DEFENSE SPECIAL WEAPONS AGENCY

1947-1997

The First 50 Years of National Service

DEFENSE SPECIAL WEAPONS AGENCY

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The First **50 Years** of National Service

Initial Charter for the Armed Forces Special Weapons Project

29 January 1947

SUBJECT: Armed Forces Special Weapons Project

TO: Chief of Staff, United States Army
Chief of Naval Operations.

1. On 1 January 1947, the Atomic Energy Commission established by the Atomic Energy Act of 1946 (Public Law 585, 79th Congress) took over the organization and properties of the Manhattan Project.

2. There is established, effective midnight 31 December 1946, a joint Army-Navy atomic energy organization which will discharge all military service functions relating to atomic energy and will be known as the Armed Forces Special Weapons Project. Military personnel on duty with the Manhattan Engineer District at midnight 31 December 1946, and who are excepted from service with the Atomic Energy Commission, will be assigned to duty with the Armed Forces Special Weapons Project as of 31 December 1946.

3. The Armed Forces Special Weapons Project will operate under a Chief who will be selected by mutual action of the Chief of Staff and the Chief of Naval Operations. A Deputy Chief from the opposite service shall be also selected by the mutual action of the Chief of Staff and the Chief of Naval Operations. Both the Chief and Deputy Chief shall be members of the Military Liaison Committee to the Atomic Energy Commission. They will be assisted by an appropriate staff drawn from the War and Navy Departments.

4. The Chief of the Armed Forces Special Weapons Project will:

a. Assume responsibility for all military service functions of the Manhattan Project as are retained under the control of the Armed Forces, including training of special personnel required, military participation in the development of atomic weapons of all types (in coordination with the Commission), technical training of bomb commanders and weaponeers, and developing and effecting joint radiological safety measures in coordination with established agencies.

b. Report directly to the Chief of Staff, United States Army, and the Chief of Naval Operations.

5. Funds, other than for pay of military personnel, will be provided initially from those funds of the Manhattan Project which have not been transferred to the Atomic Energy Commission. Pay of military personnel will be from appropriate War and Navy Department appropriations.

SECRETARY OF WAR

SECRETARY OF THE NAVY

** Reproduced text of January 29, 1947 AFSWP charter.*

On July 16, 1945, at the TRINITY site in the sands of New Mexico, the first atomic weapon was detonated. That day brought the first glimpse of the power and potential for destruction now in the hands of mankind. Soon that potential was transformed into two enormous nuclear arsenals – one in the hands of the Soviet Union and one in the hands of the United States. Throughout the Cold War, we lived with the threat of nuclear holocaust hanging over our heads like a dark cloud, threatening the extinction of all mankind.

It was during this period that the agency we now know as the Defense Special Weapons Agency (DSWA) emerged as one of the key stewards of our nation's nuclear weapons capability. Chief among its long history of accomplishments is that maintaining our nuclear arsenal actually helped prevent that nuclear holocaust and the destruction of our nation.

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TRINITY marker at Alamogordo, New Mexico.

Today, the Cold War is over, the nuclear arms race has ended, the dark cloud has lifted and all the world breathes easier. But the nuclear threat has not gone away. Instead, we face the threat of nuclear weapons, technology and materials falling into the hands of rogue nations or terrorists. We still must maintain and operate a smaller but highly powerful nuclear arsenal as a deterrent. We have embarked on a brave new era of nuclear arms reductions, bold new safeguards and innovative nuclear technologies, and we have an even greater need for DSWA.

The men and women of DSWA are leading the way into this new era. Your dedication and patriotism helped us survive nearly 50 years of nuclear terror. It will be your innovation and your continued hard work that will make the future safer and brighter for all mankind.

2-1

Secretary of Defense William Perry

No one knows what challenges the future might hold. But I do know that the people of DSWA are equal to those challenges. I extend my congratulations to them for their impressive contributions to our national security, and offer my best wishes for even greater achievements in the years ahead.

William J. Perry
Secretary of Defense

1941–1947—*Dawn of the Atomic Age*

3-1

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The New York Times.

FIRST ATOMIC BOMB DROPPED ON JAPAN; MISSILE IS EQUAL TO 20,000 TONS OF TNT; TRUMAN WARNS FOE OF A 'RAIN OF RUIN'

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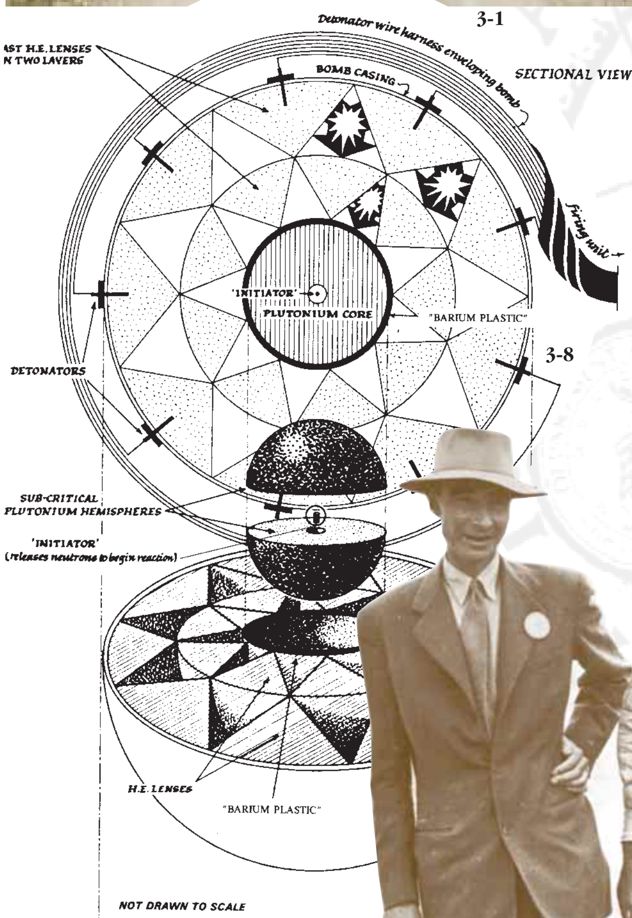

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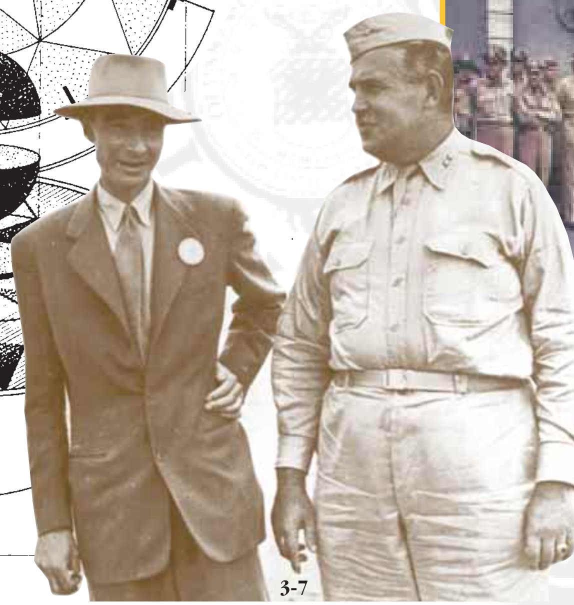

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3-1. *Los Alamos West Gate.* **3-2.** *Churchill, Roosevelt, and Stalin at Yalta, 1945.* **3-3.** *B-29 Superfortress "Enola Gay."* **3-4.** *New York Times, August 7, 1945.* **3-5.** *VJ Day, August 14, 1945.* **3-6.** *Japanese surrender ceremony on board the U.S.S. Missouri.* **3-7.** *J. Robert Oppenheimer and General Leslie Groves.* **3-8.** *The Gadget drawing passed by David Greenglass to Soviets.*

1941-1947—Dawn of the Atomic Age: *The Manhattan Project provides America with the means to terminate World War II promptly and decisively.*

1941 - Pearl Harbor attacked

1942 - Manhattan Project initiated

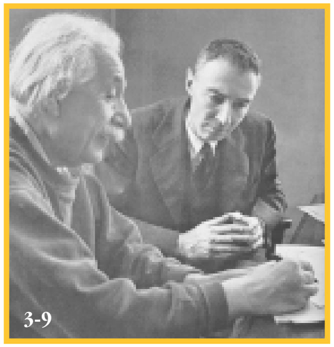
1943 - Allies begin offensive operations

1944 - D-Day in Europe

1945 - Hiroshima/Nagasaki bombed – War ends

1946 - Atomic Energy Act

1947 - AFSWP established



Albert Einstein and J. Robert Oppenheimer.

Scientific Discoveries Before the Manhattan Project: In 1911, Ernest Rutherford proposed the nuclear model for the atom based on experimental data. In 1938, Otto Hahn and Fritz Strassman discovered fission products after the irradiation of uranium with neutrons. Lise Meitner and Otto Frisch interpreted this data as being caused by the neutron-induced fission of uranium. This discovery led to over 100 published papers in 1939, essentially defining the modern theory of atomic fission. In a letter drafted by his colleagues, Einstein wrote to President Franklin D. Roosevelt on August 2, 1939: "It may become possible to set up a nuclear chain reaction in a large mass of uranium, which would... lead to the construction of... extremely powerful bombs... ."

Preliminary Government Involvement: The National Defense Research Council, under Vannevar Bush, supported research in 1940-1941 that indicated weapons development was not "remote." Shortly before the attack on Pearl Harbor, the Office of Scientific Research and Development established an office (OSRD S-1) to develop an atomic bomb. Dr. Bush proposed to transfer management of the project to the Army in the summer of 1942 to assure priority and establish security.

The Manhattan Engineer District: On August 13, 1942, the Corps of Engineers, issuing General Order 33, established the Manhattan Engineer District (MED), cover name for the atomic bomb development project. Brigadier General Leslie R. Groves served as commanding officer of the MED from September 23, 1942, through 1946.

The Manhattan Project: General Groves selected Dr. J. Robert Oppenheimer to lead the scientific effort. Together, they chose the Los Alamos Ranch School in New Mexico as the site for the atomic laboratories.

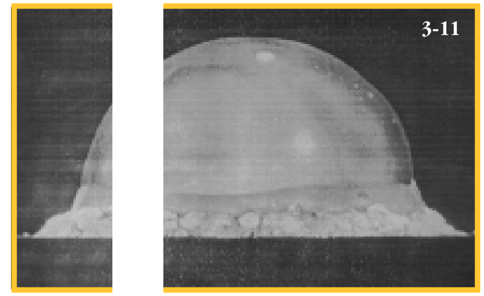
Dawn of the Atomic Era: On December 2, 1942, Enrico Fermi's group operated the world's first self-sustaining nuclear fission reactor under Stagg Field, University of Chicago. Techniques for aerial delivery of atomic weapons were developed at Los Alamos, New Mexico and Wendover Field, Utah, between 1943 and 1945. MED personnel worked with the Army Air Corps at Wendover to modify the newly-produced B-29 bomber and refine bombing techniques.

TRINITY: 100 tons of high explosives were detonated on May 7, 1945, as a dress rehearsal for the TRINITY event. It also served to calibrate instruments to measure TRINITY phenomena. Then, on July 16, 1945, Los Alamos personnel detonated an implosion-type plutonium device, named TRINITY, near the remote town of Alamogordo, New Mexico.

Hiroshima and Nagasaki: On August 6, 1945, the 509th Composite Group dropped *Little Boy* over Hiroshima, and, on August 9, *Fat Man* over Nagasaki. Soon thereafter the Japanese government agreed to surrender, ending World War II on September 2, 1945.

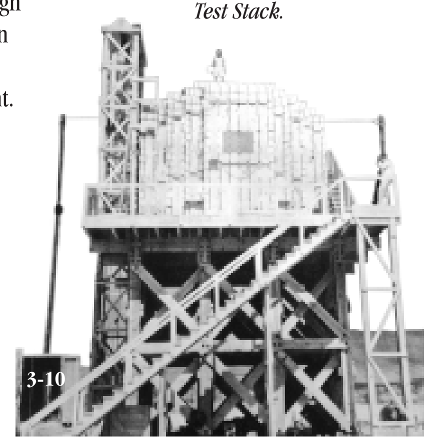
Bombing Surveys and Postwar Planning: MED staff participated in initial bomb damage and radiation assessments, as well as postwar surveys of both Hiroshima and Nagasaki. They also participated in planning for international controls, including the Baruch-Lilienthal Plan that the U.S. presented to the United Nations.

Operation CROSSROADS: In 1946, MED personnel organized the first postwar atomic test series at the Bikini Atoll in the Pacific Ocean. These tests demonstrated the effects of atomic weapons on surface ships, including the hazards of long-term radioactive contamination.



TRINITY - J *, 1945.*

TRINITY High Explosive Test Stack.



The Atomic Energy Act of 1946: President Truman signed the Atomic Energy Act of 1946 on August 1, transferring atomic weapons, production facilities, and patent rights to a five-member civilian Atomic Energy Commission (AEC), effective December 31, 1946.

Transition to the Armed Forces Special Weapons Project: On January 29, 1947, Secretary of War Robert P. Patterson and Secretary of the Navy James V. Forrestal established the Armed Forces Special Weapons Project (AFSWP), the successor organization to the MED. It assumed all functions of the MED not transferred to the AEC. AFSWP assured readiness by training for both offensive and defensive atomic warfare, assessing the effects of these new weapons, and supporting postwar national defense planning.

