DOE F 1325.8

United States Government | Department of Energy

memorandum

Rocky Flats Field Office

DATE: FEB 0 1 1999

REPLY TO ATTN OF: CPM:PPI:PMP:01012

SUBJECT: Acceptance of Historic American Engineering Record Reports

TO: Alan Parker
Vice President of Closure Projects
Kaiser-Hill Company, L.L.C.

The Rocky Flats Field Office has received notification from the National Park Service that the Park Service has accepted the Historic American Engineering Record reports for all of the historic facilities onsite. A copy of their acceptance letter is attached. Rocky Flats Environmental Technology Site is now free to pursue decontamination, decommissioning and demolition of any historic facility onsite without further National Historic Preservation Act compliance. Finalization of this project is important both for preserving the story of the historic mission of Rocky Flats, and for making the achievement of the current closure mission possible. We wish to acknowledge the contribution of Pat Ervin who had the foresight to recognize the relationship of this project to closure and the tenacity to press forward to completion of the work.

This technical direction is not intended to impact the cost, schedule, or scope of the contract. If you believe there will be such an impact, you should immediately notify the Contracting Officer's Representative and the Contracting Officer, and not implement the technical direction received.

Please provide final hard copies of the report package, as discussed with your staff, as well as an electronic copy of all of the reports in 'Word' format. You may contact me at extension 5878 or Tricia Powell of my staff at extension 3260 if there are questions.

David C. Lowe
Acting Deputy Manager Technical Programs

Attachment

cc:
L. Thompson, EH-41, HQ
H. Dalton, AMFD, RFFO
J. Legare, AMEC, RFFO
C. Dan, CMD, RFFO
K. Koch, OCC, RFFO
T. Powell, PPI, RFFO
P. Ervin, K-H

RECEIVED
NOV 29 2005

ADMIN RECORD

JUN 4 1998

98-DOE-01086

Lisa Wegman-French
National Park Service
Rocky Mountain Support System Office
Post Office Box 25287
Denver, Colorado 80225-0287

Dear Ms. Wegman-French:

For your review and approval, the Rocky Flats Field Office is submitting the completed Historic American Engineering Record documentation package covering historic facilities at this Site. Copies of the earlier reports already approved by your office are included in the package. Enclosed are four volumes which contain narrative reports, mounted photographs, negatives, and cover cards for all of the facilities that are required to be documented at this Site. Also enclosed are facility drawings on mylar. We look forward to your review of the package and any feedback you may have. Please contact me at 966-5878 or Tricia Powell, of my staff, at 966-3260 if there are questions about the reports.

Sincerely,

Keith A. Klein
Deputy Manager Technical Programs

Enclosures

cc w/o Encl:
J. Stover, EC, RFFO
P. Powell, PPI, RFFO
P. Ervin, K-H

JUN 4 1998

OUTGOING CORRESPONDENCE CTRL NO: PPI:PMP:01086

ORIGINATOR:

Powell/PPI/x3260
LOCKHART/P&I/x7846
Deputy Assistant Manager Program and Planning Integration

ISSUE:

Final submission of Historic American Engineering Record reports to the National Park Service for review and approval.

BACKGROUND:

The site is required to prepare Historic American Engineering Record documentation for historic facilities to meet the requirements of the National Historic Preservation Act. We have already received approval on several reports that covered facilities that were slated for early D&D. We are now submitting the entire package which, barring further requirements from the National Park Service, will complete our submission. Once this package has been approved by the Park Service, we will be free to D&D and demolish all historic site facilities at will. Review and approval could take as long as three months.

RECOMMENDATIONS:

Send the reports to the Park Service.

bcc:
Manager's Reading File

Copy to Reading Room: Yes No (Please initial)

PPI	PPI	AMPPI	OOM
Powell	Lockhart	Golan	Klein
5/21/98	5/21/98	5/21/98	5/26/98

54177

HISTORIC AMERICAN ENGINEERING RECORD
(HAER No. CO-83)

for the

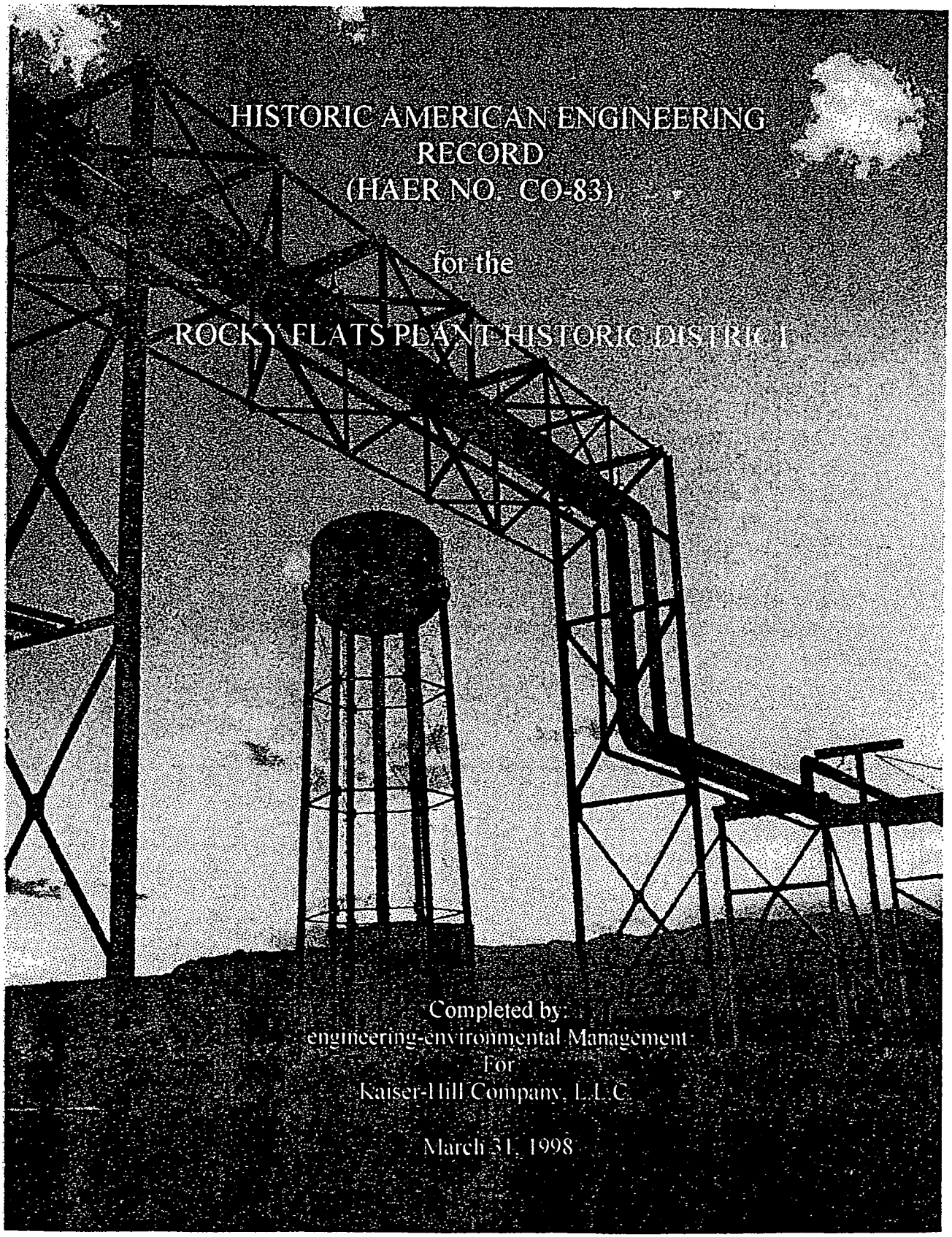
ROCKY FLATS PLANT
HISTORIC DISTRICT

Volume 1 of 4

Completed by:
engineering-environmental Management
e^2M
7000 South Yosemite, #295
Englewood, Colorado

For
Kaiser-Hill Company, L.L.C.
Rocky Flats Environmental Technology Site
Golden, Colorado

March 31, 1998



HISTORIC AMERICAN ENGINEERING RECORD
(HAER NO. CO-83)

for the

ROCKY FLATS PLANT HISTORIC DISTRICT

Completed by:
engineering-environmental Management
For
Kaiser-Hill Company, L.L.C.

March 31, 1998

Acknowledgements

I am so thrilled to have been the project manager on historic documentation of the Rocky Flats Plant. My team, Judy Berryman, Nancy Reese, and Samantha Hulme, research and writing; Margaret Leckie, graphics; and Tim McGrath and Kathy Abeyta, the Source One (Plant) photographers, was thorough, energetic, and professional until the very end. They made my job easy. Although, a few get credit for the project, it has been the efforts of many.

If you peruse the reference sections of each of the reports, you will notice that much of the information came from the employees that worked at the Plant. And there, we found the sole of the Plant. We have tried to put their words on these pages and weave together the big picture from all the stories and recollections that we have heard. After almost 40 years of silence, we hope we did justice to all the present and former employees that contributed so much for the defense of the US during the Cold War.

I would especially like to thank Jack Weaver and Steve Cunningham for always responding to our calls and endless stream of questions, and Patrick Ervin for making it happen.

Jayne Aaron
engineering-environmental Management
(e^2M)

ROCKY FLATS PLANT

(Rocky Flats Environmental Technology Site)

Bounded by Highways 93, 128 and 72, and Indiana Street

Main Entrance on Highway 93

Golden Vicinity

Jefferson County

Colorado

HAER No. CO-83

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

AND REDUCED DRAWINGS

HISTORIC AMERICAN ENGINEERING RECORD
Rocky Mountain System Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

ROCKY FLATS PLANT HAER No. CO-83
(Rocky Flats Environmental Technology Site)

Location:	Bounded by Highways 93, 128, and 72 and Indiana Street, Golden, Jefferson County, Colorado.
Date of Construction:	1951-1953 (original plant).
Fabricator:	Austin Company, Cleveland, Ohio.
Present Owner:	United States Department of Energy (USDOE).
Present Use:	Environmental Restoration.
Significance:	The Rocky Flats Plant is exceptionally significant under Criterion A at the national level under the Cold War military theme: Development of Atomic Energy for Military Purposes. The Rocky Flats Plant is associated with the United States strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack. The Rocky Flats Plant was the sole producer of triggers for nuclear weapons.
Historians:	D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M), 1998. Judy A. Berryman, Ph.D., Archaeologist, e^2M, 1998.

Project Information:

In 1995, an inventory and evaluation of facilities at the Rocky Flats Plant for their potential eligibility for listing in the National Register of Historic Places was conducted. The primary goal of this investigation was to determine the significance of the Cold War era facilities at Rocky Flats Plant in order to assess potential effects of the long-term goals and objectives of the USDOE. These goals and objectives included waste cleanup and demolition. Recommendations regarding National Register of Historic Places eligibility were developed to allow the USDOE to submit a formal determination of significance to the Colorado State Historic Preservation Officer for review and concurrence and to provide for management of historic properties at the Rocky Flats Plant.

From this determination and negotiations with the Colorado State Historic Preservation Officer, the Advisory Council, and the National Park Service, a Historic American Engineering Record (HAER) project began in 1997 to document the Rocky Flats Plant's resources prior to their demolition. Also in 1997, the Rocky Flats Plant was officially listed on the National Register of Historic Places. The archives for this HAER project are located in the Library of Congress in Washington, D.C.

Documentation for this HAER project includes a Plant-overview component (this written report followed by drawings and photographs), as well as reports and photographs of individual buildings considered contributing resources of the Rocky Flats Plant historic district.

This Plant-overview report is organized into the following topics:

- Introduction
- Cold War and the Nuclear Weapons Complex
    - Political Climate
    - Development of the Atomic Bomb
    - Nuclear Weapons Development
    - The Cold War
    - Cold War Advances in Nuclear Weapons Design
    - The Atomic Energy Program
    - The United States Nuclear Energy Program
    - The USDOE Nuclear Weapons Complex
- Rocky Flats Environmental Technology Site
    - Site Location
    - Mission of the Plant
    - Significance
- Plant Site Overview
    - The Rocky Flats Plant Site
    - Plant Organization
    - The Original Plant Construction 1951 – 1953
    - History of Operations (1953-55, 1956-63, 1964-89, and 1989-92)
- Manufacturing History
    - Plutonium Operations (Recovery and Fabrication)
    - Depleted Uranium Operations
    - Enriched Uranium Operations (Fabrication and Recovery)
    - Beryllium Operations
    - Stainless Steel Operations
    - Assembly Operations

- Major Material Processing Buildings
    - Depleted Uranium and Beryllium (Building 444)
    - Enriched Uranium and Non-plutonium Metals/Alloys (Buildings 881, 883, 865, and 460)
    - Plutonium (Buildings 771, 776/777, 707, and 371)
    - Shipping/Receiving and Assembly (Building 991)
- Security
- Communications
- Fire Safety
- Health and Safety
    - Background
    - Safety Programs
    - Health Facilities
    - Nuclear Safety Department (Critical Mass Laboratory- Building 886)
    - Heating, Ventilation, and Air Conditioning (Contaminant Zones/Filtration and High Efficiency Particulate Air Filters Testing Laboratory - Building 442)
    - Breathing Air System
    - Inert Gases
- Health and Safety Practices
    - Plutonium
    - Beryllium
    - Uranium
    - Non-radioactive Materials
- Research and Development
    - Research Efforts – Production Processes
    - Areas of Research (Material Handling, Chemical Research, Waste Treatment, Explosive Bonding Pit, Special Orders, Natural Sciences, Cleanup and Remediation Studies)
- Support Facilities
    - Office Administration
    - Waste Management (Liquid Waste Treatment, Solid Waste Treatment, Sanitary Wastewater Treatment, and Waste Storage)
    - Utilities Systems (Water, Steam Distribution, Plant Power, and Maintenance)
- Employees
- Future of the Rocky Flats Plant and the USDOE Nuclear Weapons Complex

A set of seventeen drawings and a series of current and historic photographs illustrate the Plant-overview report. The drawings delineate the geographic location of the Rocky Flats Plant; the Nuclear Weapons Complex; nuclear weapons production flow diagrams;

the Cold War time line; the Rocky Flats Plant historic district; various production flow diagrams and building relationships; and health and safety, laboratory, and security aspects of the Plant. The photographs depict the original construction, growth of the Plant, the relationship of the buildings, and the setting. The individual building reports and photographs follow the Plant photographs. Specific information regarding processes, construction, and history of each structure considered contributing resources of the Rocky Flats Plant historic district are included in the individual building reports.

Introduction

The Rocky Flats Plant is one of thirteen USDOE facilities that constitutes the Nuclear Weapons Complex which designed, manufactured, tested, and maintained weapons for the United States arsenal. The Rocky Flats Plant was established in 1951 to manufacture triggers for use in nuclear weapons and to purify plutonium recovered from retired weapons. The trigger consisted of a first stage fission bomb that set off a second stage fusion reaction in a hydrogen bomb. Parts were formed from plutonium, uranium, beryllium, stainless steel, and other materials.

A tense political atmosphere both at home and abroad during the Cold War years drove United States weapons research and development. By the 1970s, both the United States and the Soviet Union maintained thousands of nuclear weapons aimed at each other, based on submarines, bombers, and intercontinental ballistic missiles. Both the North Atlantic Treaty Organization and Warsaw Pact countries in Europe had small nuclear warheads called "theater weapons" available to be used as part of the Mutually Assured Destruction policy. The doctrine of Mutually Assured Destruction acted as a deterrent in that if one side attacked with nuclear weapons, the other would retaliate and both sides would perish (Weisberer 1984:268-9). The final nuclear weapons program at the Rocky Flats Plant was the W-88 nuclear warhead for the Trident II missile. This mission ended in 1992 when United States President George Bush canceled production of the Trident II missile.

The Rocky Flats Plant was a top-secret weapons production plant, and employees worked with a recently man-made substance, plutonium, about which little was known concerning its chemistry, interactions with other materials or shelf life. The HAER documentation effort focused on four aspects of the Rocky Flats Plant and its role in the Nuclear Weapons Complex: manufacturing operations, research and development, health and safety of workers, and security.

Documentation within the HAER includes background materials relating to the Cold War and the Nuclear Weapons Complex, an overview of the Rocky Flats Plant, a history of the five manufacturing operations (plutonium, depleted uranium, enriched uranium,

beryllium, and stainless steel), background of the four major processing plants (Plants A, B, C, and D), description of the health and safety programs, summary of the research and development efforts, and description of the support facilities, and the future of Rocky Flats and the USDOE Nuclear Weapons Complex.

Cold War and the Nuclear Weapons Complex

The Political Climate

Political instability in Europe during the 1930s and 1940s fueled a perceived need for a nuclear weapon or atomic bomb. Just as the secrets of the atom were being discovered, both Europe and Asia were experiencing political instability (revolutions and the rise of dictatorships), along with concurrent policies of expansion and repression.

From 1928 to 1936, the Soviet Union was in the midst of Stalin's Great Purges. In the Far East, Japan began expansionist activities with the invasion of Manchuria in 1931. One year later, in Europe, Leo Szilard conceived the idea of an atomic-powered bomb. In 1933, Hitler became the Dictator of Germany, and the concept of the atomic bomb was patented one year after that. The same year that Germany began occupation of the German Rhineland (1936), Leo Szilard transferred the atomic bomb patent to the British government, so that it could be protected under British secrecy laws. Expansionist activities in Asia continued with the Japanese invasion of China in 1938. The next year the German Army occupied Austria and the Sudetenland portion of Czechoslovakia.

In December 1938, German scientists demonstrated nuclear fission. As Germany invaded Poland in 1939 and World War II began, nuclear weapons went from being theoretically possible to being probable. Scientists were beginning to understand the different fissionable properties of uranium 235 and uranium 238, an understanding necessary for the development of an atomic weapon. In 1939, Albert Einstein sent a letter to President Roosevelt concerning atomic research activities and the potential for making a bomb. In response to that letter, the United States formed a committee to investigate potential military applications of nuclear fission. The committee studied the issue, but did not immediately pursue military applications of nuclear energy.

Plutonium, destined to become the primary fissionable material used in atom bombs, was discovered in 1941. Later that same year, the United States entered World War II after the Japanese bombing of Pearl Harbor. Shortly thereafter, the United States initiated the precursor to the Manhattan Project. This project was initiated in part because the United States and its European Allies feared Hitler's pursuit of atomic weapons might be successful, resulting in the fall of Europe to Hitler's Army, and threatening the stability of the United States.

Tensions between the Soviet Union and the United States in the immediate aftermath of World War II soon dashed any hopes for an international agreement controlling atomic energy. As relations deteriorated and the Cold War escalated, military requirements for fissionable materials increased accordingly. Between 1947 and 1952, the Atomic Energy Commission initiated the construction of facilities that increased United States weapons production capacity enormously. The new facilities included: three additions to Oak Ridge gaseous complex; gaseous diffusion plants in Paducah, Kentucky and Portsmouth, Ohio; five additional reactors for producing plutonium at Hanford, Washington; and five heavy water reactors for producing tritium from lithium, as well as plutonium, at the new Savannah River, South Carolina, site. In addition, the Commission constructed auxiliary facilities to enlarge and strengthen the production chain from ore to weapons. These included a feed materials production center at Fernald, Ohio and component plants at Rocky Flats, Colorado and Amarillo, Texas. By summer 1952, 150,000 workers were engaged in atomic weapons-related construction activities.

As shown in the table "Key Political Events", political instability experienced during the 1930s-1940s and continuing through the Cold War Era, fostered a perceived need for nuclear weapons, driving the major super powers towards developing various weapons research and development programs (often referred to as the nuclear arms race). In the United States and the Soviet Union, the nuclear arms race resulted in the development of a vast research, production, and testing network. Evidence of slowing down of this race did not appear until the 1960s, when a treaty was signed between the United States and the Soviet Union prohibiting underwater, atmospheric, and outer space testing of atomic weapons.

Key Political Events

DATE	DESCRIPTION
Sep 1931	Japan invaded Manchuria.
Jan 1933	Hitler appointed Chancellor of Germany.
Mar 1933	Hitler became dictator of Germany.
Sep 1935	Nuremberg Laws began persecution of Jews in Germany.
Mar 1936	Occupation of German Rhineland.
1928-36	Stalin's Great Purges.
Jul 1937	Japan invaded China.
Nov 1937	Axis Alliance was created between Germany, Japan, and Italy.

DATE	DESCRIPTION
Mar 1938	Germany occupied Austria.
Sep 1938	Germany occupied the Sudetenland portion of Czechoslovakia.
Sep 1939	World War II began with German invasion of Poland / Nuclear weapons development became probable.
Oct 1939	President Roosevelt appointed an Advisory Committee on Uranium (Briggs Uranium Committee).
Dec 1941	Japan bombed Pearl Harbor / United States entered the war.
Sep 1942	Manhattan Project began development of an atomic bomb
May 1945	May 8th - VE Day / Germany surrendered to Allies.
Jul 1945	United States exploded the first atomic bomb (gun type).
Aug 1945	United States bombed Hiroshima on the Aug 6th and Nagasaki on Aug 9th / Japan surrendered.
Mar 1946	Winston Churchill proclaimed Iron Curtain had come down across Europe.
Jul 1946	Atomic Energy Act was passed, creating the Atomic Energy Commission, which replaced the Manhattan Project.
1949	Soviet Union exploded its first plutonium implosion bomb.
Dec 1949	New process increased production of enriched uranium.
Jan 1950	Truman ordered development of the hydrogen bomb.
1950	◆ McCarthyism began a four-year reign of accusations and suspicion. ◆ Fallout shelters were built as part of a major civil defense program. ◆ June: Outbreak of Korean Conflict. ◆ Development of Redstone Rocket (ground-to-ground ballistic missile for nuclear war) began.
Oct 1952	Great Britain exploded its first atom bomb.
Oct 1952	United States exploded its first hydrogen bomb (thermonuclear bomb).

DATE	DESCRIPTION
1953	The Rosenbergs were executed for acting as spies for the Soviet nuclear weapons program.
Aug 1953	Soviet Union exploded its first prototype hydrogen bomb.
Dec 1953	Oppenheimer lost his security clearance due to hydrogen bomb opposition and 1930s communist connections.
1955	Soviet Union successfully exploded hydrogen bomb detonation
1958	United States' policy of massive retaliation was pursued.
1961	President Kennedy advised United States civilians to build bomb shelters.
1961	Berlin Wall was erected.
1962	Cuban Missile Crisis occurred
1963	United States and the Soviet Union signed the first limited test ban treaty prohibiting underwater, atmospheric, and outer space nuclear weapons tests of atomic weapons

Development of the Atomic Bomb

The development of the atomic bomb was tied directly to World War II and the race between Germany and the United States to develop such a crucial weapon. Many of the physicists working on its development in the United States were émigrés who had fled Nazi Europe and were driven by the desire to create a bomb before the German scientists did. In 1939, uranium fission was discovered, and the United States government was apprised of its military importance through a letter written by physicists Albert Einstein and Leo Szilard (Stein 1984:5). The following year, President Roosevelt established the National Defense Research Committee. This committee supervised a uranium committee, which was working on the development of a nuclear chain reaction using uranium - the first step toward the production of a bomb.

From 1940 to 1942, physicists at various American universities performed experiments with lattice piles of graphite and uranium oxide to see what the "optimum lattice" would be. They were also determining the appropriate amount, shape, and placement of uranium within graphite needed to produce the desired fission. In 1942, these physicists gathered at the University of Chicago Metallurgical Laboratory, under the direction of Dr. Arthur Holly Compton, to work toward producing a chain reaction.

The chief difficulty at the time was in procuring uranium oxide in sufficient quantities and of sufficient purity for the needs of the lattice. The raw material, hundreds of tons of black uranium oxide, was finally bought from the Canadian Radium and Uranium Company, but it was not pure enough for the experiment with fission (Smyth 1945: 45-74); however, Compton knew that uranium could be purified by ether extraction. Remembering his old friend Edward Mallinckrodt's experiments with ether and his company's safety record when working with the volatile material, he asked Mallinckrodt, in April of 1942, to tackle the important and potentially dangerous job of purifying 60 tons of uranium oxide in a matter of months. Mallinckrodt agreed, where owners of other large companies had declined, and he successfully produced the requisite amount of the material necessary for the fission experiment to succeed (Compton 1956: 94-95). Leaving the Mallinckrodt Company as brown dioxide, the material was then shipped to the Westinghouse Company, where it was turned into metal for placement in the lattice (Smyth 1945: 88-94).

The first self-sustaining nuclear chain reaction occurred in a squash court under the West Stands of Stagg Field at the University of Chicago on December 2, 1942. Once it was proved that fission could occur, work to develop the atomic bomb continued under a program called the Manhattan Project.

The first gaseous diffusion plant and nuclear reactor at Oak Ridge, Tennessee, were built in 1942 by the Manhattan District. Oak Ridge served as the field headquarters for the Manhattan Project work to separate uranium 235 and produce plutonium for the atom bomb. In 1943, a second more isolated plant was built at Hanford, Washington, with larger reactors to produce plutonium from uranium for use in the bomb (Hewlett 1962:188-190; Mazuzan 1984:9-10). The same year, an isolated laboratory was established at Los Alamos, New Mexico under the direction of J. Robert Oppenheimer (Smyth 1945: 222). Here, the first atomic bomb was designed, constructed, and demonstrated -- in July 1945 -- exploding at White Sands, New Mexico. This successful test led to the bombing of Hiroshima and Nagasaki, and the end of World War II.

Nuclear Weapon Development - The Manhattan Project

The Manhattan Project, as it became known, was officially started with the creation of the Manhattan Engineering District, as part of the United States Army Corps of Engineers in June 1942. The Manhattan Project was the code name for the United States' top-secret research project, with the goal of creating the world's first weapon powered by nuclear fission. Colonel Leslie R. Groves was appointed District head in September, with the task of ensuring the development of the atom bomb. Colonel Groves quickly appointed a scientific project leader, Robert J. Oppenheimer, to solve the theoretical problems with fission bombs, design the weapon configuration, and fabricate the weapon at what would

become the Los Alamos Laboratory. Groves and Oppenheimer worked closely together throughout the length of the project. Groves was in charge of the project schedule and development, particularly material and land acquisition, and construction of the facilities required to support the scientific endeavor. Oppenheimer was in charge of the scientific discoveries necessary for weapons design.

Los Alamos Laboratory was selected as the site for weapons design in November 1942 and was staffed in March 1943. Research at Los Alamos focused on two designs. One was a gun-type assembly, where criticality would be achieved by forcing together subcritical masses of highly enriched uranium to induce a nuclear reaction. The other design, an implosion-type assembly, relied on the use of a plutonium core, surrounded by a spherical assembly which, when imploded, would initiate a nuclear reaction.

Simultaneously, scientists at Oak Ridge Laboratory (also known as the Clinton Laboratories) and the Hanford site were doing the theoretical research necessary to obtain highly enriched uranium and to develop the reactors to create plutonium. The Hanford Site in Washington state was concerned with plutonium production and separation. At Oak Ridge, reactors were designed and constructed to produce plutonium and process facilities constructed to produce highly enriched uranium.

The level of secrecy maintained in the Manhattan Project proved to be a blessing in disguise. Although it dictated remote site locations, required subterfuge in obtaining labor and supplies, and served as a constant irritant to the academic scientists on the project, it had one overwhelming advantage: secrecy made it possible to make decisions with little regard for normal political considerations. Secrecy in the Manhattan Project was so pervasive that many people working for the organization did not know what they were working on until they heard about the bombing of Hiroshima on the radio. The need for haste clarified priorities and shaped decision-making. Unfinished research on three separate, unproven processes had to be used to freeze design plans for production facilities, even though it was recognized that later findings inevitably would dictate changes. The pilot-plant stage was eliminated entirely, violating all manufacturing practices and leading to intermittent shutdowns and endless troubleshooting during trial runs in the production facilities. The inherent problems of collapsing the stages between laboratory and full production created an emotionally charged atmosphere with alternating optimism and despair. For such a large organization to take laboratory research into design, construction, operation, and product delivery in two and one-half years (1943 to Hiroshima) was be a major industrial achievement.

By May of 1942, the decision was made to not delay production any longer. The decision to proceed with production planning led directly to the involvement of the United States Army, specifically the Corps of Engineers. President Roosevelt had

approved Army involvement on October 9, 1941. The need for security suggested placing the program within one of the armed forces, and construction expertise made the Corps of Engineers the logical choice. With this reorganization in place, the nature of the American atomic bomb effort changed from one dominated by research scientists, to one in which the scientists played a supporting role in the construction enterprise run by the United States Army Corps of Engineers.

By the time President Roosevelt authorized the Manhattan Project on December 28, 1942, work on the East Tennessee site, where the first production facilities were to be built, was already underway. The last quarter of 1942 saw the acquisition of a roughly 90 square mile parcel in the ridges just west of Knoxville (the Oak Ridge Military Reservation). By the end of 1943, three plants were well under construction at the Oak Ridge Reservation: the Y-12 area, housing the electromagnetic plant; the X-10 area, which housed the experimental plutonium pile and separation facilities; and K-25, site of the gaseous diffusion plant. This site, until the end of World War II, was known as the Clinton Engineer Works. Early population estimates for the town and production workers were 13,000 people. By 1943, population estimates for the town had risen to 45,000 people. Oak Ridge was the fifth largest town in Tennessee, and the Clinton Engineer Works was consuming one-seventh of all the power being generated in the nation.

By the end of the war, the United States Army had spent approximately $2.2 billion on production facilities and towns built in the states of Tennessee, New Mexico, and Washington, as well as university laboratories from Columbia to Berkeley. In December 1942, investigations began for a second production site. Approximately 225 square miles were needed for a full-scale plutonium production facility. On February 22, 1943, a temporary office was set up in Hanford, Washington to purchase 144,000 acres in and around the Hanford-Pasco-White Bluffs area.

In 1944, the Manhattan Project ran into difficulties when the gun assembly weapon concept was the only workable design. Because of the difficulties with uranium enrichment facilities, there were no viable production methods. Conversely, production of plutonium was proceeding, but a viable weapon design was lacking. Highly enriched uranium production problems were solved by mid-year. The production of highly enriched uranium increased to the point where output at Oak Ridge went from 40 grams per day in November 1944, to 204 grams per day in January 1945. It was predicted that by July 1, 1945 sufficient uranium (40 kilograms) would be available for bomb production.

In the spring and summer of 1945, several events happened. In April, President Roosevelt died of a brain hemorrhage and the new President, Harry Truman, was briefed

on the Manhattan Project. He had been unaware of the project or of the plans to drop the atom bomb on Japan to end the war in the Pacific. In May 1945, Germany formally surrendered to the Allies. The war in the Pacific was also nearing its end. Although military sources suggested that all the major cities in Japan would be bombed into submission by the end of the year, U.S. military casualties were expected to exceed 500,000 (Groves 1962). President Truman and his military advisors were convinced that if the atom bomb could be used against Japan, it would serve as a diplomatic tool in postwar negotiations with the Soviets. On July 16, 1945, the United States detonated the world's first atomic bomb, a fission weapon, code name "Gadget," at the Trinity Test in New Mexico.

On August 6, 1945, President Truman directed that the Enola Gay, a specially modified B-29 bomber, drop an atomic bomb on Hiroshima, the first use of an atomic weapon in war. This fission bomb released the equivalent of 12,500 tons of TNT. Seven days later, on August 9, 1945, a second atomic bomb (also fission), releasing the equivalent of 22,000 tons of TNT, was dropped on Nagasaki, leading to the unconditional surrender of Japan in August.

The Manhattan Project was unique in that it was a collaboration of university scientists, industrialists, and military engineers. It was supported by a number of facilities devoted to weapons design, atomic research, plutonium production, and enriched uranium production and testing facilities. The Manhattan Project, costing in excess of $25 billion (1995 dollars), was successfully completed in less than three years, an incredible feat considering that properties had to be selected and acquired, research and production facilities designed and constructed, and personnel screened and hired before work could begin.

As shown in "Key Events Associated with Nuclear Weapons Development", although radiation was first discovered in 1896, it was not until the 1930s that a concentrated effort to develop an atomic weapon was initiated. From the discovery of uranium fission in December 1938 by German scientists, it took less than seven years to explode the first atomic bomb at White Sands, New Mexico in 1945.

Key Events Associated with Nuclear Weapons Development

DATE	DESCRIPTION
1896	Discovery of radiation, first evidence of the fundamental structure of matter.
1905	Quantum Theory was developed.

DATE	DESCRIPTION
1932	Leo Szilard conceived of the idea of a chain reaction of neutron collisions with atomic nuclei to release energy and the potential to use this reaction to create a bomb.
1934	Leo Szilard filed patent for atomic bomb – patent described chain reaction and concept of critical mass.
1936	Patent was transferred to British Government for protection under secrecy laws.
Dec 1938	Direct evidence of fission was observed and correctly explained by Otto Hahn.
Jan 1939	Leo Szilard understood the theory in his atomic bomb patent had been realized and the creation of a bomb was possible.
Feb 1939	The different fissionable properties of uranium 235 and 238 were measured (providing crucial insight to development of the bomb).
July 1939	The Graphite-moderated-reactor concept advanced.
Oct 1939	President Roosevelt appointed committee to study military implications of atomic research.
Feb 1941	Plutonium was created.
Sep 1941	Britain began development of atomic bomb.
Dec 1941	United States began work on atomic bomb – predecessor to Manhattan Project
Apr 1942	Design began on world's first human-built nuclear reactor (Fermi).
June 1942	Manhattan Engineer District of United States Army Corps of Engineers is designated. Colonel Leslie Groves appointed District head.
Sep 1942	Colonel Groves took over the Manhattan Project.
Sep 1942	Colonel Groves purchased land for Oak Ridge Reservation.
Oct 1942	Colonel Groves appointed Dr. J. Robert Oppenheimer as head of what would become the Los Alamos Laboratory.
Dec 1942	First self-sustaining nuclear chain reaction occurred (CP-1) under the squash court at Stagg Field (University of Chicago) – reactor contained 36.6 metric tons of uranium oxide, 5.6 metric tons of uranium metal, and 350 metric tons of graphite.
Jan 1943	Hanford Engineer Works was acquired to build plutonium production reactors and separation plants.

DATE	DESCRIPTION
1943	♦ Construction of plutonium plant at Hanford site. ♦ Construction of Uranium Enrichment plants (gas diffusion, electromagnetic) Oak Ridge. ♦ Refinement of gun-assembly weapon design at Los Alamos (high priority). ♦ Preliminary implosion weapon design at Los Alamos (lower priority).
Fall 1943	Project Alberta begins – prepared for actual combat delivery of weapon.
1944	Work proceeded in weapons development, fissile material production, and weapons delivery.
June 1944	Contract for S-50 thermal diffusion producing plant for highly enriched uranium.
July 1944	Fission measurements were too high for a plutonium gun assembly weapon – shifted emphasis to implosion.
July 1944	Los Alamos shifted full priority to implosion research; required all resources.
Aug 1944	Air Force began modification of B-29 bombers for delivery of atomic weapons.
Sep 1944	♦ Total production of enriched uranium was only a few grams. ♦ Only workable bomb design (gun assembly) had no bomb material production method available. ♦ Plutonium production technique had high probability of success, but no weapon design.
Sep 26 1944	B-Pile plutonium reactor at Hanford goes on-line and spontaneously shuts down.
Late 1944 to Early 1945	♦ Highly enriched uranium output at Oak Ridge increased from 40 to 90 to 204 grams per day in November, December, and January, respectively. (July 1st was predicted as date for production of the 40 kilograms sufficient for bomb production.) ♦ Feasibility of implosion bomb design was demonstrated. ♦ Large-scale plutonium production began at Hanford B-Pile reactor.
Feb 1945	Gun design was completed and frozen
Feb 1945	F-reactor went on-line at Hanford – theoretical production up to 21 kilograms per month.

DATE	DESCRIPTION
Mar 1945	◆ Thermal diffusion plant at Oak Ridge began highly enriched uranium production. ◆ Implosion bomb design approached frozen; evidence that the design worked.
May 8 1945	◆ VE Day / Germany surrendered to Allies. ◆ Little Boy was ready except for uranium 235 core / Estimate enough available by August 1st.
Jun 1945	Implosion core design confirmed.
Jul 1945	◆ Casting of uranium 235 projectile for Little Boy was complete. ◆ Gadget (test weapon) was assembled on July 6th. ◆ Little Boy shipped out on July 9th. ◆ Gadget was exploded on July 16th / Explosive yield was 20-22 kilotons of TNT.
Aug 1945	◆ August 9th - Little Boy (gun design) was dropped on Hiroshima. ◆ August 16th - Fat Man (implosion weapon) was dropped on Nagasaki.
Jul 1946	Atomic Energy Act was passed, creating the Atomic Energy Commission; replaced the Manhattan Project.
1949	Soviet Union exploded its first plutonium implosion bomb.
Jan 1950	Truman ordered development of hydrogen bomb.
1951	Construction of the Rocky Flats Plant begins.
Oct 1952	Great Britain exploded its first atom bomb.
Oct 1952	United States exploded its first hydrogen bomb (thermonuclear bomb).
Aug 1953	Soviet Union exploded its first prototype-hydrogen bomb.
Aug 1953	Completion of the initial 21 buildings at Rocky Flats (four production buildings along with guard houses and support buildings).
1953	Production of nuclear triggers at Rocky Flats.
Jan 1954	First nuclear submarine launched with range of 62,500 miles without refueling.
1954	First warhead for missile was built.
1955	Soviet Union exploded its first "successful" hydrogen bomb.

DATE	DESCRIPTION
1957	Britain exploded its first hydrogen bomb.
1960	France exploded its first atom bomb.
1963	United States and the Soviet Union signed the first limited test ban treaty prohibiting underwater, atmospheric, and outer space testing.
1964	Enriched uranium operations (manufacturing and recovery) transferred to Oak Ridge; manufacture of all triggers transferred to Rocky Flats.
1964	China exploded its first atom bomb

The Cold War (1946-89)

The Cold War was the term applied to the competition between the United States and the Soviet Union that developed after the end of World War II and continued until 1990. This period was marked by heightened tensions between communist and capitalist nations. Instability and increased tension across the globe was used to achieve ideological, political, and economic goals, and most importantly, resulted in the massive buildup of nuclear arsenals on both sides of the conflict.

There are many opinions regarding the causes of the Cold War. Some schools of thought attribute the conflict to the American desire for an open-door economic policy around the world. The Cold War was fueled by ideological differences, the capitalist United States wanted equal economic access in the Balkans and a rebuilt capitalist Europe, with an economically healthy Germany to serve as an economic hub. The United States also supported the concept of self-determination to establish independent nations, particularly in Poland. The Soviets had different plans for Europe. They were determined to dominate the Balkans, control Poland (a historic gateway for German invasions of the Soviet Union) and destroy Germany's capacity to start another war. Others cite the Cold War as a justified response by the United States to the threat of Soviet aggression and the communist/Leninist theory of inevitable conflict between communist and capitalist forces. Another school of thought attributes the Cold War to the policy of deterrence, with each side trying to out-threaten the other.

Between 1945 and 1947, Stalin, the Soviet leader, drew what was termed an "iron curtain" across eastern Europe, and sealed East Germany, which had been given to the Soviets as part of war reparations. This "iron curtain" eliminated the pre-war exchange of information enjoyed by scientists and academics; limited diplomatic communication; restricted free trade; and eliminated travel between communist and noncommunist nations.

The competition between the superpowers quickly spread from central and eastern Europe to the Middle East and Asia. Later it spread to emerging nations in Africa and ultimately, to the Western Hemisphere. Between 1945 and the 1960s, the competition involved the governments of Turkey, Iran, Greece, Berlin, Vietnam, Korea, Japan, China, Guatemala, Cuba, Chile, Hungary, Poland, Egypt, Czechoslovakia, and Angola, with the United States and Soviets, each trying to expel the other's influences and maintain control.

After the end of World War II, a number of economic plans and alliances were developed to restore shattered economies, deal with heightened tensions, and respond to perceived adversarial moves. In 1947, the Truman Doctrine was pledged to protect free peoples from the threat of communism, no matter how repressive their governments. By 1948, the United States sponsored the Marshall Plan, an economic package designed to revitalize Western Europe. This was followed in 1949 by the North Atlantic Treaty Organization, an alliance of eleven nations who pledged to help protect each other's borders from communist expansion. The Soviets responded to the Marshall Plan with a program to tie together the economies of eastern Europe by forming the Council for Mutual Economic Assistance; by organizing a blockade of Berlin; and by forming a Sino-Soviet alliance with China.

The Soviets began their own nuclear weapons development program, culminating in the explosion of the first Soviet nuclear weapon in 1949. The arms race officially began with that 1949 detonation. One month after the Soviet nuclear detonation, President Truman ordered work to begin on the development of the fusion bomb, alternately referred to as a hydrogen bomb, H-bomb, or thermonuclear bomb.

As the postwar era entered the 1950s, the conflict spread to other parts of the world. The United States pledged economic and military support to Vietnam and proposed a peace treaty with Japan, which included United States operated military bases. To neutralize United States power in Japan, the Soviets responded by supporting plans by communist North Korea to invade South Korea. Communist China soon joined forces against the United States and South Korea. Fighting eventually stabilized along the 38th parallel. Although a peace treaty was signed in 1953, the conflict between the communist North and capitalist South had not ended nearly 45 years later. In Europe, West Germany was formally admitted to the North Atlantic Treaty Organization in 1952 and rearmed.

The political tensions between the United States and the Soviet Union drove weapons research and development. Since 1948, when United States scientists discovered a way to produce low-yield nuclear warheads in large quantities, the continued threat of Soviet expansion became the reason to produce tactical nuclear weapons in large numbers. At that time, President Truman approved a major expansion of the atomic program with a

corresponding development of smaller bombs and missile warheads for installation in Europe.

In 1953, the Atomic Energy Commission developed a high-yield, lightweight atomic weapon. This "thermonuclear breakthrough" combined with a report that the Soviets were developing long-range ballistic missiles, led President Eisenhower to assign the highest priority to development of an intercontinental ballistic missile that could carry these lightweight weapons. The United States detonated the first fusion, or hydrogen bomb, in 1954. This was exponentially more powerful than the atomic bomb, with the equivalent force of 10 megatons (1,000,000 tons) of TNT.

United States President Dwight Eisenhower, through the Central Intelligence Agency, helped to overthrow governments sympathetic, or feared to be sympathetic to communism. This included Iran in 1953 and Guatemala in 1954. The United States faced down Soviet aggression in the Middle East in 1956, and in West Berlin between 1958 and 1961. American forces were sent into Lebanon in 1958 to maintain its pro-United States stance. Economic aid and military advisors were sent to build an independent South Vietnam.

Meanwhile, the Soviet leader, Nikita Khrushchev, established new relations with India and other key neutral nations, formed an alliance with Cuba after Fidel Castro's communist revolution, and created the Warsaw Pact in 1955 to counter West German admittance to the North Atlantic Treaty Organization and subsequent rearmament. In 1956, the Soviets used the Warsaw Pact to suppress unrest by military force in communist bloc nations of Poland and Hungary protecting them from capitalist influences.

A United States "bomber-gap" panic occurred between 1954 and 1957, based on an erroneous United States Intelligence report that the Soviets had more long-range bombers than the United States. A "missile gap" panic followed during the years 1957 to 1961, caused by the Soviet launches in 1957 of Sputnik, the world's first satellite, and the world's first intercontinental ballistic missile. This perceived technological imbalance between the United States and the Soviet Union, coupled with the Gaither Report (1957, which discredited United States military preparedness and urged a 50 percent increase in military spending) led to a high infusion of money into United States weapons research and development. Between 1958 and 1960, the American nuclear stockpile of weapons tripled.

By 1960, the United States nuclear stockpile consisted of over 18,000 weapons, with a capacity exceeding 20,000 megatons of force. Over 7,000 new weapons were added to the United States stockpile that year. This buildup was in response to the United States'

fear of Soviet nuclear attack, and to that end, in 1961, President Kennedy urged American citizens to build bomb shelters to protect them from a nuclear war. In 1961, the Berlin Wall was constructed, separating Soviet-controlled East Berlin from West Berlin.

As American nuclear superiority grew, the Soviets countered by placing nuclear weapons in Cuba in 1962, resulting in the Cuban Missile Crisis, and pushing the world to the brink of nuclear war. One result of this crisis was the Limited Test Ban Treaty, banning nuclear tests in the air and under water after 1963. Otherwise, the military buildup continued.

Throughout the 1960s, the superpowers vied for control of de-colonized Africa, the Middle East, Asia and Latin America. In 1965, the United States landed troops in the Dominican Republic to prevent the emergence of another hostile communist leader, and the Soviet Union repressed a reform movement in Czechoslovakia in 1968. To prevent the further spread of nuclear weapons technology, the Soviet Union, United States, United Kingdom, and 133 other non-nuclear weapons nations signed the Nuclear Non-Proliferation Treaty.

During the 1970s, both the United States and Soviet Union maintained thousands of nuclear weapons, based on submarines, bombers, and intercontinental ballistic missiles. Both the North Atlantic Treat Organization and Warsaw Pact countries in Europe had small nuclear warheads called "theater weapons," available to be used as part of the Mutually Assured Destruction policy (MAD). Sophisticated weapons of this period included missiles armed with multiple warheads. The final nuclear weapons program at Rocky Flats was the W-88 nuclear warhead for the Trident II missile, designed at the Los Alamos National Laboratory.

The huge military buildup by the Soviets and United States began to take a toll on the economies of both countries. In 1972-73, United States President Richard Nixon signed the Strategic Arms Limitation Treaty (SALT I) with the Soviet Union leader Leonid Brezhnev to limit costly strategic arms and strengthen United States-Soviet economic ties in a period of détente. This period did not last long, as the United States and Soviets competed with each other for influence in outbreaks in the Middle East, Chile, and Angola. Internal United States politics altered the SALT I Treaty during Senate confirmation to the point that it was rejected by Soviet leader Brezhnev in 1975. President Jimmy Carter's SALT II Treaty was undercut by world events, including the Iranian Revolution in 1979, which ended a pro-United States regime, the communist-aided Nicaraguan Revolution, and the Soviet invasion of Afghanistan.

Relations between the United States and Soviets, already on a downward slide, worsened in the 1980s, with United States President Reagan's military increases and policy of confrontation with the Soviets. The combination of increased military spending and economic problems resulted in the United States going from the world's leading creditor nation to the world's leading debtor nation in 1985.

That same year, Mikhail Gorbachev gained power and, faced with a collapsing economy, began making major concessions to the United States in the areas of conventional forces, nuclear weapons, and removal of internal immigration controls. In 1989, the Soviets pulled out of Afghanistan. By 1991, a series of events worldwide, such as the fall of the Berlin Wall in 1989 and the breakup of the Soviet Union with the subsequent dissolution of the Warsaw Pact in 1991, reduced the Cold War threat. In that year, U.S. President George Bush ordered all bombers and tankers to be taken off alert, and the U.S. Department of Defense began to reconsider its needs in terms of the size and nature of its military force. Department of Defense began cutting its military force and cutting back on the production of new weapons.

Repercussions of the Cold War are still being argued; however, there is no doubt that the electronics and information industries are a direct legacy of fifty years of competition with the Soviets. The number of discoveries and technological innovations made as a direct result of the Cold War and the pace of those discoveries is staggering. Advances made in communications, electronics, computers, and other fields have changed the way the world runs.

Cold War Advances in Nuclear Weapons Design

The first nuclear weapons were designed and assembled by scientists in a laboratory at Los Alamos in 1945. After World War II ended, there was pressure for immediate simplification of the assembly process so that specially trained military personnel could assemble atomic bombs. It took several years for this to be achieved. The Mark 4 implosion system, tested in the Spring of 1948, ended the laboratory-style layout of weapons, and opened the way for mass production and use of assembly-line techniques.

In 1951, the basic nuclear weapon design was established in the United States and the subsequent effort was concentrated on making weapons lighter and smaller. In 1952, the United States detonated a thermonuclear, or hydrogen bomb, that had an equivalent force of 10 megatons of TNT. The Soviets detonated their first hydrogen bomb in 1953, followed by Great Britain in 1957 and France in 1960.

Initially, nuclear weapons were bombs, which had to be dropped from aircraft. To deploy a nuclear device, it first had to be taken from a storage facility and loaded onto a

specially modified plane to meet the mission of the moment. Under the policy of massive retaliation in response to Soviet attack, the missiles had to be ready for immediate use. Thus, during the 1950s, the United States began to integrate carriers and warheads, resulting in a specific tailoring of the warhead to the weight and shape characteristics of the missile carrier. A primary consequence of the carrier and warhead integration was that the missile system (missile with nuclear warhead) could be launched from any number of locations within the United States, from aircraft, watercraft, and from within the borders of other nations allied with the United States.

This continuing trend toward military rather than peacetime uses of nuclear energy came about in part because of the change in the political climate from 1945 to 1950. At that time, the stance of the United States toward the Soviet Union, its World War II ally, hardened into enmity, which translated into what became known as the Cold War. Through a series of events in the Soviet Union in 1948-49 -- such as the detonation of its first atomic bomb, its blockade of Berlin, and its growing influence in neighboring China culminating in the Communist takeover -- the United States came to believe that the Soviets were planning both to claim the world for Communism and to eradicate the United States through a surprise nuclear attack (Clarfield and Wiecek 1984:144).

President Truman responded to the Soviet threat with a policy declaration, NSC-68 (National Security Council) in 1950 that committed the United States to the arms race against the Soviet Union. Additionally, Truman approved the production of fusion weapons (i.e., the hydrogen bomb) and other nuclear weapons as the method for deterring Soviet attack. The Atomic Energy Commission was directed to produce "more and bigger bombs," to build reactors to produce plutonium, and to develop uranium and other raw materials (Clarfield and Wiecek 1984:122-34). The outbreak of the Korean War in the same year convinced the United States that the Soviet Union was poised to attack Europe after decoying forces away from Europe to Korea. The United States detonated a hydrogen bomb in 1952 and the Soviet Union did the same in 1953.

The establishment of the Rocky Flats Plant was the result of this post-war fear of the Soviet Union, a fear that drove the federal government to build a vastly expanded nuclear weapons production system. It was one of a number of plants built by the Atomic Energy Commission between 1948 and 1953 to design, manufacture, test, and maintain nuclear weapons for the United States military. It has been estimated that by 1952-53, the height of expansion, the Atomic Energy Commission was employing 150,000 construction workers -- equal to 5 percent of the United States construction work force -- to fabricate its necessary military nuclear facilities (Hewlett 1962:587; Dietz 1962:158).

Between 1950 and 1953, gaseous diffusion plants to extract uranium 235 were built in Paducah, Kentucky and Portsmouth, Ohio. Five heavy water reactors to produce

plutonium and tritium were built at Savannah River, Aiken, South Carolina, and those already in existence at Oak Ridge and Hanford were expanded between 1950 and 1953.

A number of research laboratories were constructed as well to supplement the research being done at Los Alamos Laboratory, including the Mound Laboratory at Miamisburg, Ohio and the Lawrence Livermore National Laboratory in Livermore, California. The Los Alamos Laboratory, taken over from the Manhattan Engineering District in 1946 by the Atomic Energy Commission, continued to conduct nuclear weapons research, development, testing, production, and storage (Dietz 1962: 158-9).

The Nevada Test Site, established in 1951, was the location of a number of field tests of bombs developed at Los Alamos. Originally (1946) the tests took place at Bikini Atoll, and later Eniwetok Atoll in the Marshall Islands. With the announcement in 1949 that the Soviet Union had exploded its own atom bomb and the outbreak of the Korean War in 1950, the United States wanted both to expand its number of tests and find a test site closer than the Pacific Ocean. There were sixteen tests in 1951 alone, twelve at the Nevada Test Site. After the Limited Test Ban Treaty of 1963 that forbade such atmospheric testing, the Nevada Test Site continued with underground test explosions, worked on miniaturizing warheads which made possible development of Multiple Independently Targeted Re-entry Vehicles, used on intercontinental ballistic missiles (Dietz 1962: 163; Kaplan 1982: 68, 96).

Six additional facilities were built to support the nuclear weapons program, including the Sandia Laboratory, The Idaho National Engineering Laboratory, the Mound Plant, the Kansas City Plant, the Pantex Plant, and the Pinellas Plant. In 1946, the Sandia Laboratory, under United States Army control during World War II, became the field headquarters of the United States Defense Atomic Support Agencies. It developed and tested atomic weapons. First under the control of the University of California, it was taken over in 1949 by the Sandia Corporation. The Idaho National Engineering Laboratory at Idaho Falls, Idaho, was established in 1949 as the National Reactor Testing Station, using materials from Oak Ridge, Paducah, Portsmouth, Savannah River, and Hanford in its experimental reactors. The Mound Plant was established at Miamisburg, Ohio in 1948 operated as the Monsanto Company to manufacture explosive detonators for the weapons program. The Kansas City plant was built in 1949 in Kansas City, Missouri, to produce electrical and mechanical components for the weapons program. The Bendix Company operated it. The Pantex Plant, in Amarillo, Texas, had been built in 1942 to build conventional bombs and shells, and was reactivated in 1951 as the site where all the weapons components produced at the other plants were finally assembled into weapons. The Pinellas Plant in Largo, Florida was established in 1957 to manufacture neutron generators (Buffer 1995; *Citizen's Guide to Rocky Flats* 1992).

The Atomic Energy Program

World War II ended with the use of atomic bombs in Japan in August 1945. At that time, the United States was the only country to possess the knowledge of atomic weapons. After the war, the Manhattan Project was terminated, and was eventually replaced with a peace-time program. By July 1946, Congress passed the Atomic Energy Act and appointed the Atomic Energy Commission to oversee the national atomic energy program. Projects associated with the Manhattan Project were not transferred to Atomic Energy Commission control until 1947.

In the first few post-war years, the United States held a monopoly on atomic energy and the production of nuclear weapons. The Atomic Energy Commission was a civilian group that had the directive to develop both military and peacetime uses for the newly discovered nuclear energy. It was to be the owner of existing nuclear facilities and any fissionable material that would be produced in the future. Through the influence of Enrico Fermi, who had worked on the original bomb, the priority concentrated on the development of uranium and other raw materials for weapons production and the manufacture of bombs, rather than for peacetime applications (Clarfield and Wiecek 1984:113, 121).

During the years from 1946 to 1950, Atomic Energy Commission's first mandate was to rehabilitate the wartime plants, find additional sources of uranium and plutonium, continue to carry out scientific research, and create and stockpile atomic weapons. Each year, the President determined the number of bombs to be made as part of the Atomic Energy Commission military program, and the Atomic Energy Commission carried out the President's mandate (Stein 1984:8). At this stage, all nuclear bombs were made at Los Alamos from materials shipped from Hanford or Oak Ridge (*Citizen's Guide to Rocky Flats* 1992).

The Atomic Energy Commission had retained the contractors from the Manhattan Project, and consequently was able to continue working with highly trained civilians after the war (Mazuzan 1984). Mallinckrodt Chemical Works in St. Louis, Missouri was one of the private firms that continued to provide the Atomic Energy Commission with purified uranium for the Hanford reactor. The Atomic Energy Commission built a new plant on the company's property in 1947. Another feed materials production plant was built at Fernald, Ohio in 1952 to augment the supply from Mallinckrodt.

This expanded endeavor to strengthen the weapons production program from the initial procurement of uranium ore through the production of weapons created a system of research, engineering, testing, manufacturing and stockpiling of weapons that was monumental in scope. As a result of testing, the hydrogen bomb was successfully

detonated in 1952 at Eniwetok Atoll, under the code name Operation Ivy, and refined in a series of subsequent tests between 1954 and 1958. After that time, laboratory and test goals were to manufacture smaller warheads that could be used on a variety of delivery vehicles, such as bombers, intercontinental ballistic missiles, and rockets.

The Atomic Energy Commission was tasked with the responsibility of directing the national atomic energy program. The paramount objective of the Commission in the 1940s and 50s was defense and security. Issues that required immediate attention included national security, retention of nuclear facilities and experienced personnel, control of the nuclear material stockpile, dissemination or sharing of information with other nations, establishing the direction of the United States nuclear program, and setting new goals. All requests for fissionable material were funneled through the Atomic Energy Commission and the review committee that was established to aid and advise the commission. Due to the extreme difficulty in creating fissionable materials, and the extremely small national stockpile of nuclear material, potential uses were limited. As military applications had higher immediate priority than non-military applications, the entire nuclear stockpile was dedicated to weapons development.

In the rush to successfully develop and deploy a nuclear weapon, security concerns were not given full scrutiny, and generally considered less important than ability. As the hectic pace of the United States nuclear program slowed, there was time to consider a new, stricter set of security measures, including full background checks for personnel with access to classified information. The Atomic Energy Commission developed a new set of security clearances for nonmilitary personnel. These procedures and security clearances are still in place today. All information associated with the United States nuclear program was classified as secret, and all individuals with access to classified information had to undergo a security clearance review. This lead to development of the "Q clearance" which was required for all non-military personnel with access to nuclear information.

United States Nuclear Energy Program

The Atomic Energy Act was amended in 1954, allowing the Federal government and private industry to promote nuclear power in partnership. Until that time, all nuclear information was in the hands of the government. This new partnership resulted in a shift in emphasis from strictly military applications to allow industrial peacetime uses of nuclear energy.

An energy crisis occurred in the early to mid-1970s, leaving the United States with an inadequate energy supply. The Energy Reorganization Act of 1974 resulted in the creation of the Energy Research and Development Administration and the Nuclear

Regulatory Commission. The Nuclear Regulatory Commission was given the licensing and regulatory functions previously under the Atomic Energy Commission. The Energy Research and Development Administration was tasked with focusing federal programs to promote speedy development of energy technologies. The Energy Research and Development Administration also retained oversight of military applications of nuclear energy. The U.S. Department of Energy (USDOE) replaced the Energy Research and Development Administration in 1977. The USDOE, the 12th cabinet level department, is responsible for the United States Nuclear Weapons Complex.

The USDOE Nuclear Weapons Complex

The nuclear arms race resulted in the development of a vast research, production, and testing network that came to be known as the "Nuclear Weapons Complex." From the Manhattan Project to 1995, the United States spent over 300 billion dollars on nuclear weapons research, production, and testing (in 1995 dollars)(USDOE 1995). During a half century of operations, the complex manufactured tens of thousands warheads and detonated more than one thousand nuclear warheads.

At its peak, the complex consisted of thirteen major facilities, including laboratories, production plants, and testing facilities; and numerous smaller facilities including warehouses, mines, and storage areas. All of the thirteen sites had interrelated functions. The USDOE complex contains four types of facilities: 1) nuclear sites (fabrication and assembly); 2) non-nuclear sites (manufacture of non-nuclear components); 3) laboratories and test sites (research and test support); and 4) weapons assembly and disassembly. The rest of this record describes historical events, construction history, and actions at the Rocky Flats facility.

Rocky Flats Environmental Technology Site

Site Location

In 1950, the Dow Chemical Company in Midland, Michigan was chosen by the Atomic Energy Commission to establish the Rocky Flats Plant (named later for its location) as an alternative fabrication facility for Los Alamos that would manufacture triggers for atomic bombs. F.H. Langell of Dow was placed in charge. Dow in turn chose the Austin Company of Cleveland as the architectural/engineering firm in charge of construction (Buffer 1995). The site of the Rocky Flats Plant, with the code name "Project Apple," was chosen after a lengthy study by the Austin Company, in consultation with the Santa Fe Operations Office of the Atomic Energy Commission at Los Alamos, and the Dow Chemical Company. The criteria for siting such a plant were that it be located west of the Mississippi River, north of Texas, south of the northern border of Colorado, and east of

Utah. Additionally, it required a dry, moderate climate, a supporting population of at least 25,000 people, attractive surroundings for future workers, and accessibility from Los Alamos, Chicago, and St. Louis (The Austin Company 1951).

Twenty-one areas in the United States were suggested initially as potential sites; only Denver satisfied all of Atomic Energy Commission's criteria. An added bonus was that a number of the workers at the Los Alamos facility came from Denver, and it was assumed that these people would be willing to relocate to the new facility. Within the Denver area itself, seven locations were screened for the additional requirement that the site be isolated from residential areas and close to the airport. Two sites, an area north of the Rocky Mountain arsenal and the Rocky Flats site were chosen. The site near the Arsenal was discarded because of its light soil that would blow in a windstorm and because the Atomic Energy Commission facility would have to share a electric power transmission line with the Arsenal (History Associates Incorporated 1987:67-69).

In 1975, a state task force appointed to study the Rocky Flats Plant concluded that the siting of the plant, with its vast amount of plutonium and potential for nuclear accidents, so close to the metropolitan area of Denver, had been a mistake. A 1988 report submitted to Congress indicated that the plant's facilities were aging, waste storage and cleanup were major problems, and the public was opposed to the siting. The following year, the Federal Bureau of Investigation investigated the Plant for alleged environmental infractions, charges that were later proved unfounded by a Grand Jury (Kennedy 1994:29-30; *The Paper* 1 October 1993).

These allegations were quite a change from Denver's initial enthusiastic reception of the site in 1951, when a Good Friday issue of *The Denver Post*, under the headline "There's Good News Today" announced the Atomic Energy Commission's plans to build the Rocky Flats Plant. Citizens, as well as the Boulder Mayor, the Chamber of Commerce President, the University of Colorado President, and both Colorado Senators, expressed great pride in the choice of the Denver-Boulder area as the site for an atomic plant. Their patriotic sentiments were expressed well in the *Rocky Mountain News*: "We are proud that the area has been chosen for another important contribution to the nation's strength and future security" (Kennedy 1994:11-12).

The original layout of the site was based on what the United States thought the enemy's (Soviet Union) weapons capabilities were at the time. Buildings had to withstand a specific magnitude of a blast at a certain distance from the site. To achieve this, the first production buildings were sunk in the ground so that the shock of a blast would then pass over the tops of the buildings. By 1957, when additional production buildings were constructed, it was recognized that with the enemy's weapons being more accurate and

larger, the Soviet Union had the capability to destroy an underground building. After that point, the remaining buildings were built above ground (Calkins, 1998 interview).

Mission of the Plant

The Rocky Flats Plant was established in 1951 to manufacture triggers for use in nuclear weapons and to purify plutonium recovered from retired weapons (called site returns). During the 1950s, the desire was to get Los Alamos out of weapons production and back into design. However, national policy at the time required that in the event of a labor strike or a nuclear attack by the Soviet Union, all critical elements of weapons production could be duplicated at another facility (Calkins, 1998 interview). Los Alamos National Laboratory retained capabilities for trigger production, although the majority of the triggers in the nuclear weapons stockpile were manufactured at Rocky Flats.

For nuclear explosion to occur, the fissile material in a trigger created a first stage fission reaction, which would ignite a second stage reaction causing fusion of hydrogen into helium. The second stage reaction created the nuclear explosion. The trigger contained the majority of the fissile material in a nuclear weapon. Parts were formed from plutonium, uranium, beryllium, stainless steel, and other materials. From 1953 until 1992, the mission of the Rocky Flats Plant was the production of nuclear weapons components. The Rocky Flats Plant also disassembled retired weapons to recover plutonium for reuse in weapons production.

Selection of a weapons program involved a number of critical phases that determined what facility or plant would receive additional or new contracts. In general, there are seven basic phases that are considered part of the weapons program development. These phases are:

- Phase 1 Conception
  The military would decide it needed a new weapon to perform a specific task. The military would meet with the design labs at Los Alamos or Lawrence Livermore; parameters of the weapons would be determined.
- Phase 2 Feasibility studies
  Department of Defense and USDOE would prepare an agreement for development and procurement responsibilities.
- Phase 3 Development Engineering (prototype study)
  A development program, based upon required military characteristics, would be undertaken. A complete design would be developed.
- Phase 4 First Production

The military would select one agency (Department of Defense, USDOE, sometimes both) to further design and in many cases, a test unit would be built. The majority of the test units were built at Rocky Flats.

- Phase 5 Preliminary production
  Selection of a lab and production facility and an assembly facility to produce the weapon. Under the dual capability policy, there were two design labs, two production facilities for each component, and two assembly points (Pantex and Burlington, Iowa).
- Phase 6 Quantity Production and Stockpile Maintenance
  Full-scale production would commence and weapons would be stockpiled.
- Phase 7 Retirement and disassembly .

The number of programs going on at an individual plant varied to a maximum of ten to twelve. Eight programs were considered the norm (Calkins, 1998 interview). There were many variables from one weapons design to another, with changes ranging from minor modifications to major advances in sophistication, tolerances, and production techniques.

Depending on specific time periods, mission statements for Rocky Flats have included:

- Developing and producing nuclear weapons components from plutonium alloys, beryllium, stainless steel, and depleted uranium;
- Recovery and reprocessing of plutonium from site returns (retired weapons),and from by-product residues from manufacturing and recovery operations;
- Fulfilling USDOE/Department of Defense new deployment and testing requirements-supporting design agency development and testing for Nevada Test Site triggers, non-nuclear hardware, and other production agency development;
- Conducting in-house technology and process development;
- Providing weapons trainers (training modules) and mockups;
- Disassembly and evaluating triggers from stockpiles;
- Providing reliability evaluation programs; and
- Fabrication and modification tractors and trailers for safe secure transport.

While specific periods of expansion at the Rocky Flats Plant (1956-57 and 1964-65) cannot be attributed to specific political and military actions, the Plant's overall growth can be seen in the context of the huge expansion of military weapons during the 1950s and 1960s, when the United States and the Soviet Union became locked in an arms race. After the fall of the Berlin Wall (1989), the breakup of the Soviet Union, and the dissolution of the Warsaw Pact (1991), the threat of the Cold War was significantly reduced.

Significance

Under the National Register of Historic Places, the Rocky Flats Plant was considered exceptionally significant under Criterion A at the national level under the Cold War military theme: Development of Atomic Weapons for Military Purposes. Its period of significance dates from its inception in 1951 to its mission change in 1992 as the Cold War ended. The Plant's particular significance came from being the sole producer of triggers of nuclear weapons from 1964 to 1992.

Of the buildings at the site, sixty-four structures are considered directly related to the mission of the Plant and are considered contributing properties to the Rocky Flats Plant historic district. Buildings central to the Plant's mission include:

- Production Work: Buildings 371, 444, 460, 701, 707, 771, 776/777, 881, 883, 991, 996, 997, 998, 999;
- Research and Development: Buildings 125, 126, 559, 779, 865;
- Worker Safety/Health: 112, 114, 122, 123, 331, 442, 778, 886;
- Security: 100, 111, 113, 120, 121, 133, 372, 372A, 375, 440, 446, 461, 550, 557, 761, 762, 762A, 764, 773, 792, 792A, 864, 888, 900, 901, 920, 992;
- Administration: 441;
- Infrastructure: 124, 215A, 443, 551, 995;
- Maintenance: 333, 334; and
- Production Waste Treatment: 374, 774.

The original configuration of administration, maintenance, infrastructure, and waste treatment buildings (built between 1951 and 1953) controlled the original layout of the site. These buildings were necessary for both Plant function and in meeting the needs of employees in a remote and secured work place. The remaining administration, office, maintenance, infrastructure, waste treatment, and storage buildings were built to accommodate an increase in production and site population. These structures supported redundant rather than new, functions at the site. Temporary structures (mostly trailers) and various storage structures and tents provided additional space for a variety of technical and administrative tasks. Structures built after 1989, when production ceased, were considered non-contributing elements to the overall historical significance of the Plant.

Plant Site Overview

The Rocky Flats Plant Site

The total Plant site consisted of 6,500 acres in northern Jefferson County, Colorado, approximately sixteen miles northwest of Denver and twelve miles from Boulder and Golden. It was situated on a plateau at the eastern edge of the Front Range of the Rocky Mountains. The site was divided into three geographic areas, each fenced and protected by security forces. The industrial area, 384 acres, was located in the center of the Plant site. There were 436 structures that included approximately 150 permanent buildings and ninety temporary trailers, plus temporary structures, sheds, tanks, or parts of larger buildings. Most of the structures were industrial in design, constructed out of concrete, concrete block, or corrugated metal. The protected area was located within the northern portion of the industrial area and contained a complex of plutonium production facilities. This area was heavily fenced and guarded. The buffer zone, the remaining 6,116 acres, surrounded the industrial area and protected the site from potential encroachment. The Rocky Flats Plant historic district consists of sixty-four contributing resources dating from 1951 to 1989 within the industrial area of the nuclear weapons production plant.

The Plant was a self-contained concentration of industrial buildings surrounded by ranch land, preserved open space, mining areas, and a low-density residential area. The original site was 1,900 acres and an additional 4,600 acres was purchased in 1972. The initial 4-square mile acreage required for the Rocky Flats Plant was acquired through condemnation when negotiations over price with the three owners of the land, G.W. Lindsay, Katherine B. Church, and Frank A. Rodgers, failed to be concluded satisfactorily ("Chronology of Rocky Flats Plant", n.d.). In 1995, 234 acres, the wind site (located in the northwest corner of the site) were transferred to the USDOE, Golden Field Office.

Plant Organization

Operations of the Rocky Flats Plant fell under the administration of the United States Atomic Energy Commission from 1951 until the Atomic Energy Commission was dissolved in January 1975. Responsibility for the Plant was then transferred to the Energy Research and Development Administration, which was succeeded in 1977 by the United States Department of Energy (USDOE).

The primary role of the USDOE was to provide the contractor with the parameters for operating the Plant, and to manage the operations contract. Dow Chemical Company, USA (Dow) was the prime operating contractor of the facility from 1951 until 1975. Rockwell International (Rockwell) succeeded Dow from 1975 through 1989. EG&G

assumed operations on January 1, 1990 after the Plant had ceased producing nuclear weapons components, although non-nuclear production continued for another two years. By 1993, the Plant had transitioned to a cleanup mission. Kaiser-Hill Company assumed operations in 1995.

In 1951, the Atomic Energy Commission assigned Rocky Flats two main weapons-production missions: the fabrication of nuclear weapons components (specifically plutonium triggers) and disassembly of obsolete weapons returned to the site (site returns) to recover and reuse valuable plutonium and uranium. Recycling operations were conducted to recover plutonium and enriched uranium from processing scraps and residues. Support programs associated with previous operations included waste handling and storage, special nuclear materials (fissile materials) accounting, laboratories, tool manufacturing, research and development, and providing utilities and maintenance facilities. Research programs pursued the development of improved methods and techniques in both fabrication and chemical processing.

Activities at the Rocky Flats Plant concerned Phases 4 through 7 of the weapons program development (production engineering, first production, quantity production and stockpile, maintenance, and retirement and dismantlement), with particular emphasis on start-up and quantity production. Rocky Flats produced most of the plutonium triggers used in nuclear weapons from 1953 until 1989.

The Plant also manufactured components for other portions of the weapons since it had the facilities, equipment, and expertise required for handling the materials involved. A component is a single part of a weapon, which is joined with other components to form a subassembly or an assembly, or larger pieces of a weapon. Assemblies are then joined with other components and assemblies to form a complete weapon. Assemblies and components are specifically created for one of several weapons programs. A code number such as W76 or W88 identifies each program.

The Original Plant Construction 1951 - 1953

Austin Company began construction at the Plant in 1951. Mr. D.W. Persons, the Atomic Energy Commission Project Engineer assigned to the plant, established a temporary office in a garage in Denver, to which personnel from the Austin Company moved as well. A temporary guard shack on the Rocky Flats property was constructed in 1951 along Highway 93. Building 91 (later changed to 991) was the first permanent building, followed by a temporary administration building. Buildings 71 (771), 44 (444) and 81 (881) followed. In 1952, Buildings 11 (111), 12 (112), 21 (121), 22 (122), 23 (123) and 42 (442) were constructed. At the end of the year, Buildings 111, 112, 122, 331, 334, 344, 551, 661, and 771 were occupied. The total cost by 1952 for construction was

$2,500,000. In 1952, a railroad spur from the Denver and Rio Grande railroad, an access road, power lines, and telephone lines were built. At this time, Gilbert Hoover replaced D.W. Persons as Field Manager of Rocky Flats (Buffer 1995).

By September 1953, the Austin Company's construction was finished, for a total cost of approximately $43 million, and there were twenty-one permanent buildings on site. By November, there were 1,200 employees (Buffer 1995). The Plant was composed of four widely separated areas, each one performing a different type of work. Plant A (444) fabricated parts from depleted uranium. Plant B (881) recovered enriched uranium and fabricated parts from it. Plant C (771) contained the plutonium operations, and Plant D (991) was the assembly and shipping point (ChemRisk 1992:51). Those facilities handling the more highly radioactive plutonium were located on the north side of Central Avenue at a distance from the other buildings on site. Facilities handling the less radioactive enriched uranium and depleted uranium were located on the south side of Central Avenue and some distance from it. The support buildings were located along Central Avenue closest to Plant A, the least radioactive facility of the production buildings. The main administration area was referred to as the "Lump Sum Area" (Calkins, 1998 interview).

The completed plant in 1953 contained the four production buildings with their guard houses, and a number of support buildings including an administration building (111), cafeteria (112), plant safety building (121), medical emergency building (122), paper shredder shed (122S), health physics building (123), hazardous storage shed (123S), garage and fire station (331), paint and blast shop (333), maintenance shop (334), production support building (441), laundry (442), heating plant (443), warehouse (551), sealed gas storage building (552), metal fabrication building (553), storage building (554), waste storage and emergency breathing air building (714), temporary electric shop (772), waste treatment plant (774), sewage treatment plant (887), and a waste water treatment plant (995). Originally each production plant had its own cafeteria; Building 112 was used by those employed in the administrative section of the Plant.

Access to the Plant was from the west on a very rough dirt road that eventually became Highway 93. Initially employees drove the route in their own cars, but soon discovered that the wear and tear on their vehicles was so bad that it was better to ride the bus. The Denver-Boulder Bus Company established an additional route between Golden and Boulder to serve plant commuters, and termed it the "atomic plant route" (Kennedy 1994:13). There were other hardships concerning employee vehicles on site. Personal cars were only allowed to travel as far as perimeter parking. Employees were then bused to the Plant buildings. The high winds blew gravel from the parking lots onto the cars, removing the paint. The wind was often so strong, particularly when there were few

buildings on site, that employees held hands, forming a chain to avoid being blown over. To everyone's relief, a new oiled State Highway 93 was built in 1954 (Buffer 1995).

History of Operations

1953-55

The original two trigger designs at the Plant were modeled on the designs of the bombs that were dropped on Hiroshima (Little Boy) and Nagasaki (Fat Man), both involving solid cores of fissile materials. The Little Boy design contained two solid masses of uranium at opposite ends of a tube that were forced together by an explosion to achieve criticality. The Fat Man design had a small plutonium core surrounded by a large amount of enriched uranium and then by explosives. The detonated explosives caused the uranium and plutonium to implode to a reduced volume to cause criticality. These initial-generation trigger designs made use of enriched uranium, depleted uranium, some plutonium, and beryllium. Triggers were fabricated and assembled in the 1950s in the original four Rocky Flats Plants A, B, C, and D (ChemRisk 1992; R. Dickey, personal communication, 1995).

Enriched uranium, the largest component of the trigger, was supplied by the Oak Ridge Reservation's Y-12 plant as hockey puck-shaped buttons. The buttons were cast, shaped and formed, machined, inspected, and assembled into component parts for the triggers at Plant B (Building 881). Enriched uranium recovery and purification of the waste from manufacturing these triggers also took place in Plant B. Floors in the chemical salvage area and a machining room were covered with stainless steel sheets to make cleaning easier. A large part of the early work at the Plant took place in this building, since the triggers required large amounts of enriched uranium (ChemRisk 1992).

Depleted uranium was cast and machined in Plant A, Building 444. The material was shipped to the Plant originally shaped as the crown of a derby hat from Paducah, Kentucky, and later as ingots from the Feed Materials Production Center in Fernald, Ohio. The material was cast in the foundry close to the final product form (in near-net shapes), machined into finished parts, and then inspected. These components were then sent to the Pantex Plant in Texas for assembly (ChemRisk 1992:76). Some beryllium was also processed in Building 444, but as part of research and development for production engineering and weapons development, rather than as part of the regular manufacturing process. Like the depleted uranium, it was cast in the foundry into shapes that were then machined (ChemRisk 1992:74).

Plant C, Building 771, housed all of the plutonium processes, including casting buttons of plutonium metal feed stock; fabrication of component parts from the buttons; coating,

inspection, testing, and storage of weapons components; and the recovery of plutonium from wastes created during this manufacturing process. The plutonium was created in reactors at Hanford, Washington; Savannah River, South Carolina; and sometimes from Oak Ridge, Tennessee. It came to the Plant in the form of either plutonium nitrate liquid or as buttons.

Trigger components manufactured in Plants A, B, and C, as well as those manufactured at Oak Ridge, were sent to Plant D for assembly and storage. They were then shipped off site to the Pantex Plant in Amarillo, Texas for final assembly into the atomic weapon.

1956-63

In 1956, a design change was made in the triggers, from a solid, mostly uranium core to a hollow, mostly plutonium core that was lighter than the previous units and could be made smaller. The plutonium buttons were machined into hollow hemispheres that were then joined. This hollow design required a great deal more machining than the previous designs. The same materials were used but in a different ratio and form (ChemRisk 1992:45-7). Such a change required the construction of a number of new buildings and a change in the uses of existing buildings. An estimated $21 million was spent on the expansion, called Part IV, and the Plant nearly doubled in size by 1962 (Buffer 1995). A number of new buildings, including Buildings 701, 776/777, 883, 999, 114, and 778 were built, as well as additions to Buildings 444, 881, and 771. Further additions to the Plant were continuous, with several buildings added each year.

With a greater use of plutonium required, the facilities in Building 771 were no longer adequate, and a plutonium fabrication and foundry building, 776/777, was constructed in 1956-57. Plutonium recovery operations remained in Building 771. Casting took place in the 776 side of Building 776/777. Rolling, forming, and machining operations were located in the eastern side of 776. Inspection, assembly, and storage was conducted in the 777 section of Building 776/777 (EG&G 1994:1-4; 9-2). Because the trigger was more complex, it was assembled in Building 776/777 rather than at Building 991. After assembly, the units were packed and shipped off site or sent to Building 991 for staging prior to shipping (EG&G 1994:9-7).

The new trigger design called for the rolling and forming of both enriched and depleted uranium as well. Building 883 was constructed in 1957 adjacent to Building 881 for rolling and forming uranium. Depleted uranium was cast into ingots in Building 444, sent to Side A of Building 883 for rolling and forming, and then returned to Building 444 for machining and inspection. After 1958, depleted uranium was fabricated on site from billets imported from Ohio. Enriched uranium was cast in Building 881 (enlarged for manufacturing in 1956), sent to Side B of Building 883 for rolling and forming, and

returned to Building 881 for machining and inspection. A reinforced concrete tunnel was constructed in 1957 to transport enriched uranium between the two buildings (EG&G 1992, 1994).

Building 447 was added to the southwest corner of Building 444 in 1956 to house equipment to anneal depleted uranium parts, assemble parts from Building 444, and to process wastes. Building 445 was added to the east side of 444 in 1957 to house the carbon shop that supplied graphite molds and crucibles to the foundries in Buildings 444 and 776. Building 448 was added to the north side of Building 447 in 1962 to house production control offices. Building 451 housed the exhaust filter plenum and exhaust fans for Buildings 447 and 448 (EG&G 1992, 1994).

The design change for triggers also meant that beryllium would be used to a greater extent than in the past. Beryllium was used as a neutron reflector within the weapon. In 1958, when beryllium operations became a standard part of Plant operations, beryllium blanks were provided by an outside source and were milled, turned, drilled, and polished in Building 444 (ChemRisk 1992:75). The trigger design remained roughly the same from 1958 to 1989, when the Plant ceased operations, with changes only in materials, quantities of materials, and dimensions.

After 1957, the primary mission of Building 991 shifted to shipping, receiving, and storage. Materials handled included special nuclear materials, classified materials, and other metal components. Most shipments were sent by rail until the mid-1970s, when specially designed tractor trailers (safe secure transports) were used. The safe secure transports were used for shipment of the final product by roadway. The underground storage vaults near Building 991 (996, 997, 998) were used to store retired weapons, sent by Pantex for recovery of plutonium and uranium, until they were taken to the 700-area buildings for recovery operations. Another vault, Building 999, was added to the existing three in 1956. Incoming materials were generally not unpacked in Building 991.

1964-89

The next large-scale change to the Plant came in the 1960s when the Atomic Energy Commission chose to make Rocky Flats the sole producer of triggers under the "single mission" concept. Previously a number of the nuclear weapons facilities had overlapping functions to provide redundancy in case of enemy attack or a labor strike. Hanford was manufacturing similar plutonium units and Oak Ridge similar enriched uranium components to those at the Rocky Flats Plant. Los Alamos also produced triggers on a small scale. Under the new arrangement, developed for economic reasons, each facility was to provide separate weapons components. As a result, the enriched uranium operations, including both manufacturing and recovery work, were transferred to Oak

Ridge in 1964, and the trigger manufacturing was given solely to Rocky Flats. Production at the Plant increased dramatically.

Plutonium fabrication continued at an expanded level with production continuing in Building 776/777. By 1967, construction had begun on a new plutonium facility, Building 707, to augment operations at Building 776/777. By 1969, Building 707, a state-of-the-art facility, was finished. It was divided into eight modules, separated to minimize potential fire damage, each for a different operation (EG&G 1992). A major fire in Building 776/777 in 1969 necessitated the relocation of some of its foundry, fabrication, and final assembly operations into the new Building 707. Building 707A was built in 1971 to handle these extra operations (EG&G 1994:7-1). Final assembly operations remained in Building 707 until the Plant ceased operation (ChemRisk 1992:79-80). Building 776/777 was cleaned, and used for machining, plutonium recovery, waste-related operations, disassembly and assembly, and testing operations. Much of the work became special-order or research and development operations (EG&G 1994:9-9).

Building 771 was expanded in 1963-64 (771A), in 1967 (771B), and in 1971 (771C) to handle increased recovery operations. Building 774 continued to be used as a waste treatment facility. By 1968, new technologies had been developed for plutonium recovery from solid and liquid waste. A new recovery building, 371 was built based on more stringent Atomic Energy Commission standards than had been in use when 771 was constructed. However, it suffered from various design problems that prevented its opening until 1981 and caused termination of recovery operations in 1986. It never did become a fully operational recovery facility, and as a result, Building 771, planned to be closed in anticipation of the use of Building 371, remained in operation. Buildings 707, 771, and 776/777 remained as plutonium production buildings until 1989 when production ceased.

Finished triggers were taken from the 700-area buildings by truck under armed guard to a small shed near Building 551, where they were staged under guard for placement on specially configured atomic material transport railcars. Spur lines from the railroad came onto the Plant site from the southwest and curved up to run along the west side of Building 551. Building 440 was constructed in 1971 to modify standard freight cars for shipment of the triggers to the Pantex Plant in Texas, as well as waste materials to Nevada. Later the building was also used to modify standard tractor trailers into safe secure transport for shipping the triggers, making them tamper-proof. These unmarked safe secure transports were escorted by unmarked trucks and cars and drove the triggers to the Pantex Plant (SAIC, 1995). Building 991 provided a shipping and storage area.

When enriched uranium operations were transferred to Oak Ridge between 1964-66, Building 881 was shut down and decontaminated (ChemRisk 1992:73). Side B of Building 883, formerly used for enriched uranium, was then used for beryllium rolling and forming (EG&G 1992). In 1966, stainless steel operations were transferred from a vendor in Albuquerque, New Mexico and were located in Building 881. Stainless steel processing was done in Buildings 881 and 444 until Building 460 was constructed in 1984 specifically for all non-nuclear manufacturing. All stainless steel processing was consolidated in Building 460.

Over the years, since the addition of new fabrication and tooling in 1958 for hollow triggers, the manufacturing facilities and production processes did not change much, although they did move from building to building. The majority of the Plant expansion was driven by changes in weapons design, higher safety standards, and expansion of production (ChemRisk 1992).

Transport of special nuclear materials was moved out of Building 991 between 1975 and 1976. During this time period, shipping occurred from Building 439/440. Because of security concerns, shipping was moved back to Building 991 after 1996. Incoming materials were generally not unpacked in Building 991. Site returns (retired weapons), however, were unpacked, tested, re-packaged, and shipped to Building 776/777 for disassembly. Other materials packaged and shipped included non-radioactive raw materials, partially finished products, purchase order items, non design agency special-order items, samples, instruments, and documents.

1989-92

Through the 1950s and 1960s, employees were treated respectfully by most of the public. The public knew little about the work at the Plant, other than it was for military purposes. The public did know that in order to work at Rocky Flats, an employee had to undergo an intensive background search by the Federal Bureau of Investigations (FBI), and that employees were working for the security and freedom of the nation (Tesitor, 1998 interview). Public opinion of the Rocky Flats Plant began to change in 1969. Anti-nuclear, pro-environmental demonstrations, organized by Citizens Concerned about Radiation Pollution, began at the Plant after the 1969 fire in Building 776/777,

A strike between Dow and its union in 1970 was a harsh struggle. The public was led to believe that by Dow continuing operations during the strike, the City of Denver could be placed in danger. These allegations brought the Plant further into the public eye (Tesitor, 1998 interview). Activities associated with the strike, along with public dissent regarding the Vietnam War, began to alter the public's perception of and opinions regarding the Plant.

In 1975, a state task force appointed to study the Plant concluded that the siting of the Plant, with its inventory of plutonium and potential for nuclear accidents so close to the metropolitan area of Denver, had been a mistake. In the ensuing years, Jefferson County's Health Department Director, Dr. Carl J. Johnson, published reports allegedly linking plutonium contamination from the Plant to cancer and infant mortality. The first large protest at the Plant came in 1978, and included well-known activists Daniel Ellsberg and Allen Ginsberg. It was the first major protest at any USDOE plant. In 1983, protestors made an attempt to encircle the Plant, drawing thousands of people to the site. Over the years, some 1,500 protester arrests were made.

The Rocky Flats Plant was one of the most protested sites within the USDOE nuclear weapons complex. Plutonium was believed to be one of the most hazardous substances in existence, and other facilities did not have plutonium in the quantities that Rocky Flats had. In cases where towns grew up around facilities like Hanford, Savannah River, and Pantex, the citizens were reliant on these Plants for their livelihood, and were sympathetic to them (Wilson, 1998 interview). In response to continuing protests, particularly a 1979 anti-nuclear rally that drew 10,000 participants, Rockwell employees at the Plant formed a grassroots organization, Citizens for Energy and Freedom, and organized a pro-nuclear rally, "Power for the People," that attracted 16,000 people (The Paper).

Many employees felt that the protesters were well intentioned, but misinformed. The employees felt strongly that the world would be worse off without their efforts. They found the protesters' conclusions to be erroneous. For example, the number of weapons in the stockpile were believed by the protesters to be the entire number of weapons ever produced, and did not take into account all the weapons that were retired and dissassembled (Rothe, 1997 interview). Some employees came to despise the protesters, believing that to assist the enemy in United States disarmament was treason and if the communists took over the United States, 60 to 70 million people would die in the purges that would certainly follow (Thompson, 1998 interview). *The Komitet Gosudarstvennoi Bezopasnosti* (KGB, Committee for State Security;), through a worldwide pro-socialist organization called the World Peace Council was funding a number of anti-nuclear protests, marches, and demonstrations around the country (Tesitor, 1998 interview).

Workers were proud of their national contribution, and were motivated through production goals and quality of work. The protests did not affect the workers' morale or the idea that their work was a necessity. The employees did not believe that if the United States threw away their weapons, the rest of the world would also do so (Hoffman, 1998 interview). During the Carter Administration (1976), President Carter believed that if the United States took the first steps to stop nuclear weapons production, so would the

Soviets. The Soviet stockpile increased dramatically during this time (Tesitor, 1998 interview).

In the early 1980s, the USDOE Albuquerque Field Office, then in charge of Rocky Flats, began a study of what Rocky Flats should look like in the year 2010. A 1988 report submitted to Congress indicated that the Plant's facilities were aging, waste storage and clean up was a major problem, and the public was opposed to the siting.

The Resource, Conservation, and Recovery Act (RCRA), regulating all aspects of the management of hazardous waste became law in October of 1976. The RCRA made it illegal to improperly dispose of and handle hazardous waste. A conflict over hazardous waste jurisdiction at the Plant between the United States Environmental Protection Agency (USEPA) and USDOE ensued. In 1987-88, the courts confirmed that the USEPA had jurisdiction. The USEPA did not have access to the Plant and was convinced of wrongdoing by the USDOE.

During a routine inventory shutdown in December of 1988, glove boxes in Building 771 were cleaned with high temperature steam. The heat from this operation exited the building through the exhaust stack and a passing aircraft registered the hot spot on film. Believing that the incinerator was illegally being used during the scheduled shutdown, the USEPA used this opportunity to convince agents from the FBI to issue a warrant to enter the Rocky Flats Plant and investigate the allegation. Although the allegation proved false, the investigation did uncover safety concerns at the Plant and ultimately led to the curtailment of plutonium operations at the Rocky Flats Plant in 1989.

The Plant contractor, Rockwell, was unable to comply both with their USDOE contract and the requirements of the RCRA and sued USDOE for statutory relief and release from liability. Rockwell stepped down as the contractor; EG&G was brought in to take over as operator of the site. The Plant remained closed for an extended period to allow the new operator to address the safety concerns (Buffer 1995). In 1989, the Plant was added to the National Priorities List of contaminated sites to be remediated under the government's Superfund program (*The Paper* 6 August, 1993).

Some Plant employees believed that neither the protests nor the FBI raid caused the ultimate shutdown of the Plant. The protests did let the government know of the public's feelings toward nuclear weapons, and that Americans were no longer proud of its nuclear heritage. The late 1980s and early 1990s were a time of transition. The USDOE was considering consolidation of the Weapons Complex (Stakebake, 1998 interview). The Plant buildings were old and potentially a hazard. To keep the Plant operating would have required extensive remodeling and additional funding. Even though weapons programs were scheduled into the mid- to late-1990s, the United States was entering into

treaties with the Soviets, and many programs were zeroed-out for funding (Wilson, 1998 interview). The government was considering whether the capabilities were still needed (Stakebake, 1998 interview).

Non-nuclear production could have continued indefinitely at Rocky Flats; however, the local government and public no longer supported the Plant. The last program, stainless steel operations, was transferred to Kansas City in 1995. The employees felt that the Secretary of Energy (Admiral Watkins) abandoned the Plant due to the strong opposition (Tesitor, 1998 interview). Some plant employees believed that the protesters were successful in the complete closure of the site.

Significant changes occurred at the site after the 1989 FBI investigation. Many outsiders were brought in to correct perceived safety problems. They expected to find a centralized chain of command, however, there was no designated individual responsible for operations as a whole. Each separate process was operated independently of the others. Management of the Plant relied on process knowledge for day-to-day operations, rather than written procedures. (Meyers, 1998 interview). A new cultural outlook and way of doing business was introduced, drastically changing the Plant operations and creating a tough transition period. With these changes, Secretary Watkins brought in a new system, which relied on written procedures and conduct-of-operations to document how work was to be conducted.

The Plant focused its activities for the next 2 or 3 years upon resumption of operations to bring the Plant up to present safety and operational standards and get back into production. Building 707 was the primary focus of the resumption efforts, so that the Plant could continue the W88 weapons program production (Wilson, 1998 interview). Buildings 701 and 559 were ready to resume production. The resumption plan caused the biggest turmoil the Plant had ever faced because it was forward looking, but no one knew where it was going (Cunningham, 1998 interview). Contractors were brought in, mobile trailers set up, numerous procedures were written, and building drawings were redlined to show all the changes and modifications that had occurred over the years of intense production. The efforts were all to no avail, and in 1992 the Plant terminated nuclear production for good (Riddle, 1997 interview).

By 1991, a series of events worldwide, such as the fall of the Berlin Wall in 1989 and the breakup of the Soviet Union with the subsequent dissolution of the Warsaw Pact in 1991, reduced the Cold War threat and the need for a plutonium trigger manufacturing facility. In that year, United States President George Bush ordered all bombers and tankers to be taken off alert, and the Department of Defense began to reconsider its needs in terms of the size and nature of its military force. As a result of this reconsideration, the Department of Defense began cutting its military forces and cutting back on the

production of new weapons. That same year President Bush also announced the cancellation of several nuclear weapons programs, including those that would provide Rocky Flats with future work. In 1992, President Bush also canceled the production of the Trident II missile and its warhead (the W-88), the weapon that was the primary production program at Rocky Flats at the time. Subsequently, Secretary Watkins publicly announced that the mission at the Plant would be changed to environmental restoration and waste management, with the goal of cleaning up and converting the plant for new uses.

Manufacturing History

Plutonium Operations

Plutonium was used to create the first-stage fission reaction (the trigger) which set off the second-stage reaction (the nuclear explosion). Plutonium is made from naturally occurring uranium in plutonium-production reactors at Hanford and the Savannah River sites. The fissile product from the reactors was processed through chemical separation plants to segregate the plutonium and uranium from other radioactive isotopes. Most of the plutonium from these plants went to Rocky Flats to be manufactured into weapons components. It was usually in the form of metal, but liquid and powdered plutonium was also produced.

Recovery

The original plutonium recovery process was adapted from Los Alamos National Laboratory processes (Crissler, 1998 interview). The process was put into operation in May 1953 with the first shipment of plutonium nitrate solution from the Hanford Plant in Richland, Washington. Several years later, the Rocky Flats Plant also started receiving plutonium nitrate feed from the Oak Ridge Reservation. All of these shipments were discontinued in 1959. Since that time, internally generated plutonium residues from Plant operations were the primary feed for the recovery/metal production. Residues normally were solid materials varying in plutonium content from a few percent to almost pure plutonium metal.

The primary objective of the plutonium recovery process was the recovery of plutonium from all residues generated during plutonium-related fabrication, assembly, and research operations. The overall recovery process consisted of fifteen major operational unit processes including incineration, cation exchange, dissolution, anion exchange, batching and evaporation, precipitation, calcination, hydrofluorination, thermal reduction, leaching, oralloy leaching, chloride dissolution/chloride anion exchange/dicesium hexachloroplutonate production, molten salt extraction, salt scrub, and electrorefining.

All incoming plutonium (either foundry-generated oxide or associated with production wastes) was dissolved in nitric acid solutions. Feed material was one of two types: a high-level material (plutonium oxide and impure metal) obtained from foundry casting operations, or low-level materials (residues produced in the recovery/manufacturing process).

The overall process and chemistry of plutonium recovery remained largely unchanged since recovery operations began. Prior to 1965, plutonium recovery operations were originally conducted in batch fashion that consisted of simple, manually operated equipment. At that time, batch operations were sufficient because the limited plutonium casting and machining operations generated little scrap. Similarly, site returns (retired or out-of-specification nuclear weapons or nuclear weapons components) were minimal.

To begin the recovery process, a mixture of nitric acid and plutonium residues was heated and agitated in a beaker inside a glovebox, to dissolve the plutonium into a nitric acid solution. In addition to being very labor intensive, the beaker method released fumes that corroded the electric heaters and caused problems for the glove box handling and filtration system. To improve dissolution, the beakers were replaced in 1965 with a system of continuous cascade dissolvers. Continuously operating and automatic control systems were later introduced to increase the recovery capacity of the facility and to decrease radiation exposure of operating personnel.

During the continuous cascade process, steam coils were immersed in the liquid nitric acid solution. The resulting slurry overflowed from the first through the last dissolver in the set. From the last dissolver, the slurry overflowed to a horizontal-pan vacuum filter, which separated the undissolved solids from the solution. The plutonium solution then went to ion exchange process. Solids were scraped from the filter, dried on a hot plate, and packaged for removal from the glove box for treatment and disposal.

After the plutonium was dissolved, the other elemental impurities were separated out of the solution. The plutonium feed was purified by solvent extraction, later replaced by the anion exchange process. The plutonium nitrate solutions were pumped through glass columns, containing anion exchange resin. The anion exchange process purified and concentrated plutonium-bearing nitric acid solutions to make them acceptable as feed for conversion to metal. The solution was concentrated in a steam-heated, natural-convection evaporator. The concentrated solution, called bottoms, was transferred to tanks.

Relatively pure plutonium nitrate solutions received from oxide dissolution, anion exchange, and feed evaporation were blended and adjusted to the proper pH and

plutonium concentration before entering the peroxide precipitation process. Feed for the peroxide precipitation process was prepared in batches by blending the available solutions in the proper ratios.

The peroxide precipitation process converted the plutonium in solution to a solid form and achieved some purification of the plutonium from metallic elements, notably americium. The feed solution was pumped into a refrigerated, stirred reactor called a digestor. Hydrogen peroxide solution was fed into the digestor. Precipitation occurred in the digestor and crystal growth occurred. The plutonium peroxide slurry cascaded through the digestors and into the rotary drum filter basin. Vacuum applied to the filter removed the liquid, causing the plutonium peroxide to collect on the filter surface. The plutonium peroxide cake collected on the rotary drum was cut off the filter wheel, collected in containers, and transferred to the calciner.

The calcination process converted plutonium peroxide to plutonium oxide and drove out residual water and nitric acid, leaving a dry, powdered product. The dried cake was collected, screened, and weighed in batches. Every third batch was sampled and analyzed for impurities for process control. Batches were stored in approved containers in racks in the glove box while awaiting hydrofluorination.

Plutonium oxide was converted to plutonium tetrafluoride in a continuous rotary-tube hydrofluorinator. The plutonium tetrafluoride product was collected, weighed, and transferred in batches to the reduction process. The hydrofluorination process produced high neutron radiation, which emanated from plutonium tetrafluoride.

Plutonium tetrafluoride produced by the hydrofluorination process was reduced in batches to plutonium metal by interaction with calcium metal in an induction-heated reduction vessel. The vessel was heated until the reduction reaction took place, producing plutonium metal and slag. The resulting plutonium metal button was separated from the crucible, sand, and calcium fluoride slag. It was cleaned, sampled, and packaged for storage until the analysis was complete, and the button was sent to fabrication.

Fabrication

At Rocky Flats, plutonium buttons from the plutonium recovery process were first cast into ingots. The casting operation created feed ingots and War Reserve ingots of plutonium metal. The first casting process created the feed ingot. Materials used for the creation of feed ingots included plutonium buttons from recovery processes, briquettes, and scrap plutonium metal. Production control personnel used sampling data to calculate the precise feed ingot mixture which would produce a War Reserve ingot of specific

purity from the second casting. The casting process consisted of weighing the metal, placing it in tantalum crucibles, and melting it in one of four electric induction furnaces. Molten metal was poured into molds to form ingots. The War Reserve ingot was used to fabricate weapons components. Samples were taken to verify the chemical makeup and purity of both the War Reserve ingot and the fabricated component.

Plutonium War Reserve ingots were rolled, formed, and heat-treated, and then were cut in a blanking press. Cut blanks were sent to thermal treatment (annealing and homogenizing). Following thermal treatment, blanks were formed into hemi-shells (1/2 shells) in a hydroform press. After forming, the parts were annealed and measured on a density balance.

The hemi-shells went to final machining involving lathes, mills, a drill box, a high-precision drill press, and a hydraulic press. Each part was then marked with a serial number, cleaned, weighed, and inspected. Plutonium parts were welded, then inspected for leaks. Parts were assembled into subassemblies, then into assemblies, and then assembled into triggers. Assembly included such operations as machining, cleaning, matching parts, brazing, welding, heating under vacuum for trace contaminant removal, marking, weighing, monitoring for surface contamination, and packaging for shipment. The assembled triggers and parts were subjected to final processing steps, final testing, and inspection, then stored to await shipment.

Depleted Uranium Operations

Depleted uranium was used as a non-fissile component in the trigger design. Uranium, more dense than lead, was also machined at the Plant into sheets used as in military tank armor. From 1951 until 1955, depleted uranium was shipped to Rocky Flats as derby-shaped parts from Paducah, Kentucky and later as ingots from the Feed Materials Production Center in Fernald, Ohio.

Uranium was cast in the foundry into near-net shapes (close to the final product form) and then sent to machining. Induction-cast depleted uranium, arc-cast depleted uranium, depleted uranium alloy ingots, beryllium ingots, and aluminum shapes were produced in the foundry. The metals were placed in crucibles, loaded into one of eight induction furnaces, and melted in a vacuum atmosphere. Induction casting used radio frequency energy to melt the metal, which was poured into graphite molds to form ingots.

Metal parts containing depleted uranium, depleted uranium alloy, and depleted uranium with traces of iron, silica, titanium, aluminum, or stainless steel were cut in the depleted uranium machining process. Machining operations included turning, facing, boring, milling, and sawing.

After 1956, the uranium ingots were processed into rolling pucks, then rolled and formed, and final machined. The depleted uranium ingots or billets were hot rolled and formed into parts or combined with niobium to form binary metal. Virgin depleted uranium ingots were weighed, immersed in a salt bath, rolled into a sheet, and sheared to length. The sheets were annealed in a second salt bath, cooled, and cleaned in water. The sheets were sheared a second time and trimmed to final length into electrode strips. The electrode strips were bent, cleaned in acid, and welded in a box configuration. Electrode filler strips were rolled, punched for boltholes, and cleaned in acid. Final assembly operations were conducted in Building 991, 777, or 707, depending on the time frame.

Recycled depleted uranium ingots were weighed, cropped, re-weighed, and heated in a salt bath. The ingots were rolled and sheared to length; the sheets were annealed, cooled, and cleaned in water. They were then sheared, cut into discs, heated, and formed into parts. A second forming, called a re-strike, was done to insure proper size.

Depleted uranium recovery operations were not conducted at the Plant.

Enriched Uranium Operations

Enriched uranium was one of the materials used to create the first-stage fission reaction. It was possible to make nuclear weapons either by using plutonium or uranium. The "Little Boy" bomb dropped on Hiroshima was a uranium-type bomb, although most modern atomic weapons used both plutonium and uranium.

Fabrication

The original trigger design required a large amount of enriched uranium. The primary operations at the Plant included fabrication support, which included the foundry for casting of shapes and ingots; machining and inspection; metal product support, which included recovery of relatively pure materials; and salvage support, which handled recovery of solutions and solid residues with relatively low enriched uranium content.

Processes used at the Plant were based upon those developed at the Los Alamos Scientific Laboratory and the Oak Ridge Reservation, during and after World War II. The processes were refined at the Oak Ridge Reservation Y-12 Plant in the several years preceding the construction of the Rocky Flats Plant, although many improvements to the process and equipment were made by Plant personnel.

For the first months of operations, uranium castings were received from the Oak Ridge Reservation in the form of hockey-puck-sized buttons. Once recovery operations were

established, uranium buttons produced at Rocky Flats were added to the feed material. In the casting process, uranium metal was placed in a crucible, heated in bottom-pouring induction furnaces, and then poured into graphite molds. Machining operations, including rolling and forming, and computer controlled turnings took place in Building 883 or the 881 Annex.

In 1964, enriched uranium operations at the Plant began phasing out with the advent of the Atomic Energy Commission's single mission policy. Production of enriched uranium components ceased at the Rocky Flats Plant in 1967, when the Y-12 Plant at the Oak Ridge Reservation assumed sole responsibility. From 1964 to 1966, plutonium production became the focus of operations at the Plant.

Recovery

Enriched uranium recovery operations were initiated shortly after fabrication operations began. Several different recovery operations were used, depending on the type of initial material. Uranium recovery involved both slow and fast processes. The slow process involved placing relatively impure materials with low concentrations of uranium into nitric acid for leaching and solvent extraction. Impure materials such as slag, sand, crucibles from the foundry operations, and residues from the incinerator were reduced via the slow process. The materials were crushed into pea-sized feed in a rod mill and placed in various dissolving tanks containing nitric acid. Solutions from the dissolution filters were concentrated in three-story-high solvent extraction columns. The solution was then pumped into various evaporators for further processing.

The fast process handled materials that were relatively pure, including uranyl nitrate, and used conversion and reduction steps to produce a pure uranium button. Materials such as chips from machining operations and black skull oxide contained fairly high percentages of enriched uranium that were easy to convert into pure uranium buttons. Chips and skull oxides were burned to form uranium oxide and then transferred for dissolution in small batches of concentrated nitric acid. The dissolution room housed three rows of controlled hoods known as B-boxes (similar to laboratory hoods). These boxes operated with high air velocities at their openings to ensure that the vapors were contained within the hood. The dissolution process yielded a uranyl nitrate solution, from which uranium peroxide was precipitated. Once filtered, the precipitate formed a yellow cake, which was heated to produce an orange uranium oxide. The dissolution, precipitation, and calcination processes were originally performed as batch processes. By the late 1950s to early 1960s, the process became a continuous operation. The orange oxides were converted to uranium tetrafluoride, a green salt. The green salts were transferred for final reduction to uranium metal.

Beryllium Operations

Rocky Flats began production scale operations in 1958, with the newer trigger design. Beryllium was used as a neutron reflector in the trigger design. The material was extremely brittle and required unique handling techniques.

Production operations initially involved only the machining, final inspection, and assembly of beryllium parts which were supplied by an off site vendor. By the mid-1960s, Rocky Flats beryllium operations also included the casting and shaping of beryllium parts to the proper dimensions. By 1975, foundry casting of beryllium on the Plant site had ceased with beryllium supplied in the form of blanks from an off site contractor. Machining of beryllium parts continued in Building 444 until production shut down in the late 1980s.

The "wrought" beryllium process was developed in approximately 1962 through research and development work at Rocky Flats and other USDOE facilities. This process involved casting beryllium ingots, sawing the ingots, "canning" (encasing) them in stainless steel, rolling them into sheets, and cutting the cans away. The beryllium ingots were very brittle, and in order to roll them they had to be encased in stainless steel and heated to a temperature ranging from 900 to 1,000 degrees centigrade. After the stainless steel can was removed, the beryllium sheet was then cut into shapes.

Beryllium machining processes involved sawing, milling, drilling, and lathe operations followed by polishing and abrading operations. Site returns (retired weapons) and components containing beryllium were also returned to the machining area for dismantling. During the Plant's operations, machining has included work on beryllium casings, wrought processing, sintered forms, and bar stock.

Other than the recycling of parts from site returns (retired weapons), beryllium recovery operations were not conducted on the Plant site. Some beryllium-related waste management activities were conducted in Building 447.

Stainless Steel Operations

When enriched uranium operations were phased out at Rocky Flats in the mid-1960s, factors including favorable economics and considerable floor space in Building 881, led to the decision to begin stainless steel machining. The phase-in of stainless steel machining work began in Building 881 in 1966. All stainless steel work on the Plant site was done in that building by 1968. In 1967, Dow, the site contractor at the time, acquired the J-line (code name) stainless steel activities. Stainless steel machining work was previously conducted by American Car and Foundry Industries, located in Albuquerque,

New Mexico. Stainless steel work was conducted in Building 881 from 1968 to 1984. In 1984, machining was moved to Building 460, a facility specifically designed for stainless steel machining operations.

Stainless steel casting, forging, or recovery operations were not conducted on a production scale at the Plant. Stainless steel was used primarily to make the reservoirs that held tritium gas within the bomb. Other stainless steel work included fabrication of the tubes and fasteners associated with the tritium reservoir-to-trigger delivery system.

Production operations included machining, assembling, inspection and testing, and support. Depending on technical requirements, methods, and/or equipment needed, the sequence of operations was altered to meet specific project needs. Conventional tools, such as lathes, mills, borers, and presses were used in machining operations. The machined parts were cleaned and inspected prior to being sent to the assembly area. Assembly operations included cleaning, matching, brazing, welding, inspection, testing, and packaging. The parts were then assembled and joined by brazing or welding. Although stainless steel recovery operations were not conducted at the Plant, scraps and turnings were generally collected for resale to an off site recycler.

Assembly Operations

Plutonium, enriched uranium, depleted uranium, beryllium, and stainless steel components fabricated on site, along with components manufactured from Hanford and Oak Ridge, were assembled into final products, inspected, tested, and placed back in storage prior to off site shipment. Because all of the radioactive components were coated in nickel or encased in plastic, assembly of the early concept design products was conducted in open rooms, not in enclosed glove boxes.

In 1957, production began on a new weapon design, requiring changes in the amount of materials used in the trigger, the amount of machining and handling required, and the need for tighter tolerances. Because of the new design, final trigger assembly took place in the newly constructed Building 776/777. Assembly of older uranium-based weapons continued in Building 991 until the 1960s. A limited number of plutonium-based triggers were also thought to have been assembled in Building 991 during the early 1960s.

Major Material Processing Buildings

(Note: A more detailed description of the buildings and building operations is included in the individual building reports.)

Depleted Uranium and Beryllium - Building 44/444 (Plant A)

Building 444 was one of the first buildings constructed at Rocky Flats. Beginning in 1953, depleted uranium was both cast and machined in this building. The original building contained the foundry, depleted uranium machine shop, beryllium machine shop, heat treating shop, plating laboratory, carbon machine shop, casting shop, tool grinding shop, welding and brazing shop, pressure and leak testing laboratories, precision measuring laboratories, building maintenance shop, and parts of the precision shop and non-destructive testing laboratory. Some of the former production areas were later used for storage of excess tools and materials.

From 1952 until the end of production, beryllium and depleted uranium casting, machining, cleaning and inspection equipment were housed in Building 444. Depleted uranium was cast into near-net (close to final product) shape in the foundry and then sent to the machine shop. Prior to the construction of Building 883, casting and final machining took place in Building 444. After 1956, the uranium and beryllium ingots were processed into rolling pucks and shipped to Building 883 (Side A) for rolling and forming.

Enriched Uranium, Non-Plutonium Metals/Alloys (Beryllium and Stainless Steel) - Buildings 81/881, 883, 865, and 460

Building 81/ 881 (Plant B)

Building 881 was one of the four original manufacturing buildings that comprised the Rocky Flats Plant in the early 1950s and was the fourth building to come on line. Beginning in 1953, this structure housed the Plant's only enriched uranium component manufacturing and recovery operations. The original purpose of Building 881 was the processing and machining of enriched uranium into finished weapons components. The enriched uranium process included chemical recovery operations and foundry equipment. A large part of the early work at the Plant took place in this building, because the triggers required a large amount of enriched uranium. The primary operations were divided into the following areas: fabrication support, which included the foundry for casting of shapes and ingots; machining and inspection; metal product support, which included recovery of relatively pure materials; and salvage support, which handled recovery of solutions and solid residues with relatively low uranium content.

Building 881 operations represent three distinct primary functions: enriched uranium manufacturing and recovery (1952-66); stainless steel operations (1966-84); and recent activities that have taken place in the building since manufacturing operations were phased out, including research and development, laboratories, and computer administration.

