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THE EXPLOSIVE COMPONENTS FACILITY -
FULFILLING ITS ROLE AS A NATIONAL RESOURCE

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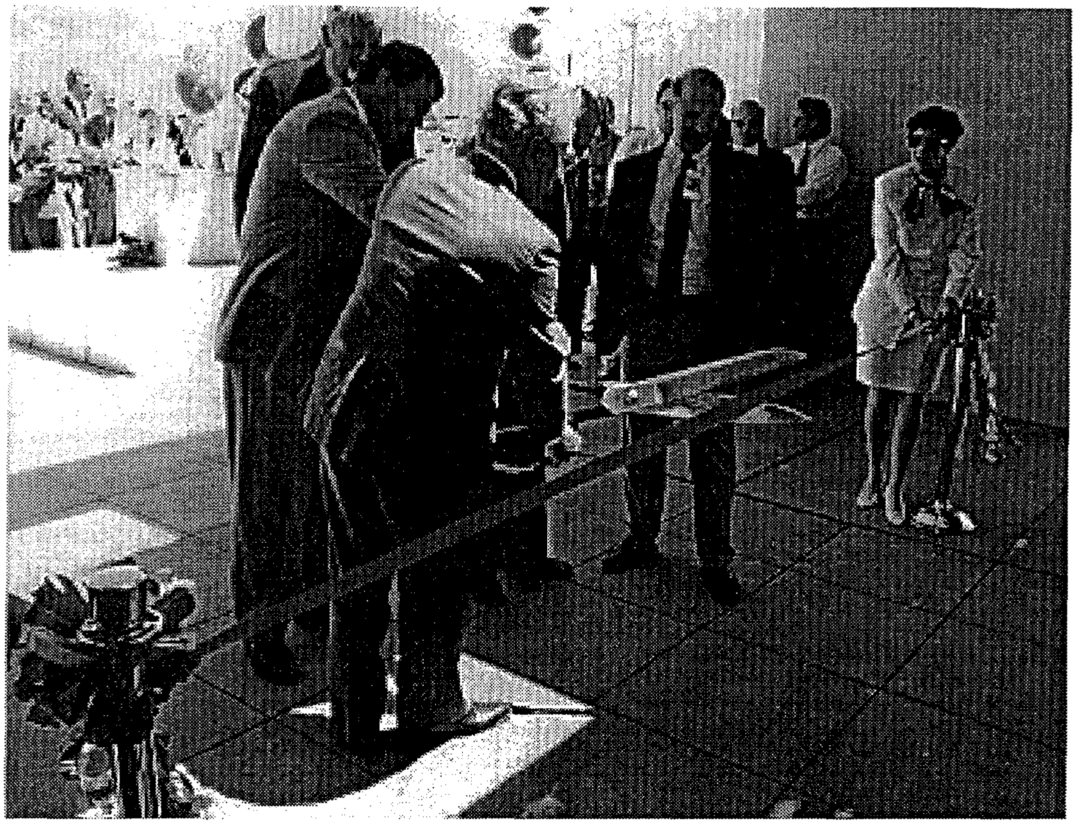
Overview

The Explosive Components Facility (ECF) is a major, low-hazard, non-nuclear, research and development facility of the Sandia National Laboratories/Albuquerque (SNL). Sandia Corporation, a subsidiary of Lockheed-Martin, operates this designated User Facility for the Department of Energy (DOE). The ECF consolidates many SNL energetic-materials activities and provides a unique combination of explosive-technologies, neutronic-components, batteries, and weapons-evaluation capabilities. This paper describes the project objectives, the basic building features, programmatic capabilities, and the processes used to beneficially occupy and assess readiness to operate.

EXPLOSIVE COMPONENTS FACILITY

The project design was started in March 1988. It was funded for $27.8 million. ECF was dedicated on July 6, 1995. Construction was completed in September, 1995. Readiness assessment was completed in April, 1996; ECF is fully operational.



DEDICATION CEREMONY

Project Objectives

The project objectives are: 1) consolidate energetic materials research and development, 2) improve safety and working conditions, 3) contain explosive detonations, and 4) maximize flexibility.

It is now easier to share technologies through better day-to-day interaction. Explosives technology, neutron-generator development and production support, battery testing, and stockpile surveillance organizations occupy the ECF. Previously, these organizations were located at several different sites at SNL.

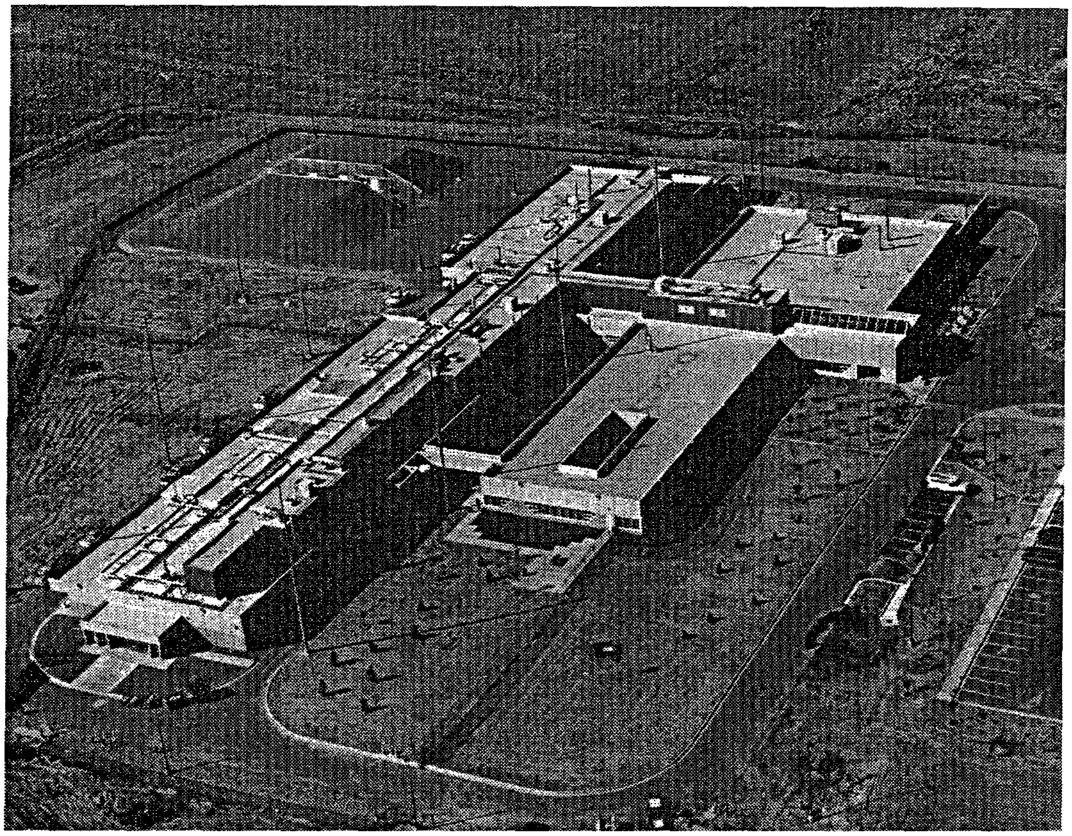
Safety and overall working conditions have been improved. The previous facilities were 30 to 40 years old. Their construction did not meet current standards and did not provide for good separation of office activities from explosives operations. The design of the previous facilities also required a large buffer zone around the explosives testing areas to prevent detonation fragments and blast over-pressures from affecting the general public. The design of ECF meets current standards, provides separation of office activities from explosives operations, provides extensive common areas such as conference rooms, and provides better access control to operations areas. Natural lighting is used extensively to provide a brighter, more pleasant atmosphere.