1947–1954 — *Early Years of the Armed Forces Special Weapons Project*

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4-1. *Berlin Airlift of 1948-1949.* **4-2.** *Korea map.* **4-3.** *Truman with election results.* **4-4.** *Mk-6 bomb.* **4-5.** *Vacuum tube computer.* **4-6.** *Edward Teller.* **4-7.** *General MacArthur.* **4-8.** *Nixon and Eisenhower at convention.* **4-9.** *Troops and DOG blast.*


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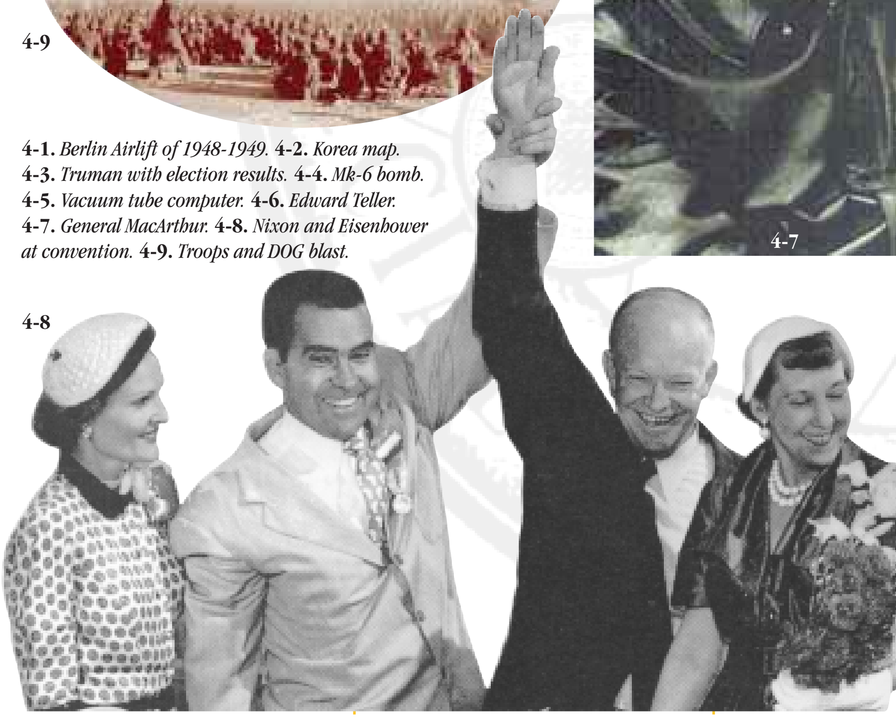


1947-1954—Early Years of the Armed Forces Special Weapons Project: *The Berlin Blockade and the Korean War, along with atomic testing by the United States and the Soviet Union, set the stage for later Cold War relations.*

1947 - Marshall Plan funds European Recovery Program

1948 - Berlin Blockade begins in April 1948 – ends in May 1949

1949 - Formation of NATO – First Soviet nuclear test

1950 - North Korea attacks South – U.S. leads military response

1951 - Truman relieves General MacArthur

1952 - Eisenhower elected President

1953 - Korean Armistice signed in July

1954 - Ballistic missile development accelerated

➔ *Initial Charters:* The original AFSWP charter in January 1947 authorized training for assembly and employment of atomic weapons. It encouraged AFSWP participation in the development of atomic weapons of all types. A revised charter in July 1947 authorized AFSWP to coordinate research in atomic energy.

➔ *Training for Custody of Atomic Weapons:* The July 1947 charter further provided for AFSWP storage and surveillance of weapons in the custody of the armed forces. Until the Korean War, all atomic weapons remained in the custody of the civilian AEC. In 1947, at Sandia Base in Albuquerque, New Mexico, AFSWP initiated a training course on atomic weapons, where instructors from Sandia Laboratory taught weapons assembly procedures.

➔ *Establishing a Deterrent Force:* A March 1948 "war warning" cable from General Lucius Clay, Commander in Chief, Europe (CINCEUR), in advance of massive Russian troop maneuvers and access challenges along corridors to Berlin, led to the first postwar U.S. plan for atomic bombardment of Soviet targets.

4-10

Firing party prior to MIKE test.

➔ *Weapons Effects Testing:* AFSWP participated in all three fission weapon tests at Enewetak Atoll during Operation SANDSTONE in 1948, and prepared technical reports on weapons effects. AFSWP developed improved instruments to measure weapons blast and shock environments during future nuclear weapon tests.

➔ *Accelerating Assembly Team Training:* In April 1948, AFSWP accelerated the pace of its assembly team training. After the SANDSTONE tests, General Groves, first AFSWP Chief, urged accelerated production of the Mk-4 bomb.

➔ *Operational Storage:* AFSWP worked jointly with the AEC to establish three National Stockpile Sites that were accessible to the 1st, 8th, and 2nd Air Forces, respectively. These sites became operational in 1949-1950.

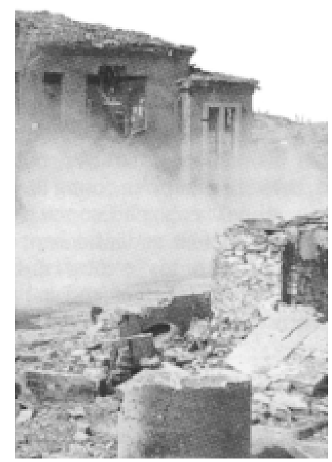
➔ *Nuclear Effects Documentation:* In 1949, the Joint Chiefs of Staff (JCS) assigned responsibility to AFSWP for collecting, reviewing and disseminating data on the effects of atomic weapons. This resulted in the first integrated report, *The Effects of Atomic Weapons* (1950), prepared jointly with the AEC.

4-11

GRABLE test explosion.

➔ *Extending Deterrence Through the Berlin Airlift:* In June 1948, the blockade of road and rail access to Berlin led to a joint Anglo-American airlift of foodstocks and supplies. President Truman approved the deployment of B-29 bombers to British bases in July 1948, to signal a U.S. commitment to deter military agression and the occupation of Western Europe.

➔ *Signaling Readiness While Protecting the Atomic Arsenal:* With a total stockpile of about 50 atomic bombs and a shortage of bomb assembly teams, the forward deployment of the U.S. atomic capabilities seemed imprudent in the absence of air defenses at prospective forward bases. In July 1948, AFSWP supported the Strategic Air Command (SAC) and an Anglo-American deception plan in signaling a forward deployment of atomic weapons two years before



A U.S. tank rolls through Chunchon, Korea.

4-13

Area 7 ground zero target.

such deployments occurred. AFSWP personnel accompanied the B-29 groups during their deceptive move to British air bases.

➜ *Success of the Berlin Airlift and Formation of the North Atlantic Treaty Organization (NATO):* The last verbal threat to Allied use of the Berlin air corridors occurred on July 14, 1948, several days before SAC B-29s arrived at British bases. The Berlin airlift expanded its deliveries, without Russian interference, until the blockade ended in the spring of 1949. AFSWP teams quietly prepared for forward assembly operations in 1949-1950, and deployed to Royal Air Force bases in the United Kingdom in 1951.

➜ *Coordinating Weapons Requirements:* Sandia Pioneers within the laboratory's ordnance division began informally coordinating weapons requirements in 1947. The September 1949 detection of debris from the first Soviet atomic test, JOE-1, intensified U.S. efforts to maintain its technological lead. AFSWP's Chief briefed the Joint Chiefs of Staff (JCS) on the potential applications of thermonuclear weapons preceding President Truman's January 1950 decision to approve development of these weapons. Jointly the AEC and AFSWP conducted research on weapons vulnerabilities and nuclear weapons effects.

Military personnel observing test.

4-14

➜ *Developing a Weapons Vulnerability Program:* In March 1950, the Military Liaison Committee, composed of Department of Defense (DoD) and AEC staff, asked AFSWP to study and test the vulnerability of nuclear weapons. The results helped support the design of air-to-air and surface-to-air weapons for air defense: Nike Ajax, Nike Hercules, and Genie, among others. A formal AFSWP Weapons Vulnerability Program emerged in 1955.

Operation GREENHOUSE at Enewetak.

4-15

➜ *Test Planning:* In 1951, the JCS assigned to AFSWP responsibility for test planning and coordinating Service needs for nuclear test data. The AFSWP and the AEC jointly searched for a continental test site, settling on the Nevada Test Site (NTS). AFSWP subsequently sponsored many nuclear effects experiments at the NTS.

➜ *Accelerating Operational Readiness During the Korean War:* With United Nations (UN) forces resisting the invasion of South Korea and uncertainty whether the war would spread to Europe, President Truman approved AFSWP support to SAC nuclear-capable units at overseas bases in July 1950.

➜ *Atomic Diplomacy and the Korean Armistice:* After China entered the Korean war, President Truman decided in November 1950 that the atomic bomb could be considered for use. AFSWP units deployed aboard three U.S. aircraft carriers in 1950-1951. Managers of nuclear component stockpiles at Sandia Base went on alert status for airplane delivery of both nuclear insertable-core components and assembly teams within 12 hours of notification, per AFSWP order of April 24, 1951.

4-16

Protective lead-glass cloth shroud being placed on sampler pilot.

➜ *Preparing for Transfer of Weapons Custody to the Military Services:* AFSWP's July 1951 charter called for technical directives, standards for training, and procedures for nuclear technical inspections by the military Services. During the Korean War, AFSWP accepted military personnel detailed from each of the military Services for training in weapons assembly and maintenance, in operational site storage, and in technical inspection of weapons. AFWSP personnel strength reached an all-time high of nearly 11,000 in 1951-1952.

➜ *Test Implications for Civil Defense:* In the 225-kiloton test, GREENHOUSE GEORGE, conducted in May 1951, the AEC confirmed the feasibility of thermonuclear weapons. Tests at far smaller yields indicated severe damage to typical wooden structures at overpressures under 10 pounds per square inch (psi). AFSWP released GREENHOUSE test data to the federal Civil Defense authorities in September 1951.

➔ *Test Implications for Protective Structures:* Operation JANGLE, in November 1951, was the first event to test surface and subsurface cratering effects. These and later tests stimulated interest in the design of protective structures for command centers and for aircraft shelters.

➔ *Troop Training:* Troop training to operate in nuclear environments commenced on a large scale during atmospheric and cratering tests at the NTS in 1951 (DESERT ROCK I) with about 5,000 troops. AFSWP participated in test site preparation and in training military personnel during field tests of atomic weapons. Operation UPSHOT-KNOTHOLE, in 1953, trained military personnel to fire tactical nuclear weapons and to take precautions to cope with ionizing radiation.

4-17

AFSWI　　*the effects of blasts on structures.*

4-18

➔ *Stockpile Surveillance:* In August 1951, AFSWP and the AEC agreed upon coordinated procedures at Operational Storage Sites for nuclear weapons. By 1952, Sandia and AFSWP Field Command in Albuquerque, New Mexico, were both assisting the Services in conducting their own inspections but were also conducting parallel AFSWP inspections of operational sites.

➔ *Test Implications for Weapons Dispersal, Intercontinental Ballistic Missile (ICBM) Development, and Bomber Rebasing:* An early thermonuclear device test, IVY MIKE, produced a yield of 10.4 megatons of TNT-equivalent energy in October 1952. A Russian 400-kiloton thermonuclear test in August 1953 (Dr. Andrei Sakharov's *Second Idea*) accelerated plans for the dispersal of U.S. Operational Storage Sites. Concurrently, the Teapot (Von Neumann) Panel recommended development of guided missiles carrying thermonuclear warheads. Other strategic developments included radar warning networks in Alaska and Canada (the Distant Early Warning or DEW Line) and rebasing of some SAC forces to interior bases in the continental U.S.

➔ *A Nuclear Strategy of Forward Deployment and Readiness for Use:* The armistice in Korea preceded Presidential approval of a new military strategy, called the *New Look* (NSC 162/2) of October 1953. The Eisenhower administration decided to expand forward deployments of nuclear weapons in Europe, and to declare a readiness to use nuclear weapons for tactical defense and for strategic bombardment.

➔ *Atomic Warfare Status Center:* On October 16, 1953, the Secretary of Defense directed AFSWP to maintain "a centralized system of reporting and accounting to ensure that the current status and location" of nuclear weapons "will be known at all times." This critical function continues to the present day.

4-19

Event MIKE (Operation IVY) detonation.

4-20

Washdown decontamination of B-17 aircraft.

1954–1963 — *Discovery*

5-1. *Sputnik model.* **5-2.** *Nixon/Kennedy debate.* **5-3.** *Fallout shelter.* **5-4.** *Kennedy.* **5-5.** *New York Times.* **5-6.** *Castro and Khrushchev.* **5-7.** *TRUCKEE Event at Christmas Island.* **5-8.** *Astronaut John Glenn.* **5-9.** *U-2 surveillance aircraft.* **5-10.** *Berlin Wall.* **5-11.** *Redstone missile.*

1954-1963—Discovery: *The U-2 Spy Plane and the Cuban Missile Crisis fuel Cold War tensions between the U.S. and the Soviet Union, while Sputnik heralds the dawn of the space race.*

1954 - Practicality of thermonuclear weapons demonstrated

1955 - Warsaw Pact founded

1956 - U-2 flights over the Soviet Union begin

1957 - *Sputnik*, the world's first space satellite, launched

1958 - Nuclear test moratorium begins

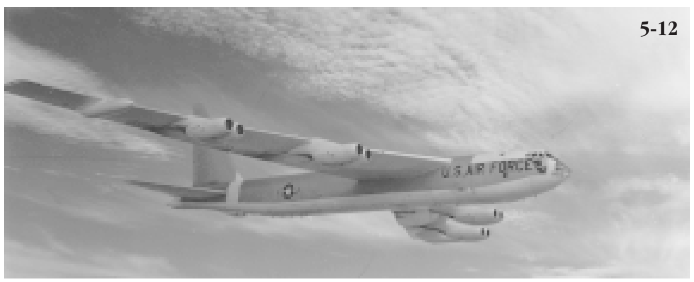
1959 - Nixon and Khrushchev engage in "kitchen debate"

1960 - Soviets down U-2 aircraft – Kennedy elected

1961 - Berlin Wall erected – Soviets break test moratorium

1962 - Cuban Missile Crisis

1963 - Limited Test Ban Treaty signed



5-12

USAF has operated B-52 bombers since 1955.

➔ *Changing Roles and Missions:* The 1954-1963 Era of Discovery was punctuated by a number of developments that, by the end of the era, forever changed the roles and missions of AFSWP, its successors, and the world. Prominent among these developments were: (1) the demonstration of lithium-based compounds as a thermonuclear fuel, permitting missiles to carry thermonuclear warheads; (2) the deployment of ICBMs and Submarine-Launched Ballistic Missiles (SLBMs), and initial development activities for ICBMs and SLBMs that would carry Multiple Independently Targeted Reentry Vehicles (MIRVs); (3) the rapid spread in the use of semiconductor-based technology in weight- and space-limited applications, such as satellites, missiles, and digital computers; and (4), the 1958-1961 moratorium on nuclear testing and the resumption of atmospheric testing, initiated by the Soviets in 1961.

➔ *Nuclear Force Survivability and Diversity:* U.S. atmospheric tests in 1954-1958 and 1962 were critical to the definition of nuclear weapons effects for the design of survivable U.S. offensive and defensive weapon systems, including their basing modes. In this era, the U.S. maintained a substantial lead in the number and yield of deployed nuclear weapon systems, offsetting the Warsaw Pact conventional force advantage over NATO.

➔ *Effects of Thermonuclear Weapons:* The CASTLE BRAVO test on Bikini Atoll on February 28, 1954, was the first of six thermonuclear weapon development tests in the CASTLE series. It had a yield of 15 megatons. The CASTLE series indicated that megaton-range weapons could be reduced in size and weight and deployed on ballistic missiles and aircraft.

