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60 Kilograms High Explosive Containment with Multi-diagnostic Capability

L. F. Simmons
M. B. Sueksdorf

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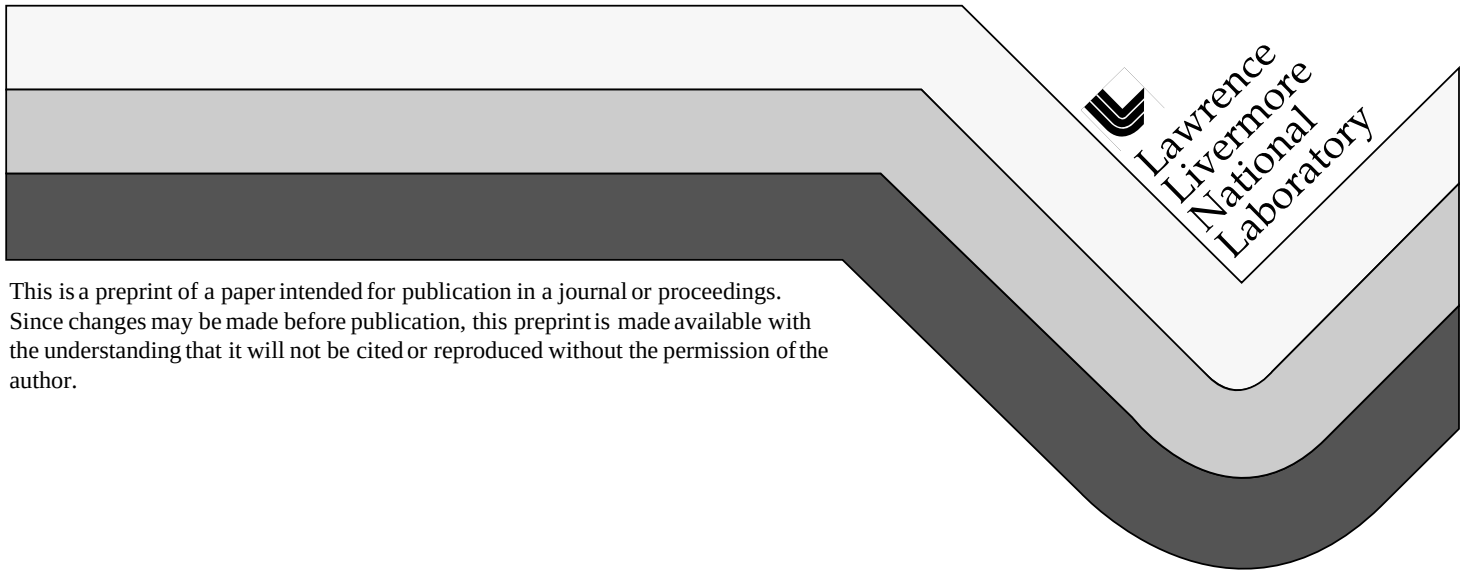

LLNL'S Contained Firing Facility (CFF)

60 Kilograms High Explosive Containment with Multi-diagnostic Capability

Larry F. Simmons
Mark B. Sueksdorf

Lawrence Livermore National Laboratory
Livermore, Ca. 94551, U.S.A.

In anticipation of increasingly stringent environmental regulations, Lawrence Livermore National Laboratory (LLNL) proposes to construct a 60 kilogram (kg) firing chamber to provide blast-effects containment for most of its open-air, high explosives, firing operations. Even though these operations are within current environmental limits, containment of the blast effects and hazardous debris will further drastically reduce emissions to the environment and minimize the generated hazardous waste.

The heart of the Contained Firing Facility (CFF) is the reinforced concrete firing chamber. Slightly larger than half a small gymnasium (15.5 meters by 16.8 meters and 9.2 meters high), the firing chamber will contain the blast overpressure and debris from detonations of up to 60 kg of cased explosive charges. The size and shape of the chamber was selected to accommodate the existing high speed camera ports and the FXR radiography source. This encompasses a large area that will be useful for complicated experiment set-up. This is one of the largest operational high explosives limit firing chamber, with the largest usable space for diagnostic set-up of this kind in the world. The inside surfaces of the chamber will be protected from shrapnel traveling as fast as 1.5 kilometers per second with 38 millimeter-thick mild steel plates. To permit repetitive firings, all main structural elements of the firing chamber are required to remain elastic when subjected to blast. Detonations will be conducted

above a 100 millimeter-thick steel firing surface (the shot anvil) embedded in the concrete floor.

CFF represents a modernization of the Building 801 Test Facility. Completed in 1980's, Building 801 houses the advanced diagnostics needed to understand the chemical explosive phase of a nuclear weapon's performance. It boasts our world-class flash x-ray (FXR) radiography machine, which can clearly image what's happening inside a thick-walled object. Its digital imaging camera can record the material structure image of an explosively driven implosion.

There are other diagnostics in CFF. A multi-beam laser velocimeter will record the velocity of imploding metal surfaces. Electronic-pin diagnostics will measure the position of such surfaces. To capture images of materials moving at ultrafast velocities, we will use our laser-illuminated image-converter camera and high-speed optics. A gamma-ray camera provides greater sensitivity for x-ray imaging.