The ECF has many features designed to contain explosive detonations. All of these features taken together require only a minimum exclusion area and allow for the elimination of a buffer zone. Mazes reduce the need for blast doors and reduce blast over-pressure in adjacent areas from an unplanned detonation. Corridor alcoves provide space for personnel doors to blow into after an unplanned detonation rather than directly into a corridor. Firing pads and walk-in high explosives chambers, with blast doors, provide an enclosed space to contain fragments from planned detonations and to reduce the blast over-pressure seen outside. Blast doors are used to contain fragments from planned detonations and to reduce the blast over-pressure seen outside. Door catchers are used to contain fragments from unplanned detonations. Explosives storage cabinets made of **S**lurry **I**nfiltrated **F**iber-reinforced **CON**crete (SIFCON) provide containment of unplanned detonations in storage areas. These features are discussed in more detail later.

Flexibility is part of the design. Laboratory and operations areas can be readily modified to accommodate new or changing programmatic requirements. The laboratories and operations areas are modular. The layout can be changed quite readily. Raised flooring is provided in most operations areas for ease of routing instrumentation cables and to provide access for cooling air throughout. A penthouse above the laboratories and operations areas is used to route mechanical and electrical utilities. Numerous spare penetrations are available. Maintenance can be done in the penthouse with minimum disruption to operations. Also, the main utility distribution lines are protected from damage during an accident in a laboratory or operations area.

Building Features

The ECF complex includes a main building of approximately 96,500 square feet, six explosive-service magazines, and service drives and parking areas needed to make the complex self-contained. Utilities such as water, natural gas, power, communications, and sanitary sewer extend from existing services on Kirtland Air Force Base (KAFB). Access to the complex is controlled at all times. The complex is within the boundaries of KAFB and is located 6-1/2 miles east of downtown Albuquerque, New Mexico.



OVERHEAD VIEW OF ECF

Design of the ECF provides state-of-the-art laboratory and testing space that promotes and enhances safe and efficient operation for high-consequence events. The building is divided into two wings: administrative and laboratory/testing. The two wings are connected by a corridor. The penthouse extends over part of the administrative wing and most of the laboratory/testing wing.

The administrative wing contains a lobby, conference rooms, offices, laboratories, a lunchroom, and some maintenance areas. The lobby provides a reception area for visitors and uncleared personnel. It is staffed by a receptionist. There are two large conference rooms adjacent to the lobby. They are equipped with state-of-the-art video teleconferencing and presentation equipment. Access is controlled to the rest of the building. Personnel must either have a security clearance or be escorted. The laboratories in the administrative wing are "light labs." No work with energetic materials is done in these labs.

The laboratory/testing wing is structurally decoupled from the rest of the building to the extent that routine explosives tests will not generally be heard or felt in the administrative wing. The laboratory spaces in this wing are devoted to the routine testing of explosives and explosive devices, neutron generators, and batteries. Nine indoor firing pads and two walk-in chambers provide the capability for detonating up to one kilogram (TNT equivalent) of explosives. Explosives laboratories are used for explosive and propellant preparation, component disassembly, analysis, and aging and ignition studies. The neutron generator laboratories are used for the assembly and testing of neutron generators for research-manufacturing and quality assurance evaluations. Tests may include life cycle testing and environmental testing. The battery laboratory is used for evaluation and abuse testing of batteries, mostly for weapon components.

Programmatic Capabilities

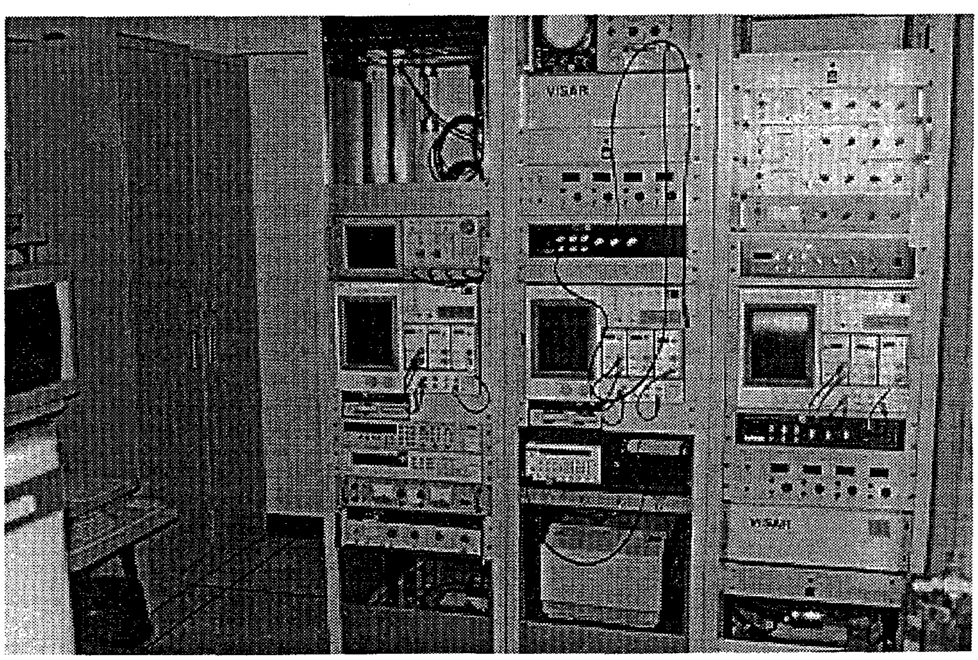
A broad range of energetic-material research, development, and application activities are carried out at the ECF. Advanced diagnostic equipment is used to carry out experiments that range from one kilogram (TNT equivalent) tests to sophisticated spectroscopic studies on milligram size samples that probe the fundamental processes of detonation.

