'x8' plywood box) waste containers
- Excessive high dose rate containers
- K-3 Filter and Modified Fuel Spacer Burial Boxes
- Special waste densities

For containers with non-uniform dose rates or "hot spots", the following process can be used to determine curie content:

- 1) The package can be considered as a set of distinct sections. 55 gallon drums can be considered as 8 equal-sized sections. 4'x 4'x 8' boxes can be considered as 16 equal-sized sections.
- 2) The curie content can be calculated over the entire package volume assuming the "hot spot" is the dose rate of the package.
- 3) The radionuclide content can then be calculated over the entire package volume assuming the average dose rate is the dose rate of the package.
- 4) The results calculated in 2) and 3) can then be combined according to their weighted average.

EXAMPLE

A 55 gallon drum with a dose rate of <0.5 mRem/hr has a "hot spot" of 3.0 mRem/hr.

The first step would be to calculate the curie content of a 55 gallon drum at 3.0 mRem/hr. The next step would be to calculate the curie content at <0.5 mRem/hr. These results could then be combined as follows:

Total

Curie Content = $1/8 \times (\text{Curies @ } 3.0 \text{ mRem/hr}) + 7/8 \times (\text{Curies @ } <0.5 \text{ mRem/hr})$

RADIONUCLIDE CURIE CONTENT CALCULATION WORKSHEET

Container PIN: _____

Radionuclide Dist.		Waste Densities (g/cm ³)			
Cs-137	40%	Plastic	0.9	Wood	0.9
Ba-137	40%	Paper	1.1	Dirt/Soil	2.0
Sr-90	10%	Air	0.001	Lead	11.3
Y-90	10%	Cloth	1.5	Glass	2.6
		Rubber	1.5	Asbestos (loose)	0.001
		Pumice	0.385	Asbestos (transite)	2.45
		Steel	7.86	Aluminum	2.70
		Stainless	7.86	Concrete (cinder)	1.60
		Copper	8.80	Concrete (Portland)	3.20

Calculate Average Density

Waste weight / container volume = average density.

$$\frac{\begin{array}{c} (\text{Kg} * 1000) \\ \text{grams} \end{array}}{\text{Waste weight}} \div \frac{\begin{array}{c} (\text{m}^3 * 1,000,000) \\ \text{cm}^3 \end{array}}{\text{Container Volume}} = \frac{\text{g/cm}^3}{\text{Average Density}}$$

Calculate Volume Percent

$$\frac{\text{Volume}}{\text{Total Volume}} = \text{Volume Percent}$$

$$\frac{(\text{LBS.} / 2.2 * 1000)}{\text{Waste Weight Grams}} \div \text{Density} = \text{Volume cc}$$

$$\frac{\text{Vol.cc}}{\text{Vol.cc}} + \frac{\text{Vol.cc}}{\text{Vol.cc}} + \frac{\text{Vol.cc}}{\text{Vol.cc}} + \frac{\text{Vol.cc}}{\text{Vol.cc}} + \frac{\text{Vol.cc}}{\text{Vol.cc}} = \frac{\text{TotalVol.cc}}{\text{TotalVol.cc}}$$

Use appropriate table from Appendix C or Microshield result to determine Ba-137m content.

$$\text{mCi}/\mu \text{Ba}_{137} =$$

$$\text{mCi}/\mu \text{Ci Cs}_{137} = \text{mCi}/\mu \text{Ba}_{137} =$$

$$\text{mCi}/\mu \text{Ci Sr}_{90} = \text{mCi}/\mu \text{Ba}_{137} \times \frac{1}{4} =$$

$$\text{mCi}/\mu \text{Ci Y}_{90} = \text{mCi}/\mu \text{Ba}_{137} \times \frac{1}{4} =$$

$$\text{Total} =$$

WASTE CATEGORY DETERMINATION WORKSHEET

REF: WHC-EP-0063-4, TABLE K-8 and K-9, PAGES K-19 and K-20

Container PIN: _____

Container Volume: _____

(1) Radionuclide Half-life > 5 yrs	(2) Curies/ Container	(3) Divide by m^3 of container to get (Ci/m^3)	(4) Divide column (3) by Table K-8 category 1 limit	(5) Divide column (3) by Table K-9 category 3 limit
(6) Total sum of the fractions				

- NOTE: (A)** If the total sum of the fractions is <1.0 for column (4) then you have a **CATEGORY 1 WASTE**.
- (B)** If the total sum of the fractions is >1.0 for column (4) you have a **CATEGORY 3 WASTE**, go to column (5) and calculate for **CATEGORY 3 WASTE**.
- (C)** If the total sum of the fractions in column (5) is >1.0 then you have a **GREATER THAN CATEGORY 3 WASTE (GTC3W)**.

Check appropriate box:

Category 1 waste []

Category 3 waste []

Greater than Category 3 waste []

Print name_____
Signature_____
Date

APPENDIX B

B PLANT COMPLEX WASTE COLLECTION AND STORAGE LOCATIONS

The following sections provide a list of the designated waste collection and storage location at B Plant Complex for hazardous, mixed and low level waste.

