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Technical Basis Document for S300 Firing Facilities Waste Identification and Characterization

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S300 Firing Facilities Waste Identification and Characterization

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1. Introduction

Site 300 (S300) firing facilities at Lawrence Livermore National Laboratory (LLNL) include a Contained Firing Facility (CFF) at Building 801 (B801) and the open-air shot table at Building 851. The B801 facility includes a 60-kg firing chamber and related support areas, and provides blast-effects containment for high explosive firing operations. Even though these operations are within current environmental limits, containment of the blast effects and hazardous debris further reduces emissions to the environment and minimizes the hazardous and radioactive waste generated.

The firing chamber is a sealed structure that contains very high-amplitude, short-duration impulsive shock pressures, but also contains the much lower amplitude and longer duration quasi-static gas pressures that are typical of explosives detonated in closed firing chambers. Anchored to the inside of the concrete chamber surfaces are 38-50 mm liner plates for shrapnel protection. All doors, optical Line of Site, and other intrusions into the firing chamber (such as the FXR bullnose) have seals that allow the firing chamber to contain the blast effects of up to 60 kg of high explosives. After detonation generated gases cool, blast dampers open, and ventilation fans purge the chamber with fresh air. The exhaust gases are processed through a scrubber system and HEPA filters before being released to the environment. Slightly negative atmospheric pressures are maintained afterward in the firing chamber and the support area to reduce the escape of unprocessed airborne hazardous particulates and gases to the environment. Solid wastes and shot-related debris are greatly diminished as compared to other open air firing configurations, and are collected and disposed of primarily as low-level radioactive waste or as mixed waste if appropriate. An internal, closed loop, water wash-down system re-circulates water sprayed throughout the chamber and filters out dust and particulates using a polishing filter system.

Extensive sampling and analysis of waste stream components has been conducted over the last 20 years to support the characterization of waste generated from firing table operations. This information has been used to guide the separation and segregation of CFF waste streams. In addition to the sampling and analysis data, B Division has maintained extensive records of the hazardous and radioactive materials used in firing table experiments. For each experiment, a *B Division Site 300 Shot Materials Database Input Record* (see example in Appendix A) is completed. This information, coupled with historical sampling and analysis data, provides a complete picture of the disposition of waste materials during an experiment.

Low-level waste generated at S300 is contaminated primarily by depleted uranium. This document is specific to wastes generated from explosive testing performed at B Division firing table facility.

This document addresses waste identification and characterization for low-level waste, mixed waste and California-combined waste destined for direct disposal off-site at an approved disposal facility or for transfer to LLNL Main site.

2. Definitions

Container Custodian - Individual(s) assigned to control low-level waste containers and verify contents of waste parcels. Container Custodians are designated and approved by the Waste Certification Official (WCO).

Low-level Waste – Radioactive waste that is not high-level radioactive waste, spent nuclear fuel, transuranic waste and byproduct material (as defined in section 11e(1) of the Atomic Energy Act of 1952, as amended).

California-combined – Low-level waste containing California regulated waste.

Mixed Waste - Waste that includes both radioactive waste and hazardous wastes as identified in Code of Federal Regulations (CFR), Title 40.

3. Chamber Balance and Distribution at CFF

This section describes the distribution of radioactive materials in dry wastes generated at the CFF. This is achieved by using mass balance data from the shot materials database or logbook maintained in the B Division S300 administrative files. In order to do this, the amount of radioactive materials that could be dispersed must be established. This number is equal to the weight of radioactive materials used in the shot, plus five percent of the radioactive material weight from the previous shot (the chamber residual). The total of these two numbers is called the Chamber Balance. (See example of chamber balance below). Dry waste streams have been assigned factoring numbers that can be multiplied by the Chamber Balance to total the radioactive material weight in that specific waste stream.

The S300 Field Technician records the quantity of the radioactive material in the waste on the Waste Disposal Requisition, and records the shot number on the *S300 Low-level Waste Container Fill Record* (WGS 0159), which are used to describe the contents of the waste container.

Prior to natural uranium, thorium or tritium being used in a firing chamber experiment, the program responsible person must notify the S300 Field Technician. The S300 Field Technician then notifies the Radiological Characterization Analyst (RCA) and requests development of a quantification strategy. See example in Table I.