Major diagnostic equipment and techniques include:

- Velocity Interferometry System for Any Reflector (VISAR);
- laser, ultraviolet/visible, and plasma spectroscopy;
- gas, pyrolysis gas, liquid, and ion chromatography;
- environmental aging studies;
- microtox and mutagenic testing;
- optical and scanning-electron microscopy;
- shock and detonation chemistry;
- burn rate determination;
- material sensitivity studies;
- laser initiation testing;
- charged-coupled-device camera image analysis;
- electrical characteristics studies;
- hydrostatic and volumetric density measurements;
- helium leak rate determination;
- moisture analysis;
- adiabatic-rate and bomb calorimetry;
- chemical reactivity testing and aging;
- flash x-ray testing;
- photometrics/high-speed photography; and
- particle size measurement.

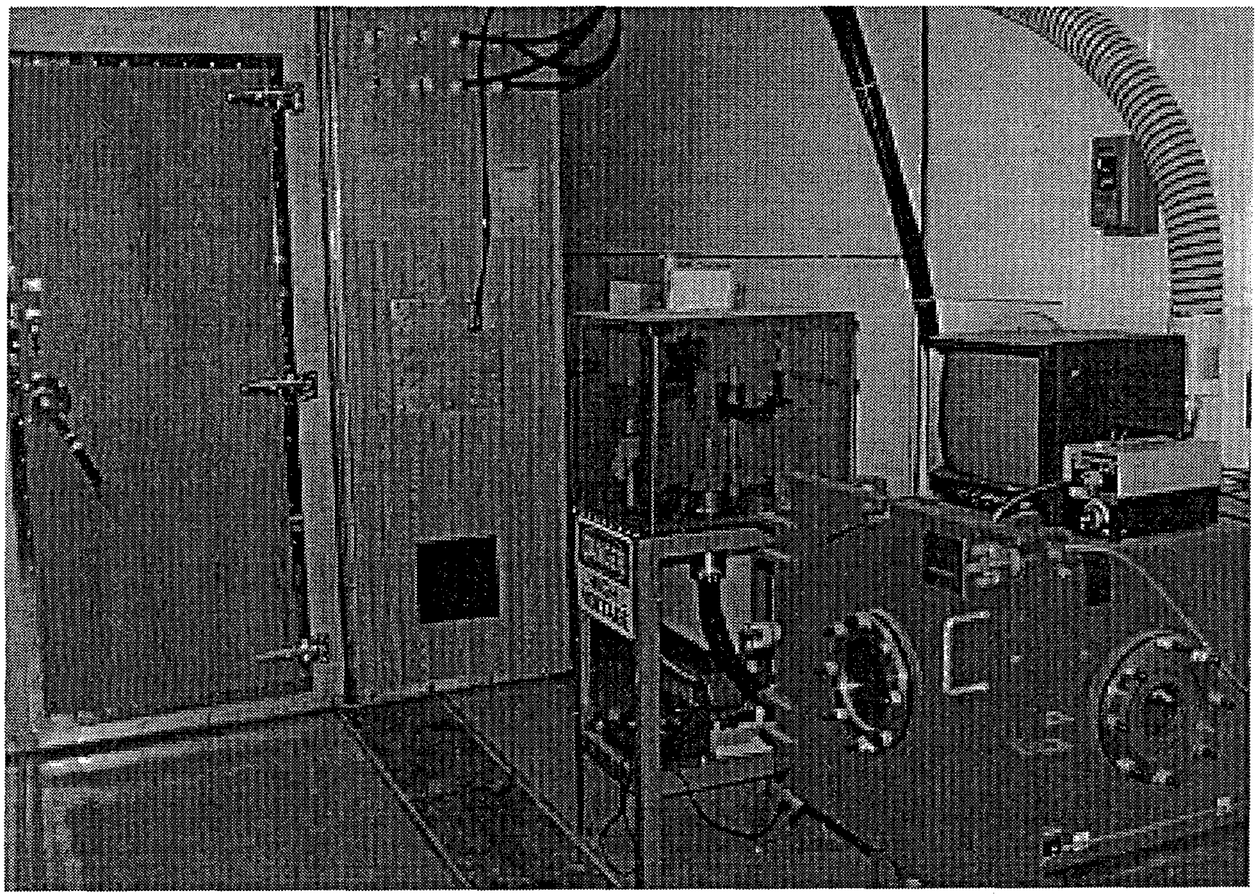
Many of the laboratories use a VISAR to collect data. A VISAR uses the Doppler effect on laser light to measure particle or fragment velocity - after an explosive is detonated, for example. The system comprises a laser and data collection instrumentation.