B.1 HAZARDOUS WASTE

Hazardous waste generated at B Plant Complex is either stored on the west side of the 226B "less than 90 day storage area" or accumulated at one of the seven satellite accumulation areas (SAA) located around B Plant Complex for specific waste streams. The seven SAAs are:

1. Location: 271B 1st floor AMU
Waste Stream: Miscellaneous dry cell batteries (Not for lead-acid batteries)
2. Location: Outside 221B Door #9
Waste Stream: Solid paint related waste
3. Location: Outside 272B Electrical Shop
Waste Stream: Non-PCB light ballasts
4. Location: Outside 272B Electrical Shop
Waste Stream: Non-leaking PCB light ballasts
5. Location: Outside 272B Electrical Shop
Waste Stream: Spent incandescent lamps
6. Location: Outside 225BE Maintenance Shop
Waste Stream: Regulated oily and solvent rags
7. Location: 221B R-13 Change-out Area
Waste Stream: Miscellaneous contaminated material

B.2 MIXED WASTE

Mixed waste generated at B Plant Complex is stored on the east side of the 226B "less than 90 day storage area".

B.3 LOW LEVEL WASTE

Table B.1 shows the locations at B Plant Complex which are designated as waste collection locations for compactible and/or non-compactible low level waste. In addition, low level waste packages awaiting shipment are stored on the asphalt pads located at 226B and on the south side of 221B.

Table B.1 B Plant Complex Low Level Waste Collection Locations

LOCATION	COMPACTIBLE	NON-COMPACTIBLE
WESF:		
Pool Cells Airlock	yes	no
Operating Gallery	yes	no
SWP Lobby	yes	no
Cold Manipulator Shop	yes	yes
Hot Manipulator Shop	yes	yes
Service Gallery (2)	yes	no
Truck Port	yes	no
Manipulator Repair Shop	yes	yes
Canyon (2)	yes	yes
Crane Pad	yes	no
B PLANT:		
Third Floor AMU (2)	yes	yes
Operating Gallery SWP Lobby	yes	yes
Railroad Cut	yes	yes
Door R-3	yes	yes
221-BB	yes	yes
291-B	yes	yes
2904-EA	yes	yes
Pipe Gallery	yes	yes
Stairwell #3	yes	yes
216-B-59	yes	yes
207-B	yes	yes
Electrical Gallery (3)	yes	yes
221-BF	yes	yes
212-B	yes	yes

APPENDIX C

MICROSHIELD CALCULATED WASTE PACKAGE CURIE CONTENTS

Table C.1 Microshield Calculated Curie Contents for 4'x4'x4' Plywood Boxes

Dose Rate mr/hr	Waste Package Density (g/cc)										
	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
	millicuries Ba-137m										
0.5	2.6	2.6	2.6	2.6	2.7	2.7	2.8	2.8	2.9	3.3	3.5
1.0	5.1	5.1	5.1	5.2	5.3	5.5	5.5	5.7	5.8	6.5	7.0
1.5	7.7	7.7	7.7	7.8	8.0	8.2	8.3	8.5	8.7	9.8	10.5
2.0	10.2	10.2	10.3	10.4	10.7	11.0	11.1	11.4	11.6	13.0	14.0
2.5	12.8	12.8	12.8	13.0	13.3	13.7	13.9	14.2	14.5	16.3	17.5
3.0	15.3	15.3	15.4	15.6	16.0	16.4	16.6	17.1	17.4	19.5	21.0
3.5	17.9	17.9	17.9	18.2	18.7	19.2	19.4	19.9	20.3	22.8	24.5
4.0	20.4	20.4	20.5	20.8	21.3	21.9	22.2	22.8	23.2	26.0	28.0
4.5	23.0	23.0	23.1	23.3	24.0	24.6	25.0	25.6	26.1	29.3	31.5
5.0	25.5	25.5	25.6	25.9	26.7	27.4	27.7	28.5	29.0	32.5	35.0
6.0	30.6	30.6	30.8	31.1	32.0	32.9	33.3	34.2	34.8	39.0	42.0
7.0	35.7	35.7	35.9	36.3	37.3	38.3	38.8	39.8	40.6	45.5	49.0
8.0	40.8	40.9	41.0	41.5	42.7	43.8	44.4	45.5	46.4	52.0	56.0
9.0	45.9	46.0	46.1	46.7	48.0	49.3	49.9	51.2	52.2	58.5	63.0
10.0	51.0	51.1	51.3	51.9	53.3	54.8	55.5	56.9	58.0	65.0	70.0
11.0	56.1	56.2	56.4	57.1	58.7	60.2	61.0	62.6	63.8	71.5	77.0
12.0	61.2	61.3	61.5	62.3	64.0	65.7	66.6	68.3	69.6	78.0	84.0
13.0	66.3	66.4	66.6	67.4	69.3	71.2	72.1	74.0	75.4	84.5	91.0
14.0	71.4	71.5	71.8	72.6	74.6	76.7	77.7	79.7	81.2	91.0	98.0
15.0	76.5	76.6	76.9	77.8	80.0	82.1	83.2	85.4	87.0	97.5	105.0
16.0	81.6	81.7	82.0	83.0	85.3	87.6	88.8	91.1	92.8	104.0	112.0
17.0	86.7	86.8	87.1	88.2	90.6	93.1	94.3	96.8	98.6	110.5	119.0
18.0	91.8	91.9	92.3	93.4	96.0	98.6	99.9	102.5	104.4	117.0	126.0
19.0	96.9	97.0	97.4	98.6	101.3	104.0	105.4	108.1	110.2	123.5	133.0
20.0	102.0	102.1	102.5	103.8	106.6	109.5	111.0	113.8	116.0	130.0	140.0
21.0	107.1	107.2	107.6	108.9	112.0	115.0	116.5	119.5	121.8	136.5	147.0
22.0	112.2	112.4	112.8	114.1	117.3	120.5	122.1	125.2	127.6	143.0	154.0
23.0	117.3	117.5	117.9	119.3	122.6	125.9	127.6	130.9	133.4	149.5	161.0
24.0	122.4	122.6	123.0	124.5	128.0	131.4	133.2	136.6	139.2	156.0	168.0
25.0	127.5	127.7	128.1	129.7	133.3	136.9	138.7	142.3	145.0	162.5	175.0
26.0	132.6	132.8	133.3	134.9	138.6	142.4	144.2	148.0	150.8	169.0	182.0
27.0	137.7	137.9	138.4	140.1	144.0	147.9	149.8	153.7	156.6	175.5	189.0
28.0	142.8	143.0	143.5	145.3	149.3	153.3	155.3	159.4	162.4	182.0	196.0
29.0	147.9	148.1	148.6	150.5	154.6	158.8	160.9	165.1	168.2	188.5	203.0
30.0	153.0	153.2	153.8	155.6	160.0	164.3	166.4	170.8	174.0	195.0	210.0
31.0	158.1	158.3	158.9	160.8	165.3	169.8	172.0	176.5	179.8	201.5	217.0