Building 881 is an irregularly shaped, multiple level structure that is built into the side of a hill. Building 881 is considered to be a three story structure with mezzanine levels on the first and second floors. The complex encompasses approximately 245,000 square feet. During the period of uranium and stainless steel production, most of the production related activities occurred on the second floor.

Building 883

Building 883 was constructed in 1957 to accommodate fabrication of enriched and depleted uranium and beryllium parts. The sealed, hollow shape of the weapons components required a significant amount of rolling and forming of both types of uranium. Because space in the existing Buildings 881 and 444, (enriched uranium and depleted uranium parts manufacturing) was inadequate, Building 883 was constructed to handle some of the uranium and beryllium rolling and forming operations.

Building 883 is a high bay, single-story building with a 38' ceiling. The majority of the building's area is contained in a high bay metal working area. Eighty percent of the area of the building has been used for metal processing.

The processing areas on the first floor were referred to as Sides A, B, and C. The building was originally designed with two functional areas or sides to prevent cross contamination of radioactive enriched uranium with non-fissile depleted uranium. Side A housed equipment used for rolling, pressing, and shearing of depleted uranium and beryllium operations. Side B housed equipment used for rolling, pressing, and shearing of enriched uranium. Side C, completed in 1985, supported acid scrubbing operations and tank armor plate production.

Building 865

Building 865 was built in 1970 to house metalworking equipment for the study of non-plutonium metals and the development of alloys. The building contained shops and equipment that supported metal fabrication, machining, and processing for both production and development in metalworking. The building conducted metallography laboratory work and decontamination activities for product research and development.

The building contained equipment for rolling, shearing, forging, extruding, swaging, grinding, pressing, heat-treating, vacuum induction casting, and vacuum casting. A number of metals were processed and fabricated into prototype hardware.

All metalworking operations were conducted in the high bay area. The metal was heated in electrical resistance furnaces and transferred to the steam hammer for forging. When beryllium and uranium were forged, permanent hoods were used to create airflow from the workplace and exhaust away from the operator. Beryllium, uranium, steel, and other ferrous and nonferrous metals are press-formed (hot or cold) into the desired shapes.

Building 460

Building 460 was built in 1984 to house equipment, systems, and personnel for fabrication, assembly, and testing of stainless steel components such as reservoirs, tubes, and non-fissile trigger components. The facility was described as the most modern non-nuclear manufacturing building in the USDOE Nuclear Weapons Complex.

Total area of the building is approximately 230,000 square feet, split between the first floor and two second-floor mezzanines. All non-nuclear manufacturing at the Plant was consolidated into this one facility. The stainless steel operations conducted in Building 881 and some non-nuclear metalworking operations from Building 444 were transferred to Building 460 after its completion. Manufactured components were associated with the tritium reservoir-to-trigger delivery system. Operational processes included fabrication, assembly, and inspection. Fabrication of stainless steel and other non-nuclear metal parts included mechanical machining, electrochemical machining and grinding, electric discharge machining, and crush grinding.

Plutonium - Buildings 71/ 771, 776/777, 707, 371

Building 771 (Plant C)

Building 771 was originally constructed as a totally self-contained plutonium fabrication and recovery facility. For the period of May 1953 until 1957, when Building 776/777 entered operation, Building 771 was the sole plutonium facility at the Plant. During this time period, the building housed plutonium parts production-related activities, including casting, fabrication (machining), coating, inspection, testing, and recovery operations; the chemical and physical operations for recovering plutonium and refining plutonium metal; plutonium chemistry and metallurgical research operations and radiochemical analytical laboratory operations; storage of plutonium metal; various laboratories; and other support operations.

The original Building 771 is a two story structure built into the side of a hill with most of three sides covered by earth. The fourth side, opening to the north, provides the main entrance to the building. The plutonium-related operations were arrayed along the southern hallway of the first floor. Plutonium manufacturing operations were located on the south side of the hallway, while plutonium recovery operations were located on the north side of the hallway. Since completion of the original building, six major additions have been constructed.

By the mid-1950s, the space within Building 771 was inadequate to support all plutonium operations needed at the Plant. A new weapon design required more plutonium than that of the original weapons. Additionally, the new weapon design required more machining to achieve the necessary plutonium shapes. An increase in plutonium recovery operations was expected, partly due to the new weapons design. A new major production building, Building 776/777, was built to support the casting and fabrication operations. On September 11 and 12, 1957, a fire occurred in a fabrication line in Building 771. The fire damaged Building 771 and caused radiological contamination, resulting in an estimated property loss of $818,600 (Buffer 1995). Many of the plutonium operations were moved to Building 776/777 after the fire. The fire debris had been cleaned up by 1958. Much of the production and fabrication equipment remained in Building 771 to provide backup plutonium production capabilities for the Plant. From 1957 onward, the mission of Building 771 focused primarily on plutonium recovery.

Building 776/777

As a result of the design changes and increase in workload, Building 776/777 was constructed for plutonium casting, fabrication, and assembly, and quality assurance testing. The main function of the 776 side of Building 776/777 was the casting and fabrication of plutonium parts. The main function of the 777 side of Building 776/777 was assembly of parts and some disassembly of site returns (weapons returned to the site for retirement, upgrade, or reprocessing).

The original foundry was located in the southwest corner of Building 776/777. The foundry contained sixteen furnaces, which were crowded into the room. Foundry operations cast plutonium, either as ingots suitable for rolling and further wrought processing or into shapes amenable to direct machining operations. Fabrication operations involved either direct machining of ingots or cast shapes or conducting the wrought process, which further prepared the ingot for machining operations. The wrought process involved rolling the ingots into sheets and cutting them into circular-shaped blanks to be passed through a press. The pressed blanks were then annealed and machined. Machining involved taking the cast or wrought part and debrimming or

removing spurs, contouring, drilling, and milling. Machining operations took place on the North-South-East Line.

Assembly operations involved assembling trigger components. The units primarily contained nuclear materials such as plutonium and uranium; however, non-nuclear materials such as beryllium, steel, copper, aluminum, and silver were also assembled. Assembly activities included drilling, welding, brazing, turning, and polishing. After assembly, complete units were packed and shipped off site or to Building 991 for final processing, storage, and shipping.

The first weapons disassembly (site return) work was performed in the 777 side of Building 776/777 in 1958. Increased site-return disassembly activities began in the late 1960s, as old weapon designs were retired and disassembled to recover valuable materials. After disassembly, parts were inspected for unusual conditions and segregated according to material type. Plutonium materials were returned to the 776 side of the building's foundry where they were cast into feed ingots. Depending on assay specifications, the ingot was then sent to the molten salt extraction facility for americium removal. Otherwise, the ingot was sent to Building 771 for chemical purification and returned to the foundry as a fresh button. Enriched uranium parts went to Building 881 for recovery, and depleted uranium and inert components were packaged for disposal at off site disposal sites.

On May 11, 1969, a fire occurred in Building 776 from the spontaneous ignition of a briquette of scrap plutonium. The fire resulted in $26.5 million in property loss, loss of production capabilities, and the decontamination took two years to complete. The incident resulted in many new safety features including installation of water sprinklers and firewalls to control the spread of fire, and the use of inert atmospheres for plutonium operations to prevent fire propagation from occurring.

After the fire, the majority of the foundry and fabrication operations were transferred to Building 707. After several months of cleanup, limited production operations resumed in Building 776. The main operation conducted in Building 776 became waste and residue handling, although operations such as disassembly of old weapons (site returns) and special projects continued in the building. Processes conducted in the building included size reduction of large scrap equipment, pyrochemistry, coating operations, and test runs of a fluidized-bed incinerator unit.

Building 707

Building 707 was the primary plutonium fabrication building from 1970 until production ceased in 1989. After two destructive fires in other plutonium production buildings

(Buildings 771 and 776/777), the design of Building 707 incorporated extensive control and safety features, including the first-time use of inert atmosphere in the glove boxes. Construction of Building 707 began in 1967 with plutonium operations commencing on May 25, 1970. Building 707A was built in 1971 to accommodate operations moved from Building 776/777 as a result of the fire in Building 776.

Operations in Building 707 included metallurgy, parts fabrication, assembly, inspection, and non-destructive testing. The main floor of Building 707 was compartmentalized into eight side-by-side modules (A through H) which contained one or more of the primary production operations. Each module was 140' x 49' with an area of approximately 6,860 square feet. The modules were arranged from the north side of the building to the south. The main floor of Building 707A was divided into two modules, Modules J and K, which contained plutonium foundry operations and two plutonium storage vaults. One storage vault, on the north end of Module K, was equipped with a remote controlled, computerized retriever (the X-Y retriever) for handling plutonium stored in the vault. The general flow of work and materials was from Modules J, K, and A sequentially to Module H.

Building 371

Building 371 was originally built to accommodate the plutonium recovery operations from Building 771, using advanced technology for plutonium handling, recovery, and safety. Although fundamentally based on the processes and principles developed previously in Building 771, the design of Building 371 incorporated many technological advances and refinements. The design, initiated in 1969, was far more sophisticated and complex than any others at the Plant; Building 371 was designed to emphasize automatically controlled, remotely operated processes, as contrasted with the direct, hands-on operations in Building 771. The operations for the building focused primarily on recovery of plutonium from both solid and liquid wastes. The final product from the process operations was intended to be recycled plutonium metal, which was to be reused in the Plant's primary manufacturing process.

Operations in Building 371 were threefold: recover plutonium from all residues generated by plutonium-related fabrication, assembly, and research activities throughout the Plant; convert the recovered plutonium into high-purity metal buttons; and recover associated americium and convert it to americium dioxide, a saleable product.

Building 371 was originally scheduled for completion in 1976 at a cost of approximately $70 million. The project was plagued with schedule overruns and construction material substitutions. The stacker-retriever, a remotely operated, mechanized transport system for movement of plutonium storage drums, became operational in 1976. In 1978, the

waste treatment process came on line. In 1980, the heating, venting, and air conditioning systems were brought on line. The rest of the building was finally completed in 1981 at a total cost of approximately $214 million.

In 1982, pilot-scale aqueous plutonium recovery operations began in Building 371. There were not enough operators to run the process continuously, so the process was run in batches, shutting down one phase to start the next. Employees were to be transferred to the new facility when it was fully operational and recovery operations in Building 771 were shut down.

One year after the aqueous recovery process began, the USDOE conducted a plutonium inventory at the Plant. The Building 371 inventory was difficult to quantify. The building had over 770 miles of piping, of which, 70 miles were plutonium process lines. Process lines ran through walls and traversed several floors. In the 1960s, personnel associated with safeguards and security were primarily concerned with the amount of material that went into the process and the amount that came out; the amount currently residing in the process was only estimated. By 1976, accountability was required for every gram of material at all times. The aqueous process was shut down until all in-process plutonium could be located. The majority of the material was found. Designed in 1968, Building 371 was not constructed to meet this type of safeguard and security requirement. Although several projects to upgrade the system were proposed, none were approved. The aqueous process, which never ran at full capacity, was not operational after 1983.

Shipping/Receiving, Assembly - (Building 91/ 991 (Plant D)

Building 991 was the first building to be completed at Rocky Flats. It was designed for shipping and receiving and for final assembly of weapons components. Administrative services for the Plant were also carried out in Building 991 until Building 111 was completed.

In addition to the handling of materials, a number of research and development projects were conducted in the building. These included: radiation studies conducted from the 1960s-70s; a beryllium coating process from 1964-76; and an explosives-forming project from 1966-74. Most special projects and research and development operations were moved out of the building by 1976.

Building 991 was primarily used for off site shipping of components, assemblies, and other materials associated with past weapons and/or plutonium metal production. The building also housed non-destructive testing operations and other support operations.

Building 991 was used to test the quality of non-nuclear raw materials and parts fabricated by off site vendors and to inventory and store parts for future use. Building 991 took over storage operations from Building 881 in the 1970s. To insure the quality of the off site materials, a metallography lab was used. In the late 1980s, the handling of non-classified materials was moved to Buildings 130 and 460. Non-nuclear materials ready for assembly were sent directly to Building 460.

Security

Indicative of the importance of security, the first structure on site was a small guard shed building in mid-May 1951. In comparison, excavation for the first permanent building on site, Building 91, did not begin until July 10, 1951. The Plant was surrounded by 10 miles of barbed wire fence, electric fence, and livestock fence, and armed guards patrolled the perimeter of the Plant. Each of the four lettered plants had its own guardhouse: Building 446 for Plant A; Building 864 for Plant B; Building 773 for Plant C; and Building 992 for Plant D. A Plant protection building (121) and firing range for security force practice were constructed as part of the original Plant. As new production buildings were constructed, individual guardhouses were also constructed for them. Guardhouse 888 was built in 1964, close to the criticality laboratory (Building 886); Guardhouse 461 in 1985, for the stainless steel fabrication plant (Building 460).

Facilities considered to be part of the security force included: Building 119; Building T120A; Building 121; Building 128; Buildings 987 and 993 (munitions storage); Buildings 100, 120, 900, and 920 (personnel access control points); Buildings 372A, 372, 762A, 763, 792A, and 792 (major access control points); Buildings 113, 133, 446, 461, 557, 773, 864, 888, and 992 (guard posts); and Buildings 375, 550, 761, and 901 (guard towers).

Security of the Plant included control of access; preparation for and prompt response to threats or acts of violence; screening of future employees, including a 15-year background check for Q clearance; inventory control of government equipment; and procedures for handling breaches of security. The Atomic Energy Act (Section 161.k) authorized security personnel to carry firearms and arrest without a warrant in order to safeguard the special nuclear material from theft and to keep citizens and workers from harm. This authorization included the use of deadly force, when necessary.

The first security chief at Rocky Flats Plant was James A. O'Brien, a former narcotics and Army intelligence officer. According to a former security director, in the early years, security was concerned with the Cold War, espionage, and the secrecy associated with building nuclear weapons. It was important to safeguard design secrets, and later, the numbers of weapons being produced. Classified information was available only on a

need-to-know basis. All employees were required to have a Q clearance, a top-secret level for atomic workers requiring a 15-year background check. Employees were forbidden to talk about their work with anyone (Kennedy 1994:16; *The Paper* 8 May 1992). Employees at the Plant were unaware of the duties of family members also employed at the Plant.

Cold War paranoia was rampant during the early 1950s through the late 1980s. Employees' backgrounds were thoroughly checked; rooms were monitored for bugs prior to meetings being held; information was compartmentalized. Production information was shared only on a need-to-know basis. Secrecy was a key component of site security. Off site, employees were only allowed to say where they worked and their official labor title (Weaver, 1998 interview). The secrecy was part of everyday life: no one asked for or offered information; it was not considered a drawback, just a fact of working at Rocky Flats.

Most employees were cleared for work only in the area or building to which they were assigned, and did not know what operations occurred in other buildings or areas. They were required to have a separate badge for each area they entered (*Rockwell News* 1983). Workers parked outside the Plant area, at the west end (the sole entry point), and were bused to Building 111, where they checked in at the clock room, and then went to their own buildings. A small bus stop (114) was built in the administrative area. By the mid-1950s, cars were allowed onto the site. A guard post, Building 100, was built at the west access road in 1969 to check traffic. By 1964, an east access route off Indiana Street had been built, with guardhouse Building 900.

Secrecy was also extended to the guards; they were not well informed as to what was to be protected. Guards were not given information regarding what to protect within individual buildings; they also worked on a need-to-know basis, gathering knowledge and information from walking the floor. Around the mid-1980s, the security force was formally trained on the nature of the materials that they were to protect (Cunningham, 1998 interview).

Formal security sanctions were imposed. The first warning for a security infraction was verbal, the second was written, the third required time off, and the penalty for the fourth infraction was termination (Weaver, 1998 interview). Informal sanctions included embarrassment and ridicule from co-workers. In one group, an eight ball was circulated. If someone was written up, the eight ball had to sit on the desk of the division manager as a constant reminder until someone else was written up and the ball was passed on (Riddle, 1997 interview).

Security infractions were considered big events at the Plant: people believed in what they were doing and simply did not talk about their individual assignments or the Plant in general (Richey, 1998 interview). Signs were posted on the outer gates with the number of infractions that had occurred. When one occurred, an investigation took place immediately, and the sign was updated regarding the outcome. Since the Plant community was extremely tight, any infraction was considered a social stigma (Cunningham, 1998 interview).

During the Manhattan Project, plutonium was also referred to as "copper." If someone was really talking about copper, it was called "honest-to-god copper" (Rothe, 1997 interview). Continuing the practice of using codes, words such as plutonium, uranium, or americium were not used at the Plant. Instead, code words like "X," "Y," or "Z" were used. Depleted uranium was also known as tube alloy, carried over from British terminology, and enriched uranium was also known as oralloy (Oak Ridge alloy).

In the 1970s and 1980s, security was concerned less with espionage and more with the threat of terrorism and infiltration of the Plant by protesters. Better protection of the outer boundaries of the site became necessary. In 1972, a buffer zone of 4,600 acres around the existing Plant was purchased for additional protection. According to Ed Young, head of security operations at that time, the terrorist attack during the 1972 Olympics led the government to believe that trained terrorists could attack national defense facilities (*The Paper* 8 May 1992). As a result, in 1978 plans were made to install a $5 million perimeter security zone surrounding the plutonium operations buildings. The perimeter security zone, when finished in 1983, consisted of a double-perimeter fence with closed-circuit television, alarms, and an uninterruptable power supply. Access to the area was controlled at three checkpoint guardhouses: Building 372 at the inner fence by Building 371; Building 762 by 707; and Building 792 by 771. Four guard towers, Buildings 375, 550, 761, and 901, were installed along the inner fence (Buffer 1995). By 1985, a perimeter intrusion detection assessment system was in place, with its security centered in Building 764, to detect activities at the perimeter security zone (*The Paper* 2 July 1993).

In 1983, a new policy required that all vehicles driven onto the Plant site be searched by security forces at the entrance gate. Guard posts and badge check houses were added at the west gate in 1985 and at the east gate in 1986. In 1988, material access areas were established to enhance security inside the production and classified building areas.

The first protests at the Plant, brought out the guards in full force, with rifles and ammunition. During these protests, a booking area was established in Building 111, instead of taking arrested protesters to the Jefferson County facility. Protesters that crossed the line were put on a bus and transported on site. Many protesters were

frightened by being brought inside the perimeter of the Plant, a response that surprised the security force. Over the years, some 1,500 arrests of protesters were made. As one of the Rocky Flats officials put it to the protesters, "We're equipped to deal with terrorists, but we are not equipped to deal with you people." Nevertheless, the arrests were peaceful and according to the head of security, Ed Young, no one was ever injured (Kennedy 1994:27; *The Paper* 8 May 1992). The practice of bringing protestors on site ceased due to infiltration concerns (Cunningham, 1998 interview). As protests continued and guards became accustomed to dealing with outsiders, the security forces were not fully armed or in full force.

Guardhouses were established in the west parking lot (133) in 1986 and at the west end of Central Avenue (113) in 1988. In 1990, the private security guard company, Wackenhut, took over the protective services contract.

The plant protection organization had a security inspector force and a lock and key control group. The security inspectors regulated Plant and interplant access, provided security patrols and checks, and escorted Plant shipments. Lock and key personnel kept records of the locks and their keys, and of safes and their keys and combinations. Security maintained a weapons arsenal, conducted tours for potential contractors, trained new inspectors, investigated violations of Federal laws, and maintained liaison with local law enforcement agencies.

Strategically located cameras detected movement in unmanned, sensitive areas for increased security from unauthorized entry. Camera monitors were located in the nearest plant protection guard post.

Procedures to heighten security measures were implemented in January 1991 because of the unrest in the Middle East. When the Persian Gulf War began on January 16, 1991, the Plant's emergency operations center was activated and staffed around-the-clock. The USDOE Rocky Flats Field Office provided the operational oversight of safeguards and security at the Plant. EG&G-Rocky Flats and Wackenhut Service, Inc., were the two primary contractors responsible for ensuring that protection program strategies, policies, and procedures were appropriately applied at the Plant to protect USDOE assets.

Document control was governed by USDOE regulations for the control and accountability of classified documents at Rocky Flats. It was responsible for the flow, safe keeping, and disposal of classified records, such as documents, microfilm, and correspondence.

The nuclear materials control group administered a computerized control system that accounted for all nuclear materials. It also supplied the USDOE nuclear materials information system with official material status information and data.

Communications

Communications at the Plant included a combination of commercial and secure telephone lines and teletype services, for secure and non-secure radio contact. Supplemental communication facilities included:

- Direct telephone links between the guard posts and central alarm station in Building 121;
- Direct telephone links between the central alarm station and ten key plant locations;
- Two push-button telephone call directors, one in the central alarm station, and one in the shift superintendent's office, with connections to thirty stations on and off the Plant site; and
- A public address system for general Plant or individual building announcements; national emergency alert and attack signals, building evacuation warnings. Direct connections to the nation's warning system and the metropolitan emergency telephone system.

There were two teletype services on site, one commercial and the other secure. The commercial teletype system, Western Union, based in Building 881, provided a printed copy of the message. The secure automatic communication network and a programmable terminal had a teletype center in Building 750. The secure automatic communication network, connected to USDOE headquarters in Maryland, could prepare, transmit, and receive classified and unclassified teletype messages from over forty USDOE offices and contractor locations. A newswire was introduced to the Plant site in 1971. This system, similar to an answering service, was updated each weekday morning and when events of major news would break.

There were twelve separate radio frequencies for two-way communication by departments on site. Radio communication was used by plant protection, the fire department, plant Services, the Plant postal service, radiation monitoring, Plant maintenance, and facilities engineering.

Radio communications between the Plant and other sites was also used. There was a two-way connection between the Plant and the Jefferson County Sheriff's Department, St. Anthony's Hospital, and nationwide USDOE locations and personnel over the emergency radio system. There was a listening watch for Colorado State Patrol transmissions.

Fire Safety

A twenty-five-person fire department provided immediate around-the-clock response to reports of fires and other emergencies. The fire department routinely inspected all Plant facilities for fire hazards; held fire training programs for its own members, as well as for members of building fire brigades and Plant protection personnel; and presented indoctrination courses for employees on fire prevention and reporting.

Fire brigades in the major buildings were trained to act as firefighters until the fire department personnel arrived on the scene. Plant protection back-up teams were trained to assist, where necessary. Security and fire personnel were cross-trained in the event additional backup was needed. Security could help with the hoses and the dress out into protective equipment. Fire brigade personnel would be next in line to be given firearms, if necessary (Cunningham, 1998 interview).

Major fires that occurred in 1957 and 1969 resulted in building redesigns and implementation of new safety procedures. The 1957 fire, damaged Building 771 and caused radiological contamination. After that fire, many of the plutonium operations were moved to Building 776/777. The fire debris from that incident was cleaned up by 1958. On May 11, 1969, a major fire occurred in the Building 776/777 glove boxes. The first notice of the fire came at 2:29 p.m., when an alarm, triggered by a glove box overheat system, alerted firemen. No one was injured in the blaze, but some thirty-three employees were treated for contamination. The fire occurred from spontaneous ignition of a briquette of scrap plutonium alloy metal contained in a small metal can, probably without a lid. The fire resulted in $26.5 million in property loss. There was an estimated plutonium release of 20 picocuries, all contained on the Plant site. Decontamination of the area took approximately two years. The fire changed the way that business was conducted at Rocky Flats and in the Atomic Energy Commission complex, and possibly had international influences. Prior to the fire, there was little quality control. After the fire, the complex started applying multi-layers of safety reviews and quality control (Calkins, 1998 interview). Safety features instituted after the fire included the creation of an inert atmosphere in the glove boxes to prevent propagation of fires and the addition of water sprinklers and more fire walls. Because of their efforts, fire department personnel received a Group Presidential Citation for heroism in the 1969 fire for risking their own health and well being to prevent a breach of the building, thus preventing plutonium contamination in the atmosphere.

Health and Safety

Background/History

During initial production and experimentation, very little was known about the properties of uranium, plutonium, and beryllium. Because of this, safety was always a priority within the weapons complex. When the first quantity of plutonium was made in the 1940s, half of it was turned over to health and safety experts to study the impacts of this new material on people. Allowable exposure limits for personnel existed throughout the life of Rocky Flats, changing over time as new information and data was learned. Major improvements and technological advancements occurred in the areas of radiation protection, detection, bioassay, and dosimetry in Building 123. During the production years, funding for equipment and research programs appeared limitless (Trice, 1997 interview). Monies granted for health and safety issues allowed the labs access to state-of-the-art equipment to develop methods to do things faster, cheaper, better, and safer. Although production information was on a need-to-know basis, information, such as an injury or accident, traveled through the Plant like a wild fire (Cunningham, 1998 interview).

In 1963, the first patent granted for a Rocky Flats invention was assigned to John R. Mann, health physicist, and Art Wainwright, a former Plant employee. The patent was for an automatic radiation hand counter. Also in the 1960s, the SX-139 supplied breathing air garment was developed at Rocky Flats and approved by USDOE. This apparatus represented a two and one half year effort to improve the supplied breathing air garments used at the Plant. In April 1995, John Schierloch, a mechanical engineer at Rocky Flats received a patent for a gas generation test canister prototype that measured the buildup of hydrogen inside plutonium residue storage drums.

In addition to the research efforts, accidents that occurred at the Plant spurred a number of new safety measures. The 1969 fire in the Building 776/777 glove boxes resulted in the creation of inert nitrogen atmosphere in the glove boxes and the addition of water sprinklers and more fire walls. As health regulations became stricter and more research on the effects of radiation or inhalation of particles became known, other changes took place at the Plant. In 1966, a personnel decontamination room was added to the southeast corner of the medical building (122), consisting of shower facilities and first-aid equipment. This addition enabled contaminated workers needing medical attention to go directly to the decontamination area rather than through the regular emergency building entrance (Buffer 1995).

Safety Programs

The first major safety program at the Plant was organized by General Manager, F.H. Langell in 1951. The first division physician, Dr. Peterson, came on site in 1952 and acted as the construction workers' physician (Buffer 1995). By September 17, 1959 Rocky Flats had established a safety record of 7 million man-hours of work without a disabling injury. The safety figure eclipsed all performances by Colorado industry in addition to the fifteen other Dow plants (operating at the time) and the eight major facilities comprising the Albuquerque, New Mexico operations of the Atomic Energy Commission. In June 22, 1960, Dr. Leland Doan, President of the Dow Chemical Company, visited the site and presented a bronze plaque representing the President's Safety Award in recognition of the excellent safety record at Rocky Flats.

In 1966, dosimeter badges used to monitor employees' exposure to radiation were a Type-A gamma ray film badge. By 1969, all gamma ray dosimeters were converted to thermoluminescent dosimeters. Dosimeter badges were provided to all employees frequently in production areas. By 1976, all neutron badges used were thermoluminescent dosimeter badges. Rocky Flats was the first nuclear weapons facilities to use the thermoluminescent dosimeter badges. Exposure levels were monitored in the Analytical Health Physics Laboratory (Building 123).

Mandatory measurements for both external and internal doses were taken. Initially, detection limits for plutonium, americium, and uranium in urine samples was 0.15 disintegration per minute; by 1995, the detection limit was 0.02 disintegration per minute. This was due to improvements in procedures and equipment developed in the laboratory over the years.

Filtering of airborne radioactive particles was done through the use of individual respirators. A respirator fitting program was established in 1964, and in 1971 employees working in production areas were required to be clean-shaven so that the respirators would have a snug fit (Buffer 1995:1971). In 1972, a system was established for checking the respirators for efficiency in the environmental test chamber of Building 123.

On January 1, 1973, a new safety program was kicked off. The "Life is Fragile – Handle with Care" safety program, designed to increase safety awareness in employees' homes and communities, was put together by and for employees. In 1973, the Atomic Energy Commission allowed state health officials to have access to the fenced, secured areas of the Plant to check on general safety conditions.

In 1974, more direct emphasis was placed on research activity with the formation of health sciences, charged with the various aspects of radiation monitoring and employee

health; and environmental sciences and waste control, overseeing all waste control activity and environmental monitoring. Radiation monitoring conducted in the analytical physics laboratory (Building 123) included gamma counting, tritium analysis, beryllium analysis, alpha and beta counting and the dosimetry process.

On July 1, 1991 the beryllium health surveillance program officially began. Employees found to be sensitized to beryllium were further evaluated for chronic beryllium disease (Buffer 1995). Two medical studies were begun to monitor the long-term effects of exposure to beryllium and radioactive materials such as plutonium, enriched uranium, americium, and others. These studies, mandated by federal law (the National Defense Act of 1993), involve all former Plant workers, and are currently being used to detect early signs of disease.

In late February 1994, the Plutonium Working Group Report on "Environmental, Safety and Health Vulnerabilities Associated with the Department's Plutonium Storage," a 28-volume, 8,300-page report, was officially released. The report looked at plutonium environmental, safety, and health vulnerability issues at USDOE facilities complex wide. The report listed Rocky Flats as having five of the fourteen most vulnerable facilities — Building 771 (No. 1); Building 776 (No. 2); Building 779 (No. 7); Building 707 (No. 8); and Building 371 (No. 9).

New technology to detect small amounts of americium, a decay tracer product of plutonium, in employees' lungs was brought on line at Rocky Flats in June 1995. This technology was the most advanced in the industry and allowed direct measurement of radiation to be taken for a lung count. Two of the three rooms used by internal dosimetry used the new technology.

Health and Safety buildings considered primary contributors to the significance of Rocky Flats according to National Register of Historic Places guidelines include: Building 122 (emergency medical services); 123 (health physics laboratory); 442 (laundry for uranium-contaminated clothing); 778 (laundry for plutonium-contaminated clothing); and 886 (nuclear safety facility and critical mass laboratory).

Health Facilities

The original health facilities were located in the medical building (122) and the health physics building (123). A laboratory and administrative area were housed in the health physics building. Equipment used in collecting air samples, control and accountability of radioactive sources, recording limits of surface contamination and radiation exposure, personal protection, surveillance equipment, x-ray equipment, and a nuclear alarm system were also housed in Building 123. Personnel also monitored Plant employees for lung

and systemic burdens, using body counting and radiochemical techniques. Analysis of personnel dosimeters and all airborne sample analyses, including stack samples and general room air samples, were conducted in the health physics laboratories.

The medical building (122) housed the doctor and emergency health care facilities. The medical department provided medical services to employees brought to them by the emergency unit of the fire department for diagnosis, first aid, x-ray, and minor surgical treatment, and also provided ambulance service (including helicopter transportation) to several local hospitals. The medical department performed scheduled physical examinations of all employees. A personnel decontamination room containing shower facilities and first aid equipment was added to Building 122 in 1966. This addition enabled contaminated workers needing medical attention to go directly to the decontamination area rather than through the regular emergency building entrance (Buffer 1995).

Nuclear Safety Department

The nuclear safety group was established in 1953. The primary purposes of the nuclear safety department were to generate technical criticality safety information, review operating procedures for nuclear safety, provide guidance for implementing those procedures, and establish nuclear safety policies for the safety of production operations. Nuclear criticality safety can be defined as practices associated with avoiding an accidental nuclear criticality event. A criticality is a spontaneous nuclear fission chain reaction caused when a sufficient quantity of fissile material is placed within a given area. A criticality event would not result in a nuclear explosion, but could liberate a large amount of energy and high levels of radiation. The presence of large quantities of fissile materials in numerous forms on the Rocky Flats site made it necessary to maintain an active criticality safety program. Although a number of nuclear criticality accidents have occurred nationwide, the Rocky Flats Plant had none.

The nuclear safety department was divided into two groups: the criticality mass laboratory, where experiments were conducted, and criticality engineering. The principal functions of criticality engineering included writing criticality limits and procedures for the safe handling of fissile materials, implementing the limits and procedures in all areas that handled fissile materials, training and indoctrinating personnel who handled fissile materials, and performing auditing operations for compliance with USDOE guidelines. Criticality limits, the amount of material allowed in any one place (process line, storage container, etc.) at one time, were strictly enforced. If criticality limits were exceeded, penalties were severe, possibly resulting in termination (Rothe, 1997 interview).

Criticality tests were conducted in the criticality mass laboratory after 1964. Until the early 1960s, criticality testing was done after-hours in the production glove boxes. Experiments were only allowed to go towards criticality, but not allowed to go critical. Values were then extrapolated. The need to obtain more actual values was recognized and in 1964, ground was broken on a state-of-the-art criticality mass laboratory (Rothe, 1997 interview). Investigators would set up the production materials in various arrays to perform neutron- multiplication experiments and make predictions with respect to safe geometries for various kinds of production vessels, spacing parameters, shipping containers, and other items. These *in situ* experiments conducted outside Building 886 were always subcritical; neutron count rates were observed as criticality was approached but never reached.

Experiments at Rocky Flats validating the safety parameters for the storage of fissionable solutions in raschig ring tanks resulted in the design of two substitute storage tank configurations: the annular tank and the poison tube tank. These designs allowed for more economical solution testing with no decrease in safety. The poison tube tanks were not used at the Rocky Flats Plant due to the change in the overall site mission; however, they were used at other USDOE facilities. Experiments were also conducted to validate the cross-sections and usefulness of materials used at the Rocky Flats Plant.

Critical Mass Laboratory (Building 886)

To further reduce hazards, criticality tests were moved to a dedicated facility, Building 886. The principal function of the laboratory was to provide accurate criticality data for engineers to use in establishing safe nuclear procedures. The laboratory facility had approximately 12,000 square feet of space for electronics, fissile material storage, and critical mass testing. The actual tests were conducted in a room having 4'-thick concrete walls and a 2'-thick concrete ceiling. The room was leak tested to insure that, in the event of an accident, no contamination would be released to the environment. The room was sealed during experiments. Redundant automatic shutdown mechanisms were built into each experimental system to preclude a nuclear incident. All experiments followed detailed written procedures and were conducted by trained personnel. The criticality safety group at Rocky Flats performed experiments and calculations to identify container or vessel geometries or arrays of nuclear material that had the potential to spontaneously fission. Experiments and calculations were conducted to evaluate the potential for criticality under varying conditions and to validate computer programs used for criticality safety analysis.

The first experiments in the building were conducted in 1965 with highly enriched uranium. Between 1965 and 1992, approximately 1,600 critical mass experiments were conducted on enriched uranium metal and solution, plutonium metal, low enriched

uranium oxide, and several special applications. Additional testing programs were instituted after 1969 when the critical mass program at Lawrence Radiation Laboratories was shut down and transferred to Rocky Flats (Rothe, 1997 interview).

After 1983, experiments were conducted primarily with uranyl nitrate solutions, and did not involve solid materials. Experiments continued until 1987, when testing programs were temporarily stopped for routine equipment modifications, contamination control, and ventilation repairs. Before needed corrections and modifications were completed in 1989, operations at the entire Rocky Flats Plant were curtailed due to the FBI raid. Criticality research at the criticality mass laboratory never resumed.

Heating, Ventilation, and Air Conditioning Systems

Contaminant Zones/Filtration

Heating, ventilation, and air conditioning systems confined hazardous materials within process areas to prevent the dispersion of radioactive aerosols, noxious fumes, and vapors into areas normally occupied by personnel. They also controlled the release of such contaminants from a production facility to the lowest practicable levels, both under normal operating conditions and under accident conditions. Heating, ventilation, and air conditioning systems included not only air ventilation capability but also, in many buildings having nuclear materials, inert gas ventilation that provided environmental control and fire protection for specific areas.

For confining radioactive materials, individual buildings were divided into several zones (Zones I-IV), separated by physical barriers. The ventilation pressure was increasingly negative from zone to zone toward areas of potentially higher radioactivity. Ventilation atmosphere flowed from areas having the least potential for radioactive contamination toward areas having progressively higher potentials. Definite pressure differentials were maintained between the zones.

Zone I, the primary confinement zone, included glove boxes, canyons, vaults, and their exhaust atmosphere handling and cleaning systems (i.e., areas of highest potential radioactive contamination). There was either one additional, less critical zone between a Zone I area and the final containment barrier to the outside environment, or a monolithic concrete floor, wall, or roof with no penetrations to the outside environment. Zone I atmosphere was negative with respect to the atmosphere in all other zones.

Zone IA (buffer zone) included access air locks to glove boxes and canyons, downdraft table enclosures, downdraft tables, hood enclosures, tank vaults, and their exhaust atmosphere handling and cleaning systems. Zone IA areas were essentially open

containment areas (hoods, and downdraft tables) where the capture velocity of the ventilation atmosphere was utilized and controlled rather than a fixed pressure differential maintained.

Zone II (secondary confinement) included the process rooms and work areas containing the Zone I and Zone IA confinement areas, enclosures, and systems. Zone II atmospheres were maintained at a pressure less than that of Zone III.

Zone III (tertiary confinement) included access areas, individual process control rooms, decontamination areas, and the corridors surrounding Zone II and adjacent to the outside shell of the building itself. Zone III also housed the air supply and return system and utility systems that potentially could contain slight radioactivity. The pressure in Zone III was negative relative to that in Zone IV of the building.

Zone IV space included such areas as heating, ventilation, and air conditioning control rooms and general non-radioactive utility and support areas. Zone IV pressure was slightly negative relative to outside ambient air pressure.

The air pressure balance between zones was maintained by differential pressure-sensing instruments and was controlled by inlet and outlet zone dampers. The pressure differentials maintained air flow toward Zone I areas, then to final filtration, prior to being exhausted to the outside atmosphere.

The outside shell of the building provided the final containment barrier for radioactive materials. There were no openings in those portions of the building shell that separated Zone I, IA, and II areas from the outdoors. Passage from Zone III through the building outer shell to the outdoors was through air locks.

High Efficiency Particulate Air Filter Testing Laboratory (Building 442)

Air exhausted from facilities handling beryllium, plutonium, and uranium was exhausted through several stages of high efficiency particulate air filters. The high efficiency particulate air filters were purchased from various manufactures and tested by the filter testing group prior to use. Each plutonium production building was fitted with at least two banks of high efficiency particulate air filters. The filter testing group was formed in 1979 to act as an independent group to test the quality of high efficiency particulate air filters (ChemRisk 1992:95).

Operations in the high efficiency particulate air filter test facility were considered critical. Production buildings were continuously monitored for radioactive contamination. Air exhausted from the stacks of process and research buildings was monitored to detect

releases of particulate radioactivity and toxic dusts and chemicals. Also, ambient air was monitored for airborne particulate matter, both on and off the Plant site.

Construction of the original section of Building 442, which housed the filter laboratory was completed in 1953. The original building, containing 2,480 square feet, is a one story, reinforced concrete structure. The newer part of the facility (constructed in 1975) is a pre-engineered metal building. This addition housed the warehousing operation.

Breathing Air System

Clean, dry, breathing-quality air was available for personnel who were required to wear protective suits or masks to perform operations where the atmosphere had less than 19.5 percent oxygen, was radioactive, highly toxic or noxious, or could be hazardous. Air was supplied in personal tanks or canisters. Typical of these kinds of operations where supplied air was used include cleaning liquid storage tanks, changing contaminated filters, spraying a toxic paint or coating, or entering a smoke-filled room to extinguish a fire. Workers in plutonium process buildings were the most frequent users of supplied breathing air.

The most extensive breathing air system was in the 700-area buildings. Either one of two compressors in Building 708 could supply breathing air to Buildings 707, 771, 774, 776, 777, and 779. Portable compressors also provided Buildings 333, 444, 559, and 881 with breathing air capability.

Inert Gases

An inert atmosphere (nitrogen and less than 5 percent oxygen) was used in various glove boxes and storage areas to minimize the possibility of fire. Total nitrogen consumption during fiscal year 1975 was 515.6 million cubic feet; in 1976, nitrogen consumption was at the rate of 58,000 to 60,000 standard cubic feet per hour.

Gases used in the inert atmosphere were normally supplied from an on site, liquid nitrogen production plant that was owned and operated by a commercial supplier. A secondary supply was a liquid nitrogen storage facility that received liquid nitrogen from the on site plant or by truck or rail shipment from an off site commercial supplier. Distribution of the nitrogen began at Building 223 with an underground, closed-loop distribution line. From there, the gas was sent to Buildings 371, 701, 707, 771, and 776. The nitrogen could be delivered in either clockwise or counterclockwise directions, should one side of the loop have become inoperable. An interior system delivered the gas from the 776 to the 777 area in Building 776/777.

Another inert gas system was a manually controlled argon system used in several plutonium fabrication, assembly, and research buildings. It consisted of a supply tank with distribution headers to various stations. It was used as a shield in arc welding and to provide an inert glove box atmosphere.

Nitrogen and argon gases were used as conveying mediums for solid samples in the close-carrier transfer systems of Building 371. Argon was also used in Building 371 to safely indicate leaks in calcium metal storage facilities; was mixed with fluorine, as make-up in a fluorination process; used to provide an inert atmosphere for molten plutonium metal that was being purified; and used as a purging agent.

Health and Safety Practices

With the exception of those employees working in low-contamination areas such as the laboratories, all the men (women initially were not allowed to work in the production buildings) wore white clothing - coats, pants, hats, underwear, socks, and booties - provided by the Atomic Energy Commission/USDOE (B. Richardson). Depending on the area and task involved, at least 20 percent of an employee's time (1.5 hours per day for each 8-hour shift) was dedicated to issues and practices relating to safety. At a minimum, each employee changed out of their protective clothing for morning, lunch, personal, and afternoon breaks. After each break, the process was reversed (L. Wilson). In addition to the time required for clothes changing, individuals were routinely monitored with hand scanners and other mechanical devices. This protective clothing was laundered in various buildings; originally, Buildings 771, 881, and 991 had their own laundries, and Building 442 laundered the clothing from Building 444. When Building 778 was constructed, the laundry for the plutonium-related buildings was washed there; after 1976 -- when Building 442 became the filter test facility -- all laundry on the site was handled in Building 778 (ChemRisk 1992:96).

Plutonium

Plutonium is a radioactive material that can give off alpha and beta particles, gamma photons, x-rays, and neutrons. Alpha particles do not penetrate the skin but are dangerous. If inhaled they may decay inside the body. Plutonium that is inhaled delivers a radiation dose to the lungs, liver, and bones that may increase the risk of cancer (Sutcliffe 1995:2). As a result, plutonium machining is performed under controlled conditions that include containment, filtering, and shielding (*Citizen's Guide* 1992:16).

Glove boxes and stainless steel enclosures were designed for plutonium handling. Rubber gloves, usually impregnated with lead oxide, were affixed to the glove boxes to facilitate the handling of plutonium. The glove boxes also had lead-glass windows and

0.125"-thick lead shielding to protect personnel against gamma rays and x–rays. Water walls and hydrogenous materials were used where neutron shielding was required.

Containment and shielding meant that plutonium was machined inside lead- and water-lined glove boxes. Plutonium was moved from workstation to workstation within the six modules in Building 707 in a system of interconnected enclosed glove boxes and lines that ran for several hundred feet. In addition, Building 707 was connected to Building 776 via a glove box conveyor line (B. Richardson, personal communication, 1995). In 1971, the operations in the waste treatment building (774) were enclosed, providing containment of radioactive airborne particles. Additional shielding, using lead, leaded glass, and Benelux and Plexiglas was added to the glove boxes and conveyor lines in Buildings 776/777 and 771 in 1968 to reduce exposure to radiation (EG&G 1994). From the outset of operations in the late 1950s, employees wore dosimetry badges to measure external radiation exposure, and radiation and health physics monitors watched operations in the production buildings (Buffer 1995).

Certain glove boxes had inert nitrogen atmospheres containing a maximum of about 5 percent oxygen to protect against fire propagation. Additional protection was provided via the use of heat- and smoke-sensing devices, roll-down fire doors, and fire doors with fusible links within the glove box system, and quick-connect fire extinguishers.

Plutonium ingots and parts were generally stored in closed containers within a large vaults. An inert atmosphere was maintained inside some vaults. One inerted vault had 10"-thick concrete walls with 7.25"-thick windows made of laminated glass enclosing gelled water. Material was introduced and removed from the vault by means of a computer-operated retriever able to be manipulated in three different directions.

Safety in the plutonium fabrication and assembly operation was assured by the following physical and administrative features:

- The operations were enclosed within steel glove boxes, and operating personnel wore protective clothing;
- Certain steps were performed in an inert atmosphere to reduce the chance for combustion;
- Contaminants were filtered from liquid coolants and inert atmospheres;
- Heat, radioactivity, and oxygen levels were continuously monitored;
- Equipment was shielded to protect personnel from exposure to gamma, x-ray, and neutron radiation;
- Fire doors confined fire, and there were effective fire-suppression systems in place;
- Plutonium was handled remotely, whenever possible;
- Criticality limits were posted for easy reference;

- Safety inspectors maintained a constant vigil for unsafe conditions and practices; and
- There was adequate indoctrination and on-the-job training of personnel.

Beryllium

Most beryllium compounds are toxic; if inhaled they can cause what is frequently characterized as beryllium disease or berylliosis. Inhalation is the primary mode of beryllium entry into the body, and clinical symptoms may be either acute or chronic.

Protective measures against dust containing beryllium particles required proper ventilation that included the use of specialized exhaust hoods, immediate availability of respiratory equipment, performance of certain operations under wet conditions, and continuous monitoring at all workstations. Employees in beryllium areas wore protective clothing and had to wash themselves before eating, drinking, or smoking, and prior to leaving the area.

Uranium

Depleted uranium has low radioactivity and was handled outside glove boxes, with the airborne radiation contamination controlled through ventilation. The principal concern when working with depleted uranium is uranium's chemical toxicity. If taken into the body via inhalation or a break in the skin, depleted uranium may damage vital organs such as the kidneys or lungs (similar to heavy metal poisoning).

Workers in uranium fabrication areas wore protective clothing; before leaving their workstations and before eating, drinking, or smoking, they were required to wash adequately.

Non-Radioactive Materials

Regulations for the safe use, storage, shipment, and disposal of various chemicals and materials at the Plant were found in such publications as the material hazards manual, the chemical safety data sheets of the Manufacturing Chemists' Association, the health safety and environmental manual, operational safety analyses, and individual building rules. In its list, the material hazards volume records such information as composition, ignition temperature, irritants, odor threshold, toxicity, reactions with other materials, flash point, flammable limits, and human tolerance limits. In addition, audits, inventories, and reviews were frequently conducted at the Plant.

Research and Development

Research Efforts - Production Processes

In the early years, the Los Alamos (New Mexico) and Lawrence Livermore Laboratory handled most of the research efforts. Any research done at the Rocky Flats Plant was incorporated into production engineering for new weapon design. The Rocky Flats Plant specialized in research concerning the properties of plutonium. Since very few locations in the United States had the capabilities to work with plutonium, discoveries regarding its behavior and properties were largely unknown. Plant personnel considered projects associated with research and development exciting (Stakebake, 1998 interview). Although the mission of the Plant changed to waste management in the late 1980s, research and development programs continued at full scale. Laboratories were established in each of the three manufacturing buildings, specializing in the materials of the Plant, either plutonium, enriched uranium, or depleted uranium.

Each production process in a given building had a number of research and development personnel, technicians, and radiation monitors to handle problems as they arose. During Rockwell's contract, there were over 300 people involved in research and development (Brown, 1998 interview). Research efforts were chiefly directed toward improving the methods by which plutonium parts were produced for nuclear weapons. When the Rocky Flats Plant became the sole producer of plutonium triggers, research and development activities increased markedly.

Research issues related to metallurgy, machining, joining, material evaluation, inspection, nondestructive testing, coating, remote engineering, and chemistry were carried out in the 300, 400, 700, 800, and 900 areas of the Plant.

Specific research labs included: Building 779 (plutonium research); Building 865 (non-plutonium metals and the development of alloys); Building 993 (bonding tests on stainless steel and uranium alloy); and Building 886 (critical mass experiments with uranium and plutonium). Building 886 was one of two remaining general purpose critical mass laboratories in the United States. Experiments conducted at Building 886 were used to set safety standards for the Nuclear Regulatory Commission (ChemRisk 1992: 85-92; EG&G 1992).

Additional testing laboratories were constructed as needed. Building 125 (standards laboratory) was used for analyses of incoming materials for quality assurance/quality control. Building 126 (calibration laboratory) was used to calibrate the machining equipment used in manufacturing precision components. Building 705 was used to test coatings used on materials, and develop work for reactor fuels using depleted uranium oxides and beryllium. Design waste treatment processes were tested in Building 701. Building 559 was used for analysis of the purity of plutonium. Building 561 expanded the

capabilities of the laboratories in Building 559. Under the research and development theme, buildings considered primary contributing elements to the historic significance of Rocky Flats included buildings: 125 (testing-standards lab); 126 (testing-calibration lab); 559 (lab - chemical analytical support for plutonium production); 705 (coating lab); 779 (lab - plutonium production and recovery); and 865 (enriched uranium-material processing).

Areas of Research

Material Handling

The metallurgy section at the Plant studied the properties of plutonium and its alloys under the conditions that existed as the metals were shaped by various metalworking methods. Other metals such as beryllium, titanium, depleted uranium, stainless steel, copper, and aluminum were subjected to melting, casting, forging, rolling, forming, heat treating, and property-measuring operations. Building 865 was built in 1970 to house metalworking equipment for the study of non-plutonium metals and the development of alloys.

Conventional methods for machining plutonium, uranium, beryllium, and other metals, were continually examined in support of production. Experts knowing the latest techniques worked at Rocky Flats. In many cases, there were no commercial substitutes available. Cutting edge technologies conducted at the Plant resulted in a number of patents, doctoral degrees for some of the personnel working on the technologies, and numerous scientific discoveries. Machine shops and machinists would fabricate whatever was needed to facilitate a project. Each production person had access to a number of research and development technicians in the building to handle problems as they arose.

The joining group worked to improve the technology of bonding. They performed resistance welds, welds with an electron beam pulsed arc, a gas metallic arc, and a gas tungsten arc, plus solid-state bonding, using a variety of dissimilar metals.

Research was conducted in inspection methods using laser interferometry, interference microscopy, advanced ultrasonics, and acoustic emissions were developed at the Plant. Nondestructive testing of stainless steel, beryllium, and other materials included ultrasonic, acoustic emission, and eddy current techniques. Optical methods for measuring surface roughness by light scattering and holography were also investigated.

Experimental coating and surface-finishing activities included:

- Electroplating with copper, nickel, chromium, silver, gold, and cadmium;
- Autocatalytic plating with nickel, gold, and copper;
- Chemical milling and polishing of metals;
- Anodizing aluminum and beryllium;
- Oxidizing steels; and
- Organically coating with polyvinyl chloride, Teflon, polyurethane, and epoxy.

Research efforts improved corrosion protection, manufacturing methods, and joining and bonding techniques.

Research associated with remote engineering focused on reducing personnel radiation exposure with the use of remote controls for various processes. New technologies used included:

- Mechanical arms, hydraulically operated to replace human arms in the americium line where extremity exposure was a hazard;
- Devices that could be used in glove box atmospheres to perform as human hands and arms would perform;
- Robots that could carry out repetitive operations and, guided by a human, could handle thermally hot or very heavy operations; and,
- A remote-control vehicle to change cobalt sources for nondestructive testing.

Chemical Research

All of the major production areas contained their own chemical laboratories. Depending on the material that was handled, a wide variety of research projects were conducted. Research at the Plant included:

- Preparing purified actinide compounds, such as oxides, nitrates, fluorides, chlorides, sulfates, and similar compounds;
- Making pure metals and alloys of metals;
- Custom casting foils, disks, and ingots for special orders from USDOE design agency laboratories;
- Selectively hydriding uranium and plutonium;
- Converting the oxides of uranium and plutonium to fluorides, separate from the production stream;
- Developing special separation and purification methods for materials containing plutonium, uranium-235 and -233, americium-241, neptunium, and curium;
- Improving techniques for the recovery of americium;

- Materials development, process instrumentation and control, and equipment design and development of on site waste treatment processes; and
- Development of chemical standards.

Studies also resulted in the development of instruments that were used in improving glove box gloves, bags, and windows; storage testing; and studying the incineration of low-level plutonium-contaminated wastes.

Waste Treatment

Research and development on the treatment and handling of waste was varied and on-going throughout the life of the Plant. Some the studies were oriented towards handling special materials, such as plutonium, while others addressed problems associated with disposing of wastes produced during the production processes.

Other projects included development of an incinerator used for burning plutonium-contaminated waste, development of a waste compactor and development of the ferrite waste treatment process. The plutonium incinerator, designed and built by Plant personnel, was installed in Building 771 in 1958. This equipment functioned like an industrial incinerator with a series of filters, scrubbers and heat exchangers designed to purify toxic gases and other byproducts of the burning process.

In July 1979, the two story, 3,000 square foot fluidized-bed incinerator, housed in Building 776/777, made its first continuous 108 hour run. It brought to a close nine years of research and development on the project. The $2 million incineration facility was designed to demonstrate a process for combustion and reduction of low-level transuranic wastes generated at the Plant.

On September 26, 1985, the waste treatment process called ferrite waste treatment, which significantly improved the method for removing actinide contamination from waste water, earned Rockwell the IR-100 Award (an industry-wide award).

On May 23, 1995, an innovative way to treat waste with waste, which was developed by researchers at the Plant, was unveiled to the public during demonstrations of polymer encapsulation conducted on site.

Explosive Bonding Pit

Explosive bonding experiments were conducted at the explosive forming area near Building 993. Many of the experiments were designed to bond together flat plates of stainless steel and uranium alloy. Experiments conducted in March of 1968 with 192

grams of 40 percent dynamite drove a stainless steel plate into radioactive material, forming a bonded laminate. Other experiments of unknown nature took place near Building 993 for at least two and one half years. Until March 1968, experiments took place inside buried, sand-filled, 55-gallon drums. The explosive events took place below grade. Air shocks from the explosions were objectionable to Building 991 occupants, so a pit was dug into a hillside near Building 993 to house the apparatus and mitigate air shocks. The 10' x 19' pit was approximately 4' deep.

Special Orders

The Plant conducted special order work for other facilities in the nuclear weapons complex, the Department of Defense, and to fulfill needs of other Federal departments and agencies. Most of the special order work at Rocky Flats did not involve materials outside those used in regular production activities. The tracer work was one of the few exceptions.

Radionuclide tracers were introduced into manufactured components and triggers destined for off site test shots. These materials were blended into the regular component materials so that scientists could study performance of the different weapon components based on post-test distribution of the rare tracers. After the test shot, the scientists could then core through the site and find out how each tracer reacted, enabling them to calculate how each of the components acted in the detonation. Neptunium tracers, associated with both uranium and plutonium components, were manufactured in Buildings 771 and 881.

Most of the special order work was relatively short-lived. Perhaps the biggest exception to this would be the zero power plutonium reactor project, in which Rocky Flats manufactured approximately 4,000 stainless steel-clad fuel elements consisting of plutonium, molybdenum, and uranium. Production took place from 1967 to 1968. The Plant manufactured the fuel rods for installation in the reactor at Argonne National Laboratory. The zero power plutonium reactor fuel elements were made by first alloying uranium and molybdenum in Building 444. The uranium-molybdenum alloy was then sent to Building 771, where it was alloyed with plutonium by casting it into plates of various sizes. The ternary alloy plates were clad in stainless steel envelopes in Building 776/777 and sealed by welding.

From the mid 1970s through the late 1980s, the Plant was involved in a series of projects involving depleted uranium manufacturing expertise already developed at the Plant. One such project required the manufacturing of thousands of calorimeter plates used for shielding in reactors at Switzerland, Harvard University, and Brookhaven National Laboratory. The Army contracted the Plant to develop armor-piercing ammunition rounds. This project ran from the mid 1970s to the late 1970s. The Army, fearing that the

armor-piercing technology may fall into the wrong hands, came back to the Plant in 1981 to develop bulletproof armor plates for the M1A1 tanks. For the Army projects, the Plant was only involved in prototype development of these products and not the full-scale production.

Rocky Flats was also involved in Project Plowshare, an effort to develop technology for using nuclear explosives for peaceful applications, such as excavation and uncovering of deep mineral deposits. Example applications envisioned for the technology included excavation of a sea-level alternative to the Panama Canal and west coast harbors for Africa, Australia, and South America. Rocky Flats' involvement in making components for Project Plowshare lasted from around 1959 to the mid-1970s.

Natural Sciences

In 1976, Colorado State University at Fort Collins, under a contract with the Energy Research and Development Administration began a two-year program to determine whether the approximately one hundred deer that roam Rocky Flats ingest any plutonium and consequently transport it back up into the hills. The university was already under contract with the Energy Research and Development Administration to study plutonium in soil, vegetation, and small mammals at Rocky Flats. Results of the study indicated that none of the plant or animal communities contained evidence of radioactive contamination. Follow up studies on the grasshoppers and mice in 1991 also failed to find any evidence of plutonium in the studied ecosystem.

In 1976, Rocky Flats was selected as a test and research center for small wind energy conversion systems and a wind energy research station was established in the northwest corner of the Plant. In October 1984, the wind energy research center at the wind site became part of USDOE's Solar Energy Research Institute organization.

Clean-up and Remediation Studies

In 1994, Rocky Flats was selected as one of fourteen federal technology demonstration sites by a USDOE advisory committee to develop on site innovative technologies. The site was a candidate for demonstration of two of nine technologies identified by the committee—thermal desorption and microwave solidification. A news release issued February 9, 1996, announced that workers at Rocky Flats were using a low temperature process to treat contaminated soils from a former chemical disposal site. The low temperature thermal desorption process involves heating contaminated soils to temperatures from 150 to 300° Fahrenheit, which causes the organic chemicals in the soil to pass off as vapor. The vapors are then condensed into a liquid and passed through a granular-activated carbon unit. Wastes captured in the desorption process were treated on site and/or disposed of at an off site waste facility. In the early 1990s, Plant personnel developed a microwave melter to immobilize wastes in a vitreous, glass-like substance.

On August 25, 1994, representatives of Rocky Flats signed a collaborative agreement between EG&G Rocky Flats and the Los Alamos National Laboratory. The agreement provided for the development of unique technical approaches to environmental cleanup and restoration activities at Rocky Flats.

Support Facilities

An additional 379 structures at the Plant provided a variety of services, including offices, storage buildings, shops, utilities (heating, electrical, and water supply systems), waste management, offices, and maintenance over the years. Of those structures, seven are considered part of the Rocky Flats Plant historic district, including Buildings 333, 334, 374, 441, 443, 551, and 995.

Office Administration

Two office buildings are considered part of the historic district, Building 111 and Building 441. Because Building 111 in the 1950s was the main check-in and access point for employees, it is considered part of the Plant security.

Building 441 contains offices and administrative support facilities. The building formerly supplied analytical and general laboratories required for various Plant A operations (depleted uranium, beryllium). Testing conducted in Building 441 included x-ray chemical analyses, spectroscopy, emission, general chemistry, and water analysis (Ed Vejota, 1998 interview). When the uranium operations were transferred to Oak Ridge, most of the labs were closed down in Building 441 between 1965-1968. After that time much of the structure was converted to office and administrative support facilities.

Building 551 was constructed in 1953 as a warehouse and fabrication shop for metal cleaning, welding, cutting, and threading. The structure is single story, concrete and concrete block L-shaped outline containing approximately 100,000 square feet. A small cluster of offices, including a customer service station, are located in the southern end. Various safety equipment (except safety glasses), spare parts, and orders for special equipment were taken at the customer service area. Since its construction, Building 551 has been used as a primary warehouse. Completed materials from Building 991 were shipped to Building 551 for staging and loading onto trains. Likewise, all equipment and materials were received in Building 551, temporarily stored and then shipped to the appropriate buildings. Shipping and receiving of nuclear parts to the building were discontinued when trucks replaced the train system.

Waste Management

Waste facilities at the Rocky Flats Plant consisted of treatment facilities, process lines, storage facilities, one disposal facility, and support facilities. The historic district waste treatment buildings included: 374 and 774 (Liquid Waste Operations); 776/777 and 889 (Solid Waste Operations); and 995 (Sewage Treatment Plant).

Liquid Waste Treatment

Buildings 774 and 374 are responsible for treatment of liquid process wastes to remove chemical and radioactive constituents. Liquid process wastes were kept separate from sanitary wastes and treated in separate waste treatment facilities. Building 371 and 774 operations treated all liquid process wastes from Building 771 plutonium recovery processes, plus all other liquid process wastes that had too much plutonium content for on site impoundment. The treatment was for the purpose of liquid waste disposal; it included no plutonium recovery. Building 774 was the only Rocky Flats facility capable of processing high-level radioactive liquid waste. Building 374 processed liquid wastes contaminated with lower levels of radioactivity.

Building 774 received radioactive acid wastes, caustic, aqueous, and organic wastes, waste oils, non-radioactive waste, and photographic solutions. These wastes were either piped directly into Building 774, or transferred in drums, containers, or other types of packaging.

Treatment of liquid waste was divided into two stages. The first stage operation in Building 774 treated only the liquid materials associated with plutonium. Recovered materials were packaged in sludge drums. Aqueous wastes not compatible with the first stage operations were isolated and solidified with cement. The second stage operation in

Building 774 handled all other Plant liquid process wastes that required treatment. It also provided further treatment for the first stage effluent. The second stage consisted of two precipitation processes, one continuous and the other batch. The continuous process was used for liquids that were only radioactively contaminated. The batch precipitation process was used for all liquids that were chemically, as well as radioactively contaminated. Both processes utilized the same chemical reagents that were used in the first stage. The precipitate formed was filtered and packaged in drums as sludge. The treated effluents from both processes were held in isolated tanks until analytical sample data was obtained. Treated wastes not meeting the radioactivity requirements were recycled through the appropriate second stage process.

Chemically contaminated process waste that met radioactivity standards without treatment was impounded in lined evaporation ponds; process liquid wastes that met required water specifications without treatment were impounded in Ponds A2 and B2. The chemically contaminated waste impounded in the asphalt-lined ponds was transferred to the evaporator feed tanks in Building 774 as capacity permitted. Recovered waste materials were dried, converted into salts, and boxed for storage.

Contaminated lathe coolant and organic solvent were transferred from their sources via separate pipelines into an isolated feed tank system in Building 774. Miscellaneous organic solvents and oils received in containers were filtered and transferred into the organic solvent feed tank system also. These wastes were processed to form a solid and packaged in drums.

In the 1970s, a series of changes were made in the 774 process. After the 1970s, radioactive processes were contained in glove boxes. In 1982, laundry water processing was shifted to Building 374. Low-level and transuranic waste continued to be processed in Building 774 until 1987, when the low-level processing was halted in anticipation of the startup of the fluidized-bed incinerator in Building 776/777. The transuranic waste processing operation was then redesigned.

The role of Building 774 in process waste treatment diminished with the inauguration of the new process waste treatment facility in Building 374. Building 774 continued to process all contaminated organic waste that could not be incinerated, but decontaminated only those process wastes from the old recovery process in Building 771. Decontaminated waste solutions were then transferred to Building 374 for evaporation.

Construction on Building 374 began in 1977 and was completed in 1980. The waste treatment facility is a freestanding structure approximately 140' X 145'. Total floor space is approximately 66,330 square feet. The evaporator began operating in 1977 to process high-nitrate wastes from the lined ponds.

Building 374 Waste Treatment Facility was designed to remove radioactive and chemical constituents from aqueous waste received from Buildings 122/123, 371, 443, 444, 460, 559, 707, 774, 776/777, 778, 779, 865, 881, 883, 889, and the 207-series solar ponds through the process waste collection system (valve vaults).

The new production wastewater treatment plant was designed to replace Building 774 as the primary-process wastewater treatment plant. Building 374 was designed to more effectively treat nitrate wastes, had a greater processing capacity, improved hazardous material containment systems, and improved control systems. All wastes received were treated for disposal by:

- Decontamination - precipitation;
- Neutralization;
- Evaporation;
- Vacuum filter; and/or
- Spray dryer/saltcrete.

The effluents from these processes were converted into reusable distilled water, disposable solid wastes (saltcrete and vacuum filter sludge), and exhaust gases.

Building 374 houses approximately thirty-three tanks for receiving and storing liquid process waste for treatment; treatment areas (including the evaporator, spray dryer/saltcrete, decontamination-precipitation, neutralizer, and the vacuum filter); container handling and storage areas; supporting mechanical equipment and utilities for the building; a chemical preparation area; and office areas. An enclosed shipping and receiving dock was located on the east side of the building for receiving miscellaneous aqueous wastes from sources not connected to the process waste collection piping system and for receiving empty containers and other process-related items. The dock was also used for shipping full containers of processed solid wastes.

Wastes received at the building were segregated according to radiation and chemical content in order to tailor the treatment process to specific waste parameters for more effective treatment, and to generate a uniform sludge. Treatable liquid waste streams first underwent radioactive waste treatment, which consisted of a combination of precipitation; acid neutralization; sludge filtration, drying and packaging; and process vent scrubbing. Precipitated solids were removed and solidified by cementing in drums. Filtrates were further processed to remove chemical contaminants. Desaltable liquid waste streams were processed to remove salts. Sources of liquids for desalination were primarily laundry wastes, non-radioactive production wastes, radioactively decontaminated waste, and chemically contaminated solutions from asphalt-lined ponds.

The original process waste lines are a network of tanks and underground pipelines used to transport and provide temporary storage for aqueous chemical and radioactive process wastes from point of origin to on site treatment and discharge. The original process waste lines consist of approximately 35,000 feet of pipeline, and seventy-three tanks in thirty-four separate locations. The system handled process wastes from Buildings 123, 444, 707, 771, 776, 779, 865, 881, 881, and 889, including minor amounts of process wastes from Buildings 122 and 441. The original process waste lines routed wastes to Building 774 or to one of the ponds used for either storage or solar evaporation.

These pipelines vary in age, use, and construction materials. They range from 1" to 10" in diameter, and are constructed of a variety of materials, including cast iron, stainless steel, vitrified clay, polyvinyl chloride, Teflon, plastic, and Pyrex glass. Construction of the original process waste lines began in 1952; additions, repairs, and maintenance on the system continued until 1975. Beginning in 1975, construction of replacement waste process lines began, and continued until 1984, when a new double-lined, fully inspectable system was completed.

Solid Waste Treatment

Two buildings were primarily responsible for the treatment of solid waste: Building 776/777 after the fire of 1969; and Building 889, a decontamination facility situated outside the Protected Area. Only Building 776/777 was considered part of the historic district.

Building 776/777 was the main production facility for weapons components until the 1969 fire. Waste operations began in 1969 and were initiated as a means to systematically dispose of fire-damaged equipment.

Building 889 was an equipment decontamination and waste reduction facility for equipment and wastes. Waste materials included surplus equipment, high efficiency particulate air filters, and combustible materials (e.g., paper and plastic) generated inside process areas requiring personal protective equipment for entry, and decontamination prior to exit. Surplus equipment was evaluated for future use; decontaminated equipment might have been reused on site or sold off site. Equipment used included a compactor, a drum crusher, a steam cleaner, and tools required for cutting and disassembly.

The original solid waste landfill at the Plant was located on the south side of the property. The landfill, which opened in 1952 and closed in August 1968, received non-radioactive solid waste such as paper, food items, office wastes, lumber, etc. An incinerator, Facility 209, located on the west access road, was also in operation from 1952 to 1958. The

incinerator was used to burn non-radioactive combustible wastes. Resulting ash residue was buried next to the incinerator. The incinerator was demolished in the 1960s.
A second sanitary landfill began operation in 1968. The second landfill was located on 25 acres north of the Plant in the buffer zone. The landfill was established to dispose of solid sanitary waste generated at the Plant, including dried sanitary waste sludge. By 1971, all solid waste originating in plutonium handling areas of the Plant was monitored for radioactivity prior to placement in solid waste dumpsters destined for the landfill.

Sanitary Wastewater Treatment

Liquid sanitary wastes consisted of sewage from restrooms and janitor sinks, water from showers, food processing areas, and cooling towers. The sanitary wastes from non-plutonium areas were kept separate from sanitary wastes from plutonium areas until they reached a diversion box upstream of two holding tanks above the sewage treatment facility, Building 995. At the holding tanks, the sewage was retained if it was suspected of being contaminated.

The Building 995 treatment process was a flow-equalized, two-train, continuous-flow, activated sludge system followed by polymer/alum-enhanced, post-secondary clarification, filtration, chlorination, and dechlorination. Trucking support was required to transfer the sewage from the wind energy research station and guard station to Building 995, and for the transfer of sewage sludge to the 910 drying beds.

The sanitary waste liquids were filtered and chemically treated. The filtered liquid flowed into the clear well and the first and second chlorine basins for disinfecting. From the second chlorine basin, the treated water went into Pond B-1, then to Pond B-3, and finally to Pond B-4. Initially, treated effluent was discharged from Pond B-4 to Walnut Creek drainage. In 1979, a no discharge policy was instituted, resulting in the use of spray fields to evaporate treated wastewater. The spray fields were used from 1979 to 1985. Treated effluent was also evaporated in Building 374.

Treated wastewater was pumped to the cooling towers of production buildings and evaporated. As the cooling tower evaporated the wastewater, the dissolved and suspended solids remained in the circulating water and would eventually reach a level detrimental to cooling tower operation. Various chemicals are added to the cooling tower's circulating water systems to prevent biological growth, corrosion, scaling, and other effects that can foul heat transfer surfaces and degrade performance. Proportional amounts of these chemicals and their reactants are carried with the blow-down water, which is discharged into the sanitary sewage system. Total solids in the cooling tower water are normally maintained at approximately 500 to 700 parts per million.

Solids from each stage of the liquid waste treatment (aerators, chemical mixing pit, final clarifier, catch basin, and filters) were routed back to the digester for retreatment. From the digester, solids were sent to drying beds, then packaged for offsite shipment.

A number of sludge drying beds had been in use throughout the operational history of the treatment plant. The three original beds were sand and gravel pads; more beds were added in 1962 and 1985. One of the 1985-installed beds was lined with concrete. In 1991, two beds previously used for reverse osmosis processes associated with Building 995 were converted for use as sanitary waste sludge drying beds.

Waste Storage

Rocky Flats had numerous structures, buildings, sheds, and pads for on site storage of waste, including the following:

- Building 569 was located within the Protected Area and was used for storage and radioactive assay of waste crates
- Building 664 was a waste storage, waste staging, and waste shipping facility;
- Building 788 functioned as a storage facility - previous uses included pondcrete processing, where sludges from nearby solar ponds were pumped into the facility and mixed with Portland cement;
- Building 964 stored low-level mixed waste and low-level waste in cargo containers; and
- The 750 and 904 storage pads, which are outside facilities, were originally used as parking lots for office trailers. In 1987, the pads were paved for use as storage areas for pondcrete and saltcrete. In 1990, five tents were installed on the 750 pad and four tents on the 904 pad. The tents provided storage areas for pondcrete and saltcrete.

Utilities Systems

Water

Initially, water was brought in from the city of Boulder in tank trucks until the on site water treatment facility was operational (ChemRisk 1992). Construction of the water system began in 1952, and was completed in 1953. The system has been operating daily since then, with no interruption in service (Web, 1997 interview).

All raw water was purchased from the City and County of Denver and was drawn from two Denver-owned sources, Ralston Reservoir and the South Boulder Diversion Canal (Rockwell, 1989).

Originally, the primary year-round source of raw water was Ralston Reservoir. Completed in 1938, Ralston Reservoir is located about 5-1/2 pipeline miles south-southwest from the Plant site. The reservoir, with a capacity of 1,200-acre feet, originally provided about two-thirds of the water required by the Plant. It is filled from the drainage basin in which it lies and from Gross Reservoir, by way of the South Boulder Diversion Canal. Water was pumped from Ralston Reservoir to the Plant through a cast iron supply main (Denver Water Board, personal communication, 1997; Web, 1997 interview; Rockwell, 1989).

In the early 1980s, the South Boulder Diversion Canal, which passes about one and one-half miles west of the Plant, became the primary source of raw water at the Plant. The canal transfers water from Gross Reservoir to Ralston Reservoir. Because Gross Reservoir, located on South Boulder Creek about ten miles west-northwest of the Plant, is considerably larger and at a higher elevation than Ralston Reservoir, water was carried to the Plant by gravity flow. The Denver Water Board regulates the flow in the canal (Web, 1997 interview; Rockwell, 1989).

Incoming water may be stored in the raw water storage pond located about 1/2 mile west of the water treatment plant (Building 124). The pond has a nominal capacity of 1.5 million gallons, enough water for approximately four days. If necessary, the pond could be bypassed and the water could be pumped directly to the Plant (Rockwell, 1989).

At the Plant, the incoming raw water was divided into two streams. One entered an on site raw water distribution system to disburse water for cooling towers and minor irrigation and miscellaneous purposes. The second stream passed through Building 124 where the water was treated and distributed for domestic, process, and fire protection uses throughout the Plant (Rockwell, 1989).

The potable water system at the Plant has over 2,000,000 gallons of storage capacity in four storage tanks and the Building 124 clear well. Building 215A was one of the storage tanks, and is the only elevated water tower on site. The storage was designed so two separate 4-hour sources of fire protection water were available at all times (Rockwell 1989).

Filter backwash water from Building 124 was reprocessed in a facility that had two 60,000-gallon storage tanks, two drying beds, and several pumps. This facility permitted reuse of highly turbid water, eliminating its discharge off site (Rockwell 1989).

Near Building 124, there is a connection where, in an extreme emergency, the incoming raw water main could be connected directly to the treated water distribution main, bypassing all storage tanks and the treatment plant.

Steam Distribution

Steam produced by boilers at Rocky Flats was used in the heating and air conditioning systems in the buildings and for process heating. Condensate from the heating, ventilation, and air conditioning systems Plant wide was returned to a 300,000 gallon tank (Facility 211), which is located near the steam plant, providing a reserve of boiler feed water. The condensate from process heating was also returned to the steam plant, unless it was contaminated, in which case it was sent to waste treatment for processing.

Building 443, the steam plant, was constructed in 1952, and brought on line in 1953. The building's exterior walls are constructed of concrete and metal. Metal wall additions were constructed in 1966, 1970, 1974, and 1982 to house additional or replacement boilers. The original steam plant main space and mezzanine occupied 4,004 square feet. The 1966 addition encompasses 6,810 square feet on the main floor and mezzanine; the 1970 addition occupies 4,422 square feet on the main and mezzanine floors; and the 1974 addition consists of 4,618 square feet on the main and mezzanine floors. A locomotive was brought on site to provide steam for building heat prior to completion of the Steam Plant (ChemRisk 1992).

The steam plant originally housed boilers 1, 2, and 3, which were fueled with No. 6 fuel oil. Fuel oil was stored in two aboveground fixed roof storage tanks with a combined capacity of 2.3 million gallons. The plant converted to natural gas in 1966 with the removal of the original three boilers and installation of boilers 4 and 5. In 1970, boiler 6 was installed. Boiler 7 was installed in 1974. In 1982, a utility upgrade resulted in the final addition to the steam plant with the construction of a co-generation building.

Steam distribution lines are both above and below ground. The major underground lines in the system are a 12" line from Building 443 to a valve pit near Eighth Street and Central Avenue. The major overhead line runs from Building 443 to the plutonium recovery and waste treatment facilities, Buildings 371 and 374. The remainder of the Plant was served by a 125-pound-per-square-inch system, most of it overhead, from Building 443.

The steam plant was equipped with an emergency generator backup system able to prevent boiler shutdown during power outages by providing all four boilers with a continuous power supply. One generator also provided emergency power for the fire station part of Building 331. The generators were divided so that each one could support two boilers through automatic transfer switches at their respective motor control centers.

Supplemental, standby steam boilers were located in Buildings 881 and 771 for use should the main steam plant shut down. Building 991 was equipped with supplemental hot water boilers. The supplemental boilers were for heating purposes only, and were not used for production.

Plant Power

Plant electricity was purchased from Public Service Company of Colorado. The Plant did not produce its own power for production purposes.

Maintenance

The maintenance structures considered contributing elements to the overall significance of the Rocky Flats Plant included Buildings 333 and 334. Building 333 is a one story, concrete block building. The building is approximately 30' x 100', outside dimensions. Building 333 was originally constructed in 1953; later additions were completed in 1967 and 1973.

Paint storage and painting operations occurred in Rooms 101, 102, and 102A of Building 333. Sandblasting was performed in Room 103 with support equipment in Room 104 and external to the building. The balance of the building housed offices and building support (restrooms, janitor closets). To the west exterior, there was free standing sandblasting equipment with metal frame support for separating paint residue from the blasting agent. There was also a small concrete block storage shed and temporary metal cargo containers.

Building 333 had specialized heating, ventilation, and air conditioning systems for venting of spray paint fumes and the sandblaster. Three specialized off-gas cleanup and filtering systems were installed: a very large filter system for the Room 102A spray booth; a smaller filter system for the Room 101 spray hood; and a cyclone and filter system for the sandblaster to the west end of the building, outside Room 104.

Building 334 primarily supported site maintenance activities and included electrical, machine, sheet metal, carpentry, and pipe shops. Building 334 also had an office area and housed the credit union. Building 334 has a two story shop area and single story office wing and contains approximately 40,000 square feet of space. The exterior walls are constructed of concrete/steel, concrete block, and transite. Some of the exterior walls of the shop area have windows that have been painted.

<u>The Employees</u>

Throughout the years, the Rocky Flats Plant contractors offered jobs to many. In 1951, the Plant employed about 133 people (excluding construction workers). In 1953, when production at the Plant began, the number had risen to 1,059 employees. In 1957, the Soviet Union launched Sputnik and sent the United States into a panic. The Soviet Union had been perceived to be ten years behind the United States in technological developments, but after the launch it appeared they were five to seven years ahead. The government pressured the weapons complex contractors to increase the stockpile of weapons (Tesitor, 1998 interview). From 1957 to the end of the first expansion of the Plant in 1963, the number of employees grew to over 3,000.

In the 1960s, the Atomic Energy Commission changed to a single mission policy, the Plant became the sole producer of triggers, and the employee population rose to over 3,700 by 1970. During the mid-1970s, the Plant had finished the production for prior weapons programs and was awaiting the startup of new ones. President Carter was reluctant to authorize the enhanced-radiation weapon, which was designed to kill people as well as destroy property (Wilson, 1998 interview). Dow Chemical did not renew their contract as site operator. The Plant employee population slid to around 2,750; below the employment level in 1963. The Plant stabilized employment levels with new work in non-nuclear weapons production in stainless steel and depleted uranium armor (Tesitor, 1998 interview).

Under Rockwell and the Reagan administration, the Plant population grew again, reaching close to 6,000 employees. When production was curtailed in 1989, many outside contractors were brought in to bring the buildings up to current standards and write operational procedures so that production could resume. During 1991, the Plant population had increased to over 7,100 employees. Until 1989, slightly over half of the population had been hourly (union) laborers, with the balance being salaried. Under EG&G, hourly (union) laborers accounted for about one-third of the work force. During the early production years, the Atomic Energy Commission had a low level of representation on site (five employees in 1961). After production ceased, the USDOE and support staff population represented over 200 people (Kaiser-Hill Human Resources records, n.d.).

The Rocky Flats Plant offered steady work and good wages. Many production laborers started as janitors, cleaning up contamination, emptying trash, and mopping the floors; a position that paid better than a semi-skilled labor position outside the Plant (Riddle, 1997 interview). In the early 1960s, a janitorial position off site paid approximately $2.00 per hour, compared to $6.00 per hour at the Plant (Tesitor, 1998 interview). Most stayed in a janitorial position for a month or two, while internally competing for a production line or another position.

In July of 1956, Atomic Energy Commission's 20th semi-annual report identified Rocky Flats as a "weapons production facility," with no further explanation of the Plant's secret function. The use of plutonium at the Plant was not reported officially until June 16, 1957 by *The Denver Post*. The article came out as a result of reports that two workers had been injured in an explosion at the Plant on June 14, 1957. In November of 1960, the first aerial photograph of Rocky Flats was published in *The Denver Post*. The caption for the article stated that, "Little is known about the plant's work, except that it handles radioactive materials and some of the very rare minerals coming into new prominence in the defense program" (*The Denver Post* 30 Nov 1960).

Very few employees knew what the final product was that was being shipped to Pantex (Weaver, 1998 interview). Most of the employees did not consider it important to know what the final product of the Plant was. What the workers did know was that whatever they were doing was important to national security and was keeping communism from the United States' shores (Riddle, 1997 interview). A year or so into a job, many employees were able to deduce the true nature of their work. Although some may have been opposed to nuclear weapons in general, most supported a strong government to deter the use of these weapons by others (Wilson, 1998 interview).

Dow promised job security, and that the workers could work there until they died. Benefits were impressive – vacation, insurance, sick leave, and retirement. The contractor provided clothes, physical examinations, and a hot meal at a very low price. The work was interesting, the facility was safe, and the pay was better than most. Opportunities to move up were ample, and Dow Chemical was running the Plant satisfactorily and had good relations with the labor union (Riddle, 1997 interview). Some employees would choose the night shift so they could finish school or spend time with their family (Weaver, 1998 interview; Riddle, 1997 interview). Dow was interested in keeping their employees. The expertise and talent needed to run such a facility could not be hired off the street, and it was a one-of-a-kind plant (Tesitor, 1998 interview). In July of 1974, in recognition of superior performance in safety, environmental control, production, and energy use reduction, Dow employees at Rocky Flats were each paid cash awards equivalent to six and one-half percent of their 1973 base pay (totaling more than $2,280,000).

Despite the rapid pace that weapons production facilities went up across the country in the early 1950s, the Plant was well organized and operated in a safety conscious manner. Most of the training was on-the-job. Knowledgeable people taught new people. Written procedures were minimal. Written procedures that were available were considered guidance, and could not substitute for the feel for the job acquired by the operators (Weaver, 1998 interview). Complex processes relied as much on the operators' first-hand knowledge of the system as on their knowledge of formulas or a procedure. The

buildings were in good condition, the floors were polished, and even the desks were polished once a month (Wilson, 1998 interview).

The opportunity to work with cutting edge technologies led to many patents and advanced degrees (Cunningham, 1998 interview). In 1987, there were ninety-six employees working on site that had earned a Ph.D. (Meyer, 1998 interview), a large number for a non-academic setting. Production and laboratory staff got what they needed to do their work. If a tool was required for a specific task, it was made available. In many cases, there were no commercial products available. Machine shops and the machinists on site were top-notch; they would fabricate whatever was needed to facilitate a project.

Employees working at Rocky Flats, were leaders in the field, knew the latest techniques, and what could and could not be done (Richey, 1998 interview). Early on, there were very few locations in the United States that had the capabilities to work with plutonium. The study of the behavior and properties of plutonium was wide open. Very few people were doing it, and to those in research and development at the Plant, it was very exciting (Stakebake, 1998 interview).

Rocky Flats was a high-security facility. Interviewees and employees knew that the facility was run by the Atomic Energy Commission, and that the Plant was engaged in weapons production. Secrecy was an everyday part of working at the Plant. Even spouses and children were kept in the dark regarding the materials used at the site.

Although secrecy and need-to-know were key security strategies, gossip and comradeship flourished on site. If a co-worker sustained an injury, got a security infraction, or there was a death in the family, the site population knew of it in a very short period of time. Money was collected or good natured ribbing ensued almost immediately. The employees had a strong sense of mission and goal. As one employee put it, "we were helping to fight communism, it was as all American as you could get" (Cunningham, 1998 interview).

A Rocky Flats Family Day was held May 2-3, 1970. This was the first opportunity in the Plant's nineteen years of operation for families to see the facility. Approximately 7,700 people attended the event, including invited members of the press. During the August 26, 1972 Rocky Flats Family Day Celebration, several buildings were opened for viewing, including manufacturing facilities in Buildings 776/777 and 444, research facilities in Building 991, the library in Building 706, and the ceramics laboratory in Building 750 (USDOE Public Affairs, n.d.).

When Rockwell International took over operation of the Plant on July 1, 1975, Plant management began conducting regular briefings to the local press. By July 18, 1975, Rockwell began the first regularly scheduled public tours of the Plant, along with publishing the *Rockwell News*, a four-page employee newspaper published every other Friday.

Along with the changes in public policy, the make-up of the employees working at the Plant has undergone dramatic shifts. The Plant mission change in 1992 from weapons production to environmental cleanup had the greatest impact on the employees. Few ever believed that the Cold War would ever end. After more than thirty years of working in a cutting-edge field and developing highly specialized components, there was no market for this kind of expertise (Tesitor, 1998 interview). The work that many had spent their entire careers doing, ceased. One employee put it this way: "the mission was gone and there is no glory or grace in clean-up" (Cunningham, 1998 interview).

Future of Rocky Flats and the USDOE Nuclear Weapons Complex

All of the major facilities in the United States Nuclear Weapons Complex ceased nuclear weapons production in the 1980s. For several different reasons, the end of production was quite sudden and largely unexpected by most. Incidents of mismanagement and contamination at United States nuclear weapons sites led to a series of investigations into safety and environmental practices (USDOE 1995:79). These investigations pointed out that most of the Energy Department's weapons plants were at or near the end of their design life. Many operations were discontinued while alternatives for weapons production were considered. During this general re-evaluation, the Cold War began winding down. With the collapse of the Soviet Union in 1991, the nuclear arms race of the Cold War came to an end. USDOE's emphasis at Rocky Flats shifted from weapons production to waste management, stabilization, and clean-up activities. This transition involved both engineering and institutional changes.

Rocky Flats goals that are being addressed include: stabilization of radioactive materials; development of a waste management plan; development of new technologies to handle environmental clean-up; and development and research activities oriented towards converting the area to other uses.

At its peak, the United States Nuclear Weapons Complex consisted of the following major facilities, including:

- Hanford Site (Hanford, Washington) - fuel fabrication, irradiation;
- Lawrence Livermore National Laboratory (Livermore, California) - weapons research and design;

- Idaho National Engineering Laboratory (Idaho Falls, Idaho) - chemical separation,
- Rocky Flats Plant (Golden Colorado) - warhead triggers;
- Los Alamos National Laboratory (Los Alamos, New Mexico) - weapons research and design;
- Sandia National Laboratory (Albuquerque, New Mexico) - weapons engineering;
- Pantex Plant (Amarillo, Texas) - high explosives fabrication, final warhead assembly;
- Kansas City Plant (Kansas City, Missouri), - non-nuclear component fabrication;
- Mound Plant (Miamisburg ,Ohio) - fabrication of actuators, ignitors, and detonators;
- Oak Ridge Reservation (Oak Ridge, Tennessee) - deuteride and uranium enrichment, component fabrication (highly enriched uranium, depleted uranium, and lithium);
- Savannah River Site (Aiken, South Carolina) - fuel and target fabrication, irradiation, chemical separation, and tritium production;
- Pinellas Plant (Largo, Florida) - production of neutron generators; and
- Nevada Test Site (Las Vegas, Nevada)- weapons and weapons component testing

The key to an atomic weapon is the fissile materials. The only component in a nuclear weapon that contained fissile material was the trigger manufactured at Rocky Flats. With the retirement of the weapons program, the primary function of Rocky Flats, production of the trigger components, was no longer considered essential.

At this writing, final closure plans for the entire USDOE complex have not been determined. Presently, all buildings associated with plutonium production or use of plutonium at Rocky Flats are to be closed down and removed. Facilities identified for total closure include Mound, Pinellas, Fernald, Hanford, and Rocky Flats. Other facilities will continue to operate in research and development, storage, and/or fabrication.

The cleanup strategy for Rocky Flats is outlined in the 1998 draft document *Accelerating Cleanup: Path to Closure Rocky Flats Environmental Technology Site.* The end state for the Plant has not been finalized, however, the Rocky Flats Closure Agreement describes an end state in which:

- All special nuclear materials are shipped to an off site repository;
- All radioactive waste is shipped off site;
- All facilities are demolished except for facilities contracted for commercial reuse;
- Environmental remediation of contaminated areas is complete to the extent that future land uses are enabled and downstream water supplies are protected; and
- Land use enabled by cleanup levels would permit open space uses of the Plant's buffer zone and either open space or industrial reuse of the industrial area. The nature of open space has yet to be determined.

HISTORIC AMERICAN ENGINEERING RECORD

INDEX TO PHOTOGRAPHS

ROCKY FLATS PLANT HAER No. CO-83
(Rocky Flats Environmental Technology Site)
Bounded by Highways 93, 128, and 72, and Indiana Street
Main Entrance on Highway 93
Golden Vicinity
Jefferson County
Colorado

Photographs CO-83-1 through CO-83-9, by Timothy McGrath and Katherine T. Abeyta, Source One, site photography contractor, summer, 1997.
Photographs CO-83-10 through CO-83-32, by various site photography contractors, dates indicated in parentheses.

CO-83-1 VIEW, LOOKING NORTH, NORTH OF PORTAL 1, JUST INSIDE THE PROTECTED AREA. ON THE LEFT SIDE OF THE PHOTOGRAPH IS BUILDING 709, THE COOLING TOWER FOR BUILDING 707, AND BEHIND BUILDING 709 IS BUILDING 707, THE NEWEST OF THE PLUTONIUM FABRICATION BUILDINGS. IN THE RIGHT FOREGROUND IS BUILDING 763, A BREEZEWAY FOR PEDESTRIANS. IN THE FAR LEFT OF THE PHOTOGRAPH ARE THE T750 TRAILERS AND BUILDING 750, THE PRODUCTION SUPPORT ENGINEERING FACILITY.

CO-83-2 VIEW, LOOKING NORTHWEST, FROM INSIDE THE PROTECTED AREA AT THE BASE OF TOWER 901. THE BUILDINGS IN THE FOREGROUND INCLUDE 984, 992, 991, 989, AND 968. THESE BUILDINGS MAKE UP THE BUILDING 991 COMPLEX. BUILDING 991, PLANT D, WAS THE FIRST OPERATIONAL BUILDING ON SITE, CONSTRUCTED IN 1951 AS THE FINAL ASSEMBLY AND SHIPPING AND RECEIVING BUILDING. TO THE NORTH AND NORTHWEST OF BUILDING 991 ARE THE UNDERGROUND VAULTS AND TUNNELS USED TO STORAGE WEAPONS COMPONENTS.

CO-83-3 VIEW OF CENTRAL AVENUE LOOKING WEST FROM JUST EAST OF THE INTERSECTION OF CENTRAL AVENUE AND THE EAST PERIMETER ROAD. THE ROCKY FLATS PLANT IS ABOUT 16 MILES NORTHWEST OF DENVER ON A PLATEAU AT THE EASTERN EDGE OF THE FRONT RANGE OF THE ROCKY MOUNTAINS.

CO-83-4 VIEW LOOKING WEST DOWN CENTRAL AVENUE AT THE INTERSECTION WITH SEVENTH STREET. THE PLANT HAS MOST OF THE AMENITIES OF A SMALL TOWN – WATER SUPPLY, WASTE WATER TREATMENT, POLICE FORCE, FIRE DEPARTMENT, FOOD SERVICES, HOSPITAL, COMMUNICATIONS NETWORK, STEAM GENERATION, VEHICLE MAINTENANCE, TRANSPORTATION, AND A GOVERNMENT.

CO-83-5 VIEW LOOKING SOUTH DOWN SIXTH STREET AT THE INTERSECTION WITH CENTRAL AVENUE. AS PART OF THE INITIAL SITE DEVELOPMENT, A RAILROAD SPUR, ACCESS ROADS, POWER LINES, AND TELEPHONE LINES WERE BUILT. ALL FACILITIES WERE HEATED BY STEAM GENERATED IN BUILDING 443 AND PIPED THROUGHOUT THE SITE. THE BUILDING IN THE BACKGROUND OF THE PHOTOGRAPH IS BUILDING 664, A LOW-LEVEL WASTE STORAGE FACILITY.

CO-83-6 VIEW LOOKING NORTH ON SIXTH STREET, ACROSS CENTRAL AVENUE. THE BUILDING ON THE RIGHT IS BUILDING 551, BUILT IN 1953 AS A WAREHOUSE AND METAL FABRICATION SHOP. THE BUILDING ON THE LEFT IS BUILDING 334, ALSO BUILT IN 1953, AS THE ELECTRICAL AND GENERAL MAINTENANCE SHOP. IN THE CENTER OF THE PHOTOGRAPH IN THE BACKGROUND IS BUILDING 374, THE AQUEOUS PROCESS WASTE TREATMENT PLANT.

CO-83-7 VIEW LOOKING WEST DOWN CENTRAL AVENUE AT THE INTERSECTION WITH SEVENTH STREET. THE PLANT WAS BUILT ON THE SITE WITH FOUR SEPARATE PRODUCTION AREAS, AND AN ADMINISTRATION AND SUPPORT AREA. THIS PHOTOGRAPH SHOWS THE EASTERN EDGE OF THE CORE ADMINISTRATION AND SUPPORT AREA, BUILT IN THE EARLY 1950S. IN THE LEFT FOREGROUND OF THE PHOTOGRAPH IS BUILDING 442, USED TO TEST ALL HEPA FILTERS ON SITE.

CO-83-8 VIEW, LOOKING NORTHEAST, FROM THE T371 TRAILERS. IN THE FOREGROUND IS BUILDING 371, BUILT IN 1981 TO REPLACE BUILDING 771 FOR PLUTONIUM RECOVERY OPERATIONS. IN THE BACKGROUND, TO THE EAST OF BUILDING 371, ARE

THE 700-AREA BUILDINGS, PLUTONIUM OPERATIONS.

CO-83-9 VIEW LOOKING SOUTHEAST AT THE 771-AREA COMPLEX. THE 771 COMPLEX, ORIGINALLY KNOWN AS PLANT C, HOUSED ALL THE PLUTONIUM PROCESSES UNTIL 1956 WHEN BUILDING 776/777 BECAME OPERATIONAL.

CO-83-10 AERIAL VIEW LOOKING NORTHWEST AT THE 400-AREA COMPLEX. THIS AREA OF THE PLANT MANUFACTURED NON-PLUTONIUM WEAPONS COMPONENTS FROM BERYLLIUM, DEPLETED URANIUM, AND STAINLESS STEEL. THE 400-AREA ALSO INCLUDED A FACILITY FOR THE MODIFICATION OF SAFE SECURE TRANSPORT VEHICLES FOR SPECIAL NUCLEAR MATERIALS BEING SHIPPED TO AND FROM THE SITE. BUILDING 444, IN THE UPPER RIGHT EDGE OF THE PHOTOGRAPH, WAS THE ORIGINAL PLANT A. THE LARGE BUILDING IN THE TOP OF THE PHOTOGRAPH IS BUILDING 460, BUILT AS A STATE-OF-THE-ART STAINLESS STEEL MANUFACTURING FACILITY (6/27/95).

CO-83-11 AERIAL VIEW LOOKING NORTH AT THE BUILDING 800-AREA COMPLEX. ENRICHED URANIUM COMPONENTS WERE MANUFACTURED IN THIS AREA OF THE SITE. BUILDING 881, IN THE RIGHT FOREGROUND OF THE PHOTOGRAPH, WAS THE ORIGINAL PLANT B. BUILDING 883, USED FOR ROLLING AND FORMING URANIUM COMPONENTS, IS DIRECTLY TO THE NORTH OF BUILDING 881. TO THE EAST OF BUILDING 883 IS BUILDING 865, A RESEARCH AND DEVELOPMENT FACILITY FOR ALLOYS AND NON-PLUTONIUM METALS. IN THE FOREGROUND TO THE WEST OF BUILDING 881 IS AN OFFICE BUILDING, 850 (6/7/90).

CO-83-12 VIEW OF THE ROCKY FLATS PLANT LOOKING WEST. AFTER 38 YEARS, WEAPONS PRODUCTION CEASED IN 1989. IN 1992, THE PLANT MISSION CHANGED FROM WEAPONS PRODUCTION TO ENVIRONMENTAL CLEAN UP AND RESTORATION. BY 1995, THE SITE HAD BEGUN TO BE DISMANTLED (6/27/95).

CO-83-13 AERIAL VIEW OF THE ROCKY FLATS PLANT FROM DIRECTLY OVERHEAD IN 1954. IN 1950, DOW CHEMICAL COMPANY WAS CHOSEN BY THE ATOMIC ENERGY COMMISSION TO ESTABLISH THE ROCKY FLATS PLANT AS AN ATOMIC BOMB TRIGGER FABRICATION FACILITY. THE CRITERIA FOR SITING SUCH A PLANT INCLUDED A LOCATION WEST OF THE MISSISSIPPI, NORTH OF TEXAS, SOUTH OF THE NORTHERN BORDER OF COLORADO, AND EAST OF UTAH; A DRY MODERATE CLIMATE; A SUPPORTING POPULATION OF AT LEAST 25,000 PEOPLE; AND ACCESSIBILITY FROM LOS ALAMOS, NM, CHICAGO, IL, AND ST. LOUIS, MO. TWENTY-ONE AREAS IN THE UNITED STATES WERE SUGGESTED; SEVEN LOCATIONS WERE SCREENED IN THE DENVER AREA. THIS FOUR-SQUARE MILE AREA WAS SELECTED AND CONSTRUCTION BEGAN IN 1951 (8/31/54).

CO-83-14 VIEW LOOKING WEST AT THE EAST SIDE OF BUILDING 81 UNDER CONSTRUCTION IN 1952. THE GROUND RISES IN ELEVATION TOWARD THE CENTER OF THE SITE FROM THE NORTH, EAST, AND SOUTH. BUILDINGS 71, 91, AND 81 WERE BUILT INTO HILLSIDES SO THAT IN THE EVENT OF A SOVIET ATTACK, ALL THREE PLANTS WOULD NOT BE DESTROYED (1952).

CO–83-15 VIEW LOOKING EAST AT UNDERGROUND VAULT, BUILDING 997, UNDER CONSTRUCTION. THE VAULTS WERE USED TO STORE TRIGGERS AWAITING OFF-SITE SHIPMENT, OR RETURNED TRIGGERS AWAITING TO BE TRANSPORTED TO A BUILDING FOR RECOVERY OF THE PLUTONIUM. THE VAULT WALLS WERE CONSTRUCTED 14.5 FEET THICK. BUILDING 991, IN THE BACKGROUND, WAS THE FIRST OPERATIONAL BUILDING ON SITE (2/1/52).

CO-83-16 VIEW LOOKING NORTHEAST AT BUILDING 11 (111) IN 1952. IN 1952, BUILDINGS 11 (111), 12 (121), 21 (221), 22 (122), 23 (123), AND 42 442) WERE OCCUPIED. BUILDINGS 91 (991) AND 81 (881) WERE OPERATIONAL. BUILDINGS 44 (444) AND 71 (771) WERE UNDER CONSTRUCTION. THE TOTAL COST FOR CONSTRUCTION BY 1952 WAS $2.5 MILLION. BY SEPTEMBER OF 1953, AUSTIN COMPANY HAD COMPLETED 21 BUILDINGS FOR AN APPROXIMATE COST OF $43.3 MILLION (1952).

CO-83-17 VIEW LOOKING NORTHWEST AT BUILDING 44 (444) UNDER CONSTRUCTION IN 1952. BUILDING 444 WAS A HIGHLY SOPHISTICATED METAL FABRICATION AND MACHINE SHOP CAPABLE OF PRODUCING PARTS TO EXTREMELY CLOSE TOLERANCES FROM BERYLLIUM AND DEPLETED URANIUM (3/2/52).

CO-83-18 VIEW OF THE NORTH ELEVATION OF BUILDING 71 (771) UNDER CONSTRUCTION IN 1952. BUILDING 71 WAS THE ORIGINAL PLUTONIUM OPERATIONS BUILDING. PRODUCTION BUILDINGS WERE BUILT INTO HILLSIDES AND/OR BELOW GRADE AS A SAFETY MEASURE AGAINST RUSSIAN ATTACK (3/2/52).

CO-83-19 VIEW LOOKING NORTH AT BUILDING 81 (881) UNDER CONSTRUCTION IN 1952. THIS BUILDING IS A THREE-STORY REINFORCED CONCRETE AND STEEL BUILDING CONSTRUCTED BELOW GROUND. ITS ROOF IS FLUSH WITH THE FINISH GRADE ALONG THE NORTH AND MOST OF THE EAST AND WEST SIDES. THE BUILDING CONTAINED ENRICHED URANIUM AND STAINLESS STEEL OPERATIONS, AS WELL AS GENERAL ACCOUNTING, COMPUTER AND INFORMATION SYSTEMS, AND RECORD MANAGEMENT (3/2/52).

CO-83-20 AERIAL VIEW OF THE ROCKY FLATS PLANT LOOKING NORTHEAST. THE PLANT WAS COMPOSED OF FOUR WIDELY SEPARATED AREAS, EACH ONE PERFORMING A DIFFERENT TYPE OF WORK. PLANT A (44), SOUTHWEST, FABRICATED PARTS FROM DEPLETED URANIUM, PLANT B (81), SOUTH, WAS ENRICHED URANIUM OPERATIONS, PLANT C (71), NORTH, PLUTONIUM OPERATIONS, AND PLANT D (91), EAST, WAS FINAL ASSEMBLY, SHIPPING AND RECEIVING (2/6/66).

CO-83-21 AERIAL VIEW OF THE ROCKY FLATS PLANT LOOKING NORTHWEST. BY THE LATE 1960S, THE SITE HAD UNDERGONE TWO MAJOR EXPANSIONS. THE FIRST EXPANSION IN 1956-57, WHEN THE TRIGGER DESIGN CHANGED AND NECESSITATED THE ADDITION OF SEVEN NEW BUILDINGS. THE SECOND LARGE EXPANSION TOOK PLACE FROM 1964-65, WHEN ROCKY FLATS BECAME THE SOLE PRODUCER OF TRIGGERS. DURING THIS EXPANSION, ELEVEN BUILDINGS WERE ADDED,

PRIMARILY IN RESEARCH AND DEVELOPMENT LABORATORIES, GUARD HOUSES, AND WASTE WATER TREATMENT (7/1/69).

CO-83-22 AERIAL VIEW LOOKING EAST DOWN CENTRAL AVENUE FROM WEST OF THE ADMINISTRATIVE AND SUPPORT AREA OF THE PLANT. ON THE LEFT (NORTH) SIDE OF THE STREET IN THE FOREGROUND OF THE PHOTOGRAPH IS BUILDING 111, THE GENERAL ADMINISTRATION BUILDING. TO THE EAST OF BUILDING 111 IS BUILDING 112, THE CAFETERIA. FURTHER TO THE EAST IS BUILDING 331, THE VEHICLE MAINTENANCE GARAGE AND FIRE DEPARTMENT; BUILDING 333, THE PAINT SHOP; BUILDING 334, THE ELECTRICAL AND GENERAL MAINTENANCE SHOP; AND BUILDING 551, THE GENERAL WAREHOUSE. ON THE RIGHT (SOUTH) SIDE OF CENTRAL AVENUE, IN THE FOREGROUND IS BUILDING 121, FIREARMS REPAIR. BEHIND BUILDING 121 IS BUILDING 122, EMERGENCY MEDICAL SERVICES, AND BUILDING 123, HEALTH PHYSICS LABORATORY. BUILDING 441, THE PRODUCTION SUPPORT ADMINISTRATIVE OFFICES, IS TO THE EAST OF BUILDING 123. TO THE EAST OF BUILDING 441 IS BUILDING 443, THE STEAM GENERATION PLANT (7/1/69).

CO-83-23 AERIAL VIEW LOOKING SOUTHEAST AT THE PLUTONIUM OPERATION BUILDINGS 771, 776/777, AND 707. BUILDING 771, IN THE FOREGROUND, WAS BUILT IN 1952 TO HOUSE ALL PLUTONIUM OPERATIONS. BY 1956, BUILDING 771 WAS NO LONGER ADEQUATE FOR PRODUCTION DEMANDS. BUILDING 776/777, TO THE SOUTH OF BUILDING 771, WAS CONSTRUCTED TO HOUSE PLUTONIUM FABRICATION AND FOUNDRY OPERATIONS. PLUTONIUM RECOVERY REMAINED IN BUILDING 771. BY 1967, CONSTRUCTION ON BUILDING 707, TO THE SOUTH OF BUILDING 776/777, BEGAN AS PRODUCTION LEVELS CONTINUED TO EXPAND NECESSITATING THE NEED FOR ADDITIONAL PLUTONIUM FABRICATION SPACE (7/1/69).

CO-83-24 AERIAL VIEW LOOKING SOUTHEAST AT BUILDING 371 UNDER CONSTRUCTION IN 1974. BY 1968, BUILDING 771 WAS OUTMODED AND NEW TECHNOLOGIES HAD BEEN DEVELOPED FOR PLUTONIUM RECOVERY. AS A RESULT, A NEW RECOVERY BUILDING, BUILDING 371 WAS PLANNED.

BUILDING 371 SUFFERED FROM VARIOUS DESIGN PROBLEMS, WHICH PREVENTED ITS OPENING UNTIL 1981 AND CAUSED TERMINATION OF RECOVERY OPERATIONS IN 1986. IT NEVER BECAME FULLY OPERATIONAL. TO THE EAST OF BUILDING 371, IS THE 700 BUILDING COMPLEX (4/74).

CO-83-25 AERIAL VIEW OF THE ROCKY FLATS PLANT LOOKING WEST-NORTHWEST IN 1974. IN 1972, 4,600 ACRES WERE PURCHASED AROUND THE SITE TO BETTER PROTECT THE BORDERS FROM TERRORISM AND INFILTRATION BY PROTESTORS. ANTI-NUCLEAR DEMONSTRATION BEGAN SHORTLY AFTER THE 1969 FIRE IN BUILDING 776/777, AND CONTINUED UNTIL PRODUCTION CEASED AT THE PLANT IN 1989 (10/7/74).

CO-83-26 AERIAL VIEW OF THE ROCKY FLATS PLANT LOOKING NORTHEAST. IN 1951, A GOOD FRIDAY ISSUE OF THE DENVER POST ANNOUNCED THE ATOMIC ENERGY COMMISSION'S PLANS TO BUILD THE ROCKY FLATS PLANT, UNDER THE HEADLINE "THERE'S GOOD NEWS TODAY." POLITICAL LEADERS EXPRESSED GREAT PRIDE IN THE CHOICE OF THE DENVER-BOULDER AREA AS THE SITE FOR AN ATOMIC PLANT AS QUOTED IN THE ROCKY MOUNTAIN NEWS: "WE ARE PROUD THAT THE AREA HAS BEEN CHOSEN FOR ANOTHER IMPORTANT CONTRIBUTION TO THE NATION'S STRENGTH AND FUTURE SECURITY." BY THE MID 1970S, PUBLIC OPINION OF THE SITE HAD CHANGED (5/4/78).

CO-83-27 AERIAL VIEW LOOKING EAST DOWN THE WEST ACCESS ROAD. THE FIRST LARGE PROTEST AT THE PLANT CAME IN 1978. IT WAS THE FIRST MAJOR PROTEST AT ANY DEPARTMENT OF ENERGY PLANT. IN RESPONSE TO CONTINUING ANTI-NUCLEAR PROTESTS, IN PARTICULAR A 1979 RALLY THAT DREW 10,000 PARTICIPANTS, ROCKWELL EMPLOYEES AT THE PLANT FORMED A GRASSROOTS ORGANIZATION, CITIZENS FOR ENERGY AND FREEDOM, AND ORGANIZED A PRO-NUCLEAR RALLY, "POWER TO THE PEOPLE," THAT ATTRACTED 16,000 PEOPLE (5/4/78).

CO-83-28 AERIAL VIEW LOOKING EAST AT THE WEST GATE IN 1978. SHOWN IS BUILDING 100, THE MAIN ENTRANCE POINT TO THE SITE FROM 1969 UNTIL 1985. DURING THIS TIME EACH

AUTOMOBILE THAT ENTERED THE SITE WAS SEARCHED. IN 1985, BUILDING 120 WAS BUILT AT THE OUTERMOST WEST EDGE OF THE SITE. THERE WERE 29 FACILITIES AROUND THE SITE DEDICATED TO SECURITY (5/4/78).

CO-83-29 AERIAL VIEW OF THE ROCKY FLATS PLANT LOOKING SOUTH. IN 1983, THE PERIMETER SECURITY ZONE SURROUNDING THE PLUTONIUM OPERATIONS WAS COMPLETED. IT CONSISTED OF A DOUBLE PERIMETER FENCE, CLOSED CIRCUIT TELEVISIONS, ALARMS, AND AN UNINTERRUPTED POWER SUPPLY (7/29/83).

CO-83-30 VIEW OF A GLOVEBOX LINE USED IN PLUTONIUM OPERATIONS. SAFETY AND HEALTH CONCERNS WERE OF MAJOR IMPORTANCE AT THE PLANT, BECAUSE OF THE RADIOACTIVE NATURE OF THE MATERIALS USED. PLUTONIUM GIVES OFF ALPHA AND BETA PARTICLES, GAMMA PROTONS, NEUTRONS, AND IS ALSO PYROPHORIC. AS A RESULT, PLUTONIUM OPERATIONS ARE PERFORMED UNDER CONTROLLED CONDITIONS THAT INCLUDE CONTAINMENT, FILTERING, SHIELDING, AND CREATING AN INERT ATMOSPHERE. PLUTONIUM WAS HANDLED WITHIN GLOVEBOXES THAT WERE INTERCONNECTED AND RAN SEVERAL HUNDRED FEET IN LENGTH (5/5/70).

CO-83-31 VIEW OF A WORKER HOLDING A PLUTONIUM "BUTTON." PLUTONIUM, A MAN-MADE SUBSTANCE, WAS RARE. SCRAPS RESULTING FROM PRODUCTION AND PLUTONIUM RECOVERED FROM RETIRED NUCLEAR WEAPONS WERE RE-PROCESSED INTO VALUABLE PURE-PLUTONIUM METAL (9/19/73).

CO-83-32 AERIAL VIEW OF THE ROCKY FLATS PLANT LOOKING NORTHWEST. DURING THE 1980S, A NUMBER OF COMPLAINTS CONCERNING SAFETY AND ENVIRONMENTAL ERRORS SURFACED, CULMINATING IN THE 1989 RAID ON THE PLANT BY THE FBI FOR ALLEGED ENVIRONMENTAL INFRACTIONS. THAT SAME YEAR, PRODUCTION AT THE PLANT WAS HALTED FOR CORRECTION OF SAFETY DEFICIENCIES. BY 1991, A SERIES OF EVENTS WORLDWIDE REDUCED THE COLD WAR THREAT, AND IN 1992, THE SECRETARY OF ENERGY

ANNOUNCED THAT THE MISSION AT THE PLANT WOULD BE CHANGED TO ENVIRONMENTAL RESTORATION AND WASTE MANAGEMENT, WITH THE GOAL OF CLEANING UP THE PLANT AND SITE (1989).

ROCKY FLATS PLANT

Jefferson County, Colorado

1953 - 1992

After World War II, relations between the United States and the Soviet Union began to sour. The Cold War and a nuclear arms race ensued. In response, the Atomic Energy Commission built a vast network of research, production, and testing facilities that became known as the "Nuclear Weapons Complex." The Rocky Flats Plant was one of these production facilities.

