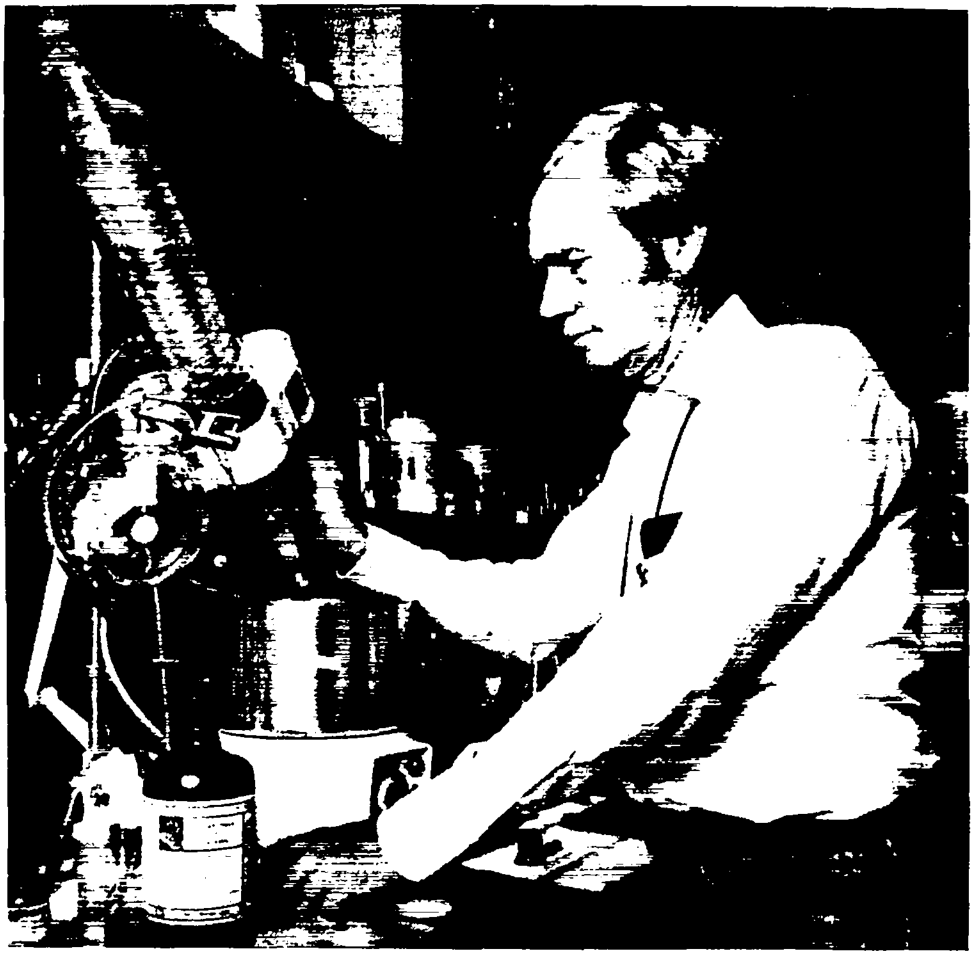
DYNAMIC TESTING DIVISION

COPY

Through fundamental and applied research in explosives and testing technology, the Dynamic Testing (M) Division contributes to Los Alamos National Laboratory's national security programs and makes its expertise available to the nation's defense community. All aspects of explosives research and development, including the development of test diagnostic procedures and equipment, are the responsibility of M Division. These activities include the detailed measurement, analysis, and understanding of hydrodynamic systems.

Current Division research includes studying the behavior of explosives at the molecular level, synthesizing new organic explosives, formulating and characterizing new insensitive explosive compounds, and studying explosive reaction rates and incorporating them into complex computational models. Division research also includes studying the physics of shock-wave interactions and the behavior of materials at extremely high pressures and temperatures, developing new dynamic testing equipment and procedures, using explosives to produce electrical energy, and developing a variety of advanced conventional munitions. Division scientists carry out their work through theoretical studies supported by computational models combined with detailed experiments that employ the most sophisticated diagnostic equipment available.

Among M Division personnel are chemists, engineers, and physicists, supported by a variety of technicians and others. The Division is organized into six groups that occupy about 20 square miles, nearly half the area occupied by the Laboratory. This area contains laboratories, offices, and most of the Laboratory's explosives firing sites.



Synthesis of new explosive molecules may lead to materials with increased resistance to accidental explosion.