VISAR



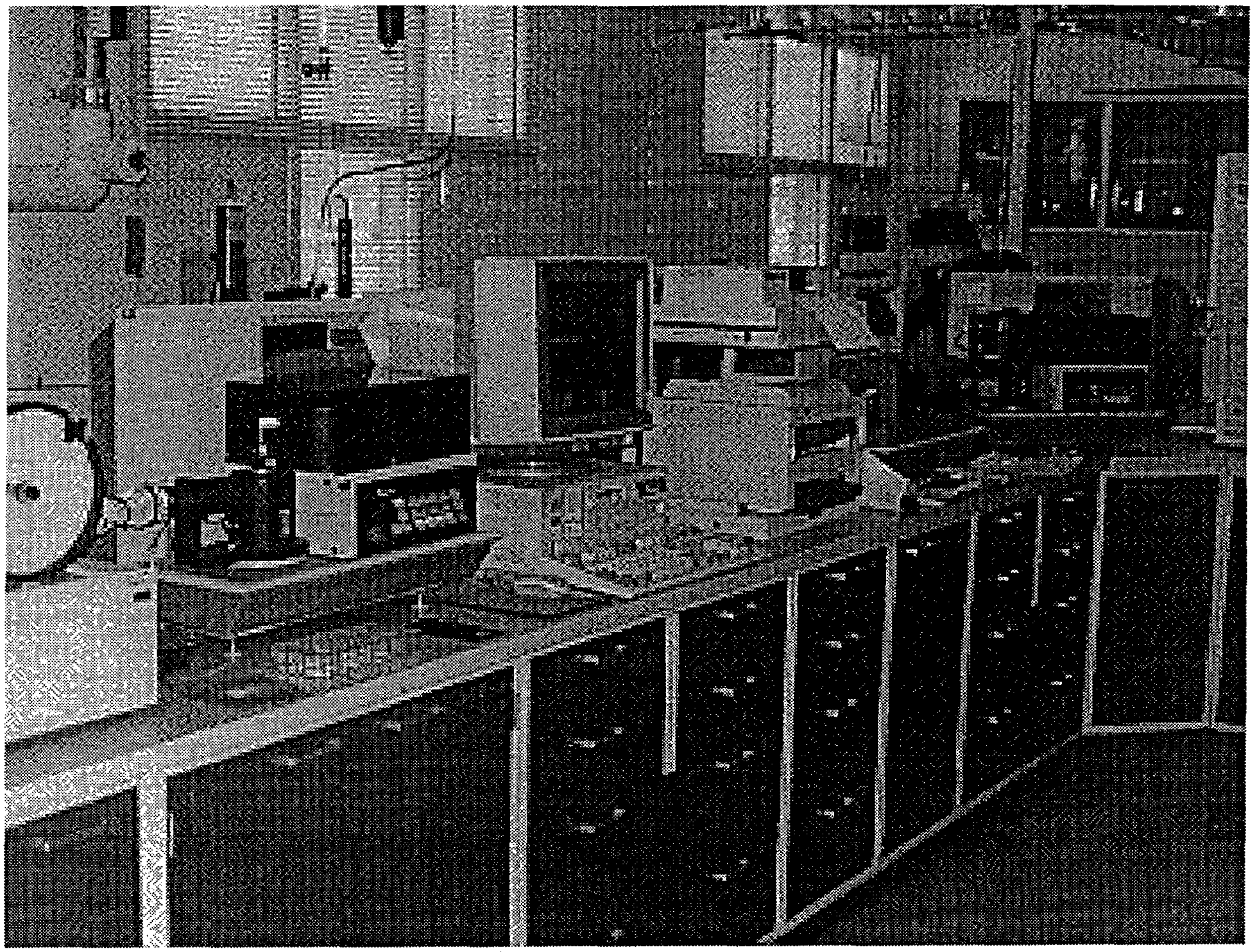
VISAR DATA COLLECTION

The Detonator Physics Laboratory is typical of the explosives testing laboratories. It contains a cable-discharge system, capable of supplying 6000 amps in three micro-seconds. Data is collected to determine the electrical characteristics of components. This laboratory also contains a small firing chamber for detonating up to 10 grams of explosives (TNT-equivalent). All operations in this laboratory are controlled administratively through the use of operating procedures. There is also an interlock system to ensure that the appropriate barriers are in place before detonating any explosives.