➔ *Radiation Monitoring:* Fallout from the BRAVO test exposed Japanese fishermen aboard the *Fukurya Maru* [Lucky Dragon]. Fallout concerns on a global scale caused the JCS in 1954 to task AFSWP with monitoring and predicting worldwide fallout. AFSWP sponsored a High Altitude Sampling Program (HASP), using U-2 aircraft, to determine the stratospheric burden of radioactivity. AFSWP also performed prediction and modeling of worldwide fallout after the U.S. and Soviet atmospheric tests of 1961-1962.

5-13

Nike-Hercules air defense missile used for launch of TIGHTROPE shot.

➔ *Dispersal of Storage Sites:* In 1954-1955, the Technology Capabilities Panel urged force dispersals and increased readiness to reduce vulnerabilities in the thermonuclear age. On December 1, 1954, President Eisenhower approved JCS-proposed plans for dispersal to multiple nuclear Operational Storage Sites in the continental U.S. manned by Service personnel. AFSWP trained military storage and maintenance staffs, inspected Service sites, and managed National Stockpile Sites in coordination with the AEC.

➔ *Coordinating Weapons Requirements Through AFSWP:* AFSWP supported DoD in its determination of the Military Characteristics, suitability, and acceptability of nuclear weapons. Concepts for low-maintenance "wooden bombs" and modular "building block" weapons emerged in the 1950s.

➔ *Understanding Nuclear Effects for Air Defense:* In the mid-1950s, the AFSWP Air Blast Panel successfully advocated tests to assess blast and thermal effects on aircraft, missiles, and aircrews. In 1955, Test HA (High Altitude) employed a three-kiloton device at 36,000 feet to explore options for air defense without prompt radioactive fallout. Nuclear air defense systems deployed later included Genie and Nike-Hercules missiles.

Premier Khrushchev.

5-14

RB-57D sampling aircraft during Event JUNIPER.

New Look Implementation: AFSWP coordinated nuclear tests and troop training preceding the forward deployment of tactical nuclear forces to Europe in 1954. A NATO agreement of June 22, 1955, required bilateral programs of cooperation for nuclear system deployments. In 1956 NATO's Military Committee (MC) adopted MC document 14/2, approving forward deployment of tactical nuclear weapons and reliance on them for the defense of NATO. The NATO force deployments subsequently included nuclear-capable fighters, ballistic missiles, atomic demolition munitions, and artillery-fired atomic projectiles.

Responding to Accidents: Following several SAC bomber-related accidents, the Services, AFSWP, and the AEC established a Joint Nuclear Accident Coordinating Center in 1958. AFSWP began coordinating accident responses abroad.

AFSWP Redesignated: In addition to AFSWP gaining new accident responsibilities, the Director, Defense Research and Engineering (DDR&E) began allocating the majority of DoD nuclear effects research and test funds through AFSWP in 1958. To reflect these increases in roles and missions, AFSWP was redesignated as the Defense Atomic Support Agency (DASA) in 1959; the Agency began reporting to both JCS and the Secretary of Defense that year.

Initial HA Nuclear Effects Program: In 1958, the Agency and the AEC jointly conducted a series of HA nuclear explosions: tests TEAK and ORANGE in Operation HARDTACK, launched by rockets from Johnston Atoll in the Pacific, and three tests over the South Atlantic in Operation ARGUS. The Soviet Union conducted its own set of HA experiments in 1962.

Disturbance of Distant Communications: Test TEAK, fired at night at an altitude of 77 kilometers, resulted in a loss of high frequency (HF) communications over much of the Pacific that lasted into the next day as a result of disturbance of the HF-reflecting layers of the ionosphere.

Electrons Trapped in Magnetic Fields: Operation ARGUS, conducted in 1958 by the U.S. Navy with DASA and Advanced Research Projects Agency (ARPA) support, verified the "Christofilos effect" in which fission decay electrons become trapped, creating man-made radiation belts. The idea of using these belts as a shield against potential ballistic missile attack was not feasible, since the earth's magnetic field was too weak to form sufficiently intense radiation belts. ARGUS did, however, indicate that semiconductor circuits were vulnerable to degradation by recurring passage through trapped electron belts. Some space satellites failed in the aftermath of the 1958 tests. DASA pursued techniques to reduce vulnerabilities of electronic components and to improve the endurance of satellite communications and other space systems.

Operation CASTLE, Test BRAVO at Bikini Island in 1954.

General Ludecke and General Stranathan with TEAPOT MET cloud behind them.

Adaptive Research During the 1958-1961 Moratorium: U.S. atmospheric testing ceased in October 1958 and did not resume until 1962, after the Soviets broke the test moratorium (the U.S. began conducting tests underground in 1961). To evaluate Minuteman silos, DASA and the Air Force sponsored high explosive (HE) tests in 1959-1960. Plans for nuclear radiation effects simulators also began to evolve in this period, and computer models of upper atmospheric chemistry were refined between the 1958 tests and those of 1962.

Force Modernization: Dispersal of SAC bases and construction of early warning radar networks improved bomber force survivability. The U.S. Navy commissioned the first operational submarine carrying Polaris missiles, the *George Washington*, on December 30, 1959. The U.S. Air Force commissioned the first Minuteman I missile wing on July 15, 1961.

Doubling of Nuclear Weapon Deployments in Europe: After East Germany constructed the Berlin Wall in August 1961, the U.S. accelerated deployments of nuclear weapons to Europe. The total NATO nuclear stockpile virtually doubled between January 1961 and May 1965 to more than 5,900 nuclear weapons.

Supporting the Joint Strategic Target Planning Staff (JSTPS): DASA supported the JSTPS, established at SAC, beginning in 1960. DASA and its contractors developed computer models of nuclear effects, notably airblast. SAC, and its successor, U.S. Strategic Command (STRATCOM), have routinely used the Agency's expertise on nuclear effects to support war planning.

DoD Damage Assessment Center (DODDAC): DODDAC began operating in the Pentagon and at the underground Alternate National Military Command Center (ANMCC) at Fort Ritchie, Maryland, in 1961. In late 1961, at White House request, DASA analyzed the effects of a 100-megaton weapon on the ANMCC, and on proposed Washington, D.C. underground facilities, after the Soviets tested a 58-megaton device.

Improving Safety and Control Over Nuclear Systems: Deployment of tactical nuclear systems abroad and the pre-assembly of warheads on missiles raised concerns about the adequacy of command and control safeguards. The Joint Committee on Atomic Energy, in its *Hollifield Report*, recommended sweeping reforms in December 1960. In 1962, the National Security Council (NSC) adopted more stringent safeguards for command and control, including Permissive Action Links and improvements in safety and security. These affected DASA training and inspection programs.

Decontamination personnel checking for radioactivity.

Joint Weapons Safety Testing: In "Project 57" and later tests, DASA participated in HE tests to predict and prevent plutonium dispersal. Joint research with the British in 1961-1962 resulted in HE testing of igloo safety in conjunction with the Armed Services Explosives Safety Board. Altered storage criteria for plutonium-bearing weapons and improved storage site designs resulted.

X-Ray Effects on Ballistic Missiles: Concern regarding the vulnerability of guidance systems, reentry vehicles (RV) and nuclear warheads intensified as more was learned about the effects of x-rays on materials and electronics. In the 1962 DoD-sponsored test MARSHMALLOW, nuclear effects on sensitive components of space and missile systems were confirmed. An *ad hoc* Committee on Radiation Effects, established under Dr. William G. McMillan, identified retrofit solutions for Minuteman II systems and advocated designed-in hardening for future strategic missiles. As MIRVed ICBMs and SLBMs entered development, their vulnerability to x-rays led to planning for underground tests and simulation of x-ray effects, implemented later in the 1960s.

Plasma Disturbances and Radar Blackout: The exoatmospheric FISHBOWL tests, in 1962, caused auroral and ionospheric disturbances. In STARFISH PRIME, bomb-generated plasma became striated and spread thousands of miles along the magnetic meridian and across magnetic field lines of the earth. The implications of these tests for the degradation of radio and radar communications were important to the design of U.S. communication satellites, and early warning and Anti-Ballistic Missile (ABM) radars.

Johnston Atoll in the Pacific Ocean.

Electromagnetic Pulse (EMP): The FISHBOWL series also confirmed distant EMP effects upon electronics predicted by earlier DASA research. Street lamps shorted on Oahu, about 800 miles from the STARFISH PRIME test. DASA served as the center of expertise in efforts to design enduring communications and command systems that could withstand EMP effects.

Operability-Survivability Tests for Complete Weapon Systems: In August 1962, Field Command, DASA recommended that "all components affecting a nuclear weapon system" be field tested as a unit in an operational environment. DASA solicited test priorities from the McMillan Panel, a nuclear effects task force for the DDR&E. One of the first complete systems to be tested was the Nike-Hercules surface-to-air missile, fired successfully in the last U.S. atmospheric nuclear test on November 4, 1962.

Strategic Force Modernization: To assure weapon systems could survive nuclear attacks, DASA designed experiments on cratering, airblast, and ground shock at the NTS and elsewhere. In the 1960s, DASA's Strategic Structures Division supported the Air Force in designing hardened silos for Minuteman II and III missiles. Initial silo construction for ICBMs was already underway before some of the lessons were learned.

Supporting Negotiations of the Limited Test Ban Treaty (LTBT): DASA supported ARPA in sponsoring research to improve the detection of nuclear tests in space, in the atmosphere, and underground. Interpretation of the first fully contained underground test, RAINIER in 1957, led U.S. scientists to conclude that seismic signals could be "decoupled" by selection of appropriate soils and cavities. This conclusion had adverse implications for monitoring a ban or yield limit on underground testing. The McMillan Panel, relying in part upon DASA research, briefed President Kennedy on options for nuclear test bans as the administration began to consider potential treaties limiting nuclear testing.

The 1963 LTBT: The world came perilously close to a nuclear exchange between the two superpowers during the 1962 Cuban missile crisis. In ensuing months, both the U.S. and the Soviet Union sought accommodations that would lessen, control, or avoid such peril in future relations. One of the realized accommodations was the LTBT, which prohibited nuclear tests in the atmosphere, in space, and underwater. President Kennedy called the treaty "...a shaft of light cut into the darkness." Eventually, it also eliminated worldwide fallout.

President Kennedy signs the Limited Test Ban Treaty.

1963–1971 — *Strategic Deterrence*

6-1. *John F. Kennedy Funeral.* **6-2.** *Anti-war poster.* **6-3.** *Lyndon Johnson.* **6-4.** *Dr. Martin Luther King.* **6-5.** *Vietnam soldier.* **6-6.** *Gunship in Vietnam.* **6-7.** *July 21, 1969, New York Times.* **6-8.** *Buzz Aldrin on the moon.* **6-9.** *Richard Nixon.* **6-10.** *Anti-war demonstration.* **6-11.** *Protest button.*

1963-1971—Strategic Deterrence: *After the Cuban Missile Crisis, Soviet leaders seek to match and exceed U.S. strategic force deployments by 1970.*

1963 - Johnson becomes President upon Kennedy's assassination

1964 - Khrushchev deposed

1965 - Aerial bombing of North Vietnam

1966 - First exposure of reentry systems/underground nuclear test

1967 - SALT Talks begin – 480,000 U.S. troops in Vietnam

1968 - Anti-war protests

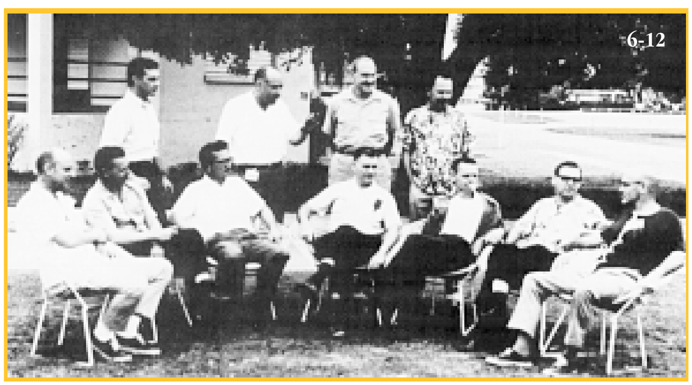
1969 - Armstrong walks on Moon – Vietnam troops at 543,000

1970 - U.S. invades Cambodia

1971 - Kissinger begins talks with Chou En-Lai

➜ *DASA Reorganization:* Following the 1962 atmospheric test series and the 1963 LTBT, DASA reorganized to attract world-class scientists and engineers to lead DoD nuclear weapons effects research and testing programs. They formed unique cooperative relationships with other scientists and engineers in industry, academia, and national laboratories that fueled an intellectual environment and peer review process for nuclear weapons effects activities. This new environment, coupled with the fact that DASA never owned or operated weapons systems, established DASA and its successors as the "honest broker" for unbiased research and evaluation of the nation's needs for nuclear weapon systems and the assessment of nuclear weapons effects on those systems.

➜ *Tests for Survival and Operability:* From 1961 through 1965, the McMillan Panel urged survivability tests for weapons systems. DASA designed and funded many of these tests between 1964 and 1970 as the centerpiece of the overall effort. Of particular concern was the vulnerability of the Minuteman II guidance system to radiation. The DDR&E and the Air Force agreed upon testing, redesign, and retesting. Missile RV hardness, silo design, and electronic system vulnerability to EMP were also of concern. With DDR&E assent in October 1964, the DASA Director began sponsorship of the McMillan Panel. From 1966 to 1993, the panel was referred to as the Scientific Advisory Group on Effects (SAGE). The SAGE Panel was disbanded after its 1993 meeting as part of a government-wide move to reduce the number of federal advisory groups.



SAGE Panel – August 1966.

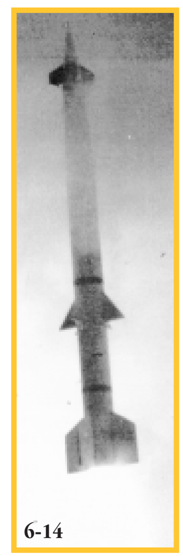
➜ *Underground Nuclear Effects Test Planning:* To implement a 1962 AEC-DoD agreement within the constraints of the 1963 LTBT, AEC and DASA representatives participated in a Nuclear Weapons Effects Coordinating Group to lay the groundwork for the nuclear effects testing advocated by the McMillan Panel and subsequently reaffirmed by JCS action. In December 1963, U.S. scientists urged priority for nuclear effects testing of full-scale reentry systems. Over the next two years, in Operation SUGAR CANE, DASA and the AEC explored methods to test underground for effects on key components of weapon systems. DASA began designing line-of-sight shaft and tunnel systems for x-ray effects tests.

Secretary of Defense McNamara and Secretary of State Rusk.