32.0	163.2	163.4	164.0	166.0	170.6	175.2	177.5	182.1	185.6	208.0	224.0
33.0	168.3	168.5	169.1	171.2	176.0	180.7	183.1	187.8	191.4	214.5	231.0
34.0	173.4	173.6	174.3	176.4	181.3	186.2	188.6	193.5	197.2	221.0	238.0
35.0	178.5	178.7	179.4	181.6	186.6	191.7	194.2	199.2	203.0	227.5	245.0
36.0	183.6	183.9	184.5	186.8	192.0	197.1	199.7	204.9	208.8	234.0	252.0
37.0	188.7	189.0	189.6	192.0	197.3	202.6	205.3	210.6	214.6	240.5	259.0
38.0	193.8	194.1	194.8	197.1	202.6	208.1	210.8	216.3	220.4	247.0	266.0
39.0	198.9	199.2	199.9	202.3	207.9	213.6	216.4	222.0	226.2	253.5	259.0
40.0	204.0	204.3	205.0	207.5	213.3	219.0	221.9	227.7	232.0	260.0	266.0
41.0	209.1	209.4	210.1	212.7	218.6	224.5	227.5	233.4	237.8	266.5	273.0
42.0	214.2	214.5	215.3	217.9	223.9	230.0	233.0	239.1	243.6	273.0	280.0
43.0	219.3	219.6	220.4	223.1	229.3	235.5	238.6	244.8	249.4	279.5	287.0
44.0	224.4	224.7	225.5	228.3	234.6	240.9	244.1	250.4	255.2	286.0	294.0
45.0	229.5	229.8	230.6	233.5	239.9	246.4	249.7	256.1	261.0	292.5	301.0
46.0	234.6	234.9	235.8	238.6	245.3	251.9	255.2	261.8	266.8	299.0	308.0
47.0	239.7	240.0	240.9	243.8	250.6	257.4	260.8	267.5	272.6	305.5	315.0
48.0	244.8	245.1	246.0	249.0	255.9	262.8	266.3	273.2	278.4	312.0	322.0
49.0	249.9	250.2	251.1	254.2	261.3	268.3	271.9	278.9	284.2	318.5	329.0
50.0	255.0	255.4	256.3	259.4	266.6	273.8	277.4	284.6	290.0	325.0	336.0
55.0	280.5	280.9	281.9	285.3	293.3	301.2	305.1	313.1	319.0	357.5	343.0
60.0	306.0	306.4	307.5	311.3	319.9	328.6	332.9	341.5	348.0	390.0	350.0
65.0	331.5	332.0	333.1	337.2	346.6	355.9	360.6	370.0	377.0	422.5	385.0
70.0	357.0	357.5	358.8	363.2	373.2	383.3	388.4	398.4	406.0	455.0	420.0
75.0	382.5	383.0	384.4	389.1	399.9	410.7	416.1	426.9	435.0	487.5	455.0
80.0	408.0	408.6	410.0	415.0	426.6	438.1	443.8	455.4	464.0	520.0	490.0
85.0	433.5	434.1	435.6	441.0	453.2	465.5	471.6	483.8	493.0	552.5	525.0
90.0	459.0	459.6	461.3	466.9	479.9	492.8	499.3	512.3	522.0	585.0	560.0
95.0	484.5	485.2	486.9	492.9	506.5	520.2	527.1	540.7	551.0	617.5	595.0
100.0	510.0	510.7	512.5	518.8	533.2	547.6	554.8	569.2	580.0	650.0	630.0
105.0	535.5	536.2	538.1	544.7	559.9	575.0	582.5	597.7	609.0	682.5	665.0
110.0	561.0	561.8	563.8	570.7	586.5	602.4	610.3	626.1	638.0	715.0	700.0
115.0	586.5	587.3	589.4	596.6	613.2	629.7	638.0	654.6	667.0	747.5	735.0
120.0	612.0	612.8	615.0	622.6	639.8	657.1	665.8	683.0	696.0	780.0	770.0
125.0	637.5	638.4	640.6	648.5	666.5	684.5	693.5	711.5	725.0	812.5	805.0
130.0	663.0	663.9	666.3	674.4	693.2	711.9	721.2	740.0	754.0	845.0	840.0
135.0	688.5	689.4	691.9	700.4	719.8	739.3	749.0	768.4	783.0	877.5	875.0
140.0	714.0	715.0	717.5	726.3	746.5	766.6	776.7	796.9	812.0	910.0	910.0
145.0	739.5	740.5	743.1	752.3	773.1	794.0	804.5	825.3	841.0	942.5	945.0
150.0	765.0	766.1	768.8	778.2	799.8	821.4	832.2	853.8	870.0	975.0	980.0
155.0	790.5	791.6	794.4	804.1	826.5	848.8	859.9	882.3	899.0	1007.5	1015.0

