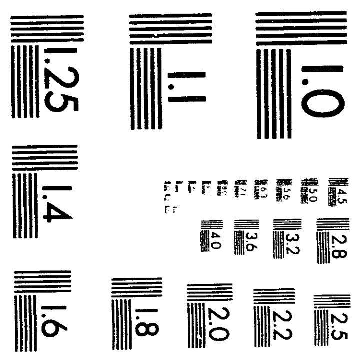
1.0
1.1
1.25
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Identification and Evaluation of the Nonradioactive Toxic Components in LLNL Weapon Designs—Phase I

James S. Johnson
Anne E. Lipska-Quinn

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LAWRENCE LIVERMORE NATIONAL LABORATORY
University of California • Livermore, California • 94551

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Introduction

The proper industrial hygiene strategy and response to a weapons accident is dependent upon the nonradioactive toxic materials contained in each weapon system. For example, in order to use the proper sampling and support equipment, e.g., personal protective and air sampling equipment, the Accident Response Group (ARG) Team needs a detailed inventory of nonradioactive toxic and potentially toxic materials in the weapon systems. The DOE Albuquerque Office of Operations funded the Lawrence Livermore National Laboratory (LLNL), Los Alamos National Laboratory (LANL) and Sandia National Laboratory to identify and evaluate the nonradioactive toxic components of their respective weapons designs. This report summarizes LLNL's first year's activities and results.

Several meetings were held with the LANL and Sandia staff to exchange ideas and gain consensus on how to approach the task of collecting the information about each weapon design. This interaction led to the acceptance of the LLNL's overall approach to the data acquisition task and data presentation format. It was also agreed that several additional topics should be included in the spreadsheets to render a more comprehensive toxicological assessment of the components of interest. The reviews and the agreement on approach and format will generate information from the three participating laboratories which can easily be integrated into a final ARG reference manual.

This project was initially planned to solely address the identification and evaluation of nonradioactive toxic and potentially toxic materials in one phase. During this analysis, however, it became evident that a Phase II effort is required to accurately define what types of accidents these weapons designs could be subject to, and what secondary toxic products and residues could be generated under certain conditions.

Phase I reviewed LLNL weapon designs in the stockpile and the storage and transportation container designated as "FL" container to identify the nonradioactive toxic material components and their amounts. The information was obtained from Physics drawings of each design and from interactions with LLNL's Weapons Engineering Group personnel. Two types of spreadsheets were prepared for each design to identify the toxic or potentially toxic components. The first spreadsheet, Figure 1 contains the information in Table 1.

NONRADIOACTIVE TOXIC OR POTENTIALLY TOXIC MATERIALS IN LLNL DESIGNS

*ITEM	NUMBER	PART NAME	DESCRIPTION		AMOUNT	ODOR	HAZARD							**Personal Protective Equipment (PPE)
			CHEMICAL	PHYSICAL	GRAMS	CHARCT/TLV	TOXICITY					FLAMMABLE	EXPLOSIVE	
							Rat Oral LD50 (mg/kg)	Eye Irritation (mg)	Skin Irritation (mg/kg)	LC/Inhalation/ Ingestion	Carcinogenicity/ Mutagenicity			See Footnote

* Indicates location of part in Physics drawing; N.D.= No Data; N.A.= Not applicable

** PPE selections should be based on the potential for direct contact of the material with the skin, eyes or respiratory tract.

1. Initial entry using an SCBA and anti-contamination PPE should be used to determine the condition of the weapon and components
2. Normal radiological control PPE e.g. fullface respirator with organic vapor/HEPA filter, anti-contamination clothing, booties and PVC, nitrile (4H or Silver Shield) or butyl gloves

Figure 1. Spreadsheet to tabulate nonradioactive toxic or potentially toxic materials in LLNL weapon designs.

Table 1. Headings and functions in Figure 1 spreadsheet.

Heading	Function
Item	lists the ID # of the component as it appears on the Physics drawing
Number	identifies each part by its six-digit number
Part name	identifies each part by name as it appears on the composite Physics drawing
Chemical description	lists the chemical name of the part
Physical description	powder, foam, fibers, liquid, gas
Amount	lists the weight of each part
Odor	lists characteristic odor of the chemical and/or the ACGIH threshold limit value
Hazard	identifies the innate toxicity, flammability and explosive property of each part where appropriate
Toxicity	involves rat oral LD_{50}, eye irritation, skin irritation, LC/inhalation/ingestion and carcinogenicity/mutagenicity if available in the published literature
Flammable hazard	lists the temperature responsible for the production of toxic products from the identified material
Explosive hazard	lists the temperature which leads to explosion of the chemical where appropriate
Personal protective equipment	recommends protective clothing and equipment

The second type of spreadsheet, Figure 2, sums up the weight for specific chemicals and elements; it lists chemicals according to their total weight in descending order. Information on Figure 2 of each weapon design is used to create a summary spreadsheet, Figure 3, which lists, in alphabetical order, all toxic or potentially toxic materials and the total quantities of each material in the Physics package. The third spreadsheet is a succinct summary sheet, which shows the quantitative distribution of the chemicals contained in the 12 LLNL weapons designs. In addition, a fourth spreadsheet, Figure 4, is included for the "FL" container (presently used at LLNL to transport and store all 12 weapons designs).

The last task of Phase I sets up a file folder for each design and its shipping container. The folder draws together all of the pertinent information compiled and created for current LLNL designs; it will contain the two design-specific spreadsheets, the summary Physics drawing and available MSDS (material safety data sheets).

Methodology

Our approach comprised two main steps. The initial step acquired the following drawings: (1) Physics drawings and their corresponding component lists for each weapon design from LLNL's Weapons Engineering Print Room; (2) "FL" container drawings from the Weapons Transportation Group. The second step is to analyzed the information from the drawings and corresponding component lists and compiled the information onto the spreadsheets.