The Rocky Flats Plant, built in 1951, became the sole producer of triggers for the U.S. stockpile of nuclear weapons. A trigger sets off a first-stage fission reaction necessary to detonate a second-stage fusion reaction, or the nuclear explosion.

W80 WARHEAD FOR SEA-OR-AIR LAUNCH

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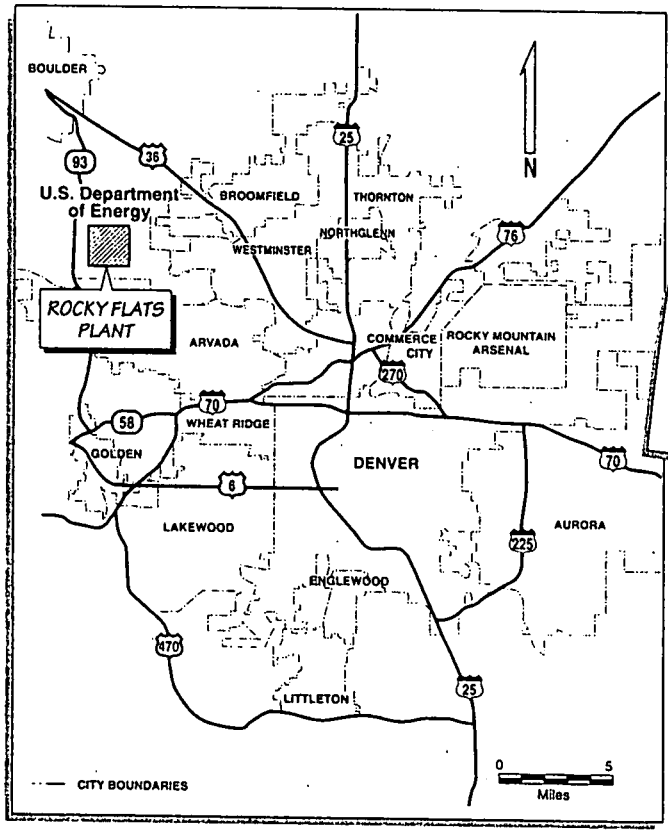
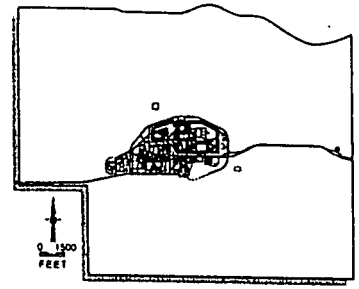
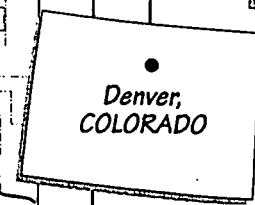
REGIONAL MAP



UTM Reference: Site Boundaries - North 758,410; East 2,094,120; South 741,880; West 2,073,700 Site Boundary

SITE MAP





This recording project is part of the Historic American Engineering Record (HAER), a long-range program to document historically significant engineering, industrial, and maritime works in the United States. The HAER program was undertaken by the US Department of Energy, administered by Kaiser-Hill Company, L.L.C, and prepared by engineering-environmental Management (e^2M), Incorporated.

The fieldwork, historical reports, drawings, and photographs were under the general direction of D. Jayne Aaron of e^2M. The recording team, consisting of D. Jayne Aaron, Dr. Judith Berryman, Nancy Reese, and Samantha Hulme, conducted field work and composed the reports. The drawings were delineated by Margaret N. Leckie. Archival photography was by Timothy C. McGrath and Katherine Abeyta of Source One Management, Inc.

DELINEATED BY: Margaret N. Leckie, 1998 for engineering-environmental Management, Inc.

INTERMOUNTAIN SUPPORT OFFICE / DENVER

GOLDEN VICINITY

ROCKY FLATS PLANT
BOUNDED BY HIGHWAYS 93, 128, AND 72 AND INDIANA STREET - ENTRANCE ON HIGHWAY 93
JEFFERSON COUNTY
COLORADO

SHEET 1 - 17

HISTORIC AMERICAN ENGINEERING RECORD
CO-83

Drawing 1
4/24/98

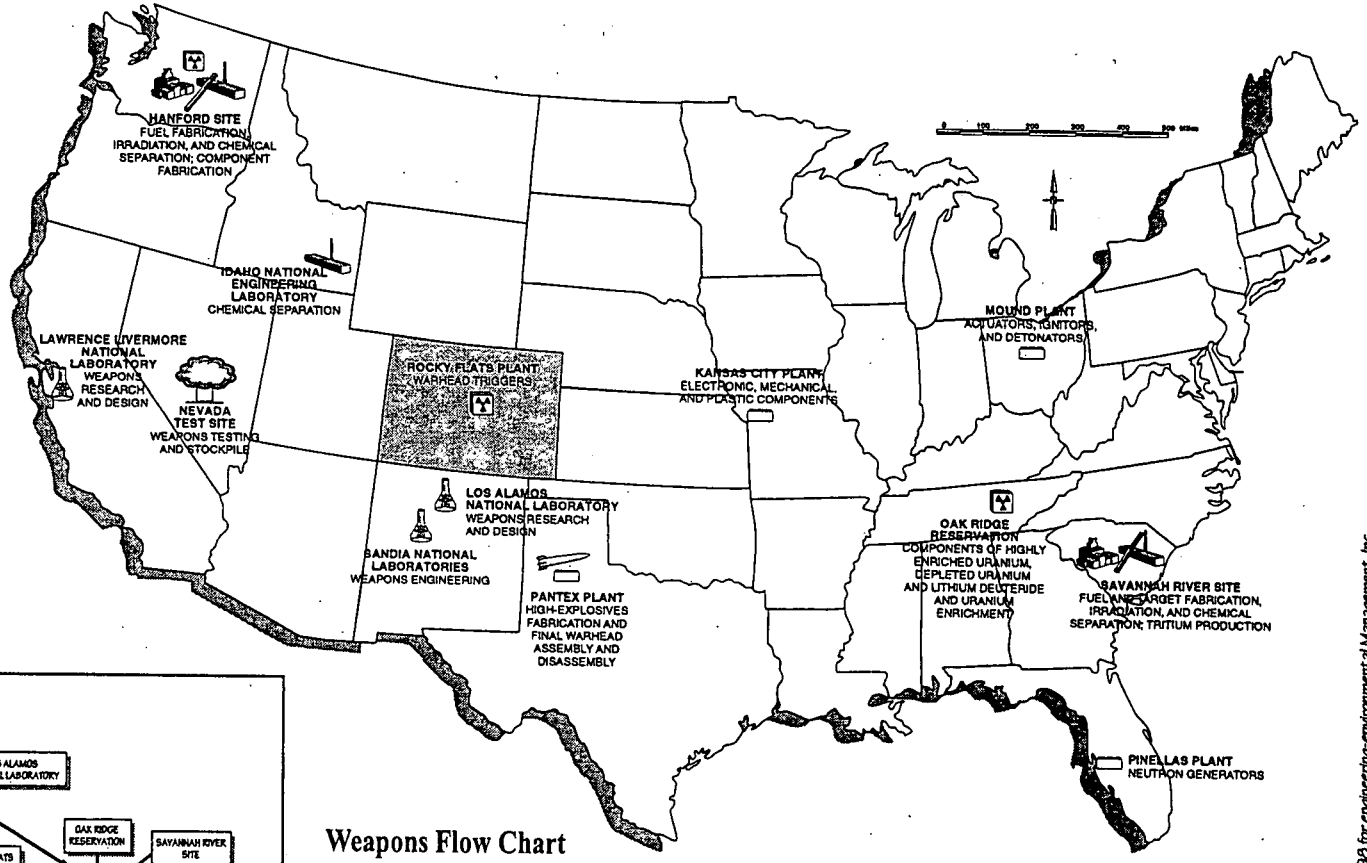
THE U.S. NUCLEAR WEAPONS COMPLEX

The Nuclear Weapons Complex designed, manufactured, and maintained the U.S. Nuclear Weapons Arsenal

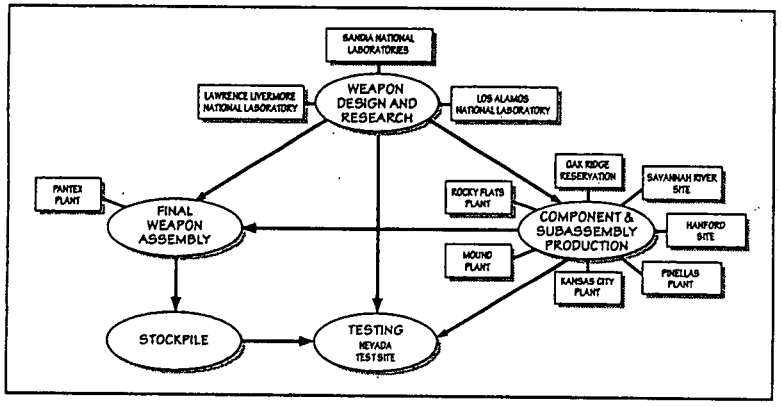
The Nuclear Weapons Complex

The U.S. Nuclear Weapons Complex is a group of thirteen interrelated nuclear weapons complex facilities that design, manufacture, test, and maintain the U.S. nuclear weapon arsenal. The Nuclear Weapons Complex began in 1942 with the creation of the Manhattan Project, the U.S. war-time top secret project to create the world's first bomb powered by nuclear fission. The Complex initially consisted of three facilities: labs and production reactors at Los Alamos, New Mexico; Hanford, Washington; and Oak Ridge Reservation, Tennessee. The Complex expanded to include thirteen major, and hundreds of minor facilities.

The Complex, developed during World War II, was run by the military. Ownership was transferred to the Atomic Energy Commission (AEC) in 1947, then to the Energy Research and Development Administration (ERDA) in 1975, and finally to the cabinet-level Department of Energy (DOE) in 1977.



WEAPONS FLOW CHART



Weapons Flow Chart

Research and design of nuclear weapons occurred primarily at Los Alamos, Lawrence Livermore and Sandia National Laboratories. These three laboratories supplied the basic weapon designs. Savannah River Site, Hanford, and Idaho National Engineering Laboratory supplied the basic materials which would be fabricated into components at the Mound, Kansas City, Pinellas, and Rocky Flats Plants. Final weapon assembly was performed at the Pantex Plant in Texas. After assembly of the completed weapon (bomb warhead), it was incorporated into the U.S. nuclear stockpile. Testing of design components, production assemblies and subassemblies, completed weapons, and older components from the stockpile was conducted at the Nevada Test Site, and other locations.

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UNITED STATES DEPARTMENT OF THE INTERIOR

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SHEET 2 - 17

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Drawing 2
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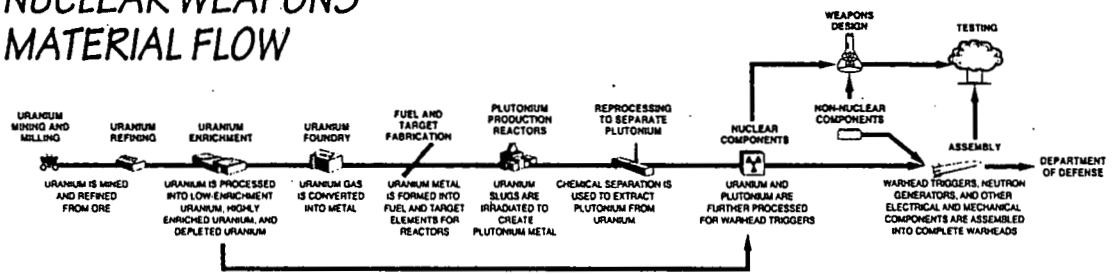
NUCLEAR WEAPONS PRODUCTION

Nuclear Weapons production occured from World War II until the early 1990s

NUCLEAR WEAPONS MATERIAL FLOW



Material Flow

Uranium mines throughout the U.S. supplied the weapons complex with the raw material to create enriched uranium parts for weapons components. The raw ore was refined, enriched, and then converted into uranium metal at foundries. Uranium metal was converted into fuel and target elements for reactors. Uranium metal was irradiated in reactors to generate the man-made element plutonium, which was extracted at chemical separation plants. At other plants, uranium and plutonium were further processed to make warhead triggers and other weapon components. Research and design laboratories developed and tested the concepts used to create weapons, using materials fabricated on-site, and from other Nuclear Weapons Complex facilities. The completed weapons were assembled at the Pantex Plant in Texas. Assembled weapons were stored at strategic locations throughout the U.S. and within the borders of U.S. allies. Test sites in Nevada and the Pacific were used to test weapon component design concepts, individual components, and the final weapon assembly, and to periodically assess existing stockpile integrity.

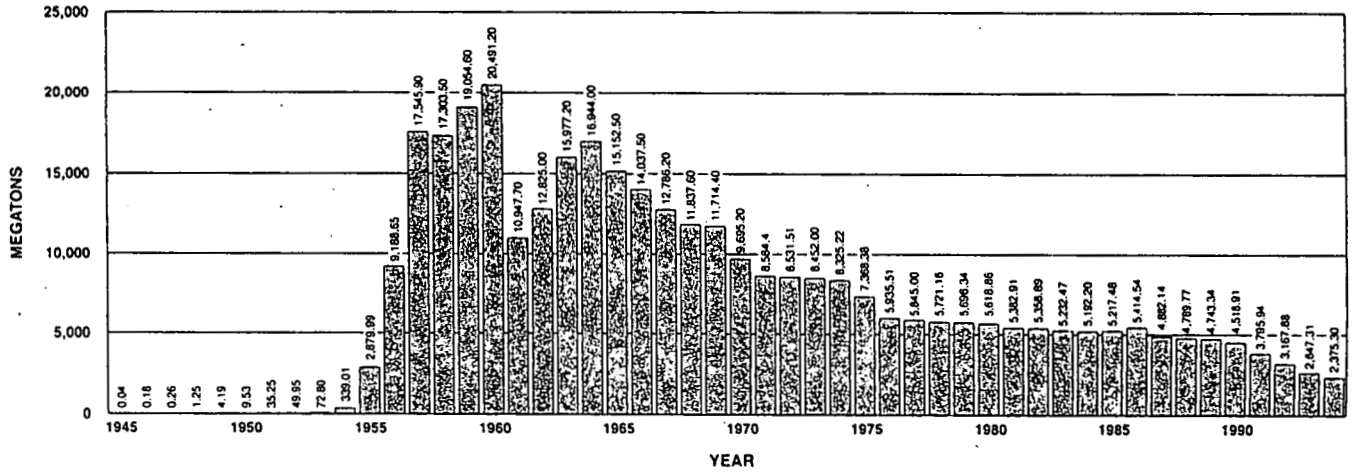
The Nuclear Weapons Stockpile

Nuclear weapons production occurred from World War II until the early 1990s. Initially, production of nuclear weapons was more akin to a laboratory experiment than a factory production line. This time-consuming process impacted the number of weapons which could be produced: two in 1945 (both used against Japan); seven in 1946; and four in 1947. Production jumped to just over 40 in 1948, and with the training of new technicians and the introduction of an assembly-line production process, to just over 120 in 1949. With few exceptions, production increased steadily until 1960, when the U.S. built over 7,000 new nuclear weapons in a single year.

Total capacity of the U.S. arsenal also peaked in 1960, at 20,491.20 megatons (MT). In 1961, the U.S. stockpile exceeded 22,000 nuclear weapons, while total capacity of the stockpile decreased to 10,947.71 MT, due in part to increased retirements of previously built high megaton weapons. The number of new weapons added to the stockpile has decreased since the 1960 peak. As of 1994, total megatonnage of the U.S. stockpile had decreased to approximately 10 percent of the 1960 peak.

EXPLOSIVE FORCE OF THE U.S. NUCLEAR WEAPONS STOCKPILE

SOURCE: USDOE PUBLICATION: DOE FACTS: DECLASSIFICATION OF CERTAIN CHARACTERISTICS OF THE UNITED STATES NUCLEAR WEAPON STOCKPILE, 1994



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GOLDEN VICINITY

ROCKY FLATS PLANT

BOUNDED BY HIGHWAYS 93, 128, AND 72 AND INDIANA STREET - ENTRANCE ON HIGHWAY 93

JEFFERSON COUNTY

COLORADO

SHEET 3 - 17

HISTORIC AMERICAN ENGINEERING RECORD CO-83

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Drawing 3
4/24/98

THE COLD WAR

The Cold War, a period of heightened tensions between the U.S. and Soviet Union, lasted from 1945 to 1990. This period of antagonism resulted in a number of alliances and conflicts involving nations in Europe and the world, including Korea, Vietnam, Turkey, Iran, Nicaragua, Cuba, Libya, and Afghanistan. The U.S. and Soviet Union pursued a policy of massive retaliation, with thousands of nuclear weapons aimed at each other. If one side used nuclear weapons, the other promised to respond with a massive barrage that would ensure the destruction of the instigator, if not the population of the entire world. The 1970s saw a brief period of détente, with a relative lessening of tensions, and the beginning of arms limitation treaties. This period of détente was short lived, and was replaced with another period of arms build-up, which lasted until the fall of the Soviet Union. Arms-related expenditures may have been at least partly responsible for that fall.

COLD WAR TIMELINE

1930's

1932 — J. D. Cockroft & E. T. S. Walton first split an atom.

1934 — Enrico Fermi produced fission.

December 1938 — Two German scientists, Otto Hahn and Fritz Strassman, demonstrated nuclear fission in uranium.

August 1939 — Albert Einstein sent letter to President Roosevelt informing him of German atomic research and potential for a bomb. Roosevelt formed a committee to investigate military implications of atomic research.

1940's

October 1941 — President Roosevelt instructed Vannevar Bush to find out if a nuclear bomb could be built and at what cost.

December 1941 — Japan bombed Pearl Harbor, and the US entered WWII.

September 1942 — The Manhattan Project was formed to secretly build the atomic bomb before Germany.

Construction of the Oak Ridge Reservation began.

November 1942 — Los Alamos was selected as the site for an atomic bomb lab.

1943 — Hanford was built to produce plutonium.

1945 — Yalta Summit ratified a divided post-war Europe.

August 1945 — US dropped atomic bombs on Japan.

March 1946 — Churchill proclaimed that an "Iron Curtain" had come down across Europe.

July 1946 — The Atomic Energy Act was passed, establishing the Atomic Energy Commission, replacing the Manhattan Project.

1947 — The Atomic Energy Commission took over Weapons Complex.

August 1949 — Russia detonated its first atomic device.

June 1950 — Korean War Began.

1950's

October 1951 — AEC appropriations increased in FY51 and FY52. By late 1951, 2% of entire American construction force was employed in AEC jobs. Department of Defense and AEC jointly called for further atomic plant expansions.

December 1951 — The first usable electricity from nuclear fission was produced at the Idaho National Engineering Lab.

1952 — New York City issued 50,000 dogtags to identify children's remains in event of nuclear attack.

October 1952 — Savannah River Site began operations.

1953 — U.S. detonated H-bomb at Bikini Atoll. The blast was 1,000 times greater than at Hiroshima.

Rocky Flats constructed and began operations, Dow Chemical Co. operator.

1957 — Soviets launched Sputnik.

1960 — First submarine - launched nuclear missiles deployed. France tested nuclear bomb. Israeli nuclear program began.

1960's

July 1961 — President Kennedy urged all Americans to build bomb shelters.

August 1961 — The Berlin wall was erected between east and west Berlin.

October 1962 — Cuban Missile Crisis.

August 1963 — Limited Test Ban Treaty agreed. Testing went underground.

February 1964 — Robert McNamara outlined policy of Mutual Assured Destruction, in which 100 million Americans would die in the first hour of nuclear attack, and even more Soviets would perish.

1968 — Nuclear Non-Proliferation Treaty: Unilateral agreement signed and ratified by the US, USSR, UK, and 133 non-nuclear-weapon states to prevent the spread of nuclear weapons.

1970's

1970 — Soviets devised the Doomsday Machine; a rocket that would launch all missiles if the U.S. attacked.

1973 — Arab-Israel war began. President Nixon ordered U.S. nuclear force to DefCom 3, two steps from nuclear war.

1974 — The Energy Reorganization Act abolished the Atomic Energy Commission and created the Energy Research and Development Administration and the Nuclear Regulatory Administration.

1975 — Energy Research & Development Admin. took over Nuclear Weapons Complex.

Rockwell International took over as contractor at Rocky Flats.

October 1977 — The Department of Energy replaced the Energy Research and Development Administration.

June 1979 — The US and USSR signed Strategic Arms Limitation Treaty II.

1980's

1984 — U.S. detected launch of 2 Soviet missiles. It turned out to be a computer glitch.

1985 — The Soviet arsenal reached its peak of 45,000 weapons.

1989 — The Rocky Flats Plant and Fernald Feed Materials Production Center ceased production.

EG&G took over as contractor at Rocky Flats.

November 1989 — The Berlin Wall was torn down, many communist governments collapsed.

July 1990 — Last U.S. nuclear weapons were assembled.

1990's

1991 — The USSR broke up.

U.S. Pres. Bush and Soviet Pres. Gorbechev agreed to reduce nuclear arsenals by a third.

1992 — Hanford and Rocky Flats changed their mission from nuclear materials production to environmental clean up.

November 1990 — Conference on Security and Cooperation in Europe formally ended the Cold War.

October 1990 — Germany was reunited as one country.

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INTERMOUNTAIN SUPPORT OFFICE / DENVER

UNITED STATES DEPARTMENT OF THE INTERIOR — NATIONAL PARK SERVICE

GOLDEN VICINITY

ROCKY FLATS PLANT
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JEFFERSON COUNTY
COLORADO

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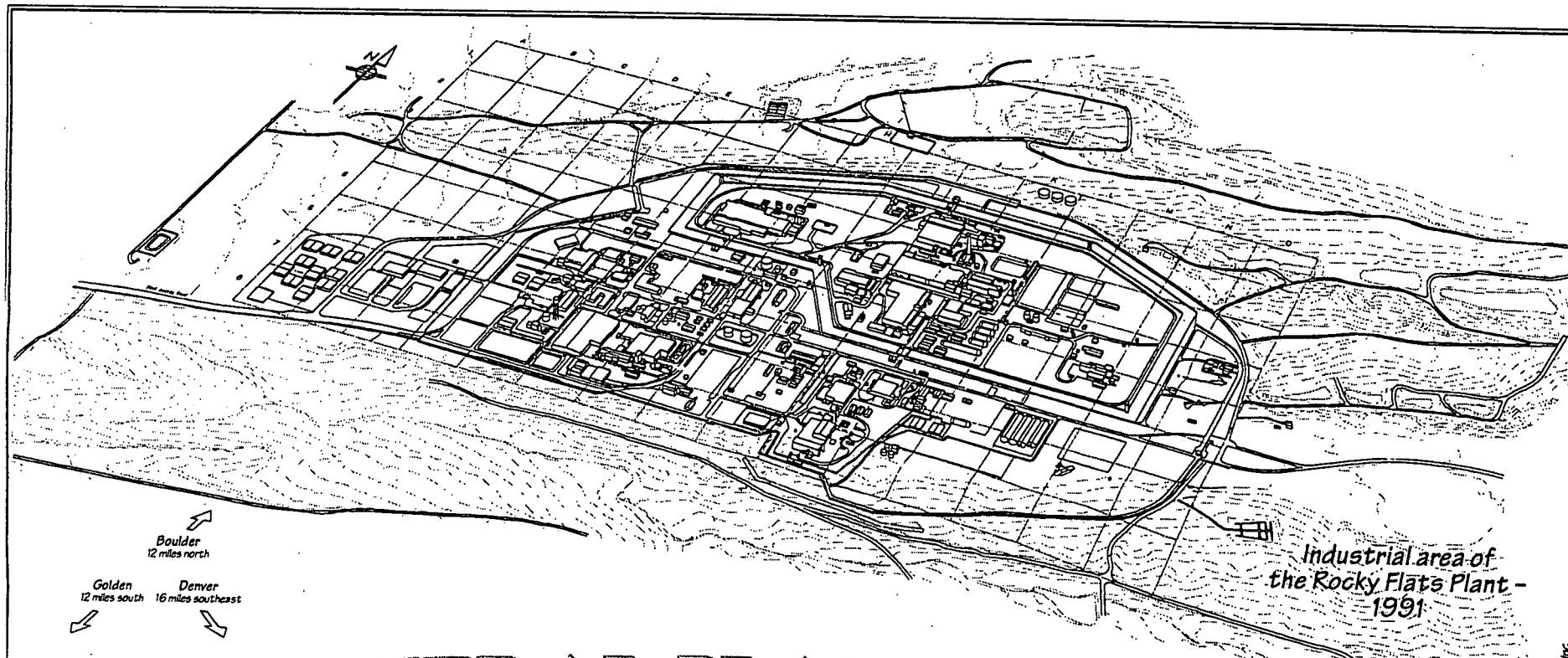

GENERAL PLANT MISSION

Jefferson County, Colorado

The Rocky Flats Plant was established in 1951 to manufacture triggers for use in nuclear weapons and to purify plutonium recovered from retired weapons (called site returns). During the 1950s, the desire was to get Los Alamos National Laboratory out of weapons production and back into design. However, national policy at the time required that in the event of a nuclear attack by the Soviet Union, all critical elements of weapons production could be duplicated at another facility. Los Alamos National Laboratory retained capabilities for trigger production, although the majority of the triggers in the nuclear weapons stockpile were manufactured at Rocky Flats.

The trigger contained the majority of the fissile material in a nuclear weapon. Parts were formed from plutonium, uranium, beryllium, stainless steel, and other materials. A number of different weapons programs were on-going at the Plant at any one time.

Depending on specific time periods, mission statements for Rocky Flats have included:

- Developing and producing of nuclear weapons components from plutonium alloys, beryllium, stainless steel, and depleted uranium;
- Recovery and reprocessing of plutonium from site returns (retired weapons) and from by-product residues from manufacturing and recovery operations;
- Fulfilling USDOE/Department of Defense new deployment and testing requirements - supporting design agency development and testing for Nevada Test Site triggers, non-nuclear hardware, and other production agency development;
- Conducting in-house technology and process development;
- Providing weapons trainers and mockups;
- Disassembling and evaluating triggers from stockpiles;
- Providing reliability evaluation programs; and
- Fabricating and modifying tractors and trailers for safe secure transport.

The weapons production and disassembly missions were canceled in January 1992, and the Plant mission became environmental restoration. To better reflect this new mission, the Plant name was changed to the Rocky Flats Environmental Technology Site.

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GOLDEN VICINITY

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JEFFERSON COUNTY

ROCKY FLATS PLANT

COLORADO

SHEET 5 - 17

HISTORIC AMERICAN ENGINEERING RECORD CO-83

Drawing 5
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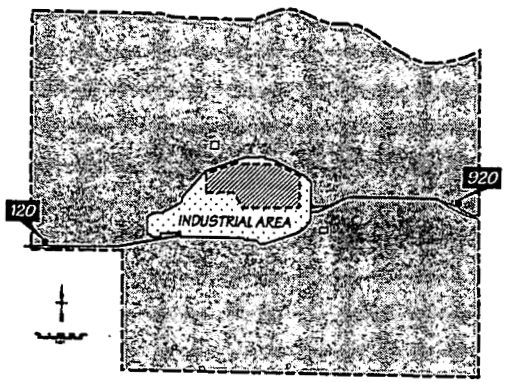
THE ROCKY FLATS PLANT HISTORIC DISTRICT

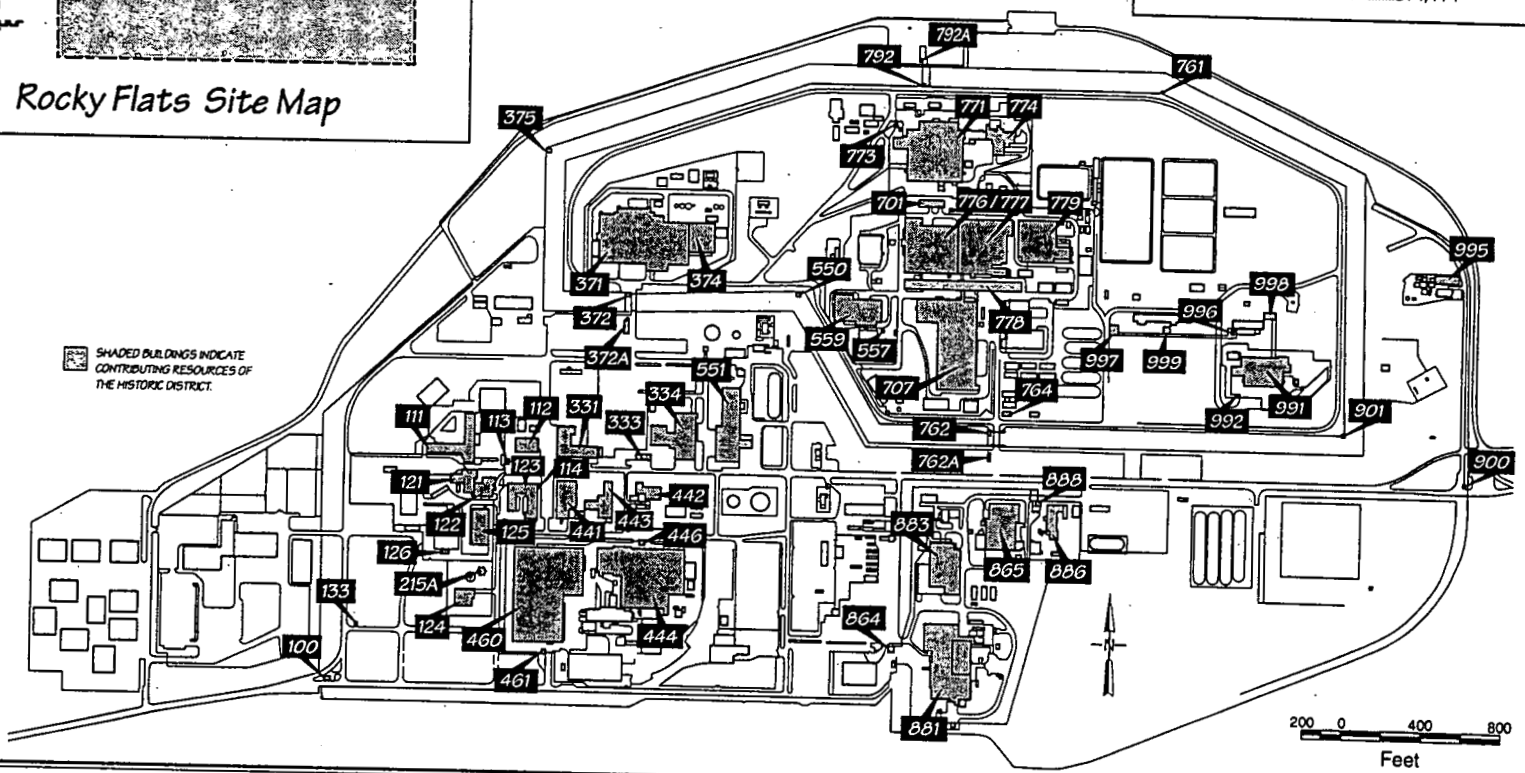


Rocky Flats Site Map

By 1992, the Plant consisted of approximately 436 structures that included 150 permanent buildings, 90 temporary trailers, and other smaller structures, temporary structures, or parts of larger buildings. Of these permanent buildings, 64 are considered contributing properties to the Rocky Flats Plant historic district as the facilities were directly associated with the mission of the plant. These buildings include the original plant built from 1951 to 1953, all of the major production facilities, the research and development buildings, the health and safety facilities, and the security structures. All of the buildings are located within the Industrial Area except the guard facilities at each site entrance.

BUILDING LEGEND

Production Work	371, 444, 460, 701, 707, 771, 776/777, 881, 883, 991, 996, 997, 998, 999.
Research and Development	125, 126, 559, 779, 865
Worker Safety/Health	112, 114, 122, 123, 331, 442, 778, 886;
Security	100, 111, 113, 120, 121, 133, 372, 372A, 375, 440, 446, 461, 550, 557, 761, 762, 762A, 764, 773, 792, 792A, 864, 888, 900, 901, 920, 992
Administration	441
Infrastructure	124, 215A, 443, 551, 995
Maintenance	333, 334
Production Waste Treatment	374, 774



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Drawing 6
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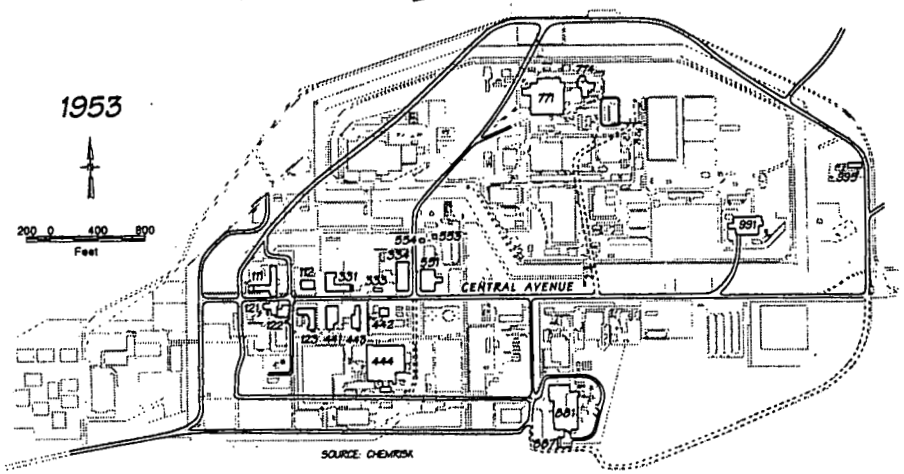
HISTORY OF SITE

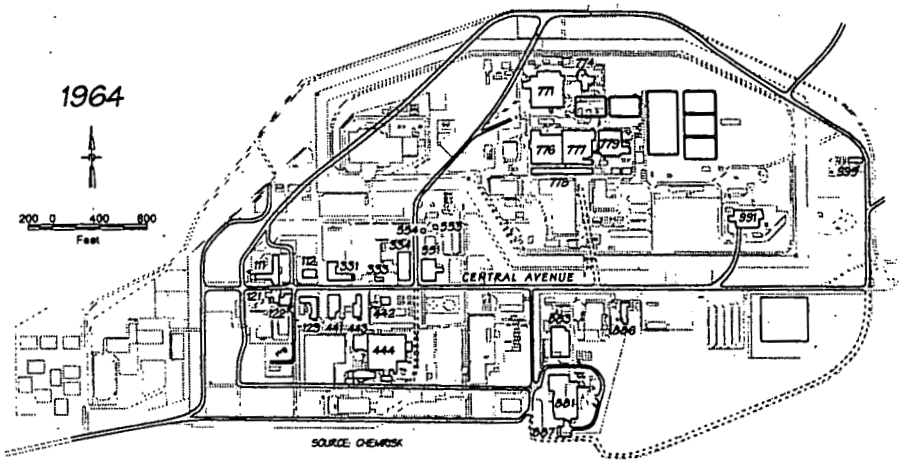
1953



1953 – Original Plant

By September of 1953, there were 21 permanent buildings on-site, and about 1,100 workers. Manufacturing was divided into four independent areas. Depleted uranium manufacturing occurred in Building 444, located in the southwest portion of the Plant. Enriched uranium manufacturing and recovery was located in Building 881 in the south. Plutonium recovery and manufacturing was located in Building 771, to the north. Assembly of parts fabricated around the Plant took place in Building 991, to the east. Plant administration, the cafeteria, security headquarters, medical services, the fire department, and the laundry were clustered together along Central Avenue in the area farthest from the radioactive materials.

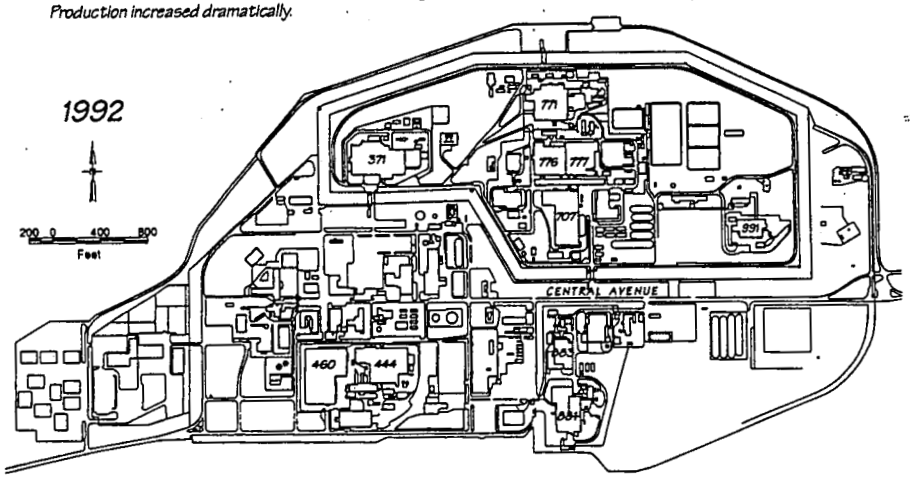
1964



1954-91 – Production Era

The first major expansion of the Plant came in 1956 with a large-scale change in the design of the trigger. The change required the construction of new production and support buildings. The next expansion of the Plant came in the 1960s when the Atomic Energy Commission adopted a singe mission policy for all nuclear weapons production facilities. Previously, all key production functions were duplicated at other facilities to provide redundancy in case of enemy attack. Under the new concept, each facility was to provide a separate weapon production function. As a result, enriched uranium work was transferred to Oak Ridge, and Rocky Flats became the sole producer of triggers. Production increased dramatically.

1992



1992 – Mission Change

In 1989, the Federal Bureau of Investigation raided the Plant for alleged safety and environmental infractions. That same year, nuclear production at the Plant was halted by the Secretary of Energy to correct safety deficiencies. Also in 1989, the Plant was added to the National Priorities List of Contaminated Sites to be remediated under the government's Superfund program. By 1991, a series of events worldwide, such as the fall of the Berlin Wall and the break up of the Soviet Union, caused the U.S. to reconsider the need for continued nuclear weapons production. In 1992, the President canceled the Trident II missile program. Although other weapons programs were planned and in production, the Trident II represented the majority of the production work at the Plant at that time. Also that year, the Secretary of Energy publicly announced that the mission at the Plant would be changed to environmental restoration and waste management, with the goal of cleaning up and converting the Plant to a new use.

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Drawing 7
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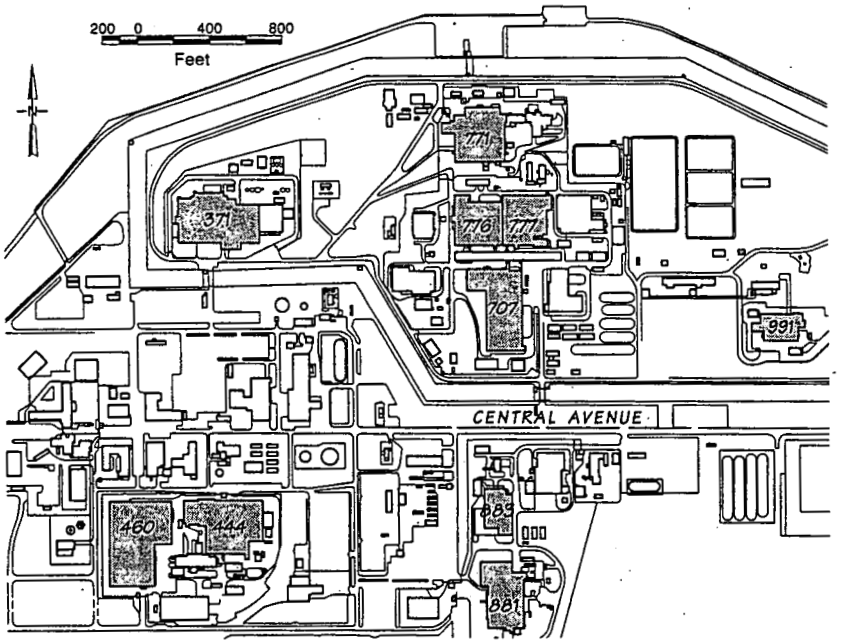
MATERIAL OVERVIEW



Plutonium

Plutonium was used to create a first-stage fission reaction, or trigger, which set off a second-stage reaction, or nuclear explosion. As the quantity of plutonium used in later trigger designs changed, fabrication processes increased in complexity, resulting in a dramatic expansion of plutonium operations at the site. Sources of plutonium at the Plant included virgin material from other Nuclear Weapons Complex facilities, site returns (retired or returned weapons), and chemical recovery from Plant wastes. Plutonium operations began in 1953. Plutonium recovery operations occurred in Buildings 771 and 371. Manufacturing processes occurred in Buildings 771, 776/777, and 707, all within the Protected Area of the Plant.

Stainless Steel

Reservoirs, tubes, and other non-fissile trigger components were made from stainless steel. Most of these components were associated with the tritium "reservoir-to-trigger" delivery system, which boosted the yield of the explosion produced by the weapons. Initially, prefabricated stainless steel components were received from American Car and Foundry Industries in Albuquerque, New Mexico for final assembly. Fabrication operations were transferred to the Plant in 1966. Stainless steel operations moved into vacant space in Building 881, and later moved to the newly constructed Building 460.

Beryllium

Production-scale beryllium operations began at Rocky Flats in 1958. These operations initially involved only the machining, final inspection, and assembly of beryllium parts supplied by an off-site vendor. By the mid-1960s, beryllium operations also included the casting and shaping of parts. Due to its brittle nature, unique handling techniques had to be developed. Beryllium operations took place in Buildings 444, 881, and 883. Beryllium was used as a lightweight nuetron deflector.

Enriched Uranium

Until a design change in 1956, the core of the trigger was made mostly of enriched uranium. Enriched uranium operations at the Plant occurred from 1952 until 1964, when they were consolidated in another Nuclear Weapons Complex facility. From 1964 until 1989, enriched uranium components were shipped to the Plant for assembly into the trigger. Enriched uranium operations occurred primarily in Building 881, with rolling and forming conducted in Building 883. Enriched uranium recovery operations were conducted in Building 881, and on a limited basis involving site-returns, in Building 771.

Depleted Uranium

Other non-fissile weapons components in the trigger were manufactured from depleted uranium. Later, this material was also machined into sheets used as a bulletproof shielding in military tank armor. Depleted uranium operations at the Plant occurred from 1952 until 1989. Depleted uranium operations were conducted in Building 444, and later also in Building 883. Finished depleted uranium parts were sent to Buildings 991, 777, or 707 for final assembly, depending on the time frame. Depleted uranium recovery operations were not conducted at the Plant.

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NATIONAL PARK SERVICE
WESTERN REGIONAL OFFICE / SAN FRANCISCO

GOLDEN VICINITY

ROCKY FLATS PLANT
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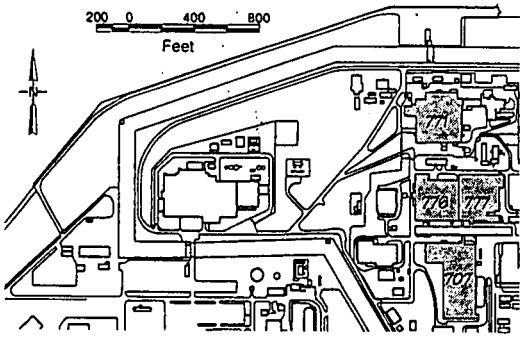
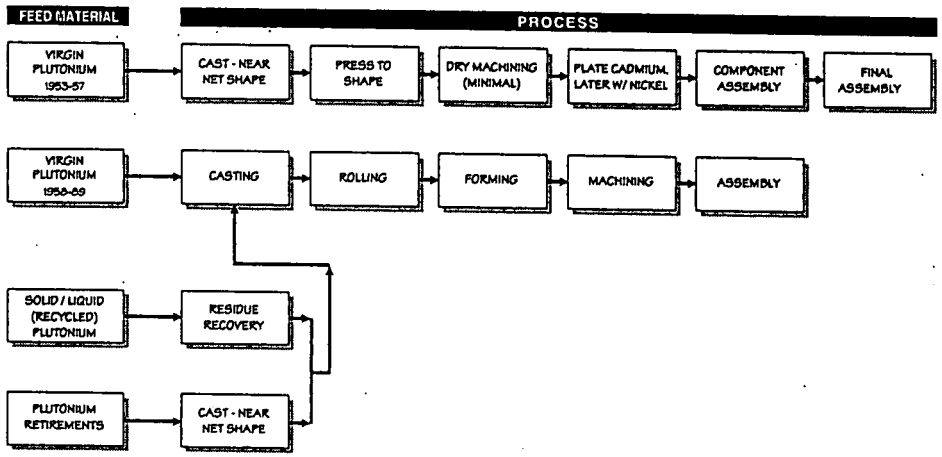
PLUTONIUM FABRICATION

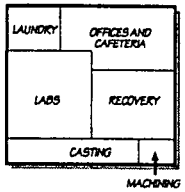


Plutonium fabrication began in 1953 in Building 771, and, as the scale and complexity of plutonium operations increased, expanded to other buildings. Initial operations involved minimal machining and processing, and included coating of the plutonium to allow for handling in the open air. With changes in trigger design, additional processing was required, and Buildings 707 and 776/777 were constructed to house expanded operations. These operations included plutonium casting, machining, fabrication, assembly, and quality assurance testing. Building 707 incorporated new design features such as glove boxes provided with inert atmospheres, and increased use of glove boxes. Additional plutonium foundry, fabrication, and assembly operations moved to Building 707 after a fire in Building 776/777.

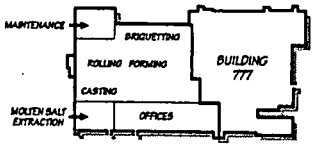
PLUTONIUM FABRICATION FLOW DIAGRAM



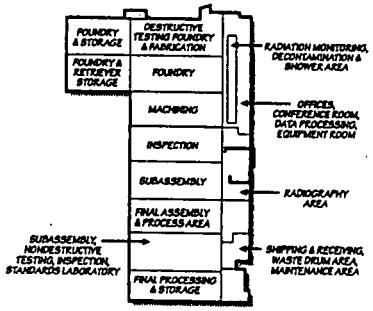
BUILDINGS INVOLVED IN PLUTONIUM FABRICATION



Building 771
(schematic floor plan 1953 - 1957)



Building 776
(schematic floor plan 1957 - 1969)



Building 707
(schematic floor plan 1969 - 1989)

DELINEATED BY: Margaret N. Leckie, 1996 for engineering-environmental Management, Inc.

INTERMOUNTAIN SUPPORT OFFICE / DENVER

GOLDEN VICINITY

BOUNDED BY HIGHWAYS 93, 128, AND 72 AND INDIANA STREET - ENTRANCE ON HIGHWAY 93

ROCKY FLATS PLANT
JEFFERSON COUNTY
COLORADO

SHEET 9 - 17

HISTORIC AMERICAN ENGINEERING RECORD
CO-83

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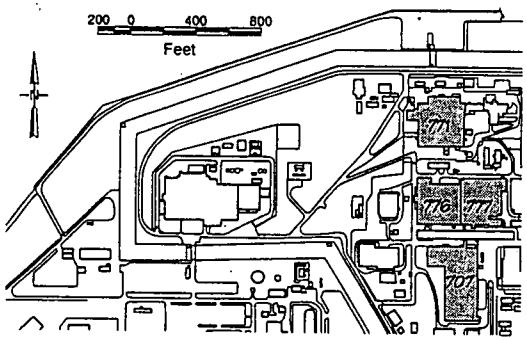
Drawing 9
3/24/98

PLUTONIUM FABRICATION



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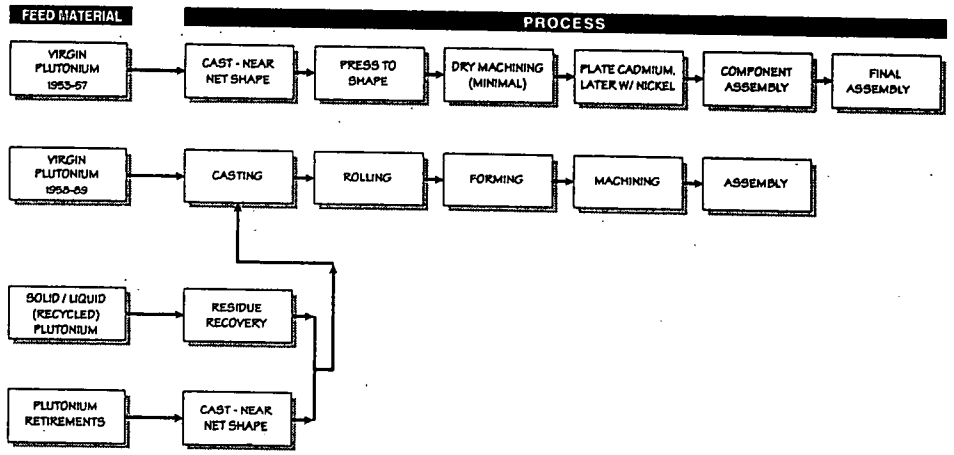
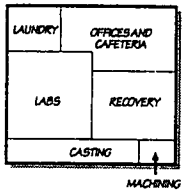
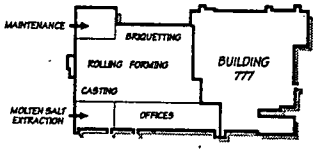
PLUTONIUM FABRICATION FLOW DIAGRAM



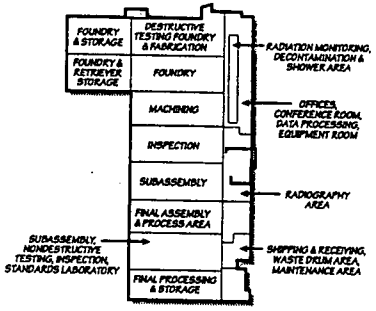
BUILDINGS INVOLVED IN PLUTONIUM FABRICATION



Building 771
(schematic floor plan 1953 - 1957)



Building 776
(schematic floor plan 1957 - 1969)



Building 707
(schematic floor plan 1969 - 1989)

DELINEATED BY: Margaret N. Leckie, 1998 for engineering-environmental Management, Inc.

INTERMOUNTAIN SUPPORT OFFICE / DENVER

GOLDEN VICINITY

ROCKY FLATS PLANT
BOUNDED BY HIGHWAYS 93, 128, AND 72 AND INDIANA STREET - ENTRANCE ON HIGHWAY 93
JEFFERSON COUNTY

COLORADO

SHEET 9 - 17

HISTORIC AMERICAN ENGINEERING RECORD CO-83

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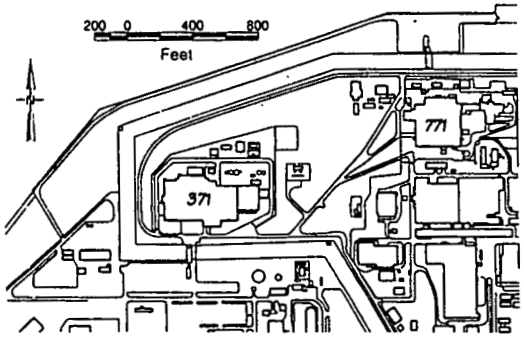
Drawing 9
3/24/98

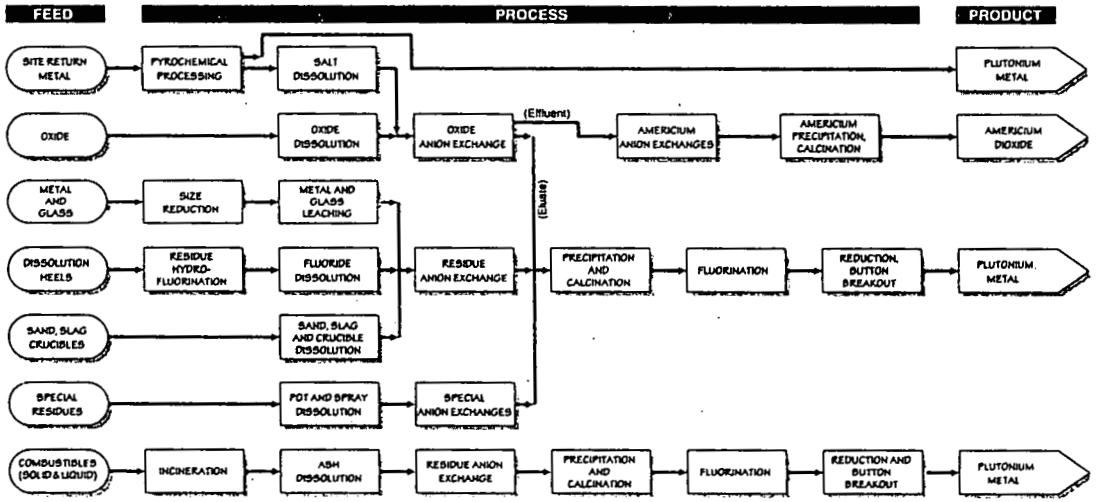
PLUTONIUM RECOVERY



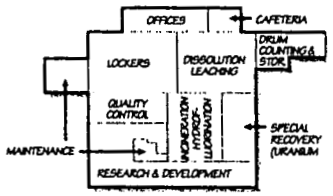
Plutonium operations began in Building 771 in 1953. Building 371 was built to replace the recovery operations in Building 771 in the early 1980s. However, satisfactory recovery operations were never achieved due to design and process deficiencies. Operations continued in Building 771 until 1989. The overall process and chemistry of plutonium recovery remained relatively unchanged.

A variety of materials and wastes were processed, resulting in the generation of plutonium metal, americium, and wastes for disposal.

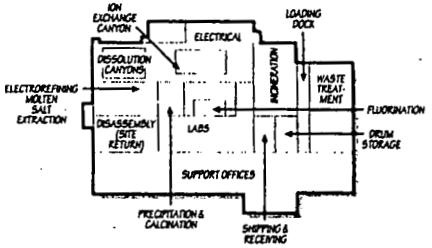
PLUTONIUM RECOVERY FLOW DIAGRAM



BUILDINGS INVOLVED IN THE PLUTONIUM RECOVERY PROCESS



Building 771
(schematic floor plan after 1957)



Building 371
(schematic floor plan)

DELINEATED BY: *Margaret N. Leckie, 1998 for engineering-environmental Management, Inc.*
INTERMOUNTAIN SUPPORT OFFICE / DENVER
GOLDEN VICINITY
ROCKY FLATS PLANT
BOUNDED BY HIGHWAYS 93, 128, AND INDIANA STREET – ENTRANCE ON HIGHWAY 93
JEFFERSON COUNTY
COLORADO
SHEET 10 – 17
HISTORIC AMERICAN ENGINEERING RECORD CO-83

NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR
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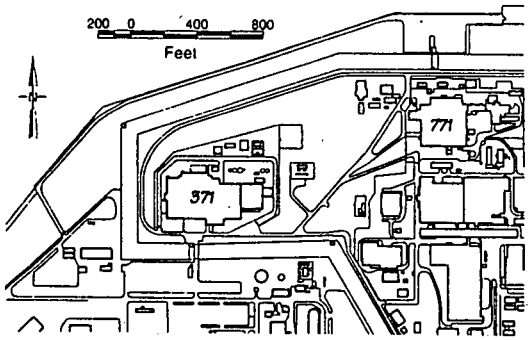
Drawing 10
4/24/98

PLUTONIUM RECOVERY



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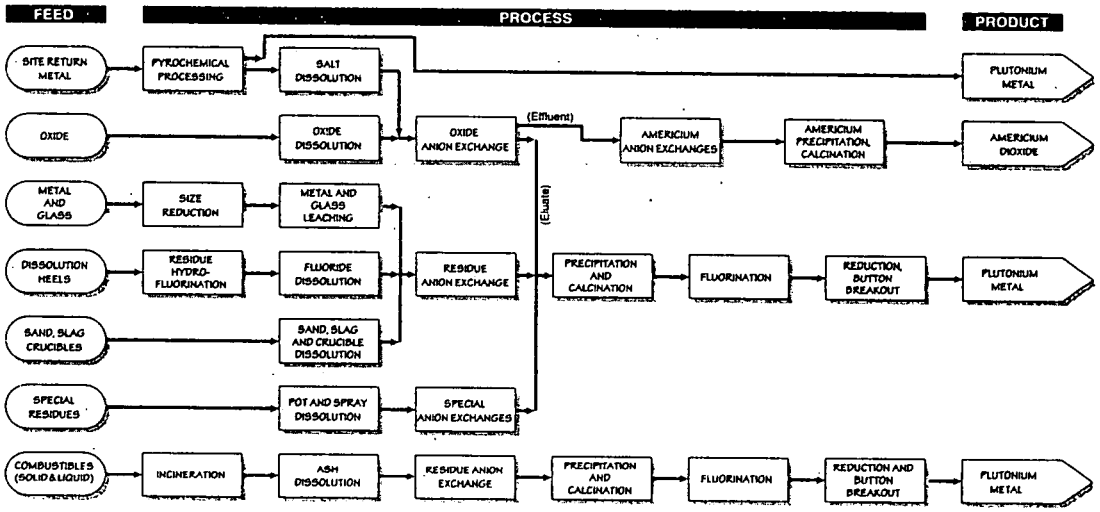
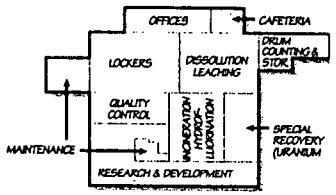
A variety of materials and wastes were processed, resulting in the generation of plutonium metal, americium, and wastes for disposal.

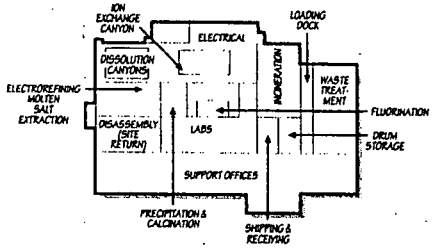
PLUTONIUM RECOVERY FLOW DIAGRAM



BUILDINGS INVOLVED IN THE PLUTONIUM RECOVERY PROCESS



Building 771
(schematic floor plan after 1957)



Building 371
(schematic floor plan)

DELINEATED BY: Margaret N. Lackie, 1998 for engineering-environmental Management, Inc.

INTERMOUNTAIN SUPPORT OFFICE / DENVER

NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

GOLDEN VICINITY

ROCKY FLATS PLANT
BOUNDED BY HIGHWAYS 93, 128, AND 72 AND INDIANA STREET – ENTRANCE ON HIGHWAY 93
JEFFERSON COUNTY COLORADO

SHEET 10 – 17

HISTORIC AMERICAN ENGINEERING RECORD
CO-83

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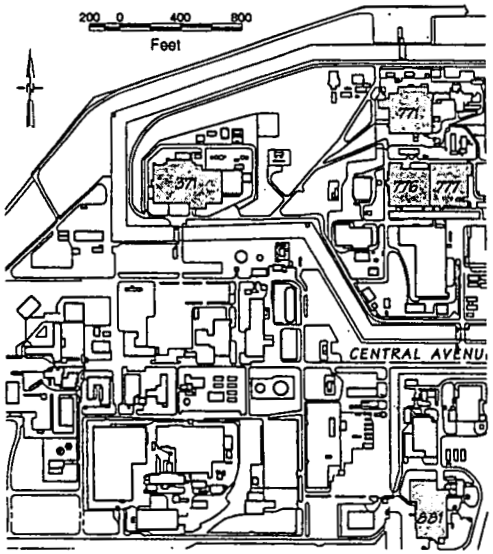
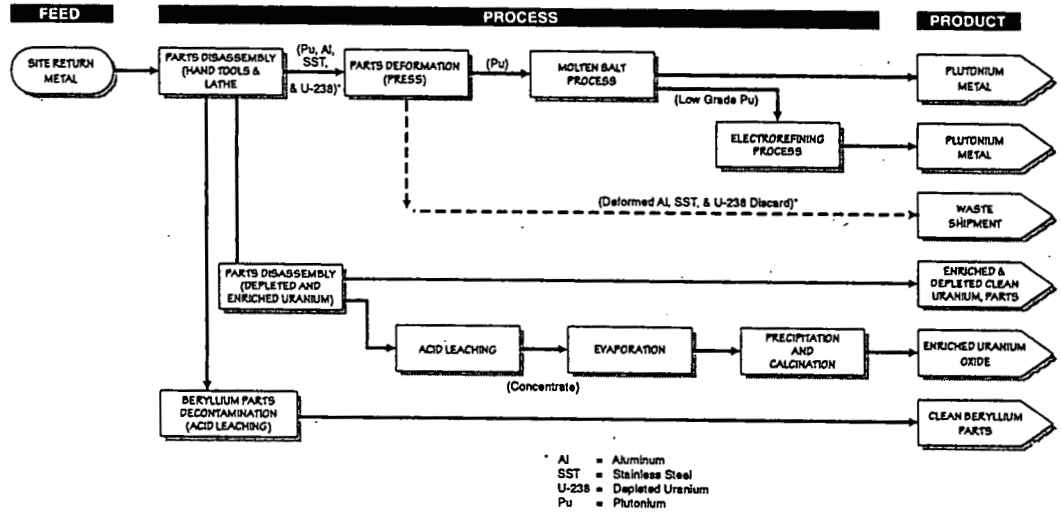
Drawing 10
4/24/98

SITE RETURNS

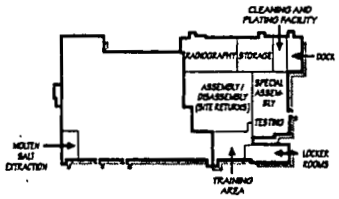


Site returns were obsolete nuclear weapons retired from the stockpile, or weapons needing modifications or conversions. The weapons were disassembled and the valuable materials were recovered and reprocessed. After processing, the site returns yielded plutonium metal (containing Americium), cleaned uranium parts (depleted and enriched), uranium oxides, cleaned beryllium parts, and wastes for disposal. Site returns were disassembled in Building 777 and Building 371. Recovery processing of plutonium and uranium occurred in Buildings 371, 771, and 881.

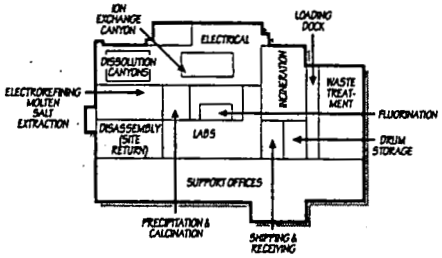
SITE RETURNS PROCESS FLOW CHART



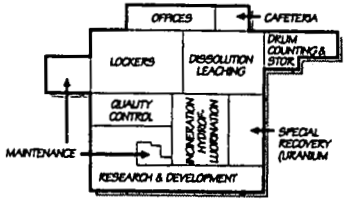
BUILDINGS INVOLVED IN THE SITE RETURN PROCESS



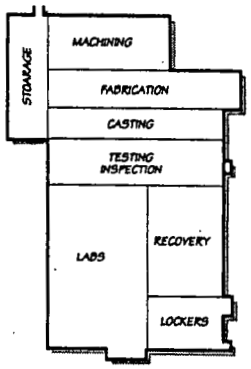
Building 776/777
(Disassembly)
(schematic floor plan after 1969)



Building 371
(Plutonium Recovery)
(schematic floor plan)



Building 771
(Plutonium/Uranium Recovery)
(schematic floor plan after 1957)



Building 881
(Enriched Uranium Recovery)
(schematic floor plan)

DELINEATED BY: Margaret N. Lackis, 1996 for engineering-environmental Management, Inc.

INTERMOUNTAIN SUPPORT OFFICE / DENVER

GOLDEN VICINITY

ROCKY FLATS PLANT
BOUNDED BY HIGHWAYS 93, 128, AND 72 AND INDIANA STREET – ENTRANCE ON HIGHWAY 93
JEFFERSON COUNTY

COLORADO

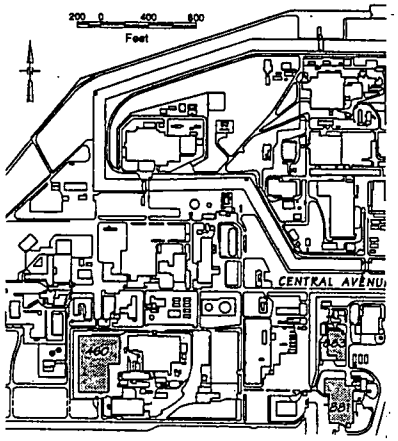
SHEET 11 – 17

HISTORIC AMERICAN ENGINEERING RECORD CO-83

Drawing 11
3/24/98

ENRICHED URANIUM

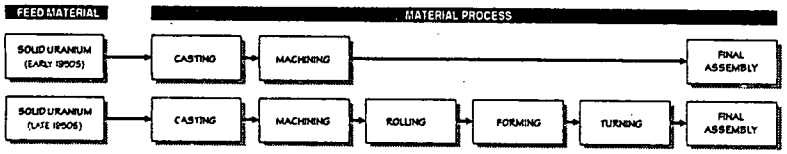
Enriched uranium fabrication began in 1952 in Building 881. In 1957, fabrication expanded to Side B of Building 883, which was dedicated to enriched uranium processes. Production demands were so great that enriched uranium fabrication began in Building 883 before the roof was completed. To prevent emissions, enclosures were placed around process equipment. Enriched uranium was received as solid uranium, recovered from on-site processes and wastes, and from site returns. Fabrication processes included casting, machining, rolling, forming, turning, inspection, and assembly. Enriched uranium fabrication was transferred to another Nuclear Weapons Complex facility in 1964.



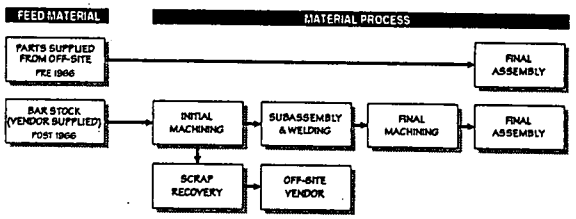
STAINLESS STEEL

Stainless steel fabrication operations were transferred to the Plant in 1966. Prior to that, finished stainless steel components were shipped to the Plant for final assembly. Building 881, which had previously held uranium operations, was used for the new stainless steel operations. In 1984 Building 460 was constructed, and all stainless steel operations were moved to it. Stainless steel was received as bar stock; fabrication processes consisted of machining and assembly. Stainless steel was also used to "can" (encase) beryllium as part of the beryllium fabrication process. Recovered scrap was shipped off-site for recovery.

ENRICHED URANIUM FABRICATION FLOW DIAGRAM



STAINLESS STEEL FABRICATION FLOW DIAGRAM



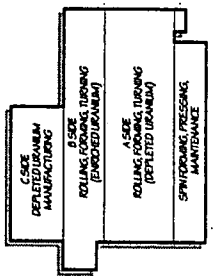
NOTE: Pre 1966 - Parts received from American Car and Foundry Industries.

1966-1983 - Parts machined in Bldg. 881.

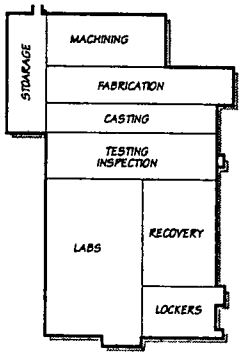
1983 - 1985 - Parts machined in Bldg. 460.

Stainless steel casting/ forging processes were not conducted on a production scale.

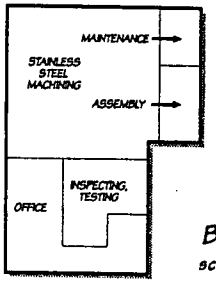
BUILDINGS INVOLVED IN THE ENRICHED URANIUM AND STAINLESS STEEL PROCESSES



Building 883
schematic floor plan



Building 881
schematic floor plan



NOTE: Building 460 was not used for Enriched Uranium.

Building 460
schematic floor plan

DELINEATED BY: Margaret N. Leckie, 1998 for engineering-environmental Management, Inc.

INTERMOUNTAIN SUPPORT OFFICE / DENVER
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

GOLDEN VICINITY

ROCKY FLATS PLANT
BOUNDED BY HIGHWAYS 93, 128, AND 72 AND INDIANA STREET - ENTRANCE ON HIGHWAY 93
JEFFERSON COUNTY
COLORADO

SHEET 12 - 17

HISTORIC AMERICAN ENGINEERING RECORD
CO-63

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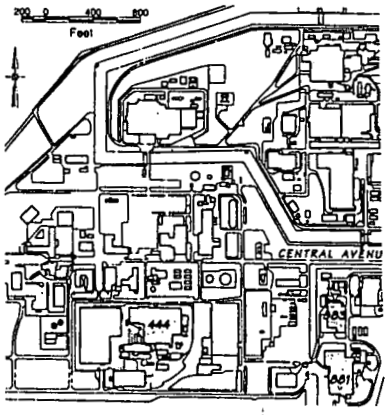
Drawing 12
3/24/98

DEPLETED URANIUM

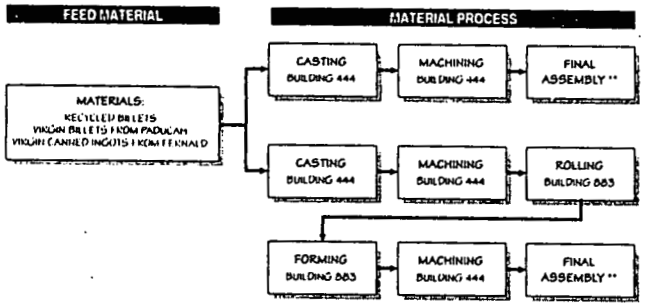
Depleted uranium operations began in 1952 in Building 444. Depleted uranium operations involved casting, rolling and forming, machining, inspection, and final assembly. In the late 1950s rolling and forming of parts took place in Building 883, and casting and final machining remained in Building 444. In 1985, Building 883 was expanded to support manufacturing of armor plates containing depleted uranium for the M1A1 tank.



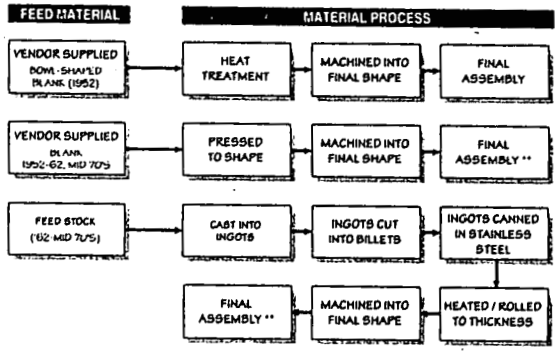
BERYLLIUM

Beryllium operations came to the Plant with the hollow-core trigger design, and were initially housed in a corner of Building 444. At one time, beryllium operations included casting in Building 444, encasing in stainless steel (canning) in Building 881, rolling and forming in Building 883, and final machining in Building 444. Beryllium feed materials were alternately cast by an off-site vendor, or were cast on-site. From 1975 until 1993, beryllium was supplied by a vendor, and operations were confined to Building 444.

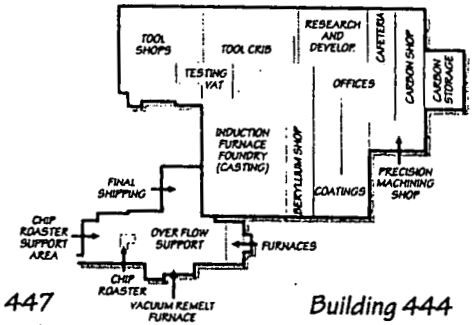
DEPLETED URANIUM COMPONENT MANUFACTURING



BERYLLIUM PRODUCTION FLOW CHART

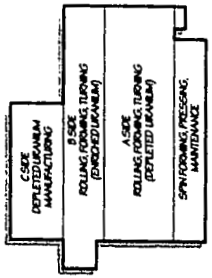


BUILDINGS INVOLVED IN DEPLETED URANIUM AND BERYLLIUM PROCESSES



Building 447
schematic floor plan

Building 444
schematic floor plan



Building 883
schematic floor plan

** Final Assembly locations for depleted uranium and beryllium production: Building 991, later to Building 777, finally in Building 707

DELINEATED BY: Margaret N. Leckie, 1998 for engineering-environmental Management, Inc.

INTERMOUNTAIN SUPPORT OFFICE / DENVER

GOLDEN VICINITY

ROCKY FLATS PLANT
BOUNDED BY HIGHWAYS 93, 128, AND 73 AND INDIANA STREET - ENTRANCE ON HIGHWAY 93
JEFFERSON COUNTY

COLORADO

SHEET 13-17

HISTORIC AMERICAN ENGINEERING RECORD CO-83

Drawing 13
4/24/98

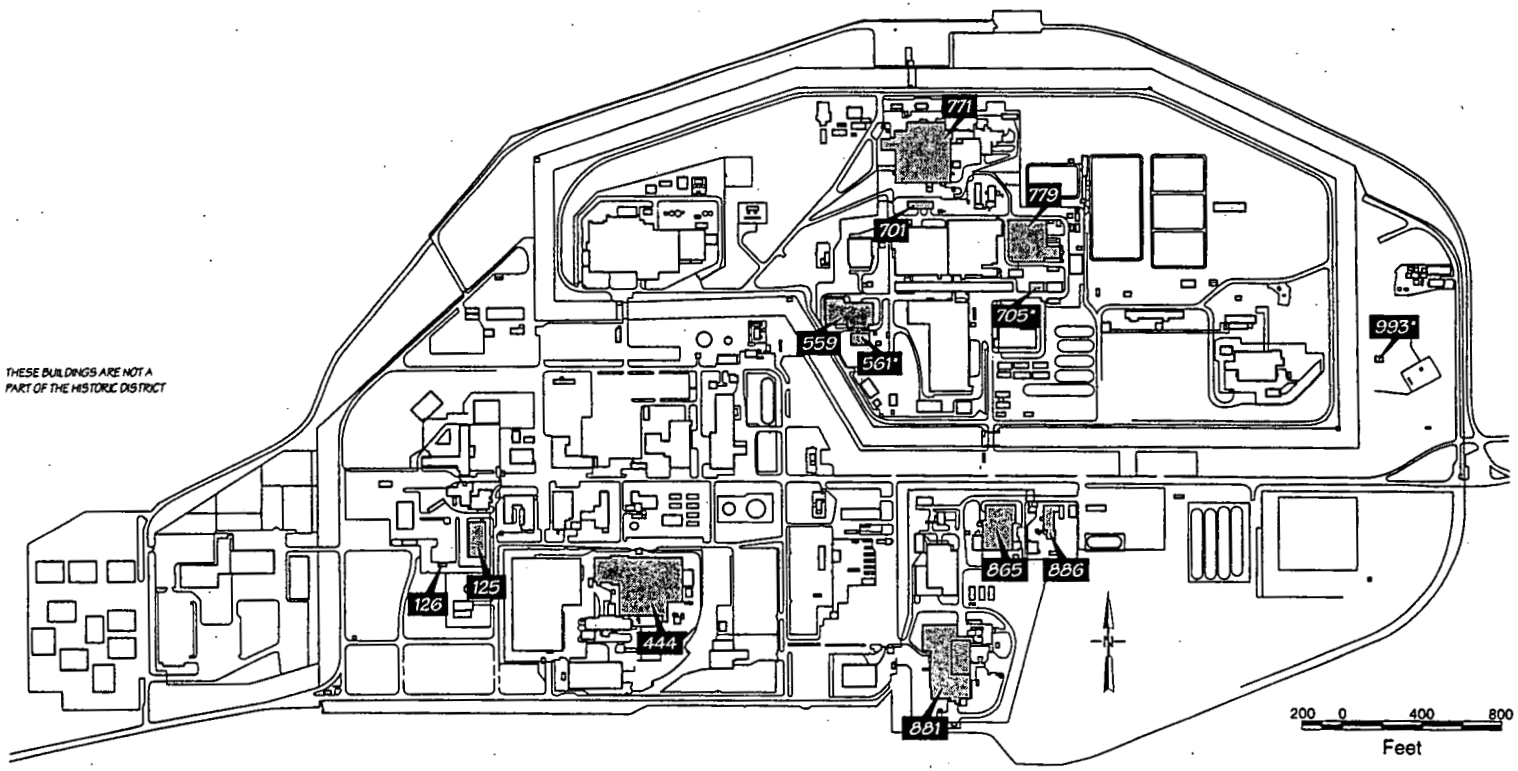
RESEARCH AND DEVELOPMENT

LABORATORIES

During the 1940s and 1950s, most of the research and development was conducted at the two national laboratories within the Nuclear Weapons Complex: Los Alamos in New Mexico and Lawrence Livermore in northern California. In the early years at the Plant, research was incorporated into production engineering. Laboratories were established in each of the original manufacturing buildings, specializing in the material handled in that building, either plutonium (Building 771), enriched uranium (Building 881), or depleted uranium (Building 444).

When the Rocky Flats Plant became the sole producer of plutonium triggers, research and development activities increased markedly and several new labs were constructed. Much of research focused on learning more about the materials handled at the Plant. To investigate plutonium's chemistry, interaction with other materials, and shelf life, a plutonium laboratory, Building 779, was constructed in 1965. To establish criticality limits for uranium and plutonium, critical mass experiments were moved from the production lines to a new state-of-the-art lab, Building 886, which was also built in 1965. Explosive bonding tests, joining plates of stainless steel and uranium alloy, were conducted in Building 993 from 1965 to 1968. To house metal-working equipment for the study of non-plutonium metals and the development of alloys, Building 865 was built in 1970. Experiments with the various coatings used on materials, as well as development work for reactor fuels using depleted uranium oxides took place in Building 705*, which was built in 1966.*

Several laboratories were constructed for improved production and quality. Analyses of incoming materials for quality assurance/quality control were conducted in Building 125, the standards laboratory, built in 1965. The analysis of the purity of plutonium, and the sampling of incoming material and recovered, cast, and purified materials from the site took place in the plutonium laboratory, Building 559, which was built in 1967. Building 561 was built in 1973 to expand the capabilities of the plutonium laboratory. Machining equipment was calibrated in Building 126, built in 1968. Waste treatment processes were designed in Building 701, which was built in 1962.*



* THESE BUILDINGS ARE NOT A PART OF THE HISTORIC DISTRICT

DELINEATED BY: Margaret N. Leckie, 1998 for engineering-environmental Management, Inc.

INTERMOUNTAIN SUPPORT OFFICE / DENVER

NATIONAL PARK SERVICE
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GOLDEN VICINITY

ROCKY FLATS PLANT
BOUNDED BY HIGHWAYS 93, 128, AND TY LAND ROAD, STREET - ENTRANCE ON HIGHWAY 93
JEFFERSON COUNTY

COLORADO

SHEET 14 - 17

HISTORIC AMERICAN ENGINEERING RECORD
CO-63

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Drawing 14
3/17/97

HEALTH AND SAFETY

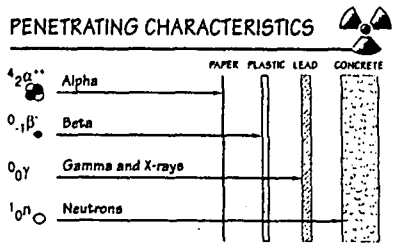
PROPERTIES OF RADIOACTIVE MATERIALS

PROPERTIES OF RADIATION

Different radiations have different properties, as summarized below:

Radiation	Type of Radiation	Mass (AMU)	Charge	Shielding material
Alpha	Particle	4	+2	Paper, skin, clothes
Beta	Particle	1/1836	-1	Plastic, glass, light metals
Gamma	Electromagnetic Wave	0	0	Dense metal, concrete, earth
Neutrons	Particle	1	0	Water, concrete, polyethylene, oil

PENETRATING CHARACTERISTICS



Radioactive materials are those materials that undergo a spontaneous emission of energy in the form of particles or waves, or both, from their atomic nucleus. Plutonium is such a material, emitting alpha, beta, and gamma radiation, x-rays, and neutrons.

Alpha radiation consists of positively charged alpha particles that are identical to the nuclei of ordinary helium atoms. Alpha radiation does not penetrate the skin but is dangerous if inhaled. Beta radiation consists of negatively charged beta particles that are identical in their properties to electrons. Beta radiation can penetrate the skin up to one centimeter. Gamma radiation consists of high-energy photons and accompanies most nuclear processes. Gamma radiation can penetrate the skin up to fifty centimeters. X-rays are similar to gamma radiation except that they are generated from atomic processes. Neutrons are uncharged particles that are emitted from the nucleus of an atom.

Radiation can ionize and destroy body cells. The extent of damage depends mainly on the amount of the radiation absorbed and the type of radiation. Radiation may increase the risk of cancer and may cause mutagenesis.

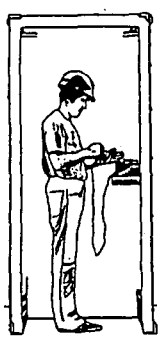
WORKING WITH PLUTONIUM

The radioactive nature of materials used in the production process was the primary health and safety concern at the Rocky Flats Plant. Due to the potential health effects of working with plutonium, precautions were taken to reduce the exposure of personnel. These precautions included personnel protection and contamination control, such as monitoring for levels of radiation, and the use of protective clothing and shielding. Alpha radiation can be shielded with coveralls or gloves; respirators can prevent its inhalation. Beta, gamma, and x-ray radiation can be shielded with lead or concrete. Neutrons can be shielded with water, polyethylene, or concrete.

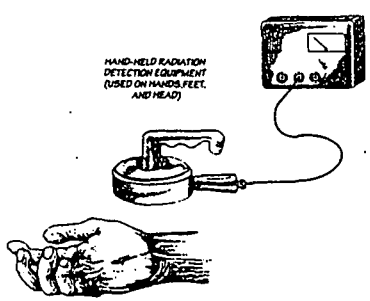
An additional hazard is plutonium's pyrophoric nature; it spontaneously ignites in the presence of oxygen. To avoid a fire, glove boxes, with inert atmospheres of nitrogen or argon, were used to reduce the exposure of plutonium to oxygen. Additional protection was provided by heat- and smoke-sensing devices and fire doors.

Spontaneous nuclear fission chain reactions, called nuclear criticality events, were also of concern. Nuclear criticality events can occur if a sufficient quantity of fissile material is placed within a given area. To avoid such an occurrence, plutonium was stored in critically safe arrangements and criticality limits were posted for easy reference.

MONITORING FOR CONTAMINATION



FULL BODY AND HAND-HELD RADIATION DETECTION EQUIPMENT



HAND-HELD RADIATION DETECTION EQUIPMENT (USED ON HANDS, FEET, AND HEAD)

Personnel wore dosimeters to monitor the amount of radiation to which they were exposed. The amount of radioactive material that was inhaled was determined by body counting.

Continuous monitoring for radioactive contamination was conducted in the production building work areas and on the air exhausted from the stacks of process and research buildings. Ambient air was monitored for airborne particulate matter, both on and off the Plant site.

PROTECTIVE CLOTHING

SELF-CONTAINED BREATHING APPARATUS

FULLY-ENCAPSULATING SUIT

FULL PROTECTIVE CLOTHING
- COVERALLS
- COTTON HOODS
- PLASTIC SHOE COVERS
- RUBBER SHOE COVERS
- COTTON GLOVE LINERS
- RUBBER GLOVES

Personnel wore a variety of protective clothing and equipment to minimize the amount of radiation to which they were exposed. Protective clothing consisted of company-supplied undershirts, shorts, socks, coveralls, shop coats, booties, and caps. Half-mask and full-face-respirators were also provided. Personnel who performed operations such as cleaning liquid storage tanks, changing contaminated filters, spraying toxic paint or coatings, or entering a smoke-filled room to extinguish a fire were each provided with a self-contained breathing apparatus and a protective suit or mask.

DELINEATED BY: Margaret N. Leckie, 1998 for engineering-environmental Management, Inc.
INTERMOUNTAIN SUPPORT OFFICE / DENVER
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR
GOLDEN VICINITY
ROCKY FLATS PLANT
BOUNDED BY HIGHWAYS 93, 128, AND 72 AND INDIANA STREET – ENTRANCE ON HIGHWAY 93
JEFFERSON COUNTY
COLORADO
SHEET 15 – 17
HISTORIC AMERICAN ENGINEERING RECORD CO-83

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HEALTH AND SAFETY

VENTILATION SYSTEM

Heating, ventilation, and air conditioning (HVAC) systems confined hazardous materials within process areas to prevent the dispersion of radioactive aerosols, noxious fumes, and vapors into areas normally occupied by personnel. In many buildings having fissile materials, the HVAC system provided a separate inert gas ventilation system for environmental control and fire protection. Ventilation equipment in plutonium handling areas filtered, recirculated, and exhausted the air. Some air conditioning in production buildings was capable of drying the air to reduce the reactivity of plutonium with oxygen.

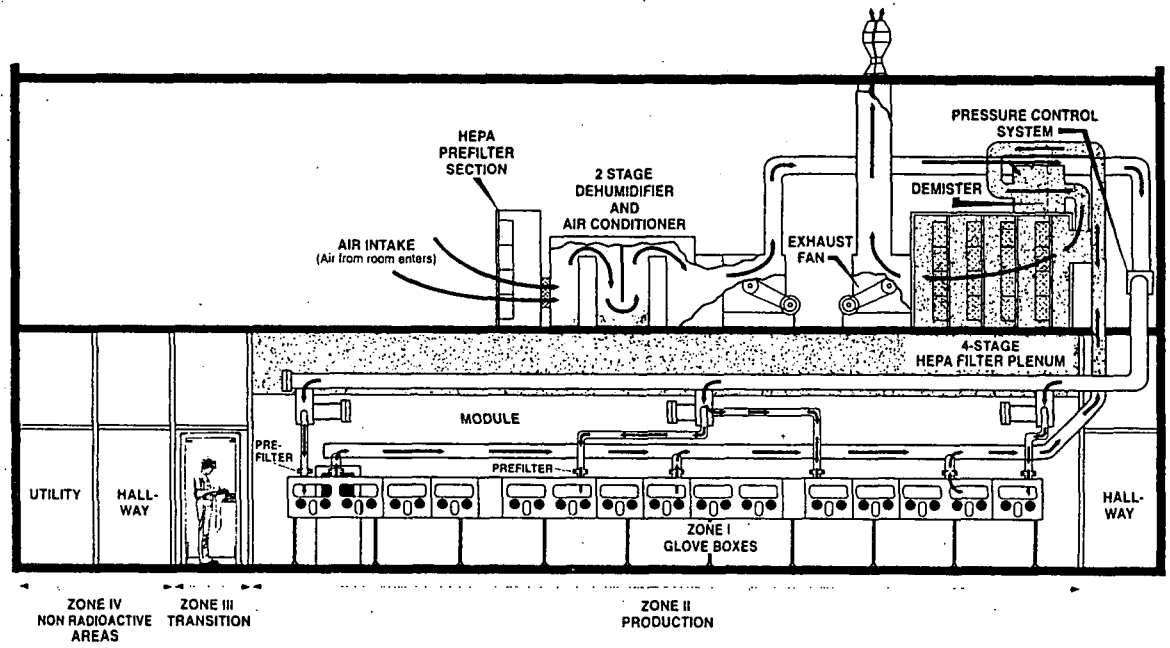
To prevent the dispersal of radioactive materials, facilities were divided into several zones, separated by physical barriers. The ventilation atmosphere flowed from areas having the least potential for radioactive contamination toward areas having progressively higher potentials. The pressure differentials maintained air flow toward Zone I areas and then to final filtration, prior to being exhausted to the outside atmosphere.

Zone I, the primary confinement zone, was the area of highest potential radioactive contamination, and included glove boxes, plutonium processing canyons, tank vaults, and their exhaust atmosphere handling and cleaning systems. Zone I atmosphere was negative with respect to the atmosphere in all other zones. Zone IA was a buffer zone that included access air locks to radiation areas. Zone IA pressure was intermediate between that of Zone I and II. Zone II was the zone of secondary confinement; it included process rooms and work areas containing the Zone I and IA confinement areas. Zone II atmosphere was maintained at a pressure less than that of Zone III. Zone III, the tertiary confinement zone, included access areas, individual process control rooms, decontamination areas, and the air supply and return systems. Zone III pressure was negative relative to that in Zone IV. Zone IV included the HVAC control rooms and general non-radioactive utility and support areas. Zone IV pressure was slightly negative relative to outside ambient air pressure. The outside shell of the building provided the final containment barrier for radioactive material.

GLOVE BOXES AND HEPA FILTERS

Glove boxes are stainless steel enclosures designed for plutonium handling operations in an effort to contain plutonium contamination. Rubber gloves, usually impregnated with lead oxide, were affixed to the glove boxes to facilitate the safe handling of plutonium. The glove boxes had lead-glass windows and lead shielding to protect personnel against gamma and x-rays. Hydrogenous materials were used where neutron shielding was required. The atmosphere in certain glove boxes was nitrogen, containing a maximum of five percent oxygen to minimize the possibility of fire caused by the pyrophoric nature of plutonium.

Air exhausted from facilities handling beryllium, plutonium, and uranium passed through several stages of High Efficiency Particulate Air (HEPA) filters. The filters were tested on specially designed equipment utilizing a reproducible, nontoxic, thermally-generated aerosol and forward-light-scattering, particulate-detecting equipment. The test confirmed that the filters and cartridges had a minimum efficiency of 99.97 percent for 0.3 micron particles. All of the measuring instruments on the test equipment were calibrated and certified by the Rocky Flats Plant's standards laboratory according to the National Bureau of Standards.



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INTERMOUNTAIN SUPPORT OFFICE / DENVER

GOLDEN VICINITY

ROCKY FLATS PLANT
BOUNDED BY HIGHWAYS 93, 128, AND 72 AND INDIANA STREET - ENTRANCE ON HIGHWAY 93
JEFFERSON COUNTY COLORADO

SHEET 16 - 17

HISTORIC AMERICAN ENGINEERING RECORD CO-83

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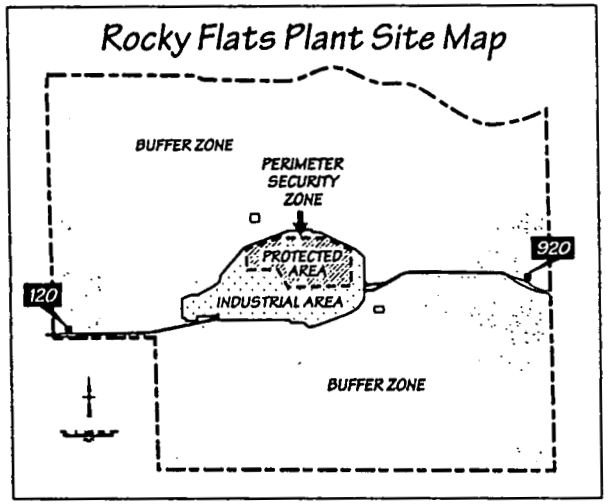
Drawing 16
4/24/98

PLANT SECURITY



As a top-secret weapons production facility, the Rocky Flats Plant was concerned with security precautions. In the early years of the Plant, security focused on preventing espionage, and guarding design and production secrets.

Plant security included control of access; preparation for and prompt response to threats or acts of violence; screening of future employees; inventory control of property; and procedures for handling security breaches. The Plant security maintained a weapons arsenal, escorted Plant shipments, provided patrols and checks, investigated violations of federal laws, and maintained liaison with local law enforcement agencies. The fire department and reserve forces supplemented Plant security, when necessary.

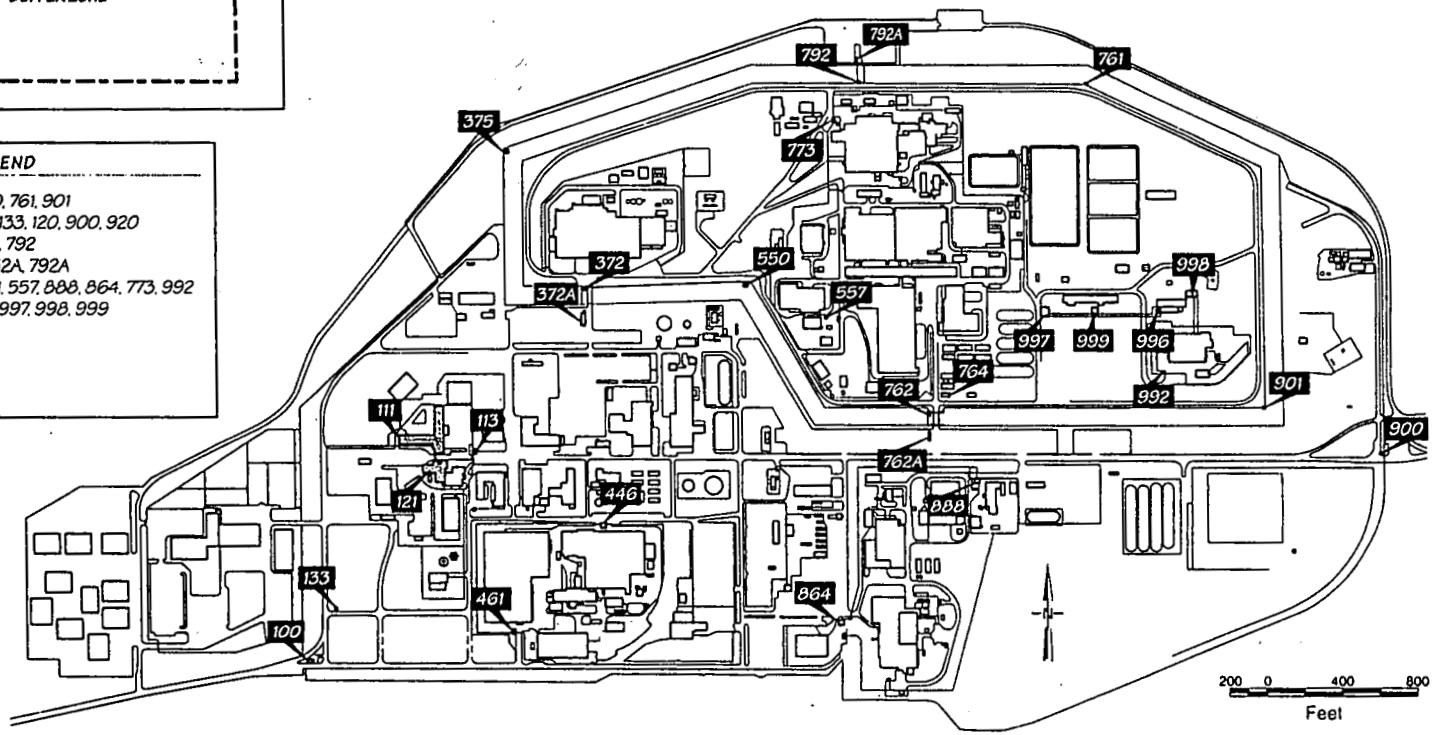
Information was compartmentalized at the Plant. Employees had limited access to classified information regarding plant processes. Throughout the production years, most employees were cleared for access only into the buildings to which they were assigned.

Security structures included numerous guard posts, guard houses and facilities to control access to specific buildings and areas; access posts to control vehicles and personnel onto the site; guard towers used to enhance observation and detection; and vaults for arms and equipment storage.

The layout of the site also provided security. All of the buildings, with the exception of a few security and support structures, are centrally located within a 384-acre fenced area, referred to as the **Industrial Area**. Surrounding the Industrial Area is undeveloped open space, called the **Buffer Zone**. The original site was 1,900 acres. In the 1970s and 1980s, security became more concerned with the threat of terrorism and infiltration of plant protesters. To increase protection of the outer boundaries, an additional 4,600 acres was purchased in 1972. This purchase increased the site to a total of 6,500 acres. Then in 1983, all the plutonium operations buildings were surrounded by a **Perimeter Security Zone**, a double-perimeter fence with guard towers, controlled access, closed-circuit televisions, alarms, and an uninterrupted power supply. The area within the Perimeter Security Zone is known as the **Protected Area**.

BUILDING LEGEND

Guard Towers	375, 550, 761, 901
Guard Facilities	100, 113, 133, 120, 900, 920
Guard Posts	372, 762, 792
Access Control	372A, 762A, 792A
Guard House	446, 461, 557, 888, 864, 773, 992
Vaults	111, 996, 997, 998, 999
Plant Security/Armory	121
Original Employee Check-in	111
Electronics for intrusion detection	764



DELINEATED BY: Margaret N. Leckie, 1998 for engineering-environmental Management, Inc.

INTERMOUNTAIN SUPPORT OFFICE / DENVER

NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

ROCKY FLATS PLANT
BOUNDED BY HIGHWAYS 93, 128, AND 72 AND INDIANA STREET - ENTRANCE ON HIGHWAY 93
JEFFERSON COUNTY
GOLDEN VICINITY
COLORADO

SHEET 17 - 17

HISTORIC AMERICAN ENGINEERING RECORD
CO-83

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Drawing 17
4/24/98

ROCKY FLATS PLANT, CRITICAL MASS LABORATORY
(Rocky Flats Plant, Building 886)
(Rocky Flats Plant, Building 86)
Located at the intersection of Central Avenue and 86 Drive
Golden Vicinity
Jefferson County
Colorado

HAER No. CO-86-A

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Rocky Mountain System Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

ROCKY FLATS PLANT,
CRITICAL MASS LABORATORY
(Rocky Flats Plant, Building 886)

HAER No. CO-83-A

Location: Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County, Colorado. Building 886 is in the southeast section of the industrial area of the Rocky Flats site, located at the intersection of Central Avenue and 86 Drive.

Date of Construction: 1964.

Fabricator: Stearns-Rogers Corporation, Denver, Colorado.

Present Owner: U.S. Department of Energy (USDOE).

Present Use: Inactive (experiments ceased in 1987).

Significance: This building was a primary contributor to the Rocky Flats Plant historic district, associated with the U.S. strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack on the U.S. This building was one of five critical mass laboratories in the nation that performed criticality measurements on a variety of fissile materials. The purpose of these experiments was to set safety standards for fissile material safety. These safety data have been used worldwide.

The Rocky Flats Plant (Plant) had unique site operations support organizations due to the handling of large amounts of radioactive materials. One such organization was the Nuclear Safety Group. The Plant's Critical Mass Laboratory conducted experiments directly tied to plant operations.

Historians: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M), 1997. Alexandra Cole, Architectural Historian, Science Applications International Corporation, 1997.

Project Information:

In 1995, an inventory and evaluation of facilities at the Plant for their potential eligibility for listing in the National Register of Historic Places was conducted. The primary goal of this investigation was to determine the significance of the Cold War era facilities at the Plant in order to assess potential effects of the long-term goals and objectives of the USDOE. These goals and objectives have not yet been formalized, but include waste cleanup and demolition.

Recommendations regarding National Register of Historic Places eligibility were developed to allow USDOE to submit a formal determination of significance to the Colorado State Historic Preservation Officer for review and concurrence and to provide for management of historic properties at the Plant.

From this determination and negotiations with the Colorado State Historic Preservation Officer, the Advisory Council, and the National Park Service, and Historic American Engineering Record project began in 1997 to document the Plant's resources prior to their demolition. The archives for the Historic American Engineering Record project are located in the Library of Congress in Washington, D.C.

Introduction:

The Plant is one of thirteen USDOE facilities that constitute the Nuclear Weapons Complex, which designed, manufactured, tested, and maintained nuclear weapons for the United States arsenal. The Plant was established in 1951 to manufacture triggers for use in nuclear weapons and to purify plutonium recovered from retired weapons. The trigger consisted of a first-stage fission bomb that set off a second-stage fusion reaction in a hydrogen bomb. Parts were formed from plutonium, uranium, beryllium, stainless steel, and other materials.

The Plant was a top-secret weapons production plant, and employees worked with a recently man-made substance, plutonium, about which little was known concerning its chemistry, its interactions with other materials, and its shelf-life. The Historic American Engineering Record documentation effort focused on four aspects of the Plant and its role in the Nuclear Weapons Complex: manufacturing operations, research and development, health and safety of workers, and security.

Chronology of Building 886:

1963 Construction began.

1964 Construction completed.

1965 January 28 – technical readiness meeting held, permission to conduct criticality experiments granted.

1970s Office space added to northeast corner of building. Fissile metal storage room extended to southeast side of building to double storage space. Several programs for the Nuclear Regulatory Commission performed on a contract basis, in addition to supporting the plant mission.

1980 Office trailer was added to the northeast corner.

1987 October – last criticality experiment conducted.

1988 Plant curtailed production.

1992 Plant mission was changed to environmental restoration and waste management.

1997 Nuclear fuel removed from Building 886.

Building History:

The continued presence of large quantities of fissile material in numerous forms at the Rocky Flats Plant made it necessary to maintain an active criticality safety program. A Nuclear Safety Group was formed in 1953 to perform the criticality experiments. At that time, the group did not have its own facility. In those early years, the group performed subcritical experiments in the areas in which the materials were handled, using the actual materials which went into the production of the product. The experimenter would set up the production materials in various arrays to perform multiplication-type experiments ("in situ" experiments, which were always subcritical) and to measure critical nuclear conditions with respect to safe geometries for various kinds of production vessels, spacing parameters, shipping containers, and other items. Once Building 886 was commissioned, the Nuclear Safety Group conducted its work there. Since that time, the Nuclear Safety Group conducted about 1,700 critical mass experiments using uranium and plutonium in solutions (900 tests), compacted powder (300), and metallic forms (500).

Nuclear criticality safety can be defined as anything associated with avoiding an accidental nuclear criticality event. A criticality is an instantaneous nuclear fission chain reaction caused when too much fissile material is placed within too small an area. A criticality event would not result in a nuclear explosion, but could liberate a large amount of energy and high levels of radiation. While criticality events can vary widely in power level, the amount of radiation which could be generated in a criticality could be fatal to nearby personnel. Since the beginning of the nuclear industry to 1967, there have been a few dozen nuclear criticality accidents nation-wide. These extensively studied incidents, none of which occurred at Rocky Flats Plant, caused eight deaths and, in some cases, resulted in property damage (Rothe).

Building Description:

The Building 886 (originally called Building 86) complex consists of: Building 886 (Critical Mass Laboratory); Building 880 (storage facility); Building 875 (filter plenum facility); and an underground tunnel containing ventilation ducts that connects Building 886 to Building 875. Building 886 is rectangular with a shallow-pitched gabled roof. Two shed-roof wings extend from its northeast and southeast corners. A 37-foot tall concrete windowless building (Room 101) is attached to the south. A temporary pre-fabricated trailer housing offices is attached to the northeast wing by a breezeway. Building 886 is 10,360 square feet on a single level.

Building 886 consists of three areas: the Radiological Controlled Area; office space; and a small electronics and machine shop. The Radiological Controlled Area is comprised of three rooms and a hallway. Almost all criticality experiments were conducted in Room 101, the assembly room. The ceiling is 2 feet thick. Room 102, a storage vault, was constructed in the mid-1970s

to meet the Department of Energy requirements for a Special Nuclear Material Vault. Both rooms, 101 and 102, have double reinforced concrete walls integrally case to the ceiling. Room 103, the Mixing Room, is a fissile solution storage area; three walls are reinforced concrete, and the west wall is cinder blocks. The remainder of the load bearing walls in Building 886 are constructed of cinder blocks.

Building Operations:

The primary mission of the Critical Mass Laboratory was to perform criticality measurements on a variety of fissile material configurations in support of plant activities. The criticality experiments and measurements were performed in order to establish criticality limits and ensure the safe handling and processing of fissile materials. A simplified sequence of events in performing a typical critical mass measurement involved removing the fissile material from storage, placing it in one of the Reactivity Addition Devices, operating the device remotely until criticality was achieved, measuring the slightly super critical parameters, reversing the operation of the device to slightly subcritical and measuring these parameters, completing the reversal to well below subcritical, and returning the fissile material to storage (Rothe). This effort supported the Plant's activities and assisted the Nuclear Regulatory Commission in setting of industry safety standards. The measurements were essential to validate computer models that were, in turn, used to establish nuclear criticality safety limits now called Criticality Safety Operating Limits.

The experiments were conducted in a manner to control the approach to criticality, for example, by varying the distance between pieces of metal and depth of solutions. Only rarely were the radiation levels such that it was not possible to directly touch the fissile material and testing apparatus immediately after the experiments. The experiments conducted in the Critical Mass Laboratory generally involved power levels generated of no more than 10 milliwatts for no more than one hour. Approximately half of the experiments conducted in Building 886 actually achieved criticality.

Highly enriched uranium was introduced into the building in the summer of 1965 and the first experiments were performed in September of 1965. Since then, the building was used to perform experiments on enriched uranium metal and solution, plutonium metal, low enriched uranium oxide, and several special applications. After 1983, experiments were conducted primarily with uranyl nitrate solutions, and did not involve solid materials.

Experiments to validate the safety parameters for the storage of fissionable solutions in Raschig Ring tanks resulted in the design of two-substitute storage tank configurations: the Annular tank and the Poison Tube tank (Rothe). These designs allowed for more economical solution testing with no decrease in safety. The Poison Tube tanks were not used at the Plant due to the change in the overall site mission; however, they have been used at other USDOE facilities. Experiments were also conducted to validate the cross-sections and usefulness of materials (i.e., concrete, polyvinyl chloride) used at the Plant. Data generated from decades of experiments at the Plant is still being used to set new safety standards and validate computer models.

Sources: ChemRisk, 1992, Final Draft Report, *Reconstruction of Historical Rocky Flats Operations and Identification of Release Points.*

EG&G Rocky Flats, Inc., 1995, Draft *Basis for Interim Operations, Building 886, Revision A*, Rocky Flats Repository.

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Rothe, Dr. Robert E., employed at the Plant since August 1964, Nuclear Criticality Experimenter in Nuclear Safety, personal communication, 1997.

USDOE Public Affairs, n.d. *Tour Information. Rocky Flats Facilities.* Golden, Colorado: U.S. Department of Energy, Office of Communications and Economic Development.

USDOE, 1995, *Final Cultural Resources Survey Report, Rocky Flats Environmental Technology Site, The Industrial Area,* Rocky Flats Repository.

HISTORIC AMERICAN ENGINEERING RECORD

INDEX TO PHOTOGRAPHS

ROCKY FLATS PLANT, CRITICAL MASS LABORATORY HAER No: CO-83-A
(Rocky Flats Plant, Building 886
(Rocky Flats Plant, Building 86)
Located at the intersection of Central Avenue and 86 Drive.
Golden Vicinity
Jefferson County
Colorado

Photographs from the Rocky Flats Environmental Technology Site Archives. Photographs were taken by various site photography contractors.

CO-83-A-1 VIEW OF THE WEST ELEVATION, LOOKING EAST, OF BUILDING 886 WHILE UNDER CONSTRUCTION IN 1964. ON THE RIGHT OF THE PHOTOGRAPH IS THE CRITICALITY ASSEMBLY ROOM, ROOM 101, CONSTRUCTED OF DOUBLE REINFORCED CONCRETE WALLS INTEGRALLY CAST TO THE TWO FEET THICK CEILING. IN THE FOREGROUND, IS THE 19' FEET DEEP PIT AREA INTENDED TO HOUSE WASTE SOLUTION STORAGE TANKS. ONLY ONE TANK WAS USED, TO STORE WASTEWATER.

CO-83-A-2 VIEW OF THE EXPERIMENT CONTROL PANEL IN 1970. THE NUCLEAR SAFETY GROUP CONDUCTED ABOUT 1,700 CRITICAL MASS EXPERIMENTS USING URANIUM AND PLUTONIUM IN SOLUTIONS (900 TESTS), COMPACTED POWDER (300), AND METALLIC FORMS (500). ALL 1,700 CRITICALITY ASSEMBLIES WERE CONTROLLED FROM THIS PANEL.

CO-83-A-3 VIEW OF THE DEPRESSION PIT IN ROOM 103, IN 1965, WHEREIN FISSILE SOLUTION WAS STORED. THIS PHOTOGRAPH SHOWS THE URANIUM SOLUTION TANKS ON THE LEFT AND THE PLUTONIUM SYSTEM ON THE RIGHT. NO PLUTONIUM SOLUTION WAS EVER STORED IN BUILDING 886.

CO-83-A-4 VIEW OF ROOM 103 IN 1980. SIX OF THE NINE URANIUM NITRATE STORAGE TANKS ARE SHOWN. HIGHLY ENRICHED URANIUM WAS INTRODUCED INTO THE BUILDING IN THE SUMMER OF 1965 AND THE FIRST EXPERIMENTS WERE PERFORMED IN SEPTEMBER OF 1965. EXPERIMENTS WERE PERFORMED ON ENRICHED URANIUM METAL AND SOLUTION, PLUTONIUM METAL, LOW ENRICHED URANIUM OXIDE, AND SEVERAL SPECIAL APPLICATIONS. AFTER 1983,

EXPERIMENTS WERE CONDUCTED PRIMARILY WITH URANYL NITRATE SOLUTIONS, AND DID NOT INVOLVE SOLID MATERIALS.

CO-83-A-5 VIEW OF THE INSPECTION PORT ON THE SIDE OF A TYPICAL URANIUM SOLUTION STORAGE TANK IN 1996. INSIDE THE TANK ARE RASCHIG RINGS, WHICH ACT AS NEUTRON ABSORBERS TO CONTROL FISSION AND KEEP THE SOLUTION AT SUB-CRITICAL.

ROCKY FLATS PLANT, ANALYTICAL HEALTH PHYSICS LABORATORY
(Rocky Flats Plant, Building 123)
Located on Central Avenue between Third and Fourth streets,
Golden Vicinity
Jefferson County
Colorado

HAER No. CO-83-B

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Rocky Mountain System Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

ROCKY FLATS PLANT,
ANALYTICAL HEALTH PHYSICS
LABORATORY
(Rocky Flats Plant, Building 123)

HAER No: CO-83-B

Location: Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County, Colorado. Building 123 is located on Central Avenue between Third and Fourth streets, in the western section of the industrial area of the Rocky Flats Plant (Plant).

Significance: One of the original buildings on the site, this building was a primary contributor to the Rocky Flats Plant historic district, associated with the U.S. strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack on the U.S. Building 123 housed the analytical health physics laboratory.

Description: Building 123 is U-shaped and made of concrete block on a poured concrete foundation. The doors are metal with upper glass panes. The recessed industrial, multi-pane, metal-sash windows are arranged in sets of four. On all but the east side of the building, the upper two panes are covered with metal. The east side of the building has numerous steam pipes protruding from it. The roof is flat with vents and utility boxes. The building is 18,980 square feet.

History: the Austin Company of Cleveland, Ohio originally constructed the building, in 1953. Additions were made in 1971, 1973, and the west wing of the building was added in 1975. Other major modifications included the addition of the laboratory hood scrubber system to reduce hazardous chemical releases to the environment and the discontinuance of the use of natural gas at the laboratory benches and as a facility utility system. The facility housed approximately twenty-eight offices, seventeen laboratory rooms, two laboratory support areas (instrument repair, diagnostic and calibration, etc.), one computer room, one utility room, separate men's and women's change/locker rooms with showers, two men's restrooms and two utility corridors.