EXPLOSIVES RESEARCH

The Los Alamos emphasis on safety in its nuclear weapon research has led to the development of insensitive high explosives. During the 1970s, the Laboratory pioneered the use of insensitive high explosives, which dramatically increase safety during handling and transportation and reduce the likelihood of nuclear material dispersal from a weapon accident. Most modern weapons are designed to incorporate these insensitive explosives. Insensitive high explosives—such as triaminotrinitrobenzene, or TATB—can be dropped from great heights and will only shatter. These materials resist explosion caused by extreme pressures, high temperatures, and shock. In addition, they can be handled safely when normal precautions are observed and remain stable when stored for long periods in military stockpiles. To ensure the reliability of nuclear weapons in the nation's stockpile, Division researchers continue to study the compatibility of materials in long-term storage and continue to develop new materials for weapon components.

Through testing, M Division confirmed theories that a reaction strongly accelerated by change in temperature or pressure is characteristic of an insensitive explosive. These experiments should lead to more precise computer models of initiation and detonation, helping researchers understand how reaction rates affect sensitivity, initiation, and detonation.

M Division's interests are not limited to new explosives. Nitroguanidine (NQ), which was first prepared in 1877 and used extensively in both world wars, is a major ingredient in propellants. Its crystals

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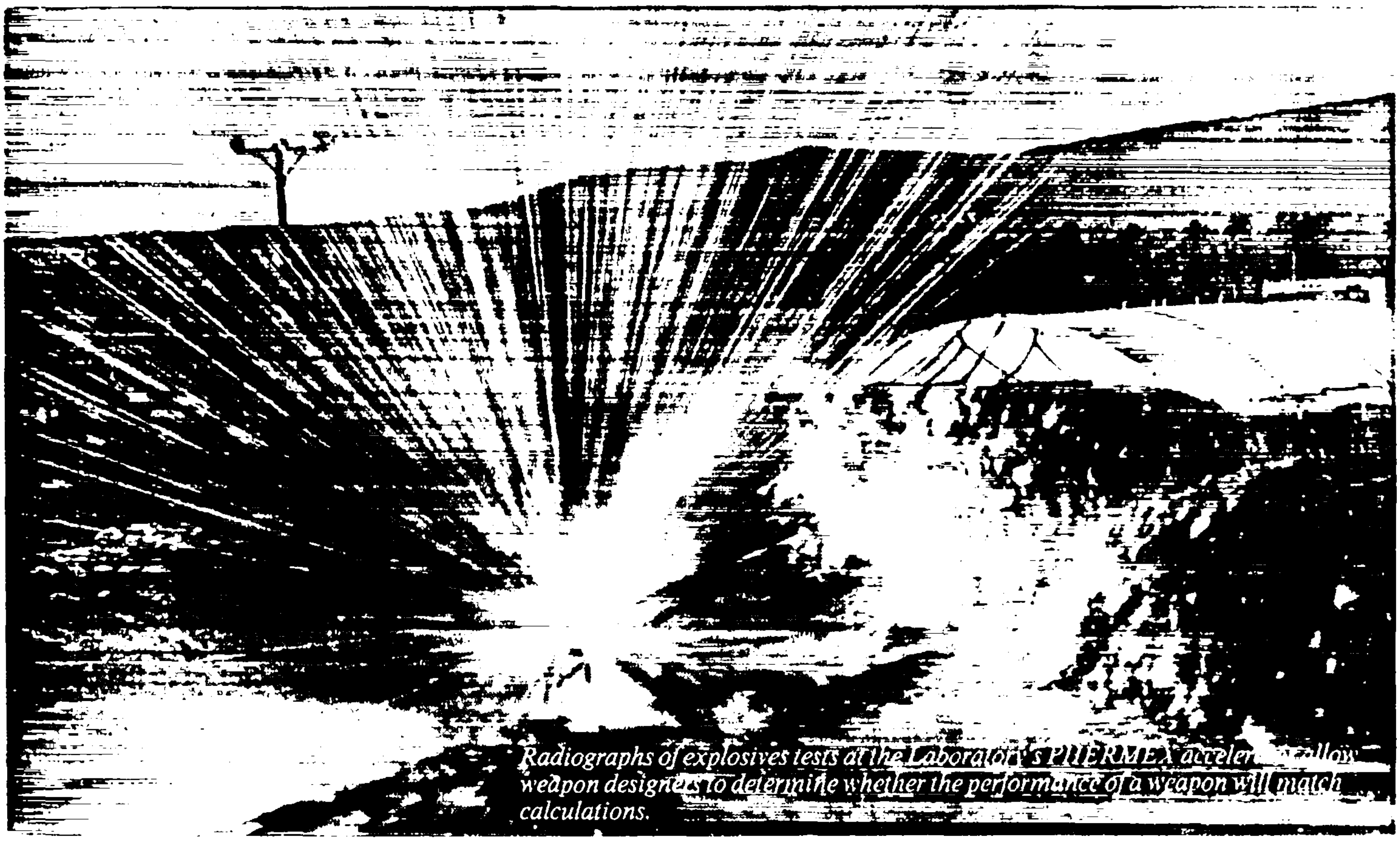