160.0	816.0	817.1	820.0	830.1	853.1	876.2	887.7	910.7	928.0	1040.0	1050.0
165.0	841.5	842.7	845.6	856.0	879.8	903.5	915.4	939.2	957.0	1072.5	1085.0
170.0	867.0	868.2	871.3	882.0	906.4	930.9	943.2	967.6	986.0	1105.0	1120.0
175.0	892.5	893.7	896.9	907.9	933.1	958.3	970.9	996.1	1015.0	1137.5	1155.0
180.0	918.0	919.3	922.5	933.8	959.8	985.7	998.6	1024.6	1044.0	1170.0	1190.0
185.0	943.5	944.8	948.1	959.8	986.4	1013.1	1026.4	1053.0	1073.0	1202.5	1225.0
190.0	969.0	970.3	973.8	985.7	1013.1	1040.4	1054.1	1081.5	1102.0	1235.0	1260.0
195.0	994.5	995.9	999.4	1011.7	1039.7	1067.8	1081.9	1109.9	1131.0	1267.5	1295.0
200.0	1020.0	1021.4	1025.0	1037.6	1066.4	1095.2	1109.6	1138.4	1160.0	1300.0	1330.0
210.0	1071.0	1072.5	1076.3	1089.5	1119.7	1150.0	1165.1	1195.3	1218.0	1365.0	1365.0
220.0	1122.0	1123.5	1127.5	1141.4	1173.0	1204.7	1220.6	1252.2	1276.0	1430.0	1400.0
230.0	1173.0	1174.6	1178.8	1193.2	1226.4	1259.5	1276.0	1309.2	1334.0	1495.0	1470.0
240.0	1224.0	1225.7	1230.0	1245.1	1279.7	1314.2	1331.5	1366.1	1392.0	1560.0	1540.0
250.0	1275.0	1276.8	1281.3	1297.0	1333.0	1369.0	1387.0	1423.0	1450.0	1625.0	1610.0
260.0	1326.0	1327.8	1332.5	1348.9	1386.3	1423.8	1442.5	1479.9	1508.0	1690.0	1680.0
270.0	1377.0	1378.9	1383.8	1400.8	1439.6	1478.5	1498.0	1536.8	1566.0	1755.0	1750.0
280.0	1428.0	1430.0	1435.0	1452.6	1493.0	1533.3	1553.4	1593.8	1624.0	1820.0	1820.0
290.0	1479.0	1481.0	1486.3	1504.5	1546.3	1588.0	1608.9	1650.7	1682.0	1885.0	1890.0
300.0	1530.0	1532.1	1537.5	1556.4	1599.6	1642.8	1664.4	1707.6	1740.0	1950.0	1960.0
310.0	1581.0	1583.2	1588.8	1608.3	1652.9	1697.6	1719.9	1764.5	1798.0	2015.0	2030.0
320.0	1632.0	1634.2	1640.0	1660.2	1706.2	1752.3	1775.4	1821.4	1856.0	2080.0	2100.0
330.0	1683.0	1685.3	1691.3	1712.0	1759.6	1807.1	1830.8	1878.4	1914.0	2145.0	2170.0
340.0	1734.0	1736.4	1742.5	1763.9	1812.9	1861.8	1886.3	1935.3	1972.0	2210.0	2240.0
350.0	1785.0	1787.5	1793.8	1815.8	1866.2	1916.6	1941.8	1992.2	2030.0	2275.0	2310.0
360.0	1836.0	1838.5	1845.0	1867.7	1919.5	1971.4	1997.3	2049.1	2088.0	2340.0	2380.0
370.0	1887.0	1889.6	1896.3	1919.6	1972.8	2026.1	2052.8	2106.0	2146.0	2405.0	2450.0
380.0	1938.0	1940.7	1947.5	1971.4	2026.2	2080.9	2108.2	2163.0	2204.0	2470.0	2520.0
390.0	1989.0	1991.7	1998.8	2023.3	2079.5	2135.6	2163.7	2219.9	2262.0	2535.0	2590.0
400.0	2040.0	2042.8	2050.0	2075.2	2132.8	2190.4	2219.2	2276.8	2320.0	2600.0	2660.0
410.0	2091.0	2093.9	2101.3	2127.1	2186.1	2245.2	2274.7	2333.7	2378.0	2665.0	2730.0
420.0	2142.0	2144.9	2152.5	2179.0	2239.4	2299.9	2330.2	2390.6	2436.0	2730.0	2800.0
430.0	2193.0	2196.0	2203.8	2230.8	2292.8	2354.7	2385.6	2447.6	2494.0	2795.0	2870.0
440.0	2244.0	2247.1	2255.0	2282.7	2346.1	2409.4	2441.1	2504.5	2552.0	2860.0	2940.0
450.0	2295.0	2298.2	2306.3	2334.6	2399.4	2464.2	2496.6	2561.4	2610.0	2925.0	3010.0
460.0	2346.0	2349.2	2357.5	2386.5	2452.7	2519.0	2552.1	2618.3	2668.0	2990.0	3080.0
470.0	2397.0	2400.3	2408.8	2438.4	2506.0	2573.7	2607.6	2675.2	2726.0	3055.0	3150.0
480.0	2448.0	2451.4	2460.0	2490.2	2559.4	2628.5	2663.0	2732.2	2784.0	3120.0	3220.0
490.0	2499.0	2502.4	2511.3	2542.1	2612.7	2683.2	2718.5	2789.1	2842.0	3185.0	3290.0
500.0	2550.0	2553.5	2562.5	2594.0	2666.0	2738.0	2774.0	2846.0	2900.0	3250.0	3360.0