Table I, Example of Chamber Balance and Distribution

A shot containing radioactive material equaling 6,000 grams would leave a residual of 300 grams in the chamber after clean up. (5% or the radioactive material weight divided by 20). That residual amount is added to the next shot weight and is called the chamber balance. If the very next shot after the one listed above contained 3,000 grams of radioactive material, the residual would be carried over and they both would equal 3,300 grams. This is the number used to calculate the distribution of radioactive material in each of the dispersible waste streams. Using 3,300 grams of radiological weight, you can quantify waste from waste streams A, C and D by multiplying the 3,300 by 0.6. 3,300 x 0.6 = 1,980 grams of radioactive material in the rinsed pre-filter frames, chamber debris and personal protective equipment (PPE) from that shot. When non-radioactive shots are performed in the firing chamber the chamber balance drops significantly. As a rule, the chamber balance shall go no lower than 50 grams. This is done to account for fixed contamination that will be re-dispersed after an explosives test. If a shot is not detonated or is fully recovered after the experiment the chamber balance will not change from the previous shot. Quantification methods other than the chamber balance approach may be approved as documented in the applicable IGD.

4. Waste Stream Distribution and Characterization at CFF

All waste streams are generated under approved IGDs.

Air Filters

Waste Stream A: Pre-filters

Process Description
Pre-filters are used in the HEPA plenum to protect the HEPA filters from excessive loading. They are routinely changed after each shot but can remain in the system for multiple experiments depending on shot size and particulate loading.

Sampling of the pre-filters has been conducted on what is considered the worst-case contamination by metals used in CFF experiments. After a review of the sampling data, the WCO has determined that the pre-filters can be taken to the firing chamber during wet operations and rinsed to the weir. The filters are then packed in an approved low-level radioactive waste container and managed as certified low-level waste along with the solid debris and PPE from waste streams C and D. The date, description, HAC # and bunker # are recorded on the *S300 Low-level Waste Container Fill Record* (WGS 0159) when these wastes are placed into the approved low-level waste containers.

This waste stream is quantified by 0.6 multiplied by the Chamber Balance.

Identification of Waste Stream Components
The waste stream consists of rinsed contaminated pre-filters, including metal or cardboard frames, wire mesh and plastic bags. Sampling and analysis of this waste stream has been done to determine the regulatory status. The need for additional sampling shall be evaluated by the Environmental Analyst (EA) when shots containing elevated levels of regulated metals are used.

Waste Stream B: HEPA Filters

Process Description
HEPA filters are used at the CFF to control the release of airborne particulates. Annually, the Industrial Hygiene Instrument Laboratory performs a functional test and certifies each individual HEPA filter. Certification stickers are located on the outside of the HEPA plenum and are clearly marked with the Month and Year of the certification. HEPA filters that cannot pass the annual certification will be replaced.

Contaminated HEPA filters are removed from the plenum by a complex bag out procedure. The waste stream will consist of contaminated HEPA filters and plastic bags. It is expected that through the operation of the facility the filters will become contaminated with particulates containing regulated metals and radioactive particulates.

Identification of Waste Stream Components
HEPA filters may be quantified by multiplying the Chamber Balance from all of the shots performed during the use of the filter by x 0.005, or other method (e.g., gamma spectroscopy). The remainder represents the amount of radioactive material on one HEPA filter. Additional sampling for toxic metals and/or generator knowledge from the shot database may be used to determine the regulatory status and the requirements for disposal. The need for additional sampling shall be evaluated by the EA when shots containing elevated levels of regulated metals are used.

Solid Debris

The WCO approves all mechanical equipment included in this waste stream via an IGD.

Waste Stream C: Solid debris from firing chamber clean-up operations

Process Description
After an explosives experiment, contaminated debris is removed from the firing chamber. Prior to debris removal, the chamber is inspected by B Division personnel and released for all explosives hazards (Confirmed High Order Explosion). After being released, a wash down of the firing chamber is performed. A wash down consists of the use of a high volume spray nozzle to deluge the chamber. Approximately 3,000 gallons of wash water is used for each wash down.

When the wash down process is complete, workers enter the chamber and prepare the debris for removal. Debris is rinsed of all particulates. Debris is encapsulated and dried prior to removal. The debris (unless otherwise determined) is managed as certified low-level waste along with the rinsed pre-filters and PPE from waste streams A and D. The date, description, HAC # and Bunker # are recorded on the *S300 Low-level Waste Container Fill Record* (WGS 0159) when these wastes are placed into the approved low-level radioactive waste containers.

This waste stream is quantified by 0.6 multiplied by the Chamber Balance.

Identification of Waste Stream Components
Chamber debris consists of solid items such as steel plates and shields, aluminum frames, copper cables and diagnostic components such as mirrors and glass.

Dry Inert Materials

Waste Stream D: Personnel Protective Equipment (PPE)

Process Description
PPE is commonly used at the CFF. When discarded, PPE is collected in plastic bags and managed as certified low-level waste along with rinsed pre-filter frames from waste stream A and solid debris from Waste Stream C. The date, description, HAC # and Bunker # are recorded on the *S300 Low-level Waste Container Fill Record* (WGS 0159) when these wastes are placed into the approved low-level radioactive waste containers.