Building 123 housed the Analytical Laboratory, the principle shops of the Health Physics Instrumentation Section, the External Dosimetry Section, and the majority of the Radiological Records Sections of the Radiological Health Branch of Radiation Protection. The Analytical Laboratory analyzed environmental (air, water, vegetation, soil), biological (urine, fecal material, nose swipes), health physics (room air), and industrial hygiene samples (beryllium and organic vapors in room air). The Health Physics Instrumentation Section repaired and calibrated radiation-detection instruments. The External Dosimetry Section processed the thermoluminescent dosimeters. The Radiological Records section handled most of the occupational radiation exposure and dose records of radiation workers.

The Analytical Laboratory's procedures involved preparing samples for analysis by purifying and concentrating the plutonium, americium, uranium, and tritium that may have been present in

a sample. The original samples were various forms of liquids and solids that were administratively controlled by chain-of custody procedures. Several processes were used in the laboratory depending upon the physical state of the sample and the possible contaminant. The gamma counting process electronically measured soil and water samples from around the Plant for gamma radiation. The tritium analysis process determined tritium content in urine, stack effluent air, and water samples. The beryllium analysis process analyzed air filters for beryllium content. The gross alpha and beta counting process measured the levels of alpha and beta radiation in brass-ring-mounted paper in air filters. The dosimetry process evaluated body thermoluminescent dosimeter badges, worn by Plant personnel, for radiation exposure levels. The gas chromatography process analyzed for organic compounds. The bacterial lab analysis process analyzed water samples for fecal coliform and total coliform for the sewage treatment facility. Until the early 1980's, the Laboratory also participated in an autopsy program, in which site employees could register on the Transuranic Registry to have organs and tissues donated for scientific research (Trice).

Safety has always been a priority within the nuclear weapons complex. When the first quantity of plutonium was made back in the 1940s, half of the plutonium was turned over to Health and Safety experts to study the impacts of this new hazardous material on people.

Allowable exposure limits to personnel have existed throughout the life of the Plant, changing over time as new information and data has been learned. Major improvements and technological advancements occurred in the areas of radiation protection, safety, detection, bioassay, and dosimetry in Building 123. Typically in competition with the National Laboratories during the 1950s and 1960s, the Plant's scientists had real issues to solve. During the production years, funding for equipment and research programs seemed limitless. This allowed the labs access to state-of-the-art equipment to develop methods to do things faster, cheaper, and better. Rocky Flats was on the forefront of pioneering health and safety solutions and implementing advanced technologies.

In 1966, the dosimeter badges used at the Plant were a Type-A film badge. By 1969, all gamma dosimeters were converted to thermoluminescent dosimeters, and by 1967, all neutron badges used were thermoluminescent dosimeters. The Plant was the first nuclear weapons facility to use the thermoluminescent dosimeter badges (Fawk). Major advances were also made in the chemistry department. Detection limits for plutonium, americium, and uranium in urine samples was 0.15 disintegration per minute, today the detection limit is 0.02 disintegration per minute (Fawk).

This was due to improvements in procedures and equipment developed in the laboratory over the years. "Back in the old days, it was fun. We had no documents, methods, or data to work from. Everything was new, and there was so much we didn't know. Today, it's kind of old hat" (Trice).

Sources: Buffer, Pat, 1995, *Highlights in Rocky Flats History*, Rocky Flats Repository.

EG&G Rocky Flats, Inc., 1994, *Rocky Flats Plant Site Safety Analysis Report, Notebook 1, Health Physics Buildings*, Rocky Flats Repository.

Fawk, Roger B., Health Physicist at the Plant, employed by the site contractor since 1966, personal communication, January 1997.

Trice, Conrad, Developmental Chemist in Building 123 of the Plant, employed by the site contractor since 1974, personal communication, January 1997.

U.S. Department of Energy, 1994, *Final Cultural Resources Survey Report, Rocky Flats Environmental Technology Site, The Industrial Area*, Rocky Flats Repository.

Historians: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M), 1997. Alexandra Cole, Architectural Historian, Science Applications International Corporation, 1997.

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ROCKY FLATS PLANT, ANALYTICAL HEALTH PHYSICS LABORATORY
(Rocky Flats Plant, Building 123)
Located on Central Avenue between Third and Fourth streets.
Golden Vicinity
Jefferson County
Colorado

HAER No. CO-83-B

Photographs by Timothy McGrath and Katherine T. Abeyta, Source One, Rocky Flats Environmental Technology Site, site photography contractor, spring 1997.

CO-83-B-1 VIEW IN ROOM 125, BIOASSAY LABORATORY. SHOWN IS THE FIRST STEP IN A SIX-STEP PROCESS TO ANALYZE URINE SAMPLES FOR PLUTONIUM AND URANIUM CONTAMINATION. IN THIS STEP, NITRIC ACID IS ADDED TO SAMPLE, AND THE SAMPLE IS BOILED DOWN TO A WHITE POWDER.

CO-83-B-2 VIEW IN ROOM 111, ATOMIC ABSORPTION BERYLLIUM ANALYSIS LABORATORY. AIR FILTERS AND SWIPES ARE DISSOLVED WITH ACIDS AND THE REMAINING RESIDUES ARE SUSPENDED IN NITRIC ACID SOLUTION. THE SOLUTION IS PROCESSED THROUGH THE ATOMIC ABSORPTION SPECTROPHOTOMETER TO DETECT THE PRESENCE AND LEVELS OF BERYLLIUM.

ROCKY FLATS PLANT, PLUTONIUM LABORATORY, HAER No. CO-63-C
(Rocky Flats Plant, Building 771)
Located in the north-central section of the Industrial Area at 99 Drive,
Golden Vicinity,
Jefferson County,
Colorado

PHOTOGRAPHS,

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Rocky Mountain System Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

ROCKY FLATS PLANT,
PLUTONIUM LABORATORY
(Rocky Flats Plant, Building 779)

HAER No: CO-83-C

Location: Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County, Colorado. Building 779 is in the north-central section of the industrial area of the Rocky Flats Plant (Plant).

Significance: This building was a secondary contributor to the National Register eligible Rocky Flats Plant historic district, associated with the U.S. strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack on the U.S. Building 779 provided research and development support for plutonium production and recovery processes.

Description: Building 779 is an irregular-shaped, two-story, flat-roofed building constructed of concrete block on concrete footings. A one-story, metal-sided ell extends to the north. The doors are steel or steel with safety glass; the windows, on the south wall only, are single panes in metal sash. There is a second floor passage to Building 776/777 (plutonium fabrication and assembly) on the west side. Building 779 has nearly doubled in size since it was built in 1965, with two major additions in 1968 and 1973. The first addition, the larger of the two, provided office and laboratory space, plus an environmental storage facility for product aging studies under various environmental extremes, and a storage vault. A filter plenum facility (Building 729) was also constructed in 1973 next to Building 779 and linked by a second-story bridge for the ducting. The new plenum facility served as the second addition to the main building and housed an emergency generator. A year later, a new filter plenum facility was added o the East End of 779 to serve the original building and that portion added in 1968. A structural upgrade was completed in 1988 to provide added resistance to damage from earthquakes and high winds. The building is 67,710 square feet.

History: In the early years of nuclear weapons production at the Rocky Flats Plant, most of the research and development functions were handled by the three laboratories associated with the Nuclear Weapons Complex: Los Alamos National Laboratory in New Mexico, Lawrence Livermore Laboratory in northern California, and Sandia National Laboratory in New Mexico and California. Any research done at the Rocky Flats Plant was incorporated into production engineering for new weapons design. When the Rocky Flats Plant became the sole producer of plutonium triggers (early 1960s); research and development activities and funding increased markedly. Laboratories were established for each of the three manufacturing buildings, specializing in the material of the plant, either plutonium (Building 771), enriched uranium (Building 881), or depleted uranium (Building 444). Building 779 was built in 1965 to provide additional research and development capabilties to support plutonium production and recovery processes.

The specific purpose of this facility was to gain more knowledge of the chemistry and metallurgy of plutonium and its interactions with other materials, which might be used in the manufacturing process. Although some of the processes in the building changed over the years, the primary purpose of the activities did not. Most of the materials used in this facility were the same as those in the plutonium manufacturing buildings, and much of the work conducted involved improvement of existing processes and understanding the materials employed. Research, development, and support operations were divided into five areas of responsibility: process chemistry technology; physical metallurgy; machining and gauging; joining technology; and hydriding (plutonium recovery) operations.

The Process Chemistry Technology group supported plant production, manufacturing, and assembly operations. The process chemistry laboratories engaged in weapons process development, stockpile reliability testing, testing of various materials compatibilities, plutonium aging under various environmental conditions, and methods development for recovering, separating, and purifying actinides from waste streams and residues. The Physical Metallurgy group, which included tensile testing, study of casting dynamics, electron microscopy, X-ray analyses, hardness testing, and dimensional dynamics, conducted research on various metals, alloys, and material required by plant missions. This group also supported different research groups, design agencies, plant production, and other metallurgy studies. The Machining and Gauging group, which involved manufacturing of special order parts and test components, had two shops and a laboratory for tool making, maintenance operations, and high-precision machining for special orders and tests. The Joining group, which involved methods such as welding and brazing, developed sophisticated joining techniques for nuclear materials.

Building 779 was also used to find new ways to recover plutonium and associated actinides. The Hydriding group was involved in plutonium recovery experiments. During plutonium processing, significant amounts of plutonium would coat on metallic and non-metallic substrates such as crucibles, tools, and equipment. These crucibles needed to be re-used in certain operations. For many years, the sole method available for recovery of plutonium from these substrates was acid dissolution, which in some cases damaged the substrate. The nonaqueous hydriding process was developed in order to effectively remove and recover plutonium without damage to the substrates. In addition to this main advantage, the hydriding process involved relatively few process operations and generated very little waste. These features resulted in fewer material accountability problems and reduced the potential for personnel radiation exposure. It was soon discovered that plutonium could also be recovered from non-valuable or discardable substrates. A decision was made in early 1971 to design a production prototype hydriding apparatus. The prototype hydriding apparatus was constructed in Building 779A and went on line in April of 1972.

Research in Building 779 also improved the pyrochemical process for plutonium purification, one of the main plutonium recovery operations. Pyrochemical processing included molten salt extraction and electrorefining processes. Molten salt extraction and electrorefining were used for plutonium recovery from site return materials and scraps, while other processes were used for recovery from residues and oxides. As much plutonium as possible was recovered from site

returns (dated weapons) and manufacturing scraps, since the material was extremely expensive, difficult to obtain, and highly controlled for national security reasons.

Sources: ChemRisk, 1992, *Reconstruction of Historical Rocky Flats Operations And Identification of Release Points, Project Tasks 3 & 4, Final Draft Report,* Rocky Flats Repository.

Crisler, L.R., October 1991, *Rocky Flats Plant Plutonium Recovery Reference Process,* Rocky Flats Repository.

EG&G Rocky Flats, Inc., 1990, *Final Safety Analysis Report, Building 779,* Rocky Flats Repository.

Stakebake, Jerry, Plutonium Metal Researcher in Building 779 of the Plant, began employment with the site contractor in 1965, personal communication, January 22, 1997.

U.S. Department of Energy (DOE) Public Affairs, n.d. *Tour Information. Rocky Flats Facilities.* Golden, Colorado: U.S. Department of Energy, Office of Communications and Economic Development.

U.S. Department of Energy (DOE), 1995, *Final Cultural Resource Survey Report Rocky Flats Environmental Technology Site, the Industrial Area.* Rocky Flats Repository.

Historians: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M), 1997. Alexandra Cole, Architectural Historian, Science Applications International Corporation, 1997.

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ROCKY FLATS PLANT, PLUTONIUM LABORATORY HAER No. CO-83-C
(Rocky Flats Plant, Building 779)
Located in the north-central section of the Industrial Area at 79 Drive.
Golden Vicinity
Jefferson County
Colorado

Photographs from the Rocky Flats Environmental Technology Site archives Rockwell International, site photography contractor, January 5, 1977.

CO-83-C-1 VIEW OF A PORTION OF THE HYDRIDE PROCESSING LABORATORY. OPERATIONS IN THE GLOVE BOX IN THE BACKGROUND OF THE PHOTOGRAPH INCLUDED HYDRIDING OF PLUTONIUM AND HYDRIDE SEPARATION. IN THE FOREGROUND, THE VACUUM MONITOR CONTROL PANEL MEASURED TEMPERATURES WITHIN THE GLOVEBOX. THE CENTER CONTROL PANEL REGULATED THE FURNACE INSIDE THE GLOVE BOX USED IN THE HYDRIDING PROCESSES. THIS EQUIPMENT WAS ESSENTIAL TO THE HYDRIDING PROCESS, AS WELL AS OTHER GLOVE BOX OPERATIONS.

ROCKY FLATS PLANT, GUARD HOUSE

HAER No. CO-83-D

(Rocky Flats Plant, Building 888)

Located northwest of Building 886, just south of Central Avenue

Golden Vicinity

Jefferson County

Colorado

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Rocky Mountain System Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

ROCKY FLATS PLANT, GUARD HOUSE HAER No. CO-83-D
(Rocky Flats Plant, Building 888)

Note: The documentation for Building 888 also represents other guard houses, including buildings 446, 461, 557, 773, 864, and 992.

Location: Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County, Colorado. Building 888 is located in the eastern portion of the Industrial Area, northwest of Building 886 (the Critical Mass Laboratory), on the south side of Central Avenue.

Significance: This building is a primary contributor to the National Register eligible Rocky Flats Plant historic district, associated with the U.S. strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack. Building 888 is one of seven guardhouses used to control access to designated security areas within the Industrial Area.

Description: Building 888, built in 1964, is 20' x 20' (400 square feet) with windows on all four sides. The building is a small one-room concrete building with a flat roof. The windows are large (fixed), single pane with metal sashes; the doors are metal. Building 446, built in 1952, is 23' x 13' (305 square feet) with windows on four sides. This guard house is located to the north of Building 444, the depleted uranium and beryllium production facility. Building 461, built in 1985, is 20' x 20' (400 square feet) with windows on all four sides. This building is located south of Building 460, the non-plutonium (primarily stainless-steel) pit components facility. Building 557, built in 1968, is 13' x 26' (336 square feet) with windows on two sides. It is located within the Protected Area, southeast of Building 559, the chemical analytical laboratory for plutonium production. Building 773, built in 1952, is 14' x 14' (190 square feet) with windows on four sides. It is located northwest of Building 771, the original plutonium fabrication facility. Building 992, built in 1951, is a two-story building, 16' x 16' (370 square feet), with a second floor observation deck. This guardhouse is located in the southwest corner of the Protected Area, southwest of Building 991, the final assembly facility for weapons components.

History: As a top-secret weapons production plant, the Rocky Flats Plant was concerned with security precautions from its inception. According to a former security deputy, in the early years plant security personnel were concerned with the Cold War, espionage, and the secrecy associated with building nuclear weapons. Safeguarding design secrets and later, the number

of weapons being produced was of prime importance. Classified documents were available only on a "need-to-know" basis, all employees were required to qualify for a Q clearance, a high-level security clearance for atomic workers requiring a fifteen year background check. Employees were forbidden to talk about their work with anyone.

The security or protective force regulated plant and interplant access, provided security patrol and checks, and escorted plant shipments. The security force also maintained a weapons arsenal, trained new security police officers, investigated violations of Federal laws, and maintained a liaison with Federal and local law enforcement agencies. A highly trained special response team could respond to actual or potential incidents, such as hostage situations, barricade incidents, or other emergencies. The security forces were responsible for material control and accountability, computer security, personnel security, classified material security, access control, and security protection for special nuclear materials at the Rocky Flats Plants.

The security facilities distributed across the plant site included more than twenty-five buildings. The security facilities can be divided into groups based on similarity in use. Buildings 446, 461, 557, 773, 864, 888, and 992 were used to control access to designated security areas (i.e., a production building and its complex). Each of the four original letter-named plants had its own guard house: Building 446 for Plant A (Building 444); Building 864 for Plant B (Building 881), Building 773 for Plant C (Building771), and Building 992 for Plant D (Building 991). As new production plants were built, individual guardhouses were also constructed for them. Guard house 888 was built in 1964, close to the Critical Mass Laboratory (the Building 886 complex); guard house 461 was built in 1985 for the stainless steel fabrication plant (the Building 460 complex); and guard house 557 was built in 1967 near the Chemical Analytical Laboratory (the Building 559 complex). Day-to-day operations and emergency operations varied little for these security facilities. The guards were responsible for securing the buildings (locking gates and doors) and controlling access. Security was provided for these areas twenty-four hours a day. However, during off-shifts, weekends, and holidays, the security guards may have been in the production buildings on patrol or in the guardhouse (Newby).

Sources: EG&G, 1995, *Site Safety Analysis Report, Notebook 13-Security,* Rocky Flats Plant Repository.

Newby, Ronald, employed at the Rocky Flats Plant since 1967 by the site contractor, personal communication, January 1997.

U.S. Department of Energy (DOE), 1995, *Final Cultural Resource Survey Report Rocky Flats Environmental Technology Site, The Industrial Area,* Rocky Flats Repository.

Historians: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, 1997. Judith Berryman, Ph.D., Archaeologist, engineering-environmental Management, 1997.

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ROCKY FLATS PLANT, GUARDHOUSE HAER No. CO-83-D
(Rocky Flats Plant, Building 888)
Located northwest of Building 886, just south of Central Avenue.
Golden Vicinity
Jefferson County
Colorado

Photographs by Timothy McGrath and Katherine T. Abeyta, Source One, site photography contractor, spring 1997.

CO-83-D-1 VIEW, LOOKING SOUTH, OF THE NORTH ELEVATION OF BUILDING 888. BUILDING 888 IS ONE OF SEVEN GUARDHOUSES USED TO CONTROL ACCESS TO DESIGNATED SECURITY AREAS WITHIN THE INDUSTRIAL AREA.

ROCKY FLATS PLANT, STORAGE VAULT

HAER No. CO-63-B

(Rocky Flats Plant, Building 776)

Located in the southeast corner of the Protected Area, northwest of Building 771

Golden Vicinity

Jefferson County

Colorado

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Rocky Mountain System Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

ROCKY FLATS PLANT, STORAGE VAULT HAER No. CO-83-E
(Rocky Flats Plant, Building 996)

Note: The documentation for Building 996 also represents other storage vaults, including buildings 997, 998, and 999.

Location: Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County, Colorado. Building 996 is in the southeast corner of the Protected Area, northwest of Building 991.

Significance: This building is a primary contributor to the National Register eligible Rocky Flats Plant historic district, associated with the U.S. strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack. Building 996, part of the original D Plant, was used to store nuclear weapons components awaiting off-site shipment.

Description: Building 996 is an underground vault, rectangular in shape. The vault is 60' x 68' and 10' high. Heavy walls divide the vault into five, nearly equal, rooms and an entry hall. A 6" inch thick metal door seals the vault. The underground vault is constructed of thick, reinforced concrete. Air is supplied to the vault through an air supply plenum, and air is exhausted through the air filter plenum in Building 985.

Building 996 is located northwest of Building 991, and is connected to the northwest corner of the building by underground Tunnel 996. Tunnel 996 is 10 to 12' wide x 11 to 13' high and approximately 25 yards long. At the northwest end of Tunnel 996, Tunnel 997 begins and proceeds west for approximately 100 yards, a distance often traveled by employees on bicycles (Cunningham). Building 997 is at the western-most end of Tunnel 997, and Building 999 is on the north side approximately midway along Tunnel 997. Building 997 is a four-room chamber, similar in design and size to Building 996. Building 999 is a three-room chamber.

A second tunnel/vault system (998) extends from the center of the north wall of Building 991. Tunnel 998 is 71/2' wide and 10' high. Vault 998 is a one-room vault. The four vaults have a total area of 20, 940 square feet.

The storage vaults at the Rocky Flats Plant are unique in construction for storage facilities within the Department of Energy nuclear weapons complex. The walls of the vaults are constructed of reinforced concrete approximately 14½' in thickness and are buried 15' underground, while the tunnel walls are only 2' thick. At other Department of Energy weapons production facilities, storage vault walls are generally constructed only 2 to 3' thick (Cunningham).

History: Building 996 was constructed in 1952 as part of the original Plant D, Building 991. Building 991 was the shipping and receiving facility for incoming and outgoing special nuclear material and supplies. Trigger components manufactured in other buildings around the

Plant, as well as components manufactured at the Oak Ridge Tennessee facility, were sent to Plant D for assembly and storage. The Rocky Flats Plant received and shipped products by rail and by truck. The assembled triggers (also known as pits) were shipped off site to the Pantex Plant in Amarillo Texas for final weapons assembly. A railroad spur terminated to the northeast of Building 551 near the center of the Industrial Area of the site. For each off-site rail shipment, members of the heavily armed protective force (site security personnel) would escort the shipment from the vault, across the site, and on to the boxcars waiting at the railroad spur (Richmond).

Retired triggers were also sent back to the Rocky Flats Plant from Pantex for recovery of valuable plutonium and uranium. The retired triggers were stored in the underground vaults until they were moved to the 700-area buildings where recovery operations took place.

Building 999 was constructed in 1959 to increase storage capacity. For security reasons, the contractor hired to construct the vault was not allowed access from or contact with Tunnel 997. After the contractor completed the vault, site personnel cut a hole in the tunnel wall and connected Building 999 to the tunnel.

Sources: Cunningham, Steve, employed at the Rocky Flats Plant since 1977 by the site contractor, personnel communication, August 1997.

EG&G, 1994, *Historical Release Report (HRR)*, Rocky Flats Plant Repository.

EG&G Rocky Flats, Inc., 1995, *Site Safety Analysis Report, Notebook 13-Security*, Rocky Flats Plant Repository.

Richmond, Lou, employed at the Rocky Flats Plant since 1970 by the site contractor, personnel communication, August 1997.

U.S. Department of Energy (DOE), 1995, *Final Cultural Resource Survey Report Rocky Flats Environmental Technology Site, The Industrial Area,* Rocky Flats Plant Repository.

Wilson, Sharon, employed at Rocky Flats Plant since 1981 by the site contractor, personal communication, September 1997.

Historian: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M), 1997. Judith Berryman, Ph.D., Archaeologist, e^2M, 1997.

HISTORIC AMERICAN ENGINEERING RECORD

ROCKY FLATS PLANT, STORAGE VAULT HAER No. CO-83-E
(Rocky Flats Plant, Building 996)

Note: The documentation for Building 996 also represents other storage vaults, including buildings 997, 998, and 999.

Location: Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County, Colorado. Building 996 is in the southeast corner of the Protected Area, northwest of Building 991.

Significance: This building is a primary contributor to the National Register eligible Rocky Flats Plant historic district, associated with the U.S. strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack. Building 996, part of the original D Plant, was used to store nuclear weapons components awaiting off-site shipment.

Description: Building 996 is an underground vault, rectangular in shape. The vault is 60' x 68' and 10' high. Heavy walls divide the vault into five, nearly equal, rooms and an entry hall. A 6" inch thick metal door seals the vault. The underground vault is constructed of thick, reinforced concrete. Air is supplied to the vault through an air supply plenum, and air is exhausted through the air filter plenum in Building 985.

Building 996 is located northwest of Building 991, and is connected to the northwest corner of the building by underground Tunnel 996. Tunnel 996 is 10 to 12' wide x 11 to 13' high and approximately 25 yards long. At the northwest end of Tunnel 996, Tunnel 997 begins and proceeds west for approximately 100 yards, a distance often traveled by employees on bicycles (Cunningham). Building 997 is at the western-most end of Tunnel 997, and Building 999 is on the north side approximately midway along Tunnel 997. Building 997 is a four-room chamber, similar in design and size to Building 996. Building 999 is a three-room chamber.

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History: Building 996 was constructed in 1952 as part of the original Plant D, Building 991. Building 991 was the shipping and receiving facility for incoming and outgoing special nuclear material and supplies. Trigger components manufactured in other buildings around the

Plant, as well as components manufactured at the Oak Ridge Tennessee facility, were sent to Plant D for assembly and storage. The Rocky Flats Plant received and shipped products by rail and by truck. The assembled triggers (also known as pits) were shipped off site to the Pantex Plant in Amarillo Texas for final weapons assembly. A railroad spur terminated to the northeast of Building 551 near the center of the Industrial Area of the site. For each off-site rail shipment, members of the heavily armed protective force (site security personnel) would escort the shipment from the vault, across the site, and on to the boxcars waiting at the railroad spur (Richmond).

Retired triggers were also sent back to the Rocky Flats Plant from Pantex for recovery of valuable plutonium and uranium. The retired triggers were stored in the underground vaults until they were moved to the 700-area buildings where recovery operations took place.

Building 999 was constructed in 1959 to increase storage capacity. For security reasons, the contractor hired to construct the vault was not allowed access from or contact with Tunnel 997. After the contractor completed the vault, site personnel cut a hole in the tunnel wall and connected Building 999 to the tunnel.

Sources: Cunningham, Steve, employed at the Rocky Flats Plant since 1977 by the site contractor, personnel communication, August 1997.

EG&G, 1994, *Historical Release Report (HRR)*, Rocky Flats Plant Repository.

EG&G Rocky Flats, Inc., 1995, *Site Safety Analysis Report, Notebook 13-Security*, Rocky Flats Plant Repository.

Richmond, Lou, employed at the Rocky Flats Plant since 1970 by the site contractor, personnel communication, August 1997.

U.S. Department of Energy (DOE), 1995, *Final Cultural Resource Survey Report Rocky Flats Environmental Technology Site, The Industrial Area,* Rocky Flats Plant Repository.

Wilson, Sharon, employed at Rocky Flats Plant since 1981 by the site contractor, personal communication, September 1997.

Historian: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M), 1997. Judith Berryman, Ph.D., Archaeologist, e^2M, 1997.

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ROCKY FLATS PLANT, STORAGE VAULT HAER No. CO-83-E
(Rocky Flats Plant, Building 996)
Located in the southeast corner of the Protected Area, northwest of Building 991.
Golden Vicinity
Jefferson County
Colorado

Photograph from the Rocky Flats Plant photography archives, site photography contractor, Summer of 1994.

CO-83-K-1 VIEW OF ONE OF THE INNER ROOMS WITHIN VAULT 996. THE UNDERGROUND VAULTS WERE USED TO STORE SPECIAL NUCLEAR MATERIAL AWAITING ON- AND OFF-SITE SHIPMENT.

ROCKY FLATS PLANT BUS STOP SHELTER HAER No. CO-183-F

(Rocky Flats Plant, Building 14)

Located on the west side of Fourth Street south of Central Avenue

Golden Vicinity

Jefferson County

Colorado

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Rocky Mountain System Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

ROCKY FLATS PLANT, BUS STOP SHELTER HAER No. CO-83-F
(Rocky Flats Plant, Building 114)

Location: Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County, Colorado. Building 114 is located on the west side of Fourth Street, south of Central Avenue.

Significance: This building is a primary contributor to the National Register eligible Rocky Flats Plant historic district, associated with the U.S. strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack. Building 114 was built to shield workers from inclement weather.

Description: Building 114 is a small rectangular concrete block building with a flat metal roof. The building is approximately 8' x 9' (72 square feet). The building has windows on all sides. The east and west elevation windows are fixed, multi-paned, with metal sashes. The north and south elevations have double hung, metal sash windows, and wooden doors with windows.

History: During the 1950s, as part of early security efforts, the only point of entry to the site was from the west off Highway 93, and the only vehicles allowed onsite were construction and government vehicles. Due to the elevation, exposed nature, and close proximity to the Rocky Mountain foothills, winds at the Rocky Flats Plant periodically approach destructive levels of eighty miles per hour or greater, particularly in the winter. Vehicles were parked along on-site roadways to create windbreaks and employees often had to hold hands to be able to navigate in the strong winds (Cunningham). Building 114 was built in 1959 to shield workers from the weather while waiting for the shuttle bus to transport them to their respective work sites.

Workers parked along Highway 93 were bused on a dirt road to the administration area of the site (Building 111) to check in and have timecards punched (Weaver), or employees could park in one of two lots outside the fenced plant site. One parking lot was west of Building 111, the other was west of Building 881. Building 864, a guard post near building 881, was a second location where employees could have their timecards punched. Once on site, employees were bused or walked to their respective work locations. Buses transported employees to the security posts at the production buildings.

In 1957, a design change was made in the triggers manufactured at the Rocky Flats Plant. This design required more machining, which, in part, led to a dramatic growth in the employment. By 1958, employees were allowed to drive their personal cars on the site.

Sources: Cunningham, Steve, employed at the Rocky Flats Plant since 1977 by the site contractor, personal communication, August 1997.

EG&G Rocky Flats, Inc., 1995, *Site Safety Analysis Report, Notebook 13-Security*, Rocky Flats Repository.

U.S. Department of Energy (DOE), 1995, *Final Cultural Resource Survey Report Rocky Flats Environmental Technology Site, The Industrial Area*, Rocky Flats Repository.

Weaver, Jack, employed at the Rocky Flats Plant since September of 1961 by the site contractor, personal communication, August 1997.

Historians: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M), 1997. Judith Berryman, Ph.D., Archaeologist, e^2M, 1997.

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ROCKY FLATS PLANT, BUS STOP SHELTER HAER No. CO-83-F
(Rocky Flats Plant, Building 114)
Located on the west side of Fourth Street, south of Central Avenue.
Golden Vicinity
Jefferson County
Colorado

Photograph by Timothy McGrath and Katherine T. Abeta, Source One, site photography contractor, Summer 1997.

CO-83-F-1 VIEW, LOOKING SOUTH, OF THE NORTH ELEVATION OF BUILDING 114. BUILDING 114 SERVED AS THE BUS STOP SHELTER WHEN PERSONAL VEHICLES WERE BANNED ON THE SITE PROPERTY.

ROCKY FLATS PLANT GUARD FACILITY

HAER No. CO-83-G

(Rocky Flats Plant, Building 130)

(Rocky Flats Environmental Technology Site, Building 130)

Building 130 is located on the south side of the West (Access) Road approximately 2,323 feet east of the intersection of Colorado Highway 93 and the West Road.

Golden vicinity

Jefferson County

Colorado

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

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Rocky Mountain System Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

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ROCKY FLATS PLANT, GUARD FACILITY HAER No. CO-83-G
(Rocky Flats Plant, Building 120)

Note: The documentation for Building 120 also represents other access guard facilities, including buildings 100, 113, 133, 900, and 920.

Location: Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County, Colorado. Building 120 is located on the south side of the West (access) Road, approximately 2,323' east of the intersection of Colorado Highway 93 and the West Road.

Significance: This building is a primary contributor to the National Register eligible Rocky Flats Plant historic district, associated with the U.S. strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack. Building 120 is one of two guard facilities used by security personnel to control access to the site.

Description: Building 120 is a hexagonal structure with windows on four sides. The exterior walls are concrete block, and the interior walls are gypsum board. The dimensions are approximately 18' along the north wall, 15' along the northeast wall, 18' along the southeast wall, 14' along the south wall, 18' along the southwest wall, and 15' along the northwest wall. Three guard booths to the north of the structure, are on raised islands. Each guard booth is equipped with a traffic control barrier. Building 120 has a stand-by generator with a 2,000-gallon underground storage tank for diesel fuel, which is located south of the building.

Building 100, built in 1969, is four-sided and approximately 430 square feet. It is located approximately 550' southeast of Building 131 and is situated in the middle of the intersection of West Road, Cactus Avenue, and First Street. Building 113, built in 1988, is four-sided and 65 square feet. It is located west of the intersection of Fourth Street and Central Avenue. The structure was used to control access to the Department of Energy/Rocky Flats Field Operations Office and the Managing and Operating Site Contractors Headquarters. Building 133, built in 1986, is four-sided and 32 square feet. It is located on the roadway at the entrance to Building 130, the 130 Warehouse, and the adjacent parking areas. Building 900, built in 1964, is four-sided, approximately 320 square feet. It is located approximately 300' southeast of Building (guard tower) 901 in the middle of Central Avenue and East (access) Road. Building 920, built in 1986, is six-sided, approximately 560 square feet. It is approximately 1,500' west of the intersection of Indiana Street and the East Road on the north side of the roadway. Building 920 housed personnel responsible for controlling access to the site from the east access point.

History: Since 1951, the West Road has been the primary entry point to the Rocky Flats Plant site, and the only access until 1964. Building 120 was built to house the protective force personnel, responsible for controlling pedestrian and vehicle entrance to and egress from the Rocky Flats Plant. Visitors and deliveries to the site had to enter through the west entrance.

When the Rocky Flats Plant first opened, workers parked west of the site on Highway 93 and were bused to the administration area (Building 111) to check in, and then walked or were bused to their respective work buildings. Shortly after the Rocky Flats Plant opened, two parking lots were built outside the fenced plant operations area. One parking lot was located west of Building 111. Employees parked in this lot and entered the site through Building 11 (111). A second parking lot was located just west of Building 81 with guard post 864 as the check in point.

By 1958, employees working in buildings 77 and 91were allowed to drive their personnel cars onto the plant property through a gate near Building 81 (881) (Riddle). In 1961, work shifts were increased from one shift, five days per week to multiple shifts, seven days a week in order to keep up with production demands (Weaver). By the spring of 1962, there were 2,100 employees at the site, an increase from 1,435 employees in September of 1961 (Weaver). In 1964, an east access route from Indiana Street was built with a guardhouse, Building 900, to check employee badges as they entered the plant. Employees entering from the west were still required to park outside the fence or enter through the gate near Building 81 (881) until 1969, when Building 100 was built as a western badge check point (Riddle).

In the 1970s and 1980s, plant security personnel were concerned less with espionage and more with the threat of terrorism and infiltration of the plant by protestors. Better protection of the outer boundaries of the area became necessary. In 1972 a buffer zone of 4,600 acres around the existing plant was purchased for additional protection. In 1985, Building 120 was built to control site access from the western outermost edge of the buffer zone.

Sources: EG&G Rocky Flats, Inc., 1995, *Site Safety Analysis Report, Notebook 13-Security*, Rocky Flats Repository.

U.S. Department of Energy (DOE), 1995, *Final Cultural Resource Survey Report Rocky Flats Environmental Technology Site, The Industrial Area*, Rocky Flats Repository.

Riddle, Robert, employed at the Rocky Flats Plant by the site contractor since 1958, personal communication, September 1997.

Weaver, Jack, employed at the Rocky Flats Plant by the site contractor since 1961, personal communication, August 1997.

Historian: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M), 1997. Judith Berryman, Ph.D., Archaeologist, e^2M, 1997.

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ROCKY FLATS PLANT, GUARD FACILITY HAER No. CO-83-G
(Rocky Flats Plant, Building 120)
(Rocky Flats Environmental Technology Site, Building 120)
Building 120 is located on the south side of the West (access) Road, approximately 2,323 feet east of the intersection of Colorado Highway 93 and the West Road.
Golden Vicinity
Jefferson County
Colorado

Photograph by Timothy McGrath and Katherine T. Abeyta, Source One, site photography contractor, summer 1997.

CO-83-G-1 VIEW, LOOKING EAST, OF THE WEST ELEVATION OF BUILDING 120. BUILDING 120 HOUSES THE PROTECTIVE FORCE PERSONNEL RESPONSIBLE FOR CONTROLLING ENTRANCE TO AND EGRESS FROM THE ROCKY FLATS PLANT WEST ENTRANCE.

ROCKY FLATS PLANT GUARDS POST
(Rocky Flats Plant Building 762)
Located north of Building 762A, Inside the Protected Area
Golden Vicinity
Jefferson County
Colorado

HAER No. CO-83-H

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Rocky Mountain System Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

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ROCKY FLATS PLANT, GUARD POST HAER No. CO-83-H
(Rocky Flats Plant, Building 762)

Note: The documentation for Building 762 also represents other guard posts used to control access to the Protected Area, including 372 and 792, and Building 764, which housed equipment for the perimeter intrusion detection assessment system, used to detect activity within the Perimeter Security Zone.

Location: Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County, Colorado. Building 762 is located north of Building 762A, inside the Protected Area.

Significance: This building is a primary contributor to the National Register eligible Rocky Flats Plant historic district, associated with the U.S. strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack. Security personnel use Building 762 to control vehicles entering into the Protected Area.

Description: Building 762 is a concrete structure with tubular aluminum sections and asbestos panels to sill height of the windows on three sides. The roof is concrete on metal pans. The building is approximately 25' x 25' (625 square feet). A vehicle trap east of the building has electric gates on the north and south ends of the road cut through the double fence of the Perimeter Security Zone. Buildings 372 and 792 are similar in construction and size to Building 762.

Building 764 is approximately 20' x 50' (1,000 square feet), concrete with a flat roof. This structure is located northwest of Building 762, inside the Protected Area. Electronic equipment and computers used to run the perimeter intrusion detection assessment system was housed in Building 764.

History: Building 762 was constructed in 1983 as part of the Perimeter Security Zone, a $5 million project to surround and secure the plutonium operations at the Plant. Three access points, also referred to as portals, are located in the Perimeter Security Zone. Building 762 (Portal 1) is the only entrance point for vehicles going into the Protected Area. Building 372 (Portal 2) is located south of Building 371, is the exit point for vehicles, and Building 792 (Portal 3) located north of Building 771, is for pedestrian access only. All three portals allow entrance and egress for pedestrians.

To enter the Protected Area, until 1989, an employee placed their badge in a drawer to pass it into the guard posts to a member of the protective force for a badge check. The badge was returned and the employee entered the area through a metal detector. Upon leaving the Protected Area, an employee displayed their badge to the protective force member on duty and exited.

As the Cold War continued and concerns and fear escalated, regulations and requirements were implemented to tighten security. New requirements included more advanced special nuclear material metal detectors for people and x-rays of property entering and exiting the Protected Area. A second larger access control post was built at each of the portals to accommodate the upgraded equipment and badge-check functions.

Once the new larger access control posts were built in 1989, the original security buildings were no longer were needed to provide badge check function. At Portal 1, security personnel scrutinize all vehicles prior to entering the Protected Area with radiation monitoring and detection equipment, and search the vehicles for prohibited equipment and materials (Cunningham).

Sources: Cunningham, Steve, employed at the Rocky Flats Plant since 1977 by the site contractor, personal communication, September 1997.

EG&G Rocky Flats, Inc., 1995, *Site Safety Analysis Report, Notebook 13-Security*, Rocky Flats Repository.

Richmond, Lou, employed at the Rocky Flats Plant since 1970 by the site contractor, personal communication, August 1997.

U.S. Department of Energy (DOE), 1995, *Final Cultural Resource Survey Report Rocky Flats Environmental Technology Site, The Industrial Area,* Rocky Flats Repository.

Historians: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M), 1997. Judith Berryman, Ph.D., Archaeologist, e^2M, 1997.

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ROCKY FLATS PLANT, GUARD POST HAER No. CO-83-H
(Rocky Flats Plant, Building 762)
Located north of Building 762A, inside the Protected Area.
Golden Vicinity
Jefferson County
Colorado

Photograph by Timothy McGrath and Katherine T. Abeyta, Source One, site photography contractor, Summer 1997.

CO-83-H-1 VIEW, LOOKING NORTH, OF THE SOUTH ELEVATION OF BUILDING 762. BUILDING 762, PORTAL 1, IS ONE OF THREE PEDESTRIAN ACCESS POINTS INTO THE PROTECTED AREA, SURROUNDING PLUTONIUM OPERATIONS. PORTAL 1 IS ALSO THE ENTRANCE FOR ALL VEHICLES ENTERING THE PROTECTED AREA.

x-rays for property entering and exiting the Protected Area. A second access control post was built at each of the portals to accommodate the equipment and badge-check functions.

Once the new larger access control posts were built in 1989, the original security buildings were no longer were needed to provide badge check function. At Portal 1, security personnel who scrutinize all vehicles prior to entering the Protected Area with radiation monitoring and detection equipment, and search the vehicles for prohibited equipment and materials used Building 762 as a shelter (Cunningham).

Sources: Cunningham, Steve, employed at the Rocky Flats Plant since 1977 by the site contractor, personal communication, September 1997.

EG&G Rocky Flats, Inc., 1995, *Site Safety Analysis Report, Notebook 13-Security*, Rocky Flats Repository.

Richmond, Lou, employed at the Rocky Flats Plant since 1970 by the site contractor, personal communication, August 1997.

U.S. Department of Energy (DOE), 1995, *Final Cultural Resource Survey Report Rocky Flats Environmental Technology Site, The Industrial Area,* Rocky Flats Repository.

Historians: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M), 1997. Judith Berryman, Ph.D., Archaeologist, e^2M, 1997.

ROCKY FLATS PLANT, ACCESS CONTROL BUILDING HAER No. CO-83-I
(Rocky Flats Plant, Building 992A)
(Rocky Flats Environmental Technology Site, Building 992A)
Main Entrance on Highway 93
Bounded by Highways 93, 128, and 72, and Indiana Street
Located north of Building 771 in parking area 11, just south of the north perimeter road
Golden Vicinity
Jefferson County
Colorado

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Rocky Mountain System Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

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ROCKY FLATS PLANT,
ACCESS CONTROL BUILDING
(Rocky Flats Plant, Building 792A)

HAER No. CO-83-I

Note: The documentation for Building 792A also represents other access control buildings, including 372A and 762A.

Location: Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County, Colorado. Building 792A is located north of Building 771, in parking area 71, just south of the north perimeter road.

Significance: This building is a primary contributor to the National Register eligible Rocky Flats Plant historic district, associated with the U.S. strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack. Security personnel use Building 792A to monitor pedestrian ingress and egress for the Protected Area through the Perimeter Security Zone.

Description: Building 792A is a concrete structure. The roof is concrete on metal pans. The building is approximately 69' x 26' (1794 square feet). Two doors are located at each of the south and north ends of the building. Two turnstiles are located near the south end of the building.

Buildings 372A and 762A are similar in construction to Building 792A. Building 372A is a 1,800 square foot structure and Building 762A is 4,000 square foot structure. Building 372A is located northeast of the intersection of Sage Avenue and Fourth Street. Building 762A is located just east of Eighth Street and north of Central Avenue.

History: Building 792A was constructed in 1989 in the Perimeter Security Zone – a fence and intrusion detection project surrounding the plutonium operations. When the Perimeter Security Zone was completed in 1983, three guard posts (372, 762, and 792) were built into the inner fence to house the protective force personnel that conducted badge checks to monitor employee entry and exit from the Protected Area. As the Cold War continued, stricter requirements were implemented to safeguard against potential plutonium theft and additional building space was needed to house the equipment required for entry and egress checks. Building 792A was one of three additional access control posts, built in 1989 to accommodate the equipment and badge check functions.

Access into the Protected Area through Building 792A is gained by entering the structure through the north doors; passing through a badge check, a metal detector, and turnstile; and then exiting through doors at the south end of the building and into the fenced Protected Area. Personal property going into the Protected Area is passed through an x-ray device.

Sources: Cunningham, Steve, employed at the Rocky Flats Plant since 1977 by the site contractor, personnel communication, September 1997.

EG&G Rocky Flats, Inc., 1995, *Site Safety Analysis Report, Notebook 13-Security*, Rocky Flats Repository.

Richmond, Lou, employed at the Rocky Flats Plant since 1970 by the site contractor, personal communication, August 1997.

U.S. Department of Energy (DOE), 1995, *Final Cultural Resource Survey Report Rocky Flats Environmental Technology Site, The Industrial Area,* Rocky Flats Repository.

Historians: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M), 1997. Judith Berryman, Ph.D., Archaeologist, e^2M, 1997.

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ROCKY FLATS PLANT, ACCESS CONTROL BUILDING HAER No. CO-83-I
(Rocky Flats Plant, Building 792A)
(Rocky Flats Environmental Technology Site, Building 792A)
Main Entrance on Highway 93
Bounded by Highways 93, 128, and 72, and Indiana Street
Located north of Building 771, in parking area 71, just south of the north perimeter road.
Golden Vicinity
Jefferson County
Colorado

Photograph by Timothy McGrath and Katherine T. Abeyta, Source One, site photography contractor, Summer 1997.

CO-83-I-1 VIEW, LOOKING SOUTH, OF THE NORTH ELEVATION OF BUILDING 792A. BUILDING 792A, AT PORTAL 3, IS ONE OF THREE PEDESTRIAN ACCESS POINTS THROUGH THE PERIMETER SECURITY ZONE INTO THE PROTECTED AREA.

ROCKY FLATS PLANT, GUARD TOWER

HAER No. CO-83-J

(Rocky Flats Plant, Building 901)

Located in the southeast corner of the Protected Area

Golden Vicinity

Jefferson County

Colorado

PHOTOGRAPHS

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Rocky Mountain System Support Office
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P.O. Box 25287
Denver, Colorado 80225-0287

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ROCKY FLATS PLANT, GUARD TOWER HAER No. CO-83-J
(Rocky Flats Plant, Building 901)

Note: The documentation for Building 901 also represents other guard towers, including buildings 375, 550, and 761.

Location: Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County, Colorado. Guard tower 901 is located in the southeast corner of the Protected Area.

Significance: This building is a primary contributor to the National Register eligible Rocky Flats Plant historic district, associated with the U.S. strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack. Building 901 is an integral part of the Perimeter Security Zone, built to monitor activities around the plutonium operations.

Description: Building 901 is 12' x 12' and 45' high (144 square feet). The building has an interior stairwell leading to an observation deck. The tower is brick and concrete with a concrete-on-metal roof. The structure has three levels. The first floor has a protected entrance and houses a transformer. Approximately 26' above the first level is an equipment room for electrical heating and air conditioning equipment. The observation deck is about 10' above the equipment room.

Buildings 375, 550, and 761 are similar in construction and size of Building 901.

History: In the 1970s and1980s, security at the Rocky Flats Plant shifted its focus from espionage to the threat of terrorism and infiltration by protesters. The terrorist attack during the 1972 Olympic Games in Munich led the U.S. government to believe that trained terrorists could attack national defense facilities. A few years later, the plant also began to experience anti-nuclear demonstrations and rallies. In response, the protective force initiated riot control training and adopted a more offensive security posture (Richmond). In 1978, plans to install a $5 million Perimeter Security Zone surrounding the plutonium operations buildings were developed. The Perimeter Security Zone, completed in 1983, consists of a double perimeter fence with closed circuit televisions, alarms, and an uninterrupted power supply. Security personnel were constantly on surveillance and provided verification of movement detected by the security system at the perimeter of the plutonium operations. Access into and out of the zone was controlled at three checkpoints.

Four guard towers were installed as part of the Perimeter Security Zone inside the inner fence. The towers provided security personnel with a clear, higher view in all directions, including the Protected Area, fence lines, and the buffer zone. Building 901 is located in the southeast corner of the Perimeter Security Zone. The other towers are located in the three remaining corners of the Perimeter Security Zone. Building 550 is in the southwest corner, Building 761 is in the northeast corner, and Building 375 is in the northwest corner.

Prior to construction of the Perimeter Security Zone, each of the production buildings had a separate "protected area." Fencing surrounded each building complex, as well as the entire Industrial Area. Production buildings outside the Perimeter Security Zone (beryllium and uranium) maintained separate "protected areas" until well after production stopped in 1989. The protective force controlled access into each building. Multiple layers of security were enforced throughout the site and at every production building.

The end of the Cold War and weapons production at the Rocky Flats Plant brought the end to site protests. The protective force has returned to a more defensive security posture (Richmond).

Sources: EG&G Rocky Flats, Inc., 1995, *Site Safety Analysis Report, Notebook 13-Security*, Rocky Flats Repository.

Cunningham, Steve, employed at the Rocky Flats Plant since 1977 by the site contractor, personnel communication, September 1997.

Richmond, Lou, employed at Rocky Flats Plant since 1970 by the site security contractor, personal communication, August 1997.

U.S. Department of Energy (DOE), 1995, *Final Cultural Resource Survey Report Rocky Flats Environmental Technology Site, The Industrial Area.* Rocky Flats Repository.

Historians: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M), 1997. Judith Berryman, Ph.D., Archaeologist, e^2M, 1997.

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ROCKY FLATS PLANT, GUARD TOWER
(Rocky Flats Plant, Building 901)
Located in the southeast corner of the Protected Area.
Golden Vicinity
Jefferson County
Colorado

HAER No. CO-83-J

Photograph by Timothy McGrath and Katherine T. Abeyta, Source One, site photography contractor, Summer 1997.

CO-83-J-1 VIEW, LOOKING NORTH, OF THE SOUTH ELEVATION OF BUILDING 901. BUILDING 901 IS ONE OF FOUR GUARD TOWERS INSTALLED AS PART OF THE PERIMETER SECURITY ZONE TO PROVIDE PROTECTIVE FORCE PERSONNEL WITH A CLEAR HIGH VIEW OF THE SURROUNDING AREAS. THE PERIMETER SECURITY ZONE CONSISTS OF A DOUBLE PERIMETER FENCE WITH CLOSED CIRCUIT TELEVISIONS, ALARMS, AND AN UNINTERRUPTED POWER SUPPLY.

HISTORIC AMERICAN ENGINEERING RECORD

ROCKY FLATS PLANT,
PLUTONIUM RECOVERY FACILITY HAER No. CO-83-K
(Rocky Flats Plant, Building 371)

Location: Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County, Colorado. Building 371 is located in the northwestern portion of the Rocky Flats Plant (Plant).

Date of Construction: 1981.

Fabricator: Frank Briscoe.

Present Owner: United States Department of Energy (USDOE).

Present Use: Plutonium Recovery.

Significance: This building was a primary contributor to the National Register eligible Rocky Flats Plant historic district, associated with the United States (U.S.) strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack. Building 371 was built to house Plant plutonium recovery operations using advanced technology.

Historians: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M), 1997. Judith Berryman, Ph.D., Archaeologist, e^2M , 1997.

Project Information:

In 1995, an inventory and evaluation was conducted of facilities at the Rocky Flats Plant for their potential eligibility for listing in the National Register of Historic Places. The primary goal of this investigation was to determine the significance of the Cold War era facilities at the Plant in order to assess potential effects of the long-term goals and objectives of the USDOE. These goals and objectives have not yet been formalized, but include waste cleanup and demolition activities. Recommendations regarding National Register of Historic Places eligibility were developed to allow the USDOE to submit a formal determination of significance to the Colorado State Historic Preservation Officer for review and concurrence and to provide for management of historic properties at the Plant.

From this determination and negotiations with the Colorado State Historic Preservation Officer, the Advisory Council, and the National Park Service, a Historic American Engineering Record project began in 1997 to document the Plant's resources prior to their demolition. The Plant was listed on the National Register of Historic Places in 1997. The archives for the Historic

American Engineering Record project are located in the Library of Congress in Washington, D.C.

Introduction:

The Plant is one of thirteen USDOE facilities that constitute the Nuclear Weapons Complex, which designed, manufactured, tested, and maintained weapons for the U.S. arsenal. The Plant was established in 1951 to manufacture triggers for use in nuclear weapons and to purify plutonium recovered from retired weapons. The trigger consisted of a first-stage fission bomb that set off a second-stage fusion reaction in a hydrogen bomb. Parts were formed from plutonium, uranium, beryllium, stainless steel, and other materials.

A tense political atmosphere both at home and abroad during the Cold War years drove U.S. weapons research and development. By the 1970s, both the U.S. and the Soviet Union maintained thousands of nuclear weapons aimed at each other. These weapons were based on submarines, aircraft, and intercontinental ballistic missiles. Both the North Atlantic Treaty Organization and Warsaw Pact countries in Europe had small nuclear warheads known as theater weapons used as part of the Mutually Assured Destruction program. (The Mutually Assured Destruction program acted as a deterrent in that if one side attacked with nuclear weapons, the other would retaliate and both sides would perish.) The final nuclear weapons program at the Plant was the W-88 nuclear warhead for the Trident II missile. This mission ended in 1992 when President Bush canceled production of the Trident II missile.

The Plant was a top-secret weapons production plant, and employees worked with a recently man-made substance, plutonium, about which little was known concerning its chemistry, interactions with other materials, and shelf life. The Historic American Engineering Record documentation effort focused on four aspects of the Plant and its role in the Nuclear Weapons Complex: manufacturing operations, research and development, health and safety of workers, and security.

Chronology of Building 371:

1968	The decision was made to replace the Building 771/774 Plutonium Recovery Facility with the Building 371/374 complex.
1970	The construction plan for Building 371 was authorized.
1973	Site preparation, groundbreaking, and fencing for building construction began.
1976	The building was originally scheduled for start-up, however, construction was temporarily halted due to problems with the construction contractor.

1978	Waste treatment operations began in Building 374.
1980	Waste treatment in Building 374 began handling non-radioactive wastes from Building 371. The wastes were generated from start-up testing operations of non-radioactive solutions.
1981	Construction of Building 371 was completed. USDOE authorized radioactive operations. Plutonium pyrochemical recovery operations (molten salt extraction) began on a limited basis. The first electrorefining run in the tilt-pour furnace began.
1982	Pilot-scale aqueous plutonium operations began, including recovery in March, primary purification in April. Initial full-scale operations of the aqueous recovery system began in August.
1983	The Plant produced the first plutonium metal processed entirely through the building's aqueous recovery system. The Plutonium Recovery Modification Project was established as a result of plutonium inventory accountability problems during pilot-scale operations in the aqueous recovery process. Its purpose was to identify processing deficiencies in Building 371 and to design replacement processes. Aqueous recovery operations ceased in April.
1985	The site contractor submitted the Conceptual Design Report to USDOE detailing modifications needed to bring Building 371 into full operation.
1986	Electrorefining activities ceased. Approximately half of the processes that were originally operating in the building had been shut down by this date. The last major recovery operations terminated.
1988	Pyrochemical processing ceased.
1990	Funding for replacement plutonium recovery processes for Building 371 was denied by Congress.

Building History:

Building 371 was originally built to replace plutonium recovery operations in Buildings 771 and 776, using advanced technology for plutonium handling, recovery, and safety. Although fundamentally based on the processes and principles developed previously in Building 771, the design of Building 371 incorporated many technological advances and refinements. The design, initiated in 1969, was far more sophisticated and complex than any others at the Plant. Building 371 was designed to emphasize automatically controlled, remotely operated processes, in

contrast to the direct, hands-on operations in Building 771. The projected operations for the building focused primarily on recovery of plutonium from both solid and liquid wastes. The final product from the process operations was intended to be recycled plutonium metal, which was to be reused in the Plant's primary manufacturing process.

Building 371 was originally scheduled to be completed in 1976 and to cost approximately $70 million. The stacker-retriever, a remotely operated, mechanized transport system to move plutonium storage drums, became operational in 1976. In 1980, the heating, venting, and air-conditioning systems were brought on-line and start-up testing operations using non-radioactive solutions began. The rest of the building was finally completed in 1981 for a total cost of approximately $214 million. Limited pyrochemical plutonium recovery operations began in 1981.

In 1982, pilot-scale aqueous plutonium recovery operations began in Building 371. There were not enough operators to run the process continuously, so the process was run in batches, shutting down one phase to start the next. Employees were to be transferred to the new facility when it was fully operational and Building 771 was shut down.

One year after the aqueous recovery process began, the USDOE conducted an inventory of the plutonium at the Plant, and the Building 371 inventory was found to be deficient. The building had more than 770 miles of piping, of which 70 miles were plutonium processing lines. Process lines ran through walls and traversed several floors. In the 1960s, plutonium inventories were calculated by the amount of material that went into the process and the amount that came out; the amount residing in the process was estimated. By 1976, accountability was required for every gram of material at all times; estimating the amount of plutonium residing in the process was no longer acceptable. The aqueous process was shut down until all in-process plutonium could be located. The majority of the material was found. Designed in 1968, Building 371 was not constructed to meet this type of safeguard and security requirement. Although several projects to upgrade the system were proposed, none were approved. The process never ran at full capacity nor did the process ever again become operational after 1983.

Building Description:

Building 371 was designed to emphasize the use of automatically controlled, remotely operated processes. Design features included the use of remotely operated transfer systems for movement of radioactive materials. The stacker-retriever, a computer-operated, rail-mounted shuttle moved radioactive material between storage and plutonium recovery operations.

The plutonium handling areas of the building are compartmentalized by fire walls, airlocks, and the use of negative air pressure to prevent the spread of plutonium from one area to another. The compartments are further divided into rooms, canyons, and vaults. Rooms were used to house glove box operations and equipment that did not require special containment precautions.

Canyons were used to house plutonium handling operations that were not contained within glove boxes. Process equipment within the canyon was remotely operated; the canyon and all the equipment inside were contaminated with plutonium.

Vaults are essentially storage areas that are designed to prevent criticality of stored plutonium-containing materials. To prevent nuclear criticality, storage racks hold containers in a safe geometry, and tanks and containers within the vaults are of a safe geometry, or are filled with boron-glass Raschig rings. Tanks in certain areas are located behind 2' concrete walls, which helped to shield personnel from radiation in the unlikely event of a nuclear criticality.

Building Layout
Building 371 is a four-level partially buried structure constructed of reinforced concrete. It encompasses approximately 186,000 square feet of floor space. The building construction was hardened to withstand the forces imposed by a design-basis earthquake or tornado. The hardened construction includes the exterior walls and roof, those parts of the building where plutonium recovery operations were conducted, and portions of the building that housed equipment or systems essential to the recovery processes or were required to contain plutonium within the building.

The sub-basement, the bottom level, is an irregularly shaped area, consisting primarily of the lower portion of the plutonium storage vault and its transfer, repair, and the stacker-retriever maintenance bays. Areas at the east end contain the lower parts of the glove box scrubbers, the incinerator vent scrubber, and the filtration process area, plus utility equipment for the sub-basement. The sub-basement measures 364' (east to west) x 180' (north to south).

The east end of the sub-basement contains a stacker-retriever transfer bay, Room 1220; a repair bay, Room 1218; a maintenance bay, Room 1216; a preventative maintenance bay, Room 1224; and three airlocks (Rooms 1214, 1222, and 1230). These provided space and equipment to service the stacker-retriever and to house a spare stacker-retriever. Glove boxes in the preventative maintenance bay allowed access for repairs to stacker-retriever electronic systems. The sub-basement has hardened walls and a nitrogen atmosphere. The repair bay can be entered through an airlock, but before entering, the bay must be closed off and the nitrogen atmosphere must be replaced with breathable air. This allowed personnel access to make repairs to the mechanical systems of the stacker-retriever.

Extending from the sub-basement upward to the ground floor level, is Room 1206, the plutonium storage vault. The vault, which provided temporary storage for plutonium compounds, is a long narrow chamber with approximate dimensions of 300' x 15' x 40'. Vault walls are 14' thick concrete. The vault has an array of 1,428 metal storage bins attached to the full length and height of the side walls, with a single open aisle down the center. Each bin holds a 4' x 4' metal pallet, which has cylindrical holders for plutonium storage containers. For criticality safety, the cylindrical holders are at predetermined locations, and the storage containers are double-walled

and water-filled. To access the containers, the stacker-retriever is mounted on rails that run the length of the aisle between the two rows of bins. At one end of the vault, the rails end in a large transfer bay that connects to the repair and preventative maintenance bays.

The basement houses heating, venting, and air conditioning equipment and mechanical utilities, the upper part of the plutonium storage vault and maintenance bay, and small plutonium processing areas. The basement level is divided into nearly equal north and south parts by the upper portion of the plutonium storage vault. The basement is 330' (east to west) x 250' (north to south); it extends to the south nearly 70' under the ground floor of the office areas in the southern portion of the building. In the northeast section, Room 2327, is a portion of the incinerator vent scrubber canyon; Rooms 2325 and 2321 are the dissolution process area and control room. The upper parts of two glove box ventilation scrubbers are in the basement, one on the north side and one on the south side.

The ground floor contained the majority of the plutonium recovery processes, and office space. The office space, located along the southern length of the building, is segregated from the plutonium handling areas of the building by hardened construction.

The plutonium processing areas of the ground floor are divided by hallways into six compartments. The compartments are constructed of noncombustible materials, and have at least a two-hour fire rating to prevent the spread of fire, and to limit potential contamination from a fire to a single area. Each of the compartments is further subdivided into modules or rooms, and within the modules or rooms, the plutonium processing equipment is contained in glove boxes, canyons, or vaults. The purpose of these enclosures within enclosures was to contain particulate radioactive material and shield operating personnel from radiation.

The northwest compartment contains equipment for aqueous and pyrochemical plutonium recovery processes. This compartment is divided into two modules (north and south). The north module is further divided into two canyons, one vault, and nine other rooms. The south module is further divided into four rooms.

The southwest compartment is divided into two vaults, a control room, and an area for processing site returns. Site returns were nuclear weapons returned to the site for upgrade or retirement.

The north central compartment contains equipment for aqueous recovery operations, and storage areas for plutonium oxides and residues from the aqueous recovery operations. This compartment is divided into two modules (north and south), and three other rooms. The north module is further divided into two vaults, two canyons, and twelve other rooms. The south module is further divided into four canyons, and nine other rooms.

The south-central compartment is divided into thirteen rooms which included analytical and standards laboratories, the health sciences group, decontamination areas, heater rooms, and a backlog barrel storage area.

The northeast compartment is divided into three canyons, and four other rooms. Two of the canyons house incinerators; the third canyon houses a scrubber system for the incinerators. The rooms house residue loading and unloading operations, and control operations for the canyons.

The southeast compartment is divided into two rooms. The southeast compartment was used for shipping and receiving of plutonium and plutonium-containing materials, and a high-bay drum storage area for residues with high levels of radioactivity.

The attic, level four, provides protected space for air distribution systems, chemical piping, electrical conduit, and two motor-generator sets.

Transfer systems
Building 371 is equipped with two systems for the transfer of radioactive materials. The pneumatic transfer system was used to transfer materials of moderate to low radioactivity. The vacuum transfer system was used to transport highly radioactive materials.

Pneumatic Transfer System
The pneumatic transfer system consists of twenty-four transfer lines of two sizes and uses pneumatic pressure to move materials. The smaller line is 1" x 3" (inner dimension), is made of polyethylene, and was used to transfer liquid and solid samples. The larger line is 3" x 12" (inner dimension), is made of polycarbonate, and was used to transport used filters. The pneumatic transfer system was used to transfer materials between the basement and ground floors.

Vacuum Transfer System
The vacuum transfer system consists of thirty-one lines, and uses vacuum pressure to move highly radioactive materials. Two of the lines also use argon and nitrogen pressure as well as vacuum as the motive force. These two lines need the additional force to keep the material in a fluidized state during transfer. The vacuum transfer system was used to transfer materials between the sub-basement, basement, and ground floors.

A typical bulk vacuum transfer system consists of a hand-held pick-up wand, pick-up vessel (or slop pot), conveyor tube (0.75"- or 1.5"-diameter welded stainless steel), cyclone separator, filters, material receiver, and process vessel. The system also has high- and low-level sensors, valves, switches, and indicator lights, all interlocked and tied into local control sequence panels.

Incinerators
There are two incinerators and their afterburners, in separate concrete canyons, that were used for burning wastes: one in Room 3713 for high specific activity waste, and the other in Room 3715 for low specific activity waste. Due to the size and shape of the incinerators, they span multiple levels (basement to attic). Feed material entered the incinerators at ground floor level.

The high specific activity waste incinerator is an oil-fired, refractory-brick-lined, rotary kiln that can burn both liquid and solid line-generated waste from plutonium processing buildings. The revolving cylinder is horizontal, but it can be adjusted through a series of angles from the horizontal to control the rate of material flow. Ash and residue from the high specific activity incinerator was further processed for plutonium recovery.

The low specific activity incinerator is an oil-fired, raked-hearth, stationary, vertical furnace lined with refractory brick. It has forced-air-cooled rabble arms rotating on a central vertical shaft. The arms swept material across a stationary hearth plate during burning. Ash and residue from the low specific activity incinerator were packaged for disposal.

The plutonium recovery facility, Building 371, is one of five buildings that comprise the Plutonium Recovery and Waste Treatment complex. The other buildings in the complex are Building 372, a guard post; Building 373, a cooling tower; Building 374, a waste treatment facility; and Building 381, fluorine gas storage. Utility lines, roads, drainage control structures, and fencing also constitute part of the total complex.

Building Operations:

Operations in Building 371 focused on the recovery of plutonium from Plant activities (nuclear weapons parts fabrication, component assembly, and research and development activities). Americium, a decay by-product of plutonium, was separated from plutonium and recovered for resale. Other operations included material transfer, waste incineration, and laboratory support.

Plutonium Recovery
Plutonium recovery operations used two different systems to separate high-purity plutonium metal from production-generated wastes. Pyrochemical processing used furnaces and molten salts to separate high-purity plutonium in a dry process. Pyrochemical processing was efficient, but could not be used in all situations. Aqueous processing used a series of wet and dry chemical steps to separate high-purity plutonium from production generated wastes.

Materials entering the plutonium recovery process were received as pieces of impure plutonium metal, plutonium oxide, various compounds containing plutonium, and plutonium-contaminated residues. The plutonium content of these materials ranged from a few percent to almost pure plutonium metal. The plutonium and americium content of the residues was reduced by the recovery processes to a level below the economic discard limit.

Pyrochemical Plutonium Recovery

Metal plutonium was processed through a pyrochemical operation in which americium was extracted from plutonium by direct contact with molten salts, yielding a plutonium button low in americium. If other impurities had to be removed, the extracted metal went to an electrorefining process where the plutonium was transformed by electrolysis in a molten-salt bath, resulting in an impure plutonium heel, contaminated salt, and product metal of very high purity. Impure metal was burned, converting it to an oxide, and processed through the aqueous chemical recovery systems. The high-purity plutonium button was transferred to the Building 707 foundry operations for casting and weapon component fabrication. Contaminated salts were transferred to Building 771 for americium separation and plutonium recovery.

Aqueous Plutonium Recovery

Plutonium oxide and other materials required a series of wet and dry chemical processing steps to produce a plutonium button of high purity. As a first step, the oxide and other materials were dissolved in nitric acid in a series of cascade dissolution pots. The plutonium-containing acid solutions from the dissolution process were blended into a nitric acid feed which was pumped through anion-exchange resin columns. The anion-exchange resin selectively absorbed plutonium ions while allowing certain other metallic ions to pass through. Americium formed a weak bond with the resin, allowing selective segregation of some americium from the plutonium-rich stream. Solutions high in americium were segregated for further processing in americium recovery, and the remainder went through a secondary recovery process.

The anion-exchange eluate was concentrated in an evaporator. The evaporator concentrate fed into a line of precipitation vessels where the plutonium was precipitated as plutonium peroxide. The precipitate was filtered and the filtrate recycled through anion exchange. The precipitate was transferred to a calcining furnace where the plutonium peroxide was converted to plutonium oxide by heating.

The dry plutonium oxide was pneumatically transported to a fluidized-bed reactor in the direct fluorination canyon (Room 3523). The plutonium oxide was contacted with a fluorine-argon gas mixture to keep it fluidized while converting it to plutonium tetrafluoride. When the reaction was complete, the plutonium tetrafluoride was transported to a receiving chamber in the reduction canyon (Room 3515).

Calcium metal was measured into reduction vessels, and the plutonium tetrafluoride was added. The reduction vessel was sealed in an induction furnace and heated to initiate a reduction reaction that yielded a pure plutonium metal button and calcium fluoride slag. The plutonium button was sampled, stamped, and shipped as product. The calcium fluoride slag was recycled as cascade dissolver feed.

A process line was installed in the building to recover americium from solutions isolated during the anion exchange loading steps. Although the system was never fully operational, it was

designed to operate as follows. The solutions were to be alternately evaporated and diluted to reduce the nitric acid concentration. Then, sets of anion and cation exchange columns, operated in series, were to be used to purify the concentrated americium solution. Next, oxalic acid was to be added to the concentrate to precipitate americium oxalate. The precipitate was to be collected in a filter boat and calcined to convert it to americium dioxide. Americium was a saleable product used in medical diagnostic tracer procedures, in ionization-type smoke detectors, and in static eliminators.

Laboratories
Building 371 housed plutonium analytical laboratories and a chemical standards laboratory, which supported operations throughout the Plant. The plutonium analytical laboratories served Buildings 371 and 374, and acted as backup for the Building 771 analytical laboratory. The majority of the work at this laboratory consisted of total alpha and beta counts along with radiochemical analyses for specific isotopes in liquid and solid samples. These analyses served as a screen to identify highly radioactive samples which were unsuitable for detailed analysis in Building 881.

The chemical standards laboratory prepared both non-destructive assay and destructive assay standards for various user groups at the Plant and inspected standards used in the field. Most laboratory operations took place in glove boxes. Non-destructive assay standards were prepared for plutonium, americium, and uranium oxides and metals (including beryllium) for a wide range of instrumentation.

Incinerators
The low specific activity waste incinerator burned all combustible waste generated outside glove boxes or hoods from plutonium process buildings throughout the Plant. Solid waste was burned to reduce volume. The resulting ash was packaged for disposal.

The high specific activity waste incinerator burned waste generated within glove boxes and hoods from plutonium processing buildings. Both solid and liquid wastes were burned. The resulting ashes were analyzed by radiometric counting methods for plutonium content, classified, and subjected to appropriate plutonium recovery processes.

Pneumatic Transfer System
The pneumatic transfer system transferred process filters from glove boxes associated with metal and glass leaching, pyrochemical salt dissolution, and dissolution filtration processes to the high specific activity incinerator glove box. Process material samples (liquid and solid) were transferred from process glove boxes to laboratory glove boxes for analysis.

Before transfer, contaminated filters and samples were containerized, filters were sealed in plastic bags, and samples (liquid or solid) were placed in bottles with screw-on caps. The bagged filter or the bottled sample was placed inside a carrier, which also had a screw-on cap,

providing double containment for the material. The closed carrier was then placed in the loader-receiver and sent to the opposite end of the pneumatic system. When the loader-receiver arrived, the door was opened, the carrier removed and opened, and the bagged filter or the bottled sample taken out.

Vacuum Transfer System
The vacuum transfer system transported highly radioactive materials between recovery processes, from the plutonium storage vault to recovery processes, and to and from shipping and receiving areas. The bulk liquid or solid was loaded into the transfer pipes and moved using pumps to create the vacuum force. These highly radioactive materials were transferred in measured batches. Before a transfer was made, the operator ensured there was adequate space in the receiving vessel, and that the receiving vessel discharge valve was closed.

When bulk transfer conveyor tubes passed outside glove boxes or canyons, secondary containment was provided by enclosing the conveyor tubes within welded stainless steel pipes. The stainless steel pipes had ports for contamination monitoring. Gas-tight barriers at intervals along the pipes separated the secondary containment space at one end of the system from that at the other end.

Stacker-Retriever
Storage and retrieval of plutonium metal and solid residues was accomplished by using the stacker-retriever. The stacker-retriever moved materials between the shipping and receiving areas, the plutonium storage vault, and the plutonium recovery processing areas.

Operations Since 1989:

Since operations ceased at the Plant in 1989, operations in Building 371 have focused on waste and special nuclear material handling and storage and on laboratory operations.

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ROCKY FLATS PLANT,
PLUTONIUM RECOVERY FACILITY — HAER No. CO-83-K
(Rocky Flats Plant, Building 371)
Located in the northwest portion of the Rocky Flats Plant.
Golden Vicinity
Jefferson County
Colorado

Photographs CO-83-K-1 through CO-83-K-20 were taken by various site photography contractors, dates are indicated in parentheses.

CO-83-K-1 AERIAL VIEW, LOOKING SOUTH-SOUTHEAST, OF BUILDING 371 UNDER CONSTRUCTION. THE BUILDING IS A MULTI-LEVEL STRUCTURE, PARTIALLY UNDERGROUND. THE PLUTONIUM STORAGE VAULT EXTENDS FROM THE WEST SIDE OF THE BUILDING. FOOTERS FOR BUILDING 374 ARE VISIBLE TO THE LEFT OF BUILDING 371. (5/2/74)

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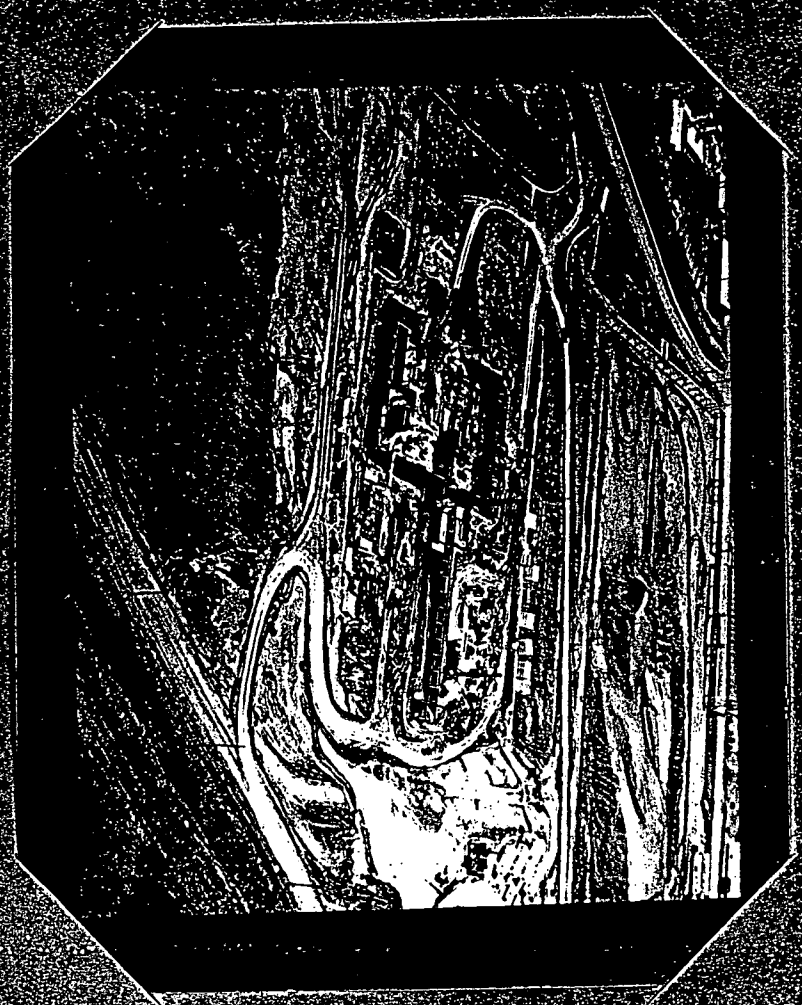

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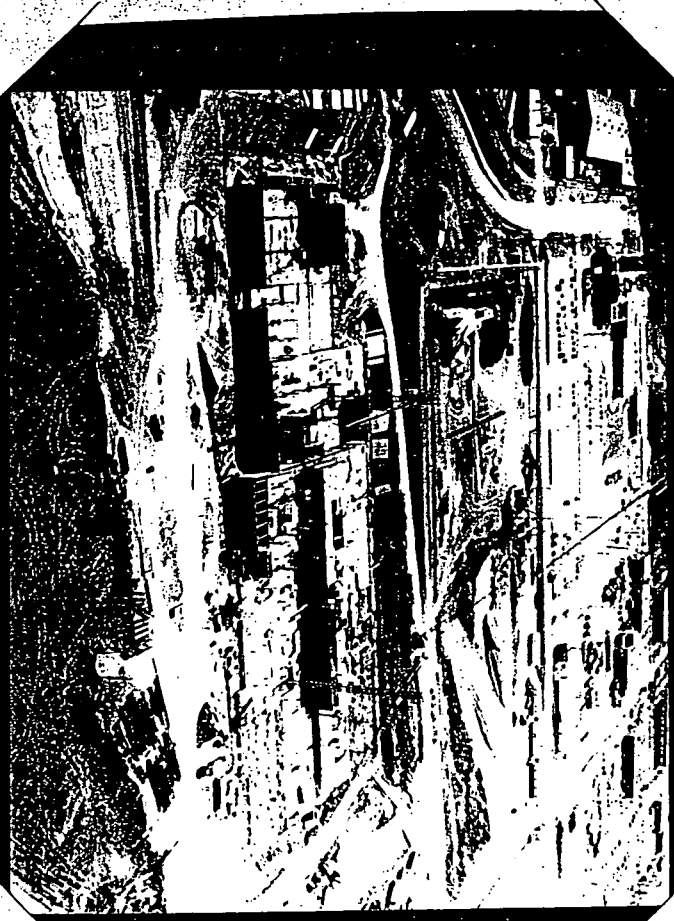

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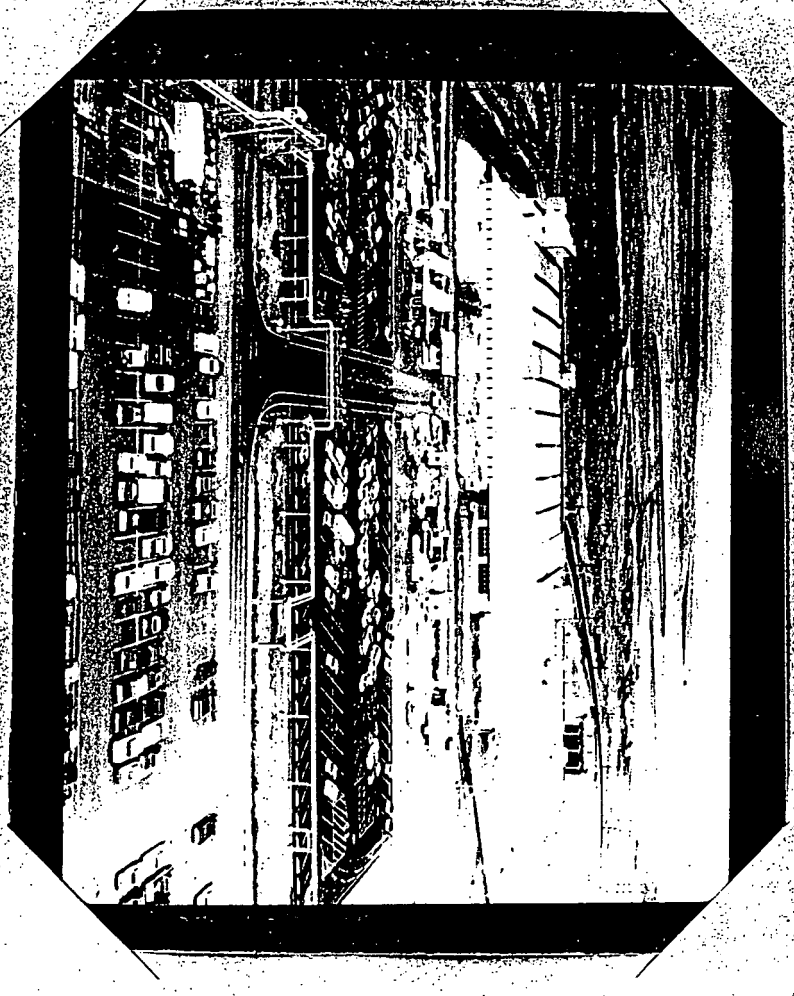

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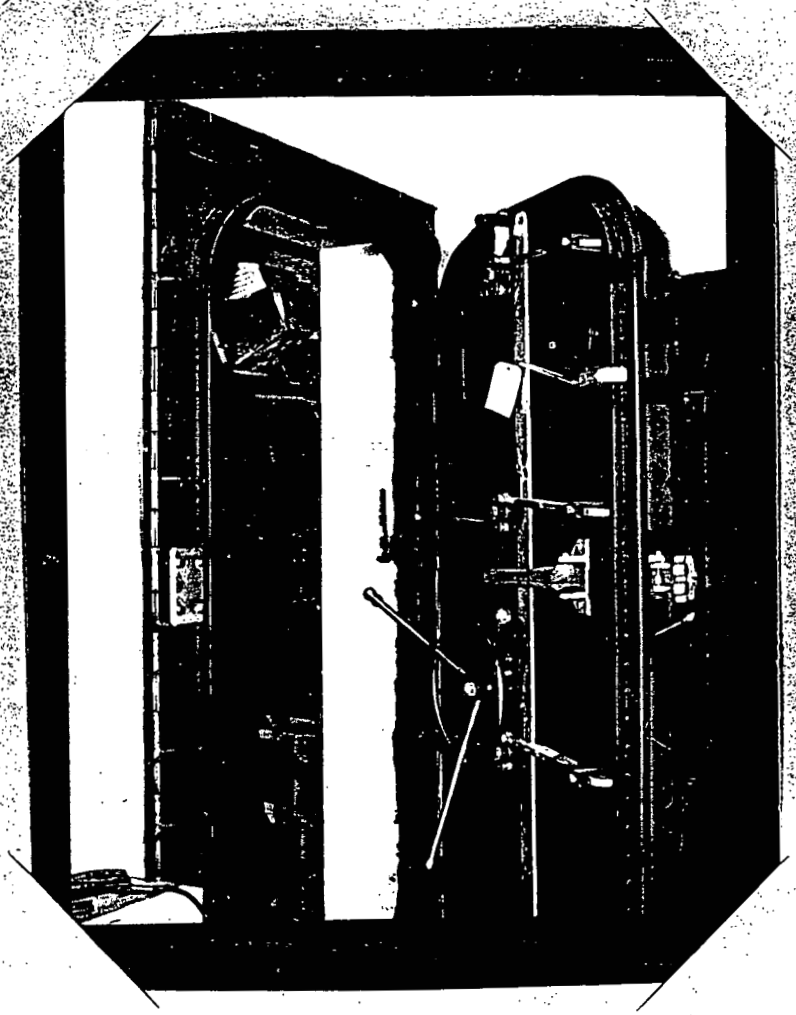

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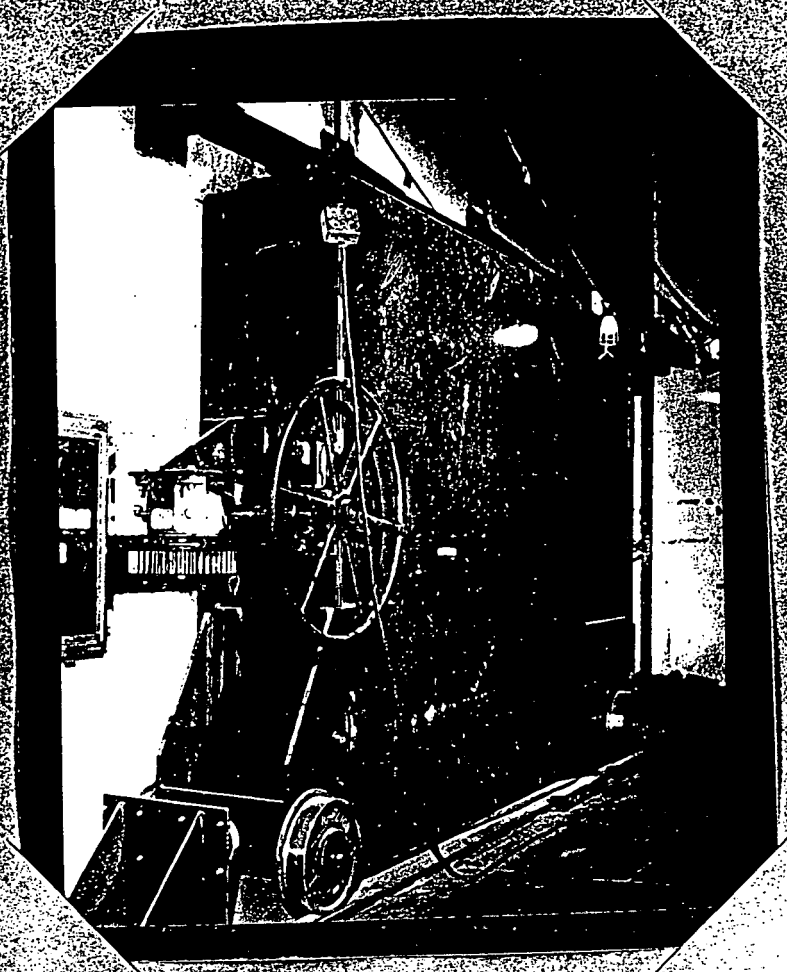

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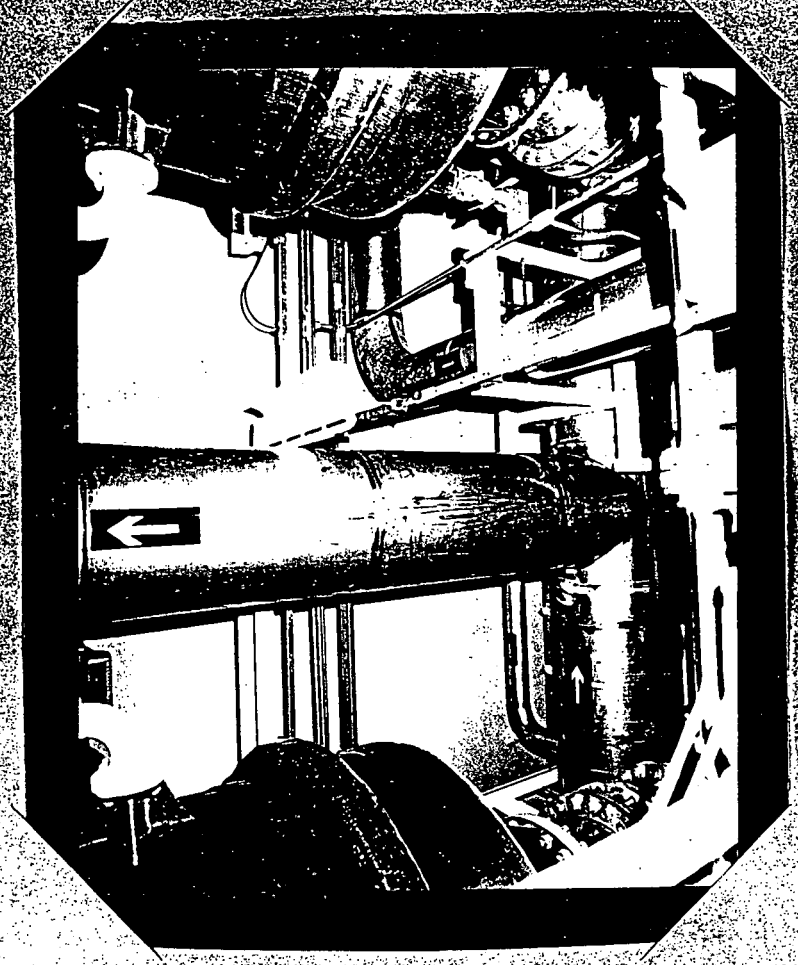

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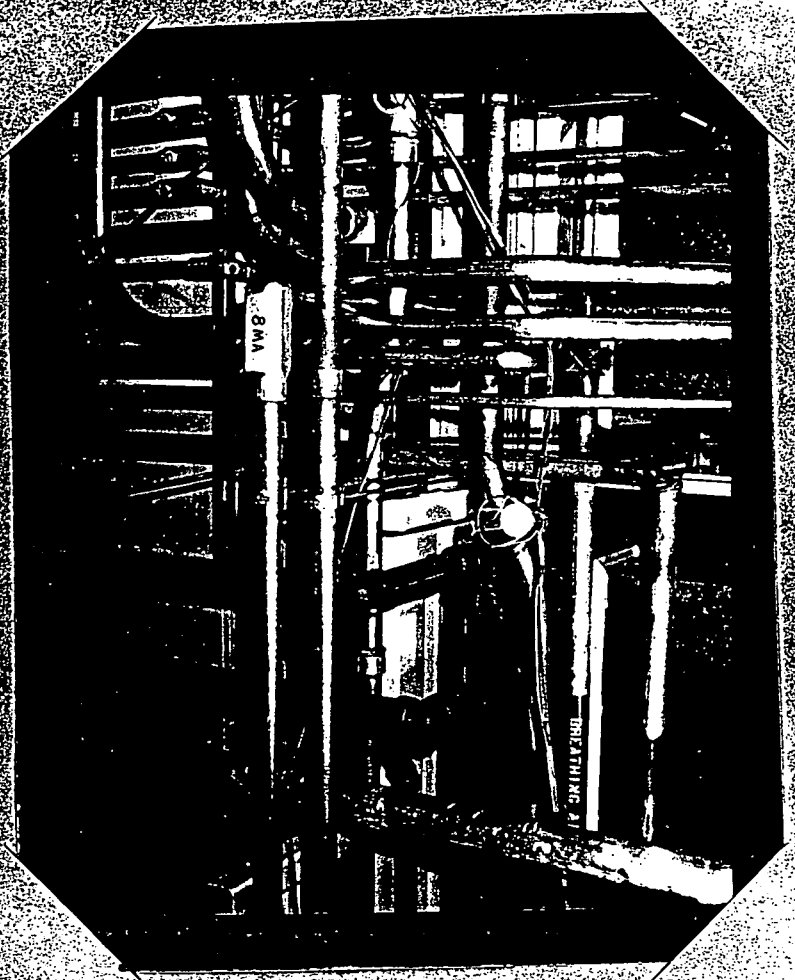

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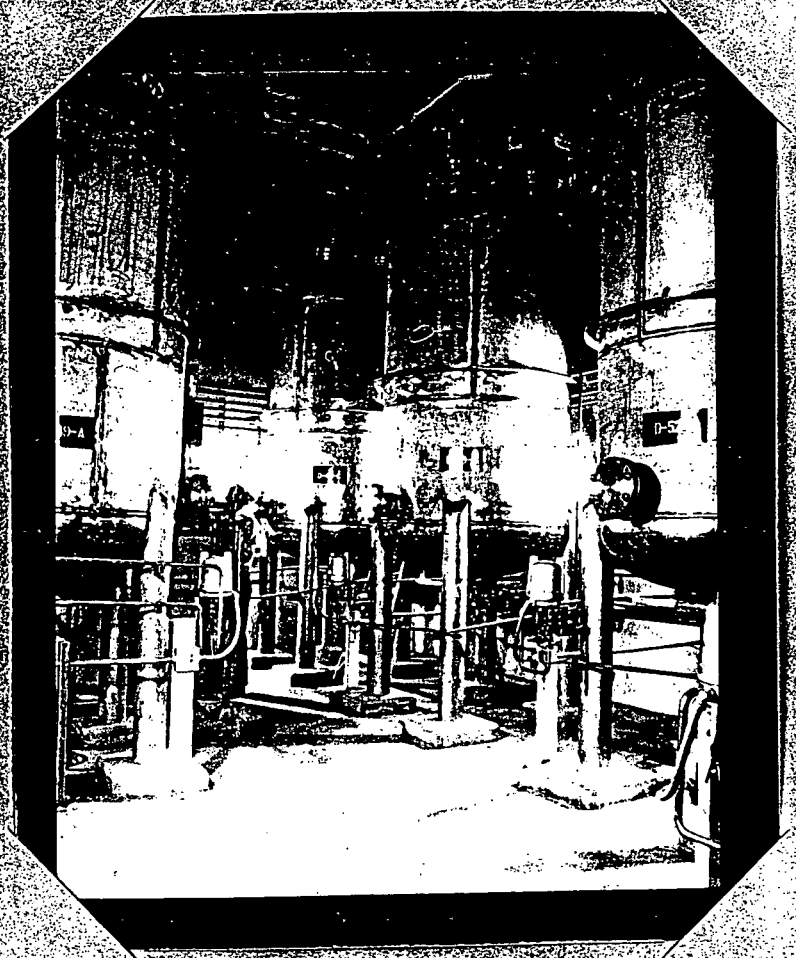

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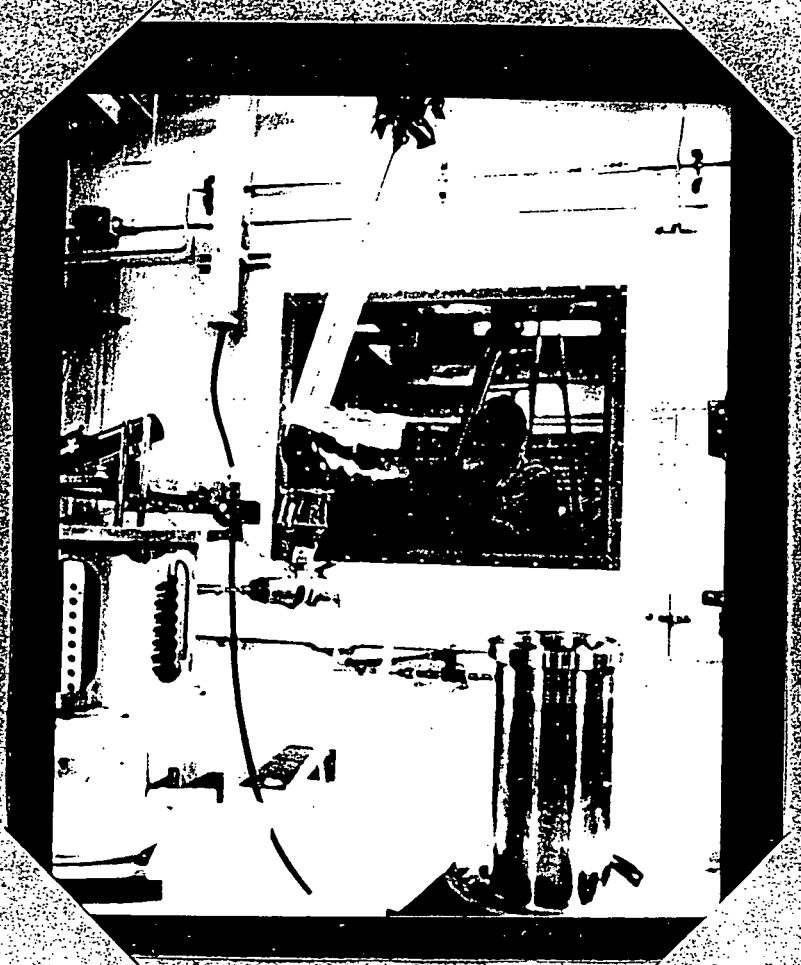

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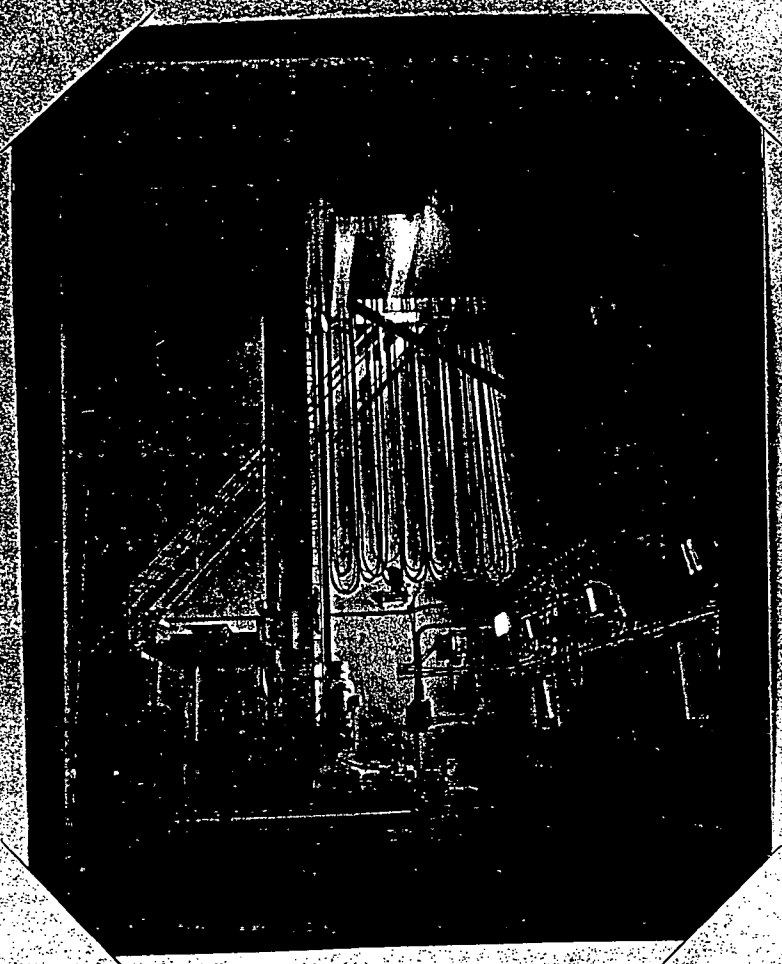

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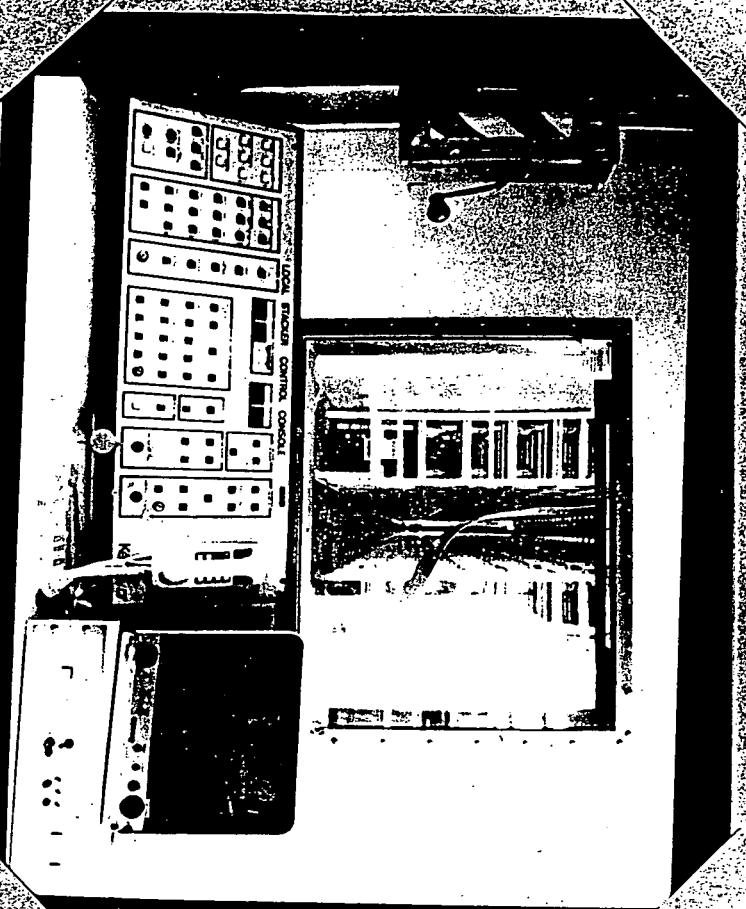

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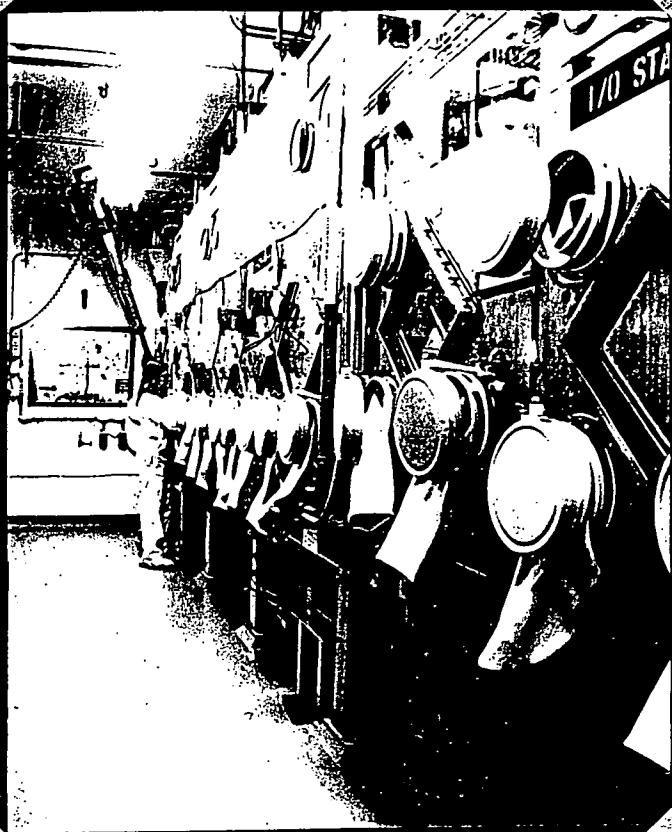

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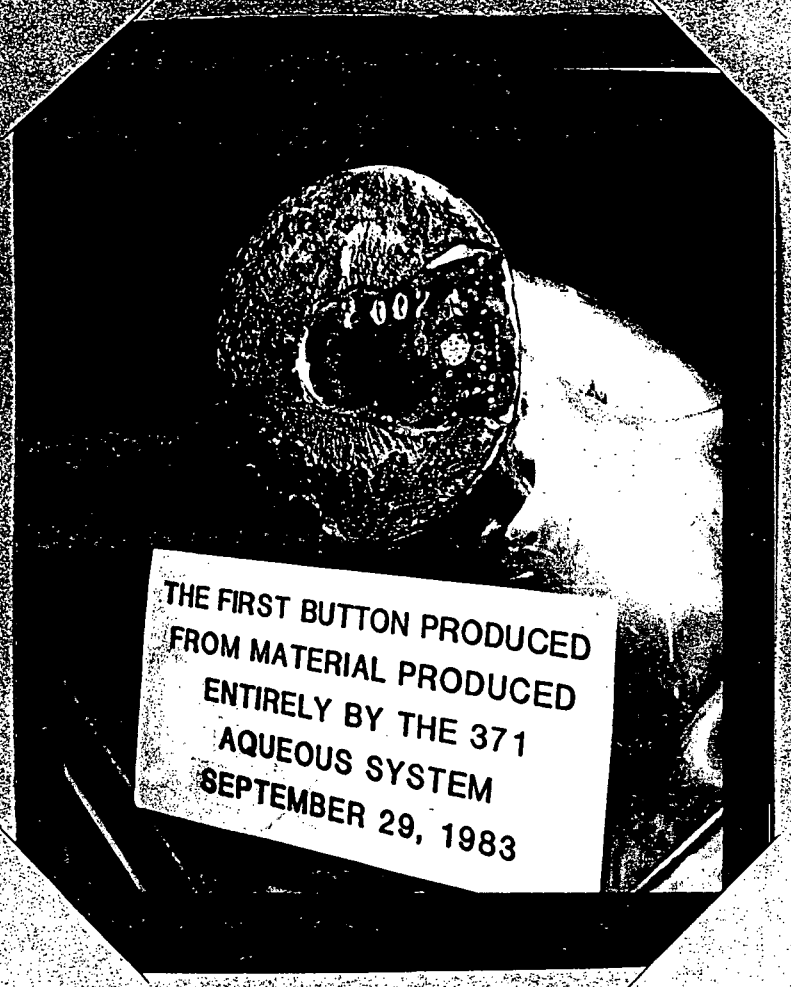

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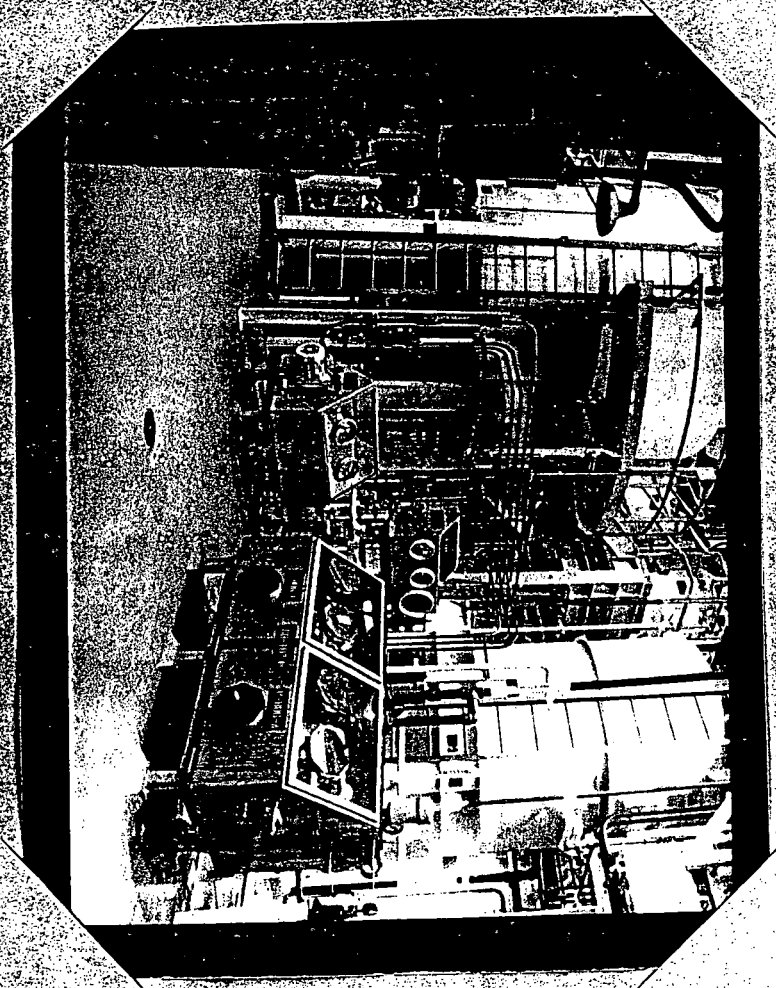
HAER No. CO-83-K-19



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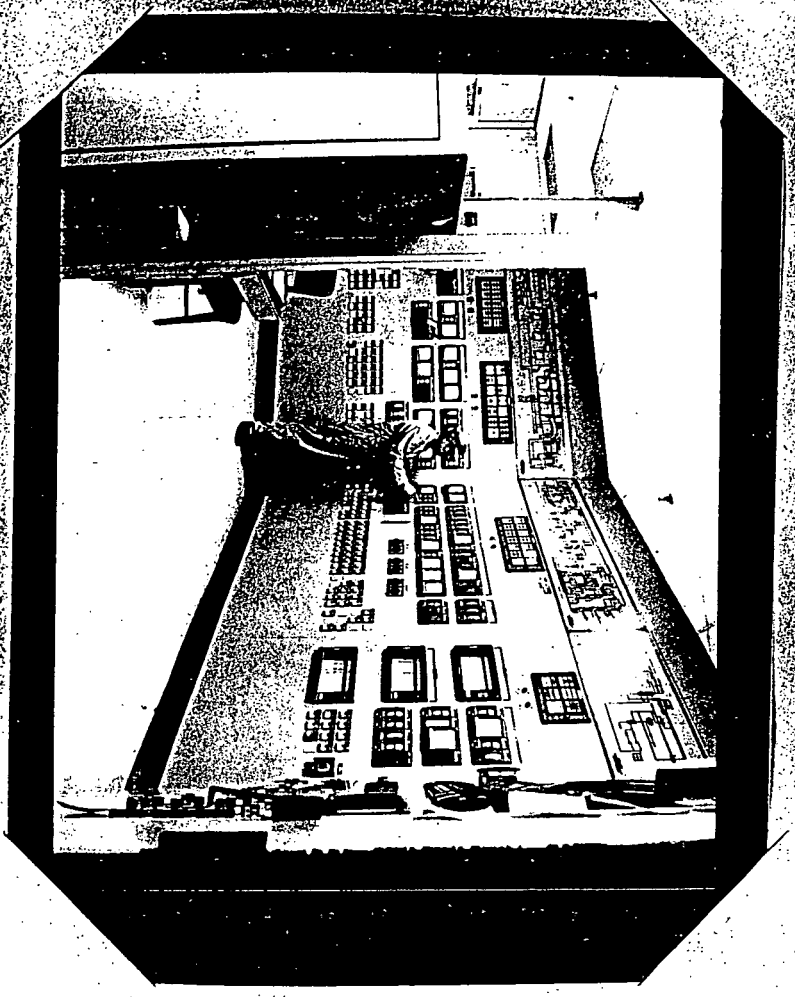

HISTORIC AMERICAN ENGINEERING RECORD
Rocky Mountain System Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD
(HAER No. CO-83)

for the

ROCKY FLATS PLANT
HISTORIC DISTRICT

Volume 2 of 4

Completed by:
engineering-environmental Management
e^2M
7000 South Yosemite, #295
Englewood, Colorado

For
Kaiser-Hill Company, L.L.C.
Rocky Flats Environmental Technology Site
Golden, Colorado

March 31, 1998

ROCKY FLATS PLANT, NON-NUCLEAR PRODUCTION FACILITY
(Rocky Flats Plant, Building 444)
(Rocky Flats Plant, Plant A)
(Rocky Flats Plant, Building 44)
Located south of Cottonwood Avenue, west of Seventh Avenue, and east of B-460
(Golden vicinity)
Jefferson County
Colorado

HAER No. CO-83-L

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Rocky Mountain System Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

ROCKY FLATS PLANT,
NON-NUCLEAR PRODUCTION FACILITY HAER No. CO-83-L
(Rocky Flats Plant, Building 444)
(Rocky Flats Plant, Plant A)
(Rocky Flats Plant, Building 44)

Location: Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County, Colorado. Building 444 is located south of Cottonwood Avenue, directly east of Building 460, and west of Seventh Avenue.

Date of Construction: 1953.

Fabricator: Austin Company, Cleveland, Ohio.

Present Owner: United States Department of Energy (USDOE).

Present Use: Depleted Uranium Manufacturing.

Significance: This building was a primary contributor to the National Register eligible Rocky Flats Plant historic district, associated with the United States (U.S.) strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack. Building 444, one of the first four buildings constructed at the Rocky Flats Plant (Plant), was the primary non-nuclear manufacturing facility.

Historians: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M), 1997. Judith Berryman, Ph.D., Archaeologist, e^2M, 1997.

Project Information:

In 1995, an inventory and evaluation was conducted of facilities at the Rocky Flats Plant for their potential eligibility for listing in the National Register of Historic Places. The primary goal of this investigation was to determine the significance of the Cold War era facilities at the Plant in order to assess potential effects of the long-term goals and objectives of the USDOE. These goals and objectives have not yet been formalized, but include waste cleanup and demolition activities. Recommendations regarding National Register of Historic Places eligibility were developed to allow the USDOE to submit a formal determination of significance to the Colorado State Historic Preservation Officer for review and concurrence and to provide for management of historic properties at the Plant.

From this determination and negotiations with the Colorado State Historic Preservation Officer, the Advisory Council, and the National Park Service, a Historic American Engineering Record Historic American Engineering Record project began in 1997 to document the Plant's resources prior to their demolition. The Plant was listed on the National Register of Historic Places in 1997. The archives for the Historic American Engineering Record project are located in the Library of Congress in Washington, D.C.

Introduction:

The Plant was one of thirteen USDOE facilities that constituted the Nuclear Weapons Complex, which designed, manufactured, tested, and maintained weapons for the U.S. arsenal. The Plant was established in 1951 to manufacture triggers for use in nuclear weapons and to purify plutonium recovered from retired weapons. The trigger consisted of a first-stage fission bomb that set off a second-stage fusion reaction in a hydrogen bomb. Parts were formed from plutonium, uranium, beryllium, stainless steel, and other materials.