➜ *Moscow-Washington Hot Line:* During the Cuban Missile Crisis, President Kennedy and Secretary Khrushchev often had difficulty conveying confidential messages to one another. In 1963, DASA reviewed the survivability of technical designs supporting the June 1963 agreement for a Heads-of-Government *Hot Line*. This *Hot Line* connected the White House, through the National Military Command Center in the Pentagon, to the Kremlin. DASA also supported the addition of *Hot Line* Communications Satellite (COMSAT) links in 1971.

➜ *HA Effects Analysis:* The SAGE Panel recommended priorities for HA effects analysis. In the 1960s, DASA advanced the understanding of both weapons effects and planetary physics through analyses of tests conducted in 1958-1962. The SAGE Chairman also served as Chairman of the Special Weapons Effects Group (SWEG), which analyzed the 1962 Soviet high altitude tests. Suspected nuclear effects, such as EMP disruption of buried communication links, were confirmed by Russian scientists in 1995.

➜ *Safeguards for the LTBT:* To protect U.S. nuclear capabilities, four safeguards for the 1963 treaty were to: (1) continue underground testing; (2) maintain modern nuclear laboratories; (3) establish the National Nuclear Test Readiness Program; and (4) improve methods to detect and monitor foreign nuclear detonations. DASA supported verification research for ARPA's nuclear detection (VELA HOTEL) satellites and for seismic detection of decoupled underground tests (VELA UNIFORM).



Spartan missile.

➔ *Information Systems:* Beginning in 1960, DASA sponsored the Defense Atomic Support Information Analysis Center (DASIAC). The initial purpose for the DASIAC program was to ensure the collection and preservation of the HA nuclear test data and the establishment of a center of knowledge on it. Subsequently, DASIAC's mission expanded to include similar activities for all types of nuclear effects.

➔ *Biomedical Research and Civil Defense:* Biomedical research supported protective measures for troops and civil defense. In 1963, Congress appropriated funds for a nationwide fallout shelter program. From 1964 through 1993, DASA (and later DNA) managed the Armed Forces Radiobiology Research Institute (AFRRI) in Bethesda, Maryland. This interservice facility studies the biomedical effects of radiation and the treatment of radiation illnesses.

➔ *Tools for War Plans:* In the 1960s, DASA maintained and refined models of nuclear effects and radioactive transport, which helped SAC develop options for a strategy of controlled response.

➔ *Supporting NATO:* Bilateral programs of cooperation permitted forward basing of U.S. nuclear weapons and contingency planning for allied use. After the 1962 Nassau Agreement, DASA and the AEC supported tests in Nevada of British warheads. The U.S. sold Polaris A-3 missiles to the British to carry these warheads. DASA also supplied planning data to NATO's Nuclear Planning Group. Nuclear stockpiles in U.S. custody for use by allied forces increased to peak levels in 1971.

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Mk-12 reentry vehicle damaged by x-rays.

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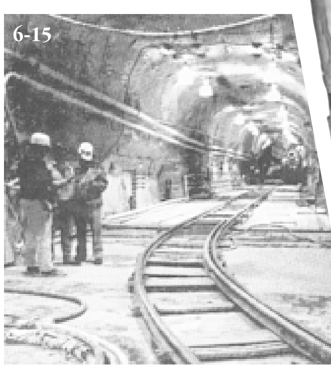

Underground testing.

6-17

Tritium facility at Savannah River.

➔ *Integrating Nuclear-Based Science and Technology:* Under DASA's July 1964 charter, a civilian Deputy Director (Science and Technology) oversaw radiation, blast and shock, biomedical, and test plans and programs activities. With just four percent of DASA staff in 1965 (290 positions), science and technology research and test staff managed more than three-quarters of the agency's budget.

In November 1964, DASA consolidated nuclear effects knowledge in the classified publication, *Capabilities of Nuclear Weapons*. A revised edition was published in 1968. These publications preceded the two-volume *Effects Manual-1 (EM-1),* first published in 1972.

➔ *Operational Tactics:* In August 1964, the JCS established Joint Task Force-2 (JTF-2) at Sandia Base to test and validate tactics to penetrate Soviet nuclear-armed air defenses. The JTF-2 tested low-level penetration tactics in conjunction with Sandia Laboratory and the Air Force Special Weapons Center. Stand-off weapons entered the stockpile in the late 1960s.

➔ *Techniques for Testing and Simulation:* From 1964 through 1965, DASA surveyed effects-related risks to weapon systems and developed testing and simulation options. These included: underground nuclear tests of airblast and ground shock; exposure of weapons, electronics, and materials to radiation; and development of radiation simulators to assess EMP, gamma ray, and x-ray effects.

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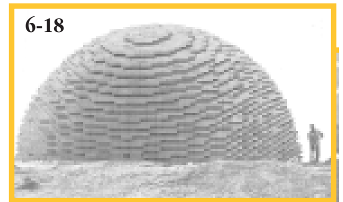

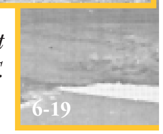

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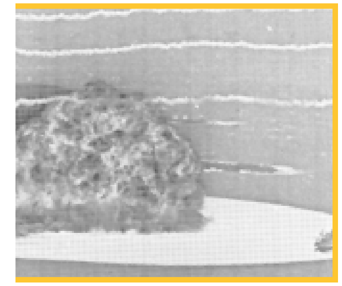


SAILOR HAT test – 500 tons of TNT.

➔ *Modeling Global Impacts:* For force exchange models and for projecting the impact of nuclear war on fallout and global climate, DASA sponsored software development at RAND, at the JSTPS, and at AEC laboratories.

➔ *HE Testing:* When the LTBT prohibited nuclear detonations in the atmosphere, DASA developed large-scale (kiloton-class) HE test beds to generate airblast and ground shock. In 1964, Operation SNOWBALL, a 500-ton HE event, was conducted in Alberta, Canada. The SAILOR HAT test was conducted the following year. These tests simulated nuclear airblast loading of structures and underwater shock on ships. Subsequent DASA tests included PRAIRIE FLAT and DIAL PACK, both of which helped the Air Force assess and improve the survivability of Minutemen II silos. As HE testing evolved, distributed HE arrays, such as the High Explosive Simulation Technique (HEST) and the Direct-Induced HEST (DIHEST), were developed by the Agency to test reverse-engineered Soviet silos and to evaluate candidate silo basing modes for Peacekeeper and the Small ICBM. DASA also employed HE testing for evaluating the dynamics of crater formation.

DASA conducted additional experiments on forest blowdown in Australia and Canada. British and Canadian scientists played key roles in the development and refinement of HE simulation of nuclear effects. The results achieved by those two countries and the U.S. were coordinated and exchanged through The Technical Coordinating Panel (TTCP). The TTCP played a major role in establishing a series of multinational shock physics conferences on the military applications of airblast.

➔ *Stockpile Surveillance:* During 1965-1966, DASA developed common nuclear stockpile reporting standards for all of the military Services. In 1966, the JCS tasked Field Command, DASA with responsibility to account for the entire U.S. nuclear stockpile. With confidence in this system, the JCS authorized transfer of all war reserve nuclear weapons to Service custody in the late 1960s.

Transfer of War Reserve Weapons to the Services: In 1965, forty percent of DASA personnel worked at five National Stockpile Sites. With the transfer of all "war reserve" stockpiles to the military Services in the late 1960s, authorized personnel declined from a peak of almost 11,000 in the 1950s to 1,800 in fiscal year 1975.

Nuclear Devices for Underground Nuclear Effects Tests: In 1965, during the SCREAMER event, engineers at Los Alamos employed a new nuclear device for AEC, DASA, and Service experiments. Subsequently, Livermore used its new device in a similar test called TAPESTRY. These two nuclear devices were subsequently furnished by the Department of Energy (DOE) laboratories as the

6-20

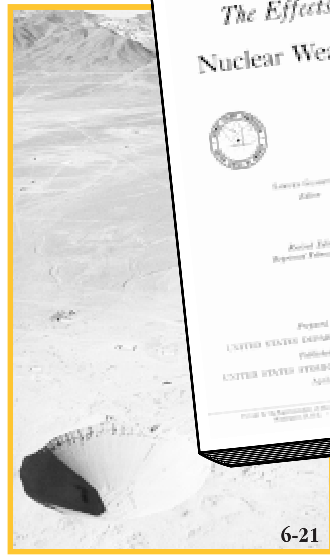
DIAMOND SCULLS underground test facility.

radiation sources for underground nuclear effects tests conducted by DASA.

Early DASA Underground Nuclear Effects Tests: In 1965, DASA began a series of vertical line-of-sight tests that exposed electronic components, circuits, and systems to gamma rays and neutrons. The first such test was WISHBONE. The first exposure of full-scale reentry systems (Mk-11C and Mk-12) was the DASA-sponsored DOUBLE PLAY event, executed in June 1966. Other tests measured shock propagation in granite for stronger ICBM silos and national command centers.

Supporting the JCS Test Initiatives: In 1966, the JCS approved a plan, drafted by the DASA Deputy Director (Science and Technology), for an intense series of underground tests to assure the hardness to nuclear effects of U.S. strategic offensive and defensive missile forces. These tests were executed in accordance with the development schedules of each Service System Program Office (SPO) and were the most comprehensive effects tests ever conducted.

Testing Ballistic Missiles to Avert System Failures: The first major test under the JCS-approved test program–MIDI MIST–was conducted by DASA on June 26, 1967. It involved reentry systems and other elements of Poseidon and Minuteman II and III, plus



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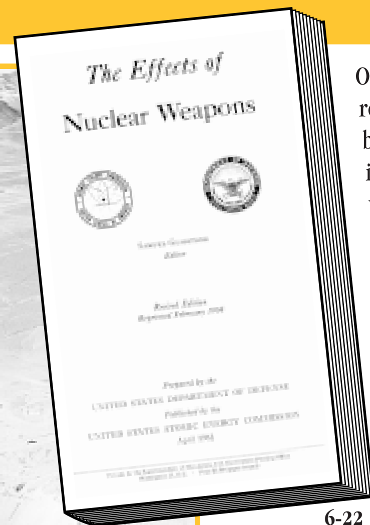
The SEDAN crater at NTS.



6-22

Effects Manual.

components and materials for the Sentinel ABM. DASA subsequently carried out an extensive series of exposures of those four strategic systems, with results that often required redesign for survivability. DASA staff briefed SAGE in 1969 on the results of survivability testing to avert potential system failures.

Responding to Overseas Emergencies: DASA coordinated emergency response to remove radioactive debris and recover Mk-28 bombs near Palomares, Spain, in 1966. DASA oversaw Service decontamination efforts that removed 237 tons of radioactive ice and debris after a B-52 crash near Thule, Greenland, in 1968. After the Thule crash, DASA provided a database of nuclear accidents to the Office of the Secretary of Defense (OSD). In 1968, OSD suspended routine SAC airborne bomber patrols involving nuclear weapons. DASA's databases and staff expertise on matters of nuclear safety remained accessible to both the military Services and OSD. Access to DASA's expertise convinced Dr. Carl Walske, Assistant to the Secretary of Defense (Atomic Energy), that it was essential to retain DASA or a successor agency that would serve as the conscience of the DoD in matters of nuclear safety.

Assessment Methods for Target Planning: DASA sponsored field tests, calculations, and algorithm development to improve the probability-of-damage calculations used in force exchange models. These models were developed by the Air Force Intelligence Center, refined later by the Defense Intelligence Agency (DIA), and applied by the Joint Strategic Target Planning Staff. The method is referred to as the VNTK system, denoting Vulnerability Number/Type (of target)/K-factor. The "K-factor" accounts for weapon yield effects and was formulated by the University of Illinois based on DASA experimental data. Initially, DASA produced slide rules that incorporated the VNTK system. Later, the Agency made the methodology available on programmable, hand-held calculators. Both the slide rules and the calculators were widely used by target planners throughout the DoD.

Radiation Simulators: DASA supported EMP simulator design and sponsored an EMP Simulator Panel in 1967-1968. This work encouraged design of EMP simulators of different types for each of the military services. DASA funded and the Air Force Weapons Laboratory initially operated ARES, an EMP simulator in Albuquerque, New Mexico. DASA also funded the Transportable EMP Simulator (TEMPS), built for the Army, and the EMP Radiation Effects Simulator for Ships (EMPRESS), a simulator system built for the Navy.

Testing ABM Systems: A megaton-range underground test (CANNIKIN) in 1971 verified Spartan warhead performance. Subsequently, the U.S. Army and the Agency tested full-scale Spartan interceptor survivability in nuclear environments. These tests helped confirm U.S. readiness for ABM deployments. System costs and effects analyses were factors in the eventual negotiation of the 1972 ABM Treaty.

Creating the Defense Nuclear Agency: On March 29, 1971, Deputy Defense Secretary David Packard announced the creation of the Defense Nuclear Agency (DNA) as successor to DASA.

1971–1981—*Strategic Deterrence with Nuclear Parity*

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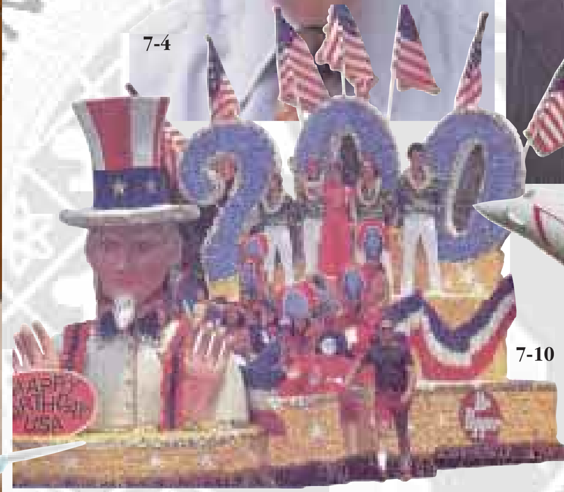
7-1. *Commemorative stamp.*
7-2. *Watergate finale.*
7-3. *Terrorist at Munich Olympics.*
7-4. *Jimmy Carter.*
7-5. *Lech Walesa.* **7-6.** *Khomeini.*
7-7. *The Concorde.* **7-8.** *Three Mile Island.* **7-9.** *Gas shortage signs.*
7-10. *America's 200th Birthday Parade.* **7-11.** *Vietnam evacuation.*
7-12. *Afghanistan rebel.*

7-6



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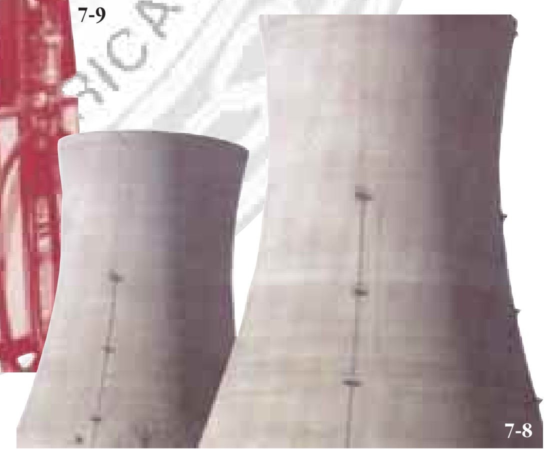

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1971-1981—Strategic Deterrence with Nuclear Parity: *International tensions fueled by the Afghanistan invasion and the seizure of the U.S. embassy by Iranians lead to a U.S. military buildup and strategic modernization.*

1971 - "Vietnamization" underway

1972 - President Nixon reelected – Visits China

1973 - U.S. leaves Vietnam

1974 - Nixon resigns – Ford sworn in

1975 - First personal computers appear – South Vietnam falls

1976 - U.S. Bicentennial – Carter elected President

1977 - Neutron bomb controversy

1978 - Vietnam invades Cambodia

1979 - Soviets invade Afghanistan – Iranians seize U.S. embassy

1980 - Reagan elected – Iran/Iraq war begins

1981 - Iran releases hostages

➜ *DNA Becomes Sole Effects Test Sponsor:* Since 1971, DNA has sponsored all U.S. nuclear weapons effects tests, designed primarily to permit exposure of the test objects to radiation while protecting them from high-velocity debris or other products of a nuclear detonation. In a one-of-a-kind nuclear effects test, DNA exposed a Defense Satellite Communications System III (DSCS III) mock-up to nuclear effects during the HURON KING event. During exposure, the satellite mock-up was housed in a specially designed vacuum chamber at the top of an evacuated vertical shaft over the nuclear device.