For workers in the facility, decontamination of the firing chamber after testing is important. Some of the toxic and hazardous products from the testing that will be monitored include ammonia, carbon monoxide, hydrogen fluoride, nitrogen oxide, hydrogen cyanide, as well as beryllium and depleted uranium metals. Special mechanical systems will be installed for internal purging and cleaning of the chamber. An air purge will be conducted to remove contamination by exchanging roughly ten times the volume of the firing chamber with outside air. The wash-down decontamination system will recirulate water spray within the chamber and filter out dust and particulates in the form of sludge.
These systems have been designed with the goal for the workers to return to work in the chamber without protective clothing or breathing apparatus.
All doors, optical lines of sight , and other penetrations into the firing chamber will be sealed to provide a pressure boundary for the blast and quasistatic pressures. After the gases have cooled, the blast dampers will be opened and ventilation fans will supply

fresh air. The exhaust gases will be processed through a wet scrubber and high-efficiency particulate air (HEPA) filters before being released to the environment.

Testing and instrumentation data collection:

All main structural elements of the firing chamber must be able to withstand repetitive firing as well as meet design safety standards. These criteria require the structure to withstand a 94 kg TNT blast, which is equivalent to 60 kg of high explosives. During the Qualification Testing phase of the CFF project, a 124% “overtest” will be run using 75 kg of high explosives to provide an addition margin of safety and satisfy prescribed requirements.

A comprehensive research and development program was executed to verify the chamber design concept. We conducted three experimental tests, close-in load testing of the 1/4 scale floor section, shrapnel penetration tests of wall section and a 1/4 scale replica model of the firing chamber was designed , constructed and instrumented with strain gauges pressure transducers and temperature gauges. The data from these tests has been used to verify the conceptual design of the firing chamber and locate the instrumentation for the qualification experiments.

We plan to install instrumentation including strain gauges, accelerometers, temperature and pressure sensors as a part of the construction. This instrumentation will be used during the initial chamber testing and qualification phase to verify the structural response is consistent with the design expectations.

Conclusion:
It appears that the CFF design features will be capable of handling the blast effects and detonation byproduct cleanup challenges inherent in cased high explosive experimentation while maintaining extensive diagnostic capability. This new facility will offer operational advantages and opportunity per new diagnostic development. The CFF project is scheduled to start

construction in April 1999 with the completion of construction in January 2001 and the completion of activation and testing in July 2001.

Acknowledgement:

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References:

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J. W. Pastrnak, C.F. Baker, and L. F. Simmons, *Quarter-Scale Close-in Blast-Loading Experiments in Support of the Planned Contained Firing Facility*, Lawrence Livermore National Laboratory, UCRL-JC-116822 (1994)

J. W. Pastrnak, C.F. Baker, and L. F. Simmons, *Empirical Validation of the Conceptual Design of the LLNL 60-kg Contained Firing Facility*, Lawrence Livermore National Laboratory, UCRL-JD-119432 (1995)

Site 300 Contained Firing Facility-Conceptual Design Report, U.S. Department of Energy Project Number 96-D-105, prepared by Holmes & Narver Architects-Engineers, (Revised January 1995)

Science & Technology Review, Lawrence Livermore National Laboratory, (March 1997)