Radiographs of explosives tests at the Laboratory's PHERMEX accelerator allow weapon designers to determine whether the performance of a weapon will match calculations.

naturally assume the form of long felt-like needles, making NQ impractical for processing into explosive charges. M Division researchers recently developed a way to produce NQ crystals in the form of spherical particles that can be processed with other materials to make high-density charges; with further development, NQ may prove advantageous in many new weapon applications.

Los Alamos scientists are extending their historic mission in this area of research to discover at the molecular level what an explosive is and how it works. This fundamental research enlists the most sophisticated techniques with which researchers hope to learn what holds the explosive molecules together, what makes them come apart during an explosive reaction, how the released energy interacts with other molecules, and how that released energy causes other molecules to break up and release even more energy. Such studies should improve the ability to predict how a new explosive will behave; they may also lead to a first-principles approach for prescribing explosives with specific desired characteristics.

DYNAMIC RADIOGRAPHY

Dynamic radiography is one of the major tools used in M Division to obtain data on the hydrodynamic performance of components used in nuclear weapons. In dynamic radiography, large machines are used to produce extremely short-duration bursts of x rays. After passing through the rapidly moving test object, the x rays are recorded on film as an image of the test object. The short bursts of x rays effectively "freeze" the motion of explosive-driven weapon components. The resulting radiographs are then examined in detail to determine whether the theoretical calculations used to design the weapon components agree with the experimental results. This process saves both time and money because it reduces the number of full-scale tests of weapon designs required for comparing calculations with experiments.

For the past two decades, PHERMEX (Pulsed, High-Energy Machine Emitting X Rays) has been used to examine the hydrodynamic performance of all new Los Alamos nuclear weapon designs and all major changes to stockpile weapons. PHERMEX is a large radio-frequency linear accelerator. It directs pulses of high-energy electrons to a tungsten target where the energy of the electrons is converted into x rays.

M Division recently completed a second major radiographic installation, the Multidiagnostic Hydrotest Facility. At the heart of this complex is Ector, a diode-type pulse-power machine that produces extremely short bursts of x rays. Ector is used with other diagnostics, including high-speed rotating-mirror cameras, electric

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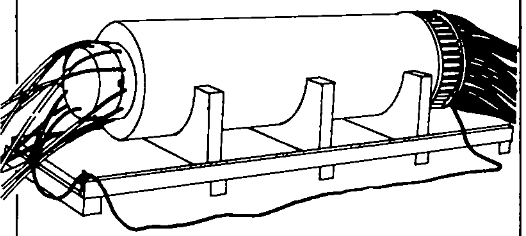
contactor pins, and laser interferometry to study the behavior of weapon components in explosive tests. A computer monitors and controls the facility's extensive diagnostic and power-control equipment.



Huge bursts of electrical energy can be obtained from explosive-driven generators.

PULSED-POWER APPLICATIONS

Division scientists are experimenting with explosive-driven generators that convert part of the energy released by an explosive reaction into huge amounts of electricity. The generators employ the fast compression of magnetic flux. Fast-switching components that also employ explosives are being developed to sharpen the output pulse from explosive-driven generators. At Los Alamos, explosive-driven generators have served as power sources for electric railguns, dense plasma devices, and several new applications related to the national strategic defense initiative.

In addition, M Division uses the unique intense electron beam of the PHERMEX machine to evaluate the propagation and erosion of electron beams for the strategic defense initiative. Using a krypton fluoride laser to photoionize a channel in low-pressure benzene gas through which the 30-MeV PHERMEX electron beam was propagated, scientists learned that the full beam could be propagated down a 13.4-meter-long laser channel without degradation. Further experiments are planned to evaluate the beam erosion caused by transverse magnetic fields.