This waste stream is quantified by 0.6 multiplied by the Chamber Balance.

Identification of Waste Stream Components
This waste stream consists of disposable protective coveralls, booties, rubber gloves and boots, tape and respirator cartridges.

Factoring Numbers for Water Filters

Waste Stream G: Scrubber Polishing Filters

Process Description
The scrubber is used to control acid gases and particulates that may be generated in the firing chamber after an explosives test. To prevent build up, water is constantly pumped to the top of the scrubber to the jets. An inline polishing filter has been added to the scrubber to prevent the jets from clogging. Depending on shot sizes and configuration the polishing filters may not load up for several shots. The date, description, HAC # and Bunker # are recorded on the *S300 Low-level Waste Container Fill Record* (WGS 0159) when these wastes are placed into the approved waste containers.

Identification of Waste Stream Components
Scrubber polishing filters are quantified by multiplying the Chamber Balance from all of the shots performed during the use of the filters by x 0.1, or by assay. The remainder represents the amount of radioactive material on all nine of the polishing filters removed. Additional sampling for toxic metals and/or generator knowledge from the shot database may be used to determine the regulatory status (low-level waste [non-NNSS] or mixed) and the requirements for disposal.

Waste Stream H: Wash Water Polishing Filters

Process Description
The 20,000-gallon wash water holding tank is equipped with a series of polishing filters designed to remove particulates from the wash down water, allowing re-use of the water. After a firing chamber wash down, contaminated water flows to the weir to catch large pieces of debris (greater than 1/8"). The wash water then flows from a weir drain to a 4,000-gallon lift tank. Wash water from the lift tank is pumped to the 20,000-gallon tank located outside of the building in the north containment berm. The wash water is then pumped through a series of polishing filters and re-circulated back to the 20,000-gallon tank. The wash water polishing filters will require replacement when they become loaded. Depending on shot sizes and configuration, the polishing filters may load several times to meet mandated polishing requirements. The date, description, HAC # and Bunker # are recorded on the *S300 Low-level Waste Container Fill Record* (WGS 0159) when these wastes are placed into the approved waste containers.

Identification of Waste Stream Components
Wash water polishing filters are quantified by multiplying the Chamber Balance from all of the shots performed during the use of the filters by x 0.1. The remainder represents the amount of radioactive material on all of the polishing filters removed until the next shot. Additional sampling for toxic metals and/or generator knowledge from the shot database may be used to determine the regulatory status (low-level waste [non-NNSS] or mixed waste) and the requirements for disposal.

5. Special Case – Scattered Explosives

Special cases are evaluated on a new or separate IGD.

If explosives are inadvertently scattered as a result of a misfire, its components and debris will be subject to specific cleaning processes and evaluations.

Results from the sampling of wastes generated during system qualification tests indicated that reactive levels of explosives are not present in the waste streams.

6. Firing Facility Wastes from Outdoor Shot Tables

Following the shot, debris is raked and pieces sorted by the bunker crew under the supervision of the Bunker Supervisor or designee. Wastes are segregated into one or more of the following groupings, as applicable, and placed into the containers specified below. Special precautions are taken to ensure that waste identified as containing, or potentially containing, hazardous waste constituents, or potential mixed waste, is isolated from low-level waste.

- Gravel and small fragments - Wastes are transferred to B804 Low-level Waste Staging Area holding bin.
- Large debris - Wastes are loaded into cargo containers. The gross load of the cargo container shall not exceed 40,000 pounds. The cargo containers are loaded as efficiently as possible. Void spaces shall be minimized.

Radionuclide Determination and Quantification
The S300 Field Technician records the activity of the waste on the Waste Disposal Requisition. The RCA determines the activity by applying the following methodologies:

- Gravel: To determine the amount of radioactive materials present, initiate the data quality objective (DQO) process described in *Data Quality Objectives* (WIC 140) or use past data from the DQO process to develop a contamination factor that may be applied based on the mass of gravel generated from shot table activities.
- Debris: Determine the maximum amount of radioactive materials that might be contained in the experiments by reviewing the shot records associated with generating the debris and multiply by 0.10

At the discretion of the RCA, gamma spectroscopy may be used to quantify isotopes in specific items and packages.

Hazardous material determination and quantification
The program responsible person notifies the RCA for S300 prior to experiments using regulated hazardous materials, as determined by the EA, so a characterization strategy can be developed through normal procedures (e.g., a new IGD).

For experiments not using significant quantities of regulated hazardous materials the RCA reviews the shot records to ensure that any materials on the shot record will not result in the waste material being regulated (e.g., copper wiring is often used, but does not result in enough finely divided metal in the waste to make a hazardous determination).

The RCA requests EA evaluation and sampling if necessary to determine the waste classification.