Table C.2 Microshield Calculated Curie Contents for 55 Gallon Drums

Dose Rate mr/hr	Waste Package Density (g/cc)											
	0.00122	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	2.00
	millicuries Ba-137m											
0.50	0.17	0.17	0.18	0.19	0.21	0.23	0.24	0.26	0.27	0.30	0.32	0.60
1.00	0.34	0.35	0.35	0.37	0.41	0.45	0.47	0.51	0.54	0.59	0.65	1.20
1.50	0.51	0.52	0.53	0.56	0.62	0.68	0.71	0.77	0.81	0.89	0.97	1.80
2.00	0.68	0.70	0.71	0.74	0.82	0.90	0.94	1.02	1.08	1.19	1.30	2.40
2.50	0.85	0.87	0.88	0.93	1.03	1.13	1.18	1.28	1.35	1.49	1.62	3.00
3.00	1.02	1.04	1.06	1.11	1.23	1.35	1.41	1.53	1.62	1.78	1.95	3.60
3.50	1.19	1.22	1.23	1.30	1.44	1.58	1.65	1.79	1.89	2.08	2.27	4.20
4.00	1.36	1.39	1.41	1.48	1.64	1.80	1.88	2.04	2.16	2.38	2.60	4.80
4.50	1.53	1.56	1.59	1.67	1.85	2.03	2.12	2.30	2.43	2.68	2.92	5.40
5.00	1.70	1.74	1.76	1.85	2.05	2.25	2.35	2.55	2.70	2.97	3.25	6.00
6.00	2.04	2.09	2.12	2.22	2.46	2.70	2.82	3.06	3.24	3.57	3.90	7.20
7.00	2.38	2.43	2.47	2.59	2.87	3.15	3.29	3.57	3.78	4.16	4.55	8.40
8.00	2.72	2.78	2.82	2.96	3.28	3.60	3.76	4.08	4.32	4.76	5.20	9.60
9.00	3.06	3.13	3.17	3.33	3.69	4.05	4.23	4.59	4.86	5.35	5.85	10.80
10.00	3.40	3.48	3.53	3.70	4.10	4.50	4.70	5.10	5.40	5.95	6.50	12.00
11.00	3.74	3.82	3.88	4.07	4.51	4.95	5.17	5.61	5.94	6.54	7.15	13.20
12.00	4.08	4.17	4.23	4.44	4.92	5.40	5.64	6.12	6.48	7.14	7.80	14.40
13.00	4.42	4.52	4.58	4.81	5.33	5.85	6.11	6.63	7.02	7.73	8.45	15.60
14.00	4.76	4.87	4.94	5.18	5.74	6.30	6.58	7.14	7.56	8.33	9.10	16.80
15.00	5.10	5.21	5.29	5.55	6.15	6.75	7.05	7.65	8.10	8.92	9.75	18.00
16.00	5.44	5.56	5.64	5.92	6.56	7.20	7.52	8.16	8.64	9.52	10.40	19.20
17.00	5.78	5.91	5.99	6.29	6.97	7.65	7.99	8.67	9.18	10.11	11.05	20.40
18.00	6.12	6.26	6.35	6.66	7.38	8.10	8.46	9.18	9.72	10.71	11.70	21.60
19.00	6.46	6.60	6.70	7.03	7.79	8.55	8.93	9.69	10.26	11.30	12.35	22.80
20.00	6.80	6.95	7.05	7.40	8.20	9.00	9.40	10.20	10.80	11.90	13.00	24.00
21.00	7.14	7.30	7.40	7.77	8.61	9.45	9.87	10.71	11.34	12.49	13.65	25.20
22.00	7.48	7.65	7.76	8.14	9.02	9.90	10.34	11.22	11.88	13.09	14.30	26.40
23.00	7.82	7.99	8.11	8.51	9.43	10.35	10.81	11.73	12.42	13.68	14.95	27.60
24.00	8.16	8.34	8.46	8.88	9.84	10.80	11.28	12.24	12.96	14.28	15.60	28.80
25.00	8.50	8.69	8.81	9.25	10.25	11.25	11.75	12.75	13.50	14.87	16.25	30.00
26.00	8.84	9.04	9.17	9.62	10.66	11.70	12.22	13.26	14.04	15.47	16.90	31.20
27.00	9.18	9.38	9.52	9.99	11.07	12.15	12.69	13.77	14.58	16.06	17.55	32.40
28.00	9.52	9.73	9.87	10.36	11.48	12.60	13.16	14.28	15.12	16.66	18.20	33.60
29.00	9.86	10.08	10.22	10.73	11.89	13.05	13.63	14.79	15.66	17.25	18.85	34.80
30.00	10.20	10.43	10.58	11.10	12.30	13.50	14.10	15.30	16.20	17.85	19.50	36.00
31.00	10.54	10.77	10.93	11.47	12.71	13.95	14.57	15.81	16.74	18.44	20.15	37.20
32.00	10.88	11.12	11.28	11.84	13.12	14.40	15.04	16.32	17.28	19.04	20.80	38.40