A tense political atmosphere both at home and abroad during the Cold War years drove U.S. weapons research and development. By the 1970s, both the U.S. and the Soviet Union maintained thousands of nuclear weapons aimed at each other. These weapons were based on submarines, aircraft, and intercontinental ballistic missiles. Both the North Atlantic Treaty Organization and Warsaw Pact countries in Europe had small nuclear warheads known as theater weapons used as part of the Mutually Assured Destruction program. (The Mutually Assured Destruction program acted as a deterrent in that if one side attacked with nuclear weapons, the other would retaliate and both sides would perish.) The final nuclear weapons program at the Plant was the W-88 nuclear warhead for the Trident II missile. This mission ended in 1992 when President Bush canceled production of the Trident II missile.

The Plant was a top-secret weapons production plant, and employees worked with a recently man-made substance, plutonium, about which little was known concerning its chemistry, interactions with other materials, and shelf life. The Historic American Engineering Record documentation effort focused on four aspects of the Plant and its role in the Nuclear Weapons Complex; manufacturing operations, research and development, health and safety of workers, and security.

Chronology of Building 444:

1951 Construction began on Building 444.

1953	Manufacturing operations began. Historic names include Building 44 and Plant A. Initial manufacturing operations were devoted to the manufacturing of depleted uranium weapons components.
	Building 446, a guard post associated with the non-nuclear manufacturing complex, was completed.
1954	Beryllium research and development scale operations began in Building 444.
1955	Radiography vaults were added to Building 444.
1956	Building 447 was added to the southwest corner of Building 444 to provide manufacturing space, an assembly area, and a waste processing area. Heat furnaces were installed to anneal depleted uranium parts.
1957	Building 445 was added to the east side of Building 444 to house the carbon shop, which supplied graphite molds and crucibles to Building 444 and 776 foundries, and the graphite storage and cutting areas.
	Building 883 was constructed. Uranium ingots were cast in Building 444, transferred to Building 883 for further processing, then returned to Building 444 for final machining.
1958	Building 450, an exhaust plenum, was completed. Full-scale beryllium fabrication (machining) operations began. AeroTech® ventilation systems were installed at each machine.
1960s	Beryllium operations included casting and shaping.
1962	Building 448 was added to the north side of Building 447 to house production control activities for the 444 Complex. Beryllium wrought process (casting and forming) was developed.
1964	Installation of a central AeroTech® system in the basement of Building 444 replaced the initial ventilation system.
1966	Uranium-niobium alloying research and development began, using an electron beam furnace.
1967-68	Zero Power Plutonium Reactor Project began.

1969	Building fire (depleted uranium).
1973	Building 453, used for storage of tools, fabricated weapon parts, and raw materials, was completed.
1974	AeroTech® system replaced with an overhead duct system, external chip cyclone, and a high efficiency particulate air filter in the exhaust systems.
1975	Building 457, used for graphite storage, was completed.
Mid-1970s	Full-scale production of uranium-niobium alloys began after the installation of an arc furnace.
1976	Beryllium was supplied from off-site contractors; foundry casting (wrought process) ceased.
1980	Foundry cleaned of all beryllium; associated equipment removed.
1981	Production plating laboratory became operational.
1986	Beryllium ventilation system was upgraded to include two sets of high efficiency particulate air filters and high and low vacuum systems for fines and heavier particulates.
1987	Titanium stripping operations began.
1989	Uranium foundry was shut down.
1990	A fire occurred in the coating room of the production plating lab; plating laboratory was shut down.
1992-4	Process operations were ceased.
1993	Building awaited decontamination and decommissioning.

Building History:

Originally called Plant A, Building 444 was one of the first buildings constructed at the Plant. Building 444 was the primary non-nuclear manufacturing facility at the Plant. Manufacturing processes completed in this complex were used to fabricate weapons components and assemblies

for a variety of materials, including depleted uranium, beryllium, stainless steel, aluminum, and vanadium. Since depleted uranium was used in the manufacturing process, Building 444 was a non-reactor nuclear facility.

The production equipment located in Building 444 was used to support war reserve, special orders work, and manufacturing development. Operations included casting, machining, heat treating, welding, brazing, chemical milling, plating, coating, and testing and inspection of weapons components made of depleted uranium, depleted uranium composites, beryllium, stainless steel, and ferric metals. Each material required different processing techniques.

When expansion of the Plant, called Part IV, took place in 1956 and 1957, additions were made to Building 444. The expansion was motivated by changes in trigger design and subsequent increased fabrication requirements.

Building Description:

Building 444 is constructed of poured, reinforced concrete. A portion of the building has a second floor and a basement (112,900 square feet on the ground floor; 23,700 square feet in the basement; and 25,400 square feet on the second floor and mezzanines). Design elements include cast-in-place concrete superstructure with interior columns, exterior walls with monolithic columns, and elevated floor and roof slabs with monolithic beams and girders. Additionally, some of the interior firewalls are reinforced concrete with monolithic columns.

The roof is flat with short parapet walls. Roofing is built-up over rigid insulation with gravel ballast. The exterior walls initially had window openings. With the exception of a lunchroom, the wall openings are covered with asbestos-cement sheets or filled with concrete masonry units. Interior partition walls are concrete masonry units or gypsum board. In special environmentally controlled areas, interior partition walls are composite laminates with rigid insulation panels. Bridge cranes and monorails were installed throughout Building 444; most are out of commission.

Within Building 444, there are three designated areas: the open access area, the radiological control area, and the beryllium control area. The open access area was not subject to any administrative controls. The radiological control area was a management control area, within which personnel were required to wear personal protective equipment to shield against radiation exposure, and dosimeters to record radiation exposure. Over half of the original building is contained within the radiological control area. There are no physical barriers between the open access area and the radiological control area. The smallest designated area is the beryllium control area. This area is equipped with separate ventilation control systems to control the release of beryllium dust. This area is separated from the others by physical barriers.

The original building area contains a foundry and numerous shops and laboratories. Shops within the original portion of the building include depleted uranium, beryllium, and carbon (graphite) machine shops, and heat treating, coating, tool grinding, welding and brazing, and building maintenance shops. A portion of the precision shop is also housed in this building. Laboratories include pressure and leak-testing, plating, precision measuring, and non-destructive testing laboratories. Some of the former shop areas have been converted into storage areas for excess tools and materials.

Two x-ray vaults and a portion of the precision shop are located west of the original portion of Building 444. The walls of the x-ray vaults are 4'-thick concrete with labyrinth-type entryways. The tops of the vaults are open to the building roof.

The remaining portions of the precision shop and the calibration laboratory are located west of the x-ray vaults. Construction and design elements include reinforced-concrete exterior walls and steel interior columns and roof framing. Three below-grade utility tunnels run north-south beneath this area.

Rooms 180C and 179, located on the southern side of the western end of the building, are oil storage areas. Rooms 180C and 179 are additions to the original building configuration. Room 179 is within the radiological control area.

A receiving and stock storage area for the precision shop, Room 148C, is located on the north side of the building. Mechanical utility equipment is stored immediately west of Room 148C, in Room 148D.

The area east of the original portion of Building 444 was open, with a rail spur alongside the building. This area was later enclosed to contain an inspection laboratory for the tool grind shop, a tool storage room, and a corridor.

The open access side of Building 444 houses the tool and gauge shop, the tool grind shop, the erbia coating lab, a carbon shop, and administrative areas. Specialized graphite molds and crucibles needed in the foundry were produced in the carbon shop. The tool and gauge, tool grind, and carbon mold producing shops supported plant-wide manufacturing efforts.

The building utility systems include process and domestic water, process and sanitary waste, and air supply and exhaust systems. Plant air, house vacuum, instrument air, steam heating, and cooling water systems are contained within the building. Most of the utility systems have been significantly upgraded since the original construction of the building. All mechanical and electrical utility equipment is contained in the basement or on the roof. A grid of lightning rods and ground cables provide lightning protection.

The beryllium machining area is equipped with specialized ventilation equipment that has undergone several replacements. When beryllium operations first began in 1958, this ventilation equipment consisted of AeroTech® cyclone separator units placed at each machine to filter airborne beryllium at the point of generation. These units' exhausts were connected to the main building exhaust that served the uranium areas. This first system was replaced in 1964 by a central AeroTech® system which was connected to the main building exhaust. This second system was arranged so that each machine's local ventilation went through a drop box to collect heavier debris, through the central plenum, and finally through a single bank of high-efficiency particulate air filters prior to exhaust. The AeroTech® system was replaced in 1974. The replacement system consisted of an overhead duct system that led to an external chip cyclone and a high-efficiency particulate air filtration unit. This system was upgraded again in 1986 to include two stages of high-efficiency particulate air filtration. This last and final upgrade included two types of conveyance systems: a low-vacuum system to carry fine particulates, and a high-vacuum system to carry heavier particulates.

Building Complex

Building 444 is part of the non-nuclear manufacturing complex. Buildings associated with the non-nuclear manufacturing complex include Building 427, an emergency generator; Building 446, a guard post; Building 445, carbon storage; Building 447, manufacturing of depleted uranium; Building 448, depleted uranium material storage; Building 449, carpenter and paint shop storage; Building 450, an exhaust plenum; Building 455, a plenum; and Building 453, a storage area. Buildings 445 and 447 are pre-engineered, single-story metal buildings attached to Building 444. The complex, as a whole, covers 178,340 square feet, of which 35,200 square feet is open-access and 143,120 square feet is within a radiological control area.

The radiological control area portion of the complex includes part of Building 444 (108,800 square feet), Building 447 (25,820 square feet of floor space), and Building 448 (3,720 square feet of floor space). The radiological control area portions of the complex house equipment which was used for processing depleted uranium, beryllium, and other metals.

Building Operations:

Each operational area within Building 444 was designed to facilitate a systematic flow of material, primarily depleted uranium and beryllium. Building operations included foundry processes, fabrication and assembly of parts, testing and inspection of fabricated products, and support operations. Coating and plating operations were conducted on materials from Building 460 (outside the Building 444 flow of materials). Other operations within Building 444 included special projects.

Foundry Process
Depleted uranium ingots (arc-cast, induction cast, and alloys), beryllium ingots, and aluminum shapes were produced in the foundry.

Depleted Uranium Casting
During the initial research and development period (1951-55), depleted uranium was shipped to the Plant as derby-shaped parts from the Gaseous Diffusion Plant in Paducah, Kentucky and later as ingots from the Feed Materials Production Center in Fernald, Ohio. The Plant foundry cast ingots of depleted uranium from virgin depleted uranium, scrap depleted uranium, depleted uranium alloys, silver, aluminum, and copper. The metals were placed in crucibles, loaded into one of eight induction furnaces and melted in a vacuum atmosphere. Induction casting used radio frequency energy to melt the metal, which was poured into graphite molds to form ingots. Depleted uranium casting operations ceased in 1988.

Beryllium Casting
Casting of beryllium (beryllium wrought process) began in 1962, and involved a number of processes and buildings. Beryllium was received in the form of bar stock prior to development of the wrought casting process. The beryllium wrought process was a complicated process whereby beryllium ingots were cast in Building 444, then transferred to Building 881 to be canned (encased) in stainless steel (the canning process was used to aid the subsequent rolling process, as beryllium is very brittle). Canned beryllium was transferred to Building 883 to be heated and rolled to the required thickness. The stainless steel was cut away after rolling, and the resulting beryllium sheets were pressed into the required shapes, and transferred back to Building 444 for machining. The beryllium foundry ceased operation when the wrought process was discontinued in 1975, and was replaced by the purchase of sintered (pressed powder) beryllium blanks from off-site vendors.

Fabrication
Fabrication operations in Building 444 included machining of beryllium and depleted uranium. Tools used during machining operations included engine lathes, mills, turning and milling machines, electrical-discharge-machining equipment, and chemical-machining equipment. Individual machining operations were divided into two areas: beryllium and depleted uranium. A negative air pressure was maintained in fabrication areas to prevent the spread of contaminated dust into other areas.

Beryllium Fabrication
Beryllium machining operations were conducted on bar stock (1958-62), beryllium castings (1962-75), and sintered forms (1975-93). The machining process included sawing, milling, drilling and lathe operations. If needed, the pieces were then polished and abraded. Chemical milling of fabricated beryllium parts occurred in Room 203 of Building 444. Site returns

(weapons returned to the Plant for reprocessing, upgrade, or retirement) that contained beryllium were returned to the Building 444 beryllium machining area to be dismantled. Beryllium machining operations continued until 1993. Ingots and semi-finished and finished beryllium parts were heat treated in the induction furnace located in Room 403 of Building 447.

Beryllium machining operations were conducted in isolated rooms containing independent air filtering systems. A number of systems have been used in Building 444 to filter airborne beryllium, to maintain a negative air pressure in the beryllium work areas, and to prevent the spread of beryllium dust.

Depleted Uranium Fabrication

Prior to the construction of Building 883 in 1956, final machining of depleted uranium took place in Building 444. After 1956, the uranium ingots were cut into slices (rolling pucks) in Building 444 and shipped to Building 883. There the pucks were rolled and formed into their initial shape and transported back to Building 444 for final machining.

Machining of depleted uranium was conducted in Room 101. Metal parts containing depleted uranium, depleted uranium alloy, and depleted uranium with traces of iron, silica, titanium, aluminum, or stainless steel were cut in the depleted uranium machining process. Machining operations included turning, facing, boring, milling, and sawing. Ingots and semi-finished and finished depleted uranium parts were heat treated in the induction furnace located in Room 403 of Building 447.

In 1956, the chip roaster in Building 447 became operational. Depleted uranium chips recovered from machining areas were collected in covered 55-gallon drums, transferred to Building 447, and burned to an oxide (a more stable form) under controlled conditions in the chip roaster. The oxides were packaged and shipped off-site for disposal.

Assembly

Assembly operations included cleaning, brazing, welding, assembly etching, metallic coating, weighing, and leak testing. Component parts and partially assembled weapon components (subassemblies) from Building 444 were shipped to the final weapon assembly areas (Buildings 991, 777, and 707, depending upon the time frame) for use in finished trigger assemblies. Weapons components and assemblies were also shipped directly to the Y-12 Plant located on the Oak Ridge Reservation in Tennessee and the Pantex Plant in Amarillo, Texas.

Uranium, beryllium, and stainless steel parts were cleaned prior to welding, brazing, and coating. Deionized water, isopropyl alcohol, ethyl alcohol, and Oakite® were among the materials used to clean fabricated parts.

During assembly parts underwent one or more welding or brazing operations. Assembly welding processes included tungsten inert gas, electron beam, and tungsten inert gas crimp welding, and electron bombardment and vacuum furnace brazing. Materials welded included beryllium parts, depleted uranium, and other source materials.

The electron beam welder joined parts made of beryllium with parts made of other materials. The brazing operations used rings and wires of various filler metals and a flux to join like and unlike materials. Electron bombardment brazing was conducted using a bell jar and vacuum pump arrangement. Vacuum furnace brazing was performed in a furnace chamber.

Assembly etching was performed prior to assembly coating. Uranium parts were acid etched using an ultrasonic etching bath. Subsequently, uranium parts were coated with silver using a hot-hollow cathode chamber and titanium vapor deposition coatings were applied using a vacuum coating chamber.

Testing and Inspection

In-process and final inspections were performed for quality assurance on all products generated in the Building 444 complex. This included special order and regular production components, subassemblies, graphite molds, and cutting tools from tool grinding. Inspection equipment included fixed, open setup, and machine gauging. Testing and inspection activities included assembly testing, non-destructive testing, and product inspection.

Assembly testing

Assembly testing included a variety of operations to determine product integrity and conformance to design specifications. Test procedures included one or more of the following: leak and pressure tests, weight determination, crimping or swaging, and electromarking.

Non-Destructive Testing

Test methods included radiography, ultrasonic inspection, weight and density measurement, and dye penetrant inspection. Radiographic testing (also referred to as beta back scattering) used x-rays to detect internal flaws (i.e., cracks, lack of fusion, and inclusions) in parts and subassemblies. Ultrasonic inspection (also referred to as eddy current inspection) was used to detect voids and other defects in welded joints of parts and subassemblies. Dye penetrant testing used dye penetrant oil to detect surface cracks and other defects in parts and subassemblies.

Product Inspection

Product inspection, used to provide quality assurance for parts fabricated in the building or purchased off-site, consisted of a series of cleaning and non-dimensional inspection processes to determine the dimension of machined parts and conformance to design specifications.

Coating and Plating
Coating and plating operations were performed on non-nuclear parts such as stainless steel and copper. These parts were not fabricated in Building 444, rather, they were fabricated in Building 460 (stainless steel and non-nuclear component manufacturing).

Coating
Non-nuclear parts fabricated in Building 460 were coated with erbium oxide. In preparation for coating, the parts were grit-blasted, ultrasonically cleaned, rinsed, and dried. The parts were then coated with erbium nitrate, dried, and heat-treated. The heat-treating decomposed the erbium nitrate to erbium oxide. The spray and heat processes were repeated as necessary. Residual spray was removed using a silicon grit blast.

Plating
War reserve and special order parts fabricated from copper, steel, and stainless steel were etched and plated. Various plating tanks containing different plating solutions were used, including: silver plating, sulfuric etch, nickel plating, alkaline cleaner, and electroless nickel-plating tanks.

Support Operations
Non-production operations included production control, certification, tool engineering, tool grinding, tool/gauge fabrication (precision shop), tool and gauge inspection, development and application of plating techniques and materials, and graphite mold fabrication.

Special Projects
The Plant conducted special order work for other facilities in the weapons complex, the Department of Defense, or to fulfill the needs of other federal departments or agencies. Most of the special order work at the Plant did not involve materials outside those used in regular production activities. Most of the special order work was relatively short-lived. One exception to this was the Zero Power Plutonium Reactor project.

Zero Power Plutonium Reactor project
From 1967 to 1968, the Plant manufactured approximately 4,000 stainless steel-clad fuel elements consisting of plutonium, molybdenum, and uranium. The fuel rods were manufactured for installation in a reactor at Argonne National Laboratory. The Zero Power Plutonium Reactor fuel elements were manufactured by alloying uranium and molybdenum in Building 444. The alloy was then sent to Building 771, where it was alloyed with plutonium, and then clad in stainless steel envelopes in Building 776/777.

Other Special Projects
Other known special projects conducted in Building 444 included cadmium rolling and forming research and development operations; beryllium research and development work using

tetrabromoethylene for float/sink tests from 1968 to 1972; and machining of lithium salts, using processes similar to those used in uranium machining.

Operations Since 1989
After nuclear weapons components production ceased at the Plant in 1989, fewer and fewer components were produced in Building 444 each year. Manufacturing continued in the building until 1994. By the end of 1994, Building 444 was idle, awaiting the decontamination and decommissioning process.

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HISTORIC AMERICAN ENGINEERING RECORD

INDEX TO PHOTOGRAPHS

ROCKY FLATS PLANT, NON-NUCLEAR
PRODUCTION FACILITY HAER No. CO-83-L
(Rocky Flats Plant, Building 444)
(Rocky Flats Plant, Plant A)
(Rocky Flats Plant, Building 44)
Located south of Cottonwood Avenue, west of Seventh Avenue, and east of B460.
Golden Vicinity
Jefferson County
Colorado

Photographs CO-83-L-1 through CO-83-L-20 were taken by various site photography contractors, dates are indicated in parentheses.

CO-83-L-1 VIEW LOOKING NORTHWEST AT BUILDING 444 UNDER CONSTRUCTION. ORIGINALLY CALLED PLANT A, BUILDING 444 WAS ONE OF THE FIRST BUILDINGS CONSTRUCTED AT THE ROCKY FLATS PLANT. (4/15/52)

CO-83-L-2 VIEW LOOKING NORTHEAST AT BUILDING 444 UNDER CONSTRUCTION. BUILDING 444 WAS THE PRIMARY NON-PLUTONIUM MANUFACTURING FACILITY AT THE ROCKY FLATS PLANT. MANUFACTURING PROCESSES COMPLETED IN THIS BUILDING WERE USED TO FABRICATE WEAPONS COMPONENTS AND ASSEMBLIES FOR A VARIETY OF MATERIALS, INCLUDING DEPLETED URANIUM, BERYLLIUM, STAINLESS STEEL, ALUMINUM, AND VANADIUM. (4/25/52)

CO-83-L-3 VIEW OF ADDITION TO BUILDING 444. IN THE MID 1950s, RADIOGRAPHY VAULTS, A GRAPHITE STORAGE AND CUTTING AREA, AND A GRAPHITE PRODUCTION PROCESSING AREA WERE ADDED TO BUILDING 444. (1956)

CO-83-L-4 VIEW LOOKING SOUTHEAST AT BUILDING 444. (1/1/98)

CO-83-L-5 VIEW LOOKING NORTHWEST OF BUILDING 444. (1/1/98)

CO-83-L-6 VIEW OF INSIDE OF RAIL CAR CONTAINING GRAPHITE DELIVERED TO BUILDING 444. THE GRAPHITE WAS FORMED INTO MOLDS AND CRUCIBLE FOR USE IN THE FOUNDRY. (1/12/54)

CO-83-L-7	VIEW OF THE CHIP ROASTER LOCATED IN BUILDING 447. THE CHIP ROASTER BURNED URANIUM CHIPS FROM MACHINING AREAS TO AN OXIDE, A MORE STABLE FORM FOR DISPOSAL. (4/27/55)
CO-83-L-8	VIEW OF RADIOGRAPHY EQUIPMENT. TEST METHODS INCLUDED RADIOGRAPHY AND BETA BACKSCATTERING. (7/13/56)
CO-83-L-9	VIEW OF FOUNDRY FURNACE. DEPLETED URANIUM INGOTS, BERYLLIUM INGOTS, AND ALUMINUM SHAPES WERE PRODUCED IN THE FOUNDRY. (10/30/56)
CO-83-L-10	VIEW OF DEPLETED URANIUM INGOT AND MOLD IN FOUNDRY. (11/11/56)
CO-83-L-11	VIEW OF DEPLETED URANIUM INGOT. THE METALS WERE PLACED IN CRUCIBLES, LOADED INTO ONE OF EIGHT INDUCTION FURNACES AND MELTED IN A VACUUM ATMOSPHERE. (11/11/57)
CO-83-L-12	VIEW OF DEPLETED URANIUM INGOT AND MOLDS. DEPLETED URANIUM CASTING OPERATIONS CEASED IN 1988. (11/14/57)
CO-83-L-13	VIEW OF SHEFFIELD GAGE, USED TO MEASURE ROUNDNESS OF WEAPON PARTS, AS PART OF THE FINAL PARTS INSPECTION PROCESS. (6/2/67)
CO-83-L-14	VIEW OF VACUUM COATING CHAMBER. THE SYSTEM USED TITANIUM VAPORS TO DEPOSIT TITANIUM COATING ONTO URANIUM PARTS UNDER A VACUUM. (1/11/83)
CO-83-L-15	VIEW OF THE SPECIAL SHROUDING AND AIR HANDLING SYSTEM USED IN BERYLLIUM PRODUCTION. (3/30/89)
CO-83-L-16	VIEW OF PLANT FABRICATED EQUIPMENT IN THE COATINGS LABORATORY. A MASS SPECTROMETER IS TO THE LEFT OF THE PHOTO. (6/23/89)
CO-83-L-17	VIEW OF EQUIPMENT BURNED IN A TITANIUM FIRE. (11/13/89)

CO-83-L-18 VIEW OF ENGINEERING CONTROLS USED IN THE BERYLLIUM SHOP TO REDUCE EMPLOYEE EXPOSURE. THE LATHE IS COVERED BY A HOOD WITH A SEPARATE AIR-HANDLING SYSTEM. PRECISION EQUIPMENT IS CONTROLLED DIGITALLY. (11/113/89)

CO-83-L-19 VIEW OF THE PLATING BATHS AND CONTROL PANELS. GOLD AND SILVER WERE AMONG THE MATERIALS PLATED ONTO PARTS MADE OF COPPER, STAINLESS STEEL AND STEEL. (11/15/89)

CO-83-L-20 VIEW OF THE WASTE STORAGE TANKS ASSOCIATED WITH THE PLATING LABORATORY. (11/15/89)

CO-83-L-21 VIEW OF THE FIRST FLOOR PLAN. THE ORIGINAL DRAWING HAS BEEN ARCHIVED ON MICROFILM. THE DRAWING WAS REPRODUCED AT THE BEST QUALITY POSSIBLE. LETTERS AND NUMBERS IN THE CIRCLES INDICATE FOOTER AND/OR COLUMN LOCATIONS.

CO-83-L-22 VIEW OF THE BASEMENT AND MEZZANINE FLOOR PLANS. ALL MECHANICAL AND ELECTRICAL UTILITY EQUIPMENT IS CONTAINED IN THE BASEMENT. THE MEZZANINE CONTAINS OFFICES. THE DRAWING WAS REPRODUCED AT THE BEST QUALITY POSSIBLE. LETTERS AND NUMBERS IN THE CIRCLES INDICATE FOOTER AND/OR COLUMN LOCATIONS.

CO-83-L-23 VIEW OF SECTION DRAWINGS. THE SECTION LINES FOR A-A AND C-C CUT THE BUILDING EAST-WEST; SECTION LINE B-B CUTS THE BUILDING NORTH-SOUTH. THE ORIGINAL DRAWING HAS BEEN ARCHIVED ON MICROFILM. THE DRAWING WAS REPRODUCED AT THE BEST QUALITY POSSIBLE. LETTERS AND NUMBERS IN THE CIRCLES INDICATE FOOTER AND/OR COLUMN LOCATIONS.

CO-83-L-24 VIEW OF THE BUILDING 447 AND 448 ADDITIONS. THE DRAWING WAS REPRODUCED AT THE BEST QUALITY POSSIBLE. LETTERS AND NUMBERS IN THE CIRCLES INDICATE FOOTER AND/OR COLUMN LOCATIONS.

HISTORIC AMERICAN ENGINEERING RECORD
SEE INDEX TO PHOTOGRAPHS FOR CAPTION

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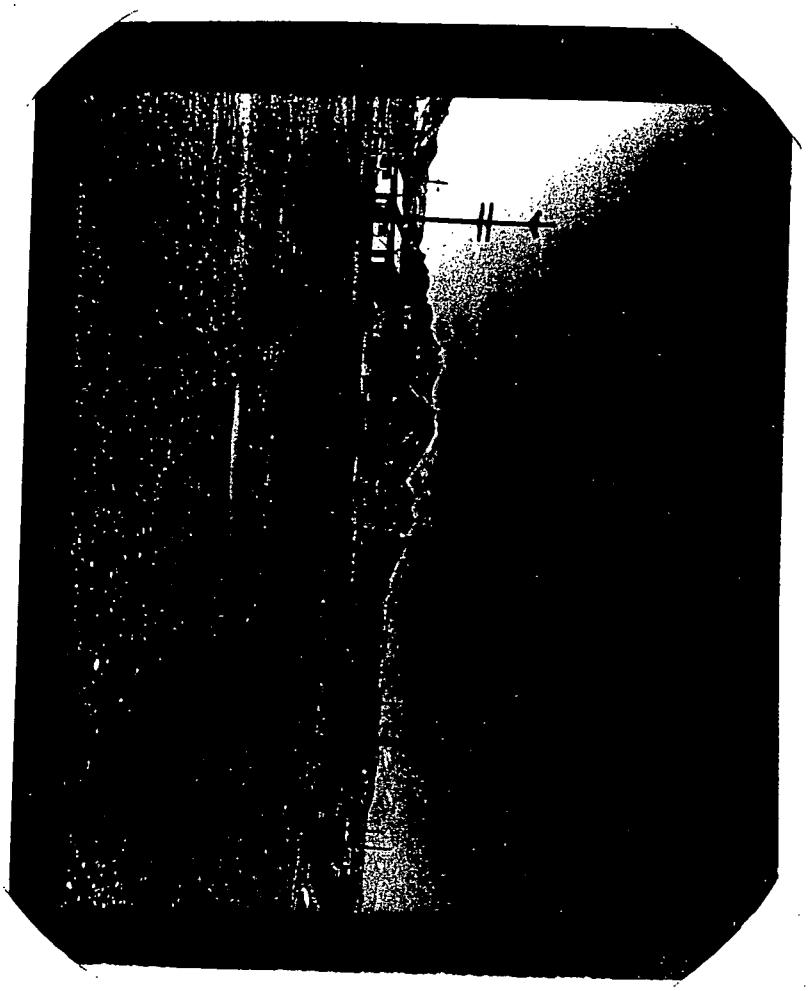

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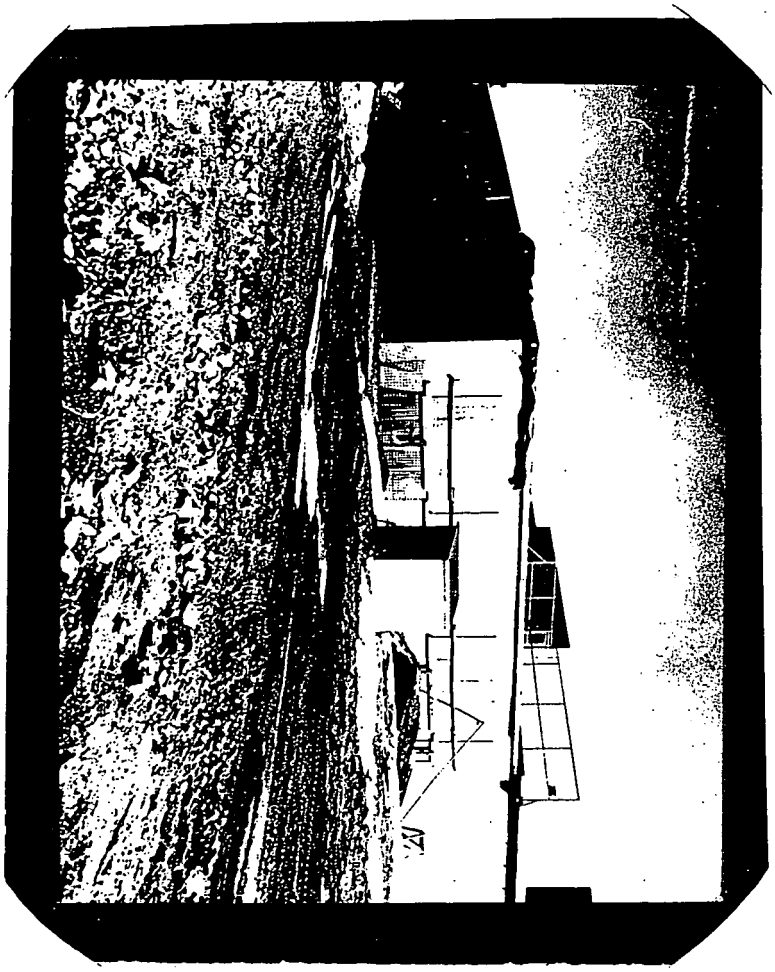

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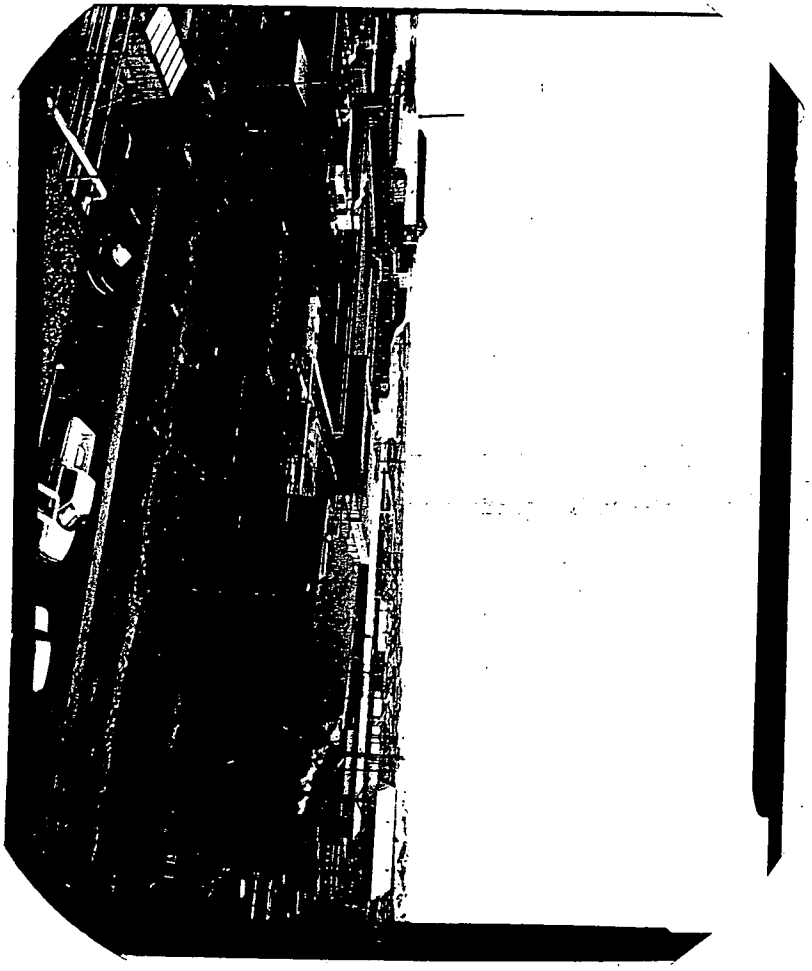

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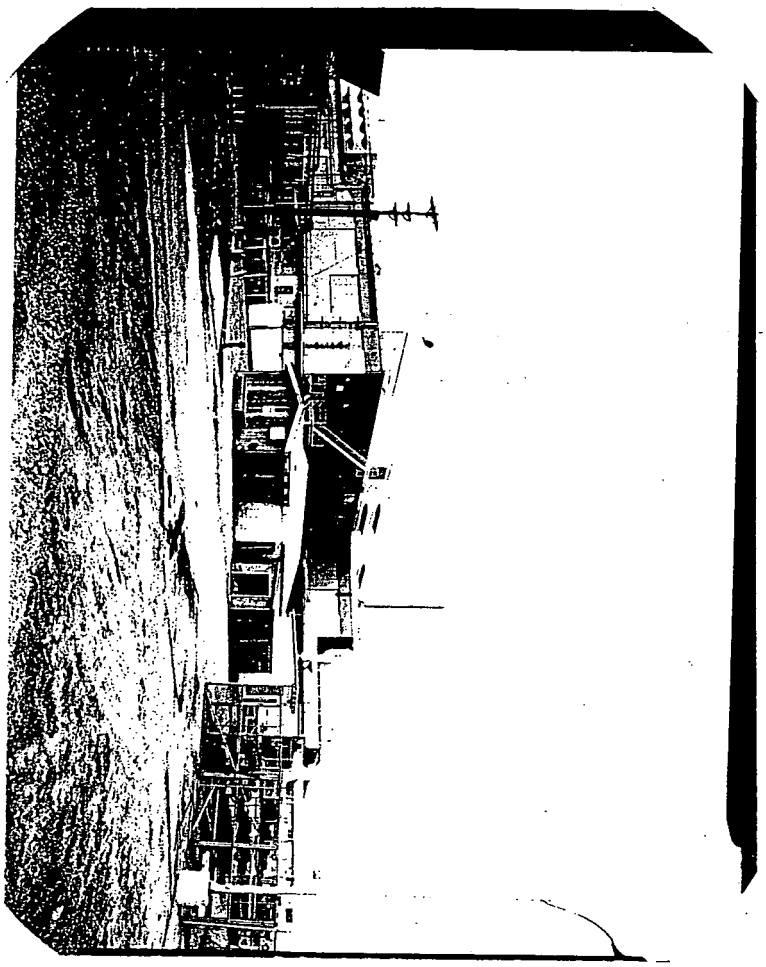

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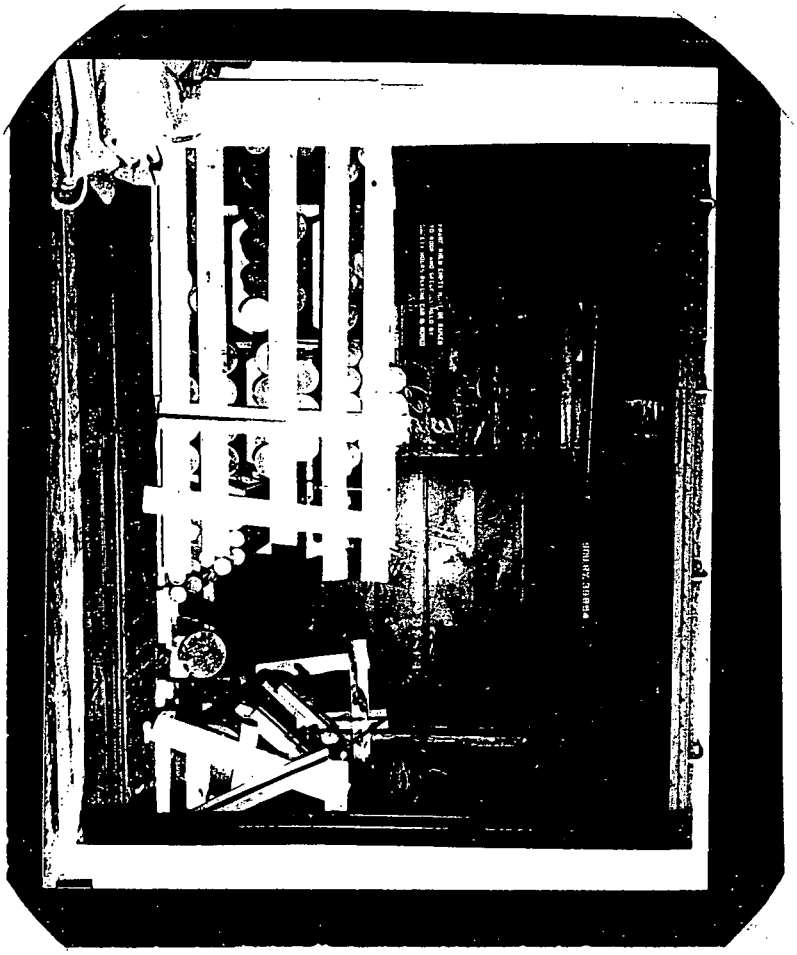

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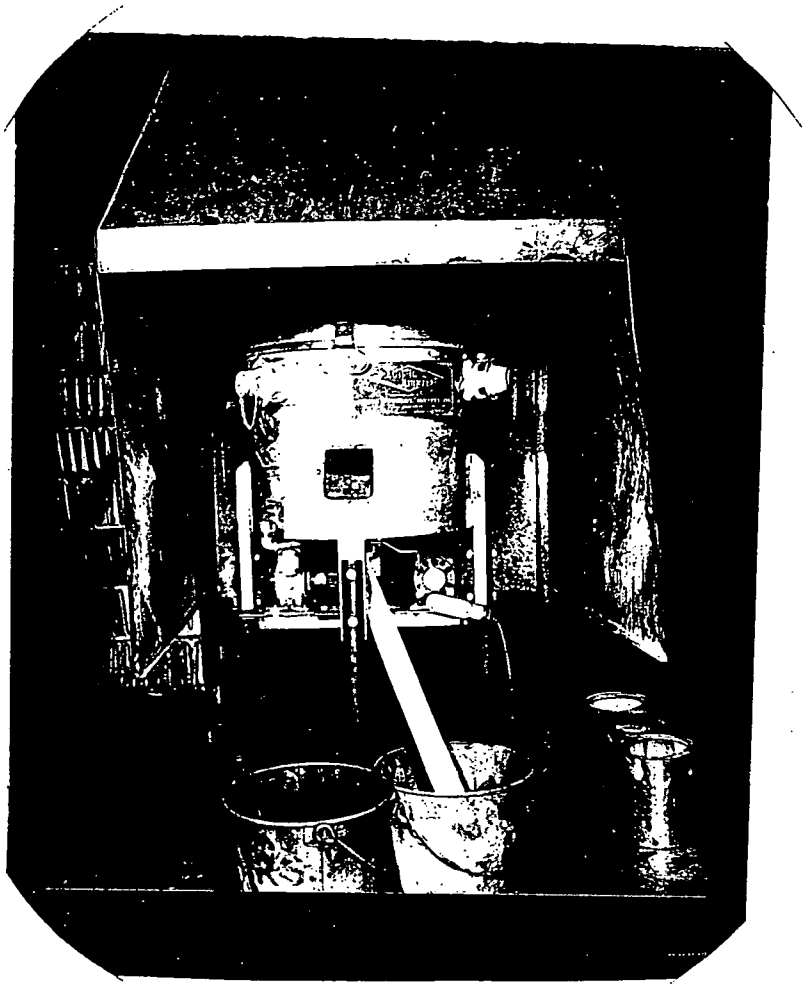

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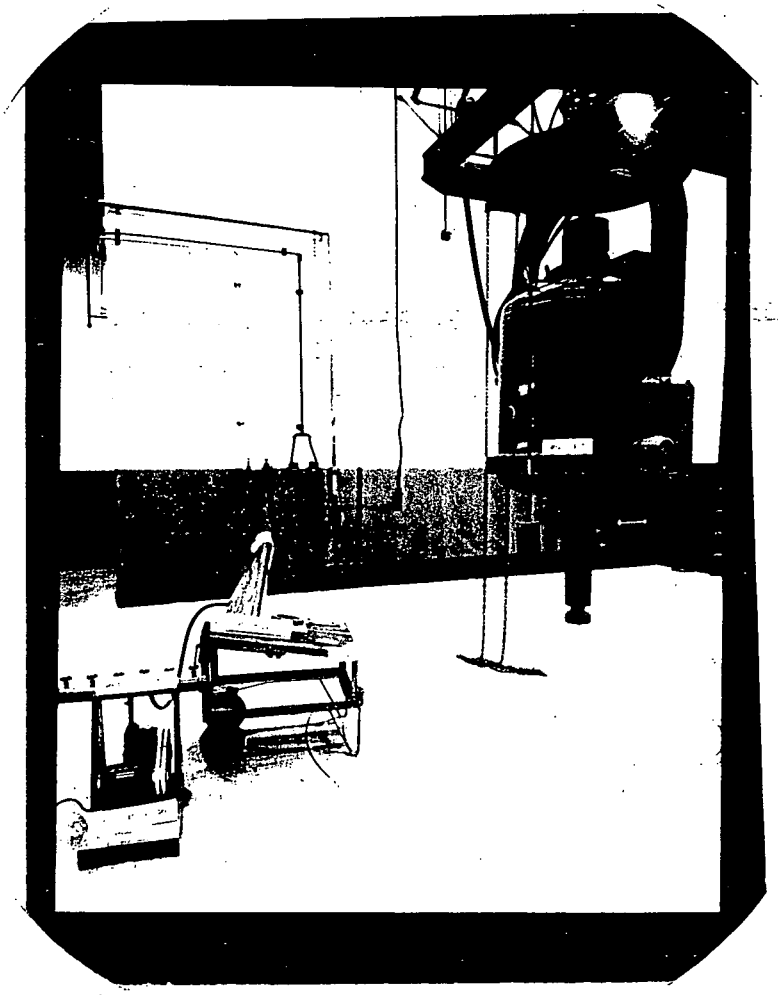

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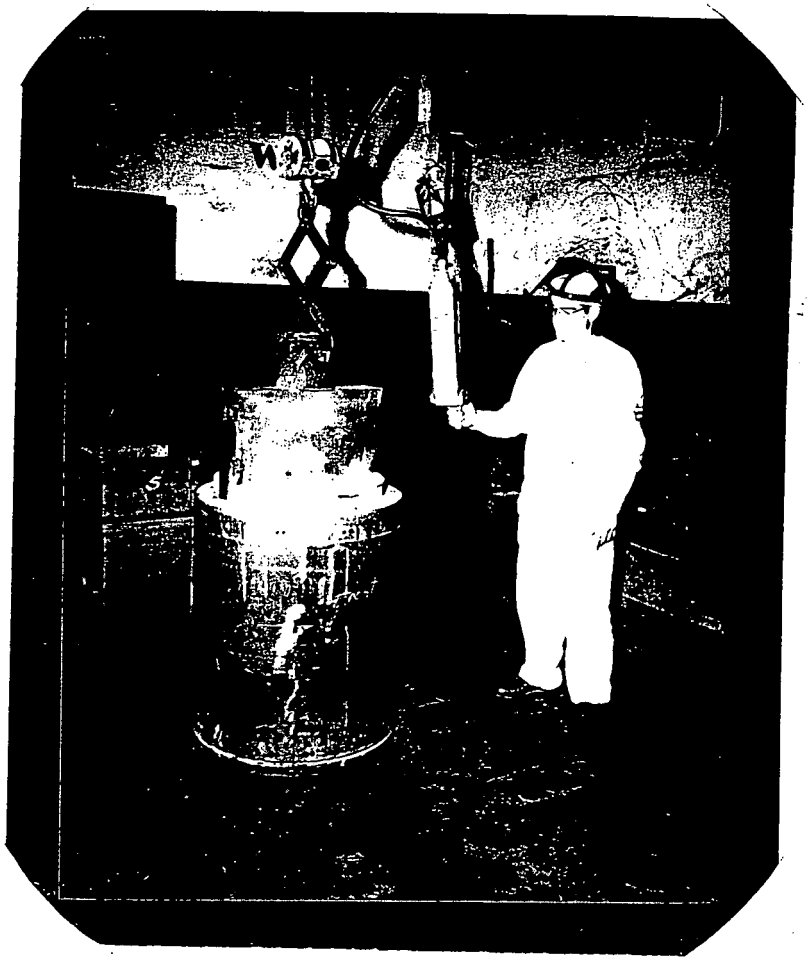

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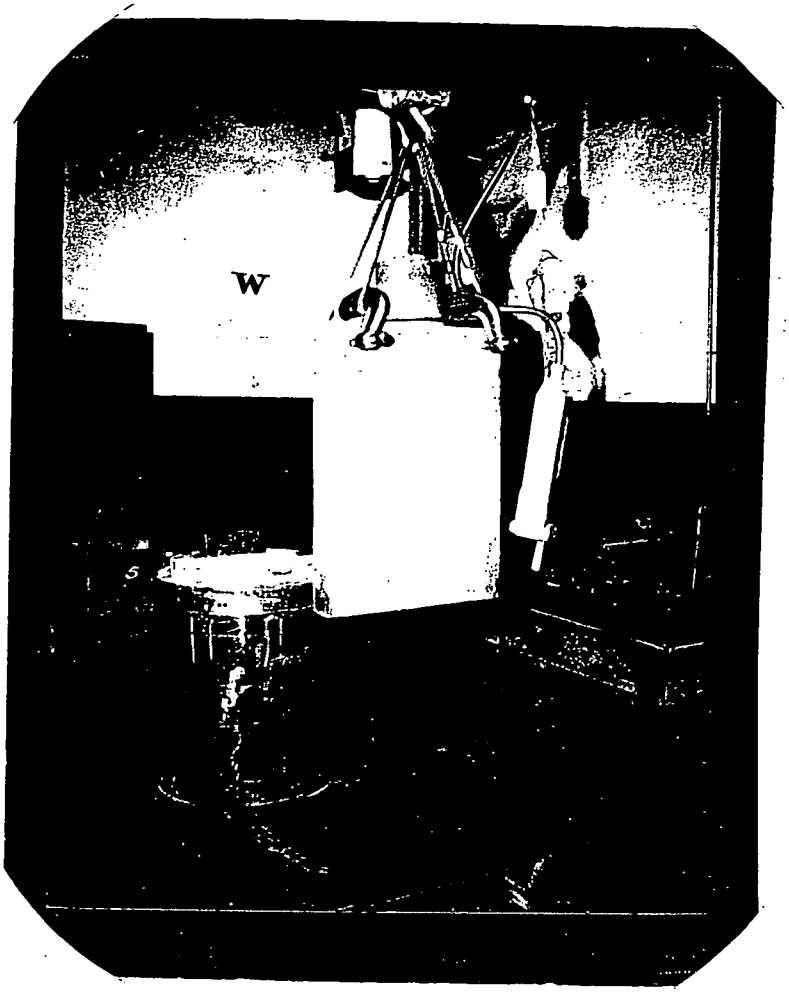

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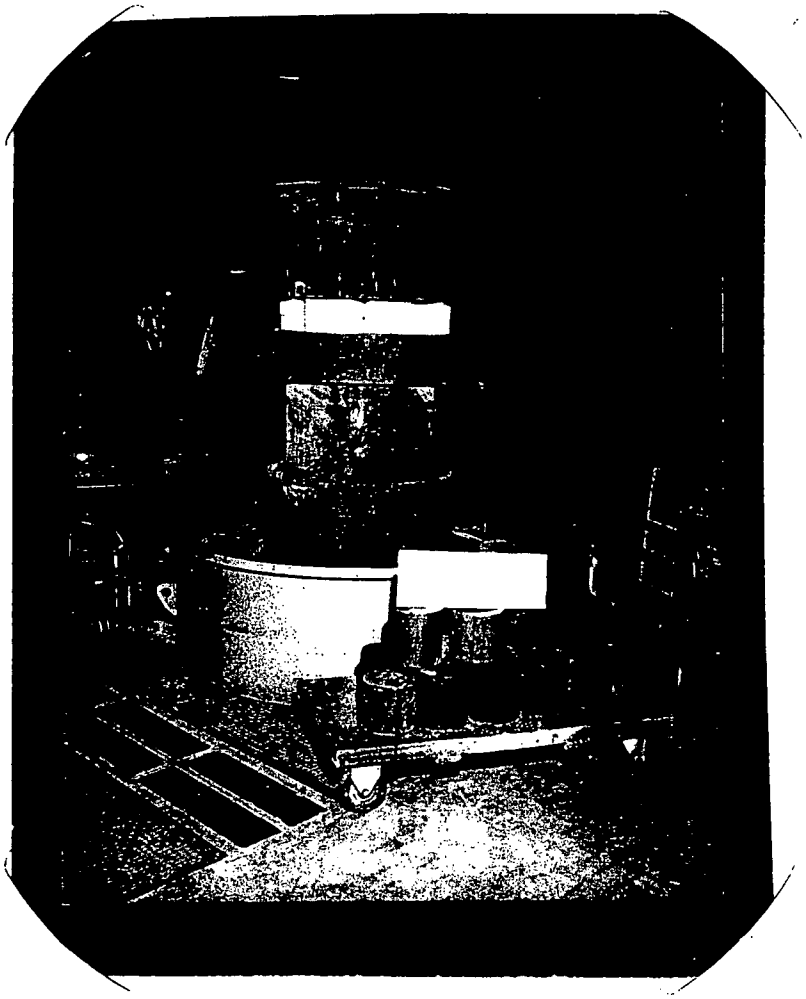

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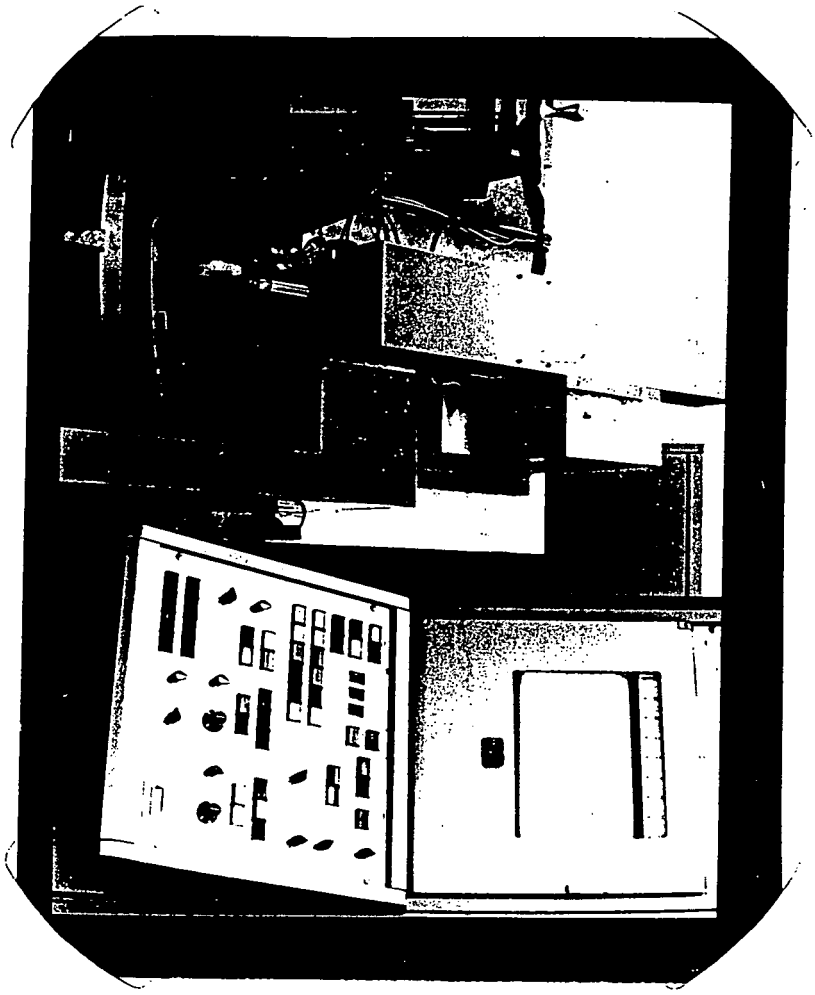

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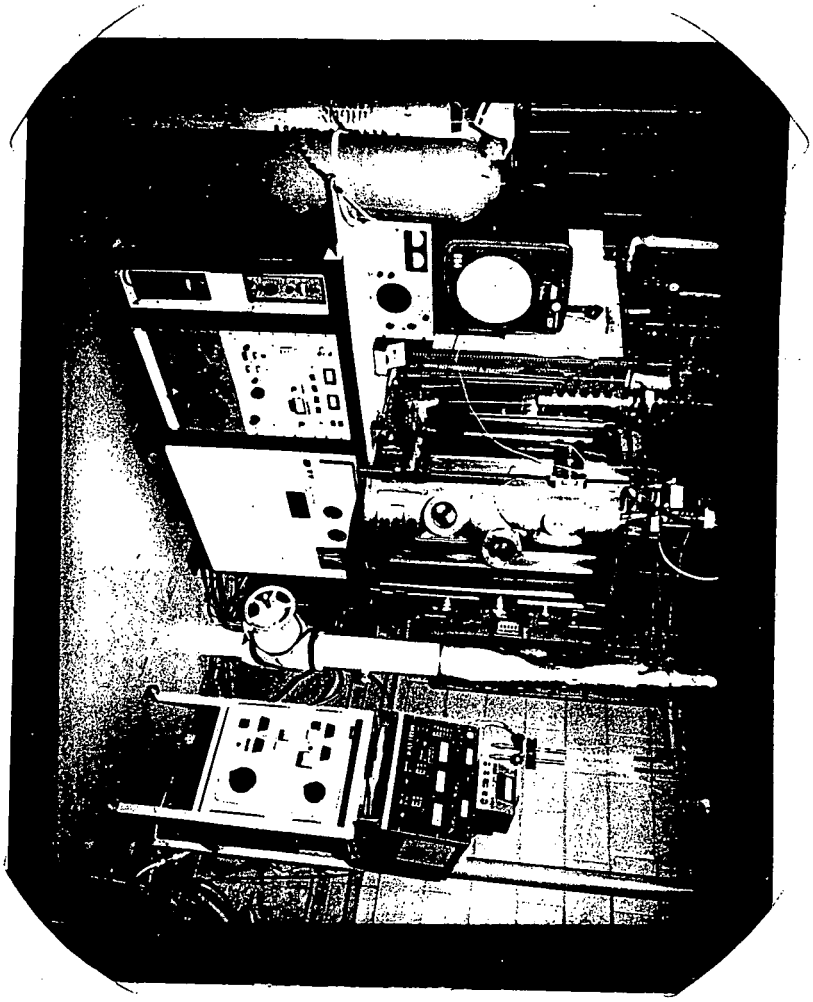

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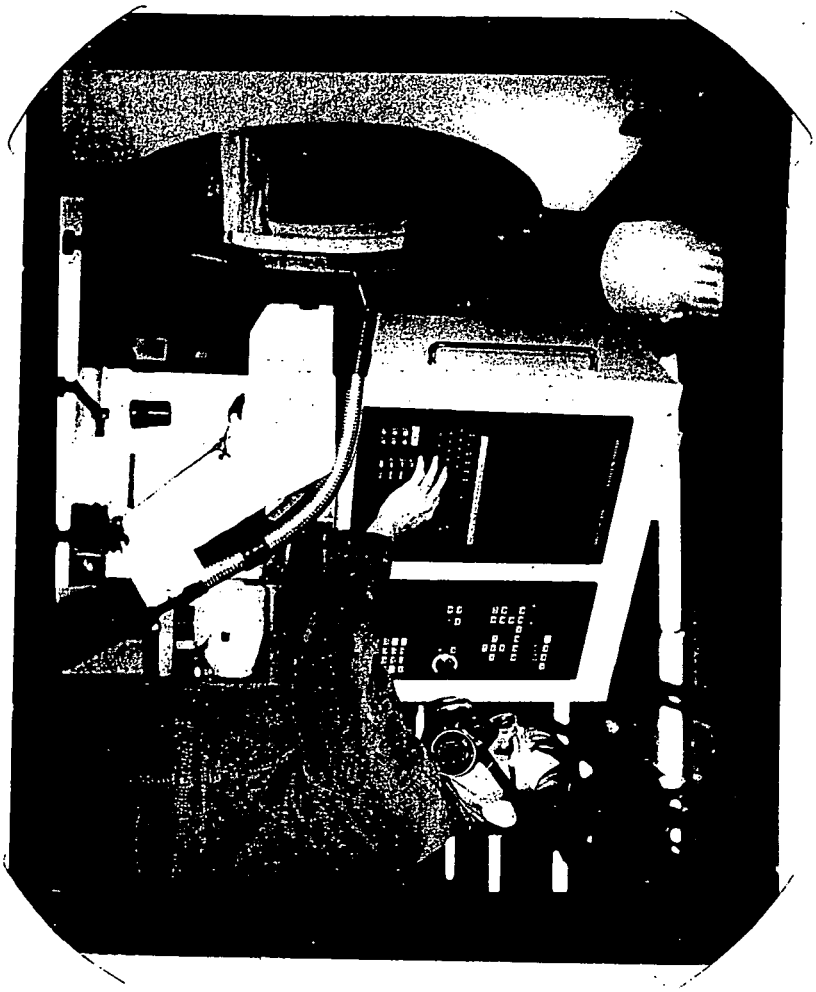

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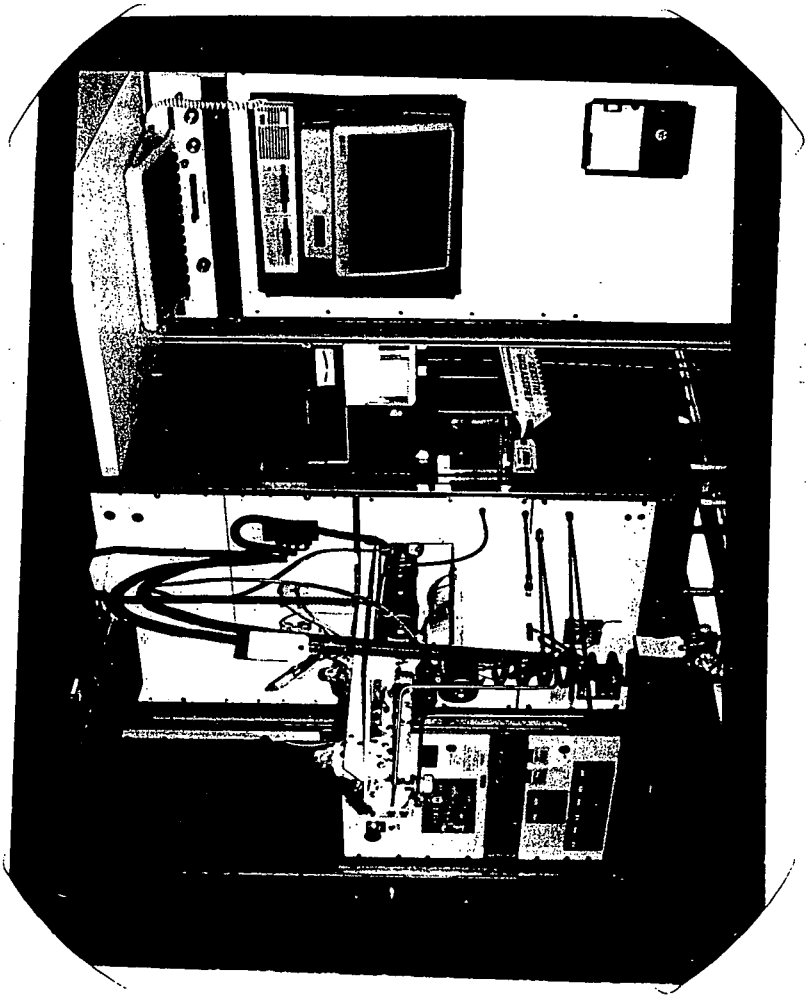

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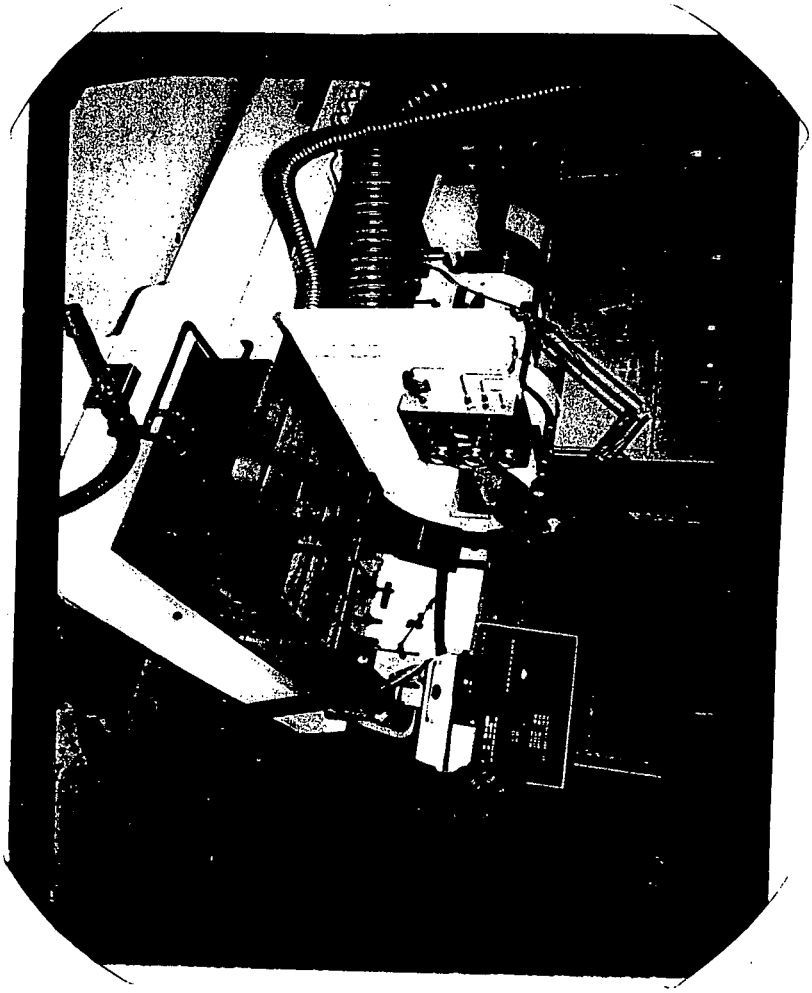

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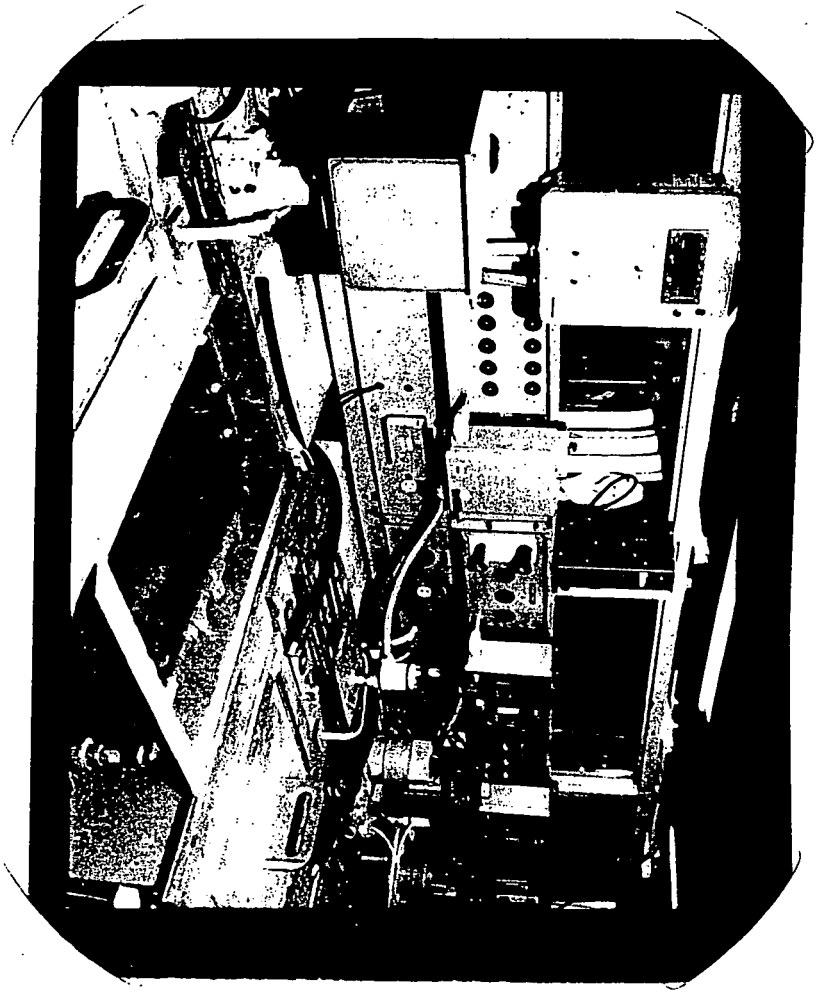

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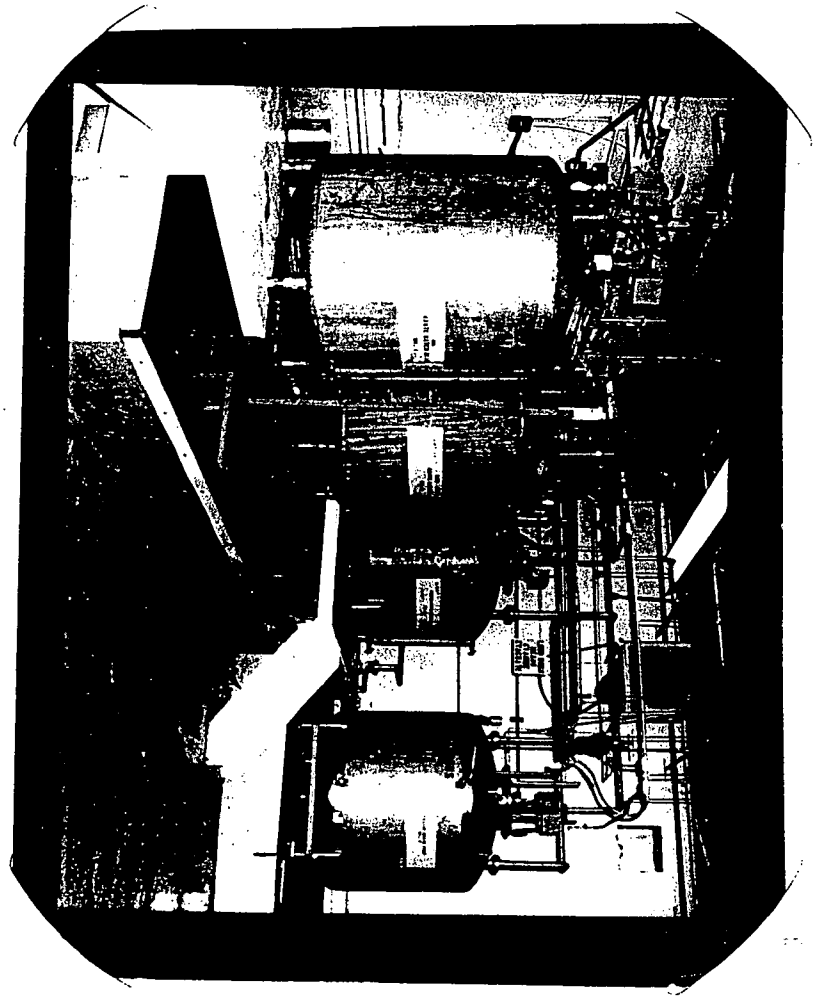

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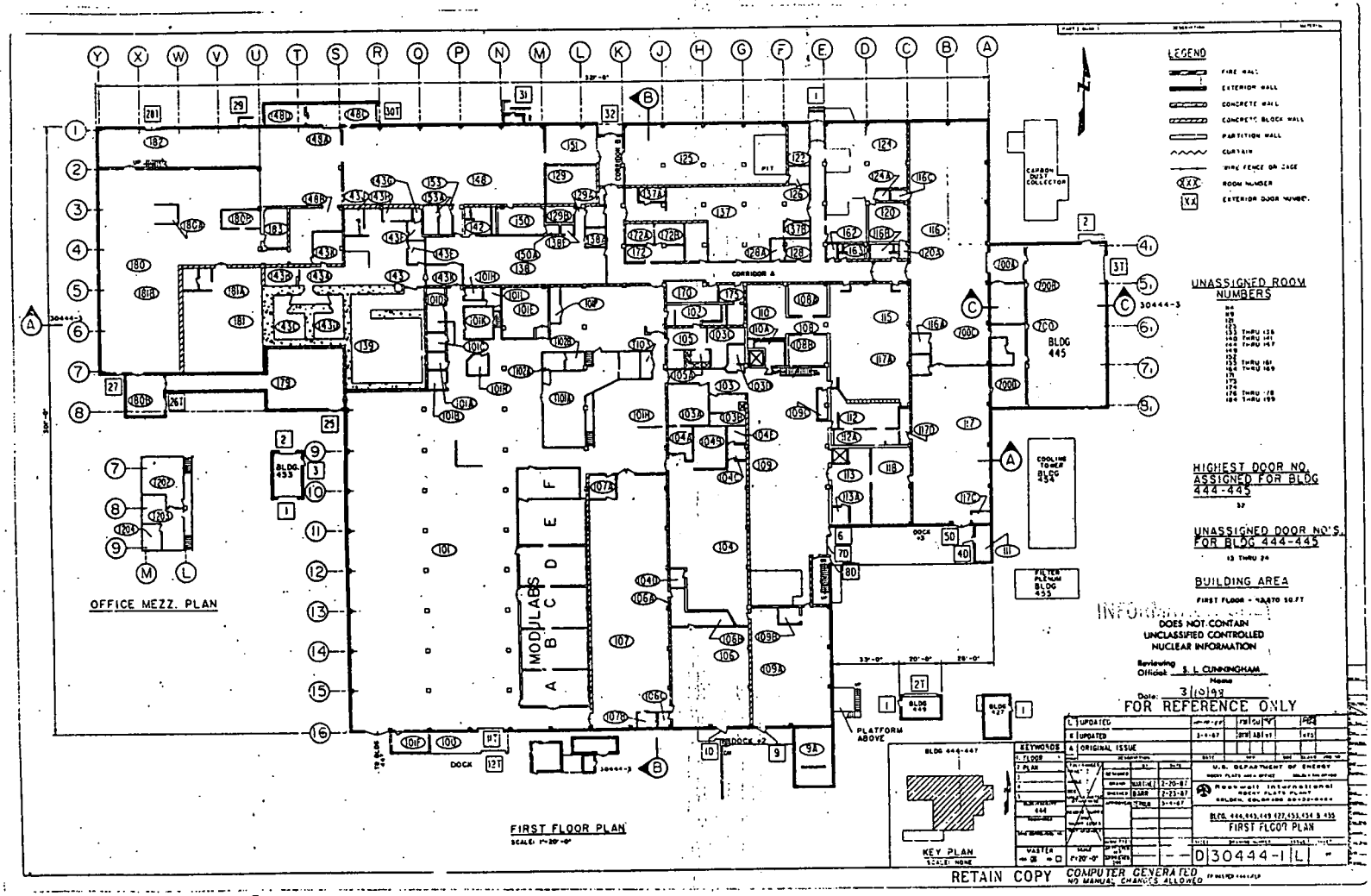
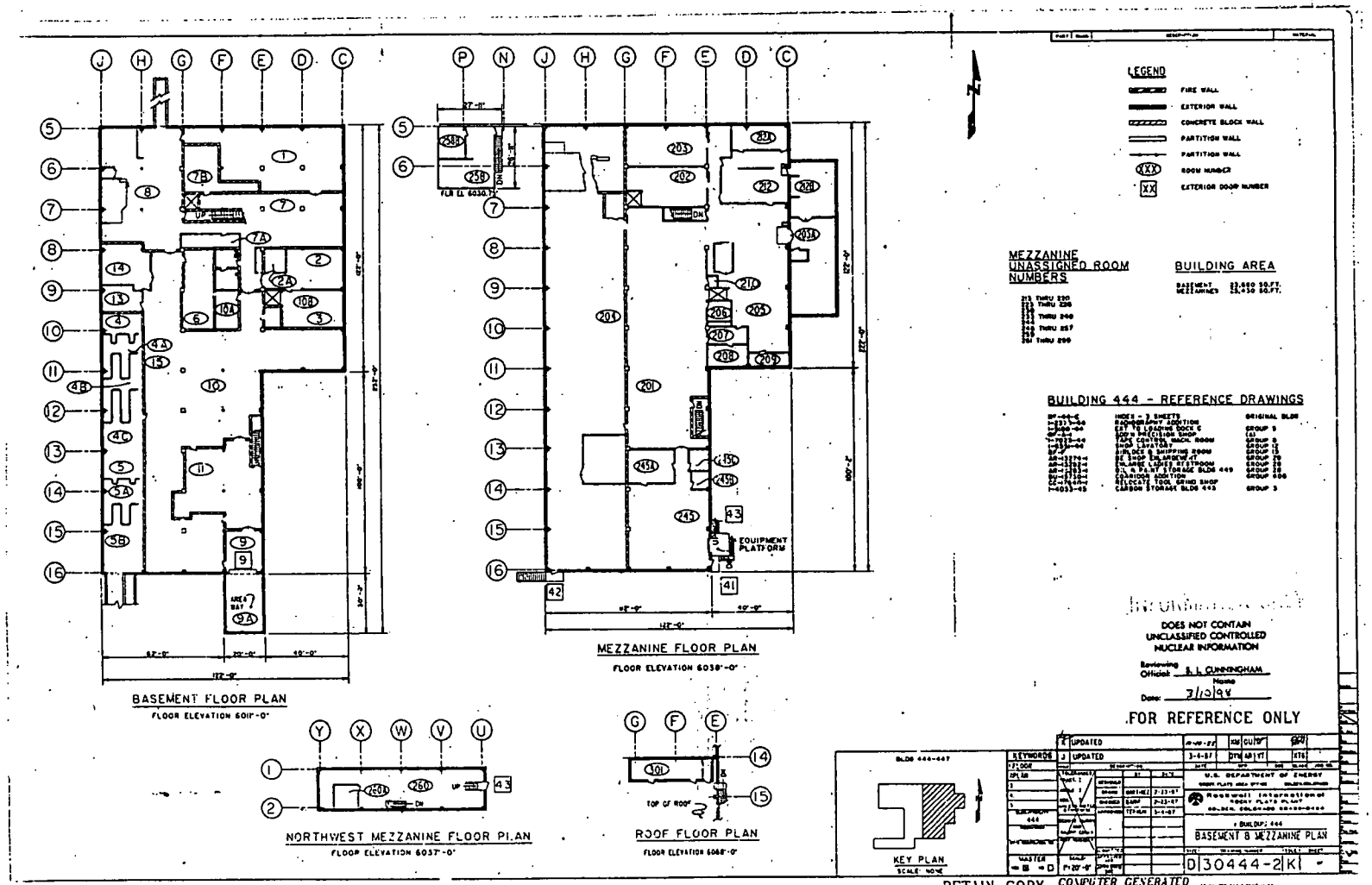

LEGEND
FIRE WALL
EXTERIOR WALL
CONCRETE WALL
CONCRETE BLOCK WALL
PARTITION WALL
CURTAIN
WIRE FENCE OR CAGE
ROOM NUMBER
EXTERIOR DOOR NUMBER
UNASSIGNED ROOM NUMBERS
HIGHEST DOOR NO. ASSIGNED FOR BLDG 444-445
UNASSIGNED DOOR NO'S. FOR BLDG 444-445
BUILDING AREA
FIRST FLOOR - 43,870 SQ.FT
DOES NOT CONTAIN UNCLASSIFIED CONTROLLED NUCLEAR INFORMATION
Reviewing Official: S. L. CUNNINGHAM
Name
Date: 3/10/98
FOR REFERENCE ONLY
OFFICE MEZZ. PLAN
FIRST FLOOR PLAN
SCALE: 1"=20'-0"
MODULABS
A B C D E F
CORRIDOR A
CORRIDOR B
CARBON DUST COLLECTOR
BLDG 445
COOLING TOWER BLDG 454
FILTER PLENUM BLDG 455
BLDG 453
BLDG 449
BLDG 427
PLATFORM ABOVE
DOCK
DOCK #2
DOCK #3
KEY PLAN
SCALE: NONE
BLDG 444-447
KEYWORDS
1. FLOOR
2. PLAN
MASTER
L UPDATED
K UPDATED
A ORIGINAL ISSUE
U.S. DEPARTMENT OF ENERGY
Rockwell International
ROCKY FLATS PLANT
GOLDEN, COLORADO 80402-0464
BLDG. 444,445,449,427,453,454 & 455
FIRST FLOOR PLAN
D 30444-1 L
RETAIN COPY
COMPUTER GENERATED
NO MANUAL CHANGES ALLOWED

HISTORIC AMERICAN ENGINEERING RECORD
SEE INDEX TO PHOTOGRAPHS FOR CAPTION

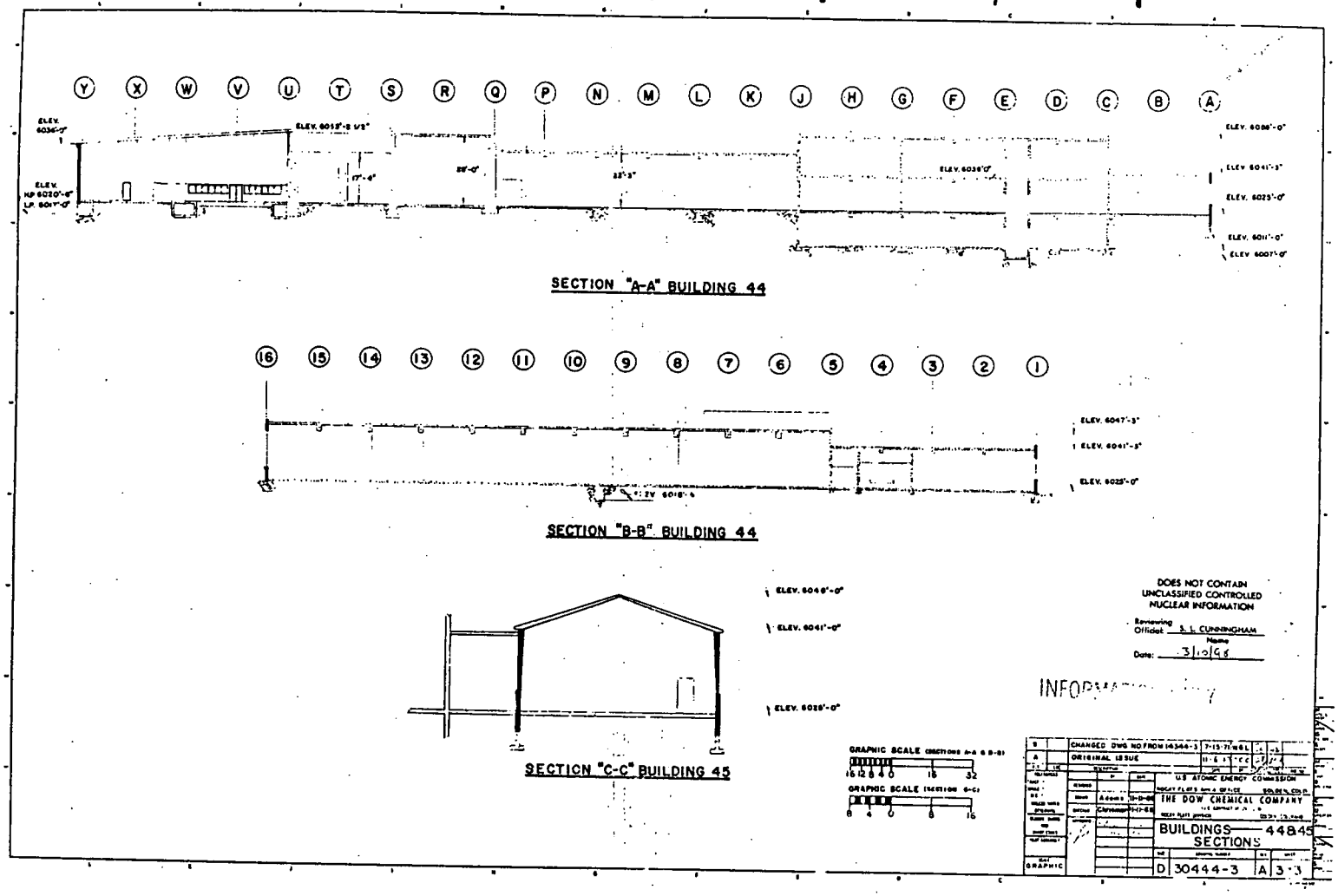
HAER No. CO-83-L-22



BASEMENT FLOOR PLAN
FLOOR ELEVATION 6011'-0"
MEZZANINE FLOOR PLAN
FLOOR ELEVATION 6038'-0"
NORTHWEST MEZZANINE FLOOR PLAN
FLOOR ELEVATION 6037'-0"
ROOF FLOOR PLAN
FLOOR ELEVATION 6068'-0"
EQUIPMENT PLATFORM
TOP OF ROOF
LEGEND
FIRE WALL
EXTERIOR WALL
CONCRETE BLOCK WALL
PARTITION WALL
PARTITION WALL
ROOM NUMBER
EXTERIOR DOOR NUMBER
MEZZANINE UNASSIGNED ROOM NUMBERS
BUILDING AREA
BUILDING 444 - REFERENCE DRAWINGS
DOES NOT CONTAIN UNCLASSIFIED CONTROLLED NUCLEAR INFORMATION
Reviewing Official: S. L. CUNNINGHAM
Date: 3/10/98
FOR REFERENCE ONLY
KEY PLAN
SCALE: NONE
U.S. DEPARTMENT OF ENERGY
Rockwell International
BASEMENT & MEZZANINE PLAN
D 30444-2 K
RETAIN COPY
COMPUTER GENERATED
NO MANUAL CHANGES ALLOWED

HISTORIC AMERICAN ENGINEERING RECORD
SEE INDEX TO PHOTOGRAPHS FOR CAPTION

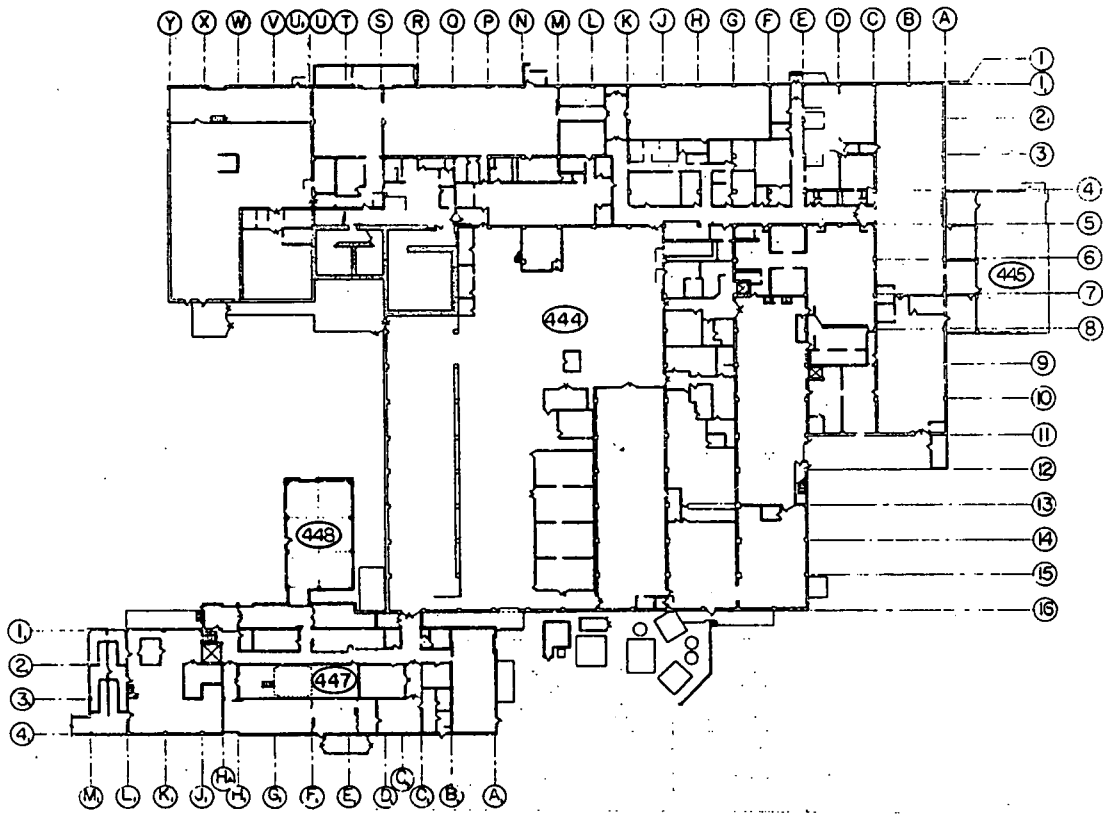
HAER No. CO-83-L-23


SECTION "A-A" BUILDING 44
SECTION "B-B" BUILDING 44
SECTION "C-C" BUILDING 45
ELEV. 6047'-3"
ELEV. 6041'-3"
ELEV. 6025'-0"
ELEV. 6046'-0"
ELEV. 6041'-0"
ELEV. 6025'-0"
GRAPHIC SCALE
DOES NOT CONTAIN UNCLASSIFIED CONTROLLED NUCLEAR INFORMATION
Reviewing Official: S. L. CUNNINGHAM
Date: 3/10/98
INFORMATION
CHANGED DWG NO FROM 14344-3
ORIGINAL ISSUE
U.S. ATOMIC ENERGY COMMISSION
THE DOW CHEMICAL COMPANY
BUILDINGS 44&45
SECTIONS
D 30444-3 A 3-3

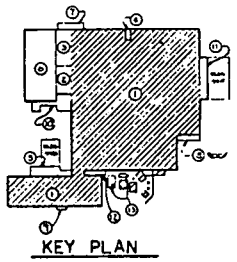
HISTORIC AMERICAN ENGINEERING RECORD
SEE INDEX TO PHOTOGRAPHS FOR CAPTION

HAER No. CO-83-L-24

HISTORIC AMERICAN ENGINEERING RECORD
Rocky Mountain System Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287



FLOOR PLAN



KEY PLAN

DOES NOT CONTAIN
UNCLASSIFIED CONTROLLED
NUCLEAR INFORMATION

Reviewing Official: S. L. CUNNINGHAM
Name

Date: 3/10/98

GRAPHIC SCALE

U.S. DEPARTMENT OF ENERGY

CENTRY SYSTEMS GROUP
ROLWELL INTERNATIONAL

BUILDINGS 444 / 447
FLOOR PLAN

D 30444-4 B

ROCKY FLATS PLANT, PLUTONIUM FABRICATION

HAER No. CO-83-M

(Rocky Flats Plant, Building 707)

Located in the north-central section of the Plant, within the Protected Area, just south of Building 776/777.

Golden Vicinity

Jefferson County

Colorado

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Rocky Mountain System Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

ROCKY FLATS PLANT,
PLUTONIUM MANUFACTURING
FACILITY
(Rocky Flats Plant, Building 707)

HAER No. CO-83-M

Location: Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County, Colorado. Building 707 is located in the central section of the protected area of the Rocky Flats Plant (Plant).

Date of Construction: 1970.

Fabricator: C.F. Braun and Company, Alhambra, California.

Present Owner: United States Department of Energy (USDOE).

Present Use: Plutonium Weapons Components Manufacturing.

Significance: This building was a primary contributor to the National Register eligible Rocky Flats Plant historic district associated with the United States (U.S.) strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack. Building 707 was the primary plutonium manufacturing and assembly facility at the Plant from 1970 until curtailment of operations in 1989.

Historians: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M), 1997. Judith Berryman, Ph.D., Archaeologist, e^2M, 1997.

Project Information:

In 1995, an inventory and evaluation was conducted of facilities at the Rocky Flats Plant for their potential eligibility for listing in the National Register of Historic Places. The primary goal of this investigation was to determine the significance of the Cold War era facilities at the Plant in order to assess potential effects of the long-term goals and objectives of the USDOE. These goals and objectives have not been finalized, but include waste cleanup and demolition. Recommendations regarding National Register of Historic Places eligibility were developed to allow USDOE to submit a formal determination of significance to the Colorado State Historic Preservation Officer for review and concurrence, and to provide for management of historic properties at the Plant.

From this determination and negotiations with the Colorado State Historic Preservation Officer, the Advisory Council, and the National Park Service, a Historic American Engineering Record project began in 1997 to document the Plant's resources prior to their demolition. The Plant was officially listed in the National Register of Historic Places in 1997. The archives for the Historic American Engineering Record project are located in the Library of Congress in Washington, D.C.

Introduction:

The Plant is one of thirteen USDOE facilities that constitute the Nuclear Weapons Complex, which designed, manufactured, tested, and maintained weapons for the U.S. arsenal. The Plant was established in 1951 to manufacture triggers for use in nuclear weapons and to purify plutonium recovered from retired weapons. The trigger consisted of a first-stage fission bomb that set off a second-stage fusion reaction in a hydrogen bomb. Parts were formed from plutonium, uranium, beryllium, stainless steel, and other materials.

A tense political atmosphere both at home and abroad during the Cold War years drove U.S. weapons research and development. By the 1970s, both the U.S. and the Soviet Union maintained thousands of nuclear weapons aimed at each other. These weapons were based on submarines, aircraft, and intercontinental ballistic missiles. Both the North Atlantic Treaty Organization and Warsaw Pact countries in Europe had small nuclear warheads called theater weapons used as part of the Mutually Assured Destruction program. (The Mutually Assured Destruction program acted as a deterrent in that if one side attacked with nuclear weapons, the other would retaliate and both sides would perish.) The final nuclear weapons program at the Plant was the W-88 nuclear warhead for the Trident II missile. This mission ended in 1992 when President Bush canceled production of the Trident II missile.

The Plant was a top-secret weapons production plant, and employees worked with a recently man-made substance, plutonium, about which little was known concerning its chemistry, interactions with other materials, and shelf life. The Historic American Engineering Record documentation effort focuses on four aspects of the Plant and its role in the Nuclear Weapons Complex: manufacturing operations; research and development; health and safety of workers; and security.

Chronology of Building 707:

1967 Construction of Building 707 began.

1970 The first plutonium operations in Building 707 began on May 25. Operations focused on casting and fabrication of plutonium components and final assembly of the plutonium triggers.

1971 The Building 707 Annex (Building 707A) was constructed.

1972 The X-Y retriever used for handling and storing plutonium began operations in the spring.

1989 Operations including metallurgy, fabrication, assembly, inspection, and testing of plutonium and plutonium parts ceased in November following a Federal Bureau of Investigation raid on the Plant.

1992 Operations included removal of oxides from plutonium metal and repackaging the cleaned metal; storage of removed oxides began under the new Plant mission of environmental restoration.

Building History:

Building 707 became the primary plutonium fabrication building at the Plant when operations commenced on May 25, 1970. The design of Building 707 incorporated extensive control and safety features, including the first-time use of inert atmosphere in the glove boxes, primarily in response to two earlier fires (in Buildings 771 and 776/777). The building was originally intended to house new fabrication processes associated with new plutonium weapons designs, but many of the existing foundry and fabrication operations from Building 776/777 were transferred to Building 707 as the result of a 1969 fire in Building 776/777. The transferred operations were not changed significantly. Building 707A was built in 1971 to accommodate plutonium casting and fabrication processes moved from Building 776/777 as a result of the 1969 fire.

Building Description:

The Building 707 complex was a manufacturing facility for fabrication of plutonium parts, and assembly of parts made of plutonium and other materials into nuclear weapons components. The major structures of the complex include Building 707, Building 707 Annex (707A), and Building 708. Building 708 houses emergency generators and three brine chiller systems for Building 707 temperature control and dehumidification in plutonium handling areas. Other structures in the complex are a cooling tower, an electrical distribution station, a process waste station, and outside storage tanks for inert gases, such as argon and nitrogen.

Building 707 is located in the north-central section of the Plant, within the protected area and just south of Building 776/777. Building 707 is a two-story building with a single-story section on the east side. The two-story portion is 160' x 464'. The single-story section is 40' x 464'. The two-story portion of the building is 74,240 square feet per floor while the single-story section is 18,560 square feet. A small basement in Building 707 contains an additional 1,000 square feet.

Building 707 has precast, prestressed concrete exterior walls, supported on precast concrete columns. The first floor is a concrete slab on grade. All floors in the production areas are reinforced concrete finished with an epoxy coating designed to facilitate decontamination. The roof is constructed of prestressed, precast concrete twin-tee panels. There are no windows in the exterior walls.

The single-story portion of Building 707 contains office and support areas, and is divided into three main sections. The northern section consists of offices, a conference room, a data processing equipment room, restrooms, janitor closets, and an entrance lobby, all opening into a corridor. An airlock separates non-plutonium handling areas from plutonium production areas. The middle portion of the single-story section was used for radiographic inspection. The radiography area consists of two vaults housing radiographic inspection equipment and an adjoining support area. The southern section of the single-story section houses a shipping and receiving area. This area contains production storage, offices, shipping and receiving space, a waste drum counting and storage area, a maintenance area, and two docks with airlocks opening to a recessed loading area under the single-story roof.

Building 707A, a freestanding two-story structure, is 104' x 125' and abuts the northwest side of Building 707. It contains 13,000 square feet per floor. Although Building 707A is a separate structure, with its own east wall, it is considered to be part of Building 707. Operations within the two buildings were integrated.

Building 707/707A is divided into ten modules, which are separate rooms, sets of rooms, or workstations, segregated from other non-plutonium production areas. Letters A-K are used to designate the modules. There is no Module I.

The main floor of Building 707 is compartmentalized into eight side-by-side modules (A through H) which contained one or more of the primary production operations. Each module is 140' x 49' with an area of approximately 6,860 square feet. Modules A though E were identical in size and shape, but contained various glove box configurations designed to support the specific operation performed in each module. The main floor of Building 707A is divided into two modules, Modules J and K, which contained plutonium foundry operations and two plutonium storage vaults. One storage vault, on the north end of Module K, was equipped with a remotely controlled, computerized, three-axis retriever (the X-Y retriever). The basement room (under Module C) was used for filtering and storing machining coolants and other process liquids.

Inert atmospheres were provided for the glove boxes and conveyors of Modules A, B, C, D, E, F, J, and K to prevent the propagation of fire. An enclosed chain conveyor connected glove box workstations in and between the modules. Leaded gloves were affixed to ports in the equipment to allow operator access. Temperature and humidity controlled air was provided to other plutonium handling areas.

Module F is divided into two areas, one for special assembly operations which required specialized atmospheric controls, the other for final processing. The temperature, humidity, and airflow in Module F were precisely controlled. The module has airlocks for equipment and personnel, alarms, an escape door, and a tall equipment door. Downdraft tables are equipped with a mesh screen work surface and high-efficiency particulate air filters to draw air in the room toward the table, through the filter, and out through the exhaust ventilation plenum. A conveyor line connects one of the downdraft tables to Module E.

Module G is divided into separate areas for offices, sub-assembly processes for non-radioactive areas, inspection, and two laboratories (standards and non-destructive testing).

Module H contains six high-pressure process chambers, an open process area, and a storage vault. The storage vault is freestanding, and does not form a part of the main building structure. The vault is constructed of concrete to provide additional radiation shielding.

The second floor of Building 707 contains heating, ventilating and air conditioning equipment, and air filtration systems. Some equipment, tanks, and pumps are also located on the second floor. Utility equipment located on the second floor provides air filtration, ventilation, and dehumidification to the modules and glove boxes. Two inert atmosphere systems maintain a dry, inert atmosphere of nitrogen, with less than five percent oxygen. Each system includes a separate exhaust plenum equipped with a four-stage, high-efficiency particulate air filter. A standby filter is connected to the two plenums to allow high-efficiency particulate air filters in either system to be changed without interruption of service. The arrangement of the northern end of the two-story portion of Building 707 is duplicated in Building 707A. Two production modules, J and K, divide the first floor, and heating, ventilating and air conditioning equipment is located on the second floor.

Building Operations:

Operations in Building 707 included metallurgy, parts fabrication, inspection and testing, assembly, and storage. Plutonium, particularly in finely divided forms, was subject to oxidation and spontaneous combustion, and required a controlled environment for processing and storage. Control was achieved by enclosing plutonium metal and associated equipment within glove boxes and conveyors and by providing certain work areas with an inert atmosphere to control the pyrophoric nature of plutonium. The general flow of work and materials was from north to south within the building, starting with Modules A, J, and K, then sequentially from Module B to Module H.

Modules A, J, and K
Modules A, J, and K were used for metallurgy, primarily casting and sampling of plutonium metal. These modules contained casting furnaces, glove boxes, and casting molds made of graphite and other metals. Operations were conducted in an inert atmosphere. The primary

difference between casting operations in Modules K and J were the types of molds used: graphite molds were used in Module J, and molds made of other metals were used in Module K. Ingots were sampled by breaking a small nodule off the side of the casting. Limited casting operations were conducted in Module A. Other activities in this module included sampling of cast ingots for analysis of chemical purity, and removal of plutonium oxides and other impurities from the casting molds.

The casting process created feed ingots and War Reserve ingots of plutonium metal. Materials used for the creation of feed ingots included plutonium buttons from recovery processes, briquettes, and scrap plutonium metal. The first casting process created the feed ingot, which was then sampled. The sample was transferred to Building 559 and analyzed for chemical composition and purity. Production control personnel maintained all records of ingot composition, and used this data to calculate the precise feed ingot mixture which would produce a War Reserve ingot of specific purity. The second casting process used this feed ingot recipe to create the War Reserve ingot. The War Reserve ingot was used to fabricate weapons components, the purity of which was identified by design specifications. Samples were taken to verify the chemical makeup of the War Reserve ingot as well.

The casting process, conducted in a vacuum, consisted of weighing the metal, placing it in tantalum crucibles, and melting it in one of four electric induction furnaces. Molten metal was poured into graphite, tantalum, or erbium oxide-coated stainless steel molds to form ingots. Although four furnaces were present in Module K, only two were used during routine casting operations. Rejected ingots from casting in Modules A, J, and K were cut with a shear press within a glove box and returned to the X-Y retriever for storage.

Module B

Plutonium War Reserve ingots cast in Modules A, J, and K were rolled, formed, and heat-treated in Module B under an inert atmosphere. War Reserve ingots were rolled to a specified thickness then moved to another glove box where shapes were cut in a blanking press. Cut blanks were sent to adjacent glove boxes for thermal treatment (annealing and homogenizing). Following thermal treatment, blanks were formed into hemi-shells (1/2 shells) in a hydroform press. After forming, the parts were annealed and measured on a density balance. A percentage of the parts were selected for further quality assurance evaluation. Scraps left from cutting were cut into smaller pieces in the same glove box, placed in a container, and sent to the briquetting process in Module C.

Module C

Activities in Module C were conducted in an inert atmosphere. The module was used for final machining of plutonium parts and also contained equipment for the briquetting process. Glove boxes within Module C contained lathes, mills, a drill box, a high-precision drill press, cleaning solvents, and a hydraulic press. Machining operations included jig boring, slot cutting, and threading. All tools, gauges, and fixtures remained within the glove boxes for the useful life of

the device and were removed only for disposal. When machining operations were completed, the parts were cleaned, degreased, and stored to await assembly.

The briquetting process was used to generate hockey-puck-sized briquettes of plutonium metal scrap. Machine turnings and scrap from the blanking press were cleaned in a solvent bath to remove cutting oils, then pressed into small briquettes. These briquettes were returned to the foundries for casting of feed ingots.

Module D
In Module D, each machined part was marked with a serial number, cleaned, weighed, and inspected. As part of the cleaning process, parts were also repeatedly wire brushed to remove oxides. Completed parts were transferred to Module E by a chain conveyor.

Module E
In Module E, plutonium parts were welded with electron beam welders in glove boxes, then inspected for leaks using non-destructive testing methods. These methods included radiography x-ray examination of plutonium parts to identify structural flaws; eddy current testing on plutonium parts to check the depth of weld penetration; and weld scanners and fluorescent dye penetrant processes to qualify welds and detect minute cracks and voids in parts. The washing, welding, and leak detection processes in Modules D and E were repeated several times.

Module F
Module F contained an assembly area referred to as the super-dry room, where plutonium parts were assembled and tested. The super-dry room provided space for special assembly operations that required precisely controlled conditions of humidity, temperature, and airflow. As part of the assembly process, an outer metal casing was welded onto the plutonium components. One area of the super-dry room was divided into two compartments, each was provided with a downdraft table. One of the downdraft tables opened into the end of a conveyor line that crossed over Module E. At this downdraft table, uncoated plutonium parts and other parts from previous glove box operations were assembled into units that could be safely transported, processed, and stored outside the protection of a glove box.

Leak testing was conducted on stainless steel and beryllium parts. Each part was placed on one of ten pump-down tables and a vacuum was exerted on the part to check for leaks and to remove moisture. The encased parts were then transferred to Module G for further processing.

Module G
Activities in Module G included brazing, machining, non-destructive testing, and non-plutonium parts assembly and disassembly. Plutonium parts encased in other metals were brazed under a vacuum. The machining process used two lathes inside B-boxes (similar to lab hoods) and a milling machine. Subassembly of non-radioactive parts occurred in a portion of the module.

Rejected aluminum, stainless steel, and beryllium parts were also disassembled in Module G and either recycled or processed for disposal. Glove boxes were not used in this Module.

Module H
Assembly processes in Module H included brazing and high-pressure assembly whereby parts comprised of various metals including beryllium, plutonium, and uranium were bonded together under pressure. Final assemblies were transferred to Building 991 for eventual off-site shipment.

Testing and Inspection
Individual parts, subassemblies, and assemblies were inspected and tested throughout the metallurgical machining and assembling operations to ensure that specifications were met. Inspection involved dimensional inspection (measuring). Testing processes were both non-destructive and destructive. Precision hand and electronic gauges, scales, rings, optical- and computer-assisted instruments, and laser beam instruments were used during dimensional inspections to verify that directly measurable dimensions were within specified tolerances. Parts were matched for physical and dimensional characteristics.

Non-destructive testing was used to inspect interior characteristics or properties of a part or assembly. The techniques most commonly used were radiographic x-ray examination, and ultrasonic, acoustic emission, and eddy current scanning. Other non-destructive measurement methods included weight and density determinations and leak tests. Radiography detected cracks, voids, and gaps in parts and assemblies. These testing techniques identified structural flaws, weld depth, minute cracks, voids, and gaps. Vacuum tests were conducted on plutonium, stainless steel, and beryllium parts to check for leaks and to remove moisture and other impurities.

Destructive testing was used to verify the chemical content and the physical integrity of a part or assembly. Parts and assemblies were subjected to gravity force analyses, and tensile strength, stress, and vibration testing. Parts were also cored and sawed for spectroscopy and chemical analyses.

Assembly
Assembly included such operations as machining, cleaning, matching parts, brazing, welding, heating under vacuum for trace contaminant removal, marking, weighing, monitoring for surface contamination, and packaging for shipment. Inspection and testing processes occurred throughout the assembly process. Parts were matched for physical and dimensional characteristics, assembled, then welded or brazed into subassemblies. The subassemblies and additional parts were cleaned, physically assembled, welded, machined to the required contour, and marked. The assembled parts were subjected to final processing steps, final testing, and inspection, then stored to await shipment.

Storage
Several locations in Building 707 were used to store nuclear and non-nuclear materials. Materials stored included raw materials needed for casting, feed ingots, War Reserve ingots, parts cast within the building, and finished components.

The X-Y retriever, which began operations in 1971, was housed in Module K, and was used to sort and retrieve plutonium metal for distribution to other processes in Building 707. Using the X-Y retriever, operators retrieved plutonium metal from storage and conveyed it to the X-Y shuttle area where it was cut and weighed. The cut pieces were then conveyed to Modules A, J, or K for casting, or Module B for rolling and forming. Rooms 141 and 142 in Module J (the J vault) were used for storage of oxides, plutonium buttons received from other USDOE facilities, and to some extent, Building 771 molten salt extracts.

Support Operations
Support groups assigned permanently to Building 707 included departments common to all process buildings, such as radiation monitoring, utilities, maintenance, custodial, tool crib, and industrial engineering. Support groups unique to Building 707 included several manufacturing technical support groups, production control, process material control, final product certification, and USDOE inspection. The production engineering support group was responsible for troubleshooting equipment problems, coordinating appropriate repairs, utilizing maintenance and assistance from the research and development group, ensuring compliance with specifications and adherence to production schedules, tracking production programs, and providing input for new production systems. The production foreman was responsible for tracking worker training and new worker indoctrination, and provided input to production engineering regarding production schedules and new production systems.

The metallurgical support group was responsible for administration of plutonium metal used for casting, scrap plutonium metal, and operation of a control system for laboratory analysis data on plutonium metal.

Plutonium Recovery
Plutonium was a rare substance, and supply seldom kept up with demand. Only a fraction of the feed plutonium that entered Modules A, J, or K came out of Module D as machined production parts. Every effort was made to salvage the excess material. Plutonium fines, chips, and scraps generated from the parts fabrication processes were collected in cans at each workstation or individual machine. These fines, never leaving the inert atmosphere system, were transferred via the chain conveyor to a workstation in Module C where the material was compressed into briquettes for later use. Residues produced by the casting operations were burned to oxide, packaged, and transferred to residue processing operations in Building 771 for plutonium recovery. This thermal stabilization process was used to convert pyrophoric plutonium to a non-pyrophoric plutonium oxide, which could be more safely handled.

Operations Since 1989

Following a raid by the Federal Bureau of Investigation in 1989, production at the Plant was curtailed. In 1992, the mission of the Plant was officially changed from weapons component production to environmental restoration and waste management. At that time, the mission of Building 707 was changed to plutonium stabilization operations.

Sources: ChemRisk, 1992, *Reconstruction of Historical Rocky Flats Operations & Identification of Release Points, Final Draft Report*, Rocky Flats Repository.

EG&G Rocky Flats, Inc., 1994, *Historical Release Report, Building Histories*, Rocky Flats Plant.

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Sasa, Paul, employed at the Plant since September of 1978 by the site contractor, personal communication, November 1997 and January 1998.

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HISTORIC AMERICAN ENGINEERING RECORD

INDEX TO PHOTOGRAPHS

ROCKY FLATS PLANT, PLUTONIUM FABRICATION HAER No. CO-83-M
(Rocky Flats Plant, Building 707)
Located in the north-central section of the Plant, within the Protected Area, just south of Building 776/777.
Golden Vicinity
Jefferson County
Colorado

Photographs CO-83-M-1 through CO-83-M-20 were taken by various site photography contractors, dates are indicated in parentheses.

CO-83-M-1 VIEW OF THE CONTROL ROOM FOR THE X-Y RETRIEVER. USING THE X-Y RETRIEVER, OPERATORS RETRIEVED PLUTONIUM METAL FROM THE PLUTONIUM STORAGE VAULTS (IN MODULE K) AND CONVEYED IT TO THE X-Y SHUTTLE AREA WHERE IT WAS CUT AND WEIGHED. FROM THE SHUTTLE AREA THE PLUTONIUM WAS CONVEYED TO MODULES A, J OR K FOR CASTING, OR MODULE B FOR ROLLING AND FORMING. (5/17/71)

CO-83-M-2 VIEW OF INTERIOR OF X-Y RETRIEVER. THE X-Y RETRIEVER WAS HOUSED IN MODULE K AND WAS USED TO SORT AND RETRIEVE PLUTONIUM METAL FROM A STORAGE VAULT FOR DISTRIBUTION TO OTHER PROCESSES IN BUILDING 707. (11/29/88)

CO-83-M-3 VIEW OF CHAINVEYOR. AN ENCLOSED CHAIN CONVEYOR CONNECTED GLOVE BOXES WITHIN AND BETWEEN MODULAR WORK AREAS. LEADED GLOVES WERE AFFIXED TO PORTS ALONG THE CHAINVEYOR PATHWAY TO ALLOW OPERATOR ACCESS. (1/25/93)

CO-83-M-4 VIEW OF PLUTONIUM CANISTER ON CHAINVEYOR. SCRAP PLUTONIUM WAS COLLECTED INTO CANS AT INDIVIDUAL WORKSTATIONS. THE CANS WERE TRANSFERRED VIA THE CHAIN CONVEYOR TO A WORKSTATION IN MODULE C WHERE THE MATERIAL WAS COMPRESSED INTO BRIQUETTES FOR LATER USE. (6/20/93)

CO-83-M-5 VIEW OF A GLOVE BOX FIREWALL DETAIL. THE FIREWALL WAS A SAFETY FEATURE TO PREVENT THE SPREAD OF FIRE BETWEEN INTERCONNECTED GLOVE BOXES. PLUTONIUM IS PYROPHORIC, AND MAY IGNITE IN THE PRESENCE OF OXYGEN. (5/8/70)

CO-83-M-6 VIEW OF BUILDING 707 INTERIOR. GLOVE BOX WORKSTATIONS ARE BEING CONSTRUCTED FOR FOUNDRY PROCESSES IN MODULE A. (10/6/69)

CO-83-M-7 VIEW OF THE INTERIOR OF MODULE A, ONE OF THE THREE PLUTONIUM FOUNDRY MODULES. ALTHOUGH CASTING FURNACES WERE PRESENT IN THE MODULE, IT WAS USED PRIMARILY FOR SAMPLING CAST PLUTONIUM. (11/6/73)

CO-83-M-8 VIEW OF FOUNDRY INDUCTION FURNACES, MODULE J. THE FOUNDRY CASTING PROCESS WAS CONDUCTED IN A VACUUM. PLUTONIUM METAL WAS MELTED IN ONE OF FOUR ELECTRIC INDUCTION FURNACES TO FORM INGOTS.