➜ *Improved Operational Safety and Security in NATO:* DNA supported an OSD site security initiative after terrorist attacks during the Munich Olympics in 1972. Results included non-lethal defenses at storage sites and site security surveys. New weapon storage vaults included subsurface weapons storage within shelters of aircraft on alert status; these weapon vaults were deployed beginning in the 1980s. The buried storage vaults afforded prompt access with improved site security and site safety in event of fire or hostile attack.

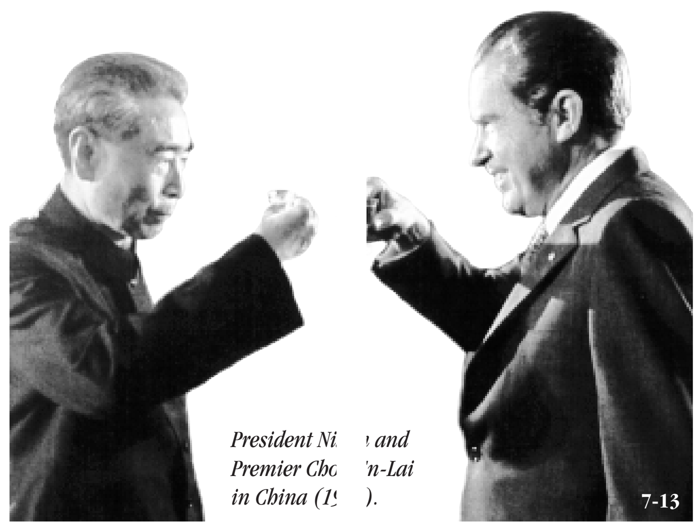
➜ *Integrating Knowledge:* In 1972, DNA published a two-volume nuclear weapons effects manual called *Effects Manual-1* (*EM-1*). Two years later, DNA issued a NATO-releasable version of *EM-1*. These volumes provided critical planning information for unified and specified CINCs, civilian civil defense activities, and NATO officials.

➜ *New Directions for Theater Deterrence and Defense:* In 1973, the Secretary of Defense and the Supreme Allied Commander Europe (SACEUR) asked DNA to make a series of assessments of methods to provide a strong forward defense in Europe. This assessment was to be based on all source information regarding Soviet force modernization and exercises. The integrated deterrent roles of strategic and theater nuclear forces were to be illuminated in these assessments, and emphasis was placed on means to provide a much improved conventional forward defense. Suggested improvements included the views of all NATO allies. All of these goals were accomplished by DNA in conjunction with many agencies of the U.S. government, including the Congress, as well as European allies and NATO. A major result was the U.S. Army's AirLand Battle Doctrine that produced theater-specific force and strategy improvements for NATO, Korea, and Southwest Asia. In 1974, DNA supported the Commander in Chief, Pacific (CINCPAC) in identifying new tactics for the use of advanced conventional weapons in the defense of Korea. CINCPAC was able to reduce dependence upon early nuclear escalation in Korean contingency plans. In the mid-to-late 1970s, DNA supported CINCPAC's effort to ensure operability of command, control, and communications (C3) links in nuclear environments, including high-altitude bursts with EMP effects.

➜ *Protective Structures:* As ballistic missile accuracies improved in the mid-1970s, DNA assessed new protective structures for U.S. strategic and theater force deployments and studied potential vulnerabilities of Soviet hardened targets. The Silo Test Program (STP), originally for Soviet target assessment, provided insights for superhard silo designs for U.S. ICBMs.


7-14

Missile silo test configuration.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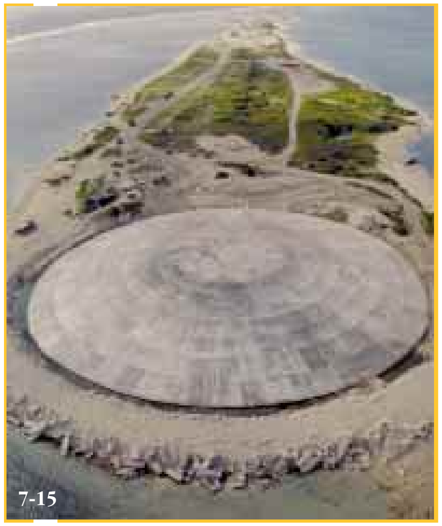
President Ni ı and Premier Cho n-Lai in China (1!).

1971–1981 — *Strategic Deterrence with Nuclear Parity*



CACTUS crater dome at Enewetak Atoll.

Simulator Development: In the 1970s, DNA operated and sponsored Service operation of an array of radiation simulators. Some simulators were portable, permitting the testing of equipment at distant sites. Simulators in this era also provided for x-ray testing at the component level. DNA provided community testbeds using HE simulation of airblast at White Sands Missile Range, New Mexico.

Computational Models and Handheld Calculators: DNA was in the forefront of developing microcomputer applications for nuclear effects. Beginning in 1974, the DNA Deputy Director for Science and Technology personally oversaw the development of nuclear effects algorithms for handheld calculators and the first generation of personal computers. This provided military and civilian analysts planning tools previously available only on mainframe computers. DNA provided field commanders with the first microcomputer-based planning tools, including the computerized Targeting and Planning System (TAPS).

Survival of Missile Systems: Survivability of land-based ICBMs became increasingly challenging during this era as the Soviets achieved "nuclear parity" with the U.S. Both underground tests and HE simulations supported options for basing the Peacekeeper (MX) ICBM. DNA supported Air Force studies resulting in retrofitting of Minuteman silos to improve survivability. Later underground tests (UGTs) led to changes for the Minuteman III Mk-12A RV and the Mk-4 reentry body (RB) for the Trident I SLBM. Trident operability testing preceded deployment of Ohio-class submarines, each carrying 24 MIRVed SLBMs.

Aircraft Operability: Aircraft shelters built in Europe protected aircraft against conventional weapon attack. DNA tested aircraft shelters and shielding against EMP. Assessments of nuclear barrages over air bases improved survivability of tankers supporting SAC operations.

NATO Theater Force Modernization: In October 1977, NATO's Nuclear Planning Group established a task force on theater nuclear force modernization. With DNA-sponsored assessments, among others, NATO approved a two-track theater force modernization and arms control strategy in December 1979.

To preclude the overrunning of Western Europe, NATO sought the capability to attack rear echelon air bases and key nodes in the Warsaw Pact resupply system. This required new classes of prompt strike weapon systems. Beyond DNA-sponsored studies of theater force modernization, the Agency participated in various Joint Working Groups that provided a forum with allies to model alternative force employment tactics and exercise new scenarios and force mixes. These activities helped to convince NATO allies of the importance of force modernization. Subsequent U.S. theater nuclear force initiatives in the 1980s included deployment of ground-launched cruise missiles (GLCMs), Pershing II ballistic missiles, and other special purpose weapons. DNA supported hardening of the Supreme Headquarters, Allied Powers Europe (SHAPE) at Mons, Belgium; protective structures assessments for GLCMs; and Pershing survivability exercises in the field.

Theater Force Deployments: To modernize theater nuclear and conventional forces, NATO forces deployed advanced technology systems to offset the quantitative advantage of deployed Warsaw Pact forces. In the aftermath of NATO's initial deployment of modern theater nuclear forces and other actions, Soviet delegations walked out of all nuclear arms control negotiations in 1983.

Effects of Radiation: AFRRI improved the understanding of incapacitating effects of radiation. Among other applications, this understanding influenced Army planning for use of, and response to, enhanced radiation weapons. The AFRRI mission included troop and medical staff training, and the availability of medical staff for response to radiological emergencies.

Environmental Remediation: As part of its cleanup of radioactive debris on Enewetak Atoll, DNA moved tons of contaminated soil to the CACTUS crater and entombed it underneath a massive concrete cover designed by the Army Corps of Engineers. DNA also developed robotic radiation monitoring equipment that has been used subsequently in site remediation activities at the NTS and at Johnston Atoll.

Nuclear Effects Research and Development: DNA employed a combination of UGTs, simulators, and analytical models to improve the understanding of a spectrum of nuclear effects important to systems being developed or under consideration during the era.

DoD satellite test chamber (HURON KING). INSET: Satellite suspended inside test chamber.

7-18

Pershing Battery undergoing tests at Cape Canaveral, Florida.

Close-in and non-ideal airblast, plus direct- and airblast-induced ground shock, were all assessed or reassessed because of their importance in understanding the survivability of hardened U.S. structures and the lethality of U.S. weapons attacking similar Soviet targets. Methods were evaluated to avoid or minimize erosion of RVs or RBs flying through dust, ice, and rain. Research began on dust effects on aircraft engines following damage observed in engines of aircraft flying near the Mt. St. Helens' volcanic cloud. Hardening techniques for system-generated EMP (SGEMP) effects began to be applied to spacecraft design. Satellite observations and modeling refined the scientific understanding of communications degradation due to nuclear effects on the atmosphere. DNA developed steps to mitigate or otherwise cope with such degradation.

➔ *Nuclear Test Personnel Review (NTPR):* The statistical association of leukemia with the 1957 SMOKY test and concern regarding the health of other test participants led OSD to establish the NTPR in 1978. DNA published reports describing major nuclear tests in the atmosphere, then developed a database on test exposures for military nuclear test participants and occupation forces at Hiroshima and Nagasaki. Subsequently, the NTPR program has provided individual dose reconstructions to help the Departments of Justice and Veterans Affairs adjudicate veterans' claims of radiation-related illnesses.

➔ *Enduring C3:* The ability to survive potential nuclear environments requires enduring C3 capabilities. In the 1970s, DNA assessed distributed C3 network survivability after both direct attack and exposure to EMP, and sponsored assessments of both satellite and ground station design for prompt and delayed radiation events. DNA-supplied data on hardening against radiation and EMP effects supported the design of more survivable space systems, ground-based communications nodes, and C3 networks. In 1979-1980, the Carter administration initiated new measures for continuity of government and military operations in nuclear environments.

➔ *Strategic Balance Assessments:* DNA supported OSD-sponsored net technical and force balance assessments for the Office of Net Assessment. Results impacted force budgeting and arms control planning preceding the Strategic Arms Limitation Treaty (SALT) I of 1979.

➔ *Joint Exercises for Emergency Response and Site Remediation:* Starting in 1979, DNA co-sponsored, with the DOE, joint emergency response exercises. Nuclear Weapon Accident Exercise-79 (NUWAX-79) was the first of many biennial emergency response exercises. It simulated aircraft accidents and employed short-lived radioactive isotopes in dilute quantities for realistic training in hazard assessments and nuclear weapon/materials recovery operations.

➔ *Holding Soviet Targets at Risk:* DNA, with DIA cooperation, reverse-engineered Soviet ICBM silos and began subscale testing. The STP led to estimates of increased silo hardness. New DNA models aided JSTPS in Single Integrated Operational Plan (SIOP) adjustments as the 1971-1981 era ended.

7-19

DISTANT RUNNER high-explosive test event.

7-20

Trident SLBM test shot.

7-21

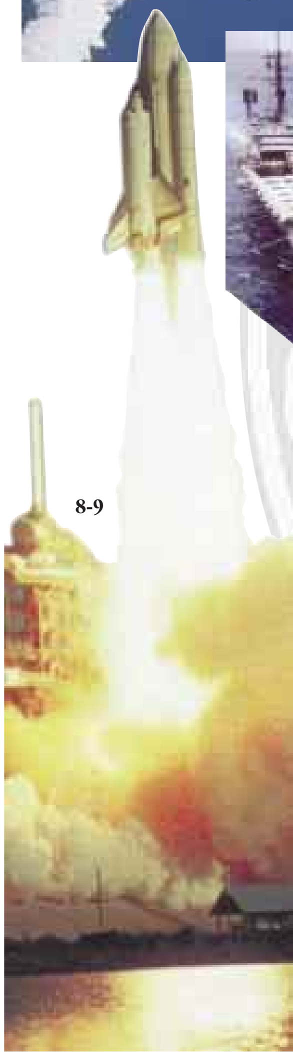
EMP simulation test setup.