CFF will be at Site 300, about 60 highway miles southeast of San Francisco

Contained Firing Facility

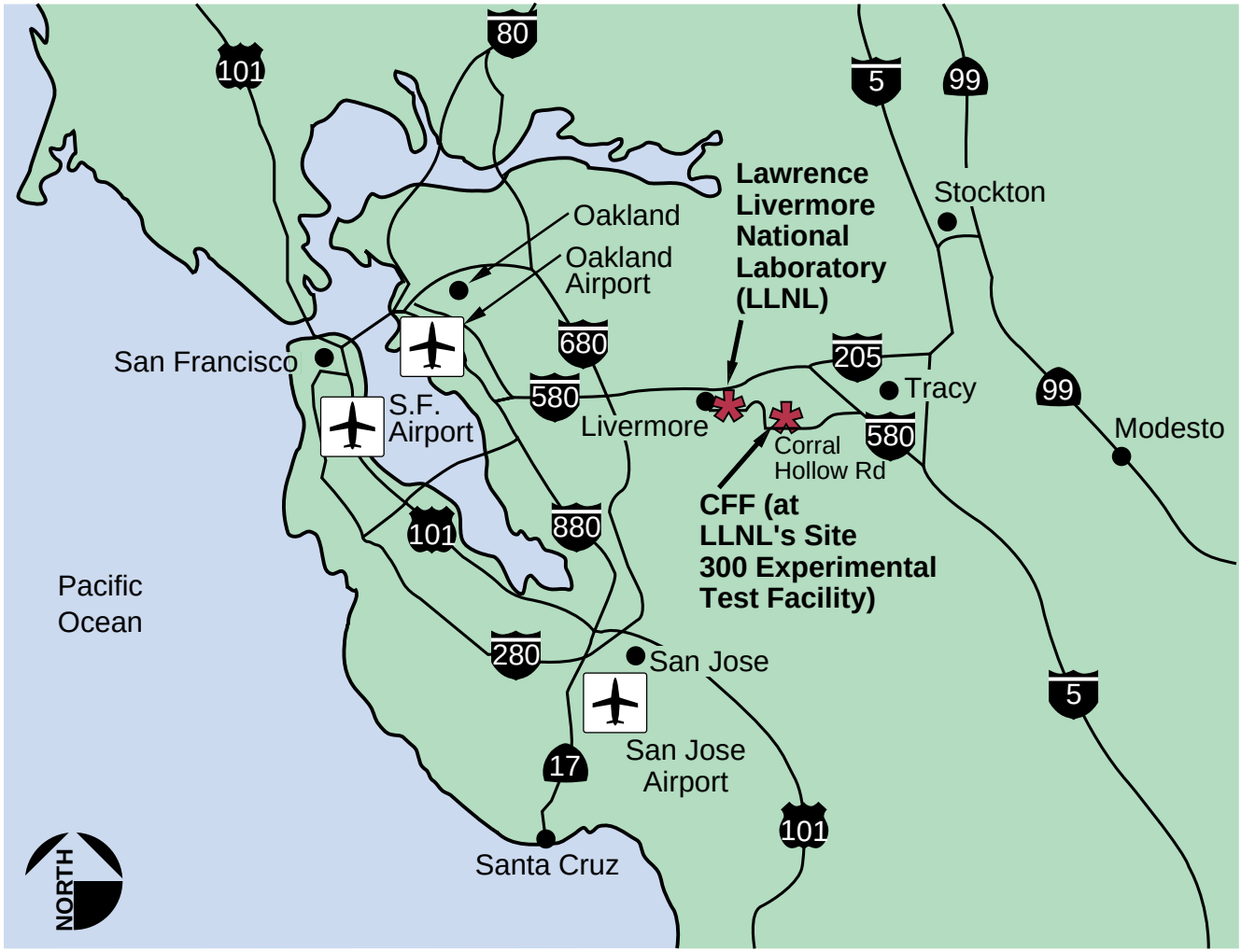

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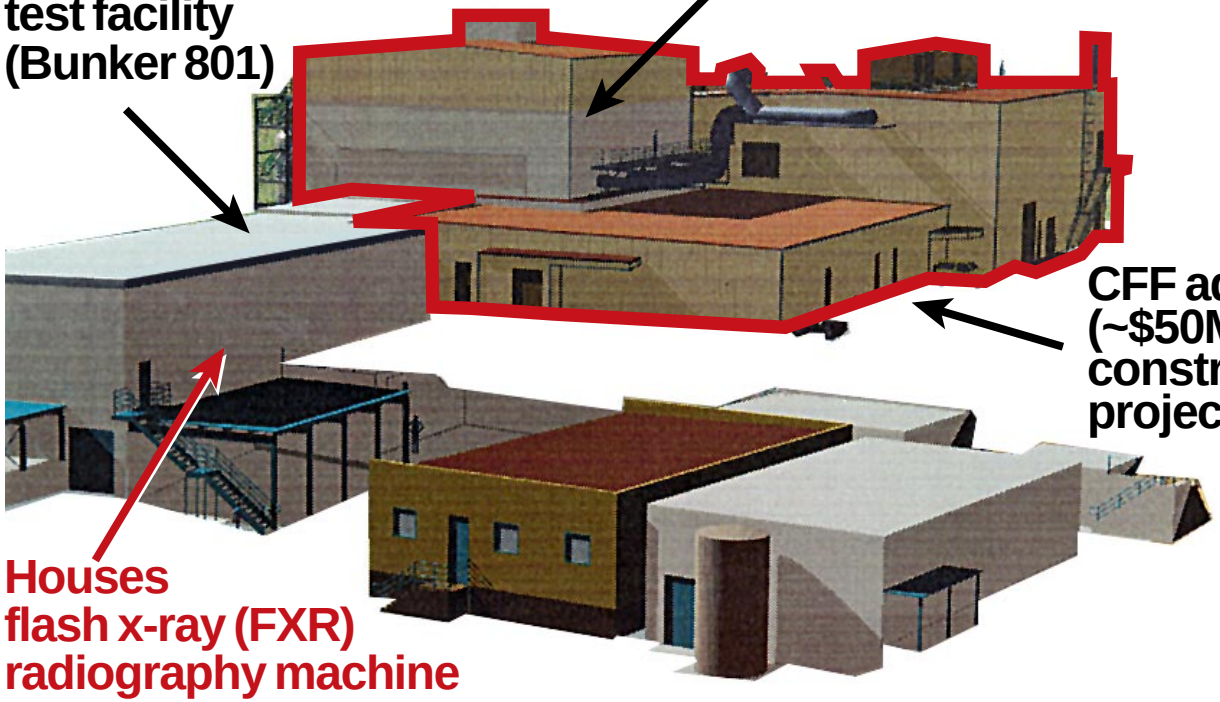
Figure 1