CO-83-M-9 VIEW OF BAG-IN BAG-OUT PORT IN MODULE J, ASSOCIATED WITH PLUTONIUM CASTING PROCESSES. (2/98)

CO-83-M-10 VIEW OF MODULE B, INSTALLATION OF A HYDRAULIC PRESS. THE PRESS WILL EVENTUALLY BE CONNECTED TO A GLOVE BOX LINE. (9/29/69)

CO-83-M-11 DETAIL VIEW OF A LATHE IN MODULE C. THE LATHE WAS USED FOR FINAL MACHINING OF TRIGGER COMPONENTS. LATHE TURNINGS WERE COLLECTED FROM THE BACK OF THE LATH FOR DISPOSAL. (2/22/84)

CO-83-M-12 VIEW OF THE INSPECTION MODULE (MODULE D). THE GLOVE BOX IN THE FOREFRONT OF THE PHOTOGRAPH CONTAINS A DRILL PRESS; OTHER GLOVE BOXES ARE USED FOR PARTS INSPECTION. (5/70)

CO-83-M-13 VIEW OF VACUUM CHAMBER AND WELDING EQUIPMENT IN MODULE E. PARTS WERE WELDED UNDER A VACUUM TO PREVENT CORROSION. (11/6/73)

CO-83-M-14 VIEW OF DOWNDRAFT TABLES IN THE SUPER DRY ROOM OF MODULE F. AIR IS DRAWN TOWARD THE DOWNDRAFT TABLE, THROUGH THE MESH-SCREEN WORK SURFACE, AND OUT OF THE BUILDING THROUGH A BANK OF FILTERS. AT THE DOWNDRAFT TABLE, UNCOATED PLUTONIUM PARTS AND OTHER PARTS FROM PREVIOUS GLOVE BOX OPERATIONS WERE ASSEMBLED INTO UNITS THAT COULD BE SAFELY TRANSPORTED, PROCESSED, AND STORED OUTSIDE THE PROTECTION OF A GLOVE BOX. (11/6/73)

CO-83-M-15 VIEW OF MODULE H, THE HIGH PRESSURE ASSEMBLY AREA. PROCESSES IN THIS MODULE OCCURRED UNDER HIGH PRESSURES AND TEMPERATURES. (5/70)

CO-83-M-16 VIEW OF THE STATIONARY OPERATING ENGINEER CONTROL PANEL INSTALLATION. THE PANEL CONTROLS AIR-HANDLING EQUIPMENT AND AIR PRESSURE WITHIN THE BUILDING. (10/6/69)

CO-83-M-17 VIEW OF AIR LOCK ENTRY DOOR. BANKS OF AIR FILTERS ARE VISIBLE TO THE SIDES OF THE DOORS. THE BUILDING WAS DIVIDED INTO ZONES BY AIRLOCK DOORS AND AIR FILTERS. AIR PRESSURE DIFFERENTIALS WERE MAINTAINED IN THE ZONES, SUCH THAT AIRFLOW WAS PROGRESSIVELY TOWARD AREAS WITH THE HIGHEST POTENTIAL FOR CONTAMINATION. (9/24/91)

CO-83-M-18 VIEW OF THE SECOND FLOOR OF BUILDING 707. AIR EXHAUST FANS ARE USED TO MAINTAIN PRESSURE DIFFERENTIALS WITHIN THE BUILDING. (5/70)

CO-83-M-19 VIEW OF SECOND FLOOR, SOUTHERN PORTION OF BUILDING 707. THE STORAGE TANKS CONTAIN MACHINE COOLANTS AND SOLVENTS USED IN FABRICATION PROCESSES. (5/70)

CO-83-M-20 VIEW OF LOW PRESSURE PUMPING EQUIPMENT ON THE SECOND FLOOR OF BUILDING 707. THE EQUIPMENT MAINTAINS PROPER COOLANT PRESSURE IN MACHINES. (5/70)

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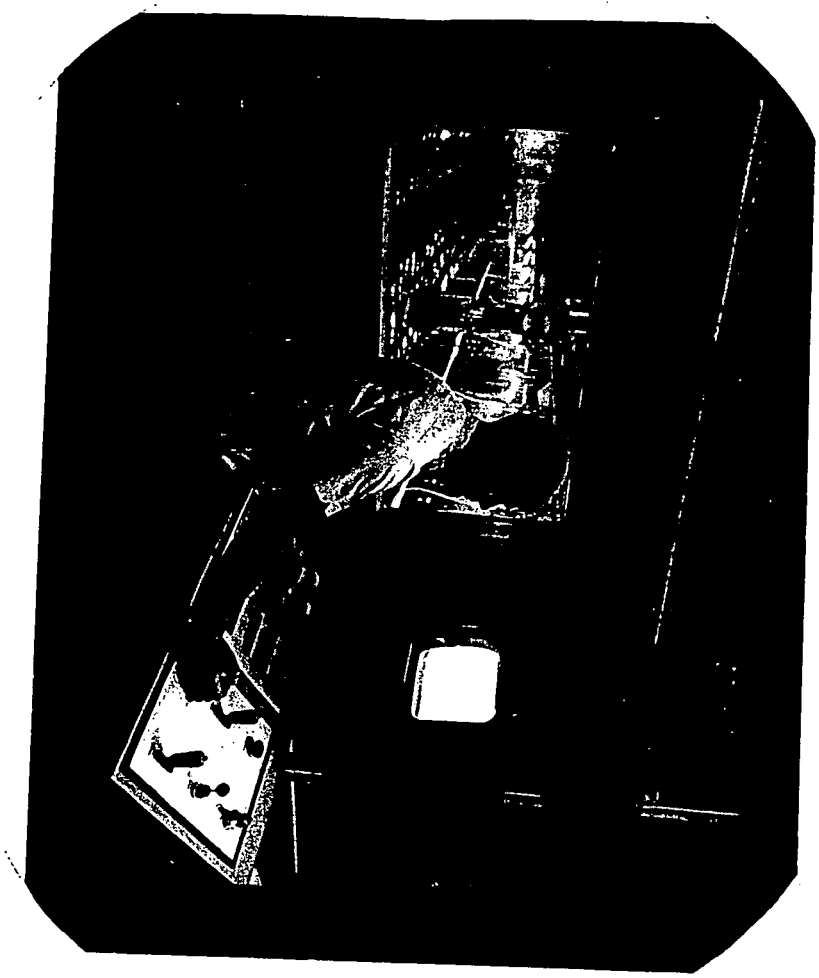

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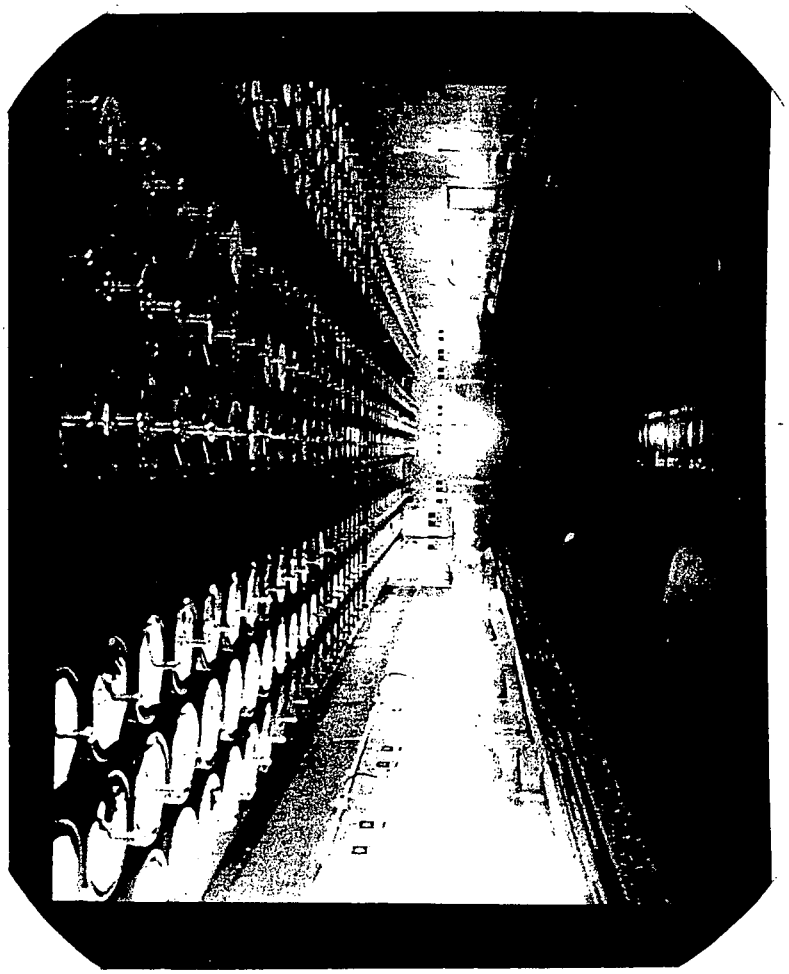

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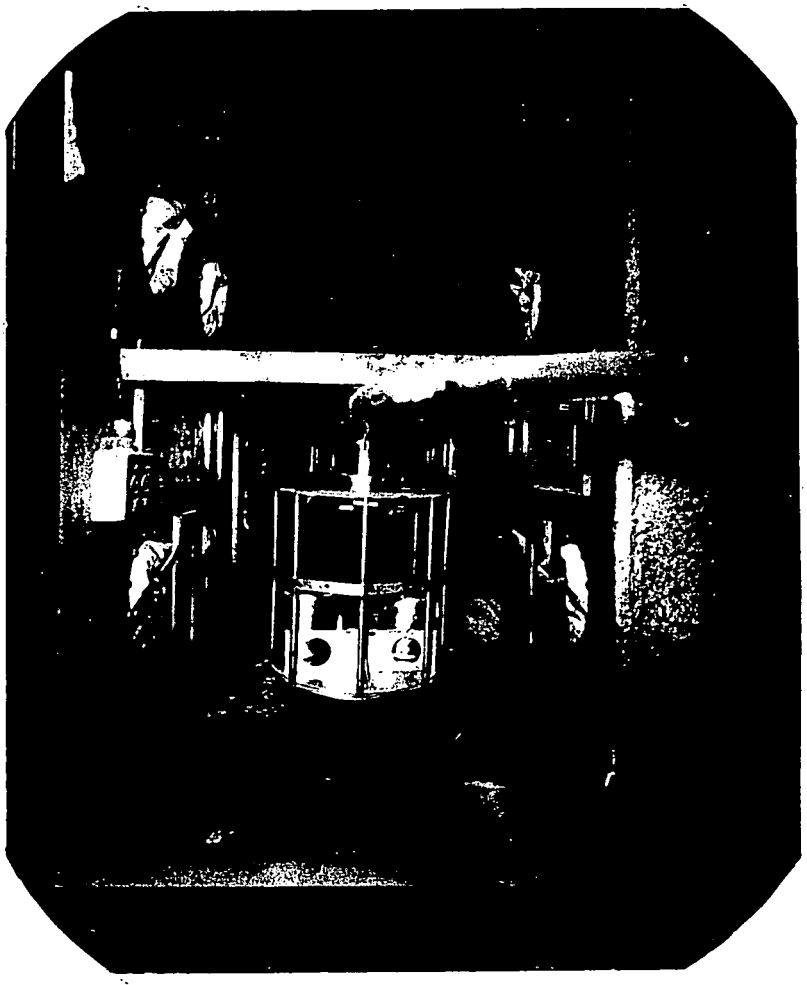

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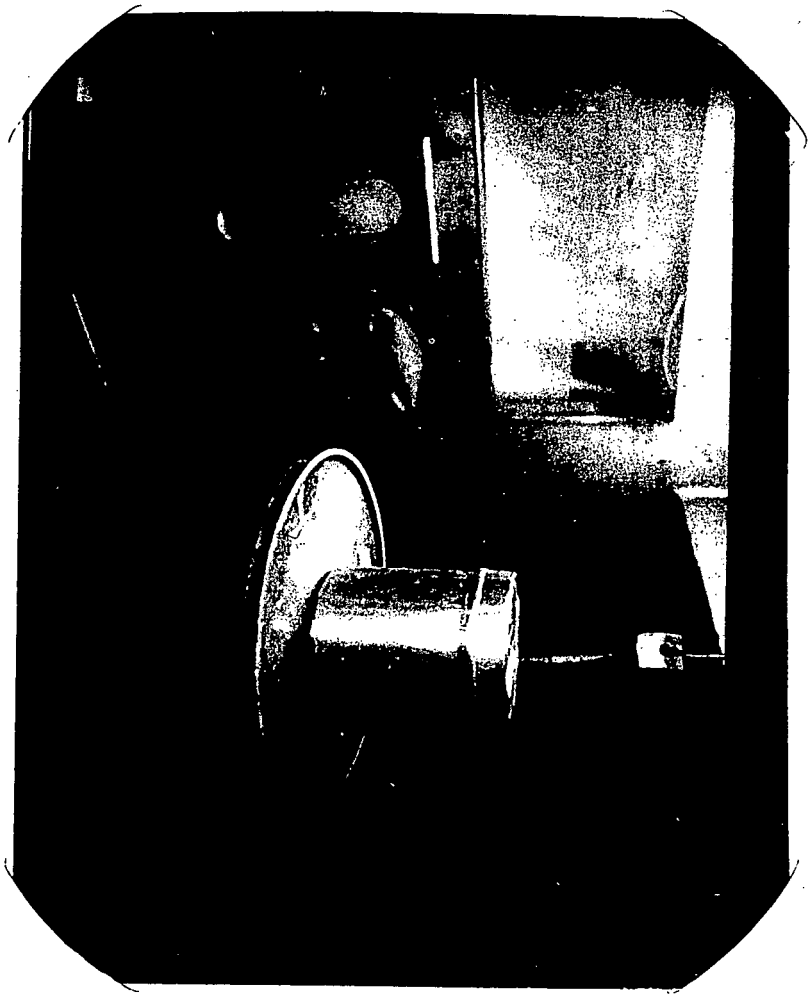

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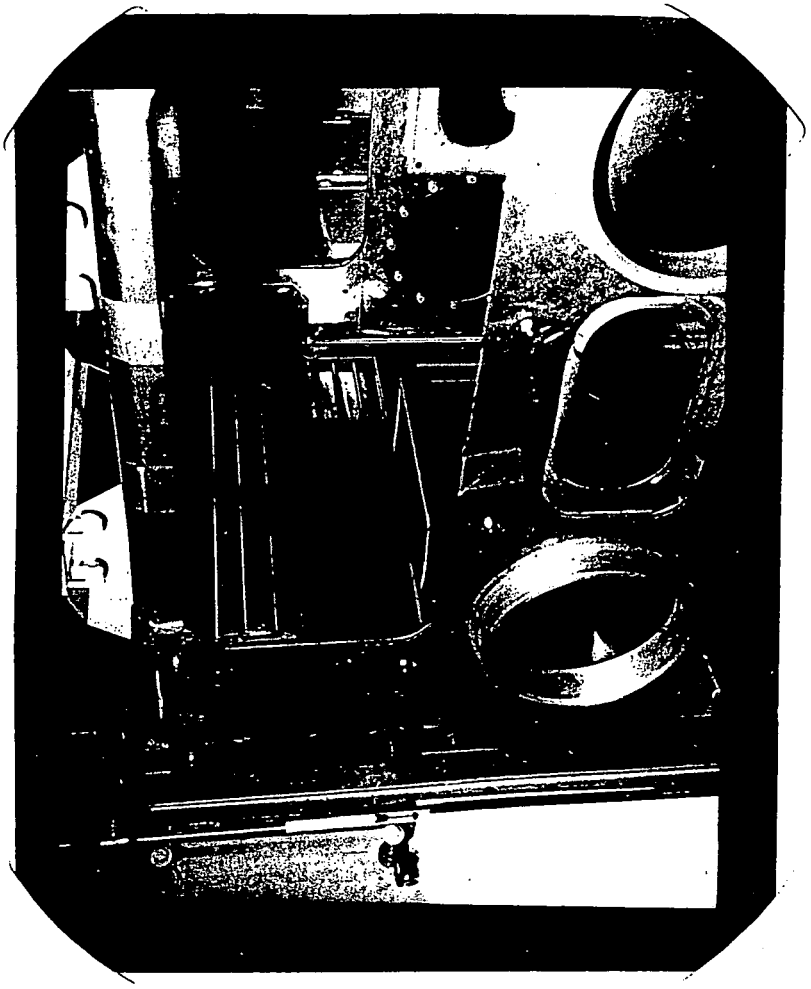

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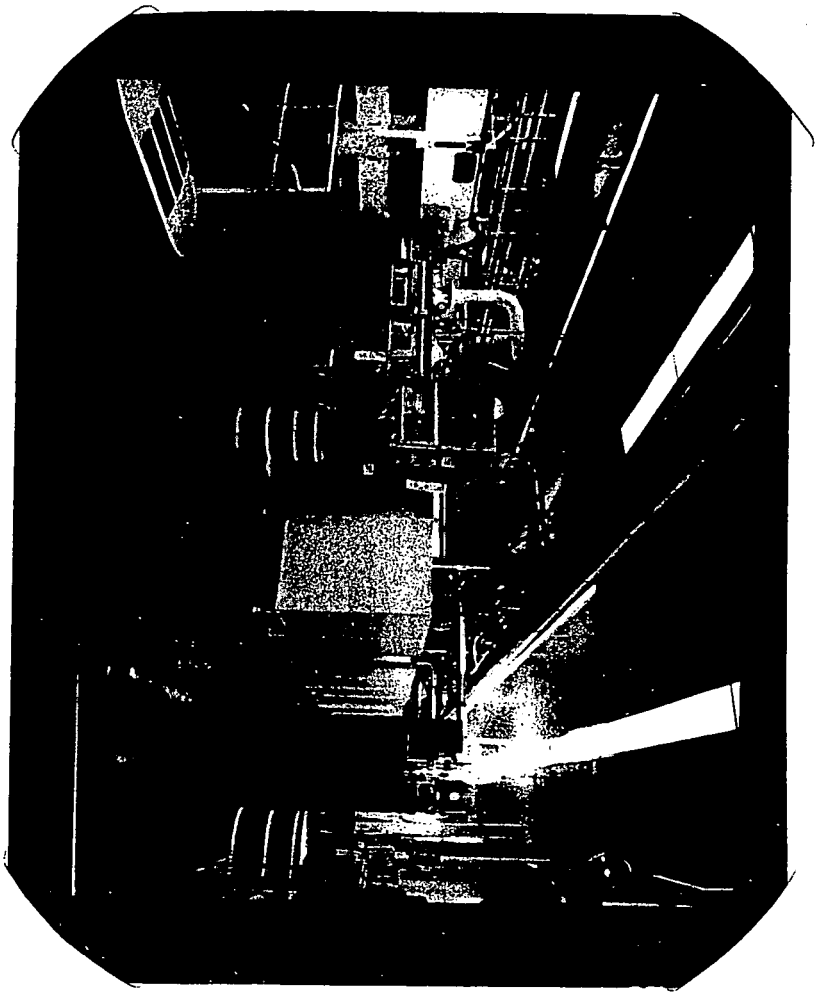

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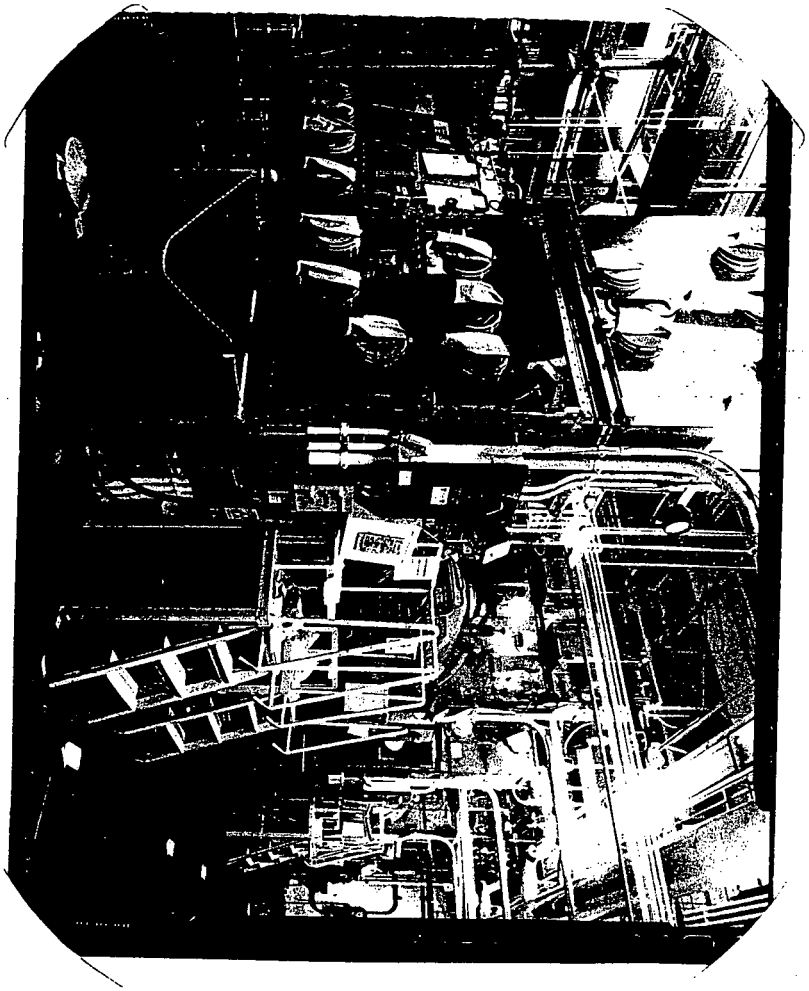

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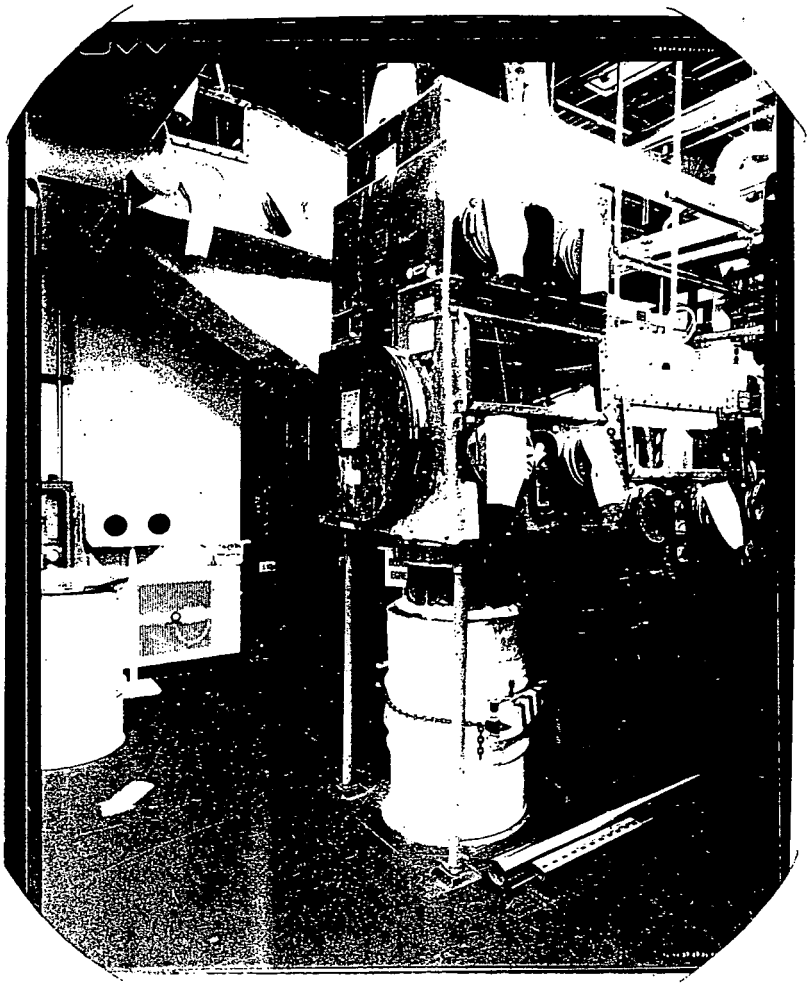

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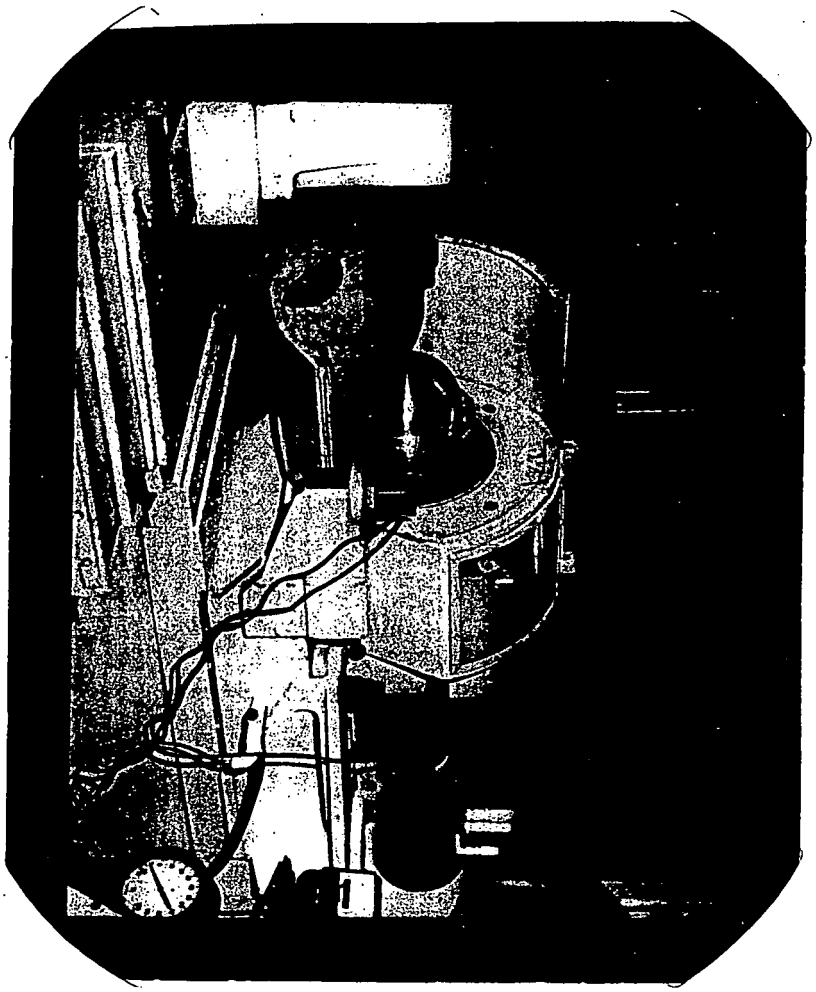

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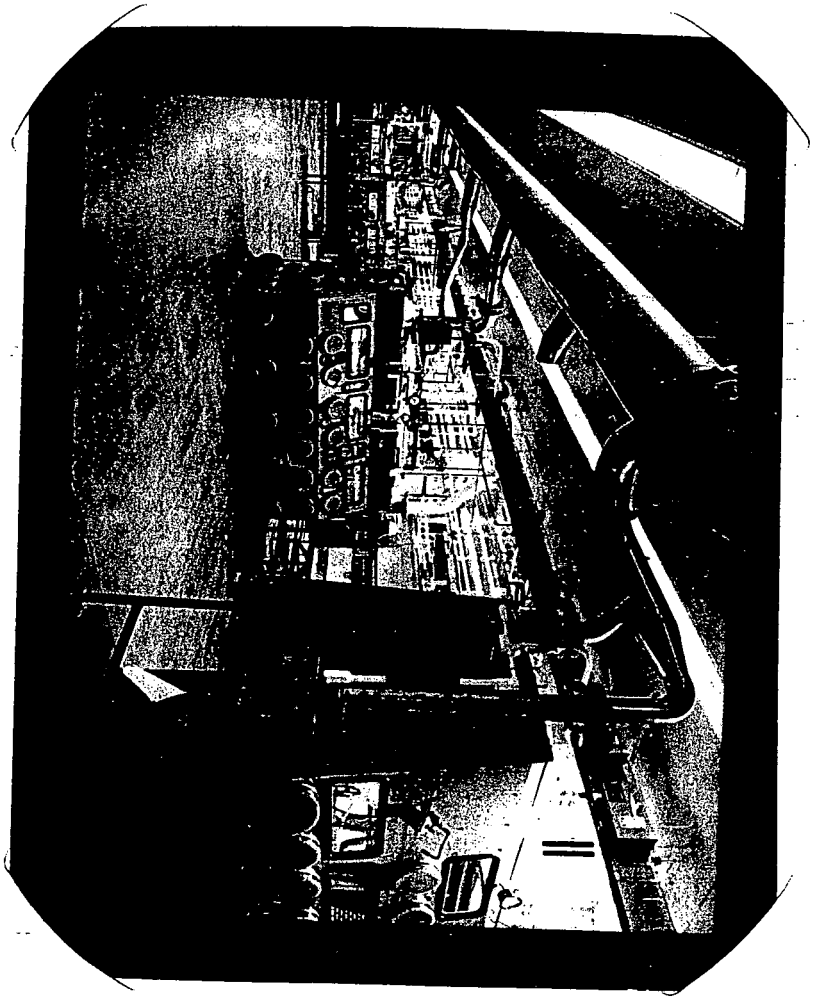

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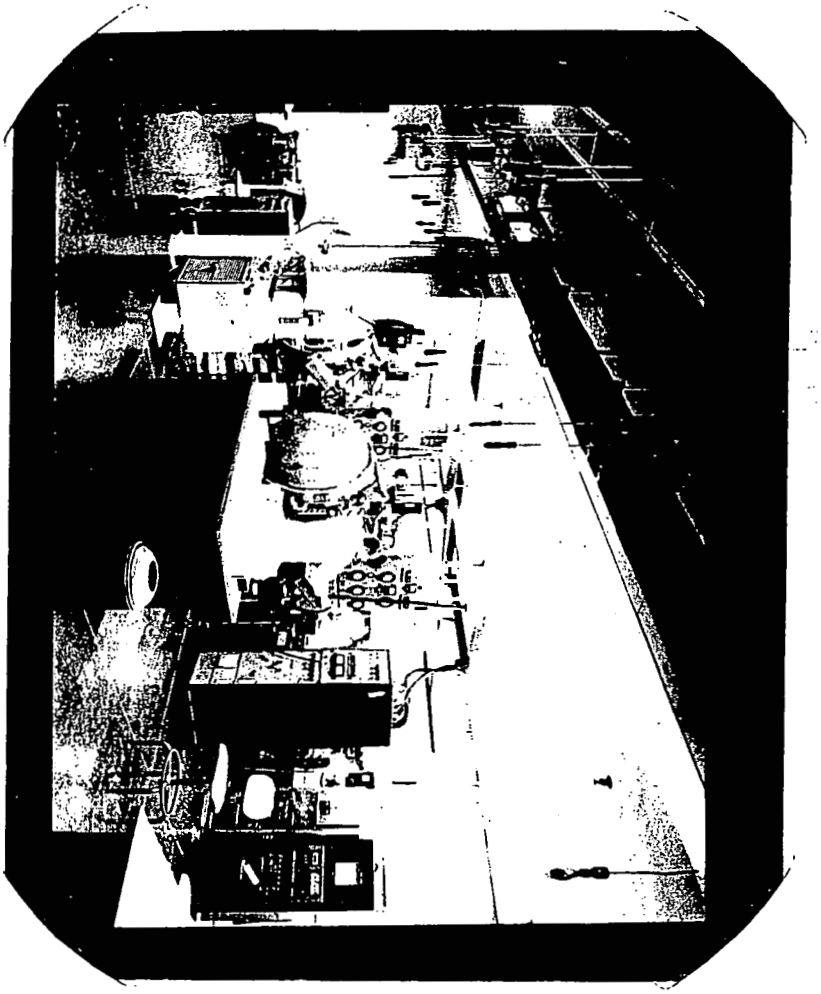

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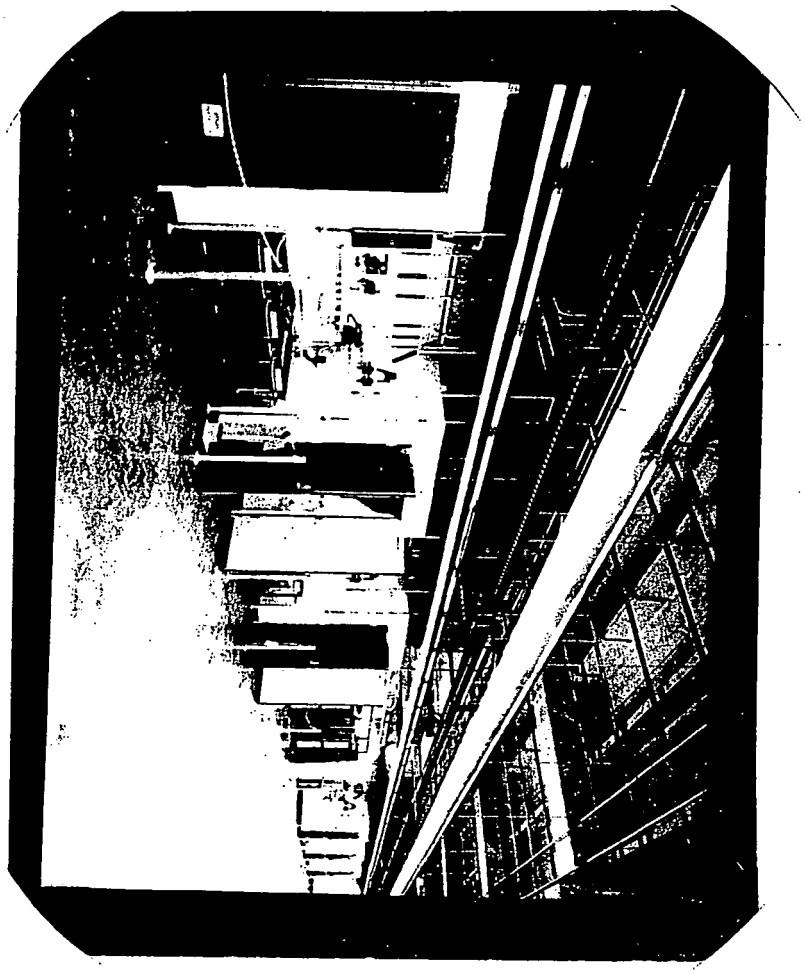

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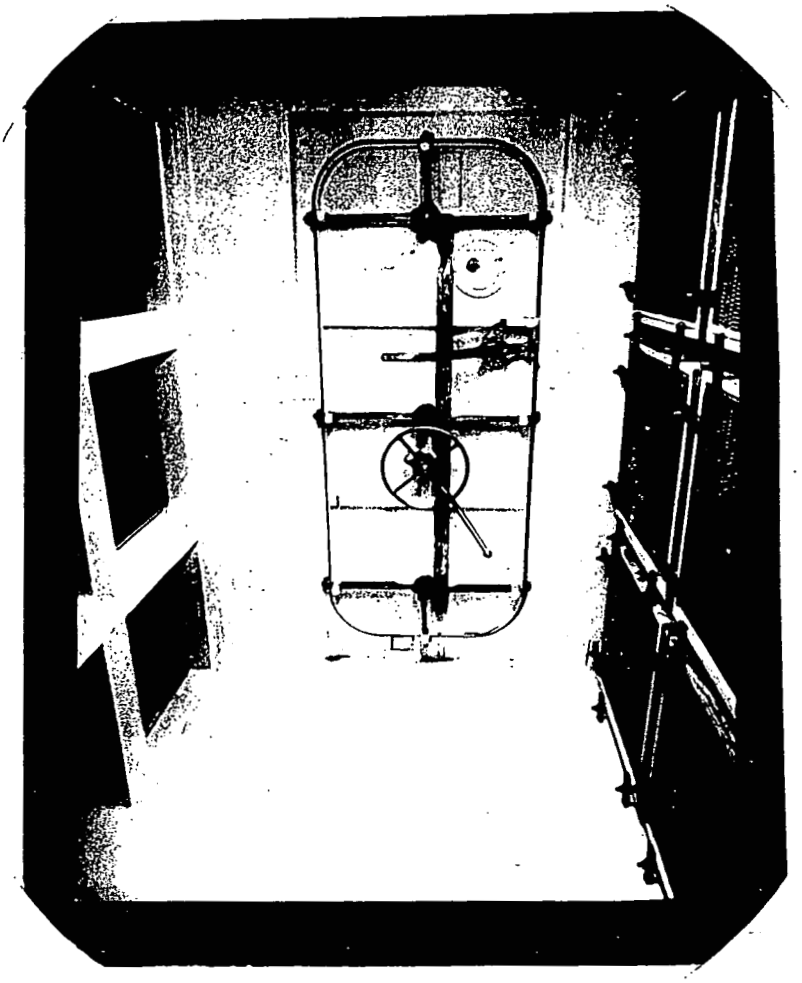

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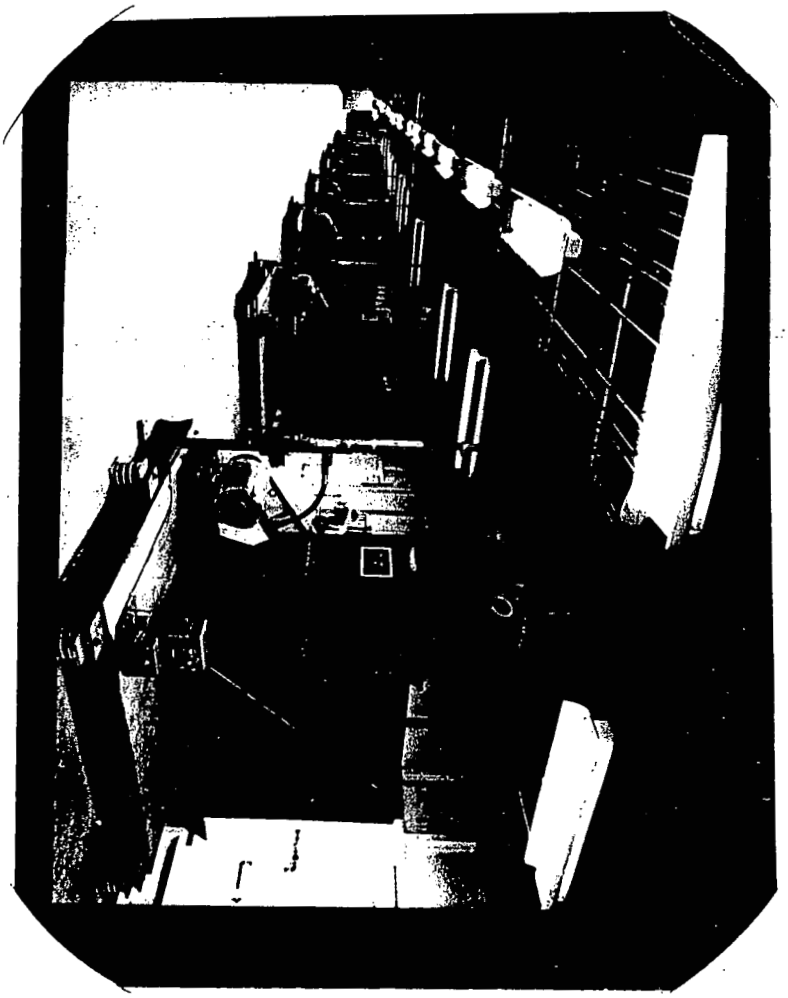

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HAER No. CO-[illegible]-[illegible]-80

ROCKY FLATS PLANT, PLUTONIUM RECOVERY
AND FABRICATION FACILITY
(Rocky Flats Plant, Building 771)
(Rocky Flats Plant, Plant C)
Located in the north-central section of the Plant
Golden Vicinity
Jefferson County
Colorado

HAER No. CO-83-N

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Rocky Mountain System Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

ROCKY FLATS PLANT,
PLUTONIUM RECOVERY
AND FABRICATION FACILITY
(Rocky Flats Plant, Building 771)
(Rocky Flats Plant, Plant C)

HAER No. CO-83-N

Location: Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County, Colorado. Building 771 is located in the north-central section of the Rocky Flats Plant (Plant).

Date of Construction: 1951.

Fabricator: Austin Company, Cleveland, Ohio.

Present Owner: United States Department of Energy (USDOE).

Present Use: Plutonium Recovery Processing.

Significance: This building was a primary contributor to the National Register eligible Rocky Flats Plant historic district associated with the United States (U.S.) strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack. Building 771 was one of the first four major buildings at the Plant. For the first few years of the Plant, Building 771 was the primary facility for plutonium operations.

Historians: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M), 1997. Judith Berryman, Ph.D., Archaeologist, e^2M, 1997.

Project Information:

In 1995, an inventory and evaluation of facilities was conducted at the Plant for their potential eligibility for listing in the National Register of Historic Places. The primary goal of this investigation was to determine the significance of the Cold War era facilities at the Plant in order to assess potential effects of the long-term goals and objectives of the USDOE. These goals and objectives include waste cleanup and demolition. Recommendations regarding National Register of Historic Places eligibility were developed to allow USDOE to submit a formal determination of significance to the Colorado State Historic Preservation Officer for review and concurrence, and to provide for management of historic properties at the Plant.

From this determination and negotiations with the Colorado State Historic Preservation Officer, the Advisory Council, and the National Park Service, a Historic American Engineering Record project began in 1997 to document the Plant's resources prior to their demolition. The Plant was officially listed in the National Register of Historic Places in 1997. The archives for the Historic American Engineering Record project are located in the Library of Congress in Washington, D.C.

Introduction:

The Plant is one of thirteen USDOE facilities that constitute the Nuclear Weapons Complex, which designed, manufactured, tested, and maintained weapons for the U.S. arsenal. The Plant was established in 1951 to manufacture triggers for use in nuclear weapons and to purify plutonium recovered from retired weapons. The trigger consisted of a first-stage fission bomb that set off a second-stage fusion reaction in a hydrogen bomb. Parts were formed from plutonium, uranium, beryllium, stainless steel, and other materials.

A tense political atmosphere both at home and abroad during the Cold War years drove U.S. weapons research and development. By the 1970s, both the U.S. and the Soviet Union maintained thousands of nuclear weapons aimed at each other. These weapons were based on submarines, aircraft, and intercontinental ballistic missiles. Both the North Atlantic Treaty Organization and Warsaw Pact countries in Europe had small nuclear warheads called theater weapons used as part of the Mutually Assured Destruction program. (The Mutually Assured Destruction program acted as a deterrent in that if one side attacked with nuclear weapons, the other would retaliate and both sides would perish.) The final nuclear weapons program at the Plant was the W-88 nuclear warhead for the Trident II missile. This mission ended in 1992 when President Bush canceled production of the Trident II missile.

The Plant was a top-secret weapons production plant, and employees worked with a recently man-made substance, plutonium, about which little was known concerning its chemistry, interactions with other materials, and shelf life. The Historic American Engineering Record documentation effort focuses on four aspects of the Plant and its role in the Nuclear Weapons Complex: manufacturing operations; research and development; health and safety of workers; and security.

Chronology of Building 771

1951	Construction began on Building 771 in November.
1952	Building 771 was occupied.
1953	The first operations began in Building 771 in May.

1957	On September 11, a glove box fire occurred in the building resulting in the transfer of the plutonium foundry, fabrication, and assembly operations to Building 776/777.
1958	A plutonium recovery incinerator, which was designed and built by Plant personnel, began operations. This prototype functioned like an industrial incinerator and contained a series of filters, scrubbers and heat exchangers designed to purify toxic gases and other byproducts of the burning process. This incinerator was the only one of its kind in the country and perhaps in the world.
1959	The solvent extraction process for plutonium recovery was replaced with the anion exchange process.
1963/64	Building 771A was constructed along the eastern portion of the north wall of Building 771 to increase plutonium production. The new space included offices, a cafeteria, and conference rooms. Processes were expanded to include an americium recovery line, dissolution lines, filtrate recovery, and batching, calcination, and fluorination operations.
1967	An office expansion, known as Building 771B, was added to the western portion of the north wall of Building 771.
1970	An addition was completed on the west side of the building for consolidation of all the maintenance, pipe, sheet metal, and painting activities.
1971	Building 771C (or Building 771 Annex), a drum-handling facility joining Building 771 to Building 774, was completed.
1979	Plutonium recovery operations in Building 771 were discontinued. Building 371 plutonium recovery operations began and were expected to fulfill the plutonium recovery needs of the Plant. Cleanup operations began in Building 771.
1980	Operations restarted in Building 771 due to Building 371 material accountability problems.
1989	Plutonium operations in Building 771 shut down in November as part of an overall plutonium operations shutdown ordered by USDOE.

Building History:

Building 771, also known as Plant C, was one of the first four major buildings to be constructed and placed into operation at the Plant. For the first few years of the Plant, Building 771 was the primary facility for plutonium operations. These operations included the production of

plutonium weapons components and recovery of plutonium from recycled materials and residues.

By the mid-1950s, the space within Building 771 was inadequate to support all plutonium operations needed at the Plant. A new weapon design required an increase in the amount of plutonium used, and more complex machining to achieve design specifications. A subsequent increase in recovery operations was expected in response to increased fabrication efforts. A new major production building, Building 776/777, was built in 1957 to support plutonium casting and component fabrication and assembly operations. Much of the original production and fabrication equipment remained in Building 771 to provide supplemental plutonium production capabilities for the Plant. After 1957, Building 771 operations consisted primarily of aqueous plutonium recovery from scrap metal.

Although plutonium recovery operations occurred at other sites within the Nuclear Weapons Complex, the recovery operations in Building 771 were the most cost effective and efficient. The complex plutonium recovery processes relied as much on the operators' first-hand knowledge of the system as well as on their knowledge of the formulae and procedures. When union workers at the Plant went on strike from July 1 until October 28, 1970, scientists, managers, and previous operational floor workers from around the Plant were transferred to Building 771 to run the recovery processes. Although many of these scientists were considered experts in certain aspects of chemical plutonium recovery, most had only worked in a laboratory setting. These scientists and managers struggled to keep operations running during the strike.

During routine operations in December 1988, a heat plume in the Building 771 incinerator was registered on film by a passing aircraft. Officials with the United States Environmental Protection Agency (USEPA) believed that illegal operations were being conducted. The USEPA used this opportunity to convince authorities to issue a warrant to enter the Plant and investigate the allegation. The investigation raised safety concerns at the Plant and ultimately led to the curtailment of operations at the Plant in 1989.

Building Description:

Building 771 is located in the north-central section of the Plant. The building is constructed mainly of reinforced concrete, with some non-production portions of the building constructed of concrete block and fabricated metal. The original building is a two-story structure built into the side of a hill with most of three sides covered by earth. The fourth side, opening to the north, provides the main entrance to the building.

The original building measures 262' (north to south) x 282' (east to west) on the ground floor; and 202' x 282' on the second floor. The building is 31' tall. There are no outside windows in the main building.

The first floor of Building 771 contains equipment for process and research operations. A central hallway, running north to south, and two transverse hallways divide this main processing floor into four major and two smaller areas. Each of the areas is further divided into rooms. Within the rooms, all of the plutonium processing equipment is contained in glove boxes. The purpose of these enclosures within enclosures was to confine particulate radioactive material and shield operating personnel from radiation.

The northwest part of the ground floor is divided into four areas. The west portion contains the building maintenance area which supports the building's stationary equipment. The north-central portion contains locker rooms and showers. The northwest portion contains radiation monitoring space, decontamination showers, and laboratory space. The northeast portion contains the shift manager's office and other support offices.

The area in the southwest part of the ground floor is divided into two modules or separate work areas. The northern module contains laboratories used to verify the quality of the plutonium recovery processes. The southern module contains research areas where new and improved plutonium recovery processes were developed.

The east area of the ground floor is divided into two modules. The northeast module (Room 114) contains the plutonium and americium processing lines. In the original building, Room 114 originally contained offices and a cafeteria. The southeast module (Room 149) contains plutonium-processing lines.

The south area contains metallurgical research laboratories. The tunnel leading to area 776 of Building 776/777 is located adjacent to this area.

The second floor of Building 771 contains mechanical equipment for the heating, ventilating, and air conditioning and other utility systems, and a chemical preparation room to prepare chemicals that were transferred by gravity to the first floor process areas.

Three reinforced concrete box tunnels emerge from Building 771. A utility tunnel, measuring 3'-6" x 3'-6" x 170', leads to Building 774. An exhaust duct tunnel, measuring 8' x 10' x 104', leads to an exhaust stack. The exhaust tunnel floor is 1' thick, and the walls and roof slab are 10" thick. The exhaust duct has an access manhole adjacent to the exhaust stack. A tunnel, measuring 8' x 10' x 267', runs from Building 771 to the 776 section of Building 776/777 at a six percent grade. The walls and roof are 1' thick, and the floor is 1'-3" thick.

The reinforced concrete exhaust stack at the southeast corner of the building has an inside diameter of 10', the base is 19' underground, and the stack rises 150' aboveground. The stack wall is 6" thick at the top and 11.5" thick at the base. The exhaust stack provides exhaust for the main filter plenum, which receives exhaust from the high-efficiency particulate air filtration system, the heating, ventilating, and air conditioning system, and the incinerator.

The heating, ventilating, and air conditioning system controls volume, temperature, and humidity of the atmosphere within areas of the building, while maintaining confinement of radioactive materials by means of pressure differential control and exhaust air filtration. Air pressure is increasingly negative from the hallways, to the rooms where radioactive materials are being used, to the glove boxes. Pressure differentials are maintained through the control of supply and exhaust air. Airborne plutonium would have to pass upstream against several stages of increasing pressure before it could escape to the environment. Automatic electrical interlocks, whose purpose is to prevent the building from becoming pressurized, are in service constantly.

Within Building 771 there are twelve systems that supply the building's air flow requirement of 210,000 to 250,000 cubic feet per minute under normal operating conditions. Outside air is taken in on the second floor through bird screens and pneumatically operated inlet dampers, and then filtered and washed. Standard air-washing equipment scrubs and cools the air. Airflow is controlled by a set of dampers at each supply fan, and backflow dampers are provided. Air is supplied through ductwork to the respective areas.

Since completion of the original building, six major additions have been constructed. This series of expansions brings the total area of the building to approximately 151,000 square feet. The first addition to Building 771, Building 771A was constructed in 1962. It is a one-story structure, approximately 41' x 110', on the north side of the main building. Offices and the cafeteria were moved into Building 771A when it was completed. This addition is separated from the process areas by a hallway and doors and has a separate ventilation system. Completed in 1966, the 771B office addition is a one-story building, measuring 41' x 81'. It was built on the north side of the main building, west of 771A. The Dock Number 1 addition was added to the northwest side of the main building in 1968. The maintenance shop on the west side of the main building was constructed in 1970, and is 60' x 77'. The waste packaging facility, Building 771C, was built in 1972, and is a one-story addition to the east side of Building 771, extending to the west side of Building 774.

A plenum deluge catch tank shed, built in 1974, was added on the west side of the original building adjacent to the maintenance shop addition. It is a one-story, 24' x 30' shed. Inside the shed is a 4,000-gallon-capacity filter drainage catch tank and support system to collect the water used while fighting a fire inside the filter plenums or the incinerator.

In addition to Building 771, the 771 complex includes five other buildings that house supporting facilities and operations, including hydrofluoric acid storage in Building 714, an emergency generator in Building 715, waste-drum storage in Building 770, fluorine storage in Building 772, and a guard post in Building 773. General plant systems provide Building 771 with electrical, water, steam, sanitary sewer, liquid process waste, natural gas, telephone, fire, and security services.

Building Operations:

Operations in Building 771 included the chemical and physical operations for recovering plutonium and refining plutonium metal, plutonium chemistry and metallurgical research, and a radiochemical analytical laboratory. The storage of plutonium within the building has also been an important feature of the building's activities since operations began.

One of the primary objectives of the plutonium recovery and purification operation was to process waste material to remove plutonium and its byproducts until it could be safely and economically discarded. To provide a quantitative target by which to measure the discardability of wastes, limits were set to define concentrations of radioactive contaminants in materials which would either be discarded or processed for recovery. These economic discard limits identified the concentration of a particular nuclear material present in a waste product below which it was not economically feasible to attempt recovery. Below the economic discard limits the material was disposed of as radioactive waste.

The first shipment of plutonium, in the form of plutonium nitrate, arrived at the Plant in May 1953 from the Hanford Plant in Richland, Washington. Later, plutonium also came from the Hanford Plant in the form of metal buttons. Occasionally, plutonium nitrate feed was received from the Oak Ridge Reservation in Oak Ridge, Tennessee. Around 1959, these shipments dropped off, and the majority of the plutonium feed for recovery and purification operations was recycled material, either from site returns (weapons returned to the plant for upgrade, reprocessing or retirement), the foundry, or the waste products from the recovery operation itself. Some of the plutonium which went through the system at this time came from outside sources in the form of plutonium dioxide. Later, shipments of plutonium were received in the form of metal buttons from the Savannah River site.

The original batch-oriented plutonium recovery process handled scrap material generated by the limited on-site plutonium casting and machining operations. A minimal amount of plutonium from site returns was also processed. This procedure involved heating and agitating a mixture of nitric acid and plutonium residues. It was very labor intensive, and allowed corrosive fumes to be released which caused problems for the glove box handling and filtration systems. Continuously operating automatic control systems were later introduced to increase the recovery capacity of the facility and to decrease radiation exposure to operating personnel.

The plutonium recovery and purification process can be described in terms of slow and fast processes. The slow process received materials with relatively more impurities, and required pre-processing before entering the fast process. The fast process converted plutonium nitrate solution from a liquid into a solid and then to a metal.

Originally, almost all plutonium-bearing materials went through slow recovery operations. Feed material generally consisted of reactor-generated plutonium, site returns, metal chips, and foundry scrap and other high-purity metal residues generated by machining operations. These

materials were eventually introduced into the fast process for conversion to a solid and reduction to metal. After the introduction of the molten salt extraction process in 1968, some of the essentially pure plutonium metal, such as the metal from site returns, went through molten salt extraction to remove americium ingrowth and were then forwarded directly to plutonium foundry operations in Building 777. The need for those materials to go through the chemical recovery process was eliminated. As a result, the slow process began to receive materials such as effluents and waste products from the fast process, rags, paper goods, sweepings, and other wastes.

There were three primary recovery processes in the slow process: cation exchange, dissolution, and anion exchange. Cation exchange feed came from lab wastes and the chloride salt process. The main reason for the cation exchange operation was to remove chlorides that could create severe corrosion problems for the anion exchange equipment.

The dissolution process received its feed, in part, in the form of incinerator ash. The feed may also have been made up of plutonium dioxide from oxidation operations in Building 771 and other buildings. In dissolution, steam coils were immersed in liquid to heat the solution. This slurry flowed through a series of dissolvers to a horizontal-pan vacuum filter. The filter separated the undissolved solids from the solution. Solids were scraped from the filter, dried on a hot plate, and packaged as waste for removal from the glove box. The effluent went to anion exchange.

Prior to 1960, dissolution was followed by solvent extraction then by cation exchange. Around 1960, solvent extraction was eliminated from the recovery process line because the materials going through the recovery process were becoming more varied. The process was replaced by anion exchange which was better able to handle the variety of feed material.

Anion exchange primarily received effluents from the fast process precipitation operation, with the dissolution and cation exchange operations contributing to a lesser degree. The anion exchange process purified and concentrated plutonium-bearing nitric acid solutions to make them acceptable as feed for conversion to metal. The plutonium nitrate solutions were pumped through glass columns containing anion exchange resin. The solution was then concentrated in a steam-heated, natural-convection evaporator. The concentrated solution, called "bottoms," was transferred to tanks.

The fast plutonium recovery process involved an aqueous dissolution process followed by precipitation, calcination, hydrofluorination, and reduction steps, to return the solute back into metallic form. Nitric acid was the primary chemical used in the dissolution steps, although the operation also involved aluminum nitrate, calcium fluoride, and water.

After dissolution in the fast process, the nitrate mixture underwent a peroxide precipitation step, which converted the plutonium in solution to a solid form and achieved some purification of the plutonium from metallic elements, notably americium. Relatively pure plutonium nitrate

solutions received from oxide dissolution, anion exchange, and feed evaporation were blended and adjusted to the proper pH and plutonium concentration before entering the peroxide precipitation process. The feed solution was pumped into a refrigerated, stirred reactor called a digestor. Hydrogen peroxide solution was also fed into the digestor. Plutonium peroxide precipitation occurred in the digestor and crystals were allowed to grow as the plutonium peroxide slurry cascaded through the digestors and into a rotary drum filter basin. Vacuum applied to the filter caused the plutonium peroxide to collect on the filter surface. The plutonium peroxide cake that collected on the rotary drum was removed from the filter wheel, collected in containers, and transferred to the calciner. Liquid wastes generated by the fast process were either transferred to the slow process or sent to Building 774 for treatment.

The plutonium peroxide was heated (calcined) to convert it to plutonium oxide. The calcination process drove out residual water and nitric acid, leaving a dry, powdered product. The dried cake was collected, screened, and weighed in batches. Every third batch was sampled and analyzed for impurities for process control. Batches were stored in approved containers in racks in a glove box while awaiting hydrofluorination.

Hydrofluorination converted plutonium oxide to plutonium tetrafluoride by mixing with hydrogen fluoride gas in a continuous rotary-tube. This tube was installed in 1963 to increase control and consistency in this step of the process. The plutonium tetrafluoride product was collected, weighed, and transferred in batches to the reduction process. The hydrofluorination process produced high neutron radiation, which emanated from plutonium tetrafluoride.

Reduction of the plutonium tetrafluoride to plutonium metal was achieved by interaction with calcium metal in an induction-heated reduction vessel. The reduction vessel was evacuated and purged with argon to provide an inert atmosphere. The reduction vessel was heated by induction until the reduction reaction took place. The plutonium metal button was separated from the crucible, sand, and calcium fluoride slag. It was cleaned, sampled, and packaged for storage, where it was held until the analysis was complete, and then sent to the foundry for weapons component fabrication.

Incineration

In 1956, an incinerator was added to Building 771 to handle the large quantities of contaminated combustible wastes generated at the Plant. These wastes were contaminated with small amounts of plutonium and americium.

The incinerator was comprised of three chambers: a firebox where combustibles were initially introduced to the system; a main burner chamber where ashes that fell through the firebox grate continued to burn; and an afterburner section. Wastes such as paper, plastic, rags, rubber, and some sludges that had plutonium concentrations lower than the economic discard limits were added into the main burner chamber and burned. The ash dropped through the grate into a catch pan. The ash was removed, cooled, and transferred to an adjacent glovebox for crushing in preparation for dissolution. The incinerator was originally fired by natural gas. After a few

explosions caused by the afterburner, wastes were used to fire the incinerator. Products of this process were an ash that contained plutonium concentrations ranging from five to ten percent by weight, and a combustion product off-gas.

Off-gases from the incinerator were passed through two heat exchangers for cooling. The gases then entered a spray chamber and were sprayed with a caustic solution to neutralize the gases and knock out the fly ash. The gases passed through a series of high-efficiency particulate air filters, into an exhaust tunnel and out through the exhaust stack.

During June and December of each year, Building 771 was shut down and inventoried. During the inventory shutdown in December of 1988, glove boxes were being steam cleaned at high temperature for removal of built-up plutonium. The heat from this operation exited the building through the high-efficiency particulate air filter system and exhaust stack. A passing aircraft registered the hotspot on film. Officials with the USEPA believed that the incinerator was illegally being used during a shutdown. The USEPA used this opportunity to convince authorities to issue a warrant to enter the Plant and investigate the allegation. The investigation raised safety concerns at the Plant and ultimately led to the curtailment of operations at the Plant in 1989.

Shipping and Receiving
Shipping, receiving, and measurement of the amount of radioactivity (counting) of containerized materials entering or exiting Building 771 were performed in Building 771C. Building 771C was separated from the remainder of Building 771 by an airlock. Typical operations in Building 771C included temporary storage of materials in containers and counting of individual containers prior to transfer into or out of Building 771. Containers remained closed while in temporary storage. Counting was a non-destructive activity that occurred while the container was closed.

Other Operations
Seven categories of waste solutions were shipped to Waste Treatment in Building 774 from Plutonium Recovery in Building 771. They were anion column effluent; distillate; steam condensate and cooling water; basic, acid chloride, and analytical laboratory waste; and oxalate filtrate. All of these solutions were collected in tanks in Building 771 where they were mixed, sampled, and analyzed for their plutonium, uranium, and americium content. If the plutonium concentration was below the economic discard limits, the contents of the tank were transferred to the waste treatment facility. If the concentration was above the limit, the tank contents were reprocessed.

Americium extraction, purification, and recovery began in 1957. From 1957 to 1967, the feed for the process was the filtrate from the peroxide precipitation step on the plutonium recovery line. In 1967, the feed for americium recovery became the salts from the molten salt extraction process. The original recovery process evaporated the plutonium peroxide precipitation effluent and separated the americium that remained in solution by anion exchange. When molten salt extraction salts became the feed source, the recovery process changed to include dissolution,

hydroxide precipitation, and anion exchange. In 1973, the hydroxide precipitation step was replaced with a cation exchange procedure that reduced exposure of personnel to penetrating radiation. Other measures to reduce the exposure of personnel included shielding the processing equipment with lead. Personnel wore lead aprons and gloves, and personnel minimized their time in close proximity to the recovery operation. Starting in 1976, molten salt extraction salts went to a salt scrub process instead of to americium recovery. By 1979, the demand for americium was so low that it was no longer economically feasible to recover and purify it. Americium recovery and purification operations were shut down in 1980, and americium work was limited to that required to extract americium from the plutonium metal in site returns.

Research and development groups in Building 771 supported and developed methods for recovering, separating, and purifying actinides from acidic waste streams. Research and development for actinide element separation and purification was performed using laboratory-scale, pilot-scale, and production-scale equipment. This same research was done for other USDOE facilities, design agencies, and governmental departments.

The plutonium metallurgy group assisted the design agency and Plant production in the development of processes that required metallurgical production of materials and related manufacturing techniques. Supporting operations included metallography, x-ray diffraction, tensile testing, dilatometry, and density measurements. Plutonium metallurgy operations consisted of casting, heat-treating, rolling, forming, forging, sizing, and swaging. Facilities for tensile testing and powder metallurgy were also located in Building 771.

The Building 771 Analytical Laboratory received or prepared samples of process line liquids and solids. These samples were analyzed for plutonium, americium, uranium, neptunium, and other radioactive isotopes. Special recovery operations processed scrap metal and oxide residues containing elements and isotopes that would contaminate or dilute the War Reserve plutonium stream.

Operations Since 1989

Following the raid 1989, production at the Plant was curtailed. In 1992, the mission of the Plant was officially changed from weapons components production to environmental restoration and waste management. The mission of Building 771 was changed at that time to plutonium stabilization operations. The building was scheduled for demolition as a part of site cleanup activities.

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Weaver, Jack, employed at the Plant since September of 1961 by the site contractor, personal communication, August 1997.

HISTORIC AMERICAN ENGINEERING RECORD

INDEX TO PHOTOGRAPHS

ROCKY FLATS PLANT, PLUTONIUM RECOVERY
AND FABRICATION FACILITY — HAER No. CO-83-N
(Rocky Flats Plant, Building 771)
(Rocky Flats Plant, Plant C)
Located in the north-central section of the Plant.
Golden Vicinity
Jefferson County
Colorado

Photographs CO-83-N-1 through CO-83-N-18 were taken by various site photography contractors, dates are indicated in parentheses.

CO-83-N-1 VIEW LOOKING SOUTH AT BUILDING 771 UNDER CONSTRUCTION. BUILDING 771 WAS ONE OF THE FIRST FOUR MAJOR BUILDINGS AT THE ROCKY FLATS PLANT. BUILDING 771 WAS ORIGINALLY THE PRIMARY FACILITY FOR PLUTONIUM OPERATIONS. (5/29/52)

CO-83-N-2 VIEW OF THE GLOVE BOX WHERE, ON SEPTEMBER 11, 1957, A FIRE STARTED. THE FIRE SPREAD TO THE REST OF THE BUILDING, RESULTING IN THE TRANSFER OF PLUTONIUM FOUNDRY, FABRICATION, AND ASSEMBLY OPERATIONS TO BUILDING 776/777. (9/16/57)

CO-83-N-3 VIEW OF GLOVE BOXES DAMAGED IN THE 1957 FIRE. (9/16/57)

CO-83-N-4 VIEW OF THE FILTER PLENUMS DAMAGED IN A FIRE IN BUILDING 771. (9/16/57)

CO-83-N-5 VIEW OF PRODUCTION AREA IN BUILDING 771. (6/20/60)

CO-83-N-6 VIEW OF CHEMICAL HOLDING TANKS IN PRODUCTION AREA. (6/20/60)

CO-83-N-7 VIEW OF ANION EXCHANGE EQUIPMENT DURING INSTALLATION. (10/18/61)

CO-83-N-8 VIEW OF GLOVE BOXES USED IN THE ANION EXCHANGE PROCESS. THE ANION EXCHANGE PROCESS PURIFIED AND CONCENTRATED PLUTONIUM-BEARING NITRIC ACID SOLUTIONS TO MAKE THEM ACCEPTABLE AS FEED FOR CONVERSION TO METAL. (6/20/60)

CO-83-N-9 VIEW, LOOKING WEST, OF GLOVE BOXES ASSOCIATED WITH THE ANION EXCHANGE PROCESS IN ROOM 149. THE GLOVE BOXES ON THE LEFT CONTAIN MIXER STIRRERS THAT AID IN THE DISSOLUTION PROCESS THAT OCCURRED PRIOR TO ANION EXCHANGE. (6/20/60)

CO-83-N-10 VIEW OF CALCINER IN ROOM 146-148. THE CALCINER HEATED PLUTONIUM PEROXIDE TO CONVERT IT TO PLUTONIUM OXIDE. THE PROCESS REMOVED RESIDUAL WATER AND NITRIC ACID LEAVING A DRY, POWDERED PRODUCT. (4/29/65)

CO-83-N-11 SIDE VIEW OF INSTALLATION OF A CONTINUOUS ROTARY-TUBE HYDROFLUORINATOR LOCATED IN ROOM 146. THE HYDROFLUORINATOR IS BEING INSTALLED INSIDE A GLOVE BOX. HYDROFLUORINATION CONVERTED PLUTONIUM OXIDE TO PLUTONIUM TETRAFLUORIDE. (1/11/62)

CO-83-N-12 END VIEW OF INSTALLATION OF THE HYDROFLUORINATOR EQUIPMENT IN ROOM 146. THIS HYDROFLUORINATOR WAS INSTALLED IN 1963 TO INCREASE CONTROL AND CONSISTENCY IN THIS STEP OF THE PROCESS. (1/11/62)

CO-83-N-13 VIEW OF THE HYDROFLUORINATOR AFTER INSTALLATION. SUPPLEMENTAL SHIELDING, WHICH MOVES ALONG TRACKS IN THE FLOOR AND CEILING PROTECT WORKERS FROM NEUTRON RADIATION EMISSIONS ASSOCIATED WITH THE PROCESS. (4/29/65)

CO-83-N-14 VIEW OF THE ANION EXCHANGE CONTROL PANEL. (2/16/66)

CO-83-N-15 VIEW OF LABORATORY EQUIPMENT IN THE BUILDING 771 ANALYTICAL LABORATORY. THE LAB ANALYZED SAMPLES FOR PLUTONIUM, AMERICIUM, URANIUM, NEPTUNIUM, AND OTHER RADIOACTIVE ISOTOPES. (9/25/62)

CO-83-N-16 VIEW OF A BALANCE IN ROOM 188. (3/64)

CO-83-N-17 VIEW OF STEAM CONDENSATE COLLECTION TANKS. THE GLOVE BOX IN THE BACKGROUND IS AT THE END OF THE AMERICIUM RECOVERY LINE. (5/27/71)

CO-83-N-18 VIEW OF THE CEILING. THE PIPING TRANSPORTED CHEMICALS FROM A CHEMICAL PREPARATION ROOM ON THE SECOND FLOOR TO THE FIRST FLOOR PROCESS AREAS. (6/12/73)

CO-83-N-19 VIEW OF PROCESSING ROOM. AFTER 1957, BUILDING 771 OPERATIONS CONSISTED PRIMARILY OF AQUEOUS PLUTONIUM RECOVERY FROM SCRAP METAL.

CO-83-N-20 VIEW OF THE INCINERATOR. DURING ROUTINE OPERATIONS IN DECEMBER 1988, A HEAT PLUME WAS GENERATED THAT WAS REGISTERED ON FILM BY A PASSING AIRCRAFT. OFFICIALS WITH THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (USEPA) BELIEVED THAT ILLEGAL OPERATIONS WERE BEING CONDUCTED. THE USEPA USED THIS OPPORTUNITY TO CONVINCE AUTHORITIES TO ISSUE A WARRANT TO ENTER THE ROCKY FLATS PLANT AND INVESTIGATE THE ALLEGATION. (NO PICTURE)

HISTORIC AMERICAN ENGINEERING RECORD
SEE INDEX TO PHOTOGRAPHS FOR CAPTION

HAER No. CO-33-NJ-1

HISTORIC AMERICAN ENGINEERING RECORD
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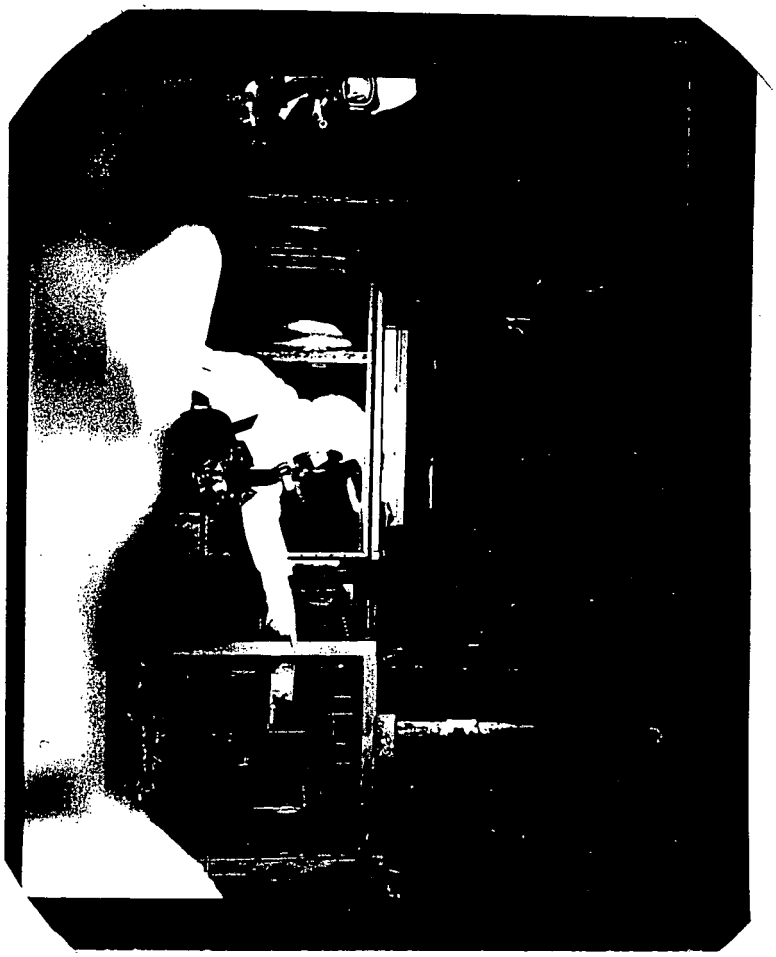
HAER No.



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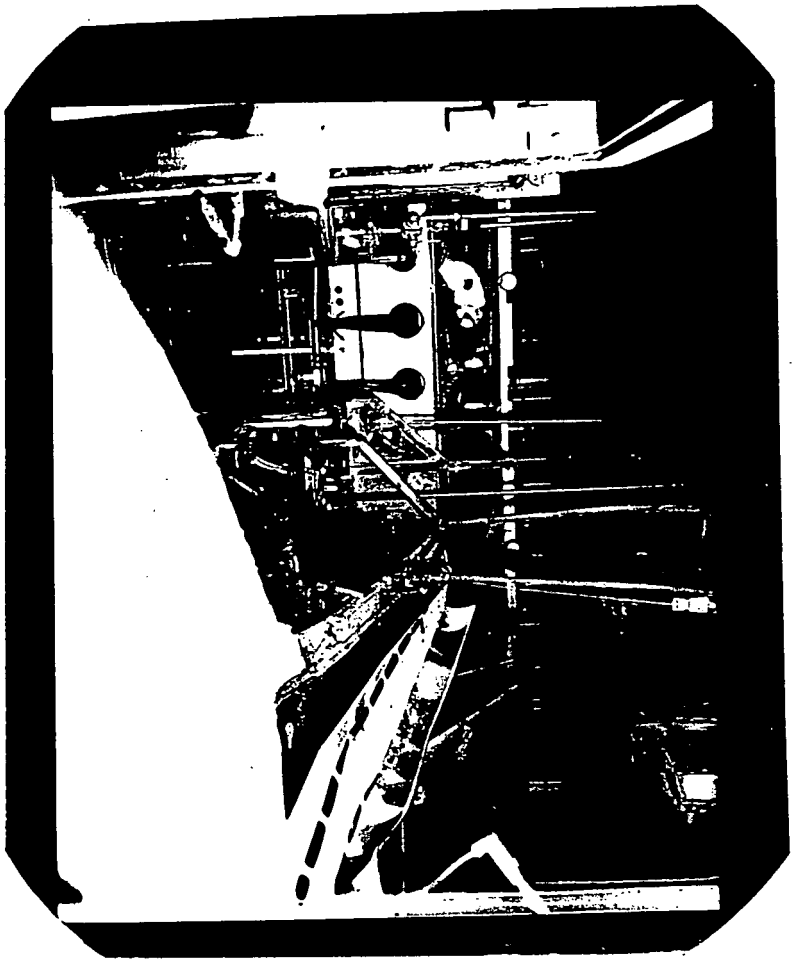

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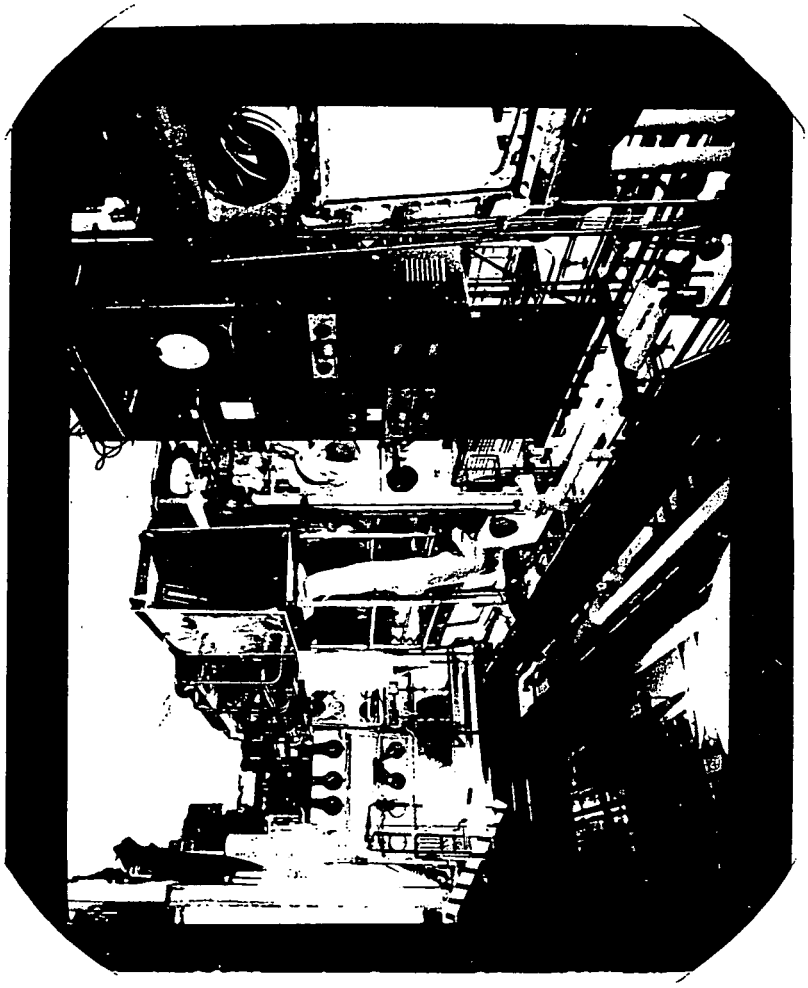

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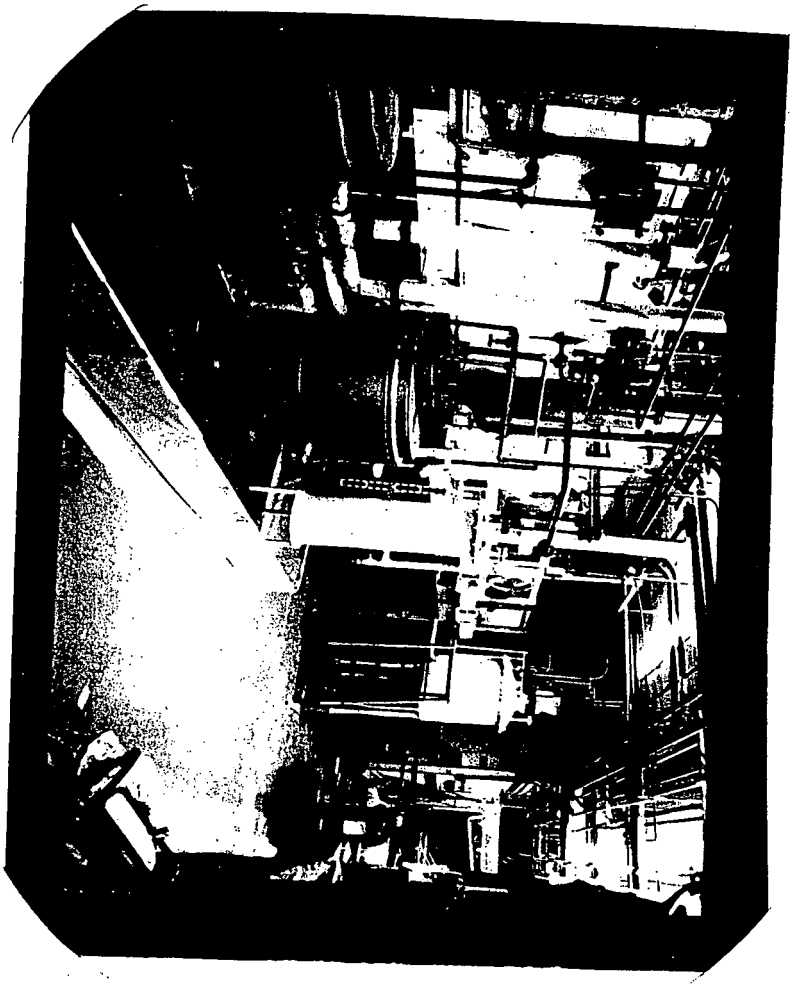

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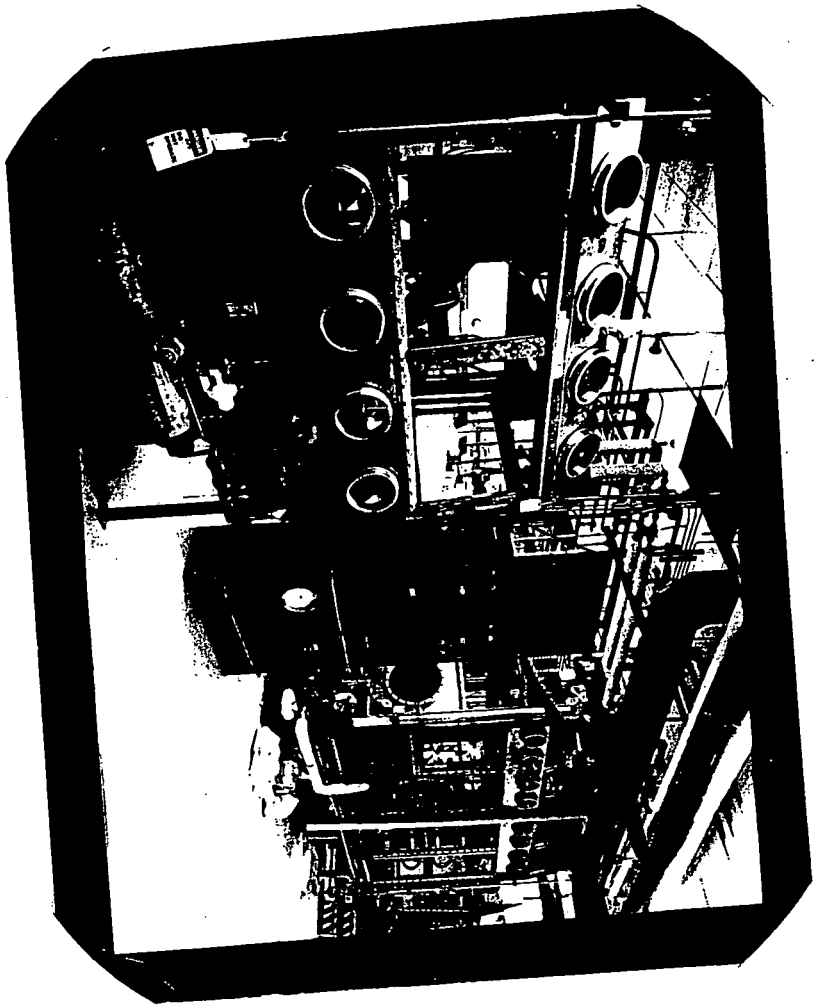

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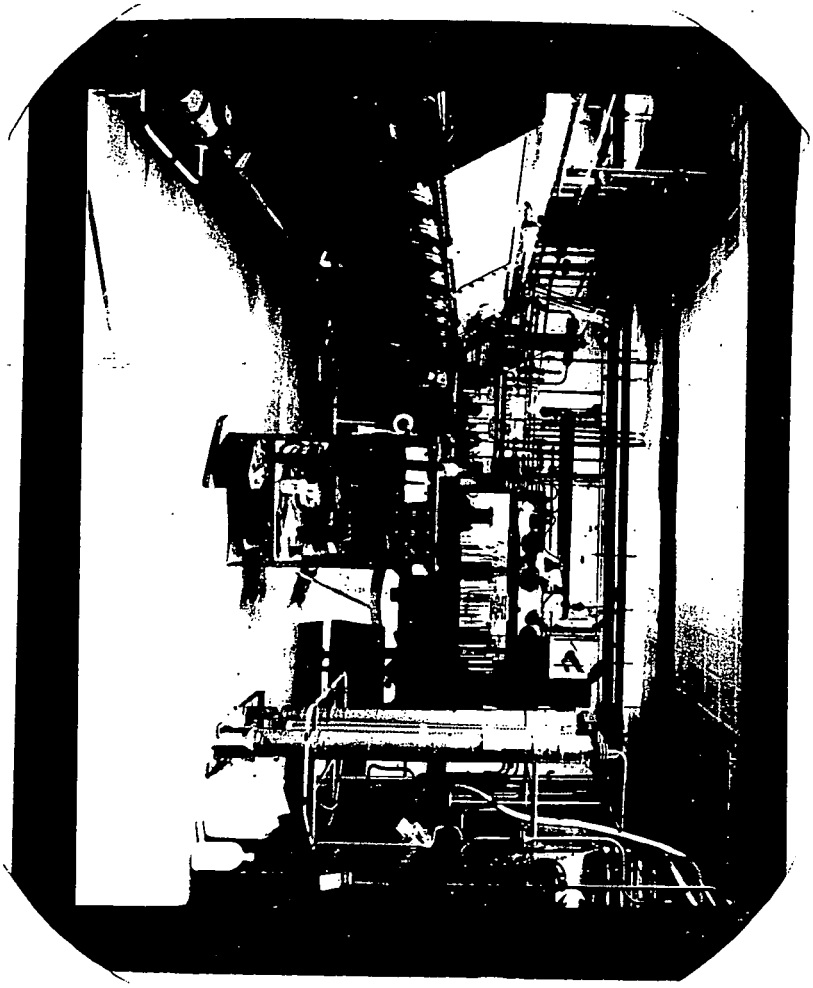

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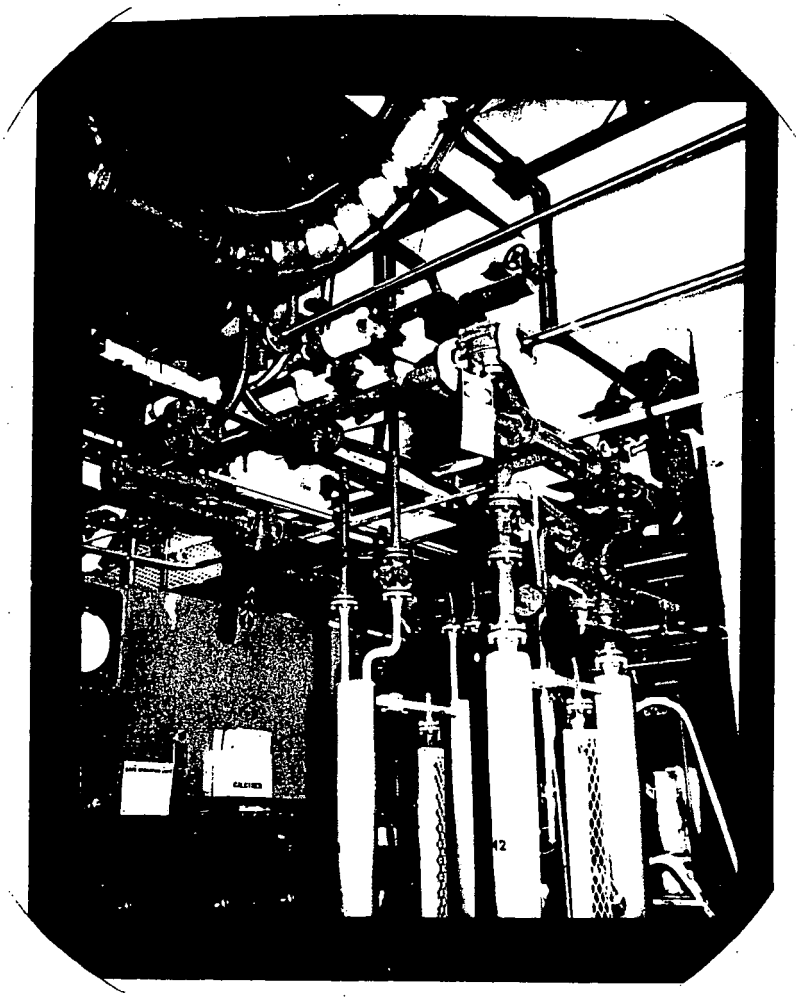

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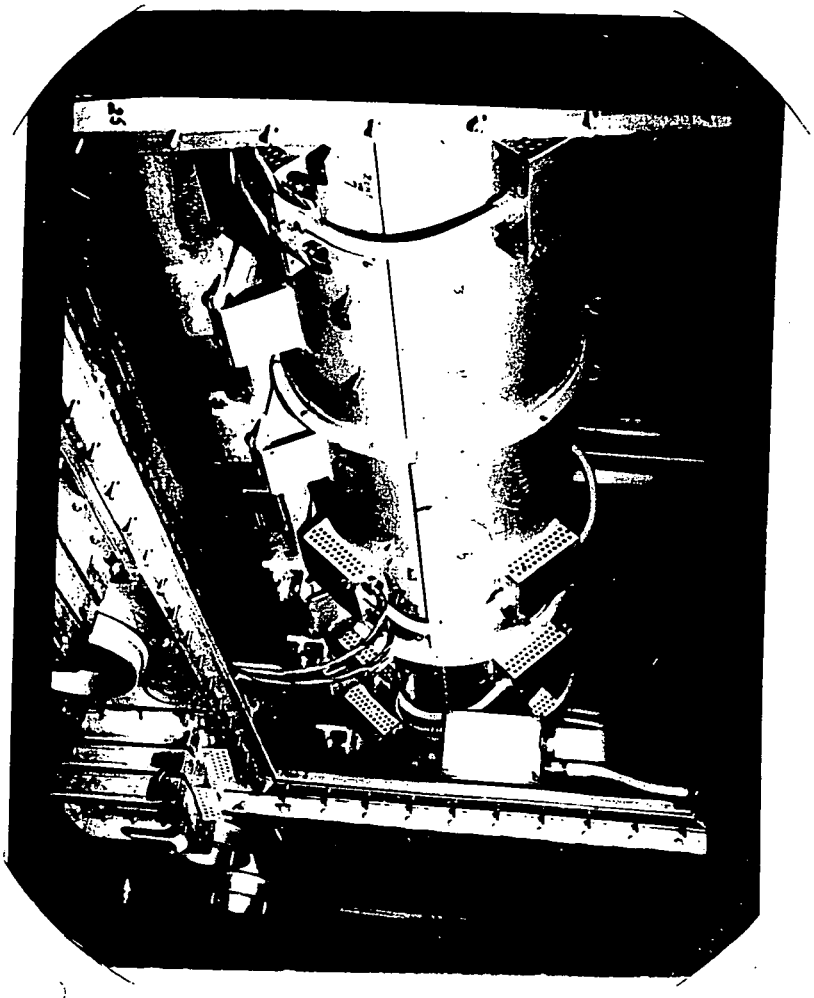

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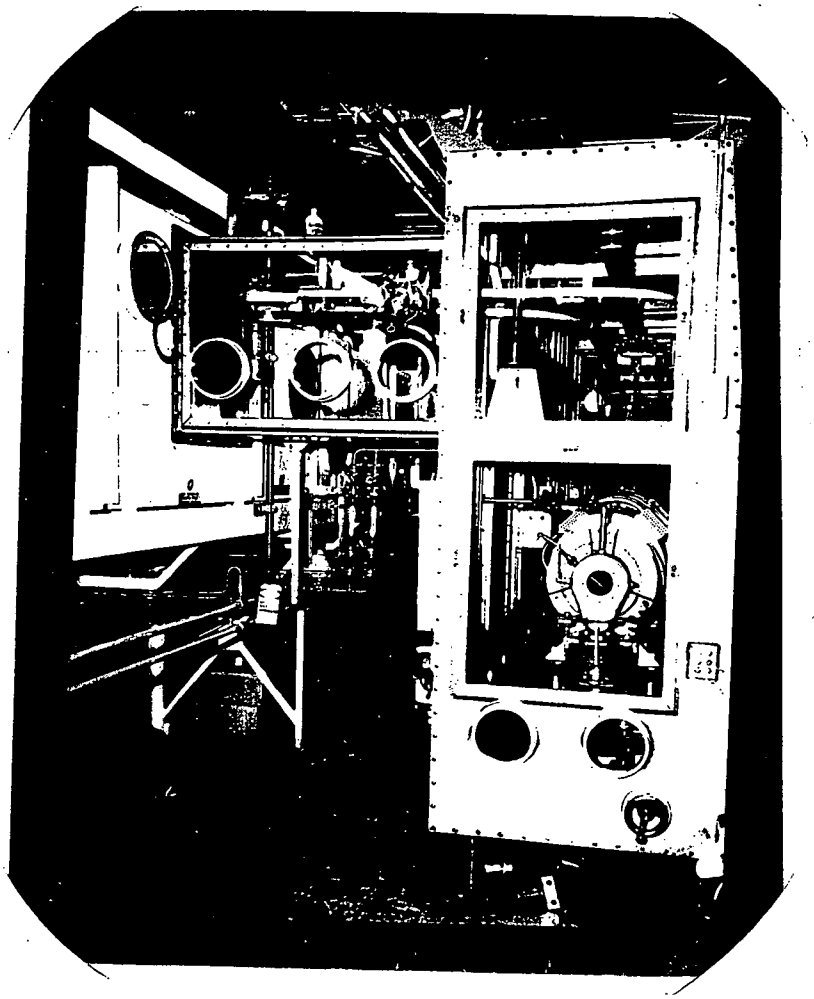

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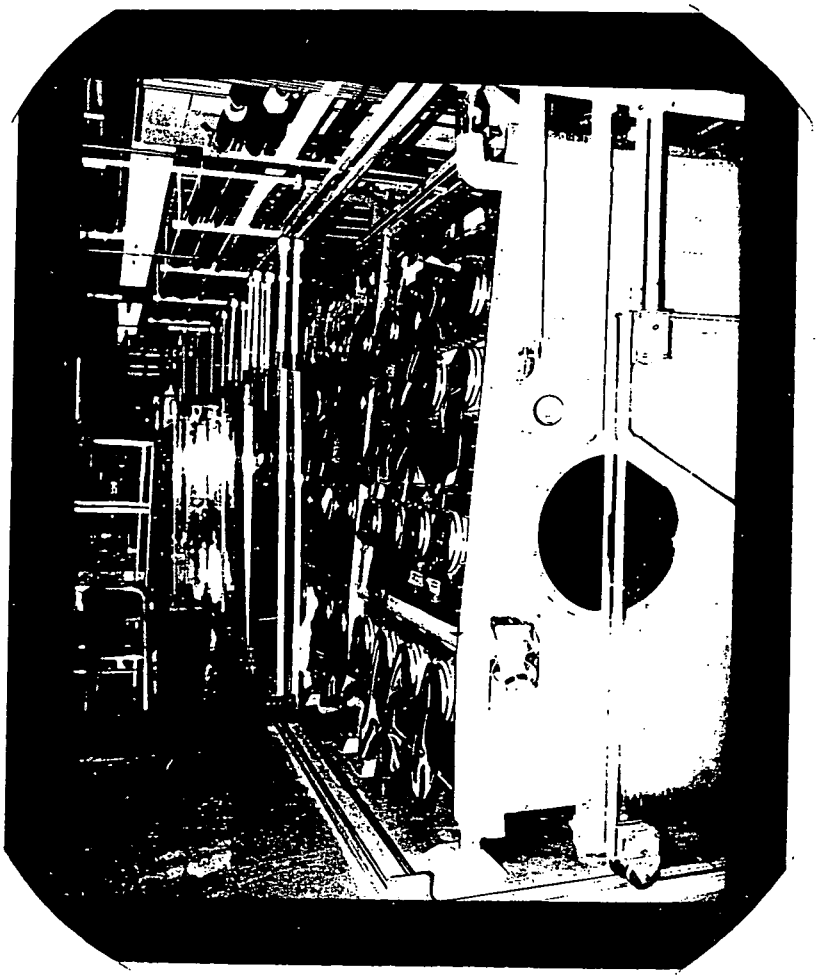

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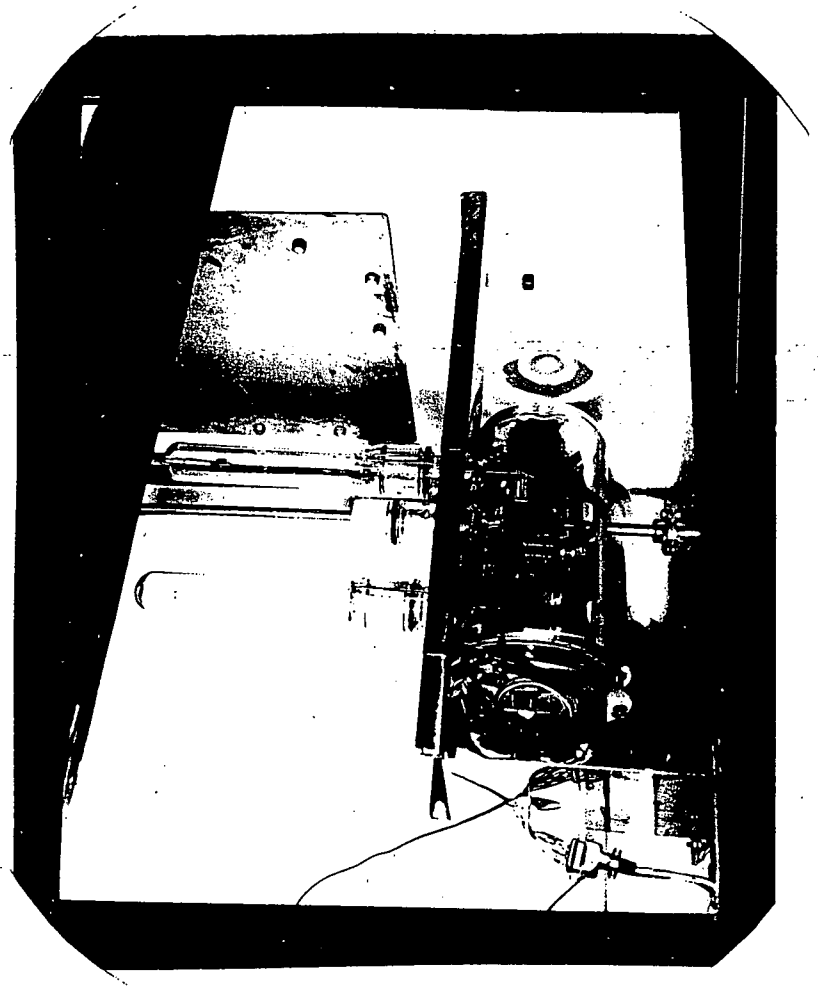

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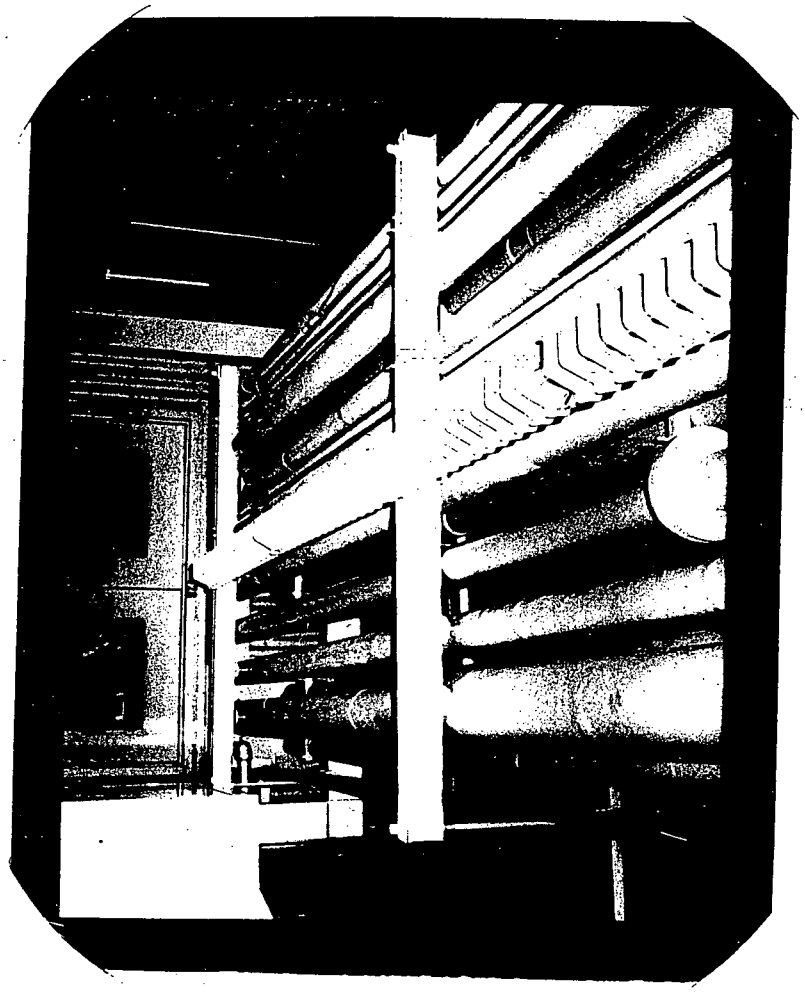

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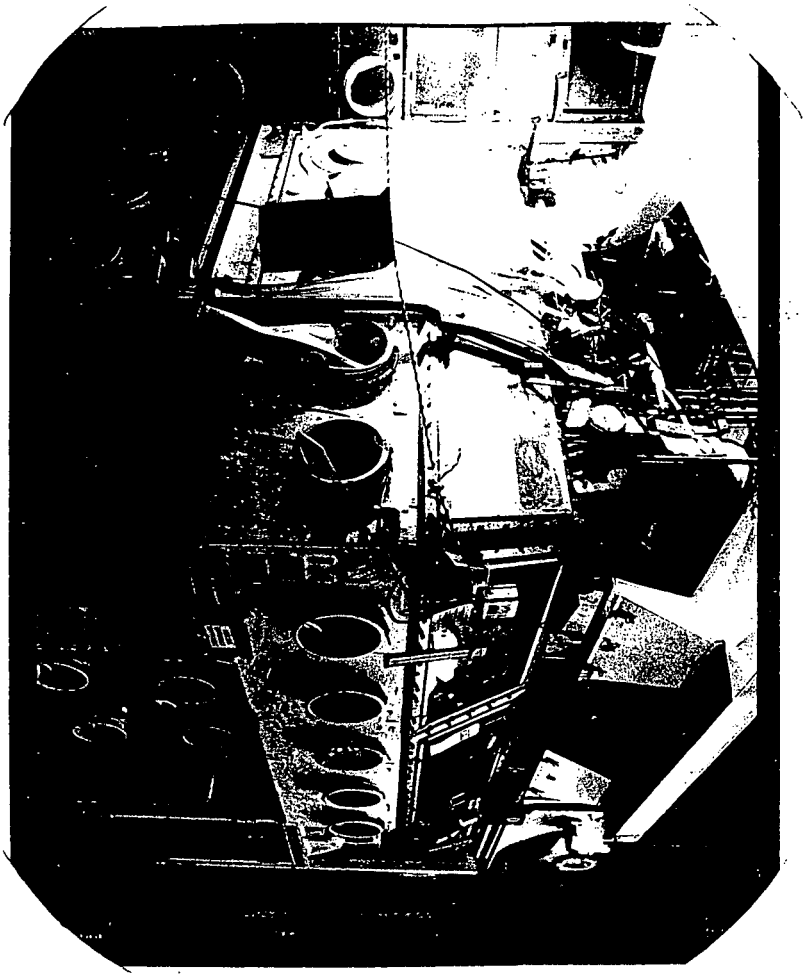

HISTORIC AMERICAN ENGINEERING RECORD
(HAER No. CO-83)

for the

ROCKY FLATS PLANT
HISTORIC DISTRICT

Volume 3 of 4

Completed by:
engineering-environmental Management
e^2M
7000 South Yosemite, #295
Englewood, Colorado

For
Kaiser-Hill Company, L.L.C.
Rocky Flats Environmental Technology Site
Golden, Colorado

March 31, 1998

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ROCKY FLATS PLANT, PLUTONIUM FABRICATION
(Rocky Flats Plant, Building 776/777)
Located in the central section of the Plant.
Golden Vicinity
Jefferson County
Colorado

HAER No. CO-83-O

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Rocky Mountain System Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

ROCKY FLATS PLANT,
PLUTONIUM PROCESSING FACILITY HAER No. CO-83-O
(Rocky Flats Plant, Building 776/777)

Location: Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County, Colorado. Building 776/777 is located in the central section of the Rocky Flats Plant (Plant).

Date of Construction: 1956.

Fabricator: Catalytic Construction Company, Philadelphia, Pennsylvania.

Present Owner: United States Department of Energy (USDOE).

Present Use: Plutonium Weapons Component Production and Recovery.

Significance: This building was a primary contributor to the National Register eligible Rocky Flats Plant historic district associated with the United States (U.S.) strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack. Building 776/777 was the major plutonium fabrication and assembly facility at the Plant from 1957 until 1970.

Historians: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M), 1997. Judith Berryman, Ph.D., Archaeologist, e^2M, 1997.

Project Information:

In 1995, an inventory and evaluation were conducted of facilities at the Plant for their potential eligibility for listing in the National Register of Historic Places. The primary goal of this investigation was to determine the significance of the Cold War era facilities at the Plant in order to assess potential effects of the long-term goals and objectives of the USDOE. These goals and objectives include waste cleanup and demolition. Recommendations regarding National Register of Historic Places eligibility were developed to allow the USDOE to submit a formal determination of significance to the Colorado State Historic Preservation Officer for review and concurrence, and to provide for management of historic properties at the Plant.

From this determination and negotiations with the Colorado State Historic Preservation Officer, the Advisory Council, and the National Park Service, a Historic American Engineering Record project began in 1997 to document the Plant's resources prior to their demolition. The Plant was officially listed on the National Register of Historic Places in 1997.

The archives for the Historic American Engineering Record project are located in the Library of Congress in Washington, D.C.

Introduction:

The Plant is one of thirteen USDOE facilities that constitute the Nuclear Weapons Complex, which designed, manufactured, tested, and maintained weapons for the United States arsenal. The Plant was established in 1951 to manufacture triggers for use in nuclear weapons and to purify plutonium recovered from retired weapons. The trigger consisted of a first-stage fission bomb that set off a second-stage fusion reaction in a hydrogen bomb. Parts were formed from plutonium, uranium, beryllium, stainless steel, and other materials.

A tense political atmosphere both at home and abroad during the Cold War years drove U.S. weapons research and development. By the 1970s, both the U.S. and the Soviet Union maintained thousands of nuclear weapons aimed at each other. These weapons were based on submarines, aircraft, and intercontinental ballistic missiles. Both the North Atlantic Treaty Organization and Warsaw Pact countries in Europe had small nuclear warheads called theater weapons used as part of the Mutually Assured Destruction program. (The Mutually Assured Destruction program acted as a deterrent in that if one side attacked with nuclear weapons, the other would retaliate and both sides would perish.) The final nuclear weapons program at the Plant was the W-88 nuclear warhead for the Trident II missile. This mission ended in 1992 when President Bush canceled production of the Trident II missile.

The Plant was a top-secret weapons production plant, and employees worked with a recently man-made substance, plutonium, about which little was known concerning its chemistry, interactions with other materials, and shelf life. The Historic American Engineering Record documentation effort focuses on four aspects of the Plant and its role in the Nuclear Weapons Complex: manufacturing operations; research and development; health and safety of workers; and security.

Chronology of Building 776/777:

1957 Construction of Building 776/777 was completed. The 776 side contained plutonium components manufacturing, and the 777 side housed assembly and inspection of triggers for nuclear weapons. A wall separated the two sides of the building.

1960 The first significant machining of plutonium began.

1962 The concrete block wall between the two sides of Buildings 776/777 was removed to accommodate additional equipment.

1964 The Campbell Incident occurred involving an explosion between plutonium and carbon tetrachloride in Building 776/777 in a briquetting operation. This incident resulted in

research and development projects that examined the interaction of plutonium with a variety of solvents.

1965 A fire in the glove box drain line occurred during maintenance on a plugged oil coolant drain line. The fire was attributed to spontaneous combustion of plutonium chips.

1966 The canteen, locker room, and laundry were relocated to another building in order to provide more operating space in Building 776/777.

1969 A major fire occurred in Building 776/777 on May 11 when a plutonium briquette spontaneously ignited. Plutonium fabrication processes were relocated due to radioactive contamination caused by the fire. Many new safety features were developed to control and prevent plutonium fires.

1969 Waste operations began in Building 776/777 for the purpose of disposing of materials contaminated by the 1969 fire.

1970 Pyrochemical operations used for plutonium recovery began in Building 776/777.

1971 Clean-up activities for the 1969 fire were completed on October 18.

1972 Plutonium fabrication operations were transferred to Building 707. Building 776/777 was converted to a waste storage and size reduction facility.

1979 The two-story, 3,000-square-foot trash compactor, officially known as a fluidized bed incinerator, made its first 108-hour burn of non-production-generated, low-level, transuranic waste. It brought to a close nine years of research and development spent on the project.

1983 Construction began on the Advanced Size Reduction Facility.

1986 The Advanced Size Reduction Facility became operational.

1988 A new hot laundry facility began operations to launder radionuclide-contaminated clothing separately from non-contaminated Plant laundry.

Building History:

In 1957, a new trigger design resulted in an increase in the amount of plutonium, relative to uranium, that needed to be processed at the Plant. In addition, different shapes of plutonium with closer dimensional tolerances were required. Thus, more rolling, forming, and machining of plutonium was required than in the earlier years of weapons production. As a result of these

design changes and corresponding increases in workload, the Building 776/777 complex was constructed for plutonium casting, fabrication, and assembly, and for quality assurance testing.

Beginning in 1958 and continuing through 1969, Building 776/777 was the main manufacturing facility for plutonium weapons components and housed foundry and fabrication operations. Building 776/777 reflected the latest design criteria and engineering technology available when it was constructed. Since the facility was first occupied in 1957, ten major modification additions were made to update the building and/or to provide increased safety.

On May 11, 1969 at 2:29 p.m., a fire was detected in Building 776/777 when an alarm in a glove box system was triggered. The fire was under control by 5:30 p.m. The fire occurred from the spontaneous ignition of a briquette of scrap plutonium alloy metal contained in a small metal can. The fire resulted in $26.5 million in property loss and the decontamination took two years to complete. The incident resulted in many new safety features including installation of water sprinklers and firewalls to control the spread of fire, and the use of inert atmospheres for plutonium operations to prevent spontaneous ignition.

After the fire, the majority of the foundry and fabrication operations were transferred to Building 707. After several months of clean-up, limited production operations resumed in Building 776/777. The main operations conducted in the building became waste and residue handling, although operations such as disassembly of site returns (nuclear weapons shipped to the Plant from the nuclear weapons stockpile for retirement, upgrade, or reprocessing) and special projects continued in the building as well. Processes conducted in the building included size reduction of contaminated glove boxes and miscellaneous large equipment volumes for waste disposal, pyrochemistry, coating operations, and test runs of a fluidized bed incinerator unit.

Building Description:

Building 776/777 is located in the north-central section of the Plant, south of Building 771 and north of Building 707. It is constructed primarily of structural steel covered with transite. Interior walls are of concrete block or structural steel and transite. Some vault areas are poured, reinforced concrete. The poured concrete radiographic vault is part of the north outside wall of Building 776/777. The original roof is structural steel under flat metal decking, with poured insulating concrete over the decking. The final seal is built-up asphalt. A second roof was added above the original in 1972 to provide a better seal. The new roof is on a tapered structural steel frame and metal decking overlain with insulating concrete and built-up composition roofing. There are no windows in the building.

Building 776/777 is a two-story structure, with a partial basement. The main floor occupies 135,000 square feet. The second floor contains 88,000 square feet, and is almost exclusively occupied by utilities. The basement occupies 1,600 square feet.