1981–1991—*Force Modernization and the Demise of the Warsaw Pact*


8-1


8-2


8-3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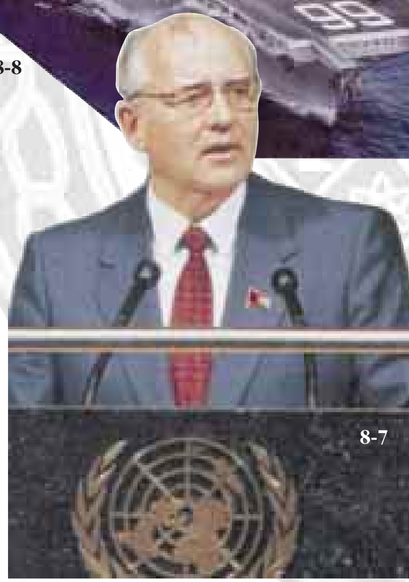
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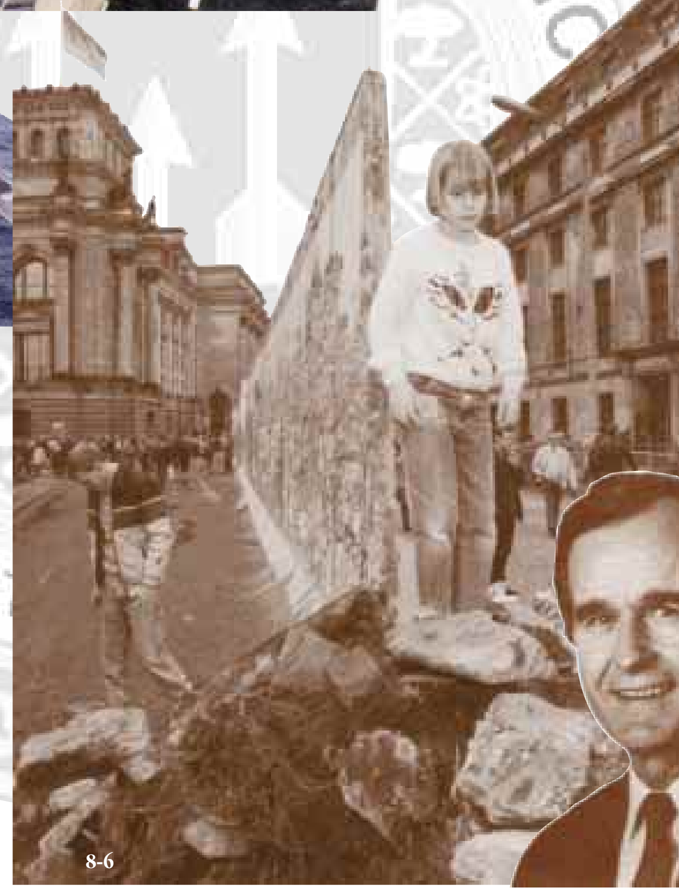
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8-1. *Challenger explosion.* **8-2.** *The Reagans.* **8-3.** *Tiananmen Square.* **8-4.** *Delta II rocket.* **8-5.** *George Bush.* **8-6.** *Berlin Wall.* **8-7.** *Gorbachev.* **8-8.** *USS America.* **8-9.** *Space shuttle launch.*

1981-1991—Force Modernization and the Demise of the Warsaw Pact: *The awesome costs of the U.S./Soviet arms race help bring down the Berlin Wall and communism in the Soviet Union; the threats of the Cold War are replaced by a series of regional conflicts; and the proliferation of weapons of mass destruction (WMD) becomes a global concern.*

1981 - Reagan inaugurated – Beginning of defense buildup

1982 - U.S.- USSR retain limits for SALT II

1983 - Reagan announces Strategic Defense Initiative (SDI)

1984 - Reagan reelected in a landslide

1985 - Gorbachev becomes General Secretary, Communist Party

1986 - Reagan-Gorbachev talks stall over U.S. SDI program

1987 - Intermediate Nuclear Forces Treaty

1988 - Bush elected President – Iran-Iraq War ends

1989 - Soviet troops leave Afghanistan – Berlin Wall torn down

1990 - Warsaw Pact ends – Iraq invades Kuwait

1991 - Gorbachev abducted but attempted coup fails

➜ *Strategic Force Modernization:* The 1981-1991 era began with President Reagan's defense buildup. Initially, the focus was on renewing B-1 bomber production and reevaluating basing modes for the Peacekeeper ICBM. DNA continued to provide support to the evaluation of candidate Peacekeeper basing modes. After the Scowcroft Commission's Report, the President approved silos as the Peacekeeper basing mode and the development of Small ICBMs with emphasis on nuclear survivability. The Agency provided technical support and briefings to the Scowcroft Commission.

Following the Commission's report, DNA applied its expertise to: craters from tests in the Pacific to reevaluate crater dynamics and their application to silo survivability; non-ideal airblast and its simulation for tests of the Hardened Mobile Launcher (HML) for the Small ICBM; ground shock at high overpressures for silo survivability and, later, for lethality against deeply buried and hardened underground structures; and superhard silo design and testing. Many of these activities were accomplished jointly with the Air Force's Ballistic Missile Office (BMO). The HML concept originated from DNA airblast testing, which demonstrated the feasibility of anchoring vehicles under high dynamic pressure loading. DNA also assisted BMO in hardening Small ICBM electronics to nuclear effects.

➜ *Operability Testing:* During the era, DNA executed UGTs that demonstrated the survivability of the Trident II guidance system, other in-flight missile electronics, and the Mk-5 RB. Separate UGTs verified the survivability of the Mk-21 RV for the Peacekeeper missile. These systems, along with Minuteman III, will comprise the strategic missile element of U.S. strategic forces into the foreseeable future.

➜ *Communications Connectivity:* DNA sponsored summer studies on high altitude nuclear effects in 1982 and 1986. Simulation of exoatmospheric plasma striations using barium clouds coincided with communication and radar experiments to test communications degradation. These tests employed satellite transmissions through the striated barium cloud phenomena. DNA sponsored three satellites designed to explore these phenomena: WIDEBAND in 1976, HILAT (high latitude) in 1983, and POLAR BEAR in 1986.

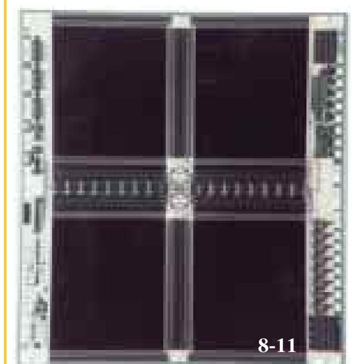
8-10

Peacekeeper missile.

➜ *Microelectronics Hardening:* Following the DoD Nuclear Survivability Directive in 1983, DNA reinforced its role in encouraging Service SPOs to adopt radiation-hardened microelectronics components. Re-analysis of SGEMP effects led to early consultations with system designers to assure operability without large system retrofit costs. As the semiconductor industry increased processing speeds within smaller packages, miniaturized circuits exhibited reduced tolerances to radiation. DNA sponsored development of radiation-tolerant satellite and computer microelectronics, which subsequently demonstrated their endurance through solar flares that disrupted other unhardened satellites. DNA's microelectronics hardening program has contributed to U.S. preeminence in long-lived reconnaissance, space exploration, and communication satellites.

Deficiencies in understanding of certain radiation effects, especially source region EMP, led DNA to design an underground test as part of the DISTANT LIGHT program and to correlate results with above ground test simulations and computer models.

➜ *Enhanced Conventional Munitions:* DNA sponsored tests of enhanced conventional munitions and their relative performance compared to nuclear weapons. In a five-year development program with the Air Force in 1983-1988, DNA co-sponsored advanced conventional munitions tests at Eglin Air Force Base, Florida.



8-11

Radiation hardened 64-kilobit static RAM chip from the early 1980s.

In 1986, the Johnson Task Force report to the Defense Science Board on DNA management reaffirmed the application of DNA's expertise to non-nuclear weapons effects. This action preceded the March 1987 charter authorizing DNA to pursue non-nuclear technology applications where the Agency's nuclear-derived skills were highly relevant. This initiative served to support precision strike operations in the Persian Gulf War of 1990-1991 and laid the foundation for the counterproliferation program.

➔ *Design for Enduring Command and Control:* Soviet doctrine and targeting gave priority to "decapitation attacks" upon the National Command Authority. Since the early 1980s, the DNA community supported presidential initiatives to procure survivable C3 systems and to assure continuity of government in wartime. These programs incorporated designs to cope with both prompt and delayed nuclear effects.

➔ *Nuclear Winter Assessments:* DNA-funded research led to the 1983 *Nuclear Winter* assessment of dust and soot impairment of sunlight transmission. DNA also funded research to improve the understanding of uncertainties regarding fire phenomenology and transport models. These models supported assessments on the impact of wartime fires, and were documented by the National Research Council in *The Effects on the Atmosphere of a Major Nuclear Exchange* (1985), and in later assessments of the more than 600 concurrent Kuwaiti oil well fires during Operation Desert Storm.

➔ *Strategic Defense:* The SDI Office assigned DNA responsibility for evaluating the lethality of all SDI weapons against their potential targets. The SDI Office co-sponsored survivability and operability tests and simulations. DNA conducted underground tests for SDI candidate subsystems, including distributed sensor systems. DNA also supported SDI Red Teams in assessments of adaptive responses to candidate SDI systems.

➔ *Operational Safety and Security:* A Titan II missile caught fire and was destroyed during routine maintenance in the early 1980s. Following the investigation of this accident, OSD reinstated emergency response teams under the coordination of DNA's Joint Nuclear Accident Coordinating Center. The Agency published a *Nuclear Weapon Accident Response Procedure* (*NARP*) manual in 1984.

The Drell Report to the Congress in 1990 urged improved hydrocodes and three-dimensional modeling to improve hazard predictions, to select weapons for early retirement, and to assure the safety of an aging nuclear stockpile. Secretary of Defense Cheney tasked DNA to establish a weapons system safety assessment capability. Working jointly with the Services, DNA applied a probabilistic risk assessment methodology to quantify the likelihood of plutonium dispersal in plausible accident scenarios. DNA's inspections brought discrepancies to Service command attention, and ultimately helped major commands overcome deficiencies.

SDI laser test.

➔ *Environmental Cleanup:* In 1986, after the waste cleanup activities begun earlier were completed, the government returned Enewetak to the sovereignty of Marshall Island inhabitants. Concurrently, DNA began a plutonium waste monitoring and sorting/collection program to reduce Johnston Atoll plutonium contamination that resulted from the pre-launch explosion of a nuclear-armed missile during the 1962 atmospheric test series. In operation from 1986 to the present, the program has achieved significant decontamination of plutonium mass on the Atoll. After the 1986 reactor fire at the Chernobyl power plant in Ukraine, DNA deployed a Chernobyl Site Restoration Assistance Team from AFRRI to identify hazard mitigation options and participate in developing medical treatment regimes.

➔ *Hard Target Kill:* DNA supported JCS initiatives to hold at risk strategic relocatable targets and Soviet hardened underground C3 facilities. DNA established a Hard Target Kill research program that included consideration of earth penetrating weapons.

➔ *Chemical Weapon Demilitarization at Johnston Atoll:* During the period when the nation maintained the option to resume atmospheric nuclear testing, DNA accepted custodianship of Johnston Atoll, located 800 miles southwest of the Hawaiian Archipelago. DNA supported users of the Atoll by

Construction of BLACKJACK radiation test simulator.

Soviet Yankee/Notch class submarine.

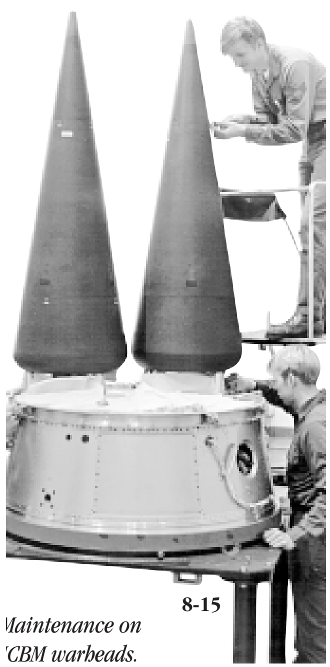
maintaining the facilities on the Atoll and protecting it against further erosion by oceanic action. In 1986, the Army began construction of a state-of-the-art chemical agent incineration system on Johnston Atoll. That system began operational testing in 1990. The processing of nerve and mustard agent stocks previously transferred from Okinawa also began. In November 1990, chemical weapon stocks in the Federal Republic of Germany were transferred to the Atoll for destruction. The Army's chemical agent demilitarization program continues as the primary user of Johnson Atoll.

➔ *Nuclear Technology Spinoffs:* Pulsed power systems developed for nuclear radiation simulators provided energy sources for evaluation of ideas to improve the range and muzzle velocity of artillery tubes and Navy guns. In a joint program with the SDI office in 1985, DNA tested an electromagnetic (EM) rail gun that fired a 150-gram projectile at 3.1 kilometers/second, a world record for a projectile of that mass.

In a joint program with the Navy, DNA developed electrothermal chemical (ETC) projectiles that doubled the range of standard Navy five-inch guns. This ETC technology became a leading candidate for up-gunning the new DD-51 class of Navy destroyers.

ETC technology is also being considered for Army artillery and tank gun applications.

➔ *Arms Control Implementation:* With NATO force modernization well underway, arms control talks resumed in 1985. The Treaty on Intermediate Nuclear Forces (INF) of 1987 was the first successful effort to eliminate an entire class of nuclear weapon systems in Europe; i.e., ground-based missiles of 500- to 5,500-kilometer range. DNA was assigned responsibility for developing treaty verification technology following the signing of the INF Treaty. Examples of achievements in this enterprise are the design and field testing of a perimeter and portal monitoring system and unique identifiers (tags) to monitor solid rocket motor and RV inventories.



8-15

Maintenance on ICBM warheads.

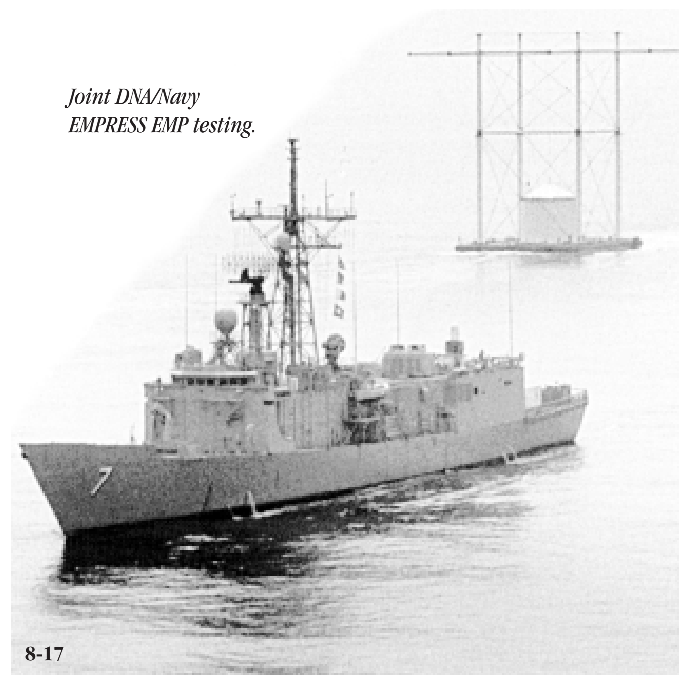
DNA provided contracting and administrative support to the newly-created On-Site Inspection Agency as it implemented inspections under the INF Treaty, the Strategic Arms Reduction Treaty (START), and other treaties and bilateral agreements. DNA studies provided an analytical foundation for the 40-percent reduction in deployed strategic warheads mandated by START I, and for deeper START II reductions.