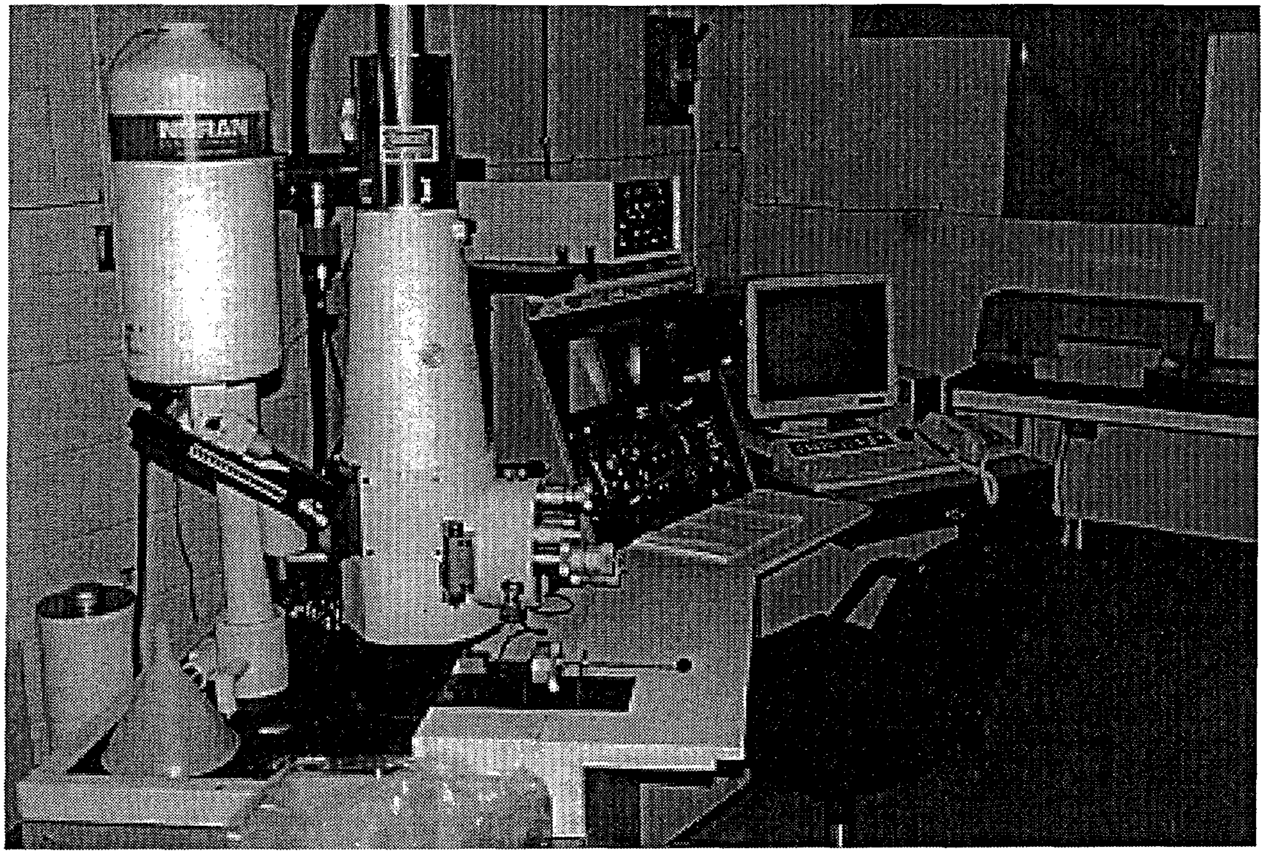
DETONATOR PHYSICS LABORATORY

The Explosive Analysis Laboratory is a chemical laboratory where work is done with small amounts of explosives - 10 grams or less. This laboratory includes capabilities for thermal, infrared, gas chromatography, bomb calorimetry, chemical reactivity, and optical microscopy analysis. Energetic, gravimetric, and mechanical changes in materials as a function of temperature or time are measured. Properties such as stability, compatibility, and aging are evaluated. Materials are analyzed in the infrared region for identification and analysis.



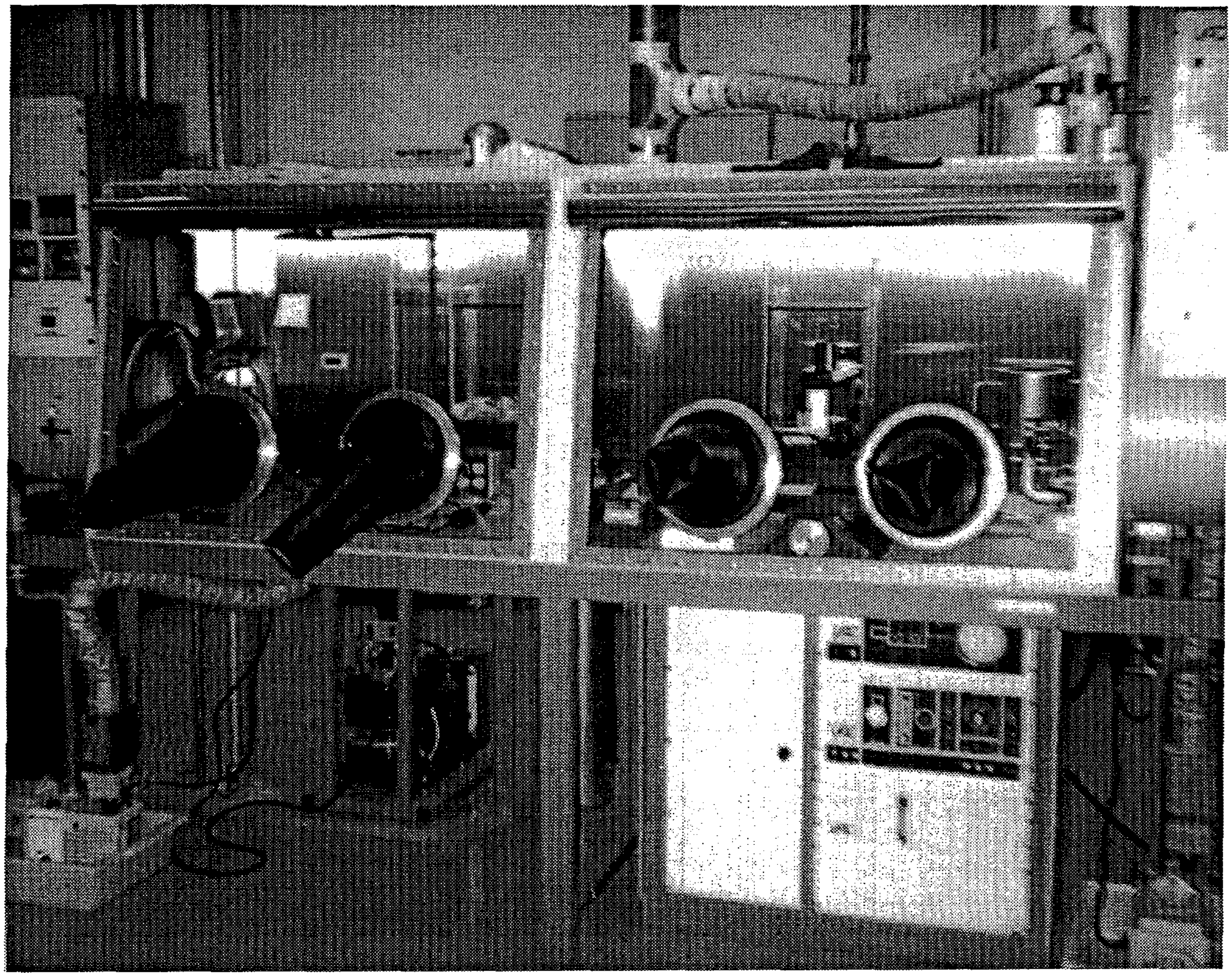
EXPLOSIVE ANALYSIS LABORATORY

The Scanning Electron Microscope (SEM) Laboratory is typical of non-explosive laboratories, where no explosives or very small amounts are used. The SEM is used to evaluate the surface form and structure of materials.