33.00	11.22	11.47	11.63	12.21	13.53	14.85	15.51	16.83	17.82	19.63	21.45	39.60
34.00	11.56	11.82	11.99	12.58	13.94	15.30	15.98	17.34	18.36	20.23	22.10	40.80
35.00	11.90	12.16	12.34	12.95	14.35	15.75	16.45	17.85	18.90	20.82	22.75	42.00
36.00	12.24	12.51	12.69	13.32	14.76	16.20	16.92	18.36	19.44	21.42	23.40	43.20
37.00	12.58	12.86	13.04	13.69	15.17	16.65	17.39	18.87	19.98	22.01	24.05	44.40
38.00	12.92	13.21	13.40	14.06	15.58	17.10	17.86	19.38	20.52	22.61	24.70	45.60
39.00	13.26	13.55	13.75	14.43	15.99	17.55	18.33	19.89	21.06	23.20	25.35	46.80
40.00	13.60	13.90	14.10	14.80	16.40	18.00	18.80	20.40	21.60	23.80	26.00	48.00
41.00	13.94	14.25	14.45	15.17	16.81	18.45	19.27	20.91	22.14	24.39	26.65	49.20
42.00	14.28	14.60	14.81	15.54	17.22	18.90	19.74	21.42	22.68	24.99	27.30	50.40
43.00	14.62	14.94	15.16	15.91	17.63	19.35	20.21	21.93	23.22	25.58	27.95	51.60
44.00	14.96	15.29	15.51	16.28	18.04	19.80	20.68	22.44	23.76	26.18	28.60	52.80
45.00	15.30	15.64	15.86	16.65	18.45	20.25	21.15	22.95	24.30	26.77	29.25	54.00
46.00	15.64	15.99	16.22	17.02	18.86	20.70	21.62	23.46	24.84	27.37	29.90	55.20
47.00	15.98	16.33	16.57	17.39	19.27	21.15	22.09	23.97	25.38	27.96	30.55	56.40
48.00	16.32	16.68	16.92	17.76	19.68	21.60	22.56	24.48	25.92	28.56	31.20	57.60
49.00	16.66	17.03	17.27	18.13	20.09	22.05	23.03	24.99	26.46	29.15	31.85	58.80
50.00	17.00	17.38	17.63	18.50	20.50	22.50	23.50	25.50	27.00	29.75	32.50	60.00
51.00	17.34	17.72	17.98	18.87	20.91	22.95	23.97	26.01	27.54	30.34	33.15	61.20
52.00	17.68	18.07	18.33	19.24	21.32	23.40	24.44	26.52	28.08	30.94	33.80	62.40
53.00	18.02	18.42	18.68	19.61	21.73	23.85	24.91	27.03	28.62	31.53	34.45	63.60
54.00	18.36	18.77	19.04	19.98	22.14	24.30	25.38	27.54	29.16	32.13	35.10	64.80
55.00	18.70	19.11	19.39	20.35	22.55	24.75	25.85	28.05	29.70	32.72	35.75	66.00
56.00	19.04	19.46	19.74	20.72	22.96	25.20	26.32	28.56	30.24	33.32	36.40	67.20
57.00	19.38	19.81	20.09	21.09	23.37	25.65	26.79	29.07	30.78	33.91	37.05	68.40
58.00	19.72	20.16	20.45	21.46	23.78	26.10	27.26	29.58	31.32	34.51	37.70	69.60
59.00	20.06	20.50	20.80	21.83	24.19	26.55	27.73	30.09	31.86	35.10	38.35	70.80
60.00	20.40	20.85	21.15	22.20	24.60	27.00	28.20	30.60	32.40	35.70	39.00	72.00
61.00	20.74	21.20	21.50	22.57	25.01	27.45	28.67	31.11	32.94	36.29	39.65	73.20
62.00	21.08	21.55	21.86	22.94	25.42	27.90	29.14	31.62	33.48	36.89	40.30	74.40
63.00	21.42	21.89	22.21	23.31	25.83	28.35	29.61	32.13	34.02	37.48	40.95	75.60
64.00	21.76	22.24	22.56	23.68	26.24	28.80	30.08	32.64	34.56	38.08	41.60	76.80
65.00	22.10	22.59	22.91	24.05	26.65	29.25	30.55	33.15	35.10	38.67	42.25	78.00
66.00	22.44	22.94	23.27	24.42	27.06	29.70	31.02	33.66	35.64	39.27	42.90	79.20
67.00	22.78	23.28	23.62	24.79	27.47	30.15	31.49	34.17	36.18	39.86	43.55	80.40
68.00	23.12	23.63	23.97	25.16	27.88	30.60	31.96	34.68	36.72	40.46	44.20	81.60
69.00	23.46	23.98	24.32	25.53	28.29	31.05	32.43	35.19	37.26	41.05	44.85	82.80
70.00	23.80	24.33	24.68	25.90	28.70	31.50	32.90	35.70	37.80	41.65	45.50	84.00
71.00	24.14	24.67	25.03	26.27	29.11	31.95	33.37	36.21	38.34	42.24	46.15	85.20
72.00	24.48	25.02	25.38	26.64	29.52	32.40	33.84	36.72	38.88	42.84	46.80	86.40
73.00	24.82	25.37	25.73	27.01	29.93	32.85	34.31	37.23	39.42	43.43	47.45	87.60