➔ *Dual-Use Technology:* Federal policy encourages dual-use research to provide civilian benefits from technologies developed for national defense purposes. DNA applied its expertise, developed primarily to address Cold War nuclear issues, to a number of dual-use activities.

DNA's e-SCRUB program employed pulsed electron beams to remove oxides of sulphur and nitrogen from coal stack gases. This technique permits the use of high sulphur coal in electrical power plants located in sensitive air basins. DNA adapted nuclear effects models to predict damage from hurricanes and other natural phenomena, thus assisting the Federal Emergency Management Agency (FEMA) and other relief organizations in concentrating disaster relief operations where most needed. DNA has also used nuclear effects ground shock research and tools to advise the construction industry on methods to mitigate earthquake damage to buildings. The results of the radiation-tolerant microelectronics program have been applied to civilian spacecraft operating in naturally disturbed environments. Finally, advanced numerics and computational mesh strategies have been employed to improve weather forecasting.

8-16

DNA EM rail gun being test fired.



Joint DNA/Navy EMPRESS EMP testing.

8-17

1991— *Post-Cold War Priorities*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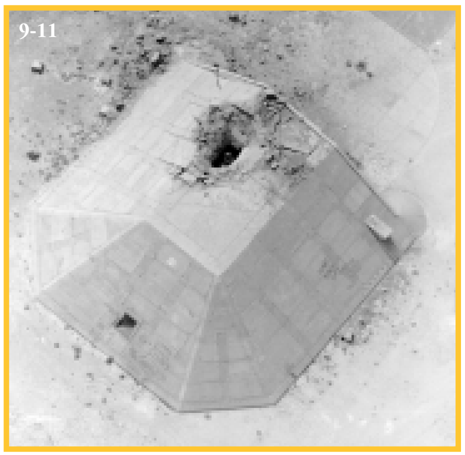
9-1. *Clinton with Rabin and Arafat.* **9-2.** *Saddam Hussein.* **9-3.** *General Colin Powell.* **9-4.** *F-117A Stealth fighter.* **9-5.** *Oklahoma City bombing.* **9-6.** *Boris Yeltsin.* **9-7.** *Map of Bosnia.* **9-8.** *Soldier with laptop.* **9-9.** *Kuwaiti kissing U.S. flag.* **9-10.** *General Norman Schwartzkopf.*

1991— Post-Cold War Priorities: *The collapse of communism is followed by regional conflicts, proliferation of weapons of mass destruction, and escalating terrorism on both domestic and international fronts.*

1991 - Iraq expelled from Kuwait – Soviet Union dissolved
1992 - Clinton elected President
1993 - START II signed – Israeli/PLO peace accord
1994 - World Trade Center bombing
1995 - Non-Proliferation Treaty extended – Oklahoma City bombing
1996 - DNA becomes Defense Special Weapons Agency (DSWA)
1997 - DSWA celebrates 50th Anniversary

➔ *The Persian Gulf War:* Following the Iraqi invasion of Kuwait in August 1990, a U.S.-led coalition of nations deployed forces to Saudi Arabia and surrounding areas to help prevent further Iraqi offensive incursions. In January 1991, coalition air power began executing an air campaign against Iraq's military and supporting infrastructure. The effectiveness of precision-guided munitions and stealth aircraft was quickly demonstrated. Coalition air power attacked suspected Iraqi WMD facilities protected by hardened bunkers. Coalition forces launched a ground offensive in late February 1991 that expelled Iraq's forces from Kuwait 100 hours after the offensive began.



9-11

Destroyed Iraqi hardened shelter.

DNA's expertise in weapons lethality and modeling of atmospheric transport supported target planning and consequence assessments during the war. The Agency deployed expert teams to a DNA assessment facility, to DIA Headquarters, and to the Pentagon in support of operational targeting from the start of the air campaign through the expulsion of Iraqi forces from Kuwait. DNA also set up a 24-hour command center to assess the consequences of potential WMD warheads on the Scud missiles Iraq launched against Saudi Arabia and Israel. DNA provided the results of these assessments to Central Command.

➔ *Postwar Validation of Damage Modeling:* DNA officers participated in post-war inspections to validate lethality and survivability models based on wartime experience. Battle damage assessments suggested new damage indicators, such as the temperature of target smoke. The Agency incorporated lessons from the Persian Gulf War in lethality, survivability, and collateral effects modeling, especially for hardened targets.

➔ *Proliferation and Counterproliferation:* The post-Desert Storm revelations of the breadth and scope of the Iraqi quest to obtain nuclear weapons spawned a heightened awareness of WMD proliferation. DNA began counterproliferation initiatives in 1991. This early planning supported a review of all U.S. nonproliferation and counterproliferation activities that was headed by the (then) Deputy Secretary of Defense, John Deutch. DNA also supported counterproliferation planning by the Assistant to the Secretary of Defense (Atomic Energy) (ATSD(AE)), now ATSD (Nuclear and Chemical and Biological Defense Programs, or NCB). That office was assigned centralized responsibility for DoD counterproliferation research and development activities.

➔ *Capabilities to Neutralize WMD Proliferation:* After the early considerations of proliferation, the ATSD (AE) designated DNA as the lead DoD agency for the counterforce elements of the counterproliferation support program. The centerpiece of DoD's counterproliferation activities is an Advanced Concept Technology Demonstration (ACTD), which involves the integration of research and development products with existing operational assets to demonstrate an improved capability to neutralize WMD targets with minimal and predictable collateral effects. The U.S. European Command (USEUCOM) is the Operational Manager of the ACTD with DNA as its Demonstration Manager. Service and DOE laboratories are also participating in the ACTD.

Early ACTD activities in 1996 involved live delivery of inventory weapons against simulated biological weapon targets. Post-1996 ACTD activities will include more advanced weapons in attacks on simulated chemical weapon production facilities that are protected by hardened structures. Although the counterproliferation ACTD has prompt weapon applications and high target kill probability in common with other similar activities, it is unique in its focus on predicting, minimizing, and measuring post-attack collateral effects. In common with all ACTDs, the counterproliferation ACTD will provide unified commands with weapons, sensors, and other assets that can be used immediately.

➔ *The Cooperative Threat Reduction (CTR) Program:* In response to the dangers associated with the potential breakdown of nuclear controls in the Former Soviet Union (FSU), in late 1991 the U.S. embarked on an innovative program of cooperative assistance. Until 1993, the CTR

Defense Secretary Perry and Ukraine Minister of Defense Shmarov signing treaty.

9-12

Program was called the Safe, Secure Dismantlement Program; it continues to be informally referred to as the "Nunn-Lugar Program." The program's fundamental objectives are: (1) to help all FSU States but Russia become non-nuclear; (2) to accelerate START arms reductions; (3) to enhance nuclear safety, security, and control; (4) to initiate FSU chemical weapon destruction; (5) to encourage demilitarization; and (6) to extend contacts between the U.S. and FSU defense establishments.

In January 1993, the ATSD (AE), assigned DNA the task of implementing the program, on a cradle-to-grave basis, for each CTR element. As of mid-1996, the Agency is executing over 50 CTR projects, ranging from supplying Russia with containers for transport and storage of fissile material, to projects in the demilitarization area designed to ensure that threat reduction efforts are of an enduring, peaceful, and commercially viable nature.

Illustrative CTR program achievements include removal of over 1,200 warheads from deployed systems in Russia; realization of nuclear-free status in Ukraine and Kazakstan, with Belarus expected to do so not later than early 1997; and elimination of many FSU strategic nuclear delivery systems.

➔ *Nuclear Stockpile Drawdown:* In 1991, President Bush announced nuclear posture changes reflecting the end of the Cold War. These changes included withdrawal of tactical nuclear weapons from Army bases, surface ships, and attack submarines; cancellation of mobile basing programs for the Peacekeeper missile; cancellation of the Short Range Attack Missile-II (SRAM-II) and the Small ICBM; and stand down from alert of strategic bombers and Minuteman ICBMs. A January 1992 Presidential decision laid the groundwork for eventual elimination of all 50 Peacekeepers, reduced MIRV deployments, and the shift of bombers to conventional missions.

The Clinton administration conducted a Nuclear Posture Review (NPR) in 1993-1994 that led to a definition of an "enduring stockpile" of nuclear weapons. DNA supported the NPR principals through a DNA point-of-contact who coordinated NPR requirements with DNA analyses and other activities, and provided products to meet the NPR needs.

The HE Computational Aid for Windows. 9-14

In September 1994, President Clinton approved a reduced strategic force comprised of Minuteman ICBMs, Trident submarines (all with D-5 missiles), B-2 and B-52 strategic bombers, and a non-nuclear role for the B-1 bomber.

9-13

Defense Nuclear Weapons School, Kirtland Air Force Base.

➔ *Training for Reliability, Safety, and Security:* Since 1993, DNA has operated the Defense Nuclear Weapons School (DNWS) at Kirtland AFB, New Mexico, for all Services. DNWS has since broadened its curriculum to include courses in counterproliferation and counter-terrorism. Although the Army, Marines, and most Navy commands are no longer nuclear capable, ongoing training is essential to maintain Service competency to operate in nuclear environments.

➔ *Verification Technology Expands:* The DNA verification technology programs have expanded to include support to virtually every arms control and bilateral agreement to which the U.S. is a party. Recent verification technology achievements and activities include sensors for Open Skies aircraft, unified databases relevant to arms control, analytical techniques and sensors for chemical and biological agents, gravity gradiometers to characterize START Treaty Limited Items, and improved seismic sensing capabilities to verify the Comprehensive Test Ban Treaty (CTBT).

➔ *Nuclear Stockpile Stewardship:* With the 1993 decision to conditionally cease U.S. nuclear testing, questions arose on maintaining the reliability of the enduring nuclear stockpile that was defined by the NPR. The DOE advocated "Science Based Stockpile Stewardship," in which reliability would be preserved through stockpile surveillance, laboratory experiments, and improved computational software and hardware.

Subsequently, a DoD-DOE agreement called for "dual revalidation" of weapons remaining in the inventory through a process in which each DOE weapons laboratory independently and periodically examines all data relevant to a specific weapon type. The results are reviewed by DOE Headquarters and provided to the Nuclear Weapons Council for final action. DNA is a participant in the process, with DNA military officers located at all three national laboratories. These officers contribute to the dual revalidation process and annual recertification of the stockpile.

High Performance Computing: The underpinning of the Agency's nuclear expertise and advanced conventional weapons applications is high performance computing (HPC) and modeling. The High Performance Computing and Communications (HPCC) program has provided advanced scientific computing resources to the nuclear effects community since the mid-1970s. In the early years, this was accomplished by buying large blocks of time from AEC and Service laboratories. From 1980-1983, DNA operated its own CDC 7600 supercomputer at Kirtland AFB. In 1983, the Agency entered into an arrangement with LANL to provide HPC resources. Since then, Los Alamos has integrated a series of DNA supercomputers (CDC CYBER 176 in 1984, Cray X-MP in 1988, and Cray M98 in 1994) into its computational environment and operated a private communications network providing classified and unclassified computing to DNA's geographically distributed support sites. In 1995, DNA augmented its HPC capability with a Cray J90 operating at its headquarters.

Data and Knowledge Preservation: Two efforts were initiated in 1993 as a cohesive program to ensure that the legacy of irreplaceable nuclear effects information and expertise will survive for future generations: the Data Archival and Retrieval Enhancement (DARE) Program and Project Graybeard. The DARE Program locates, stores, and retrieves effects data from its inventory of waveforms, numeric tables, diagrams, reports, photographs, and video media. Integration and declassification of effects knowledge is underway in the new *EM-1 Technical Handbook*, scheduled for release in early 1997. This handbook will draw upon the authoritative 22-volume *EM-1*. The Agency also advances community technology and data preservation achievements in the publication *Science & Technology Digest*. The second DNA archival program, Project Graybeard, identifies, locates, and interprets test data and lessons learned, and integrates the information into the DARE database.

Technology Applications for Counterterrorism: As the breadth and scope of terrorism began to expand in the 1980s, it became apparent that much of the DNA Cold War expertise was applicable to efforts to counter terrorism. In particular, DNA expertise in C3 facility survivability has direct application to the safeguarding of U.S. and allied facilities that are potential terrorist targets. For example, the Agency has performed approximately 50 Balanced Survivability Assessments of critical DoD and federal agency facilities. Chief among the findings are that the judgments regarding a facility's vulnerability to terrorism become virtual roadmaps to risk reduction measures. DNA has performed structural blast response calculations using codes and models originally developed for nuclear applications. This analytical support was provided to law enforcement agencies during forensic investigations of terrorist events, including the World Trade Center and Oklahoma City bombings.

DNA Transition to DSWA: In 1992 and again in 1993, Congress mandated reviews of DNA's roles, missions, and functions. The eventual result was a reaffirmation of the DoD commitment to maintain nuclear competencies with DNA as the *center of excellence* for the Department's nuclear matters, including CTR and activities in Nuclear Stockpile Stewardship. DNA also gained responsibility for non-nuclear development activities that take advantage of the Agency's nuclear heritage. The traditional DNA roles, along with the new tasks, were institutionalized in a new charter issued in 1995. Subsequently, the Agency reorganized to improve service to its customers, to implement total quality management, to break away from Cold War traditions, and to foster coordination and teamwork. The Agency was retitled DSWA during ceremonies on June 26, 1996, culminating the Agency's evolution in the Post-Cold War environment.

Joint Science Programs: DSWA sponsors joint science programs with scientific institutions in Russia, Ukraine, and Kazakstan. These programs include an evaluation of the Russian Topaz reactor for thermionic energy, applications of energetic materials, comparative findings on nuclear weapons effects, and the use of advanced computational techniques.

9-15

Science & Technology Digest.

Munitions Effectiveness: Munitions effectiveness assessment modeling uses empirical data obtained from DSWA's Permanent High Explosives Test Site (PHETS) at White Sands Missile Range, New Mexico. Since 1988, there has been more than a 30-fold increase in conventional effects tests. DSWA's White Sands facilities were also employed by the Bureau of Alcohol, Tobacco and Firearms (ATF) in tests to create a computerized database and investigative protocol for law enforcement agencies to use in large-scale vehicle bomb investigations. The Large Blast /Thermal Simulator (LBTS), operated jointly by DSWA and the Army at White Sands since 1994, is the largest shock tube in the world. LBTS can replicate the blast and thermal environments of nuclear weapons with yields from one to 600 kilotons.

Current and Future Challenges: One of the hallmarks of DSWA's predecessors was effective and timely response to the dynamics of the Agency's internal and external environments. Over the five years of this era, DNA and DSWA successfully transitioned into the Post-Cold War era. DSWA is now postured for future achievements directly relevant to the current and future national security environment, including the preservation of core competencies so painstakingly acquired over the last 50 years.