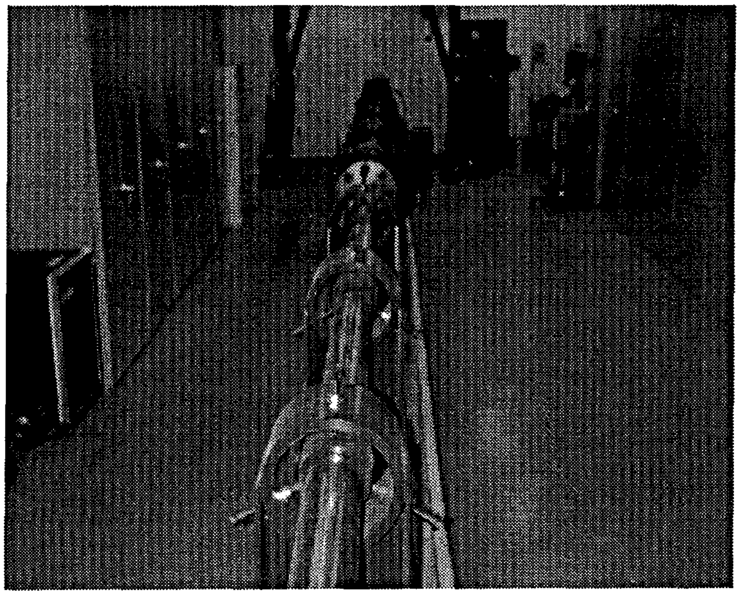
SCANNING ELECTRON MICROSCOPE LABORATORY

Abuse testing of batteries is done in the Battery Laboratory. Batteries are subjected to destructive tests in any of six test cells. Destructive tests include over-charging, reverse polarity, and over-temperature. Post-mortem examinations are conducted in a glove box. A glove box with an inert atmosphere is used because of the hazardous chemicals present in the batteries; specifically thionyl chloride.

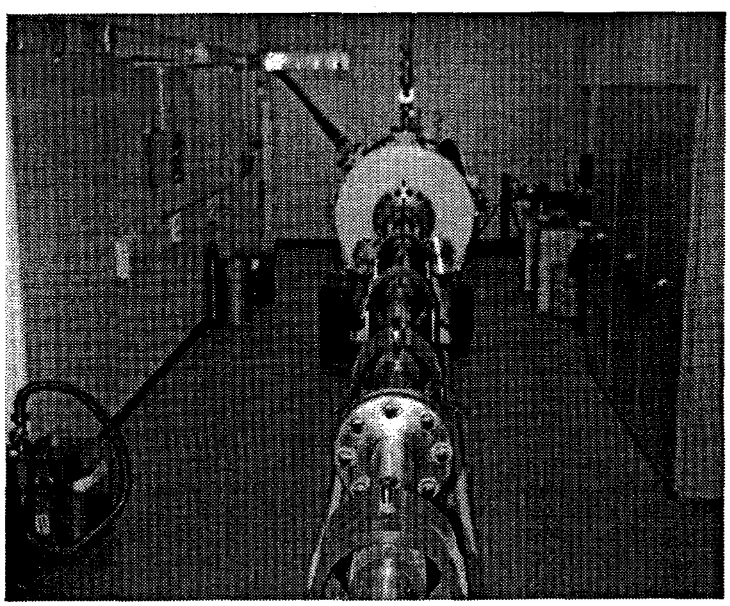


GLOVE BOX IN THE BATTERY LABORATORY

A light-gas gun is used to conduct shock-characterization, energetic-material-sensitivity, and armor-penetration studies. The gun can propel a 200 gram projectile at a velocity of up to 1.8 kilometers per second down the 57-foot-long barrel. The system includes the breech, barrel, target chamber, and catch tank. The breech is pressurized to about 6000 psig with either nitrogen or helium. This pressure is released rapidly to push a projectile down the barrel. The target chamber contains the target and provides the interface for data collection. The target chamber is fitted with a VISAR. The catch tank catches debris and exhausts the gas to atmosphere.