74.00	25.16	25.72	26.09	27.38	30.34	33.30	34.78	37.74	39.96	44.03	48.10	88.80
75.00	25.50	26.06	26.44	27.75	30.75	33.75	35.25	38.25	40.50	44.62	48.75	90.00
76.00	25.84	26.41	26.79	28.12	31.16	34.20	35.72	38.76	41.04	45.22	49.40	91.20
77.00	26.18	26.76	27.14	28.49	31.57	34.65	36.19	39.27	41.58	45.81	50.05	92.40
78.00	26.52	27.11	27.50	28.86	31.98	35.10	36.66	39.78	42.12	46.41	50.70	93.60
79.00	26.86	27.45	27.85	29.23	32.39	35.55	37.13	40.29	42.66	47.00	51.35	94.80
80.00	27.20	27.80	28.20	29.60	32.80	36.00	37.60	40.80	43.20	47.60	52.00	96.00
81.00	27.54	28.15	28.55	29.97	33.21	36.45	38.07	41.31	43.74	48.19	52.65	97.20
82.00	27.88	28.50	28.91	30.34	33.62	36.90	38.54	41.82	44.28	48.79	53.30	98.40
83.00	28.22	28.84	29.26	30.71	34.03	37.35	39.01	42.33	44.82	49.38	53.95	99.60
84.00	28.56	29.19	29.61	31.08	34.44	37.80	39.48	42.84	45.36	49.98	54.60	100.80
85.00	28.90	29.54	29.96	31.45	34.85	38.25	39.95	43.35	45.90	50.57	55.25	102.00
86.00	29.24	29.89	30.32	31.82	35.26	38.70	40.42	43.86	46.44	51.17	55.90	103.20
87.00	29.58	30.23	30.67	32.19	35.67	39.15	40.89	44.37	46.98	51.76	56.55	104.40
88.00	29.92	30.58	31.02	32.56	36.08	39.60	41.36	44.88	47.52	52.36	57.20	105.60
89.00	30.26	30.93	31.37	32.93	36.49	40.05	41.83	45.39	48.06	52.95	57.85	106.80
90.00	30.60	31.28	31.73	33.30	36.90	40.50	42.30	45.90	48.60	53.55	58.50	108.00
91.00	30.94	31.62	32.08	33.67	37.31	40.95	42.77	46.41	49.14	54.14	59.15	109.20
92.00	31.28	31.97	32.43	34.04	37.72	41.40	43.24	46.92	49.68	54.74	59.80	110.40
93.00	31.62	32.32	32.78	34.41	38.13	41.85	43.71	47.43	50.22	55.33	60.45	111.60
94.00	31.96	32.67	33.14	34.78	38.54	42.30	44.18	47.94	50.76	55.93	61.10	112.80
95.00	32.30	33.01	33.49	35.15	38.95	42.75	44.65	48.45	51.30	56.52	61.75	114.00
96.00	32.64	33.36	33.84	35.52	39.36	43.20	45.12	48.96	51.84	57.12	62.40	115.20
97.00	32.98	33.71	34.19	35.89	39.77	43.65	45.59	49.47	52.38	57.71	63.05	116.40
98.00	33.32	34.06	34.55	36.26	40.18	44.10	46.06	49.98	52.92	58.31	63.70	117.60
99.00	33.66	34.40	34.90	36.63	40.59	44.55	46.53	50.49	53.46	58.90	64.35	118.80
100.00	34.00	34.75	35.25	37.00	41.00	45.00	47.00	51.00	54.00	59.50	65.00	120.00
105.00	35.70	36.49	37.01	38.85	43.05	47.25	49.35	53.55	56.70	62.47	68.25	126.00
110.00	37.40	38.23	38.78	40.70	45.10	49.50	51.70	56.10	59.40	65.45	71.50	132.00
115.00	39.10	39.96	40.54	42.55	47.15	51.75	54.05	58.65	62.10	68.42	74.75	138.00
120.00	40.80	41.70	42.30	44.40	49.20	54.00	56.40	61.20	64.80	71.40	78.00	144.00
125.00	42.50	43.44	44.06	46.25	51.25	56.25	58.75	63.75	67.50	74.37	81.25	150.00
130.00	44.20	45.18	45.83	48.10	53.30	58.50	61.10	66.30	70.20	77.35	84.50	156.00
135.00	45.90	46.91	47.59	49.95	55.35	60.75	63.45	68.85	72.90	80.32	87.75	162.00
140.00	47.60	48.65	49.35	51.80	57.40	63.00	65.80	71.40	75.60	83.30	91.00	168.00
145.00	49.30	50.39	51.11	53.65	59.45	65.25	68.15	73.95	78.30	86.27	94.25	174.00
150.00	51.00	52.13	52.88	55.50	61.50	67.50	70.50	76.50	81.00	89.25	97.50	180.00
155.00	52.70	53.86	54.64	57.35	63.55	69.75	72.85	79.05	83.70	92.22	100.75	186.00
160.00	54.40	55.60	56.40	59.20	65.60	72.00	75.20	81.60	86.40	95.20	104.00	192.00
165.00	56.10	57.34	58.16	61.05	67.65	74.25	77.55	84.15	89.10	98.17	107.25	198.00
170.00	57.80	59.08	59.93	62.90	69.70	76.50	79.90	86.70	91.80	101.15	110.50	204.00