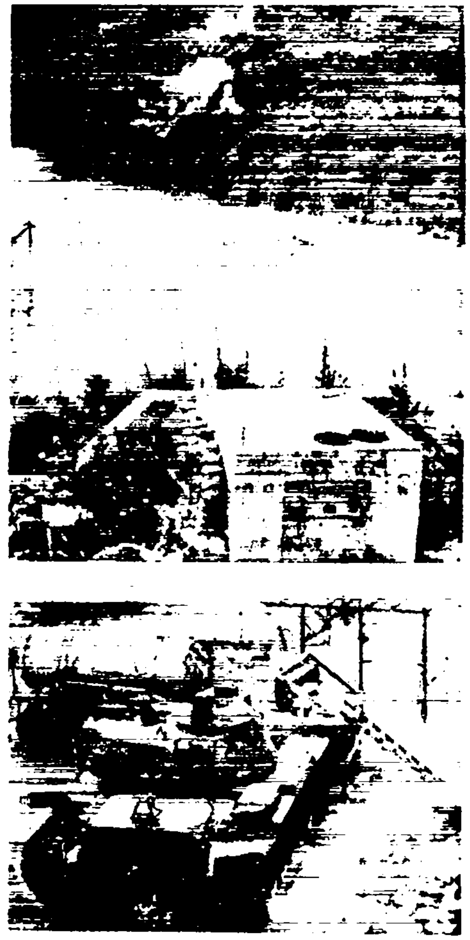
MATERIALS UNDER PRESSURE

To help understand the high-pressure properties of materials—such as plastics and metals—used in nuclear weapons, Division researchers use a variety of high-pressure-producing systems, including explosives assemblies, gas guns, and diamond anvil cells, to subject materials to pressures more than 200,000 times normal atmospheric pressure. These unconventional testing techniques are necessary to simulate the extreme conditions that occur in an explosive-driven system. Under these conditions, materials may undergo molecular re-arrangements that can alter their behavior. In dynamic experiments, metals may melt or separate into layers. In static experiments, the result can be as dramatic as the solidification of a gas such as oxygen. Computational models rely heavily on detailed data acquired from experiments; without such data, errors in the models cannot be eliminated. But accurate models based on experimental data permit theoretical designers to explore variations without requiring an actual explosive test at each step. Of current interest is the behavior of plastics used in many weapon components. These complex polymeric materials consist of large molecules held together by a complicated network of chemical bonds. Current research in M Division focuses on understanding how these materials respond to shocks and how their properties are altered as a result of the shock process.

ADVANCED CONVENTIONAL MUNITIONS

While working to support the Laboratory's nuclear weapon programs, M Division has developed unique capabilities that can be applied to advanced conventional munitions. Current efforts range from research on inexpensive insensitive explosives for conventional munitions to the design of advanced detonation systems.

Incorporating TATB-based explosives into modern nuclear weapons has greatly increased their safety. M Division chemists, engineers, and physicists are working to develop explosives for the Department of Defense (DoD) that will similarly decrease the hazards of conventional munitions. Unfortunately, TATB is too expensive for most conventional weapon applications, so the Division is working to develop safe, inexpensive cast explosives that are compatible with present DoD requirements. M Division is conducting experiments to determine whether ammonium nitrate-based compositions and spherical nitroguanidine/TNT-based explosives, which may offer increased resistance to accidental detonation, perform as well as current DoD explosives.



Capabilities and technology developed for nuclear weapon programs can often be applied to conventional munition programs.

M Division is pursuing the upgrade of both the range and lethality of artillery. To increase range, researchers are studying progressive-burning propellant grains and high-density compacted grains. In addition, the Division is evaluating a concept that could significantly increase the ballistic coefficient (and thus range) of projectiles. If this concept proves successful, it may be applied to both artillery and mortars. Using new detonation systems developed in M Division, experimenters are evaluating the extent to which multipoint axial initiation improves fragmentation and fragment velocity—and thereby increases the killing power of conventional explosive-filled artillery shells.

For many years, M Division has been involved in armor/anti-armor research for the DoD. This effort led to the development of the long-standoff penetrator, a munition that may prove useful to all three military services. M Division is also evaluating the performance of DoD kinetic-energy penetrators. The PHERMEX facility, as well as our other high-energy flash x-ray machines, is being used to look inside conventional and special armors to record penetrator/armor interactions. This capability provides analysts with information not available from the before-and-after data they usually use.