BREECH END OF THE GAS GUN

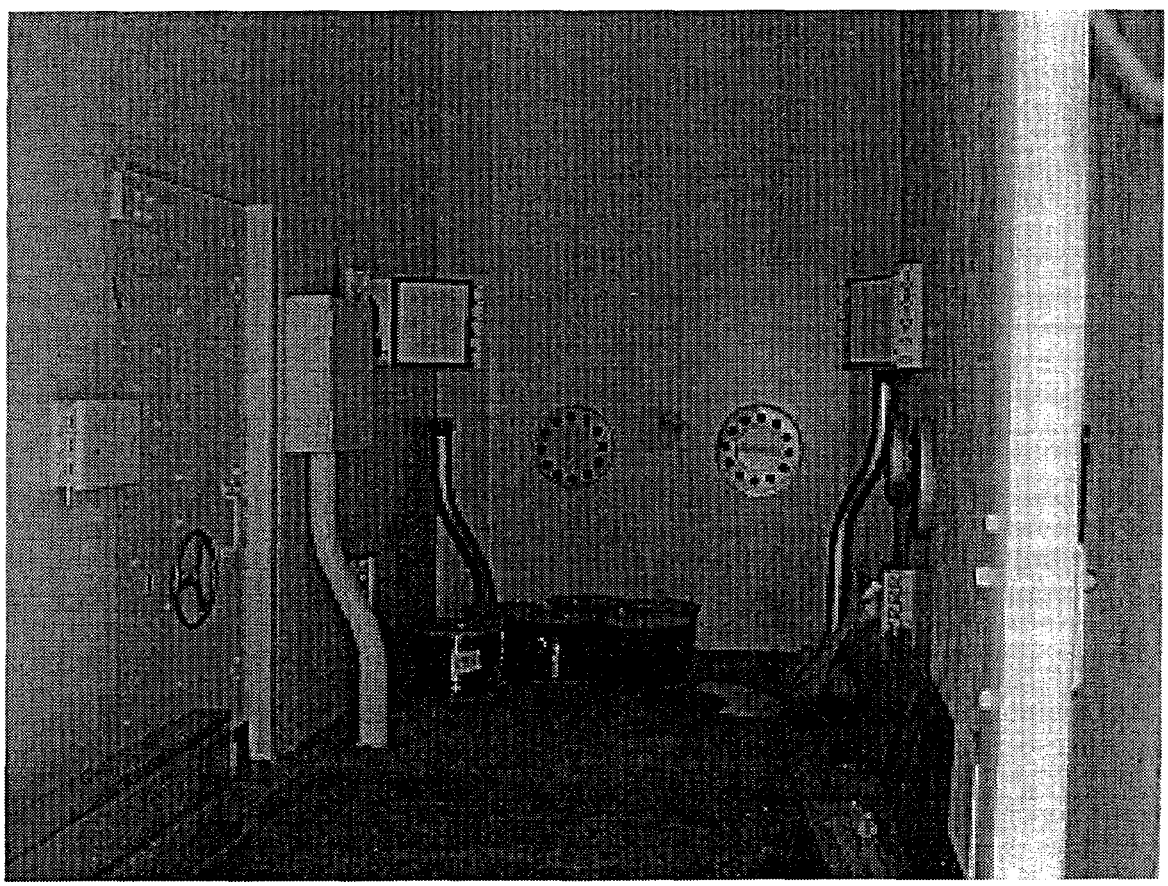


TARGET CHAMBER END OF THE GAS GUN

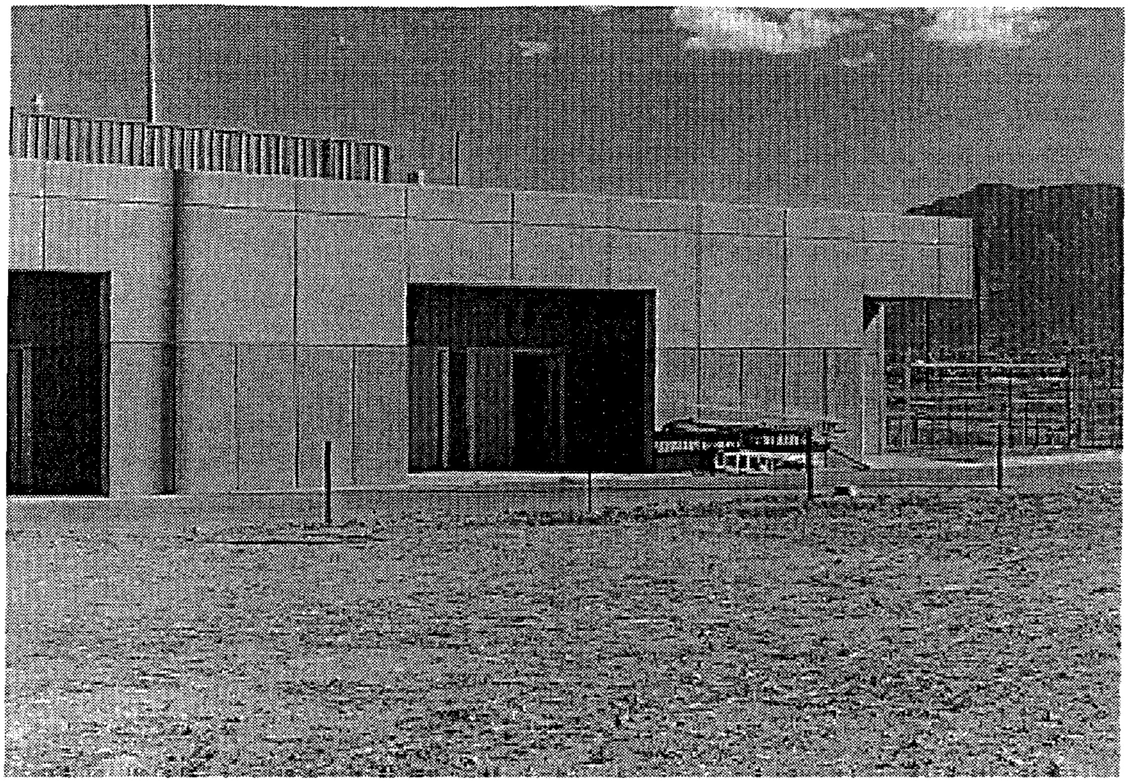
Nine enclosed firing pads and two high explosives chambers are located at the rear of the laboratory/testing wing. The firing pads and high explosives chambers are designed to protect personnel from the over pressure, hazardous fragments, and thermal effects of planned detonations of up to one kilogram (TNT equivalent). The walls, roof, and slabs-on-grade of the firing pads are designed to accommodate repeated detonations without damage to the ECF structure.

The high explosives chambers are ASME code vessels which are designed to accommodate repeated detonations without damage to the chambers or the ECF structure. Two blast doors are used to provide access control and partial containment for each firing pad and chamber. The area behind the firing pads and chambers is a fenced exclusion area. This area is monitored using video cameras.

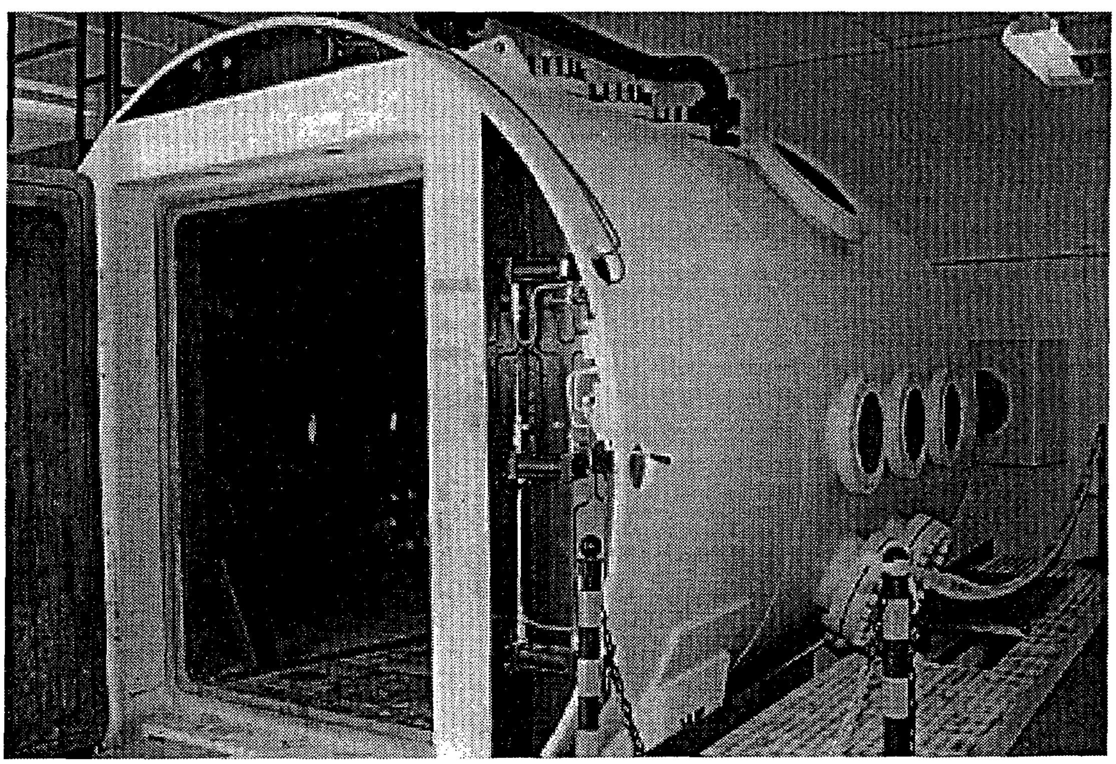
A series of proof tests were conducted on the firing pads and chambers before occupancy of the ECF. These tests confirmed design adequacy of the structures and provided input to the development of administrative controls for access and exposure to noise. The firing pads and chambers were successfully tested at 1.25 kilograms (TNT equivalent). Some minor modifications were made to the firing pads to reduce noise in the operations areas.