CFF will enhance the world's most capable stockpile stewardship test facility

Contained Firing Facility



- Anticipate environmental concerns
- Modernize bunker
- Minimize waste

Figure 2

Firing Chamber

Contained Firing Facility

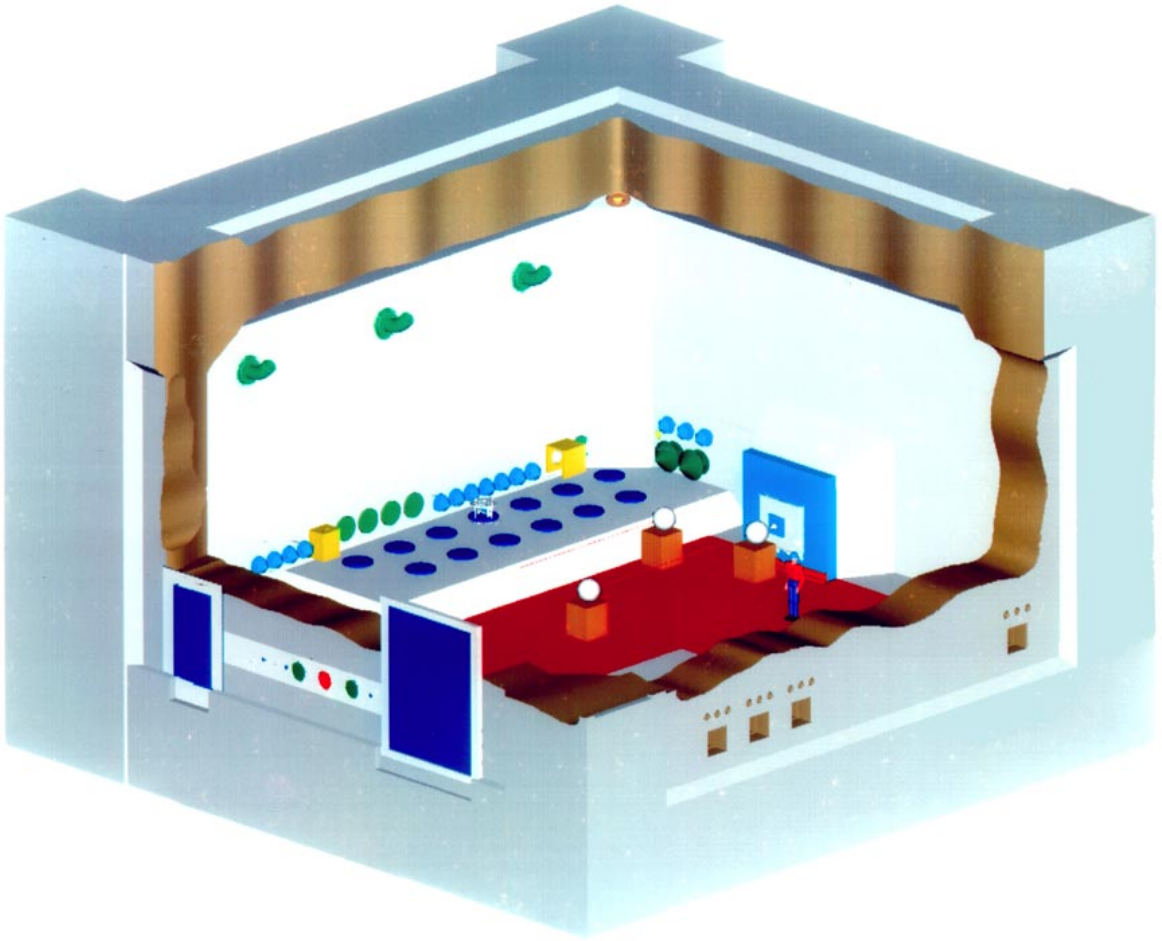
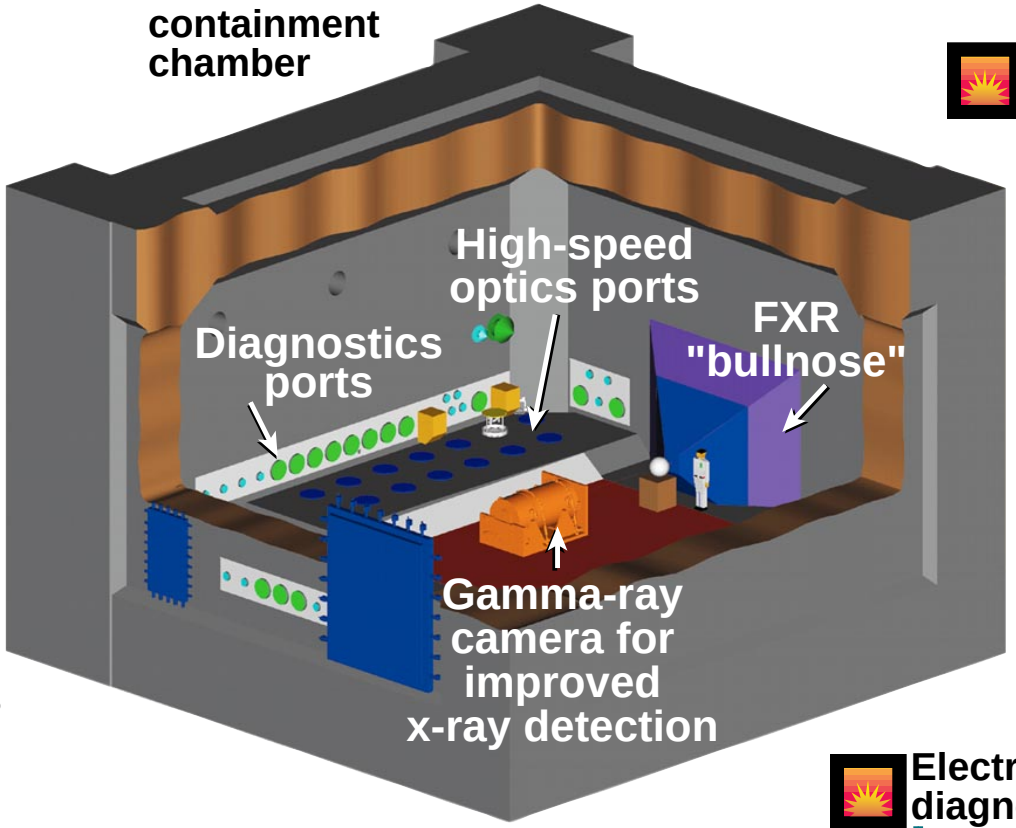