First, we identified and quantified the nonradioactive toxic components by part name and chemical description from the drawings and corresponding tables. Then we determined formulations of the explosives used in the 12 weapons systems using *LLNL Explosives Handbook*.[1] Detailed descriptions of the detonators, cables and connector components used in LLNL-designed warheads were obtained from drawings and applicable specifications. We performed toxicological assessment of the chemicals and elements using information compiled in the *LLNL Explosives Handbook*, MSDS, and

TOTAL AMOUNTS OF TOXIC OR POTENTIALLY TOXIC NONRADIOACTIVE MATERIALS IN A SPECIFIC LLNL DESIGN

*ITEM	NUMBER	PART NAME	DESCRIPTION		AMOUNT	ODOR	HAZARD							**Personal Protective Equipment (PPE)
			CHEMICAL	PHYSICAL	GRAMS	CHARCT/TLV	TOXICITY					FLAMMABLE	EXPLOSIVE	
							Rat Oral LD50 (mg/kg)	Eye Irritation (mg)	Skin Irritation (mg/kg)	LC/Inhalation/ Ingestion	Carcinogenicity/ Mutagenicity			See Footnote

* Indicates location of part in Physics drawing; N.D.= No Data; N.A.= Not applicable

** PPE selections should be based on the potential for direct contact of the material with the skin, eyes or respiratory tract.

1. Initial entry using an SCBA and anti-contamination PPE should be used to determine the condition of the weapon and components

2. Normal radiological control PPE e.g. fullface respirator with organic vapor/HEPA filter, anti-contamination clothing, booties and PVC, nitrile (4H or Silver Shield) or butyl gloves

Figure 2. Spreadsheet to tabulate the total amounts of nonradioactive toxic or potentially toxic materials in a specific LLNL weapon design.

TOXIC OR POTENTIALLY TOXIC NONRADIOACTIVE MATERIALS IN THE "FL" CONTAINER

*ITEM	NUMBER	PART NAME	DESCRIPTION		AMOUNT	ODOR	HAZARD							**Personal Protective Equipment (PPE)
			CHEMICAL	PHYSICAL	GRAMS	CHARCT/TLV	TOXICITY					FLAMMABLE	EXPLOSIVE	
							Rat Oral LD50 (mg/kg)	Eye Irritation (mg)	Skin Irritation (mg/kg)	LC/Inhalation/ Ingestion	Carcinogenicity/ Mutagenicity			See Footnote

* Indicates location of part in Physics drawing; N.D.= No Data; N.A.= Not applicable

** PPE selections should be based on the potential for direct contact of the material with the skin, eyes or respiratory tract.

1. Initial entry using an SCBA and anti-contamination PPE should be used to determine the condition of the weapon and components
2. Normal radiological control PPE e.g. fullface respirator with organic vapor/HEPA filter, anti-contamination clothing, booties and PVC, nitrile (4H or Silver Shield) or butyl gloves

Figure 3. Spreadsheet to tabulate toxic or potentially toxic nonradioactive materials in "FL" containers.

SUMMARY OF TOXIC NONRADIOACTIVE MATERIALS IN LLNL DESIGNS

CHEMICAL DESCRIPTION	H&S INFO TLV if available	W-XX (grams)	W-XX (grams)	W-XX (grams)	W-XX (grams)	W-XX (grams)	W-XX (grams)	W-XX (grams)	W-XX (grams)	W-XX (grams)	W-XX (grams)	W-XX (grams)	B-XX (grams)

Figure 4. Spreadsheet to tabulate the total amounts of nonradioactive toxic materials in LLNL weapon designs.

toxicology reference books.[2–10] Flammability information of the chemicals was obtained from the *LLNL Explosive Handbook, Thermal Characterization of Polymeric Materials* [11] and research done at LLNL on thermal degradation of polymeric formulations.[12–14] Explosive properties of the chemicals were obtained from the *LLNL Explosive Handbook,* MSDS, Fire protection Guide on Hazardous Materials,[15] and toxicology reference books. Choice of the recommended industrial hygiene (IH) controls was based on information listed on the MSDS and from published literature.[16–18]

The detailed spreadsheets were next submitted to LLNL's Weapons Engineering Group to verify accuracy. Their suggested minor changes were incorporated into the spreadsheets described previously.

Results and Conclusions

The Phase I effort resulted in a compilation of nonradioactive toxic and potentially toxic materials contained in each LLNL weapon design and in the one "FL" container. Each design has a file folder that contains the following: (1) a spreadsheet showing the amounts of nonradioactive toxic materials in different physical states (Figure 1); (2) a spreadsheet showing the total amounts of nonradioactive toxic chemicals and elements in the design (Figure 2); (3) summary Physics drawing (Figure 3) and available MSDS. The LLNL weapon designs summary sheet is useful because it clearly identifies and quantifies the specific chemicals and elements contained in each design. It also shows the chemicals that are common to the 12 LLNL weapon designs.

Our interaction with the LANL and Sandia staff allowed them to take advantage of our approach. We provided constructive input and they adopted our modified format for their own analysis. In addition, we have also identified the need for Phase II of this project. An approach has been outlined and the request was submitted to DOE Albuquerque Office of Operations for review and approval. After completion of Phase II, the LLNL ARG industrial hygienist will have adequate information to effectively respond to accidents involving LLNL nuclear weapons designs. When LANL and Sandia complete their part of the project a combined ARG industrial hygiene reference manual can be assembled. This information can also be used to determine what specialized protective clothing and industrial hygiene sampling equipment will be necessary to stock in the ARG MOBILE LABORATORIES.

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