FIRING PAD

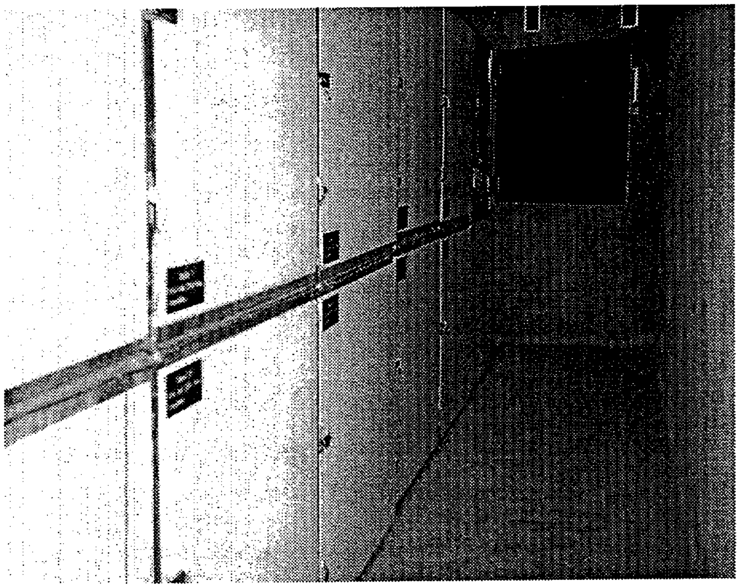


EXCLUSION AREA BEHIND FIRING PADS

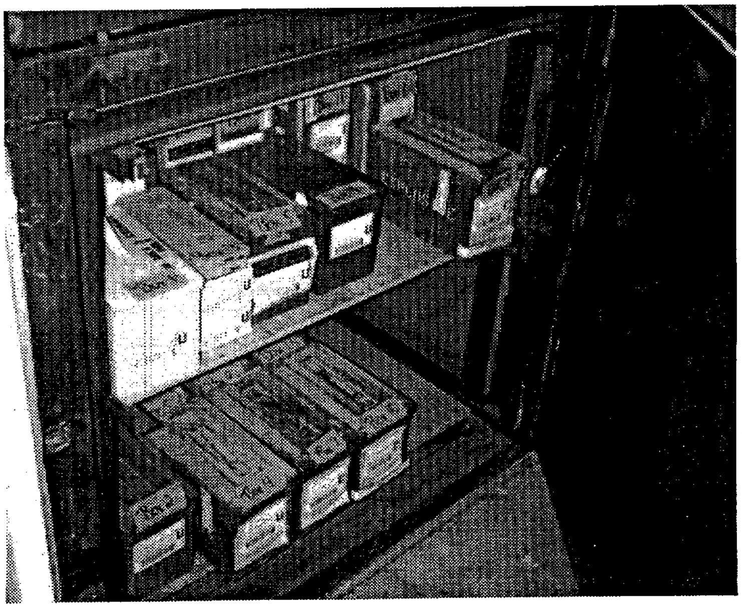


HIGH EXPLOSIVES CHAMBER

Four of the six storage magazines are used for storage of explosives. Each storage magazine contains twenty-four SIFCON cabinets. SIFCON is used because of its high resistance to back spall from blast loadings and penetration by high-velocity ballistic projectiles and fragments. Each cabinet is rated at about 2 1/4 kilograms for non-propagation of a detonation. Using SIFCON cabinets allowed the storage magazines to be designed to contain only a 2 1/4 kilogram detonation, rather than 54 1/2 kilograms. The other two storage magazines are currently used for bonded storage of neutron generators and long-term storage to support a neutron-generator shelf-life program.



SIFCON CABINETS INSIDE A STORAGE MAGAZINE



INSIDE A SIFCON CABINET

Occupancy

Beneficial occupancy started in May 1995. Over 80 personnel from many different locations were moved in a planned order determined by programmatic needs and the availability of finished space in the ECF. The priority was to minimize down time and optimize the overall startup process. As equipment was moved into a laboratory, the Laboratory Owner established the final location. Then the final installation of cabinets, benches, etc. was completed and utilities connected. The process for requesting this work was structured to minimize the time from request to completion of work with a minimum of paperwork. The Laboratory Owner also started the preparation of hazard assessments, operating procedures, and training as a predecessor to the Readiness Assessment process.

Readiness Assessment

A Readiness Assessment process was used to ensure that operational risk was minimized. The activities at ECF are grouped in terms of like operations rather than a specific, well-defined, industrial process even though, in practice, there are individual differences in equipment, hazards, and personnel. Therefore, the ECF was grouped into 57 functional areas. An independent team did a formal readiness assessment of each of the 57 functional areas after the Laboratory Owner completed the preparation of hazard assessments, operating procedures, and training. The readiness assessments were done over a one-year period. A checklist was used to provide consistent evaluation of operational readiness. The checklist included items to confirm the adequacy of the support systems, hazard assessments, procedures, and training. Observations and findings were recorded and addressed and formal approval received before commencing operations in a functional area.

Summary

The unique capabilities of the ECF enable us to design, test, and guide the production of a large number of energetic devices and systems. These range from tiny igniters, to shaped charge devices, to neutron generators, to thermal batteries, to propellant motors. It is the combination of innovative building design, state-of-the-art equipment, and experienced, well-trained personnel that enables the ECF to fulfill its role as a national resource.