Figure 3

Experimenters will have access to simultaneous leading-edge weapons test diagnostics

Contained Firing Facility



Flash x-ray (FXR) radiography machine

→ For high-resolution pictures of thick objects

Laser-illuminated image-converter camera and high-speed optics

→ Ultrafast imaging with extremely high resolution

Multi-beam laser velocimeter

→ Records velocity of imploding metal surface

Electronic-pin diagnostics

→ Measures position of imploding metal surface

Figure 4

Our plan to contain selected explosions should please our neighbors

Contained Firing Facility

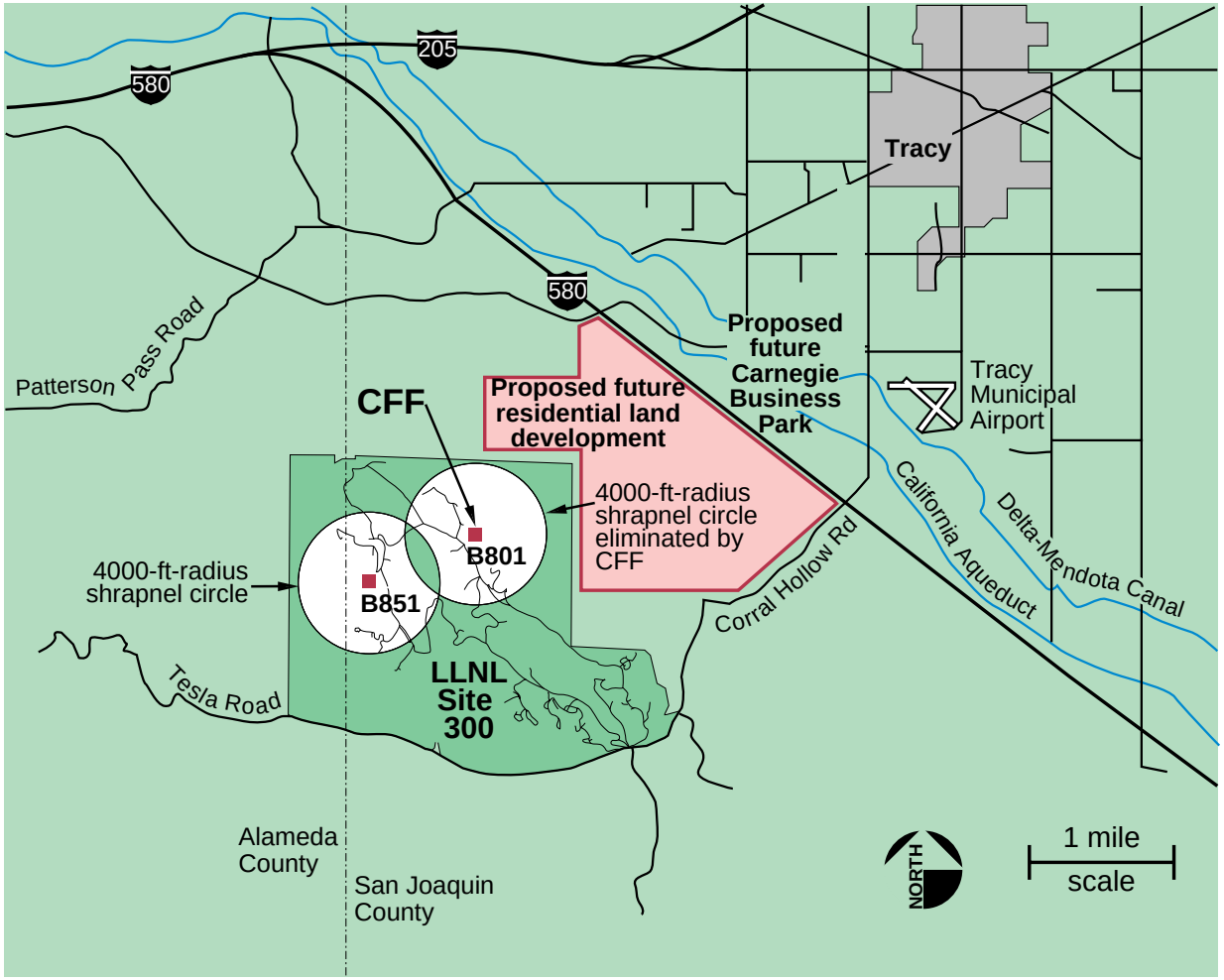


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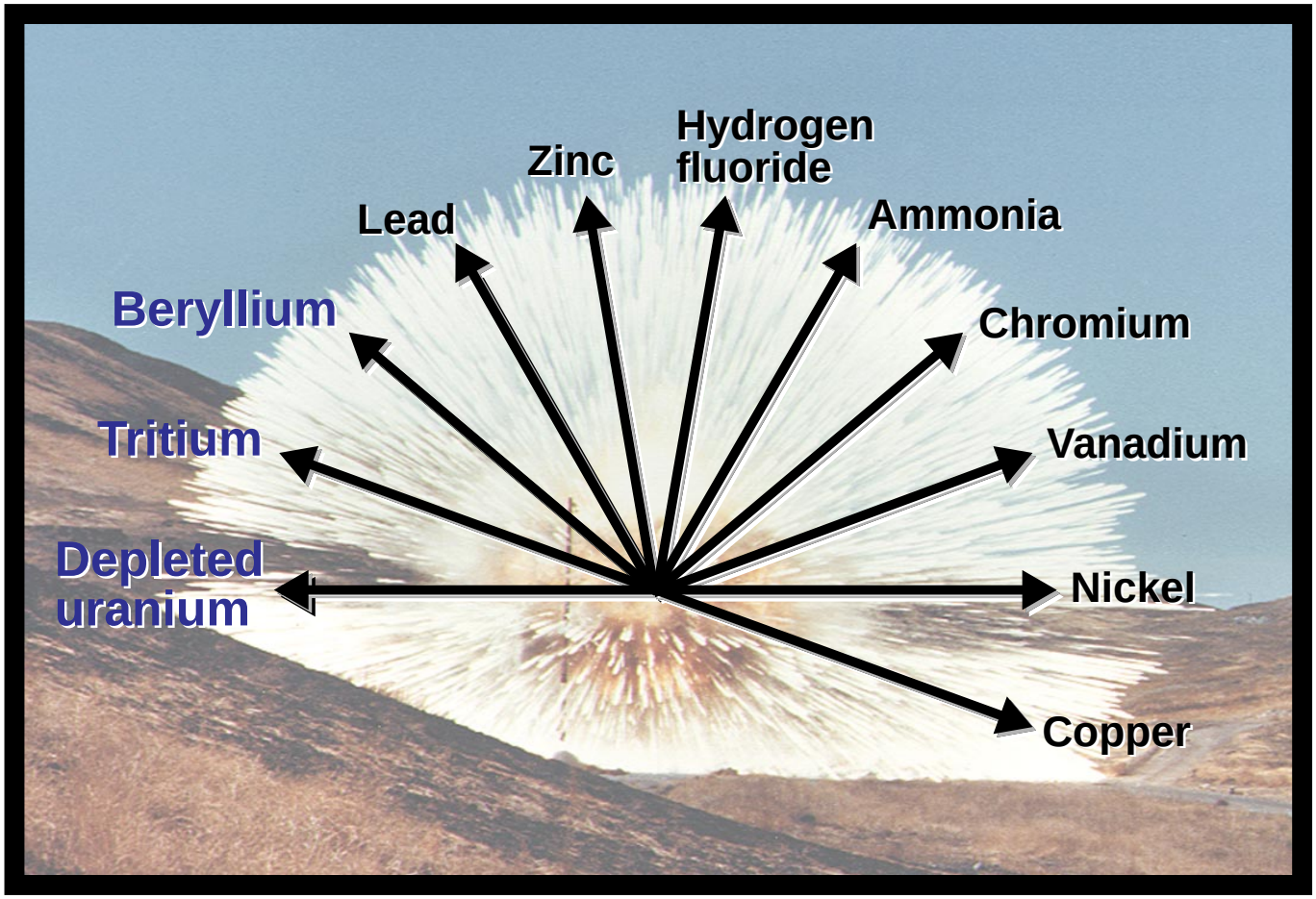
Figure 5

We plan to reduce the environmental impact of weapon-scale high-explosive experiments