THE NEXT 50 YEARS

10-1

Major General Gary Curtin, DSWA Director.

➜ *Looking Ahead:* While no one can predict the future, we can identify some of the key factors that are likely to impact the Agency's mission over the next half-century.

➜ *There will be WMD:* Since the end of the Cold War, technologies that enable state and non-state organizations to develop and deliver WMD — nuclear, radiological, chemical, and biological weapons — have proliferated. Even if all states agreed to eliminate WMD, the capability to produce such devices with little warning will persist. Planning for major contingencies will necessarily have to consider the possibility that antagonists could have WMD capabilities. Moreover, U.S. citizens may find themselves exposed to WMD incidents, even though the U.S. is not involved as a protagonist.

➜ *Many Nuclear Futures are Possible:* For the foreseeable future, there is little likelihood of a resurgence of the Cold War. However, some Cold War-related tasks will continue to engage our time and resources for programs such as CTR in the former Soviet Union and remediation of the human and environmental legacies of nuclear weapons. Over the longer term, there are a number of scenarios, ranging from further proliferation and eventual use of nuclear weapons in a regional conflict, to the alternative of success in arms control, making use of WMD a politically unacceptable option.

➜ *Nuclear Weapons Will Continue to be Special Weapons:* Throughout most of the world, nuclear weapons will continue to be perceived as fundamentally different. Current national policies are likely to persist, with the declared position of the U.S. being that our nuclear capabilities are relevant only in confrontations with other nuclear-weapons-capable states. Our emphasis will continue to be on planning military options to support deterrence and termination of hostilities, with considerable emphasis on minimizing collateral hazards. Safety, security, and positive political control will continue to be the highest imperatives.

➜ *Others May Regard Nuclear Weapons as Being Special in a Different Sense:* Unable to match U.S. economic strength, political power or conventional weapons capabilities, leaders in other states may regard the development and acquisition of nuclear weapons as an acceptable path to strategic equivalence or regional dominance. In a regional conflict, they may be tempted to use nuclear weapons to disrupt communications and damage unprotected electronics (precluding U.S. information dominance) or to directly attack critical nodes supporting conventional operations, such as ports and airfields.

➜ *Nuclear Force Structures Will Be Less Prominent :* The size of the U.S. and Russian nuclear stockpiles will decline. Fewer forces will have nuclear delivery capability. In the absence of a Cold War strategic environment, a downsized DoD will invest a smaller percentage of its resources in maintaining nuclear capabilities. Developing new nuclear capabilities will be an unacceptable political option. Earlier, nuclear weapons testing was already prohibited by Presidential direction. The United States is now party to the Comprehensive Test Ban Treaty. Now, other means will have to be used to guarantee confidence in the stockpile and to ensure forces can withstand the nuclear threats posed by proliferant nations or groups.

STRATEGIC VISION FOR DSWA

➜ *A Paradigm Shift:* At the end of the Cold War, DoD nuclear requirements for the future were sharply reassessed. One of the results from this reevaluation was the broadening of the Agency's role and its redesignation as DSWA. In preparing for its new role, the Agency adopted a new *vision* which emphasized the need for it *"to serve as the DoD center of excellence for nuclear and other special weapons matters, with emphasis on technical and operational support to the warfighter."*

➜ *Center for Nuclear Expertise:* In a world environment in which there is less emphasis on nuclear matters, the need to continue protecting a core capability within DoD is clear.

- In assuming that role, DSWA will continue to perform a critical mission of safeguarding nuclear core competencies. This will require continued work on modeling nuclear weapons effects, as well as understanding the various aspects of nuclear hardness.
- Many of the key nuclear competencies are related directly to non-nuclear advanced weapon programs. For example, the use

10-2

Dr. George Ullrich, DSWA Deputy Director of DSWA expertise in plasma and computational physics will contribute to future advances in ETC and EM artillery projectile technology.

- Maintaining nuclear effects test and simulation capabilities will also be a core strategic mission executed by DSWA. This will include sustaining DoD's capability to resume underground nuclear effects testing, if so directed by the President.
- DSWA will safeguard the unique database developed during nuclear testing and apply this information to meet DoD needs. World-class computational capabilities will be upgraded to support operational research and development requirements.

➔ *DoD Stockpile Stewardship:* DSWA will also serve as the lead DoD agency for long-term nuclear weapons stockpile stewardship.

- DSWA experts will continue to be assigned to the DOE laboratories in support of the DOE Science-Based Stockpile Stewardship Program (Dual Revalidation) and the joint DoD/DOE Annual Stockpile Certification.
- DSWA will provide support to DoD components concerning reliability, safety, security, use control, and explosive ordnance disposal of nuclear weapons.
- Members of the DSWA team will provide emergency response support for weapons-related incidents worldwide.
- DSWA Field Command will provide nuclear weapons technical inspections, quality assurance programs and logistics management support for the stockpile under DoD control.

➔ *Warfighter Support:* DSWA will continue to provide strong analytical support to the Services and Unified Commands worldwide.

- DSWA will push to develop technologies that will facilitate counterforce actions against mobile and hardened targets, especially where WMD are likely to be involved.
- Specific areas of emphasis are likely to include peacetime planning assistance, as well as direct technical support during contingencies, such as Desert Storm, to identify what must be done to defeat hardened targets, forecast collateral hazards, support counterproliferation, and provide counterterrorism technology.
- DSWA will also continue to provide strong support for U.S. STRATCOM as it carries out its nuclear contingency planning responsibilities.

➔ *National Security Policy Implementation:* Because of its program management and contracting expertise, DSWA will continue to serve as the DoD agent for numerous programs of national interest.

- DSWA will be the principal agent to carry out CTR programs to reduce the risks associated with the Former Soviet Union's nuclear, biological, and chemical capabilities. As national policy evolves with respect to CTR, so will DSWA's implementation program. If other potential proliferants eliminate their WMD stockpiles, additional CTR programs may be established.
- DSWA is likely to continue as the lead DoD agency for developing and validating technologies for use in arms control monitoring.
- Technical collaboration with other nations for work on matters of mutual interest is likely to continue in line with national policy direction.
- Finally, DSWA is likely to be tasked to support the Office of the Secretary of Defense and other authorities in management of the human health and environmental consequences that have resulted from nuclear and other designated activities.

Photograph Credits

Cover

Soldiers and cloud (DSWA/DASIAC photo).

Peacekeeper missile (DSWA/DASIAC photo).

NBC-suited students (DSWA/DASIAC photo).

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Acronym List

ABM - Anti-Ballistic Missile

ACTD - Advanced Concept Technology Demonstration

AEC - Atomic Energy Commission

AFB - Air Force Base

AFRRI- Armed Forces Radiobiology Research Institute

AFSWP - Armed Forces Special Weapons Project

ANMCC - Alternate National Military Command Center

ARPA - Advanced Research Projects Agency

ATF - Bureau of Alcohol, Tobacco and Firearms

ATSD (AE) - Assistant to the Secretary of Defense (Atomic Energy)

ATSD (NCB) - Assistant to the Secretary of Defense (Nuclear and Chemical and Biological Defense Programs)

BMO - Ballistic Missile Office

C3 - Command, Control, and Communications

CINC - Commander in Chief

CINCEUR - Commander in Chief, Europe

CINCPAC - Commander in Chief, Pacific

COMSAT - Communications Satellite

CTBT - Comprehensive Test Ban Treaty

CTR - Cooperative Threat Reduction

DARE - Data Archival and Retrieval Enhancement

DASA- Defense Atomic Support Agency

DASIAC - DoD Nuclear Information Analysis Center (formerly Defense Atomic Support Information Analysis Center)

DDR&E - Director, Defense Research and Engineering

DEW - Distant Early Warning

DIA- Defense Intelligence Agency

DIHEST - Direct-Induced High Explosive Simulation Technique

DNA - Defense Nuclear Agency

DNWS - Defense Nuclear Weapons School

DoD - Department of Defense

DODDAC - Department of Defense Damage Assessment Center

DOE - Department of Energy

DSCS - Defense Satellite Communication System

DSWA - Defense Special Weapons Agency

EM - Electromagnetic

EM-1 - Effects Manual-1

EMP- Electromagnetic Pulse

EMPRESS - EMP Radiation Effects Simulator for Ships

ETC - Electrothermal Chemical

FEMA - Federal Emergency Management Agency

FSU - Former Soviet Union

GLCM - Ground Launched Cruise Missile

HA - High Altitude

HASP - High Altitude Sampling Program

HE - High Explosive

HEST - High Explosive Simulation Technique

HF - High Frequency

HILAT - High Latitude

HML - Hardened Mobile Launcher

HPC - High Performance Computing

HPCC - High Performance Computing and Communications

ICBM - Intercontinental Ballistic Missile

INF - Intermediate Nuclear Forces

JCS - Joint Chiefs of Staff

JSTPS - Joint Strategic Target Planning Staff

JTF - Joint Task Force

LANL - Los Alamos National Laboratory

LLNL - Lawrence Livermore National Laboratory

LBTS - Large Blast/Thermal Simulator

LTBT - Limited Test Ban Treaty

MC - Military Committee

MED- Manhattan Engineer District

MIRV - Multiple Independently Targeted Reentry Vehicle

NARP - Nuclear Weapon Accident Response Procedure

NATO - North Atlantic Treaty Organization

NCB - Nuclear, Chemical and Biological

NPR - Nuclear Posture Review

NSC - National Security Council

NTPR - Nuclear Test Personnel Review

NTS - Nevada Test Site

NUWAX - Nuclear Weapon Accident Exercise

OSD - Office of the Secretary of Defense

OSRD - Office of Scientific Research and Development

PHETS - Permanent High Explosives Test Site

psi - pounds per square inch

RB - Reentry Body

RV - Reentry Vehicle

SAC - Strategic Air Command

SACEUR - Supreme Allied Commander Europe

SAGE - Scientific Advisory Group on Effects

SALT - Strategic Arms Limitation Treaty

SDI - Strategic Defense Initiative

SGEMP - System Generated Electromagnetic Pulse

SHAPE - Supreme Headquarters Allied Powers Europe

SIOP - Single Integrated Operational Plan

SLBM - Submarine Launched Ballistic Missile

SPO - System Program Office

SRAM-II - Short Range Attack Missile-II

START - Strategic Arms Reduction Treaty

STP - Silo Test Program

STRATCOM - U.S. Strategic Command

SWEG - Special Weapons Effects Group

TAPS - Targeting and Planning System

TEMPS - Transportable EMP Simulator

TTCP - The Technical Coordinating Panel

UN - United Nations

UGT - Underground Test

U.S. - United States

USAF - United States Air Force

USEUCOM - United States European Command

VNTK - Vulnerability Number/Type (of Target)/K-factor

WMD - Weapons of Mass Destruction

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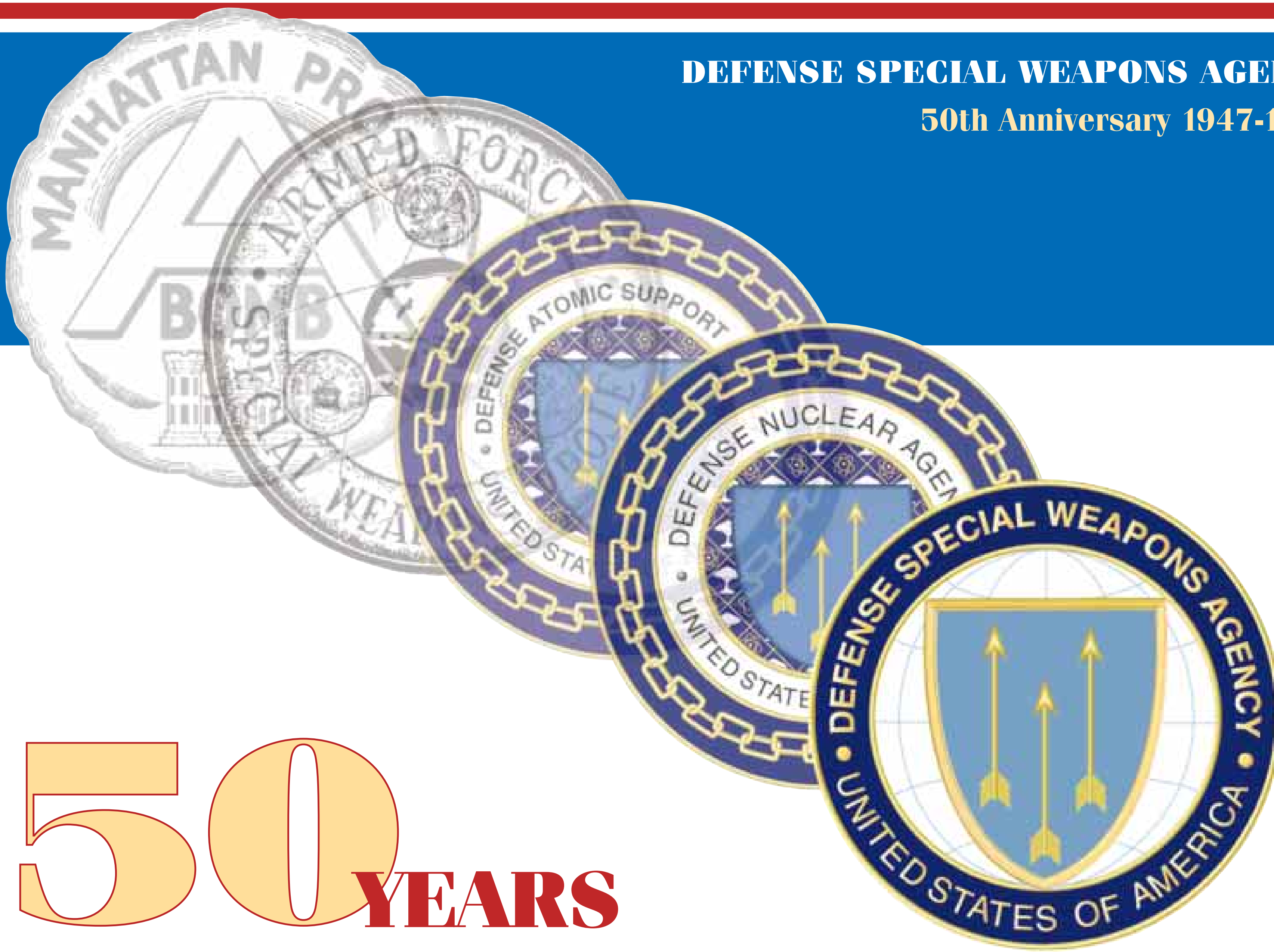

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