Since 1957, ten major modifications and additions have been completed including the Building 777 addition; an x-ray vault; a compressor house; a radiography area; a cleaning and plating facility; fabrication, maintenance, and storage areas; an assembly plant; an autoclave facility; an inert surveillance and assembly development area; and a betatron vault. Total floor area of the complex is 156,200 square feet. The x-ray vault has 4'-thick reinforced concrete walls, and the betatron vault has 7'-6"-thick reinforced concrete walls. Various additions to Building 776/777 have 8"-thick concrete block walls. Other additions to Building 776/777 have galvanized steel wall panels.

Prior to the 1969 fire, the majority of the building space was in one large open room. Since that time, the main floor of the building has been compartmentalized into four areas (Areas 1 – 4), separated by physical barriers to confine radioactive material releases and contain the spread of fire. Each area is further divided into rooms or functional areas, and within the rooms or functional areas, plutonium processing equipment is contained in glove boxes or process storage vaults. The purpose of these enclosures within enclosures was to contain radioactive material and keep exposure to personnel as low as practicable.

Area 1 is located in the north part of the 776 section of Building 776/777. This area houses a controlled maintenance area, compressor room, size reduction facility, demonstration plant for fluidized-bed incineration, and drum storage area.

Area 2 is located in the southwest part of the 776 section of Building 776/777. Located in this area are the advanced size reduction facility, a pilot plant for fluidized-bed incineration, pyrochemical operations, metallurgical operations and fabrication/inspection, the west dock, and offices.

Area 3 is located in the north and east parts of the 777 section of Building 776/777. This area houses a non-destructive testing facility, a coatings operation, production control, special assembly, physical testing, a dock area, and a drum storage area.

Area 4 is located in the southwest part of the 777 section of Building 776/777. This area contains inspection, gas sampling, training, and drum storage areas, a super-dryroom, the women's locker room, and the south dock.

The second floor of Building 776/777 has one main area above the 776 section of the building. Two north-south fire walls, one toward the west end and the second near the center of the second floor, and the primary exhaust high-efficiency particulate air filter plenum, which runs east to west, divide this main area of the second floor into four compartments. This area is dedicated to building utilities and heating, ventilating, and air conditioning equipment. There are two smaller areas over the northwest additions to the 777 section of the building which provide office space and space for filter plenums.

The basement (Room 001) is located beneath the main drum storage area (Room 127) on the first floor. Access is by stairway. This room, shielded with a lead-lined door, contains four bays and is used for waste drum storage.

The major structures of the Building 776/777 complex are Building 776/777 itself, and Building 778, the laundry building. Other structures in the complex include cooling towers (Buildings 712 and 713); Buildings 702 and 703 - the pump houses for Buildings 712 and 713, respectively; and Building 701, which is a research laboratory. A tunnel connects Buildings 771 and 776. Other features of the complex are two underground process waste storage tanks with a total capacity of 54,000 gallons, and one 5,000-gallon diesel fuel underground storage tank. Electrical, water, telephone, inert gas, sanitary sewer, and fire protection utility systems serve the complex. Most of these systems are underground.

Building Operations:

Originally, Building 776/777 was the primary plutonium fabrication facility at the Plant, and operations consisted of plutonium parts casting, fabrication, assembly, inspection and testing; research and development; disassembly of site returns (weapon components returned to the site to be retired, upgraded, or reprocessed); and plutonium waste recovery. After a major plutonium fire in 1969, most of the plutonium casting and fabrication processes were transferred to another building at the Plant. After that time, Building 776/777 was dedicated primarily to plutonium waste recovery, inspection and testing, disassembly of site returns, waste handling, and special projects.

Building operations are discussed under three general time periods. The first time period covers operations in the building from 1957 to 1969, and includes only those operations that were eventually transferred to other locations. The second time period covers operations that remained and those that began after the 1969 fire, and the third identifies processes that remained active after production at the Plant ceased.

Operations from 1957 to 1969
Originally, a concrete wall divided Building 776/777 into two main areas, each with a different function. One area, the 776 section, was used primarily for casting and fabrication of plutonium parts. The other area, 777, was used for assembly of parts and some disassembly of site returns. The concrete wall dividing the building was removed in 1962.

Four principal glove box systems existed in Building 776/777 between 1957 and 1969. These included the north foundry line, the south foundry line, the center line, and the north-south-east machining line. All production operations were carried out in glove boxes which were interconnected by conveyors.

Casting Operations

The original plutonium foundry was located in the southwest corner of Building 776/777. Foundry equipment consisted of two, nearly identical glove box lines (the north foundry line and south foundry line). The foundry contained sixteen furnaces, eight in each glove box line, which were crowded into a single room. Foundry operations cast plutonium either as ingots suitable for rolling and further wrought processing or into shapes amenable to direct machining operations. A briquetting press was also contained in the north and south foundry lines where scrap plutonium metal from foundry and fabrication processes was cleaned and pressed into small briquettes. These briquettes became part of the feed materials for the foundry.

After the 1969 fire, casting operations in Building 776/777 ceased, the furnaces were moved to Building 707, and the resulting space was used for waste recovery related operations.

Fabrication Operations

Fabrication operations involved either the wrought process, which prepared an ingot for machining operations, or direct machining of ingots and cast shapes. In the wrought process ingots were rolled into sheets and cut into circular-shaped blanks to be passed through the center line for pressing. The pressed blanks were then annealed and machined. Machining involved taking the cast or wrought part and removing the excess material by contouring, drilling, and milling. Machining operations took place on the north-south-east line. Equipment was contained in eleven glove boxes, and included a dry lathe, eight oil-cooled lathes, a mill, and a jig borer.

After the 1969 fire, the south portion of the machining line in Building 776/777 resumed operations, supporting primarily special order work and one weapons program.

Assembly

Assembly operations were located in Building 776/777 and involved assembling various nuclear and non-nuclear trigger components. Activities included drilling, welding, brazing, turning, and polishing. The components primarily contained nuclear materials such as plutonium and uranium; however, components containing non-nuclear materials such as beryllium, steel, copper, monel (a metal alloy), and silver were also assembled.

Parts were cleaned prior to final assembly. After 1961, the cleaning process changed from the use of a solvent dip tank to an ultrasonic solvent unit. Final assembly took place in a super-dry room with controlled temperature, humidity, and airflow. Fabricated components were moved to the super-dry room in the downdraft assembly area to be welded. Welded assemblies were then baked, filled and sealed, leak-tested, weighed and non-destructively tested. Completed assemblies were subjected to several inspection and testing processes including radiography, dimensional inspection, and sampling. Similar operations took place for non-nuclear assemblies.

After assembly, complete units were packed and shipped off-site or to Building 991 for final processing, storage, and shipping.

After the 1969 fire, Building 707, not Building 776/777, was the main source for parts to be assembled in Building 776/777.

Operations from 1969 to 1989

Operations after the 1969 fire included testing and inspection, disassembly of site returns, special projects, plutonium recovery, waste management, and laboratory work. Although some of these operations, such as plutonium recovery and testing and inspection, also occurred before the fire, they are discussed here since the operations were expanded after the fire.

Inspection

Testing and inspection of parts was conducted in Building 776/777 at steps throughout the fabrication and assembly processes. Inspection consisted of visual inspection of components and assemblies for cracks, voids, or other imperfections, and measurement of the parts. Density balance operations were used to determine the density of plutonium metal parts. This activity, conducted in an inert atmosphere nitrogen glove box, consisted of immersing the object in a Freon 113 bath and measuring its density relative to Freon. Parts having the specified density were further processed.

Items were also weighed in a glove box on a gram balance. Final weights were compared to design specifications.

Non-destructive Testing

Non-destructive testing was conducted to examine plutonium parts for structural flaws. Radiography was the primary non-destructive testing method. Items to be tested were exposed to a radiation source to create an image of the object on film. The recorded image was evaluated with specifications for acceptance or rejection of the item. Work was completed in vaults having high-density concrete walls varying in thickness from 2 to 8'. Interlocks ensured that the equipment activated only when the vault doors were closed and the keys were removed.

Destructive Testing

Destructive testing was conducted on components at various stages throughout the fabrication process to verify component integrity. These tests included analyses of stress, tensile strength, vibration, and gravity force. There were several test systems used to make these analyses.

Stress analysis was used to pressurize a component or assembly to either preset limits or to destruction. There were several systems used for stress analysis. One hydrostatically operated system generated a pressure of 100,000 pounds per square inch. Although the manufacturer certified the system plumbing to 150,000 pounds per square inch of pressure, the intensifier ratio and the drive pressure limited the system to 100,000 pounds per square inch maximum pressure. In this system the test item was enclosed in a heavy-walled tank to contain shrapnel in the event of failure.

A second stress analysis system was activated by helium gas and produced 30,000 pounds per square inch of pressure. A compressor located outside the building supplied the pressure. The helium gas test system was equipped with four sets of controls connected to a clam shell-type pressure chamber. Special electronic devices monitored these tests. Both of the previously mentioned pressure systems operated from a console separated from the test area by a cement block wall.

A third stress analysis test system used a clam shell-type chamber housed inside a glove box. The chamber was opened and closed hydraulically. Helium gas was used in this system.

The tensile strength of fissile weapons components was tested to evaluate material and weld-joint strength. The tensile strength and quality of non-fissile components such as rubber and plastic materials were also evaluated. There were two 60,000-pound-force tensile testers and one 20,000-pound-force, high-elongation tensile tester. One of the larger machines was enclosed in a glove box to provide capability for testing fissile material specimens.

Vibration analysis was conducted to evaluate component and waste container response to simulated seismic vibration and production-related resonant frequencies. Vibration analysis was conducted on a shaker unit. The shaker unit had a capacity of 17,500 foot-pounds of energy stimulated by a solid-state amplifier.

A gravity-inducing machine evaluated component response to situations of varying gravimetric force.

Disassembly Operations

Processing of site returns in Building 776/777 began in 1958, and continued after the 1969 fire. Processes consisted of disassembly, recovery, and waste disposal. Fissile materials (plutonium, uranium, etc.) and rare materials (beryllium) were recovered for reuse, and the remainder was disposed of. Increased weapons disassembly activities began in the late 1960s as older weapon designs were retired.

The disassembly process consisted of machining away the closure weld and separating and cutting the various weapon components for recovery of materials from a returned weapon. The weld machining operation was conducted in a B-box, (a hood-like enclosure with separate ventilation and fire protection) while wearing a respiratior. Disassembly and separation of the sub-components of a weapon were completed in glove boxes. The disassembly process used two lathes inside glove boxes with an inert argon atmosphere; one for beryllium components, the other for aluminum and stainless steel. A tritium gettering (removal) system was used to entrap tritium gases, water vapor, and hydrocarbon fumes that were released during disassembly. The inert atmosphere in the glove box minimized oxygen and moisture content. Several tritium monitoring and alarm devices checked tritium levels in the glove boxes, room air, and exhaust ducts. Sub-components were further reduced in size in a standard glove box system. Plutonium parts recovered from the disassembly process were inspected for unusual conditions and

segregated according to material type. Enriched uranium parts went to Building 881 for recovery, and depleted uranium and inert components were packaged for disposal at off-site disposal sites.

After segregation, plutonium materials were returned to the Building 776/777 foundry where they were cast into feed ingots. Depending on assay specifications, the feed ingot was sent through a molten salt extraction process for americium removal, or was sent to Building 771 for chemical purification and returned to the foundry as a fresh button.

Recovery Operations

Several recovery operations were conducted in conjunction with fabrication operations in Building 776/777. A briquetting process recovered alloyed scrap from rejected parts, scrap from the center process line, and alloyed turnings into briquettes, which were then recast directly into ingots. The briquetting operations were conducted in glove boxes on the north and south briquetting presses located toward the center of the building.

There were two primary pyrochemical processes for recovery and purification of plutonium: electrorefining and molten salt extraction. Other refining processes included direct oxide reduction and salt scrub processes. Aqueous recovery of plutonium was not conducted in Building 776/777.

In the initial step of the pyrochemical recovery process, plutonium components from site returns were reduced in size using a pneumatic sizer. These re-sized components were then transferred to one of the following purification processes.

Electrorefining, an *in-situ* process developed in the 1960s, purified plutonium that did not meet purity specifications. Six production-scale electric furnaces were installed in Building 776/777 in 1966 to conduct electrorefining. The process was discontinued by the late 1970s due to low yields, but was restarted in the building in 1988. The electrorefining process used in the 1980s purified plutonium metal by placing it in a magnesium crucible with magnesium, sodium, and potassium chloride salts. An electric furnace was used to heat the mixture, and a cathode and anode stirrer were added to generate a reaction which resulted in pure plutonium metal, salts (magnesium, sodium, and potassium) and an anode heel. An anode alloy sub-process was used to produce an alloy that was subject to further recovery operations at the Savannah River site.

The molten salt extraction process removed americium, a decay byproduct, from plutonium metal, increasing the purity of the plutonium. Six furnaces were installed in Building 776/777 in 1972. This process used an electric furnace to heat plutonium metal combined with oxidant and solvent salts. The process produced purified plutonium and contaminated chloride salts. Americium chloride and plutonium chloride salts were removed from the contaminated salt in a process referred to as the salt scrub process. If the plutonium metal was not pure enough, it was subsequently subjected to the electrorefining process.

The salt scrub process used residue salts, such as those generated in the molten salt extraction process, to generate a metal alloy that was sent to the Savannah River site for further recovery. This process concentrated actinide metals into a metal alloy. There were three separate salt scrub processes used in Building 776/777. The first used a magnesium/zinc extractant in a tilt-pour furnace. The second used aluminum and magnesium as the alloying agent and the reductant, respectively. The last used gallium as the alloying agent, and calcium as the reductant.

Research began on the direct oxide reduction process in 1967.. Without using aqueous processing, direct oxide reduction processes produced plutonium metal from plutonium oxide, and eliminated a potentially high-exposure hydrofluorination step used in the Building 771 plutonium recovery process. Pilot-scale operations were conducted from 1981 to 1983 and production-scale operations began in 1983. Plutonium oxide was batch-processed through a high-temperature calciner to remove moisture and drive off volatile compounds, resulting in a button of pure plutonium metal, calcium metal, and calcium chloride salts. If the button did not meet purity standards it was subsequently subjected to the electrorefining process.

Special Projects

After the 1969 fire, production-related activities shifted from full-scale production to research and development and special order work. This included research and development on joining technology and special coatings, and special assembly operations.

Joining Technology

Research and development on joining technology developed and maintained welding systems for product development and special order work. These systems joined non-fissile parts, components, and subassemblies. Over the years, these systems included a pressurized inert-gas metal-arc system, an electron beam system, and two types of laser welders. One of the lasers was used to cut and weld non-nuclear metal parts. The other welded non-production parts using compressed gasses. The electron beam system involved welding in a vacuum chamber in a glove box. In addition to these systems, solid-state bonding equipment was used for low temperature joining operations.

Coatings

There were two operations associated with coating research and development. One was concerned with the development of coatings for ceramic and non-plutonium substrates (sub-layer pieces); the other was concerned with the development of substrates to be coated with plutonium. These two operations were located in sections 776 and 777, respectively, of Building 776/777.

The section 776 operation researched the suitability of many elements and compounds for use as coating agents. Rare earth oxides and nitrates, chromates, manganese, and stainless steel were among those compounds and materials investigated. The operation also investigated optimal substrate preparation.

The section 777 operation developed substrates for plutonium coating, and researched optimal substrate preparation requirements. These operations were conducted in glove boxes with an inert nitrogen gas atmosphere.

Special Assembly

Special assembly operations included machining, inspection, assembly, and analysis of special items for off-site weapons design laboratories and on-site departments. These special items were for research and engineering purposes, pre-production components, or one-of-a-kind assemblies made of a range of metals and other materials. Tooling and fixturing were developed to meet unique requirements.

Waste Handling Operations

Waste handling operations included routine handling, processing, packaging of low-level radioactive waste, size reduction, fluidized-bed incineration, and drum storage.

Size Reduction

In the size-reduction operation, contaminated metals and materials were manually washed, cut up, and compressed to recover plutonium, reduce the size of materials, and minimize total volume of wastes. Discarded glove box gloves were washed to recover most of the plutonium, then placed in drums. Plutonium-contaminated metals were cut to a disposable size, washed to reduce contamination, and placed in drums or waste boxes for shipment to approved off-site locations. Shipping containers from the size-reduction operation were sent through drum or crate radiation counters for disposition.

Sludge from size-reduction operations that contained recoverable amounts of plutonium was dried and placed in containers to await recovery of plutonium. Used processing liquids were stored outside the size-reduction areas in tanks containing Raschig® rings or in safe-geometry tanks to prevent criticality events. Tank contents were sampled, and if the plutonium content was below predetermined limits, the liquid was pumped to the waste treatment facility. If not, it was sent to plutonium recovery in Building 771.

The advanced size reduction facility was used to disassemble or cut plutonium-contaminated glove boxes and miscellaneous large equipment down to an easily packaged size. The advanced size reduction facility process consisted of five sub-processes enclosed in one glove box, including an air-lock manual disassembly area, a remote disassembly area, a cutting area, a steam cleaning area, and a packaging area. In the advanced size reduction facility routine operations were performed remotely, using hoists, manipulator arms, and glove ports to reduce both intensity and time of radiation exposure to the operator. This facility included a separate exhaust-ventilation system, additional electrical power, fire protection, and alarm systems. The advanced size reduction facility ceased operations when production of weapons components at the Plant was curtailed in 1989.

Fluidized Bed Unit Incinerator

Building 776 contained two separate fluidized bed unit incineration processes: the pilot plant and the demonstration plant. The fluidized bed unit was designed to thermally treat low-level radioactive and mixed hazardous waste (liquid and solid). In both plants, process equipment was similar in design, but the demonstration plant had approximately nine times greater capacity.

The entire fluidized bed unit operation took place in a canyon and glove box system to contain radioactive contamination. A canyon was a processing room designed for eventual contamination; it contained no glove boxes. The waste passed from the canyon through an airlock into a glove box where scrap metal was manually removed. Combustibles and small, undetected scrap metal pieces were shredded, air-separated for further metal removal, and re-shredded prior to entering the primary fluidized bed unit for incineration. Emissions from the unit passed through an after-burner, a cyclone separator, and a bank of pre-filters and high-efficiency particulate air filters.

Operations Since 1989

Following a raid by the Federal Bureau of Investigation in 1989, production at the Plant was curtailed. In 1992, the mission of the Plant was officially changed from weapons components production to environmental restoration and waste management. After 1992, the major operations in Building 776/777 were waste handling and storage.

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ROCKY FLATS PLANT, PLUTONIUM FABRICATION HAER No. CO-83-O
(Rocky Flats Plant, Building 776/777)
Located in the central section of the Plant.
Golden Vicinity
Jefferson County
Colorado

Photographs CO-83-O-1 through CO-83-O-21 were taken by various site photography contractors, dates are indicated in parentheses.

CO-83-O-1 VIEW LOOKING NORTHWEST AT BUILDING 776/777, THE PLUTONIUM PROCESSING BUILDING, DURING CONSTRUCTION. (4/10/56)

CO-83-O-2 VIEW LOOKING NORTHEAST AT BUILDING 776/777 DURING CONSTRUCTION. (4/12/56)

CO-83-O-3 VIEW LOOKING NORTH DURING CONSTRUCTION OF THE TUNNEL THAT CONNECTS BUILDING 776/777 (PLUTONIUM PROCESSING) WITH BUILDING 771 (PLUTONIUM RECOVERY). (6/22/56)

CO-83-O-4 VIEW OF THE INTERIOR OF BUILDING 776/777 DURING CONSTRUCTION. (8/22/56)

CO-83-O-5 AERIAL VIEW LOOKING SOUTH AT THE PLUTONIUM BUILDINGS (700S). BUILDING 776/777 IS THE LARGE BUILDING IN THE CENTER PORTION OF THE PHOTOGRAPH. BUILDING 771 IS IN THE LOWER RIGHT CORNER, AND BUILDING 707 IS TO THE SOUTH OF BUILDING 776/777. (6/21/88)

CO-83-O-6 VIEW OF INTERIOR GLOVE BOX DURING CONSTRUCTION. GLOVE BOXES CONTAINED ALL PRODUCTION OPERATIONS AND WERE INTERCONNECTED BY CONVEYORS. (9/21/59)

CO-83-O-7 VIEW OF GLOVE BOX LINE UNDER CONSTRUCTION. (12/20/56)

CO-83-O-8 VIEW OF A MOLD FOR PRECISION CASTING. THE MOLD WAS USED IN FOUNDRY OPERATIONS THAT CAST PLUTONIUM EITHER AS INGOTS SUITABLE FOR ROLLING AND FURTHER WROUGHT PROCESSING OR INTO SHAPES AMENABLE TO DIRECT MACHINING OPERATIONS. (5/6/59)

CO-83-O-9 DETAILED VIEW OF BRIQUETTING PRESS HOUSED IN A GLOVE BOX. THE PRESS FORMED SCRAP PLUTONIUM METAL FROM FOUNDRY AND FABRICATION PROCESSES INTO SMALL BRIQUETTES. THESE BRIQUETTES BECAME PART OF THE FEED MATERIALS FOR THE FOUNDRY. (5/6/59)

CO-83-O-10 VIEW OF THE INSTALLATION OF PLUTONIUM FABRICATION ROLLING MILL. THE MILL ROLLED INGOTS INTO SHEETS THAT WERE THEN CUT INTO CIRCLE BLANKS TO BE PASSED THROUGH THE CENTER LINE FOR PRESSING. (2/19/63)

CO-83-O-11 VIEW OF A SITE RETURN WEAPONS COMPONENT. SITE RETURNS WERE NUCLEAR WEAPONS SHIPPED TO THE ROCKY FLATS PLANT FROM THE NUCLEAR WEAPON STOCKPILE FOR RETIREMENT, TESTING, OR UPGRADING. FISSILE MATERIALS (PLUTONIUM, URANIUM, ETC.) AND RARE MATERIALS (BERYLLIUM) WERE RECOVERED FOR REUSE, AND THE REMAINDER WAS DISPOSED. (8/7/62)

CO-83-O-12 VIEW OF A SITE RETURN WEAPONS COMPONENT. AFTER SEGREGATION, PLUTONIUM MATERIALS WERE EITHER RETURNED TO THE BUILDING 776 FOUNDRY WHERE THEY WERE CAST INTO FEED INGOTS, OR UNDERWENT CHEMICAL RECOVERY FOR PURIFICATION. (8/7/62)

CO-83-O-13 VIEW OF THE MOLTEN SALT EXTRACTION LINE. THE MOLTEN SALT EXTRACTION PROCESS WAS USED TO PURIFY PLUTONIUM BY REMOVING AMERICIUM, A DECAY BY-PRODUCT OF PLUTONIUM. (1/98)

CO-83-O-14 VIEW OF THE OUTSIDE OF A GLOVE BOX THAT CONTAINS ELECTROREFINING EQUIPMENT. ELECTROREFINING WAS ONE OF THE PROCESSES USED TO PURIFY PLUTONIUM THAT DID NOT MEET PURITY SPECIFICATIONS. (10/25/66)

CO-83-O-15 DETAIL VIEW OF ELECTROREFINING EQUIPMENT CONTAINED WITHIN A GLOVE BOX. (10/25/66)

CO-83-O-16 DETAILED VIEW OF SAMPLING EQUIPMENT. SAMPLED OFF-GAS IS SENT THROUGH A FOUR - STAGE COLD WATER TRAP. COOLING OF THE GAS ALLOWS A CONDENSATE TO FORM. THE CONDENSATE IS ANALYZED FOR CHEMICAL CONTENT. (6/2/80)

CO-83-O-17 VIEW OF A ROOM DAMAGE IN A FIRE THAT OCCURRED ON MAY 11, 1969. (5/18/69)

CO-83-O-18 DETAILED VIEW OF A GLOVE BOX DAMAGED IN A FIRE THAT OCCURRED ON MAY 11, 1969. THE FIRE OCCURRED FROM THE SPONTANEOUS IGNITION OF A BRIQUETTE OF SCRAP PLUTONIUM ALLOY METAL. (5/18/69)

CO-83-O-19 VIEW OF THE EXTERIOR OF THE ADVANCED SIZE REDUCTION FACILITY. (11/6/86)

CO-83-O-20 VIEW OF THE INTERIOR OF THE ADVANCED SIZE REDUCTION FACILITY USED TO CUT PLUTONIUM CONTAMINATED GLOVE BOXES AND MISCELLANEOUS LARGE EQUIPMENT DOWN TO AN EASILY PACKAGED SIZE FOR DISPOSAL. ROUTINE OPERATIONS WERE PERFORMED REMOTELY, USING HOISTS, MANIPULATOR ARMS, AND GLOVE PORTS TO REDUCE BOTH INTENSITY AND TIME OF RADIATION EXPOSURE TO THE OPERATOR. (11/6/86)

CO-83-O-21 VIEW OF THE SUPERCOMPACTOR. THE SUPERCOMPACTOR WAS USED TO REDUCE THE VOLUME OF MISCELLANEOUS PLUTONIUM CONTAMINATED MATERIALS SUCH AS GLOVES. PAPER, AND LIGHTWEIGHT METALS. THESE MATERIALS WERE COMPACTED INTO A DRUM FOR DISPOSAL. (4/4/91)

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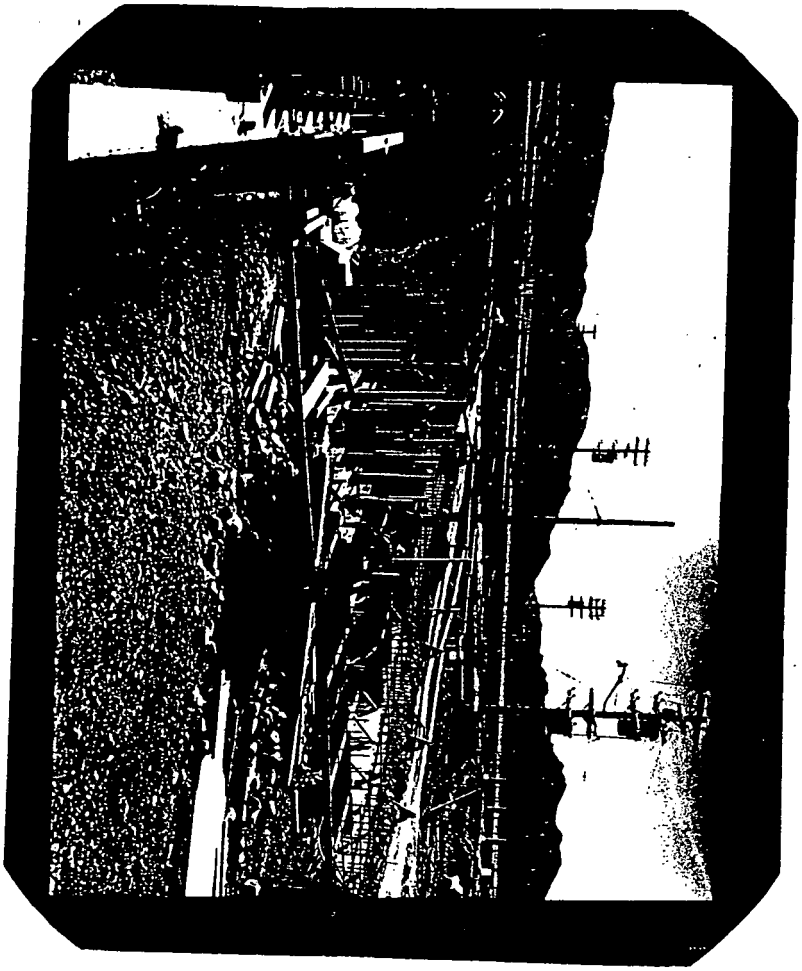

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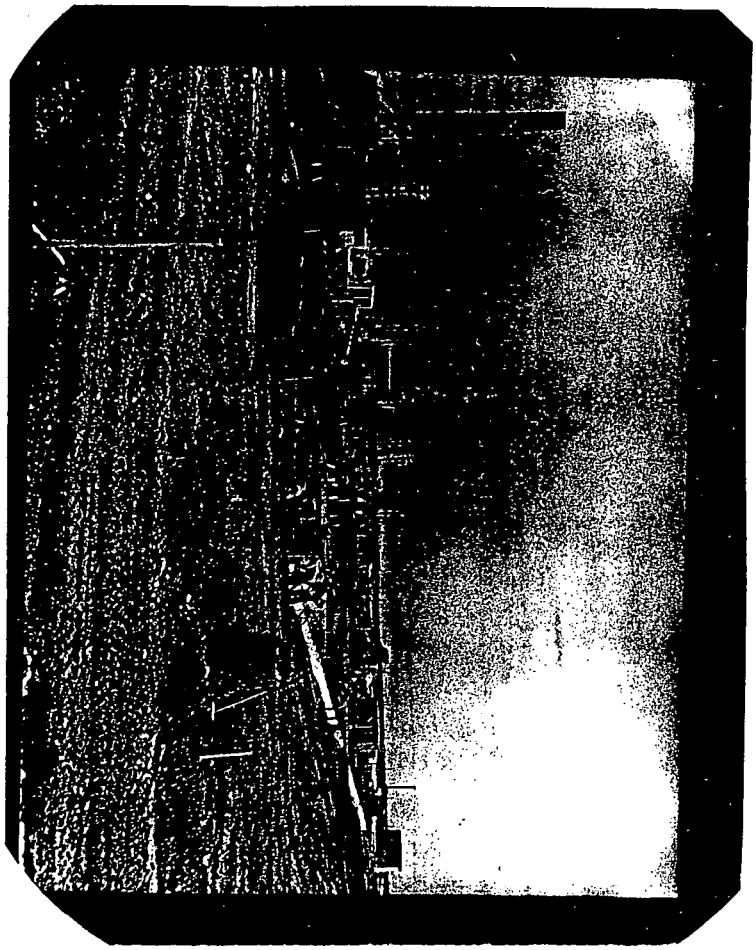

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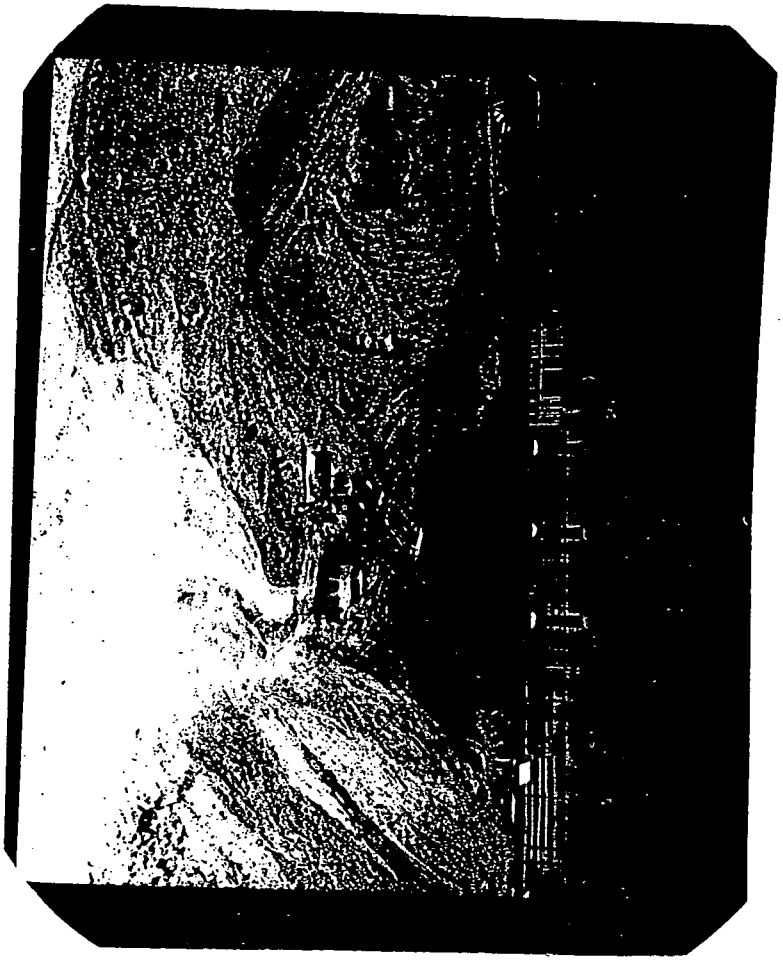

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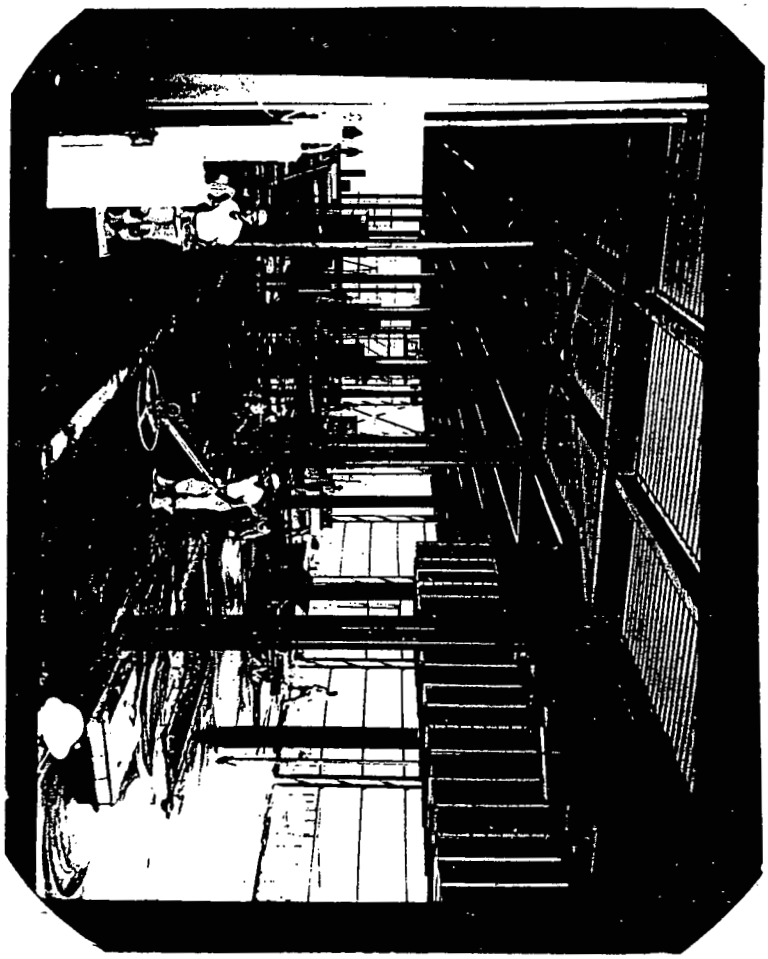

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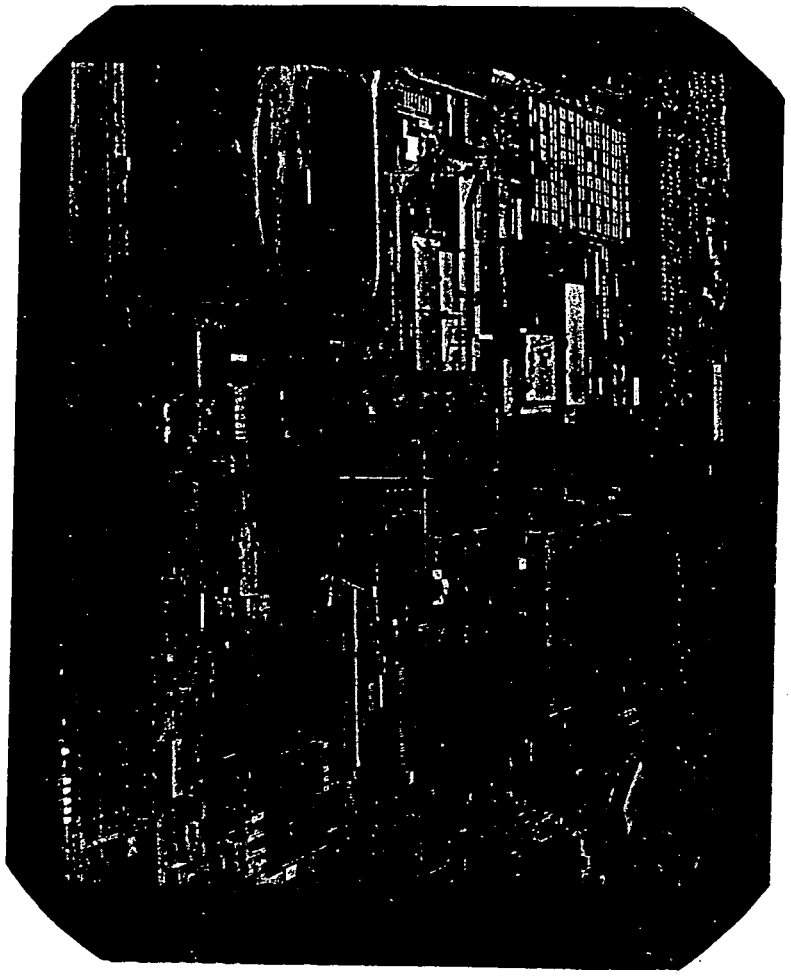

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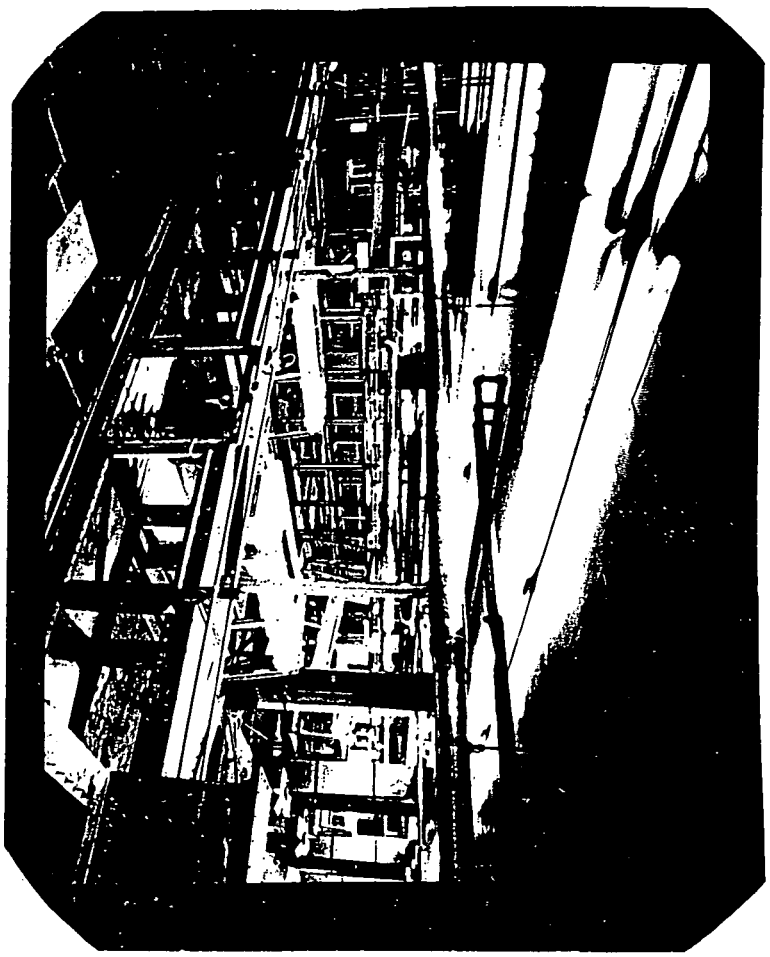

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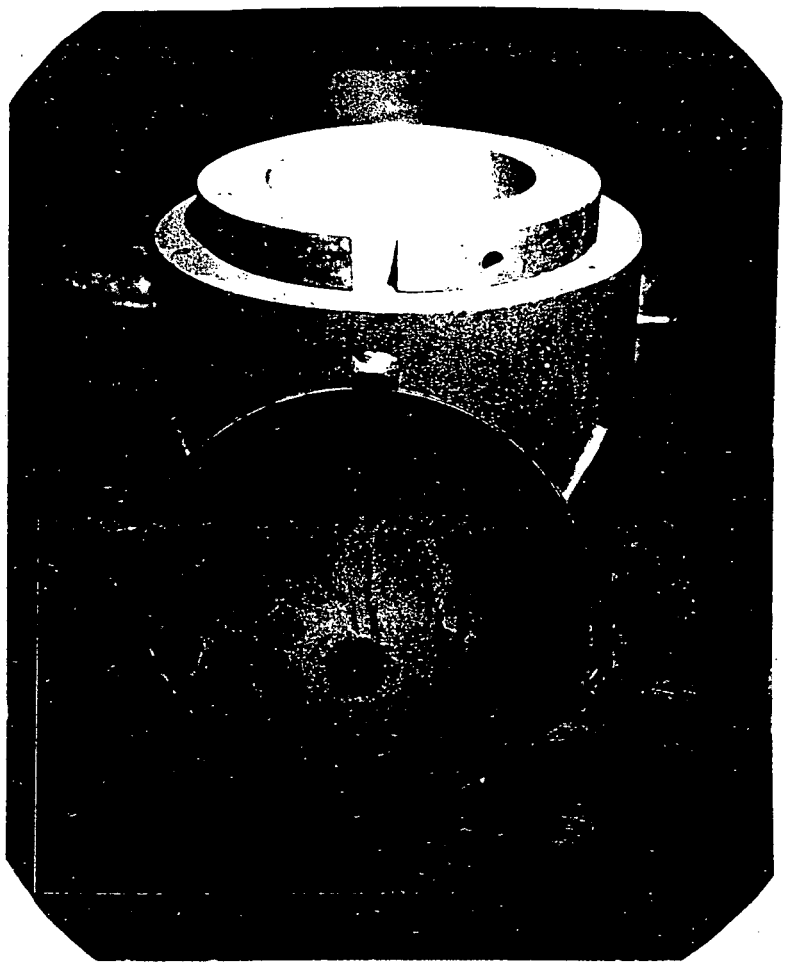

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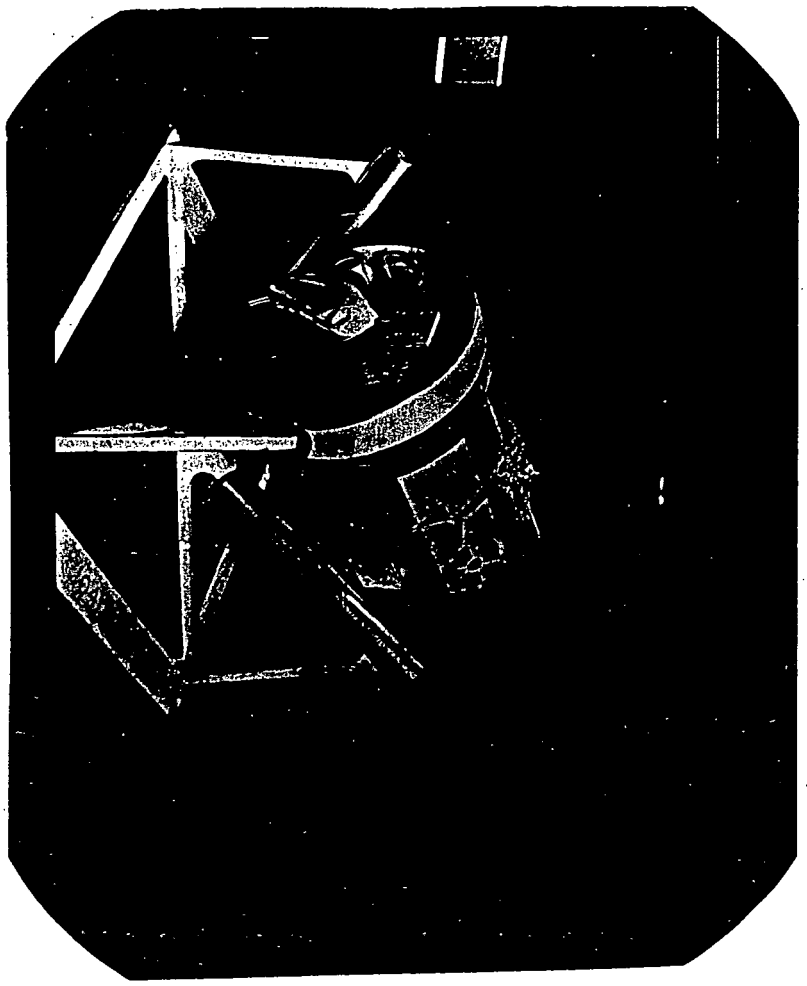

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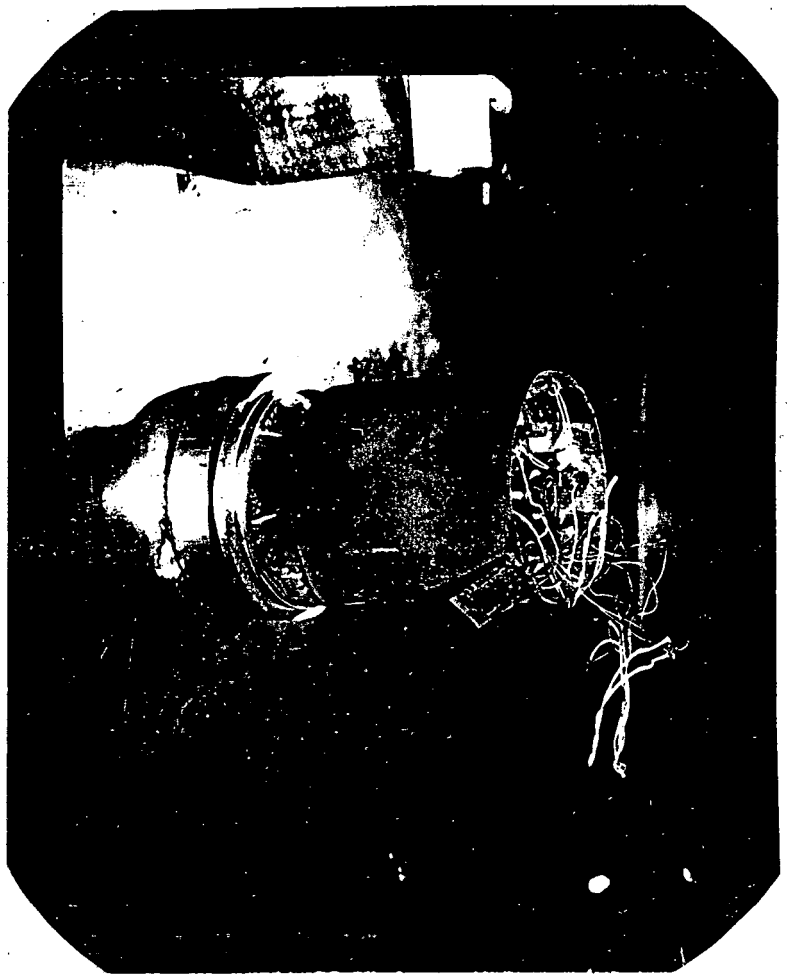

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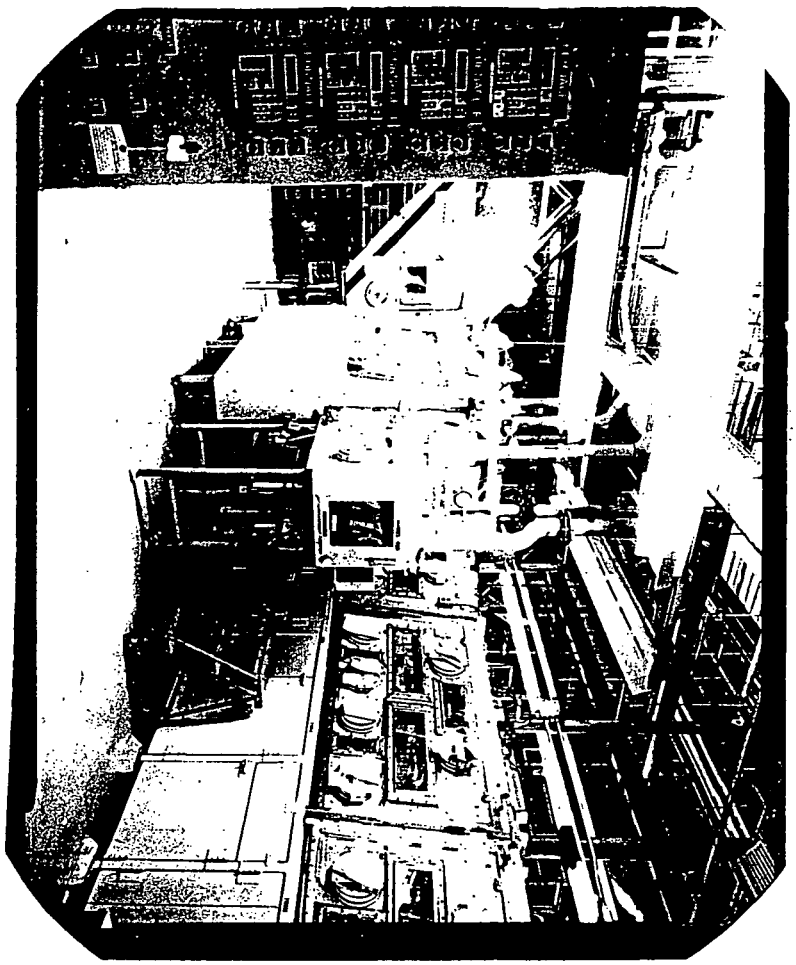

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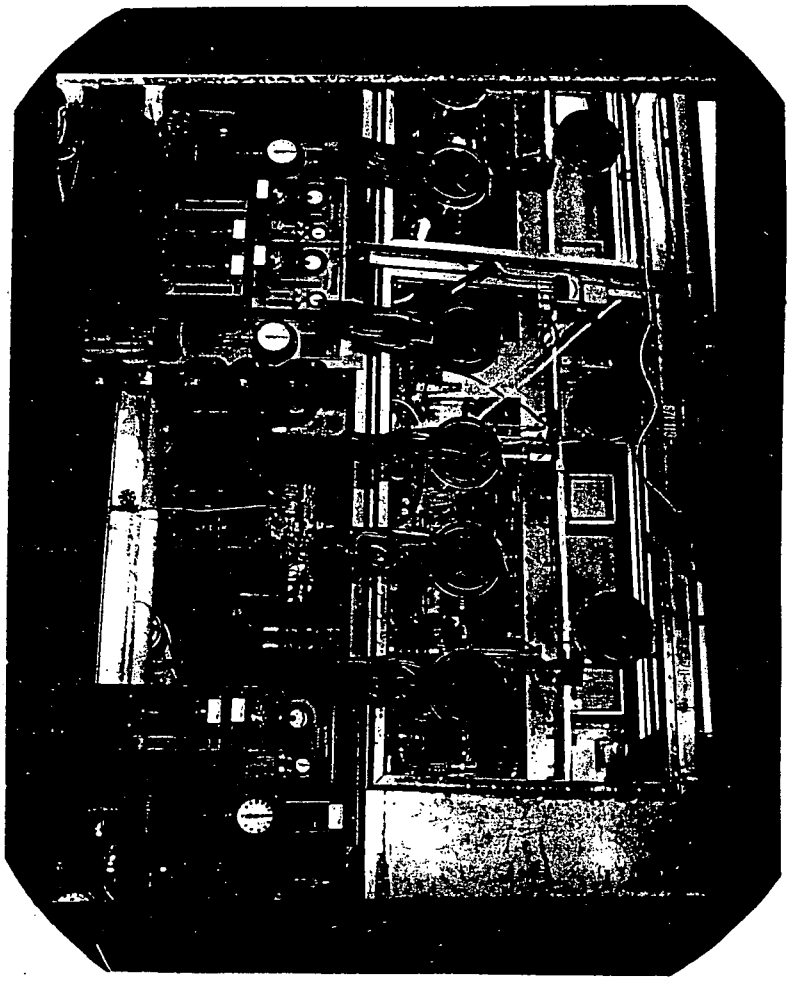

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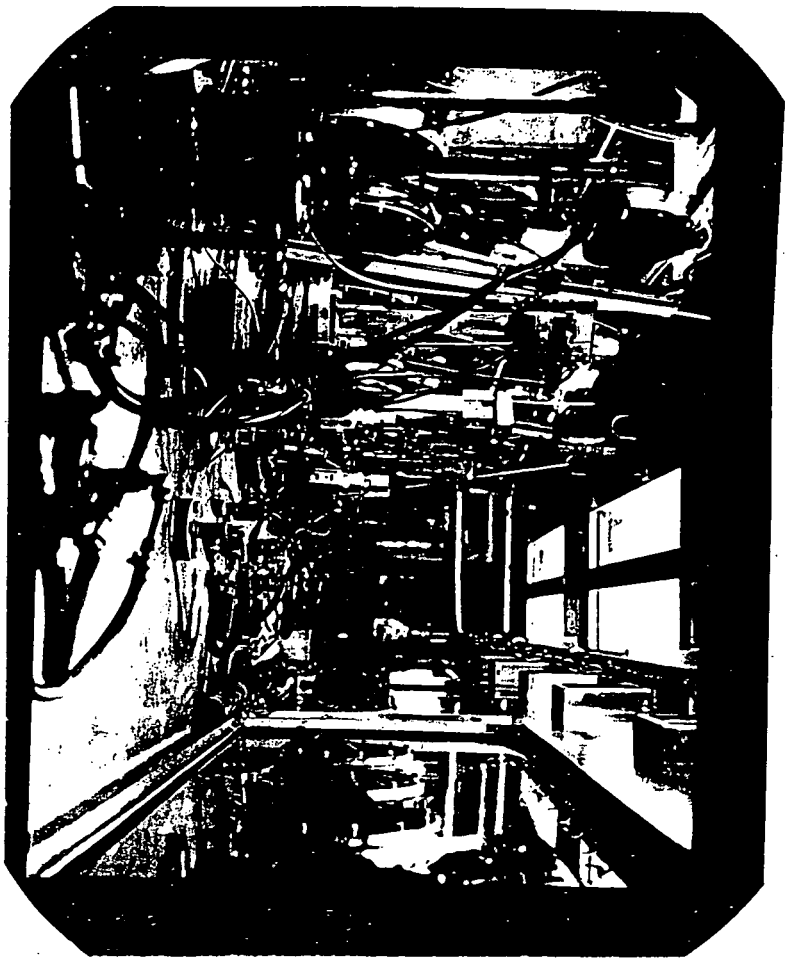

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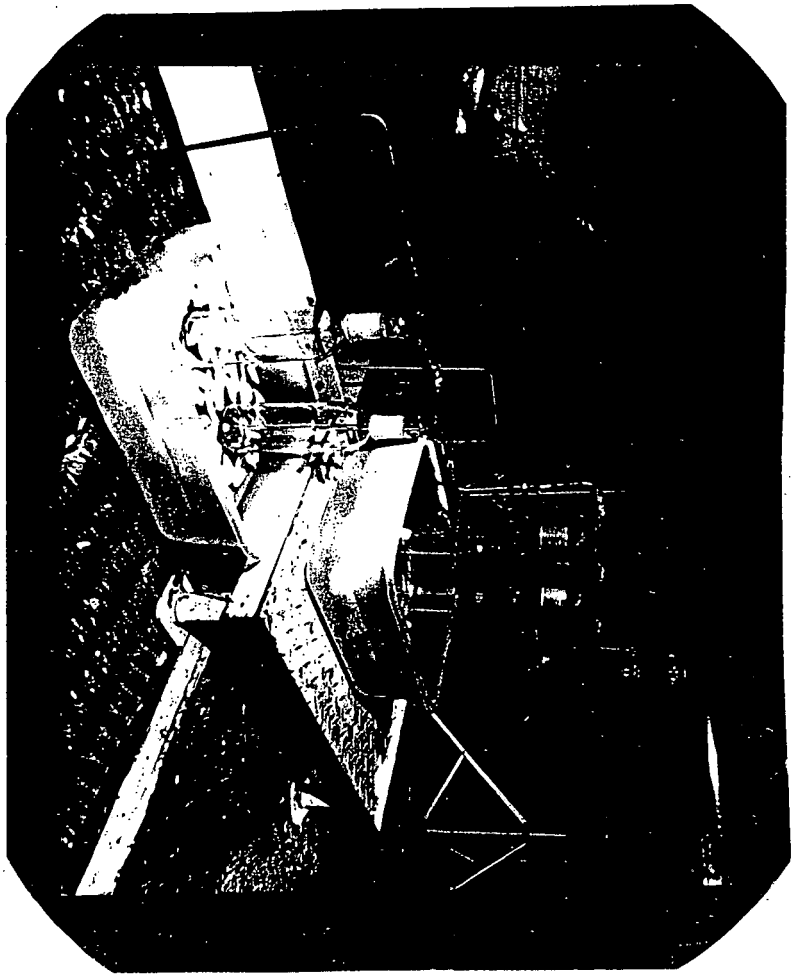

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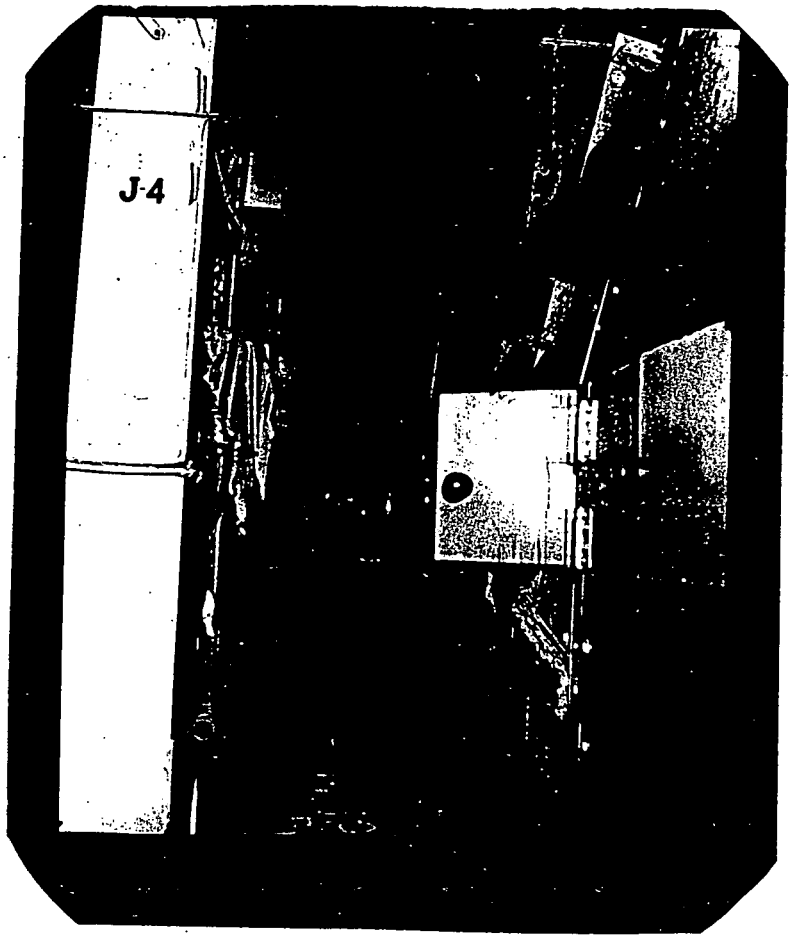

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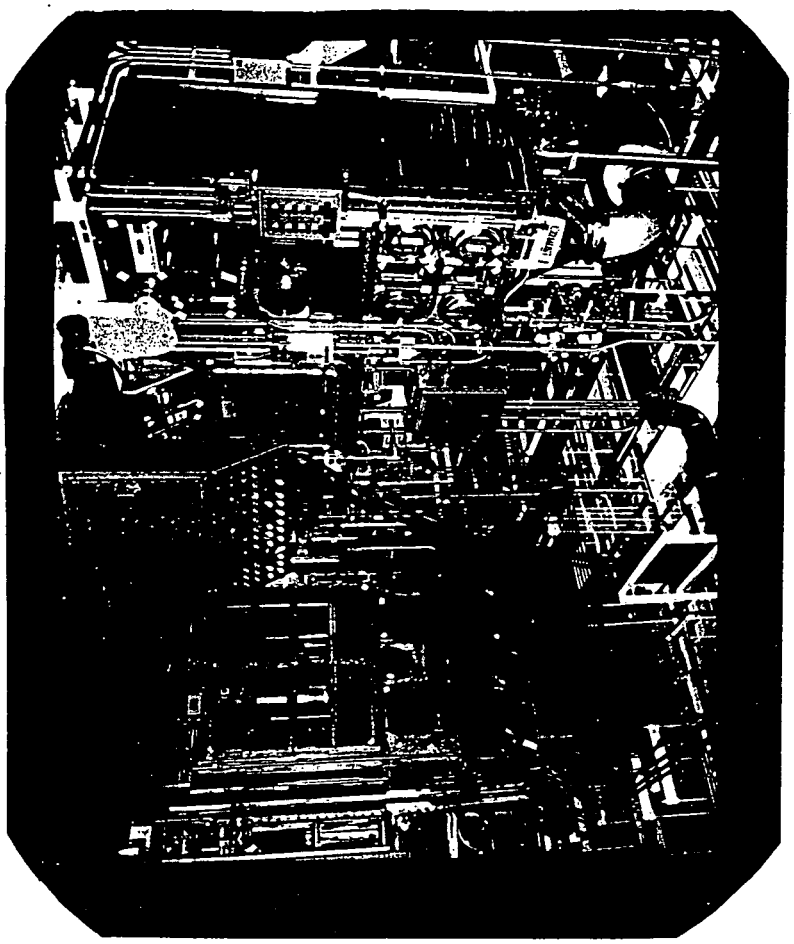

ROCKY FLATS PLANT, DESIGN LABORATORY

HAER No. CO-83-P

(Rocky Flats Plant, Building 701)

Located in the northwest quadrant of the Plant between Buildings 776/777 and 771.

Golden Vicinity

Jefferson County

Colorado

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

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Rocky Mountain System Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

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ROCKY FLATS PLANT,
DESIGN LABORATORY
(Rocky Flats Plant, Building 701)

HAER No. CO-83-P

Location: Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County, Colorado. Building 701 is located in the northwest quadrant of the Rocky Flats Plant (Plant) between Buildings 776/777 and 771.

Significance: This building was a primary contributor to the National Register eligible Rocky Flats Plant historic district, associated with the United States (U.S.) strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack. The building was used to design, build, and evaluate bench-scale technologies used in Plant waste treatment processes.

Description: Building 701 is a relatively small, one-story, rectangular building that encompasses approximately 5,200 square feet. The building has a metal gabled roof on a reinforced concrete foundation. Exterior walls are constructed of corrugated metal; interior walls are constructed of concrete block and gypsum board. The floors are painted concrete.

Building 701 originally contained carpenter shops in the east end of the building and research and design laboratories in the west end. After 1976, only research and design labs remained in the building.

History: Built in 1962, Building 701 was a research and design facility used to design, build, and evaluate bench-scale waste treatment processes. The main purpose of the research and design group located in this building was to change the form of waste materials for off-site disposal. Information from the waste treatment research and design projects was applied to waste treatment processes throughout the site. All process evaluations conducted in Building 701 were done using non-radioactive materials; once the processes were transferred to the production and waste treatment facilities, they were applied to radioactive waste. Experimental laboratory work, primarily regarding cementing techniques, was also done in Building 701.

Research and Design Projects
In the late 1970s, the use of a rotary-kiln incinerator to combust radioactive waste was investigated. This type of kiln was later installed in Building 371 for glovebox-generated solid and liquid waste from plutonium processing buildings.

A model of the fluidized bed unit incinerator eventually installed in Building 776/777 was evaluated in Building 701. The fluidized bed unit model was made of glassware to allow researchers to view the process while the incinerator was operating. The fluidized bed unit was used to thermally treat low level radioactive and mixed hazardous waste (liquid and solid). Researchers in Building 701 continued to evaluate and modify the fluidized bed unit after its installation in Building 776/777.

During the mid-1980s, the research and design group began laboratory research to establish the necessary parameters for cementing pond sludge. Cement provided a solid matrix for isolation of wastes, chemically binding water from the sludge wastes. The success of solidification with cement depended upon whether or not the waste adversely affects the strength and stability of the concrete product.

A thin film evaporator was tested as an upgrade for the liquid waste treatment process used in Building 774. The liquid was evaporated from the waste, leaving a solid. The solid was then cemented for disposal.

Beginning in the early 1980s and continuing into the 1990s, the research and design group investigated vitrification technologies. This technology was used to transform waste into a vitreous glass-like substance, thereby immobilizing the waste to prevent leaching of hazardous or radioactive compounds into surrounding media. Several different types of melters were investigated, including joule and induction melters. In the early 1990s, the research and design group in Building 701 developed a microwave melter to vitrify waste material.

The final use of the building was to house limited research and design activities. For example, a process is being developed to stabilize materials containing plutonium and americium. These materials were once considered a waste because the concentration of plutonium and americium was below the economic recovery limit. After the disposal guidelines changed, they were considered a residue. The process being developed would eventually be conducted in glove boxes.

Sources: Nieweg, Ron, employed at the Plant since 1970 by the site contractor, personal communication, February 1998.

Petersell, Jeff, employed at the Plant since 1980 by the site contractor, personal communication, December 1997.

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USDOE, 1995, *Final Cultural Resources Survey Report, Rocky Flats Environmental Technology Site, the Industrial Area, Rocky Flats Plant Repository.*

Historians: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M), 1997. Judith Berryman, Ph.D., Archaeologist, e^2M, 1997.

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(Rocky Flats Plant, Building 701)
Located in the northwest quadrant of the Plant between Buildings 776/777 and 771.
Golden Vicinity
Jefferson County
Colorado

Photographs CO-83-P-1 through CO-83-PO-2 were taken by various site photography contractors, dates are indicated in parentheses.

CO-83-P-1 VIEW LOOKING NORTHWEST AT BUILDING 701. BUILDING 701 WAS USED TO DESIGN, BUILD, AND EVALUATE BENCH-SCALE TECHNOLOGIES USED IN ROCKY FLATS PLANT WASTE TREATMENT PROCESSES. (1/98)

CO-83-P-2 VIEW OF THE MICROWAVE MELTER DEVELOPED BY THE RESEARCH AND DEVELOPMENT GROUP LOCATED IN BUILDING 701. THE MICROWAVE MELTER TRANSFORMED WASTE INTO A VITREOUS GLASS-LIKE SUBSTANCE, IMMOBILIZING THE WASTE, SO THAT IT COULD BE SHIPPED OFF SITE FOR DISPOSAL. (1/31/91)

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Located in the northwest quadrant of the Plant between Buildings 776/777 and 771.
Golden Vicinity
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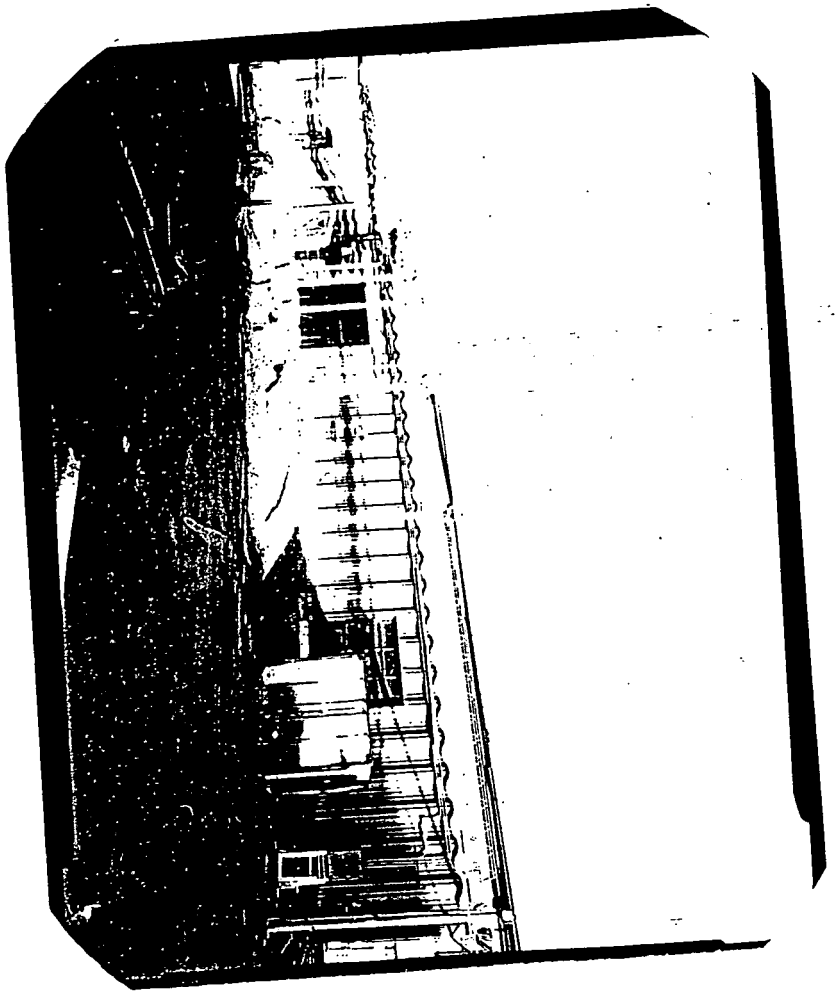

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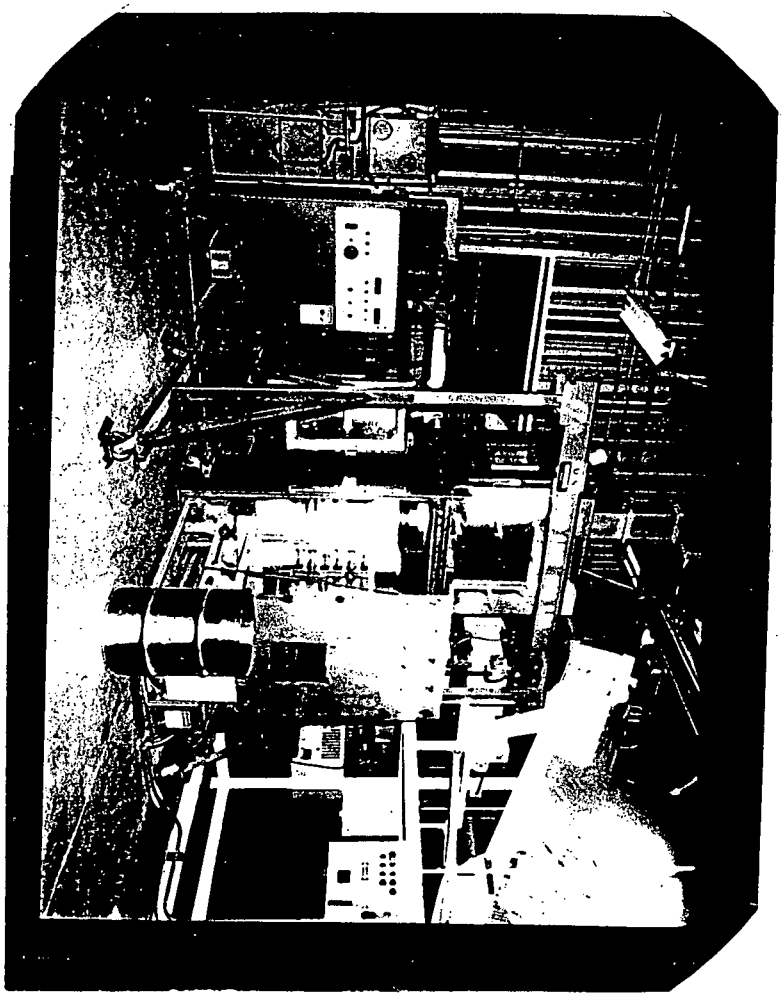

ROCKY FLATS PLANT, GENERAL MANUFACTURING SUPPORT, RECORDS / CENTRAL COMPUTING
(Rocky Flats Plant, Building 881)
(Rocky Flats Plant, Plant B)
Located in the southern portion of the Plant.
Golden Vicinity
Jefferson County
Colorado

HAER No. CO-83-Q

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Rocky Mountain System Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

ROCKY FLATS PLANT,
GENERAL MANUFACTURING SUPPORT,
RECORDS/CENTRAL COMPUTING
(Rocky Flats Plant, Building 881)
(Rocky Flats Plant, Plant B)

HAER No. CO-83-Q

Location: Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County, Colorado. The facility is located in the southern portion of the Rocky Flats Plant (Plant).

Date of Construction: 1951.

Fabricator: Austin Company, Cleveland, Ohio.

Present Owner: United States Department of Energy (USDOE).

Present Use: Administrative Operations.

Significance: This building was a primary contributor to the National Register eligible Rocky Flats Plant historic district, associated with the United States (U.S.) strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack. Building 881 was one the original four manufacturing buildings at the Plant. It was designed to produce enriched uranium components, and to recover enriched uranium from process wastes.

Historians: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M), 1997. Judith Berryman, Ph.D., Archaeologist, e^2M, 1997.

Project Information:

In 1995, an inventory and evaluation was conducted of facilities at the Rocky Flats Plant for their potential eligibility for listing in the National Register of Historic Places. The primary goal of this investigation was to determine the significance of the Cold War era facilities at the Plant in order to assess potential effects of the long-term goals and objectives of the USDOE. These goals and objectives have not yet been formalized, but include waste cleanup and demolition activities. Recommendations regarding National Register of Historic Places eligibility were developed to allow the USDOE to submit a formal determination of significance to the Colorado State Historic Preservation Officer for review and concurrence and to provide for management of historic properties at the Plant.

From this determination and negotiations with the Colorado State Historic Preservation Officer, the Advisory Council, and the National Park Service, a Historic American Engineering Record project began in 1997 to document the Plant's resources prior to their demolition. The plant was listed on the National Register of Historic Places in 1997. The archives for the Historic American Engineering Record project are located in the Library of Congress in Washington, D.C.

Introduction:

The Rocky Flats Plant is one of thirteen USDOE facilities that constitute the Nuclear Weapons Complex, which designed, manufactured, tested, and maintained nuclear weapons for the U.S. arsenal. The Plant was established in 1951 to manufacture triggers for use in nuclear weapons and to purify plutonium recovered from retired weapons. Each trigger consisted of a first-stage fission bomb that set off a second-stage fusion reaction in a hydrogen bomb. Parts were formed from plutonium, uranium, beryllium, stainless steel, and other materials.

A tense political atmosphere both at home and abroad during the Cold War years drove U.S. weapons research and development. By the 1970s, both the U.S. and the Soviet Union maintained thousands of nuclear weapons aimed at each other. These weapons were staged on submarines, bombers, and intercontinental ballistic missiles. Both the North Atlantic Treaty Organization and Warsaw Pact countries in Europe had small nuclear warheads, known as theater weapons, used as part of the Mutually Assured Destruction program. (The Mutually Assured Destruction program acted as a deterrent in that if one side attacked with nuclear weapons, the other would retaliate and both sides would perish.) The final nuclear weapons program at the Plant was the W-88 nuclear warhead for the Trident II missile. This mission ended in 1992 when President Bush canceled production of the Trident II missile.

The Plant was a top-secret weapons production plant, and employees worked with a recently man-made substance, plutonium, about which little was known concerning its chemistry, interactions with other materials, and shelf-life. The Historic American Engineering Record documentation effort focused on four aspects of the Plant and its role in the Nuclear Weapons Complex: manufacturing operations, research and development, health and safety of workers, and security.

Chronology of Building 881:

1951 Construction began.

1952 Plant operations began.

1953	Enriched uranium operations began; original building contained a foundry, analytical laboratory, machine shop, steam plant, and laundry.
1955	An L-shaped annex was added to the northeast corner of Building 881 for a machining facility.
1957	A reinforced concrete tunnel was constructed to transport enriched uranium between Buildings 883 and 881.
1964	Enriched uranium activities were phased out between 1964 and 1966. Enriched uranium recovery operations ended in 1964.
1966	Building operations shifted to other metals; stainless steel fabrication operations began.
1967	Beryllium sealing operations began; beryllium ingots received from Building 444 were placed into stainless steel cans that were sent on to be rolled in Building 883; J-line stainless steel activities began.
Mid-1970s	Uranium recovery operations on parts received from Oak Ridge Reservation were discontinued.
1984	Stainless steel machining moved to Building 460.
1991	Construction of new air filter plenum, Building 881F; the new plenums replaced two exhaust plenums located in the northeast corner of the first and second floors of Building 881.

Building History:

Initially known as Plant B, Building 881 was one of the four original manufacturing buildings that comprised the Plant in the early 1950s and was the fourth building to come on-line. Beginning in 1953, this structure housed the Plant's only enriched uranium component manufacturing and recovery operations. The original purpose of Building 881 was the processing and machining of enriched uranium (oralloy) into finished weapons components. The oralloy process included chemical recovery operations and foundry equipment. A large part of the early work at the Plant took place in this building, because the triggers required a large amount of enriched uranium.

Enriched uranium recovery processes used at the Plant were based upon those developed at the Los Alamos Scientific Laboratory and the Oak Ridge Reservation during and after World War II. The processes were refined at the Oak Ridge Reservation Y-12 Plant in the several years preceding the construction of the Rocky Flats Plant.

Plant personnel contributed many unique improvements to enriched uranium recovery processes. Improvements were made to the continuous dissolution processes of the following materials: sand and slag from foundry operations; and skull oxide (material recovered form foundry crucibles). Improvements were made in the other continuous processes for: peroxide precipitation; calcination of uranium peroxide; and leaching of powdered solids. Site personnel developed improved processes for graphite incineration; oralloy parts decontamination; and achieved a 15-kilogram (kg) scale reduction of uranium tetrafluoride to metal.

Equipment improvements included safe dimension troughs for continuous leaching or dissolution, safe-dimension rotary drum vacuum filters, and a continuous rotary calciner. Pyrex® glass Raschig rings were used extensively as the primary criticality control of large process vessels.

In 1964, enriched uranium operations in the building began to be phased out with the advent of the Atomic Energy Commission's single mission policy for each facility within the nuclear weapons complex. This policy was instituted to eliminate redundancy of activities within the complex. Production of oralloy components ceased at the Plant in 1964, when the Y-12 Plant at the Oak Ridge Reservation assumed sole responsibility.

Associated with this single mission policy was the transfer of stainless steel manufacturing from the American Car and Foundry Company of Albuquerque New Mexico to the Plant, Building 881. Stainless steel manufacturing, referred to as the J-line, began in 1966. These operations occupied the space that enriched uranium processes formerly occupied. Fabrication and testing of stainless steel parts was conducted in Building 881until 1984, when Building 460 was constructed.

Building Description:

Building 881 is an irregularly shaped, multiple-level structure that is built into the side of a hill. The main portion of Building 881 is underground, with the exception of Building 881F, a gabled-roof section that rises two stories. Overall elevations vary: at the northern end, the building roof is at ground level; at the southern end, the first floor is at ground level. At the southern end of the structure, the exterior walls of both stories are exposed. Areas east of the building are graded, allowing roadway access to the second floor loading dock and to the first

floor on the south. Building 881 is considered to be a three-story structure with mezzanine levels on the first and second floors. The complex encompasses approximately 245,000 square feet: 86,300 on the first floor; 6,000 square feet on the first floor mezzanine; 121,460 square feet on the second floor; 13,530 square feet on the second floor mezzanine; and 17,870 square feet in the basement.

All exterior walls and foundations are reinforced concrete with continuous footings. The interior columns are concrete with spread footings. The primary structural framing of the building is poured-in-place reinforced concrete columns and beams. Structural steel beam framing is used in the center stairway and in the roof on the 881 Annex. All floors are reinforced concrete. The ground floor above the basement contains reinforced concrete, supported by concrete beams. The second floor consists of either flat or beam concrete slabs.

The interior walls are either reinforced concrete (elevators, stairwells, and some rooms), concrete block, metal studs covered with gypsum board, or brick. The majority of the ceilings are either concrete slab or insulated metal pan. A few of the ceilings are steel sheets or acoustical tile. Depending on location and function, a variety of doors are present in the structure, including hollow metal (some lined with lead), steel roll-up doors, vault doors, and doors with wire mesh panels. There are no outside windows in the building.

The roof for Building 881 is flat and flush with the finished grade along the north and most of the east and west walls. There are four exits onto the roof. The original roof construction has 1' of insulation covered with built-up roofing on top of a concrete roof slab.

A reinforced concrete radiography vault (28' x 38' x 12') is located in the northeastern portion of the second floor. Four concrete bell-type caissons support the weight of the vault.

The building contains several reinforced concrete tunnels that provide both interior and exterior access. In general, the tunnels are constructed with reinforced concrete slab floors (10" thick) with 9" thick walls. There are two east portal tunnels that provide access to and from the second floor of the building (which is underground). The northernmost of these two tunnels is L-shaped and measures 100' x 8.3' x 10'. Loading dock and truck areas are contained within the shorter section of this tunnel. The second tunnel measures 17' x 65' x 9'. A third concrete tunnel connects Building 883 to the second floor of 881, this tunnel is 192' long and 8' to 10' high. Additionally, there are four utility tunnels in the basement that are 4', 10', 15', and 18' wide, with an average height of 11'. These basement tunnels were designed as fallout shelters and used for storage.

Many of the rooms in the structure have been partitioned since initial operations. The first floor is divided into four general areas: administrative offices and the central computing facility in the southwest portion of the building; future systems group in the northwest portion; utility systems in the northeast portion; and analytical laboratories, maintenance shops, and offices in the southeast section. The first floor mezzanine contains offices for the future systems group, maintenance and records storage areas, general offices, and an instrument laboratory (Room 114J). The future systems group created illustrations, models, and engineering prototypes used for weapons and energy-related concepts.

Enriched uranium and stainless steel weapons component production-related activities occurred primarily on the second floor. The floors in most of the production areas are surfaced with stainless steel to contain spills and facilitate cleaning. The second floor contains a lunch/break room; locker rooms; research and instrument laboratories; a radiation monitoring support area; offices; locker rooms; storage vaults; an instrument library; production machining, joining, and assembly shops; and radiography vaults. The second floor mezzanine contains offices, air filter banks, inlet air plenums, a utility room, control systems, and a brazing laboratory.

The basement level contains some building utility support systems, including three boilers, process cooling water tanks, pumps, an emergency generator, and electrical equipment. Tunnels in the basement are used primarily for storage. A pit is also located in the basement area, and is accessed by the basement tunnels. The pit contains tall process equipment.

An L-shaped annex was added to the northeast portion of the original building in 1955. The annex was added to provide additional space for enriched uranium component manufacturing processes. Later, stainless steel manufacturing processes were housed in this area.

Building 881 Complex

Additional buildings that make up the Building 881 complex include: Building 830 (isolated power supply); Building 881F (filter plenum for Building 881); Building 881G (diesel generator); Building 881H (electrical interfaces); Building 864 (guard post); Building 882 (hydrogen gas cylinder storage); Building 885 (paint and oil storage); Building 887 (sanitary and process waste lift station); and Building 890 (cooling tower).

Building 830 is located east of Building 881. The building is sometimes used for storage of disposal materials and equipment. Building 881F, considered an integral part of Building 881, is a metal-siding-on-metal-frame building located on the roof of Building 881. Building 881F was placed in operation around 1991, replacing two exhaust plenums located in the northeast corner of the first and second floors of Building 881.

Building 881G is a prefabricated metal building located on the first-floor level of Building 881, immediately south of the Building 881 exterior wall. This structure houses a 400-kilowatt diesel generator. Building 881H, a prefabricated metal building located on the east side of Building 881, houses various switches, switchgear, breakers, and distribution panels needed to supply power to Building 881. Building 864 is a reinforced concrete, one-story guard post, located west of Building 881. Building 882, the hydrogen gas cylinder storage shed, is a steel-framed lean-to located east of Building 881. Building 885 is a single-room, single-story, prefabricated metal building located south of Building 881, which was used to store solvents, paints, thinners, and oils used in Building 881 processes.

Building 887 is a two-level reinforced concrete building used for handling sanitary and process waste products derived from Building 881 processes. Building 887 is located south of Building 881 and houses the appropriate pipes, sample points, and pumps to transfer process waste from Building 881 to the site process waste system. Building 890, the cooling tower, consists of three structures, a reinforced concrete basin, a prefabricated wooden cooling tower with wooden stairs, and a single-story pump house. Building 890 is located east of Building 881.

A high-pressure facility consisting of a chamber, a passageway, and a blast tunnel is located on the eastern side of the building. The high-pressure facility was used for testing purposes.

The entire Building 881 complex is enclosed in security fencing. Access is either through the Building 864 Guard Post, located west of the building, or through the Building 888 Guard Post off Central Avenue, to the northeast.

Building Operations:

Building 881 operations can be divided into three categories representing three distinct periods: enriched uranium manufacturing and recovery and special projects (1952-66); stainless steel operations (1966-84); and recent activities (post-1984).

Enriched Uranium Manufacturing and Recovery and Special Projects (1952-66)
Enriched uranium component manufacturing and recovery processes were housed in Building 881 from 1952 until 1964. Manufacturing and recovery operations were phased out at the Plant between 1964 and 1966. Limited enriched uranium recovery operations for site returns (weapons returned to the Plant for upgrade, reproccessing or retirement) continued at the Plant until the mid-1970s. After 1966, prefabricated enriched uranium components were shipped to the Plant from other USDOE facilities to be incorporated into the final trigger assembly.

Manufacturing

Enriched uranium component manufacturing included a foundry for casting of shapes and ingots and machining and inspection of enriched uranium components. Initially, hockey-puck-sized buttons of pure enriched uranium were received at the Plant from Oak Ridge Reservation in Tennessee. These buttons went directly to the machining operations to be shaped. A few months after Building 881 became operational, enriched uranium buttons were produced for the foundry when recovery operations in the building were brought on line.

The original foundry process cast enriched uranium into spherical shapes that were sent directly to machining operations. When the hollow core weapon design replaced the first trigger design, enriched uranium was cast into ingots from which components were fabricated (rolled, formed, and machined).

Casting operations began with two furnaces in Room 242. As production increased, four additional furnaces were added in Room 249. In the casting process, uranium metal was placed in a crucible, heated in bottom-pouring induction furnaces, and then poured into graphite molds to form spherical shapes (1952-57) or slabs and ingots (1957-64). Crucibles in the casting process were originally made of magnesium oxide, after 1958 they were made of graphite.

Between 1952 and 1957, cast spherical shapes went directly for final machining. Milling machines and lathes in Rooms 245 through 247 were used to form the final shape of the first trigger design. The new hollow core trigger design was more complex and required additional manufacturing steps. Enriched uranium was cast into slabs or ingots in Building 881, and was sent to Side B of Building 883 for rolling and forming, then returned to Building 881 for final machining. By 1957, computer-tape-controlled turning machines used in the final machining process provided additional precision needed for hollow component designs.

Completed parts were sent for inspection and testing in the northeast corner of the building and in Building 883. Non-destructive testing used radiography to detect internal flaws in fabricated parts. Radiography was conducted in Rooms 255 and 276.

Fabricated enriched uranium components were sent to Buildings 991, 777, or 707, (depending on the time frame) for final trigger assembly.

Recovery

Enriched uranium recovery operations, conducted in Building 881 from 1952 through 1964, were initiated shortly after fabrication operations began. Several different recovery operations were used, depending on the type of initial material. Enriched uranium recovery processed relatively pure materials and solutions and solid residues with relatively low uranium content.

Uranium recovery involved both slow and fast processes. The slow process involved placing relatively impure materials with low concentrations of uranium into nitric acid for leaching and solvent extraction. Impure materials such as slag, sand, crucibles from foundry operations, and residues from the incinerator were reduced via the slow process. The materials were crushed into pea-sized feed in a rod mill and placed in dissolving tanks containing nitric acid. Solutions from the dissolution filters were concentrated in tall (three-story high) solvent extraction columns that originated in a pit in the basement. The solution was then pumped into various evaporators for further processing.

The fast process handled materials that were relatively pure, including uranyl nitrate, and used conversion and reduction steps to produce a pure uranium button (conversion steps changed the physical or chemical nature of the compound; reduction steps changed the compound from a higher to a lower oxidation state). Materials such as chips from machining operations, and black skull oxide from the foundry operations contained fairly high percentages of enriched uranium that were easy to convert into pure uranium buttons. Chips and skull oxides were burned to form uranium oxide and then transferred for dissolution in small batches of concentrated nitric acid. The dissolution room housed three rows of controlled hoods known as B-boxes (similar to lab hoods). These boxes operated with high air velocities at their openings to ensure that the vapors were contained within the hood.

The dissolution process yielded a uranyl nitrate solution, from which a uranium peroxide was precipitated. Once filtered, the precipitate formed a yellow, cake-like substance that was heated (calcined) to produce an orange uranium oxide. The dissolution, precipitation, and calcination processes were originally performed as batch processes. By the late 1950s to early 1960s, the processes became one continuous operation. The orange oxides were converted to uranium tetrafluoride, a green salt. The conversion was conducted by placing the orange oxides into monel (copper-nickel alloy) containers, heating to reduce the compound, and adding anhydrous hydrogen fluoride. The green salts were transferred to a sealed metal bomb reactor for final reduction to uranium metal. Building 881 operations initially produced enriched uranium buttons approximately 3 kg in size; however, with process improvements, these operations were able to produce buttons up to 15 kg in size.

Other recovery operations included incineration of combustible residues, reprocessing enriched uranium from site returns (weapons returned to the Plant for upgrade, reproccessing or retirement), briquetting of relatively pure enriched uranium scraps, and recovery of enriched uranium fines from oil coolant systems.

Uranium-contaminated combustible materials such as wipes, cheesecloth used to clean up minor drips, wood, cardboard, and air filters were incinerated in 3'-diameter incinerators located in

Room 233. White ash generated by the incinerator was sent to the slow recovery process side to recover enriched uranium.

Beginning sometime after 1960 and continuing until 1977, Building 881 housed the chemical recovery operations for site returns and rejected enriched uranium weapon components. The first step was to remove surface plutonium contamination by bathing the returned parts in nitric acid. The used acid solution was collected, concentrated by evaporation, calcined to a dry oxide, and sent to Building 771 for recovery of plutonium. The cleaned parts were crushed in a press, processed, and used as feed material for the foundry.

The briquetting process was used to recover scraps of relatively pure enriched uranium from machining operations. The scraps were cleaned in a solvent bath, then pressed into small briquettes to be used as foundry feed material.

Accumulated uranium fines were cleaned out of the machining operations' oil coolant system on a semi-annual basis. After the coolant lines were drained, accumulated fines were flushed from the system using an acid solution. The acid/uranium fine solution was sent through the slow process for recovery of the uranium. Uranium trapped on the oil coolant filters was recovered by incineration.

Special Projects

A number of special projects ranging from ongoing research and development to one-time operations were conducted in Building 881 between 1953 and 1966. These projects included tracer components (processing of neptunium, curium, and cerium), uranium 233 processing, lithium fabrication, recovery of fuel rods, distillation, and cadmium plating of uranium parts.

Stainless Steel Operations (1966-84)

Stainless steel work at the Plant consisted primarily of fabrication of the reservoirs that held tritium gas external to the hydrogen bomb trigger. Other stainless steel work included fabrication of the tubes and fasteners associated with the tritium reservoir-to-trigger delivery system, and the sealing of beryllium ingots into stainless steel containers as part of the beryllium wrought process. Stainless steel work was transferred from Building 881 to Building 460 between 1983 and 1985.

Feed material for stainless steel operations was received at the Plant as bar stock purchased from an off-site vendor. Stainless steel casting, forging, or recovery operations were not conducted on a production scale at the Plant.

Production operations included machining, cleaning, assembling, inspection and testing, and support. Depending on technical requirements, methods, and/or equipment needed, the sequence of operations was altered to meet specific project needs.

Stainless steel parts associated with the tritium delivery system were machined in Rooms 244, 245, and 296. Conventional tools, such as lathes, mills, borers, and presses were used in machining operations. After machining, fabricated parts were cleaned using solvents, acids, and aqueous detergents. Equipment associated with the cleaning process included two vapor degreasers, and an ultrasonic cleaning unit. After machining and cleaning, the parts were inspected and tested.

Inspection and testing operations included dimensional inspection (precise measurements), non-destructive testing, and destructive testing of representative samples. As part of non-destructive testing, parts were visually inspected for flaws and x-rayed to identify internal structural flaws.

Assembly operations were conducted in Building 881, although final assembly of some components was conducted in Building 707. Assembly operations included matching, brazing, and welding. The parts were physically matched together, then assembled and joined by brazing or welding (tungsten-inert gas, electron-beam, or resistance). Welding machines were maintained in vacuum chambers.

Other assembly operations consisted of clinching pressure fittings, tube bending, wire winding, solid film applications, fixture assembly, vacuum bakeout, resin molding, and adhesive assembly.

Stainless steel operations in Building 881 were incorporated into the beryllium wrought process in October 1967. Beryllium ingots (cast in Building 444) were transferred to Building 881 to be enclosed in stainless steel. This was done to aid in subsequent beryllium rolling and forming processes that occurred in Building 883.

Recent Operations (Post-1984)

After stainless steel manufacturing was moved out of Building 881, the building became a multi-purpose facility for research and development, computer support, analytical support, and administrative functions. Building 881 housed the Plant's central computing facilities and the general chemistry laboratory. The laboratory provided general analytical and standards calibration, as well as development operations including waste technology development and development and testing of mechanical systems for weapons systems.

After the Plant's mission changed to environmental remediation in 1989, a reduced amount of research and development continued in Building 881. The laboratories are intact, but idle.

The final use of the building was to house approximately forty organizations. These included production, production support, research, and administrative functions. Administrative operations involved operation of the computer center, development of computer systems, and management and storage of Plant records.

Sources: ChemRisk, 1992, *Project Tasks 3 and 4 Final Draft Report, Reconstruction of Historical Rocky Flats Operations and Identification of Release Points*, prepared for Colorado Department of Health.

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HISTORIC AMERICAN ENGINEERING RECORD

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ROCKY FLATS PLANT, GENERAL MANUFACTURING SUPPORT, RECORDS/CENTRAL COMPUTING — HAER No. CO-83-Q
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Photographs CO-83-Q-1 through CO-83-Q-21 were taken by various site photography contractors, dates are indicated in parentheses.

CO-83-Q-1 VIEW LOOKING SOUTH AT BUILDING 881 AIR STACK DURING CONSTRUCTION. (8/25/52)

CO-83-Q-2 VIEW LOOKING NORTH AT BUILDING 881 DURING CONSTRUCTION. (12/24/52)

CO-83-Q-3 VIEW LOOKING NORTHWEST AT BUILDING 881 DURING CONSTRUCTION. (12/26/52)

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CO-83-Q-23 VIEW OF THE FIRST FLOOR PLAN. THE FIRST FLOOR HOUSED ADMINISTRATIVE OFFICES, THE CENTRAL COMPUTING, UTILITY SYSTEMS, ANALYTICAL LABORATORIES, AND MAINTENANCE

SHOPS. THE ORIGINAL DRAWING HAS BEEN ARCHIVED ON MICROFILM. THE DRAWING WAS REPRODUCED AT THE BEST QUALITY POSSIBLE. LETTERS AND NUMBERS IN THE CIRCLES INDICATE FOOTER AND/OR COLUMN LOCATIONS.

CO-83-Q-24 VIEW OF THE SECOND FLOOR PLAN. ENRICHED URANIUM AND STAINLESS STEEL WEAPONS COMPONENT PRODUCTION-RELATED ACTIVITIES OCCURRED PRIMARILY ON THE SECOND FLOOR. THE ORIGINAL DRAWING HAS BEEN ARCHIVED ON MICROFILM. THE DRAWING WAS REPRODUCED AT THE BEST QUALITY POSSIBLE. LETTERS AND NUMBERS IN THE CIRCLES INDICATE FOOTER AND/OR COLUMN LOCATIONS.

CO-83-Q-25 VIEW OF THE MACHINE TOOL LAYOUT IN ROOMS 244 AND 296. MACHINES WERE USED FOR STAINLESS STEEL FABRICATION (THE J-LINE). THE ORIGINAL DRAWING HAS BEEN ARCHIVED ON MICROFILM. THE DRAWING WAS REPRODUCED AT THE BEST QUALITY POSSIBLE. LETTERS AND NUMBERS IN THE CIRCLES INDICATE FOOTER AND/OR COLUMN LOCATIONS.