Contained Firing Facility



The chamber will contain hazardous materials potentially subject to regulation

CFF Washwater and Chamber Purge System

Contained Firing Facility

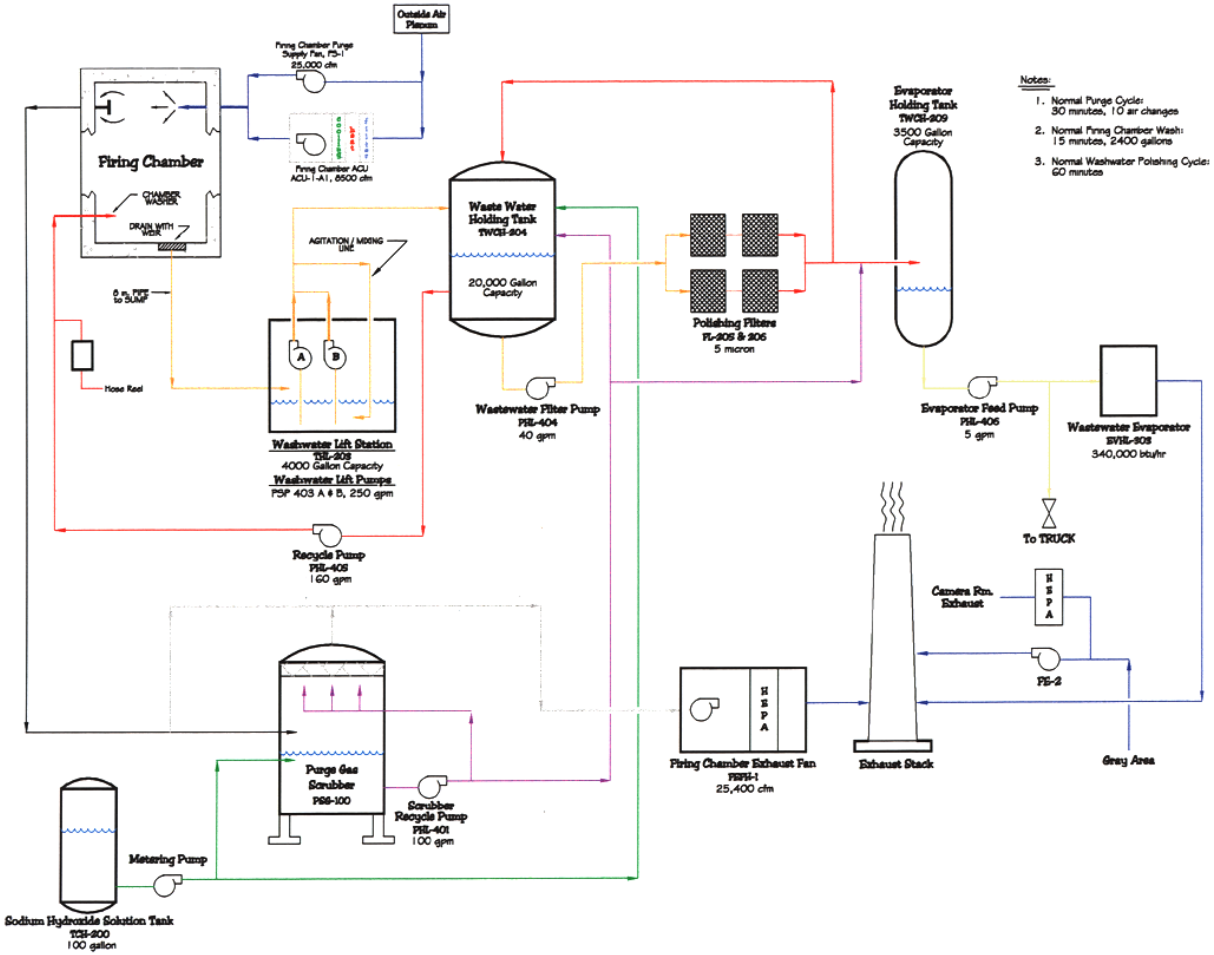


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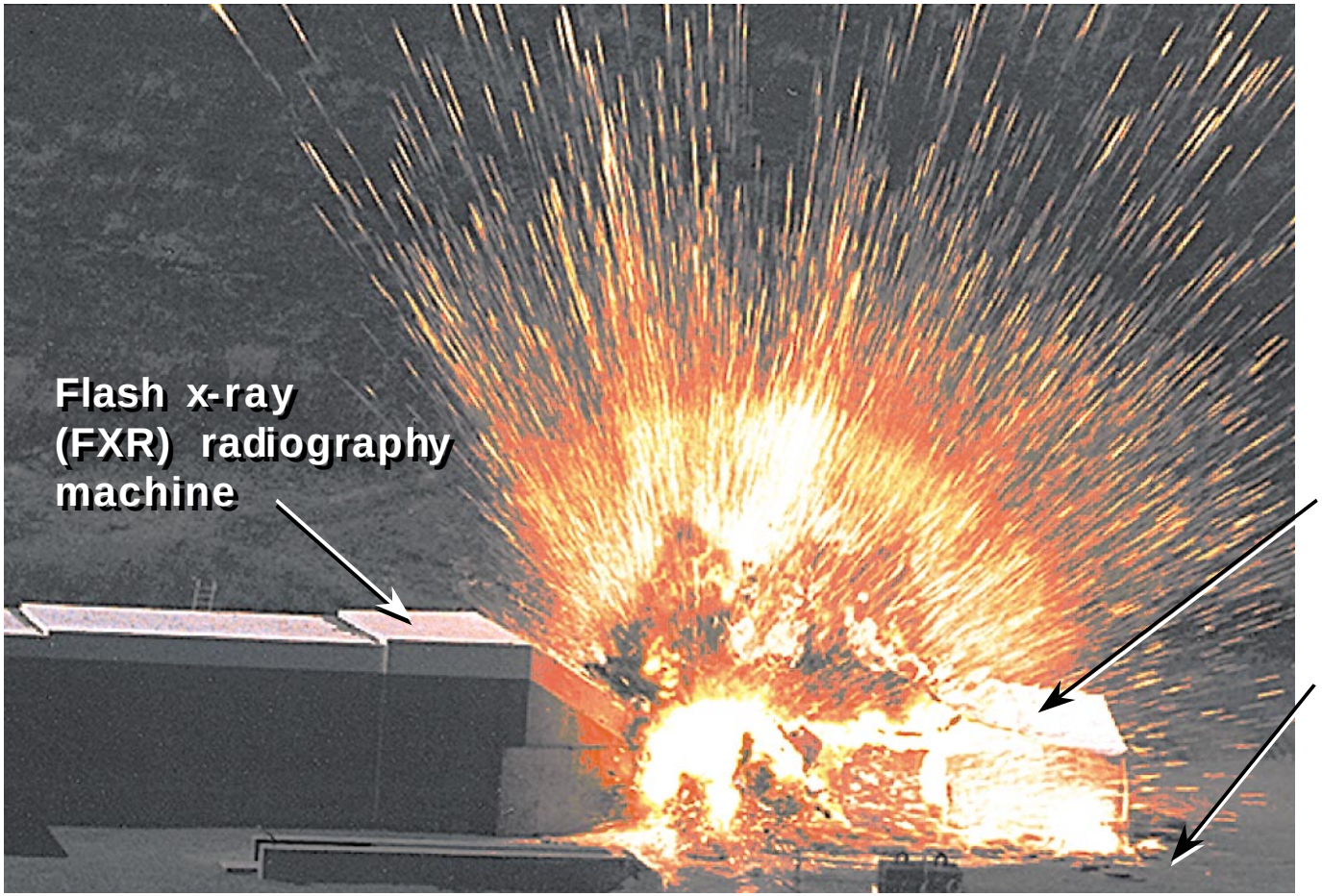
Figure 7