175.00	59.50	60.81	61.69	64.75	71.75	78.75	82.25	89.25	94.50	104.12	113.75	210.00
180.00	61.20	62.55	63.45	66.60	73.80	81.00	84.60	91.80	97.20	107.10	117.00	216.00
185.00	62.90	64.29	65.21	68.45	75.85	83.25	86.95	94.35	99.90	110.07	120.25	222.00
190.00	64.60	66.03	66.98	70.30	77.90	85.50	89.30	96.90	102.60	113.05	123.50	228.00
195.00	66.30	67.76	68.74	72.15	79.95	87.75	91.65	99.45	105.30	116.02	126.75	234.00
200.00	68.00	69.50	70.50	74.00	82.00	90.00	94.00	102.00	108.00	119.00	130.00	240.00
205.00	69.70	71.24	72.26	75.85	84.05	92.25	96.35	104.55	110.70	121.97	133.25	246.00
210.00	71.40	72.98	74.03	77.70	86.10	94.50	98.70	107.10	113.40	124.95	136.50	252.00
215.00	73.10	74.71	75.79	79.55	88.15	96.75	101.05	109.65	116.10	127.92	139.75	258.00
220.00	74.80	76.45	77.55	81.40	90.20	99.00	103.40	112.20	118.80	130.90	143.00	264.00
225.00	76.50	78.19	79.31	83.25	92.25	101.25	105.75	114.75	121.50	133.87	146.25	270.00
230.00	78.20	79.93	81.08	85.10	94.30	103.50	108.10	117.30	124.20	136.85	149.50	276.00
235.00	79.90	81.66	82.84	86.95	96.35	105.75	110.45	119.85	126.90	139.82	152.75	282.00
240.00	81.60	83.40	84.60	88.80	98.40	108.00	112.80	122.40	129.60	142.80	156.00	288.00
245.00	83.30	85.14	86.36	90.65	100.45	110.25	115.15	124.95	132.30	145.77	159.25	294.00
250.00	85.00	86.88	88.13	92.50	102.50	112.50	117.50	127.50	135.00	148.75	162.50	300.00
255.00	86.70	88.61	89.89	94.35	104.55	114.75	119.85	130.05	137.70	151.72	165.75	306.00
260.00	88.40	90.35	91.65	96.20	106.60	117.00	122.20	132.60	140.40	154.70	169.00	312.00
265.00	90.10	92.09	93.41	98.05	108.65	119.25	124.55	135.15	143.10	157.67	172.25	318.00
270.00	91.80	93.83	95.18	99.90	110.70	121.50	126.90	137.70	145.80	160.65	175.50	324.00
275.00	93.50	95.56	96.94	101.75	112.75	123.75	129.25	140.25	148.50	163.62	178.75	330.00
280.00	95.20	97.30	98.70	103.60	114.80	126.00	131.60	142.80	151.20	166.60	182.00	336.00
285.00	96.90	99.04	100.46	105.45	116.85	128.25	133.95	145.35	153.90	169.57	185.25	342.00
290.00	98.60	100.78	102.23	107.30	118.90	130.50	136.30	147.90	156.60	172.55	188.50	348.00
295.00	100.30	102.51	103.99	109.15	120.95	132.75	138.65	150.45	159.30	175.52	191.75	354.00
300.00	102.00	104.25	105.75	111.00	123.00	135.00	141.00	153.00	162.00	178.50	195.00	360.00
310.00	105.40	107.73	109.28	114.70	127.10	139.50	145.70	158.10	167.40	184.45	201.50	372.00
320.00	108.80	111.20	112.80	118.40	131.20	144.00	150.40	163.20	172.80	190.40	208.00	384.00
330.00	112.20	114.68	116.33	122.10	135.30	148.50	155.10	168.30	178.20	196.35	214.50	396.00
340.00	115.60	118.15	119.85	125.80	139.40	153.00	159.80	173.40	183.60	202.30	221.00	408.00
350.00	119.00	121.63	123.38	129.50	143.50	157.50	164.50	178.50	189.00	208.25	227.50	420.00
360.00	122.40	125.10	126.90	133.20	147.60	162.00	169.20	183.60	194.40	214.20	234.00	432.00
370.00	125.80	128.58	130.43	136.90	151.70	166.50	173.90	188.70	199.80	220.15	240.50	444.00
380.00	129.20	132.05	133.95	140.60	155.80	171.00	178.60	193.80	205.20	226.10	247.00	456.00
390.00	132.60	135.53	137.48	144.30	159.90	175.50	183.30	198.90	210.60	232.05	253.50	468.00
400.00	136.00	139.00	141.00	148.00	164.00	180.00	188.00	204.00	216.00	238.00	260.00	480.00
500.00	170.00	173.75	176.25	185.00	205.00	225.00	235.00	255.00	269.99	297.50	325.00	600.00
1000.00	340.00	347.50	352.50	370.00	410.00	450.00	470.00	510.00	539.99	595.00	650.00	1200.00
1500.00	510.00	521.25	528.75	555.00	615.00	675.00	705.00	765.00	809.98	892.50	975.00	1800.00