DETONATION SYSTEMS

The design and engineering development of detonation systems for high explosives components—including capacitive discharge units and triggers, cables, and detonators—is an important part of M Division's work. Recent advances in detonation systems include improved safety features and lower electrical energy requirements, along with increased design flexibility through the use of slapper detonators rather than traditional exploding bridgewire detonators. Division researchers have extended this emphasis on improved safety to the design of a variety of low-voltage hot-wire detonators and actuators by using less sensitive secondary (rather than primary) explosives in these devices.

The advent of slapper detonators and the development of printed-circuit technology in high-voltage cabling have significantly simplified the manufacture of high-quality detonation systems. This technology was originally developed for nuclear weapons. M Division, under the sponsorship of several DoD agencies, is investigating it for a number of conventional weapon applications.

THE FUTURE

The Dynamic Testing Division will continue to play a major role in the national defense activities of the Laboratory while maintaining the flexibility to respond to changing programs and directions.

To maintain this role, M Division has developed a long-range plan that will guide the evolution of facilities for explosives development and dynamic testing at Los Alamos for the next twenty years.

The plan calls for a centrally located complex accessible by two roads. Here a main laboratory/office building will house most Division personnel. The complex will also contain chemistry and physics laboratories, facilities for contained firing and testing, and equipment for shock-wave studies. To improve both quality and efficiency, most support functions will be contained in the central complex.

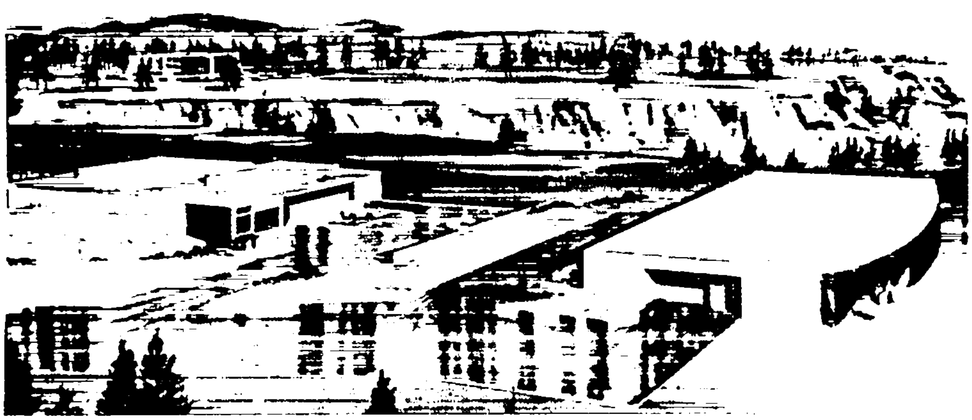
Part of the complex will be in a controlled-access area outside the security fence. This arrangement will allow Division personnel to participate in joint projects with uncleared personnel from universities, other agencies, and industry. The Explosives Physics Experimental Facility (EPEF), which will be as close to the central complex as hazard zones allow, will be an important addition to the Division.

GROUPS IN THE DYNAMIC TESTING DIVISION

M-1:	Explosives Technology
M-4:	Hydrodynamics
M-6:	Shock Wave Physics
M-7:	Detonation Systems
M-8:	Explosives Applications
M-9:	Reaction Science
M-DO:	Division Office

The plan requires construction and development of a number of new firing sites, including the Dual-Axis Radiographic Hydrotest (DARHT) facility, the Laboratory's next-generation flash radiography installation. The plan also retains many existing facilities. The total number of firing sites will remain essentially the same, although their functions will change. The plan, which will be implemented in four phases over the projected twenty-year period, ensures that research and testing capabilities will continue while new facilities are under construction.

As a technology-based organization, M Division conducts many activities not necessarily slated for immediate application. Division scientists and technicians create a reservoir of information that can be used for research by other Laboratory divisions, the military, and private industry and universities. As the Laboratory continues to explore the limits of technology applied to national security, the Dynamic Testing Division will continue to provide fundamental data on reactive and inert materials and innovative technological solutions related to nuclear and nonnuclear weapon systems.



This drawing of the proposed Explosives Physics Experimental Facility shows the main experimental building (right foreground) and the charge-preparation annex (left foreground).

Los Alamos

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