CFF will minimize the dispersal of waste material

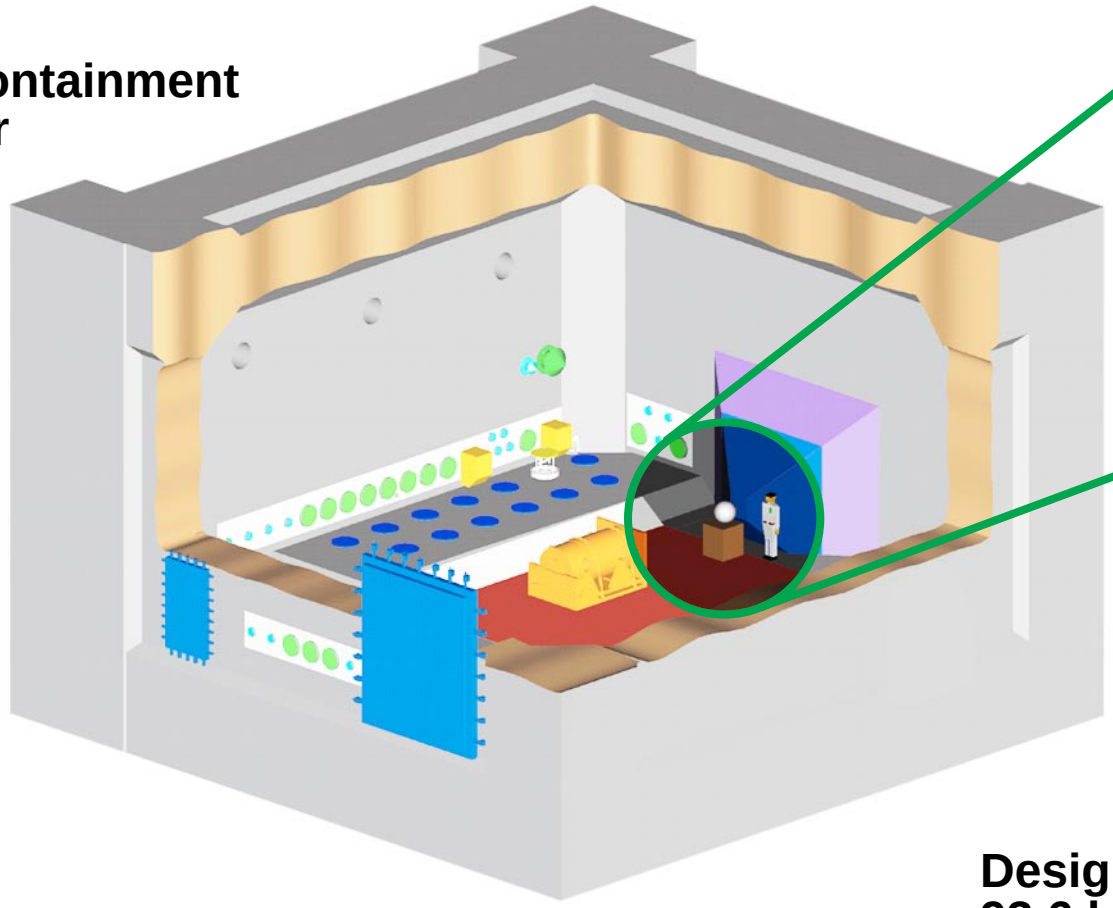
Contained Firing Facility



The chamber will have one of the world's largest operational explosive weight limits

Contained Firing Facility

CFF's containment chamber

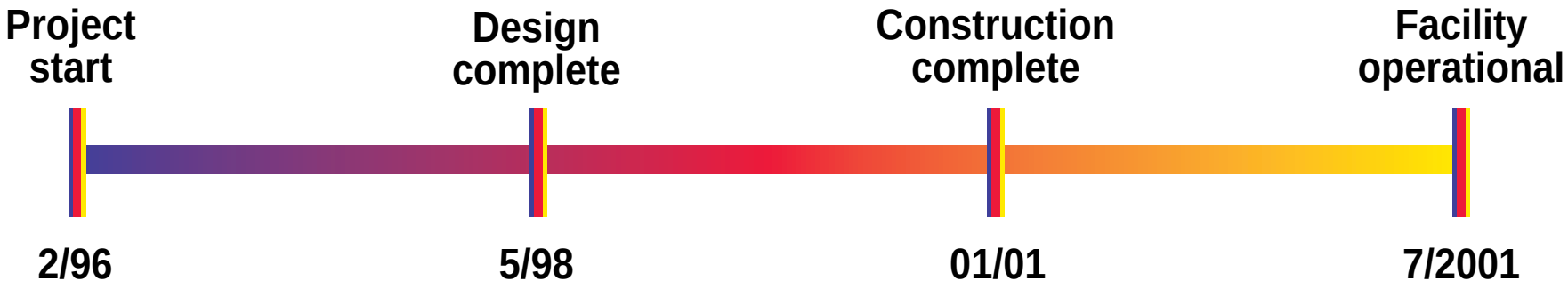


Operational weight limit = 60 kg (132 lb) of energetic high explosives

Design weight = 93.6 kg (206 lb) TNT

CFF will be designed and built in five years for about $50 million

Contained Firing Facility



Total estimated cost (Congressional allocation)	$49.7M
Total project cost (includes operational funds)	$52.8M