7. References

1. Code of Federal Regulations (CFR), Title 40, *Protection of Environment*.

2. RHWM. Controlled Form WGS 0159, *S300 Low-level Waste Container Fill Record,* latest revision.

3. RHWM. *Radioactive and Hazardous Waste Management Waste Acceptance Criteria*, LLNL-AM-570052, latest revision.

4. RHWM. Controlled Procedure, WIC 140, *Data Quality Objectives,* latest revision.

8. **Appendix A** – Example of B Division Site 300 Shot Materials Database Input.

Appendix A
Example of B Division S300 Shot Materials Database Input

B Division Site 300 Shot Materials Database Input

A. For purposes of better Quality Assurance: This form is to be taken from the server for each use. All entries by both **RAMROD** and **BUNKER STAFF** are to be made electronically. Signatures are to be in **BLUE** ink. Corrections to the hardcopy of this completed form are to be made **ONLY** by a single line-out (no whiteout) initial and date.

B. List ONLY materials that will either be expended, scattered or will end up in the waste stream; do NOT list recoverable materials.

C. Bunker Supervisors MUST be notified well in advance of any experiment containing materials listed below that are preceded by double carats (^^).

D. If this complete form is Classified, submit it appropriatly as a classified work paper.

E. If this completed form is UNCLASSIFIED, submit it with the Pre-Shot.

F. * means LX-10, 9404, Comp-B, propellant, ect. ** means and/or compounds

	RAMROD Entries	BUNKER Entries
Bunker Shot #		-FY09-
Shot Name		
Fire date		
Fire Time		
Location		

Only HE columns shaded this way are to be entered into the database

	#	RAMROD Entries **Name or type**	RAMROD Entries **Before Shot** Estimate or design weight	BUNKER Entries **Before Shot** Actual measured weight	BUNKER Entries **After Shot** Picked up	BUNKER Entries **After Shot** Detonated or not retrieved
HE	1					
HE	2					
HE	3					
HE	4					
HE	5					
HE	6					
HE TOTALS >>>>>>>						
HE TOTALS in lb. >>						

Air Permit Calculations — Place X in Green Box if Chamber Air SCRUBBER is to be used

	Air Permit N-472-62-1 Limits for THIS Shot	**Before Shot** Estimate or design weight	**Before Shot** Actual measured weight	**After Shot** Picked up	**After Shot** Detonated or not retrieved
CO	0.3980 lb/lb HE				
NOX	0.0265 lb/lb HE				
SOX	0.0010 lb/lb HE				
NH_3	0.0218 lb/lb HE				
H_2S	0.0155 lb/lb HE				
HCN	0.0210 lb/lb HE				
HF	0.0010 lb/lb HE				
HCL	0.0210 lb/lb HE				

All PM10 emissions from chamber pass through HEPA filters and are below .00006 pound per pound of explosive.

= grams of Lead used in THIS shot per gm of explosive expended

	Pounds of gas produced for THIS Shot	**Before Shot** Estimate or design weight	**Before Shot** Actual measured weight	**After Shot** Picked up	**After Shot** Detonated or not retrieved
CO					
NOX					
SOX					
NH_3					
H_2S					
HCN					
HF					
HCL					

Note: All material quantities listed below must be less than the quantities authorized for use in the Tier 3 Safety Basis Document for the B Division Site 300 Firing Areas

1	Antimony**	gm	gm
2	Arsenic**	gm	gm
3	Asbestos	gm	gm
4	***Barium****	gm	gm
5	Beryllium**	gm	gm
6	***Cadmium****	gm	gm
7	***Chromium****	gm	gm
8	Cobalt**	gm	gm
9	Copper**	gm	gm
10	Corrosives (eg.,acids, bases)	ml	ml
11	***Lead****	gm	gm
12	***Mercury****	gm	gm
13	Molybdenum**	gm	gm
14	Nickel**	gm	gm
15	PCBs (e.g., in capacitors)	ml	ml
16	Salt, fluoride	gm	gm
17	Salt, other lithium compnds	gm	gm
18	***Selenium****	gm	gm
19	***Silver****	gm	gm
20	Solvents	ml	ml
21	Thallium**	gm	gm
22	Thorium**	gm	gm
23	Tritium (micrograms)	ugm	ugm
24	Uranium, depleted**	gm	gm
25	Vanadium**	gm	gm
26	Zinc**	gm	gm

Comments (include description of unusual forms of materials):

This completed form must be reviewed and signed by the LLNL Waste Certification Officer, certifying that the container contents are as reported on this form.

Ramrod name (please print):	**Ramrod signature (blue ink ONLY):**
Bunker rep name (please print):	**Bunker Rep signature (blue ink ONLY):**

WASTE CERTIFICATION PROGRAM REPRESENTATION:

SIGNATURE:	**DATE:**