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SEE INDEX TO PHOTOGRAPHS FOR CAPTION

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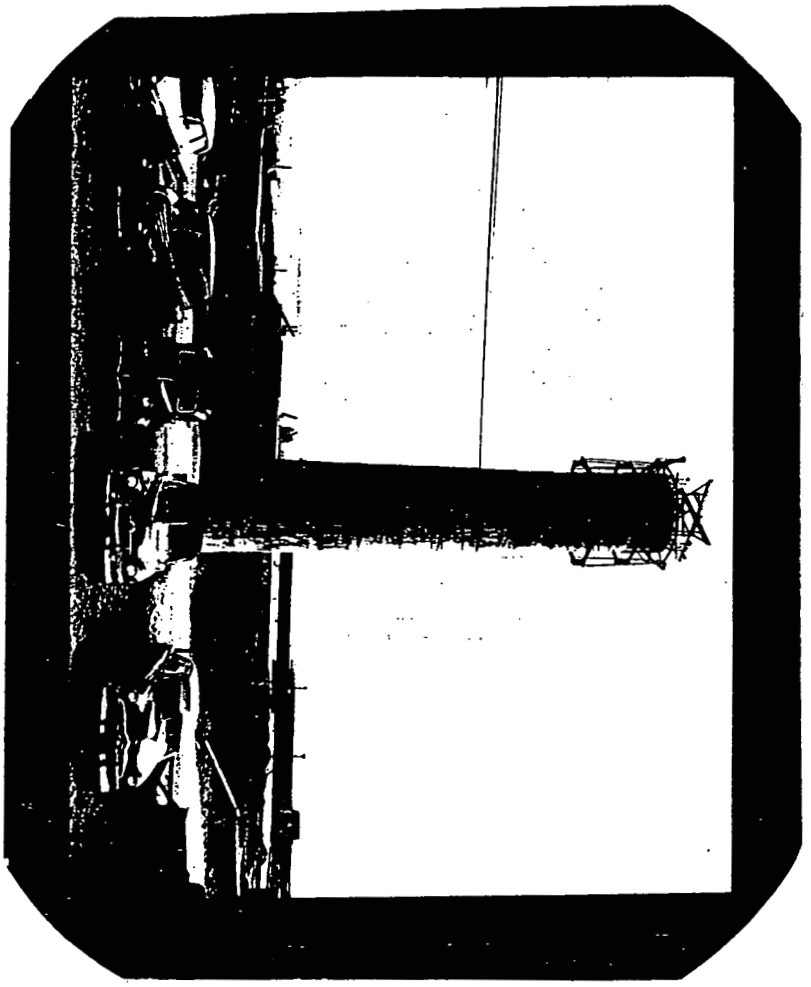

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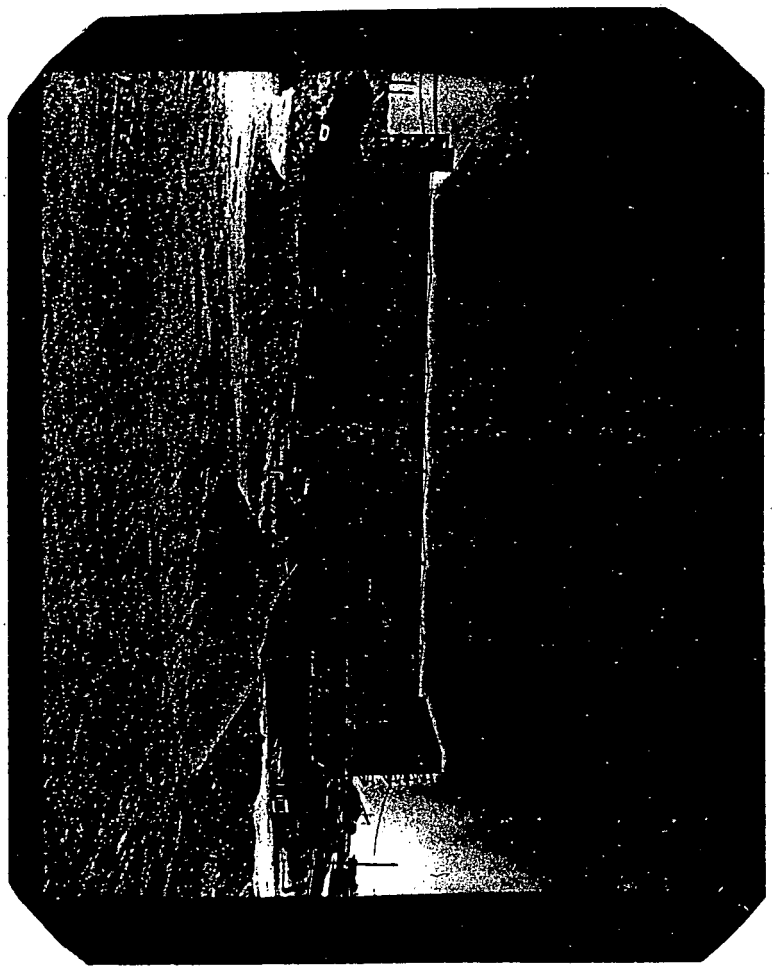

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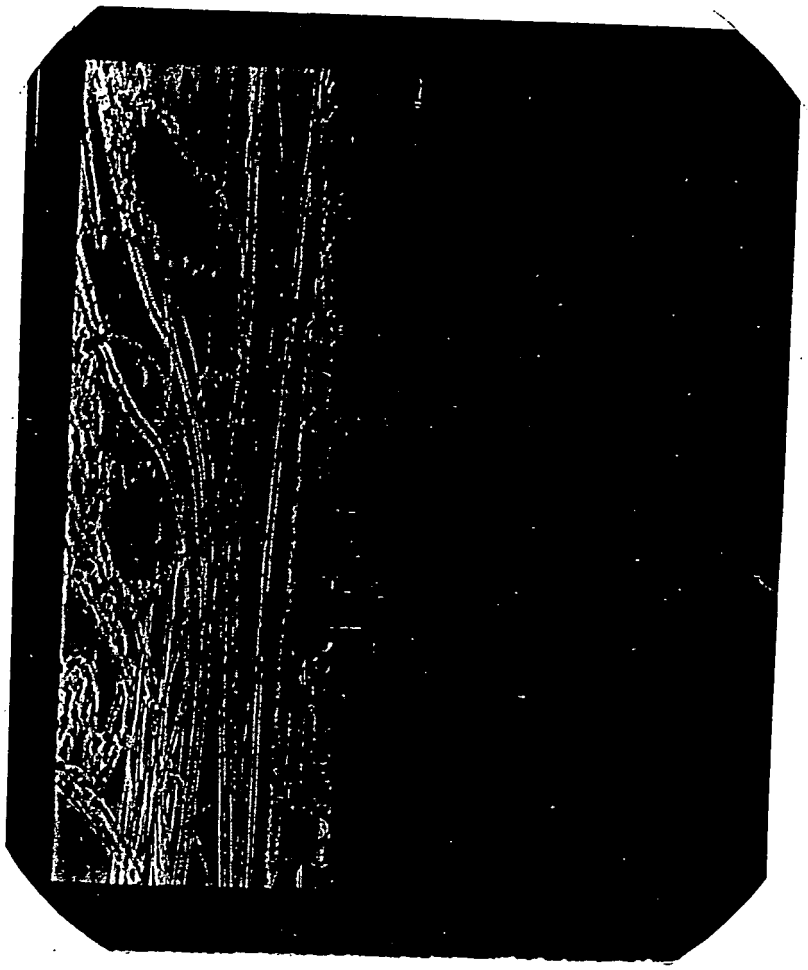

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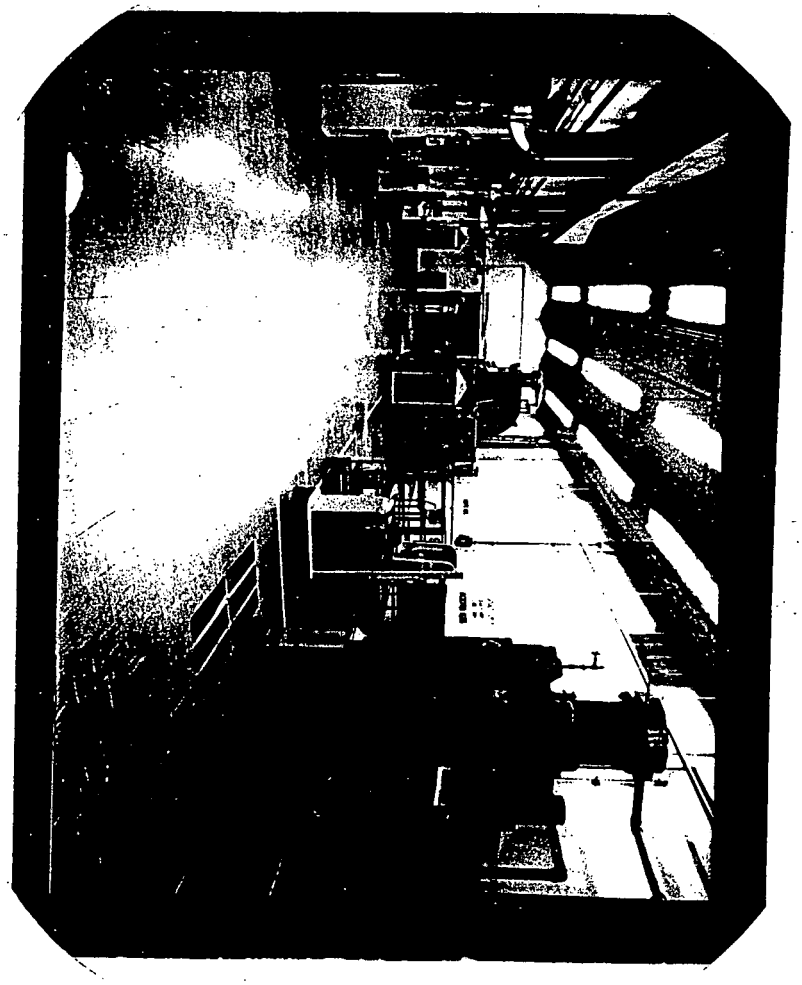

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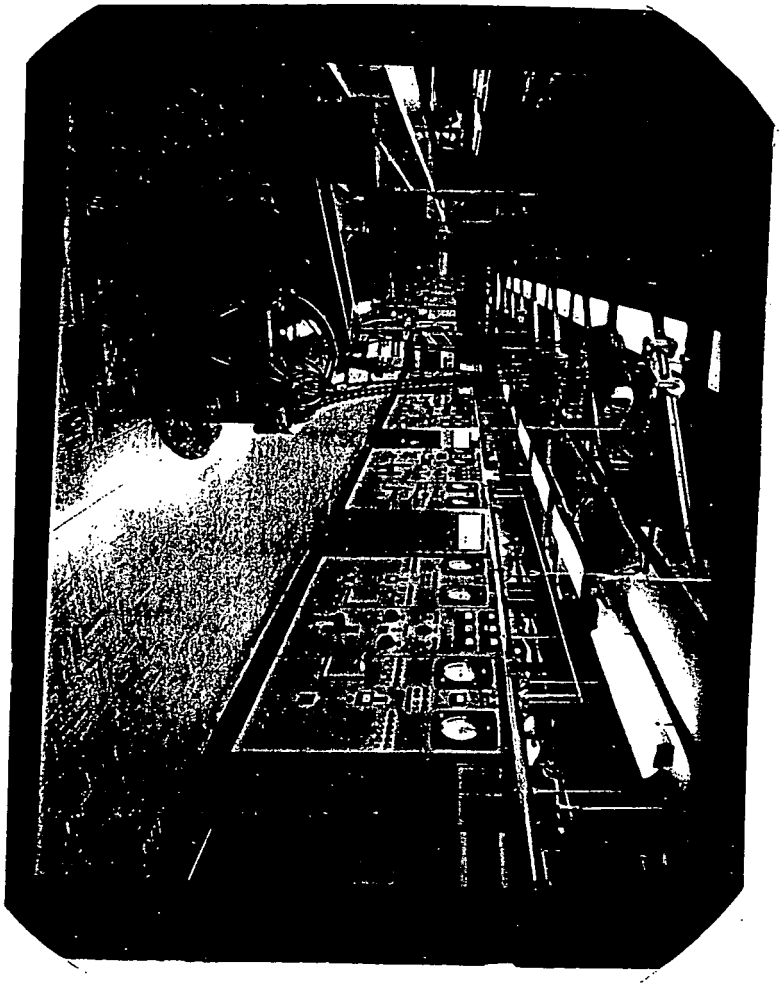

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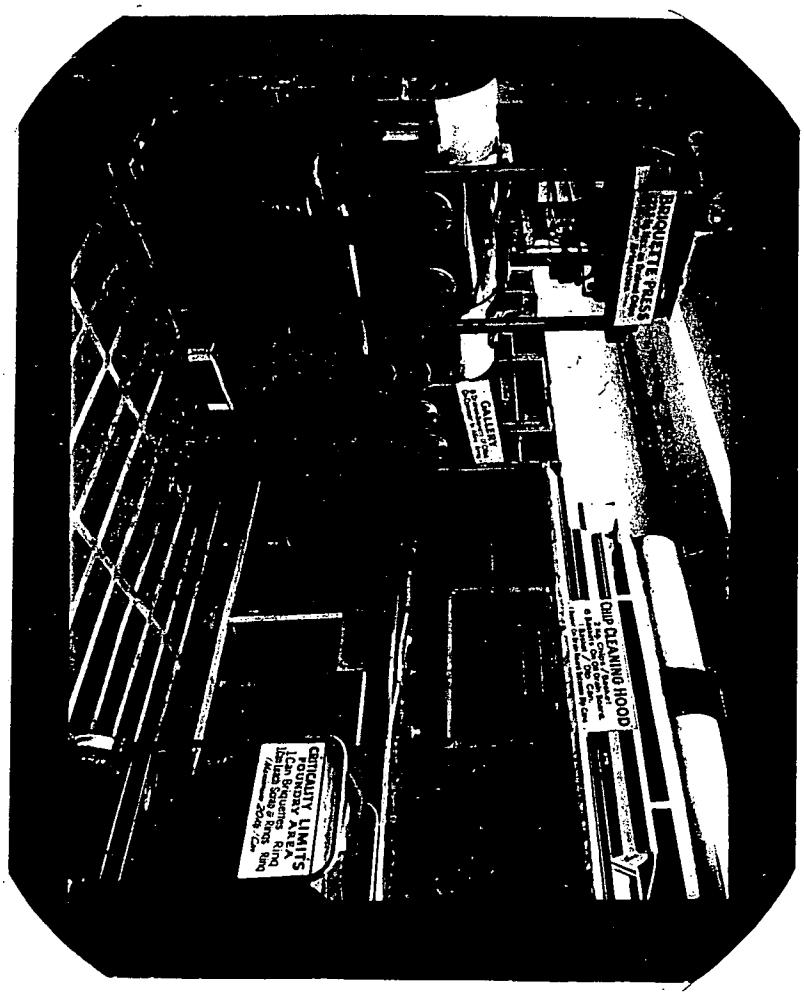

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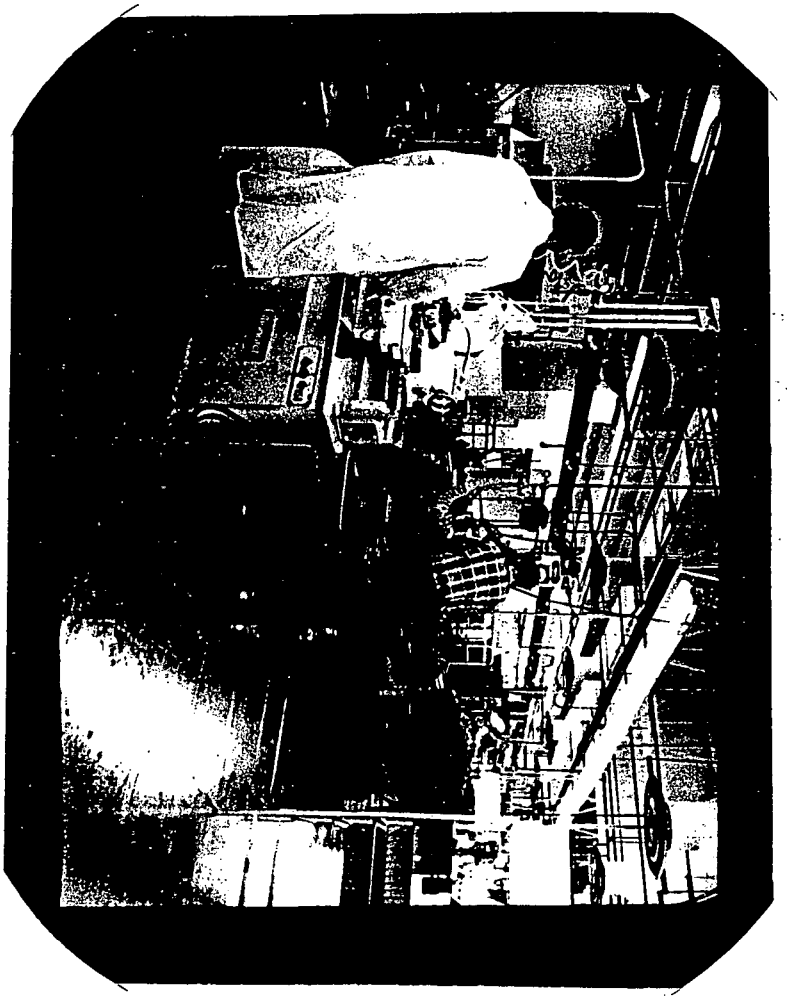

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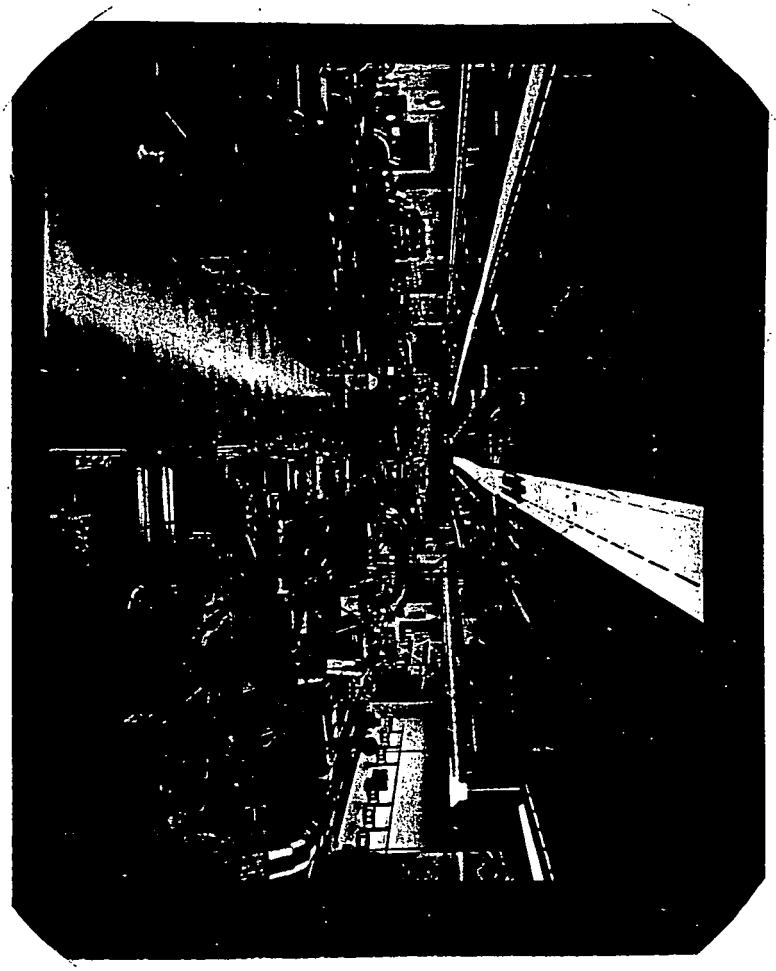

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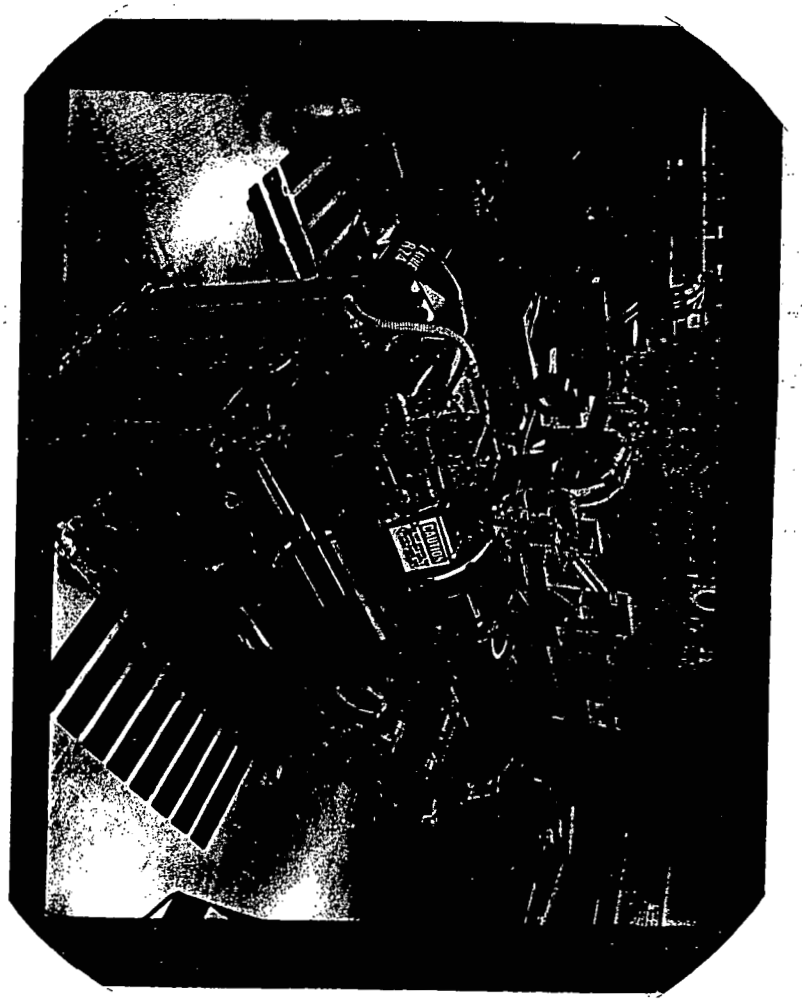

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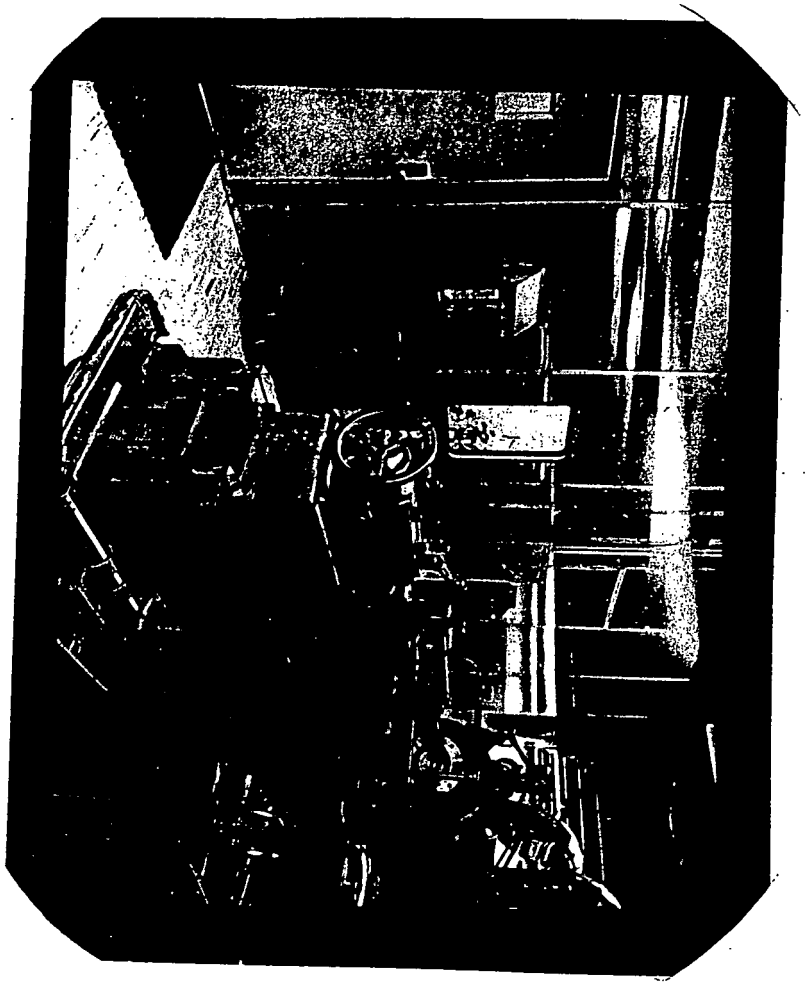

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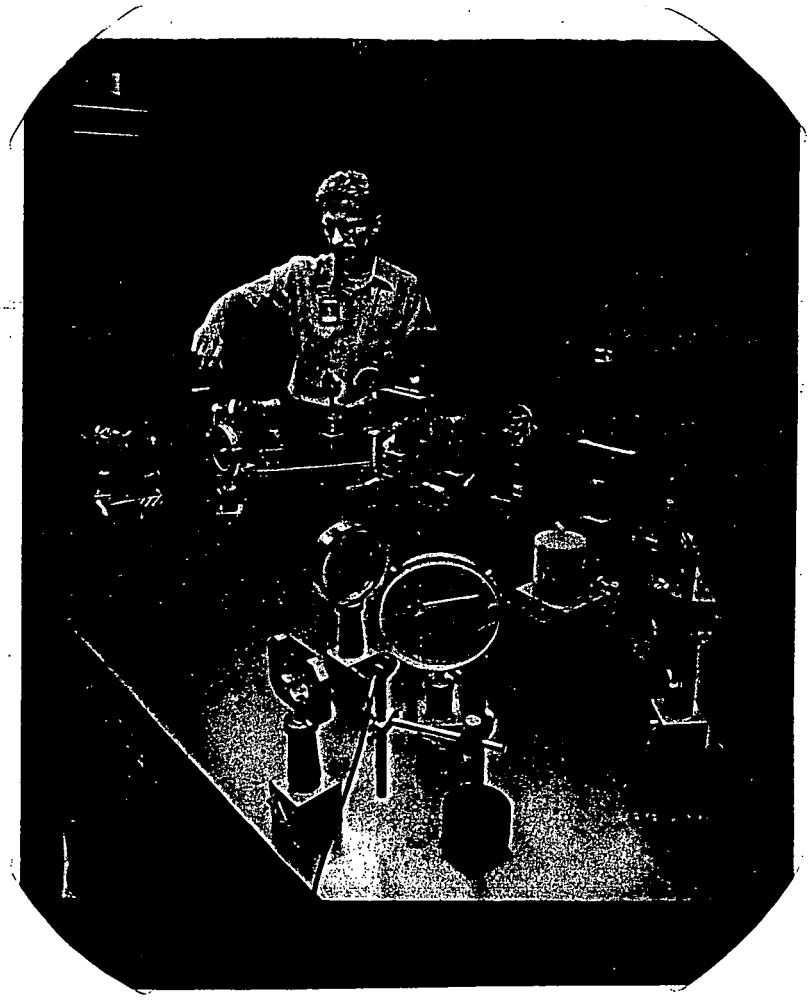

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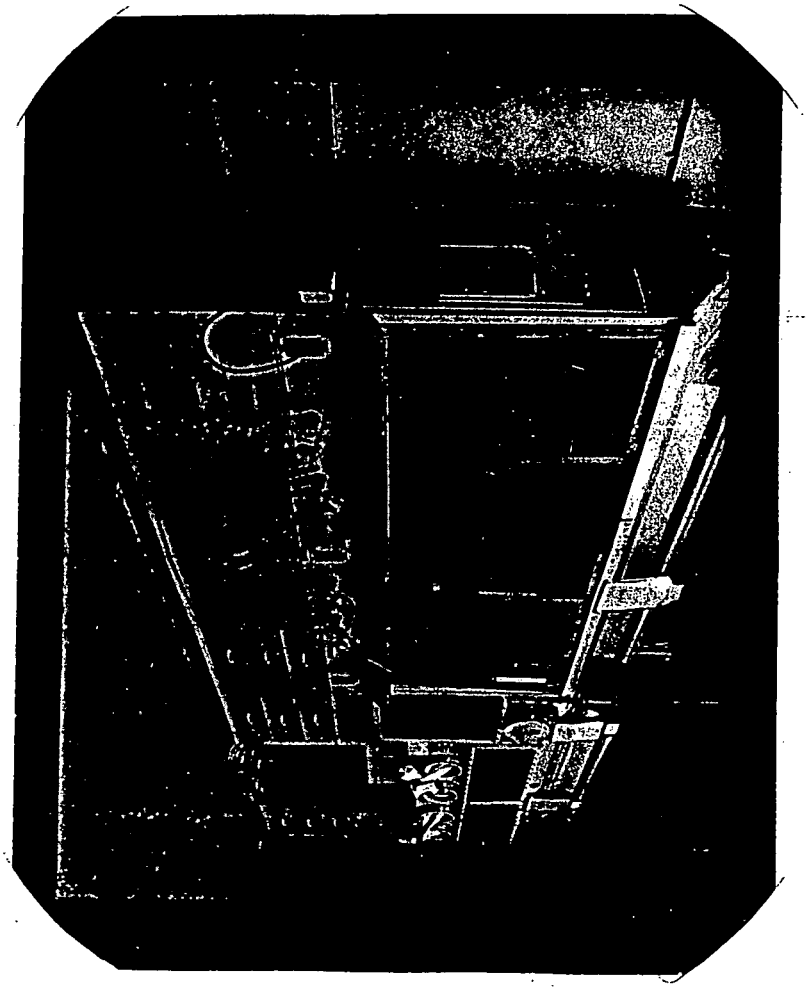

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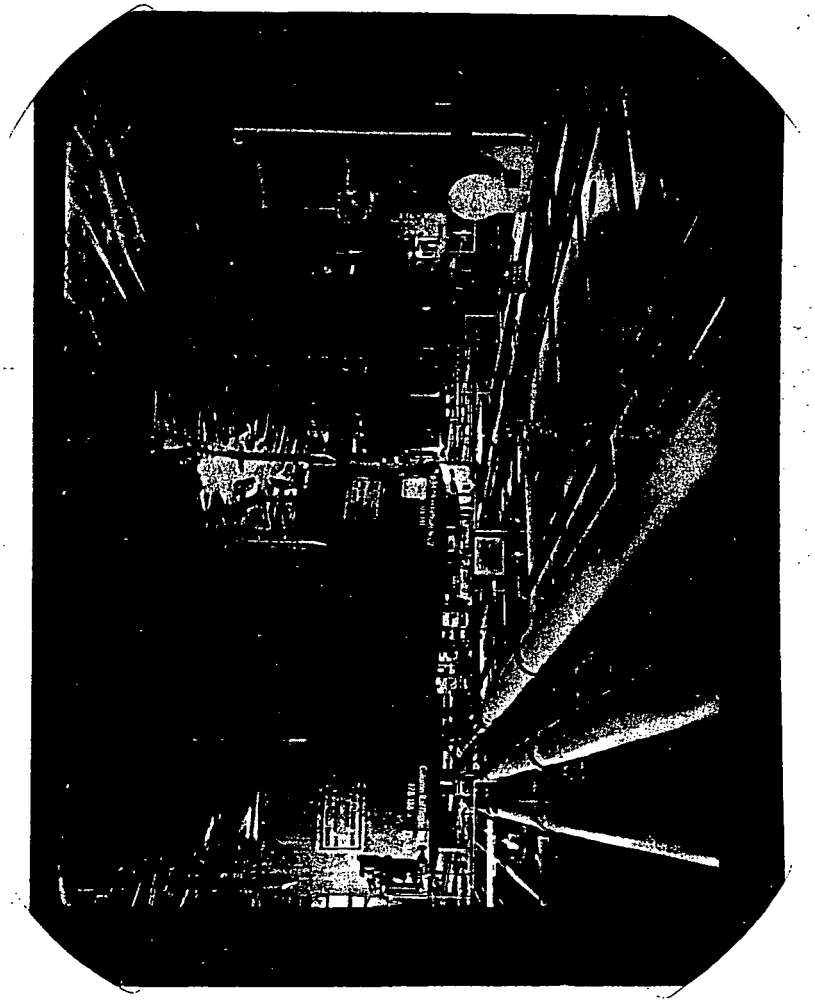

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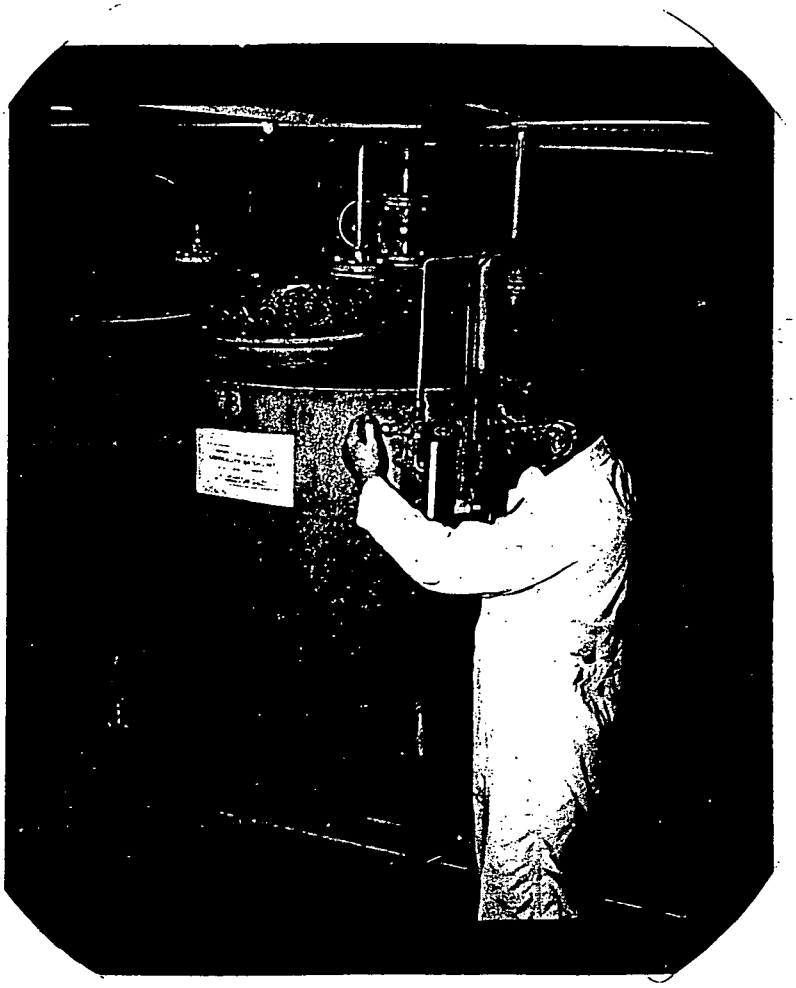

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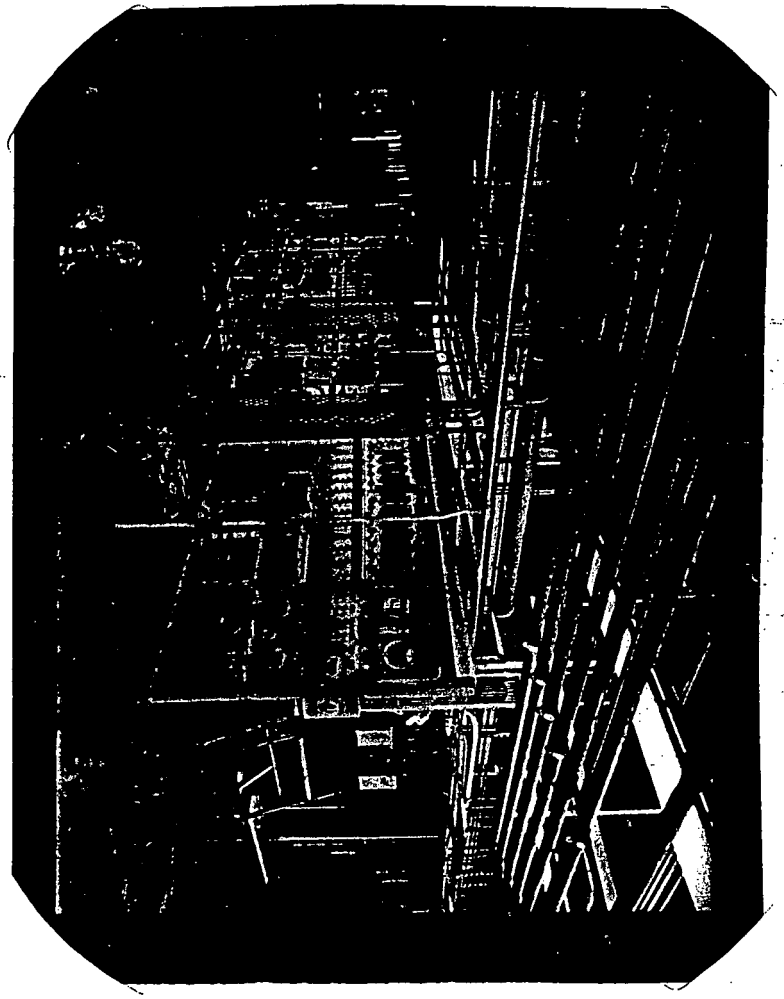

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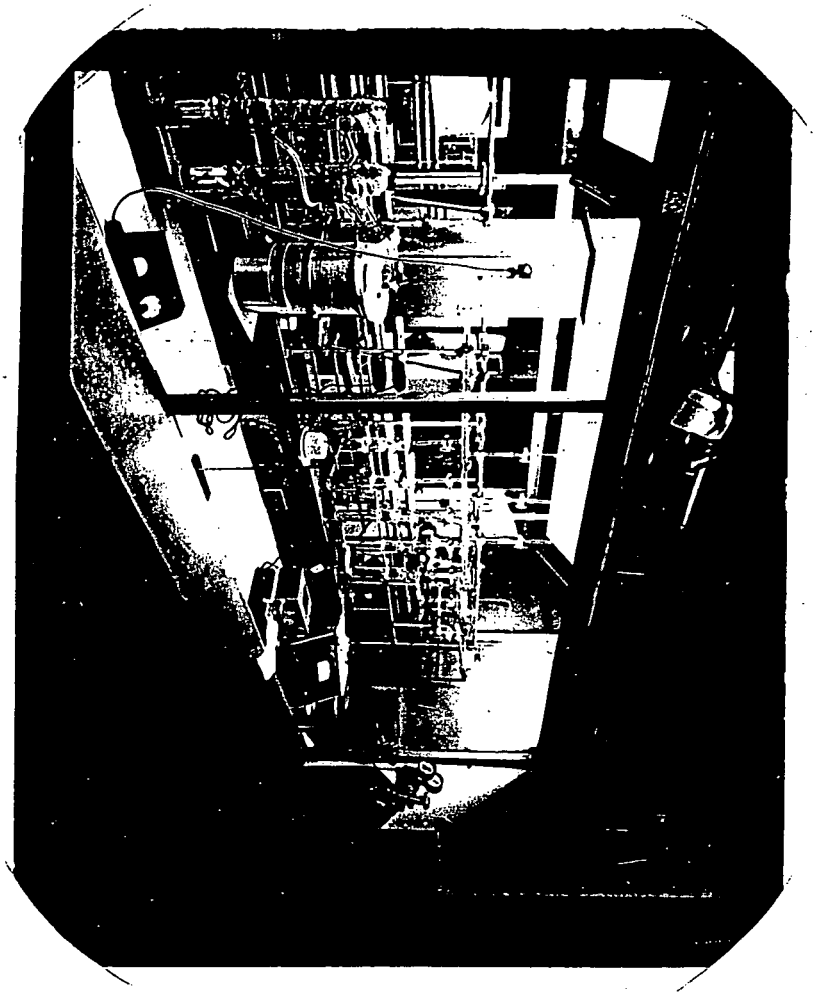

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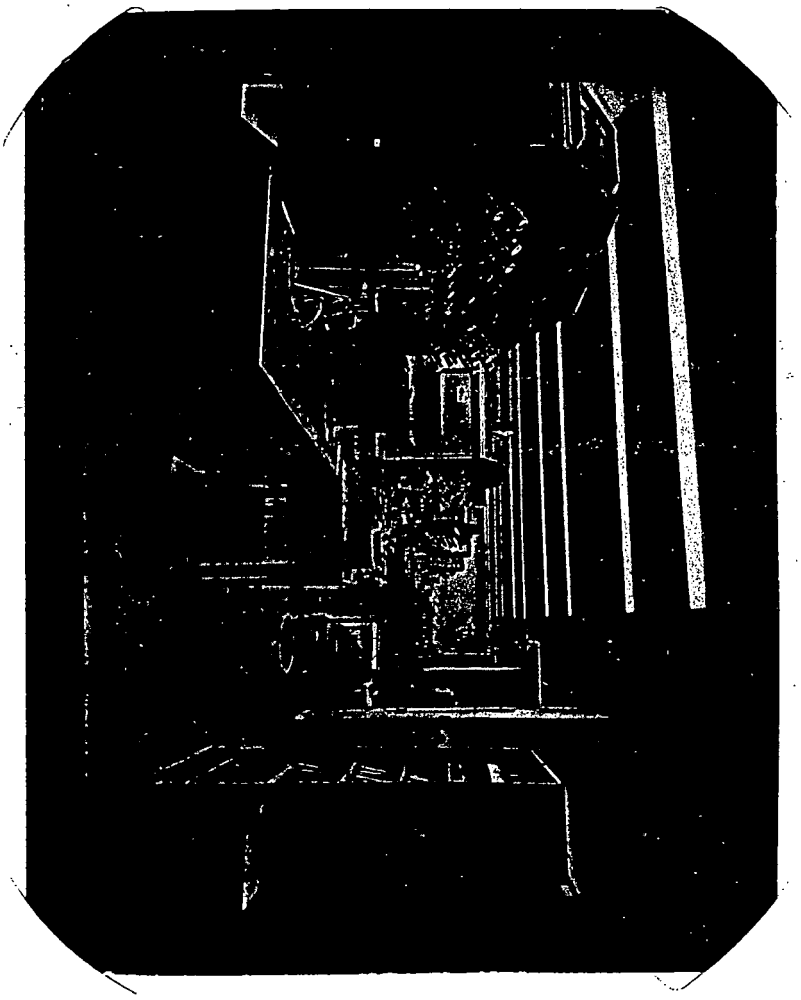

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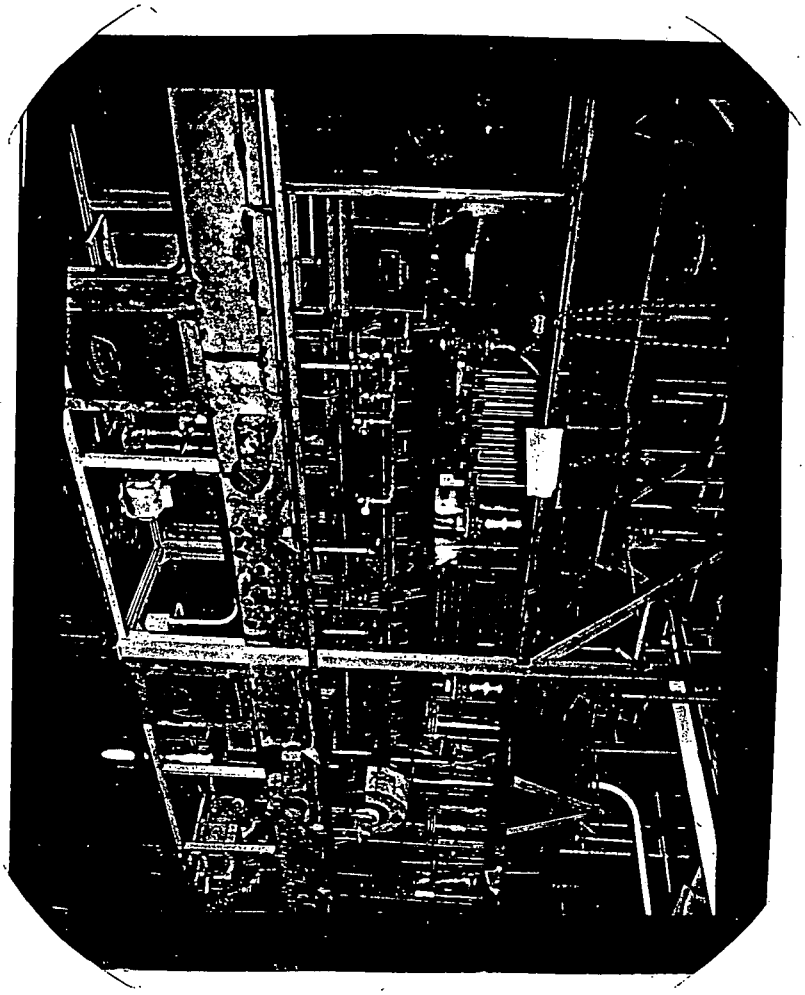

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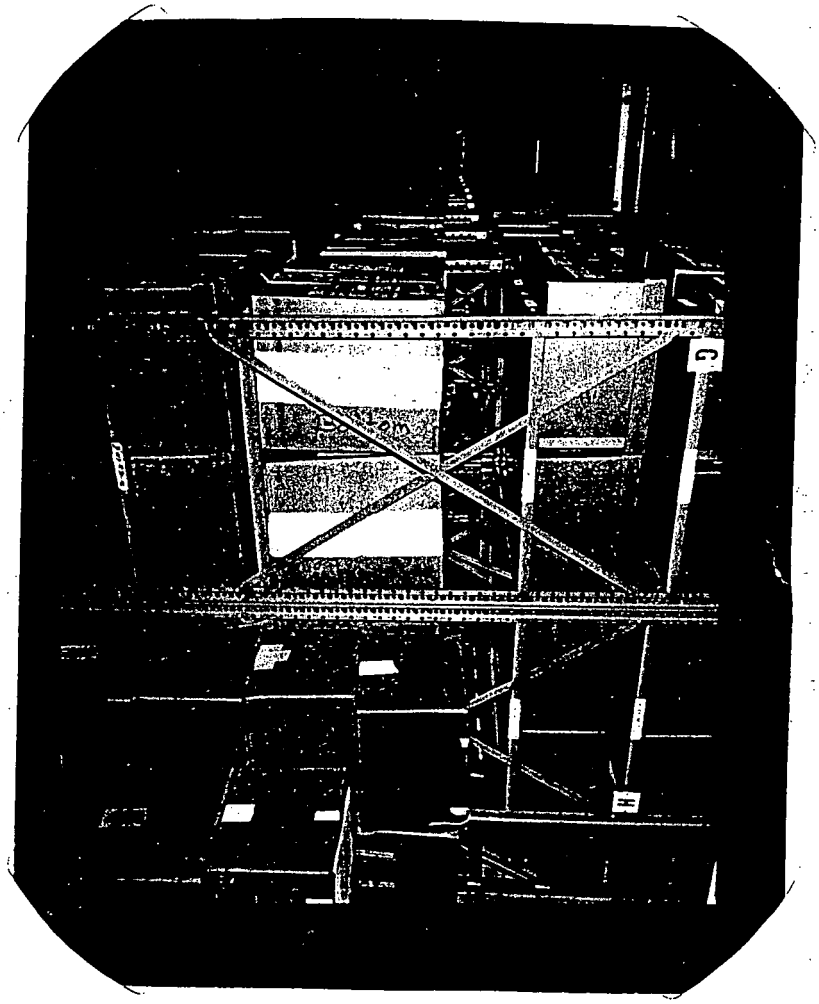

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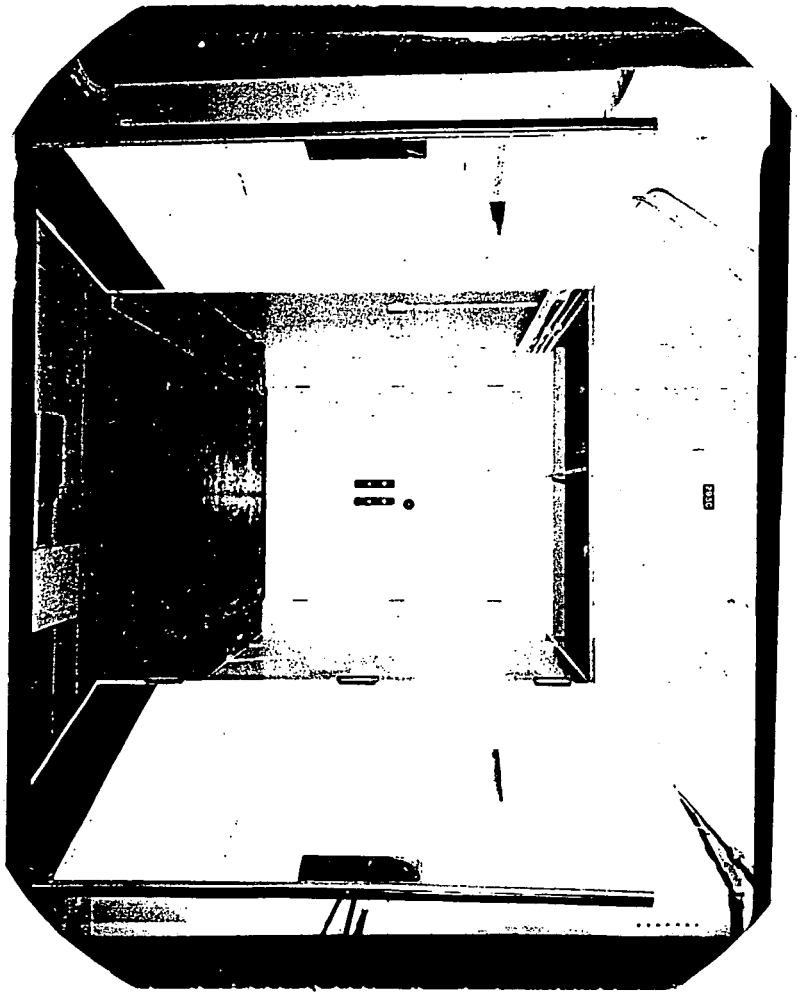

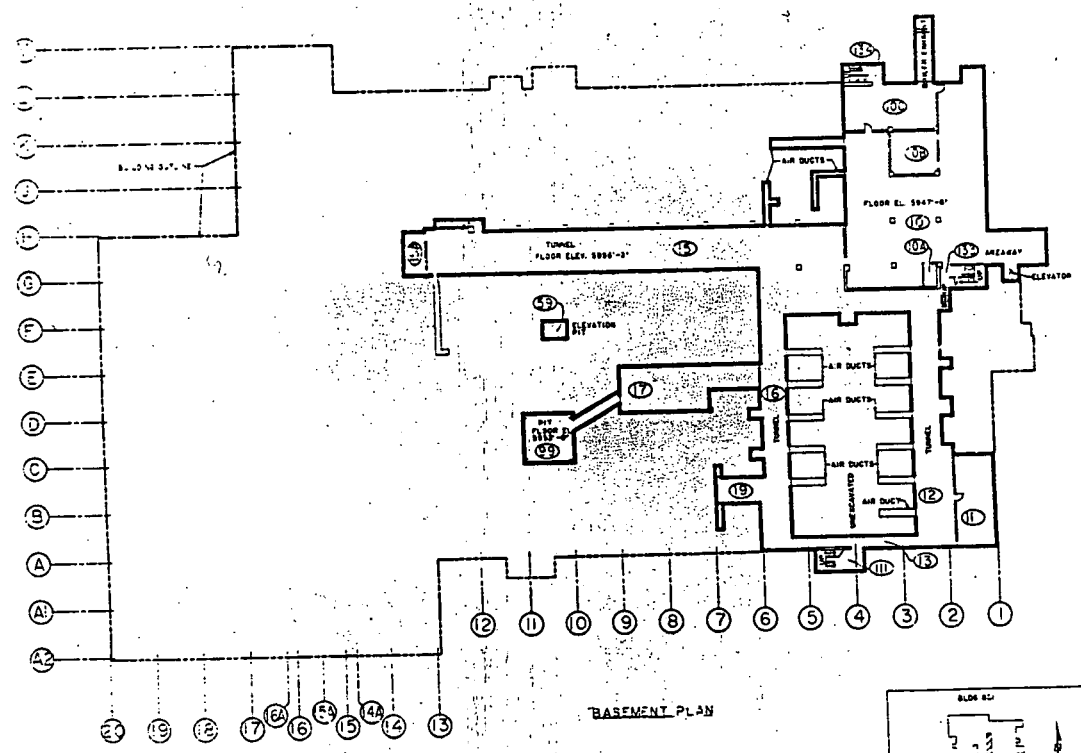

LEGEND

EXTERIOR WALL
CONCRETE WALL
CONCRETE BLOCK WALL
PARTITION WALL
ROOM NUMBER
EXTERIOR DOOR NUMBER

FLOOR AREAS

BASEMENT	17,970 SQ. FT.
FIRST FLOOR	88,300 SQ. FT.
FIRST FLOOR MEZZANINE	4,903 SQ. FT.
SECOND FLOOR	124,740 SQ. FT.
SECOND FLOOR MEZZANINE	15,330 SQ. FT.
TOTAL	245,160 SQ. FT.

DOES NOT CONTAIN UNCLASSIFIED CONTROLLED NUCLEAR INFORMATION

Reviewing Official: S. L. CUNNINGHAM
Name
Date: 3/10/98

INFORMATION ONLY

FOR REFERENCE ONLY

VIEW PLAN
SCALE NONE

U.S. DEPARTMENT OF ENERGY
ROCKY FLATS AREA OFFICE
GOLDEN, COLORADO 80402-0464

Rockwell International
ROCKY FLATS PLANT
GOLDEN, COLORADO 80402-0464

BUILDING 881
BASEMENT PLAN

D13028i-1 G

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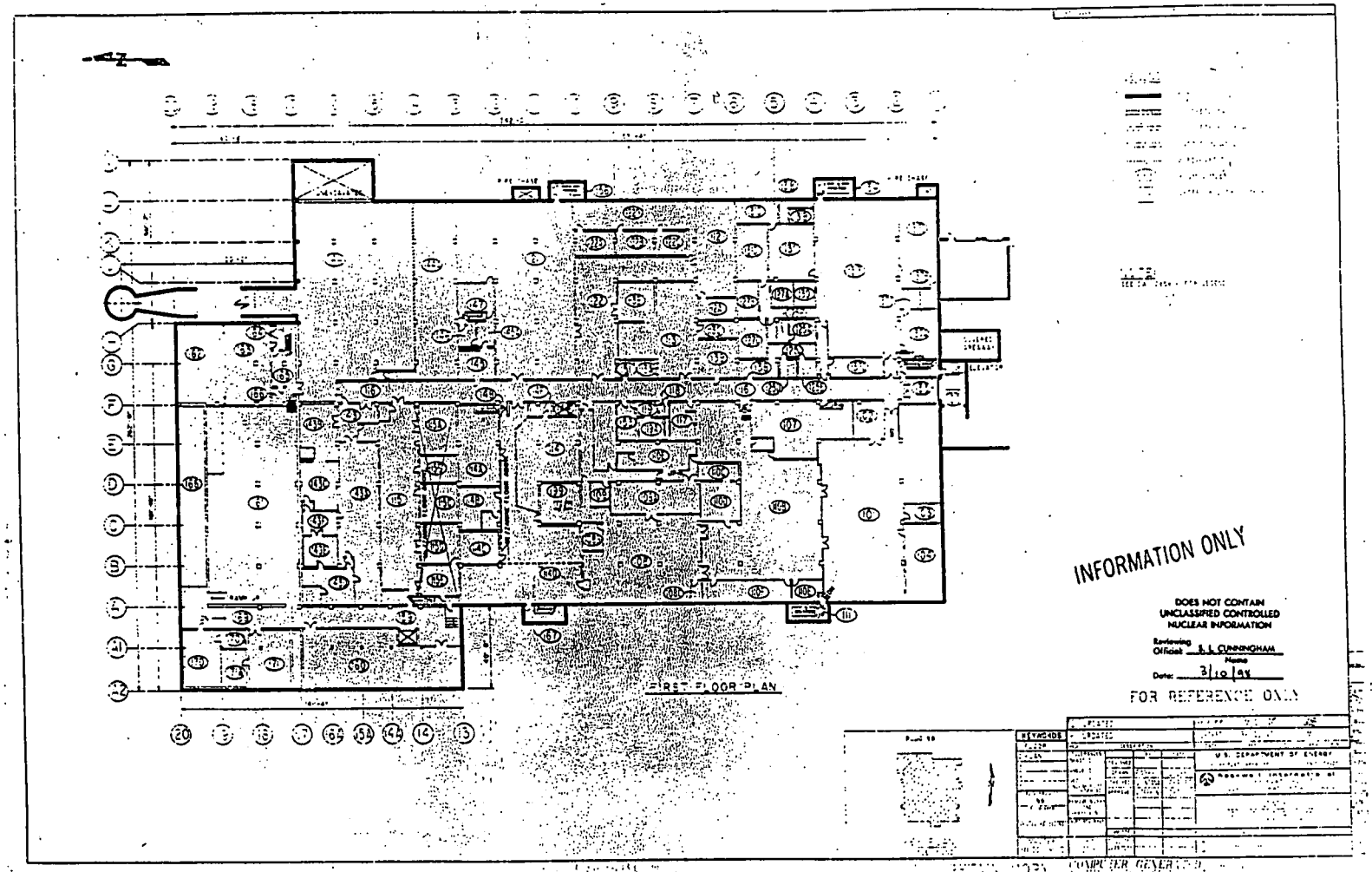
NO MANUAL CHANGES ALLOWED


FIRST FLOOR PLAN
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Name
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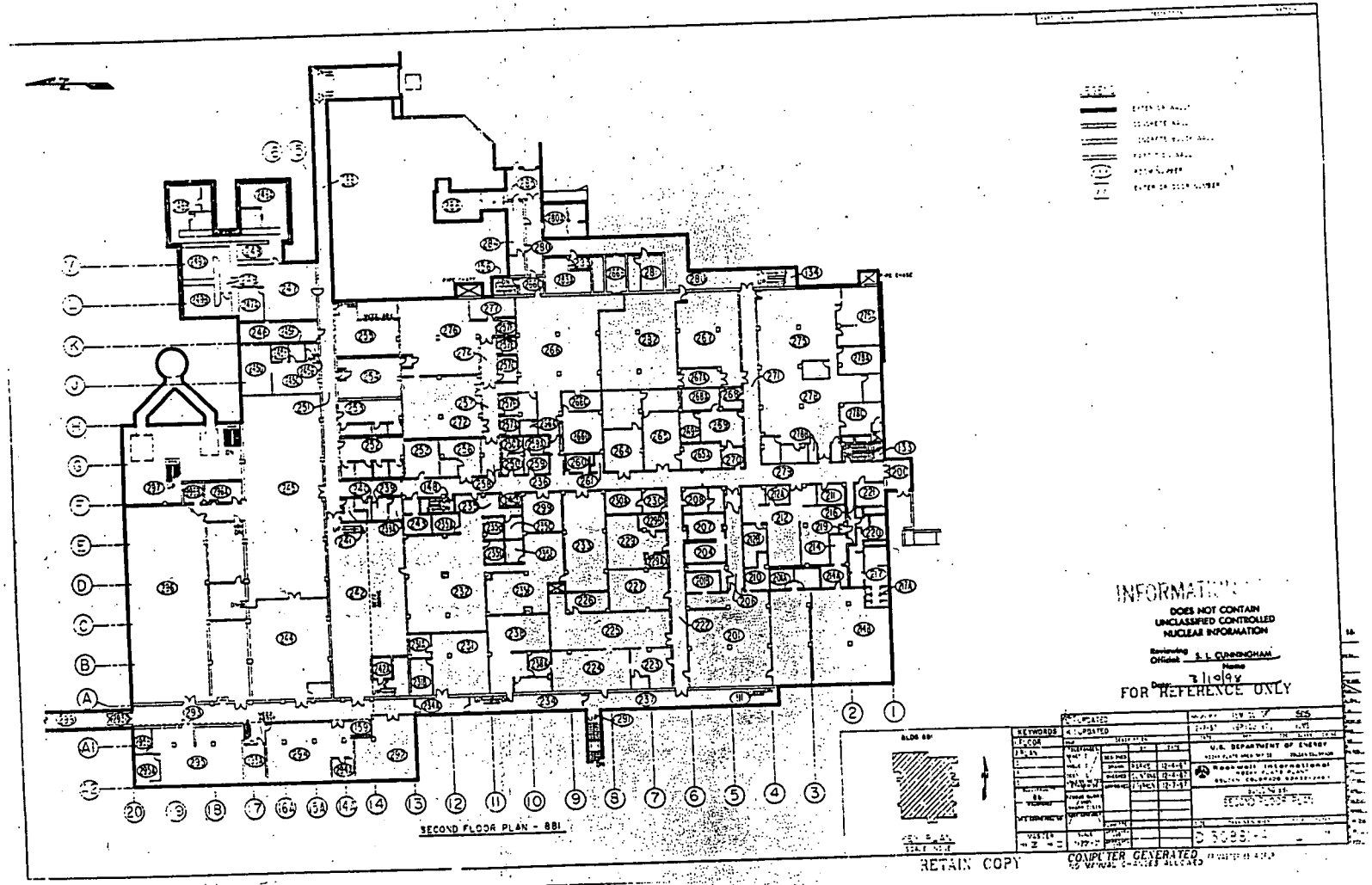
FOR REFERENCE ONLY
U.S. DEPARTMENT OF ENERGY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Date: 7/10/94
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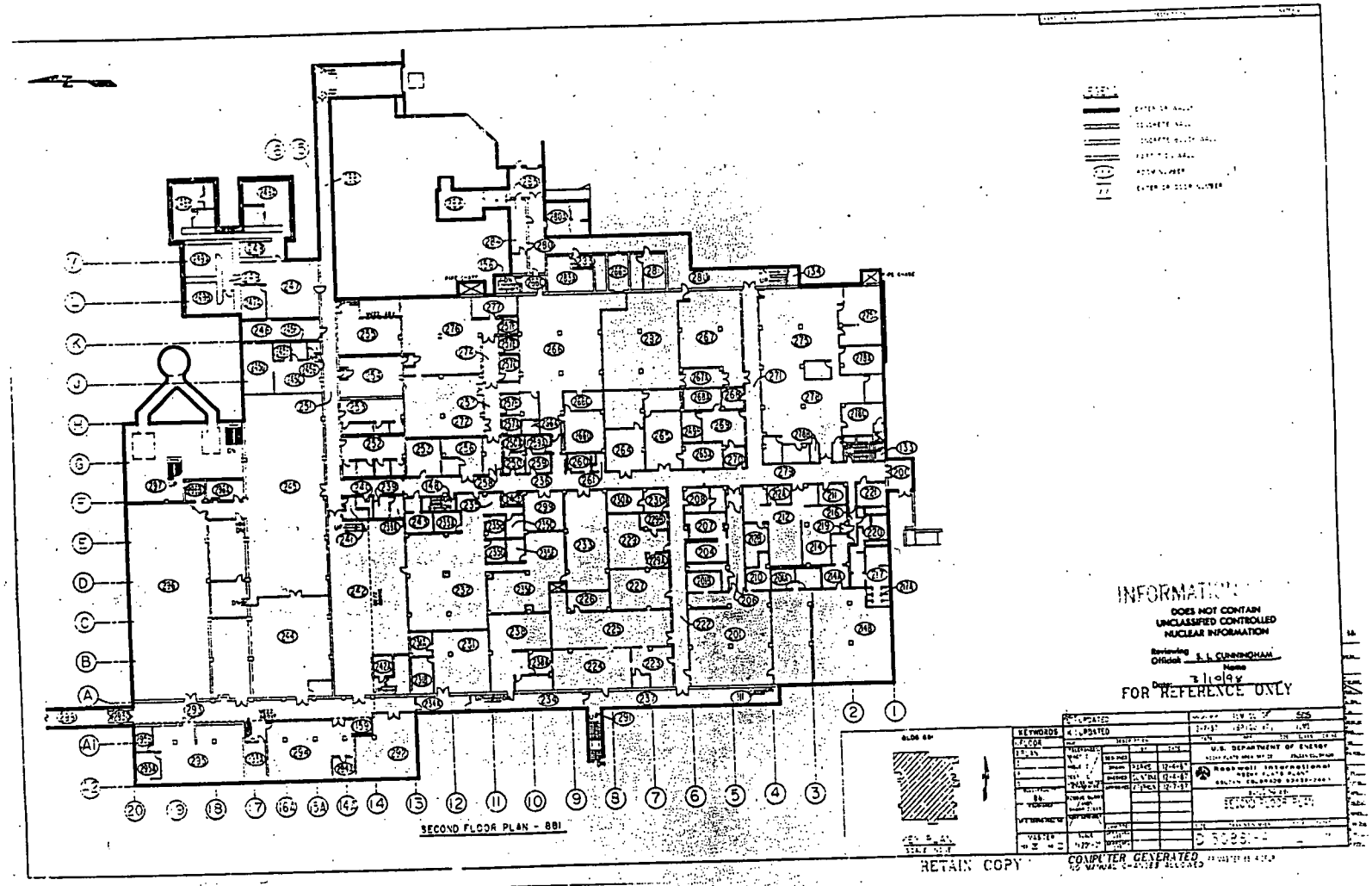
Rockwell International
ROCKY FLATS PLANT
SECOND FLOOR PLAN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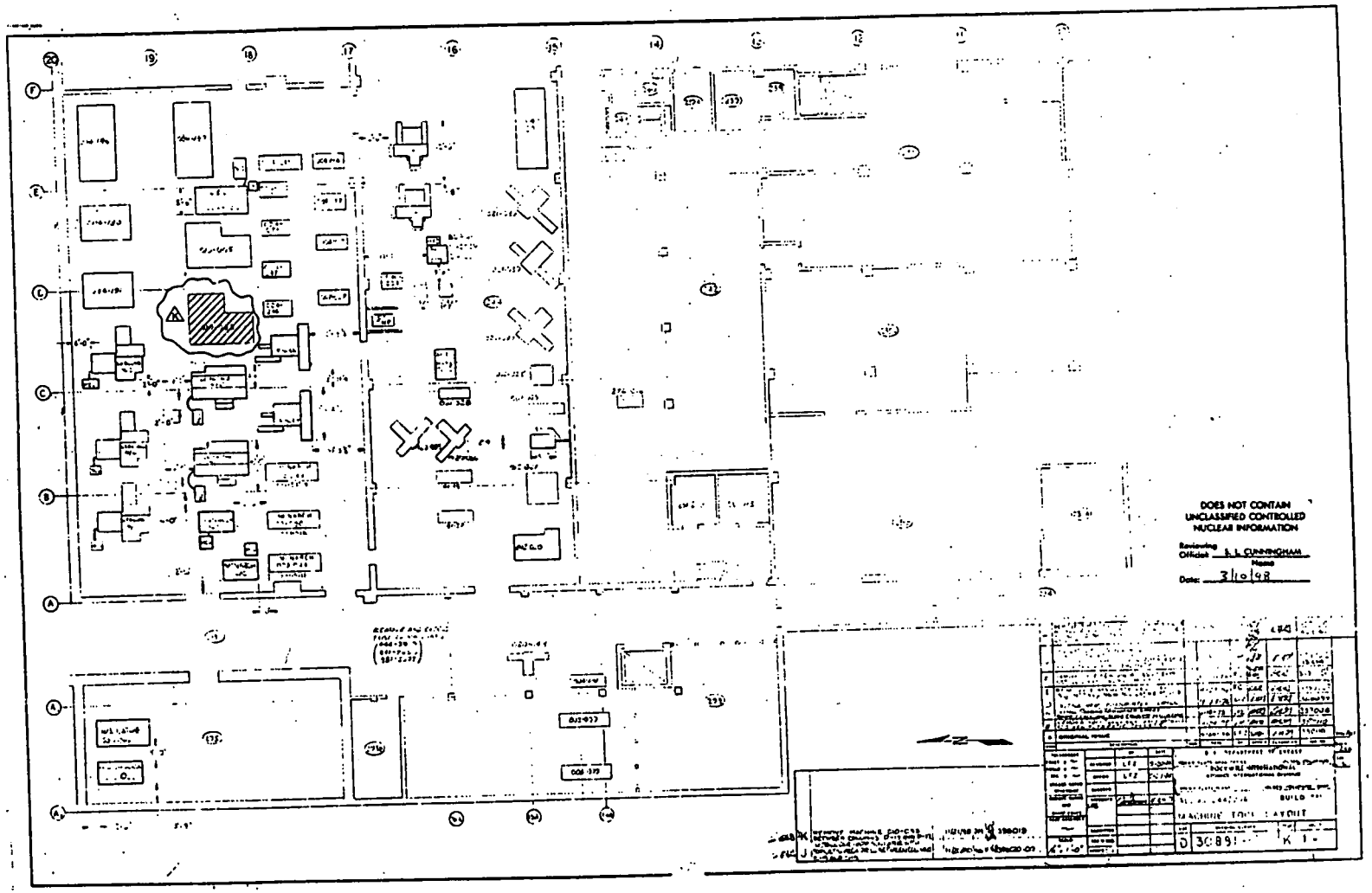
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Reviewing Officer: S. L. CUNNINGHAM
Name
Date: 3/10/98
MACHINE TOOL LAYOUT

ROCKY FLATS PLANT, URANIUM ROLLING AND FORMING OPERATIONS
(Rocky Flats Plant, Building 883)
Located in the southeastern section of the Plant, in the southeast quadrant of the intersection of Central Avenue and Eighth Street.
Golden Vicinity
Jefferson County
Colorado

HAER No. CO-83-R

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Rocky Mountain System Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

ROCKY FLATS PLANT, URANIUM
ROLLING AND FORMING OPERATIONS HAER No. CO-83-R
(Rocky Flats Plant, Building 883)

Location: Rocky Flats Environmental Technology Site, Highway 93. Building 883 is located in the southeastern section of the Rocky Flats Plant (Plant), in the southeast quadrant of the intersection of Central Avenue and Eighth Street.

Date of Construction: 1957.

Fabricator: Unknown.

Present Owner: United States Department of Energy (USDOE).

Present Use: Uranium Rolling and Forming Operations.

Significance: This building was a primary contributor to the National Register eligible Rocky Flats Plant historic district, associated with the United States (U.S.) strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack. Building 883 was constructed to accommodate expanded enriched and depleted uranium fabrication efforts.

Historians: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M), 1997. Judith Berryman, PhD., Archaeologist, e^2M, 1997.

Project Information:

In 1995, an inventory and evaluation was conducted of facilities at the Rocky Flats Plant for their potential eligibility for listing in the National Register of Historic Places. The primary goal of this investigation was to determine the significance of the Cold War era facilities at the Plant in order to assess potential effects of the long-term goals and objectives of the USDOE. These goals and objectives have not yet been formalized, but include waste cleanup and demolition activities. Recommendations regarding National Register of Historic Places eligibility were developed to allow the USDOE to submit a formal determination of significance to the Colorado State Historic Preservation Officer for review and concurrence and to provide for management of historic properties at the Plant.

From this determination and negotiations with the Colorado State Historic Preservation Officer, the Advisory Council, and the National Park Service, a Historic American Engineering Record project began in 1997 to document the Plant's resources prior to their demolition. The plant was listed on the National Register of Historic Places in 1997. The archives for the Historic American Engineering Record project are located in the Library of Congress in Washington, D.C.

Introduction:

The Plant is one of thirteen USDOE facilities that constitute the Nuclear Weapons Complex, which designed, manufactured, tested, and maintained nuclear weapons for the U.S. arsenal. The Plant was established in 1951 to manufacture triggers for use in nuclear weapons and to purify plutonium recovered from retired weapons. Each trigger consisted of a first-stage fission bomb that set off a second-stage fusion reaction in a hydrogen bomb. Parts were formed from plutonium, uranium, beryllium, stainless steel, and other materials.

A tense political atmosphere both at home and abroad during the Cold War years drove U.S. weapons research and development. By the 1970s, both the U.S. and the Soviet Union maintained thousands of nuclear weapons aimed at each other. These weapons were staged on submarines, aircraft, and intercontinental ballistic missiles. Both the North Atlantic Treaty Organization and Warsaw Pact countries in Europe had small nuclear warheads, known as theater weapons, used as part of the Mutually Assured Destruction program. (The Mutually Assured Destruction program acted as a deterrent in that if one side attacked with nuclear weapons, the other would retaliate and both sides would perish.) The final nuclear weapons program at the Plant was the W-88 nuclear warhead for the Trident II missile. This mission ended in 1992, when President Bush canceled production of the Trident II missile.

The Plant was a top-secret weapons production plant, and employees worked with a recently man-made substance, plutonium, about which little was known concerning its chemistry, interactions with other materials, and shelf-life. The Historic American Engineering Record documentation effort focused on four aspects of the Plant and its role in the Nuclear Weapons Complex: manufacturing operations, research and development, health and safety of workers, and security.

Chronology of Building 883:

1957 Building 883 was constructed. Depleted uranium was handled in Side A; enriched uranium in Side B. Other metals such as aluminum, titanium, stainless steel, and cadmium were machined in Side A.

1958	An addition was constructed to house uranium component manufacturing and to provide additional storage space.
1962	Beryllium forming operations began in Side A.
1964-66	Enriched uranium operations were transferred to Oak Ridge Reservation; Side B remained idle until 1977.
Mid-1970s	Most beryllium operations in Building 882 ceased.
1975	Foundry operations in Building 444 ceased.
1977	Manufacturing of calorimeter plates using depleted uranium began. Depleted uranium calorimeter plates were manufactured and rolled in Side A.
1970-80s	Pilot-scale operations were conducted using depleted uranium to manufacture armor plates for M1A1 tanks.
1983	Construction began on the Side C addition which was to house armor plate manufacturing for the M1A1 tank.
1985	Construction of Side C was completed; full-scale manufacturing of armor plates using depleted uranium began.
1989	Operations ceased.

Building History:

Building 883 was a non-reactor nuclear facility. It was constructed in 1956 to accommodate fabrication of enriched and depleted uranium parts used in weapons. The sealed, hollow shape of the weapon components required a significant amount of rolling and forming of both types of uranium. Because space in Buildings 881 and 444, (enriched uranium and depleted uranium parts manufacturing) was inadequate, Building 883 was constructed to handle some of the uranium rolling and forming operations.

Additions to Building 883 began in 1958 with the construction of storage and uranium component manufacturing spaces. In 1972, a valve room was added. From 1983 to 1985, additions were constructed to support the manufacturing of armor plates for M1A1 tanks.

Enriched uranium was processed in Building 883 from 1957 to 1964. These operations were moved from the building to Oak Ridge Reservation between 1964 and 1966. After 1967, metalworking operations in the building primarily involved depleted uranium (U238) and binary metal (U238 alloyed). Some stainless steel and aluminum work also occurred in the building on a fairly routine basis. Beryllium, copper, and other metals and alloys were occasionally worked on in the building. Projects included rolling, pressing, and spinning classified blanks for trigger contingency and special order work; bending tubes for weapon body parts; and swaging reservoir stems.

Building Description:

Building 883 is a high-bay, single-story building with a 38' ceiling. The structure has a partial basement and a small second floor on the north and south ends. The facility is constructed of steel framing with corrugated asbestos cement exterior panels and concrete exterior walls. The floors are concrete; limited areas are covered with asbestos tile or carpet. Ceilings in the office areas are suspended acoustical tile; ceilings in the process areas are the exposed undersides of the roof. The roofs are built-up over steel decking and supported by structural steel. The entrance to the structure is along the southern end. Office areas are located on the southern end of the building, on both the first and second floors. The majority of the building's area, encompassing approximately 76,500 square feet, is contained in a high-bay metal working area. This area contains 2,000-ton presses, rolling mills, furnaces, hot salt baths, and shearing machines. Eighty percent of the area of the building has been used for metal processing.

The three processing areas on the first floor are referred to as Sides A, B, and C. The building was originally designed with two functional areas (Sides A and B) to prevent cross-contamination of radioactive enriched uranium with non-fissile depleted uranium. In 1985, the third area, Side C, was added, to support depleted uranium armor plate production and acid scrubbing operations for cleaning depleted uranium components.

The second floor contains the inlet air plenum, associated blowers, heat exchangers, and coolers. The basement area includes a utility room, process waste storage and maintenance areas, and the entrance to an underground tunnel leading to Building 881.

Building 883 is associated with manufacturing processes in Buildings 440, 444, and 460. There is one support building and a tunnel associated with Building 883. Building 879 houses the filter plenum for Sides A and B of Building 883. A reinforced concrete tunnel connects the northwest corner of the second floor of Building 881 to the southwest corner basement of Building 883. Originally, the tunnel was used to transport enriched uranium parts and other materials between the two buildings. The tunnel is 192' x 8' x 10' with a 1'3"-thick floor slab (total floor area 1,536 square feet).

Building Operations:

Historical operations within Building 883 included manufacturing of parts from uranium and beryllium, and a series of special projects involving various metalworking operations. Manufacturing processes included rolling and forming of enriched uranium, depleted uranium, uranium-niobium alloys (binary metal), and beryllium into parts for weapons production. Actual manufacturing processes depended on the type of metal used and the desired final form.

Operations included rolling, shearing, forging, pressing, roller leveling, grinding, punching, bending, welding, heating, annealing, and cleaning. Metal was annealed in salt baths or in furnaces with argon atmospheres. Vapor degreasing, grit blasting, water washing, and nitric acid etching were used during the cleaning process. Other processes conducted in Building 883 included inspection, non-destructive testing, weighing, shipping of fabricated parts, and receipt of raw materials used to fabricate, inspect and clean the parts.

The flow of materials into, within, and from Building 883 varied according to the type of material. Enriched uranium was cast in Building 881, sent to Side B of Building 883 for rolling and forming, and returned to Building 881 for machining and inspection. Depleted uranium was cast in ingots in Building 444, sent to Side A of Building 883 for rolling and forming, and returned to Building 444 for machining and inspection. Depleted uranium products manufactured in Building 883 were shipped to Building 444 for subsequent machining operations.

Depleted and Enriched Uranium Component Manufacturing
Building 883 received depleted uranium (U238) that consisted of either virgin stock from off-site vendors or recycled scrap generated from site processes. The U238 ingots or billets were hot rolled and formed into various weapons parts or electrode strips, or were combined with niobium to form binary metal which was subsequently formed into weapon components. Virgin U238 ingots were weighed, immersed in a salt bath, rolled into a sheet, then sheared to length. The sheets were annealed in a second salt bath, cooled, and cleaned in water. These flat plates were either shaped into weapon components or were sheared a second time and trimmed to form electrode and electrode filler strips. The electrode strips were bent, cleaned in acid, and welded in a box configuration. The electrode filler strips were rolled, punched for boltholes, and cleaned in acid. The electrode and electrode filler strips were then transferred to Building 444.

Recycled U238 ingots were weighed, cropped, re-weighed, and heated in a salt bath. The ingots were rolled into sheets and sheared to length; the sheets were annealed, cooled, and cleaned in water. They were then sheared, cut into discs, heated, and formed into parts. A second forming, called a re-strike, was done to insure proper size. These parts were vapor degreased (cleaned using a hot solvent vapor process to remove contaminants) and sent to Building 444.

Manufacture of weapon parts from enriched uranium occurred in Building 883 from 1957 to 1964, at which time enriched uranium part manufacturing operations were transferred from the Plant to the Oak Ridge Reservation in Tennessee. Enriched uranium was cast in Building 881, then sent to Side B of Building 883 for rolling and forming. The formed enriched uranium parts were then transferred back to Building 881 for machining into final shape.

Binary Metals Parts Manufacturing
Binary metals, depleted uranium alloys were delivered to Building 883 as recycled ingots and non-recycled rolling pucks (slices off a cylindrical ingot). The binary ingots were heated in an argon atmosphere, and rolled into sheets. The sheets were either formed into shapes to make weapon components, or cut into electrode filler strips. The electrode filler strips were stamped with batch identification marks and bolt holes were punched in one end. The strips were then annealed in an argon atmosphere and quenched in water. The strips were strengthened in the roller leveler, cut to final length, and transferred to Building 444. The binary pucks were also heated in an argon atmosphere, rolled into sheets, annealed, and water quenched. The sheets were then straightened in a roller leveler and cut into discs for forming into parts. After inspection, the parts were sent to Building 444.

Beryllium Component Manufacturing
Beryllium-forming operations, which took place in Side A from 1962 to the mid-1980s, required the development of special techniques to compensate for the brittle nature of beryllium. Beryllium ingots, measuring 9" x 9", were cast in Building 444 and encased in stainless steel in Building 881. The stainless steel and beryllium sandwich was heated and rolled into sheets; stainless steel forms were cut away after the beryllium was rolled to the specified thickness. The beryllium sheets were heat-treated and pressed into the desired shapes in Building 883, then returned to Building 444 for further machining.

Operations Since 1989
Starting in 1989, Building 883 operations began to diminish. By 1993, Building 883 operations focused on rolling and pressing of classified blanks for trigger contingency (war reserve) and special order work; bending tubes for weapon body parts; and swaging reservoir stems to meet production requirements.

In 1994, Building 883 operations ceased and the building was closed.

Sources: ChemRisk, 1992, *Project Tasks 3 and 4 Final Draft Report, Reconstruction of Historic Rocky Flats Operations and Identification of Release Points*, prepared for Colorado Department of Health.

EG&G, 1994, *Historic Release Report*, Rocky Flats Plant Repository.

Padron, Henry, employed at the Plant by the site contractor since 1969, personal communication, December 1997.

USDOE Public Affairs, n.d. *Tour Information.* Rocky Flats Facilities. Golden, Colorado: U.S. Department of Energy, Office of Communications and Economic Development.

USDOE, 1995, *Final Cultural Resource Survey Report Rocky Flats Environmental Technology Site, The Industrial Area*, Rocky Flats Plant Repository.

HISTORIC AMERICAN ENGINEERING RECORD

INDEX TO PHOTOGRAPHS

ROCKY FLATS PLANT, URANIUM ROLLING AND FORMING OPERATIONS HAER No. CO-83-R
(Building Flats Plant, Building 883)
Located in the southeastern section of the Plant, in the southeast quadrant of the intersection of Central Avenue and Eighth Street.
Golden Vicinity
Jefferson County
Colorado

Photographs CO-83-R-1 through CO-83-R-19 were taken by various site photography contractors, dates indicated in parentheses.

CO-83-R-1 VIEW OF BUILDING 883 EXTERIOR, LOOKING SOUTHEAST. VENTILATION EQUIPMENT IS VISIBLE. (11/27/56)

CO-83-R-2 VIEW OF INTERIOR, EAST SIDE (SIDE A) OF BUILDING 883. INSTALLATION OF ROLLING MILLS AND MOLTEN SALT BATH EQUIPMENT FOR DEPLETED URANIUM FABRICATION. THE CRANE NEAR THE CEILING WAS USED TO INSTALL THE EQUIPMENT. BOXES ON THE FLOOR CONTAINED EQUIPMENT TO BE INSTALLED. (1/23/57)

CO-83-R-3 VIEW OF INTERIOR, EAST SIDE (SIDE A) OF BUILDING 883. INSTALLATION OF EQUIPMENT FOR THE MOLTEN SALT BATHS AND ROLLING MILLS PROCESSES. (4/25/57)

CO-83-R-4 DETAIL VIEW (SIDE A) OF HANDMADE STEEL BOX ASSOCIATED WITH THE DEPLETED URANIUM ALLOY DEVELOPMENT AND COMPONENT FABRICATION PROCESS. THE BOX WAS USED TO TRANSFER HEATED BLOCKS OF METAL (SHOWN IN THE OPENED DOOR) FROM THE MOLTEN SALT BATH TO THE ROLLER LINES. (4/28/62)

CO-83-R-5 VIEW OF BERYLLIUM PROCESSING AREA, ROLLING MILL. BERYLLIUM FORMING BEGAN IN SIDE A OF THE BUILDING IN 1962. (11/5/73)

CO-83-R-6 DETAIL VIEW OF SPIN FORM FURNACE FOR STAINLESS STEEL FABRICATION. STAINLESS STEEL WAS MACHINED IN SIDE A OF THE BUILDING, BEGINNING IN 1957. (4/24/78)

CO-83-R-7 VIEW OF HYDRAULIC HAMMER STAMPING PRESS ON SIDE A OF BUILDING 883. THIS TYPE OF PRESS WAS USED FOR BOTH STAINLESS STEEL AND FOR DEPLETED URANIUM. (7/2/86)

CO-83-R-8 VIEW OF THE SWITCHGEAR AND ELECTRICAL SUPPLY ROOM IN BETWEEN SIDES A AND B OF BUILDING 883. EQUIPMENT WITHIN THE BUILDING REQUIRED AN EXTENSIVE AMOUNT OF POWER. THE ELECTRICAL SUPPLY ROOM IS ESSENTIALLY AN ELECTRICAL SUBSTATION. (1/23/57)

CO-83-R-9 VIEW OF MOLTEN SALT BATH EQUIPMENT AND ROLLER PRESSES BEING INSTALLED ON THE WEST SIDE (SIDE B) OF BUILDING 883. SIDE B OF BUILDING 883 WAS USED TO PROCESS ENRICHED URANIUM FROM 1957-66. (1/23/57)

CO-83-R-10 VIEW OF THE ADDITION TO BUILDING 883, REFERRED TO AS SIDE C. ARMOR PLATE MADE WITH DEPLETED URANIUM WAS HEATED IN A MOLTEN SALT BATH, THEN PROCESSED THROUGH THE ROLLING MILL TO FORM LARGE SHEETS. (9/16/85)

CO-83-R-11 VIEW OF THE MANIPULATOR AND THE PARTS HEATING FURNACE. THE PARTS OR METALS WERE HEATED PRIOR TO BEING PRESSED. THE MANIPULATOR ARM WAS USED TO INSERT AND REMOVE PARTS OR METALS FROM THE FURNACE. (2/9/79)

CO-83-R-12 VIEW OF THE MANIPULATOR AND THE PARTS HEATING FURNACE. THE METALS WERE HEATED PRIOR TO BEING PRESSED. THE ARM IS DRAPED WITH FIRE RESISTANT MATERIAL. (2/9/79)

CO-83-R-13 VIEW OF THE MOLTEN SALT BATHS USED TO UNIFORMLY AND QUICKLY HEAT METALS PRIOR TO WORKING (ROLLING). (9/16/85)

CO-83-R-14 VIEW OF METAL ROLLING OPERATION. THE METALS ARE BEING PREPARED TO BE ROLLED INTO SHEETS OF SPECIFIC THICKNESS. COMPONENT PARTS WERE FABRICATED FROM THE METAL SHEETS. (11/82)

CO-83-R-15 VIEW OF ROLLING OPERATION. INGOTS AND BAR STOCK WERE ROLLED TO A SPECIFIED THICKNESS IN PREPARATION FOR FURTHER PROCESSING. (11/82)

CO-83-R-16 VIEW OF A ROLLING MILL THAT WAS USED TO CREATE A METAL SHEET (SHOWN). (4/16/57)

CO-83-R-17 VIEW OF FORMING EQUIPMENT. DISCS CUT FROM METAL SHEETS WERE FORMED INTO SHAPES. (7/2/86)

CO-83-R-18 VIEW OF ROLLER LEVELER USED TO STRAIGHTEN AND FLATTEN METAL SHEETS. (7/2/86)

CO-83-R-19 VIEW OF THE BAKE-OUT FURNACE, WHERE PARTS WERE HEATED UNDER A VACUUM TO HEAT TREAT OR TO BAKE OUT ANY IMPURITIES. (9/19/72)

CO-83-R-20 VIEW OF THE BASEMENT FLOOR PLAN. THE BASEMENT AREA INCLUDES A UTILITY ROOM, PROCESS WASTE STORAGE AND MAINTENANCE AREAS, AND THE ENTRANCE TO AN UNDERGROUND TUNNEL LEADING TO BUILDING 881. THE ORIGINAL DRAWING HAS BEEN ARCHIVED ON MICROFILM. THE DRAWING WAS REPRODUCED AT THE BEST QUALITY POSSIBLE. LETTERS AND NUMBERS IN THE CIRCLES INDICATE FOOTER AND/OR COLUMN LOCATIONS.

CO-83-R-21 VIEW OF THE FIRST FLOOR PLAN. THE FIRST FLOOR WAS USED FOR DEPLETED AND ENRICHED URANIUM FABRICATION. THE ORIGINAL DRAWING HAS BEEN ARCHIVED ON MICROFILM. THE DRAWING WAS REPRODUCED AT THE BEST QUALITY POSSIBLE. LETTERS AND NUMBERS IN THE CIRCLES INDICATE FOOTER AND/OR COLUMN LOCATIONS.

CO-83-R-22 VIEW OF THE SECOND FLOOR PLAN. THE SECOND FLOOR CONTAINS THE AIR PLENUM AND SOME OFFICE SPACE. THE ORIGINAL DRAWING HAS BEEN ARCHIVED ON MICROFILM. THE DRAWING WAS REPRODUCED AT THE BEST QUALITY POSSIBLE. LETTERS AND NUMBERS IN THE CIRCLES INDICATE FOOTER AND/OR COLUMN LOCATIONS.

CO-83-R-23 VIEW OF SECTION DRAWINGS. THE SECTION LINES CUT THE BUILDING EAST-WEST. THE ORIGINAL DRAWING HAS BEEN ARCHIVED ON MICROFILM. THE DRAWING WAS REPRODUCED AT THE BEST QUALITY POSSIBLE. LETTERS AND NUMBERS IN THE CIRCLES INDICATE FOOTER AND/OR COLUMN LOCATIONS.

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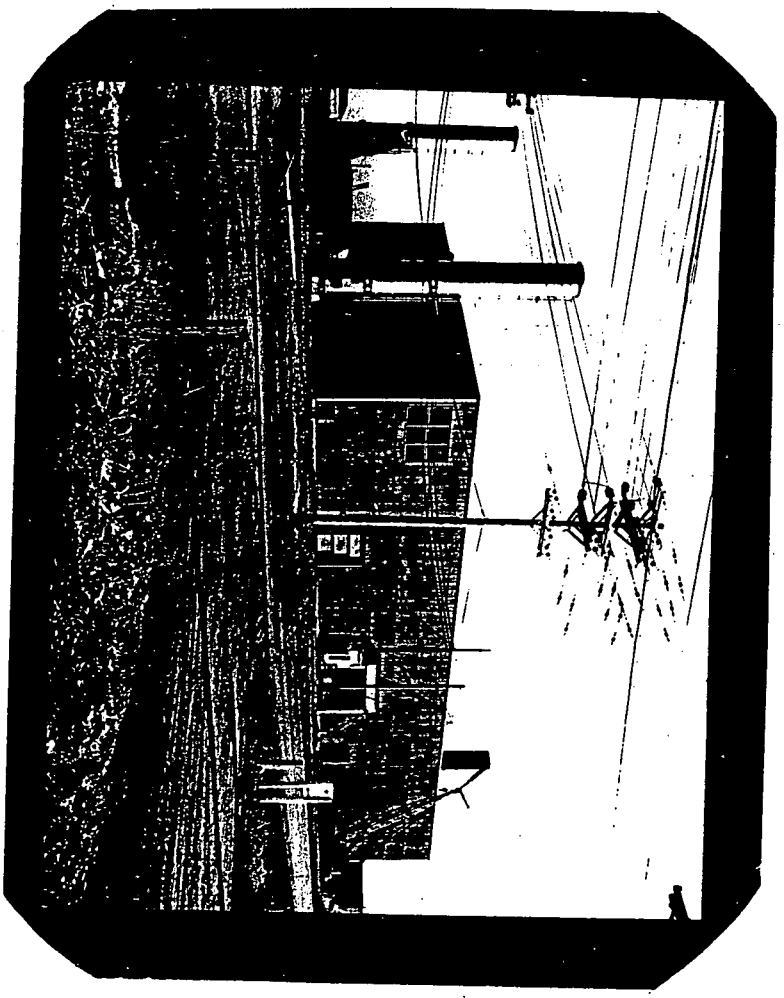

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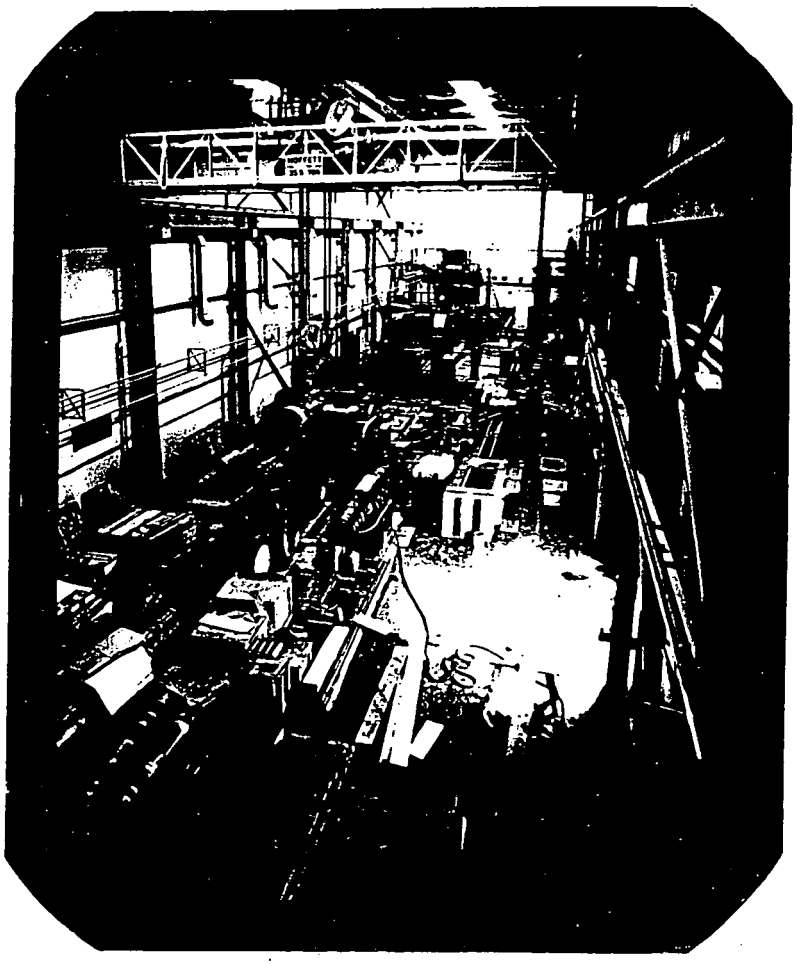

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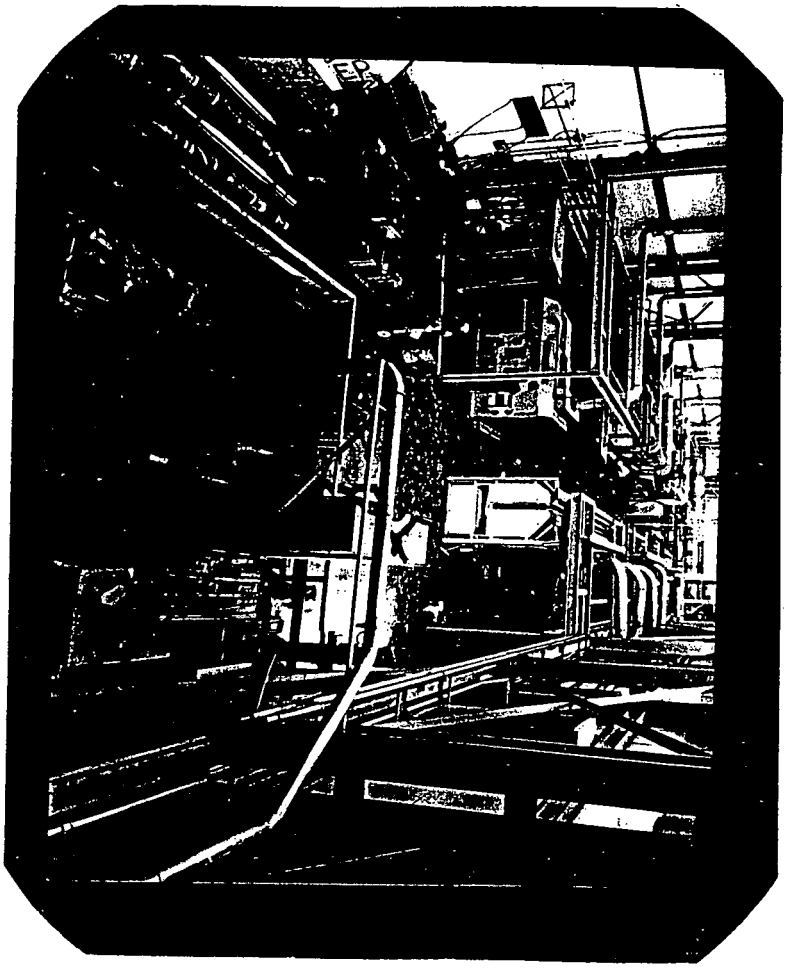

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HAER No. CO-33-R-5

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HAER No. CO-15-R-6

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SEE INDEX TO PHOTOGRAPHS FOR CAPTION

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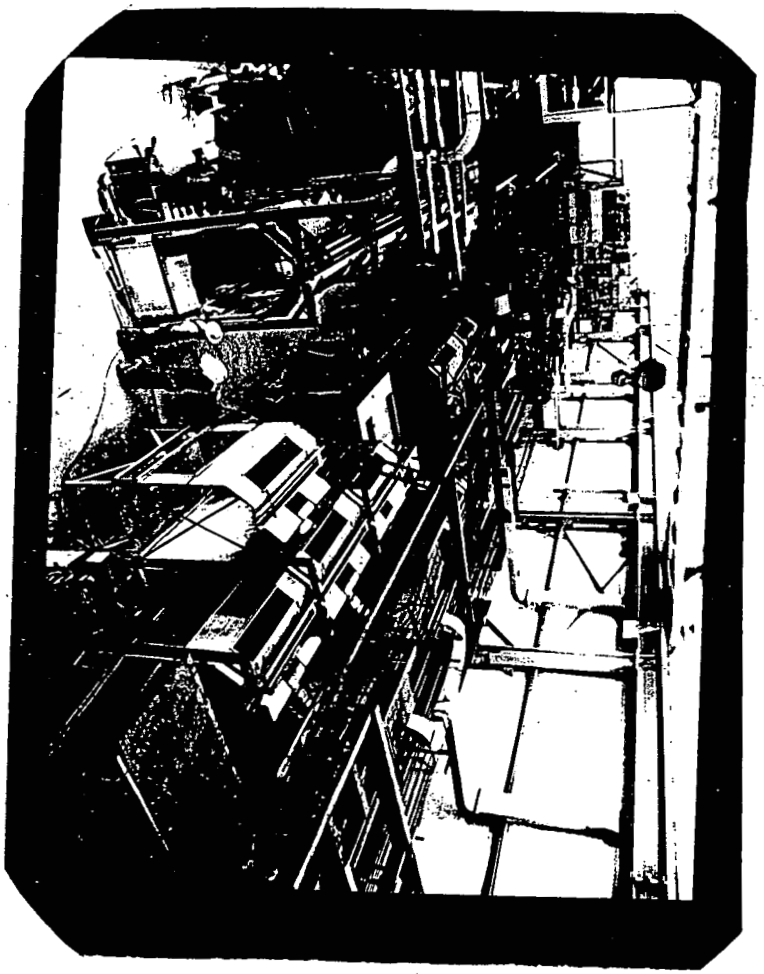

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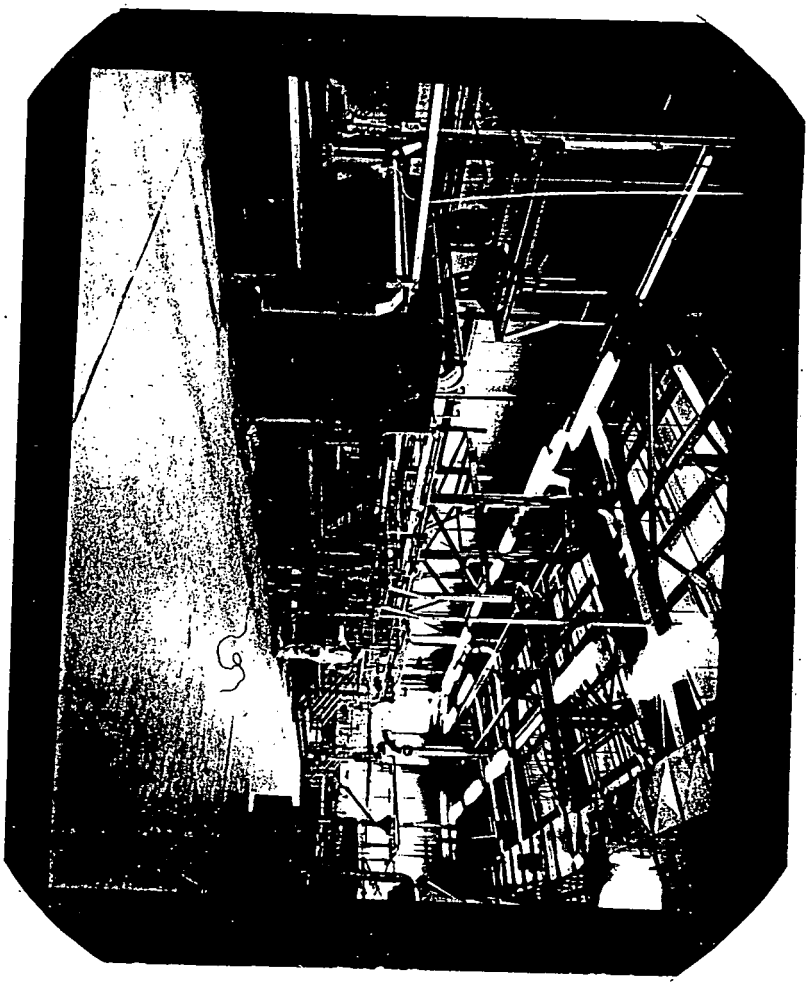

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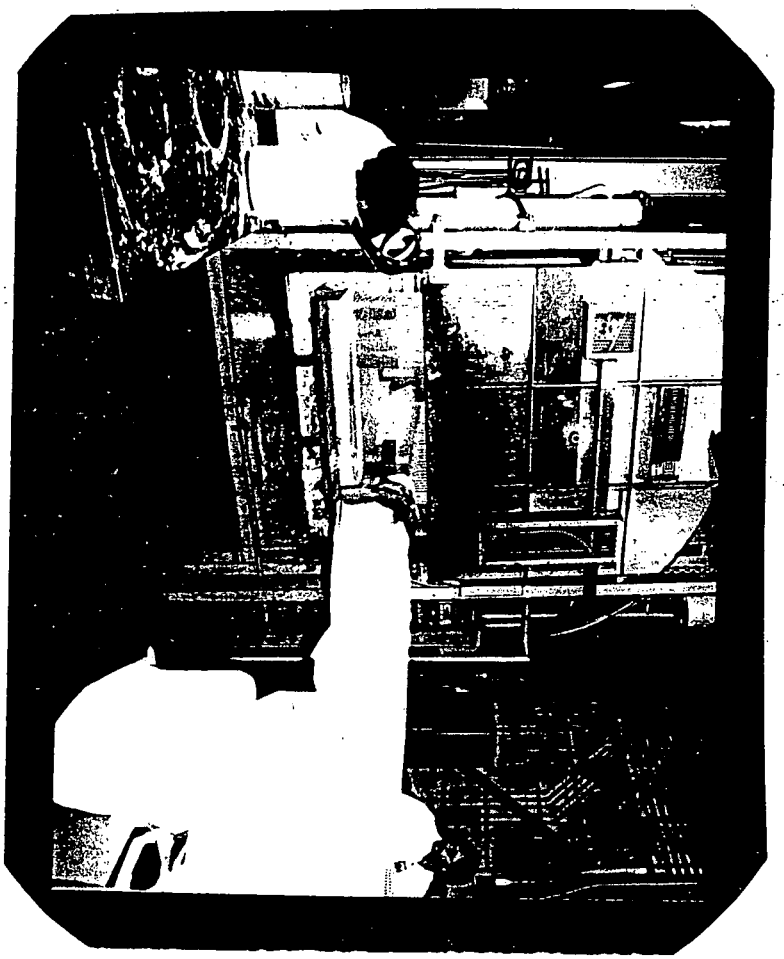

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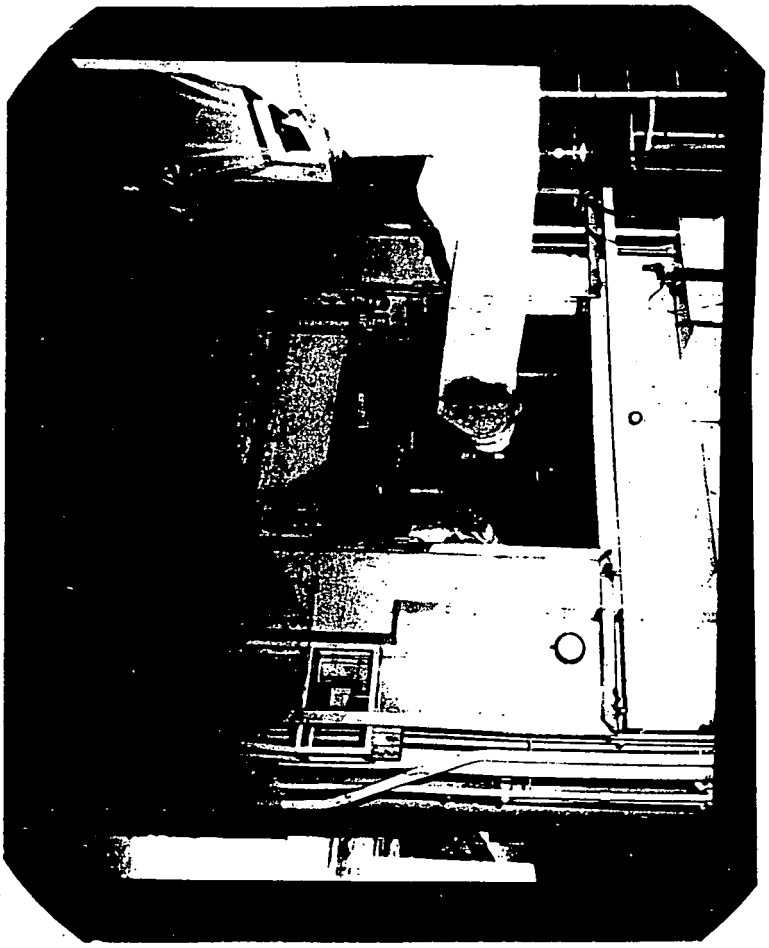

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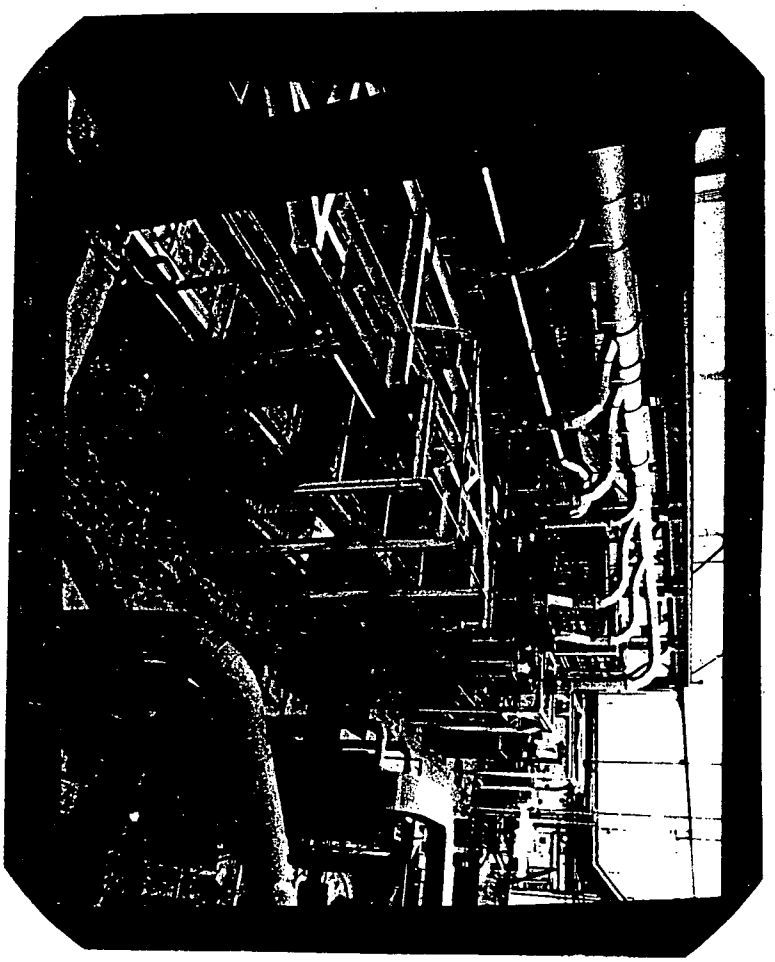

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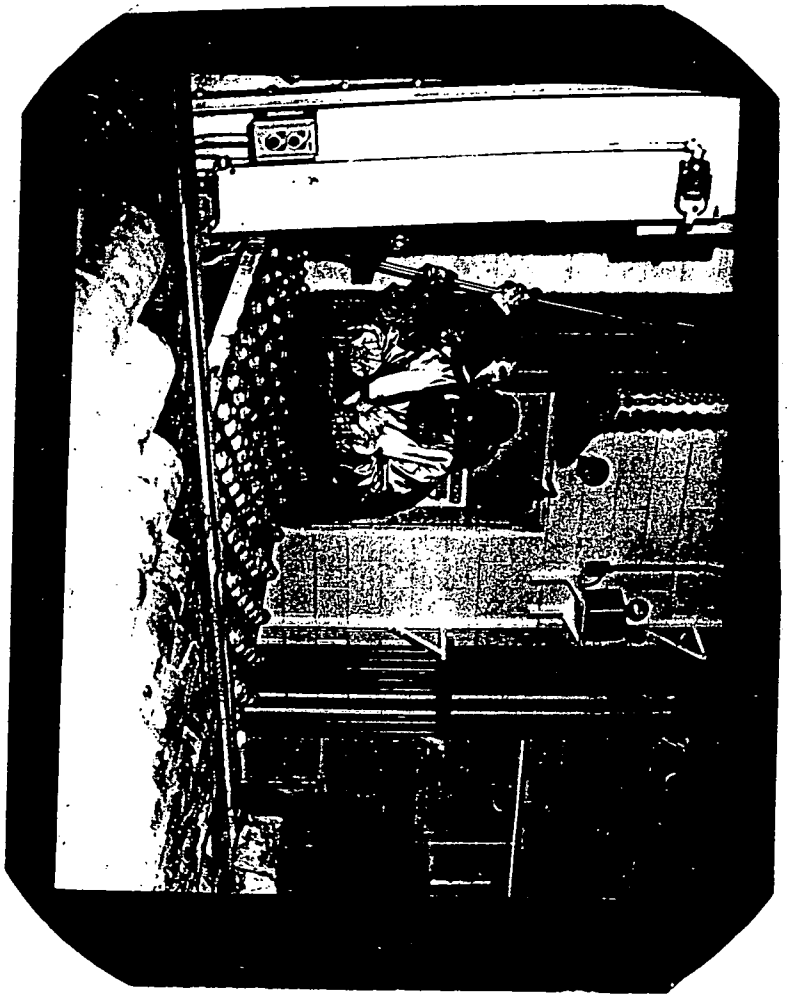

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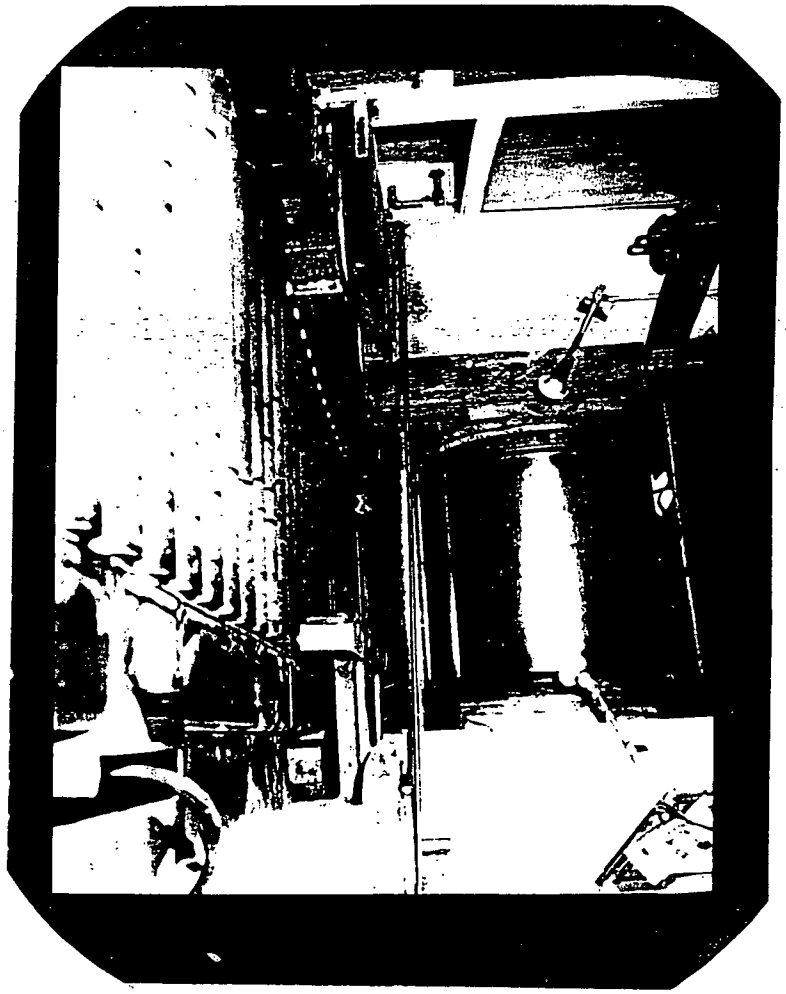

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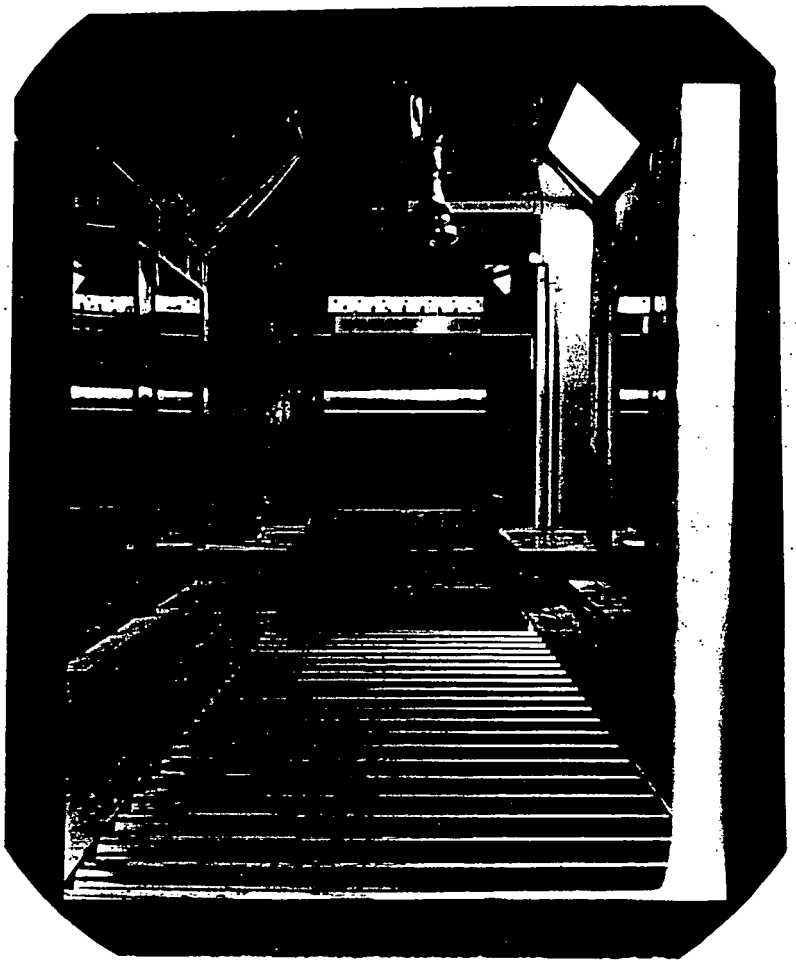

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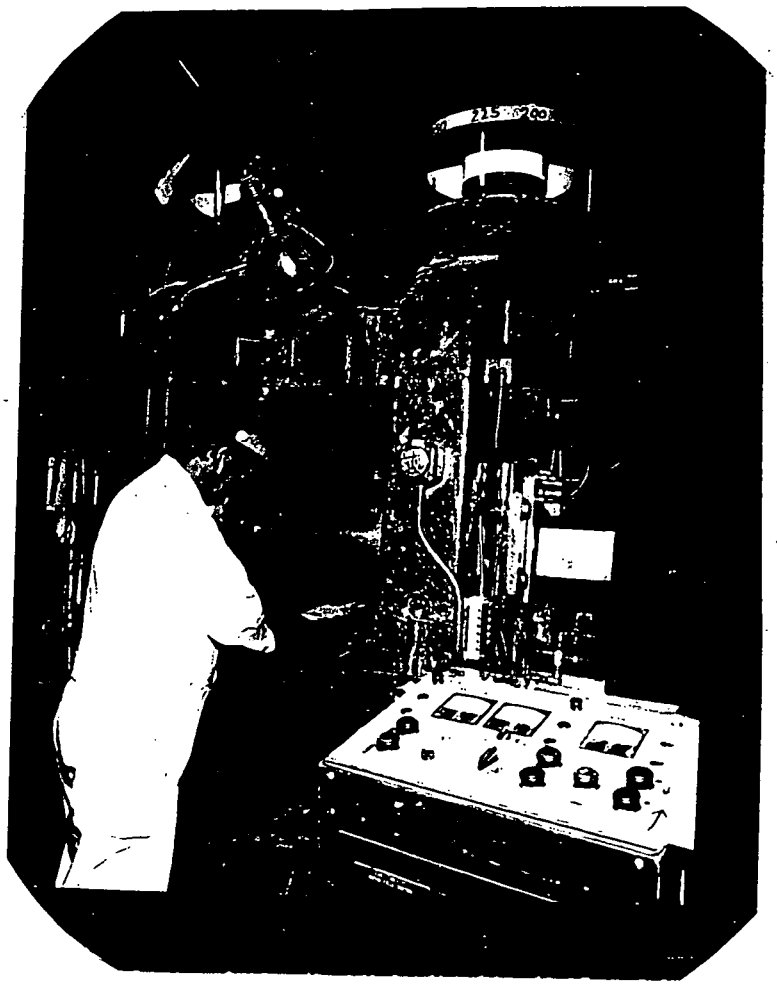

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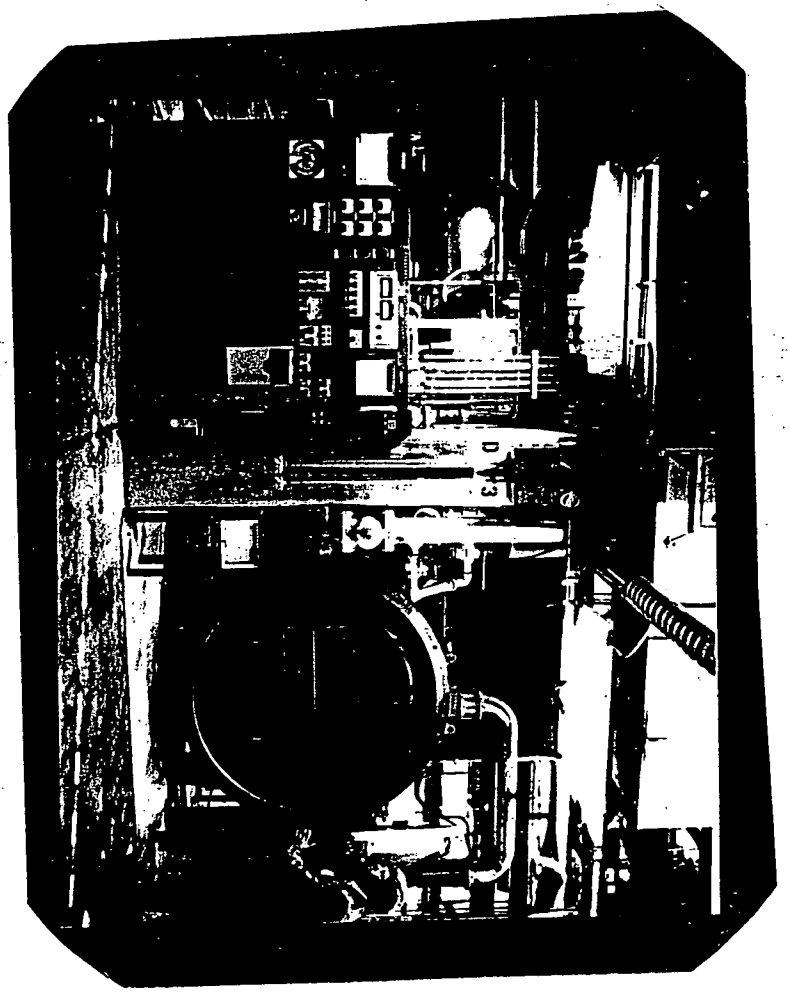

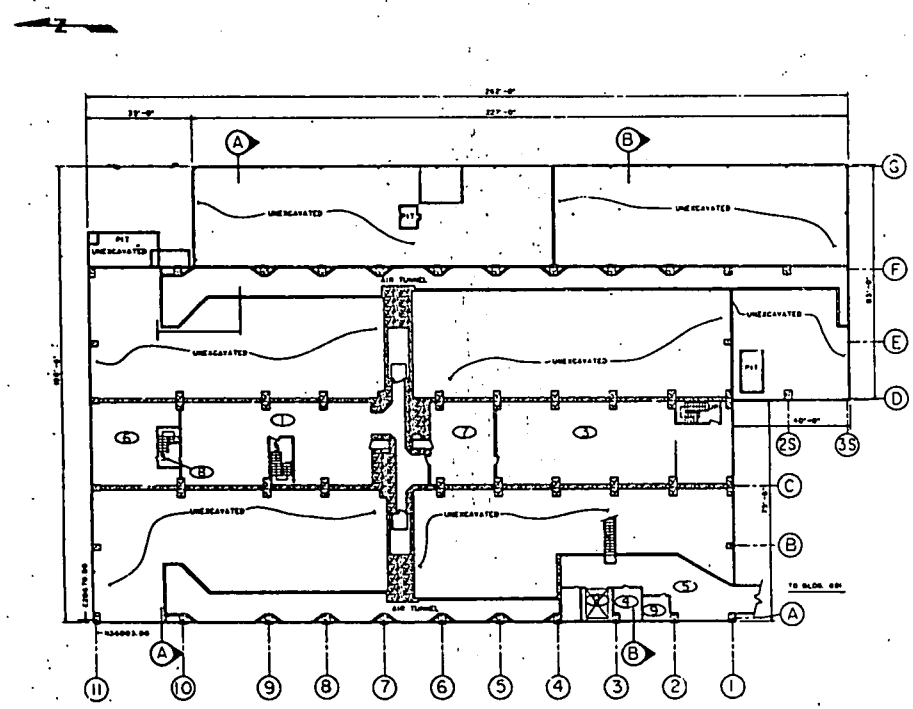

FINISH FLOOR ELEVATION

LEGEND

- EXTERIOR WALL
- CONCRETE WALL
- CONCRETE BLOCK WALL
- PARTITION WALL
- ROOM NUMBER
- EXTERIOR DOOR NUMBER

UNASSIGNED ROOM NUMBERS

BUILDING AREA

BASEMENT - 7,600 SQ. FT.

REFERENCE DRAWINGS

ITEM	DWG. NO.	TITLE	JOB NUMBER
1	RF-83-00000	INDEX	CONTRACT "RC"
2	[illegible]	PLAN & ELEVATIONS	GROUP 3
3	RF-84-[illegible]	VALVE HOUSE PLAN & DETAILS	CONTRACT "BA"
4	RF-82-[illegible]	PLAN	CONTRACT "BZ"

DOES NOT CONTAIN UNCLASSIFIED CONTROLLED NUCLEAR INFORMATION

Reviewing Official S. L. CUNNINGHAM
Name

Date 3/10/92

FOR REFERENCE ONLY

KEY PLAN
SCALE NONE

G UPDATED
F REDRAWN & REVISED

U.S. DEPARTMENT OF ENERGY

Rockwell International
Rocky Flats Plant
Golden, Colorado 80402

BUILDING 803
BASEMENT PLAN

D 30883-3 G

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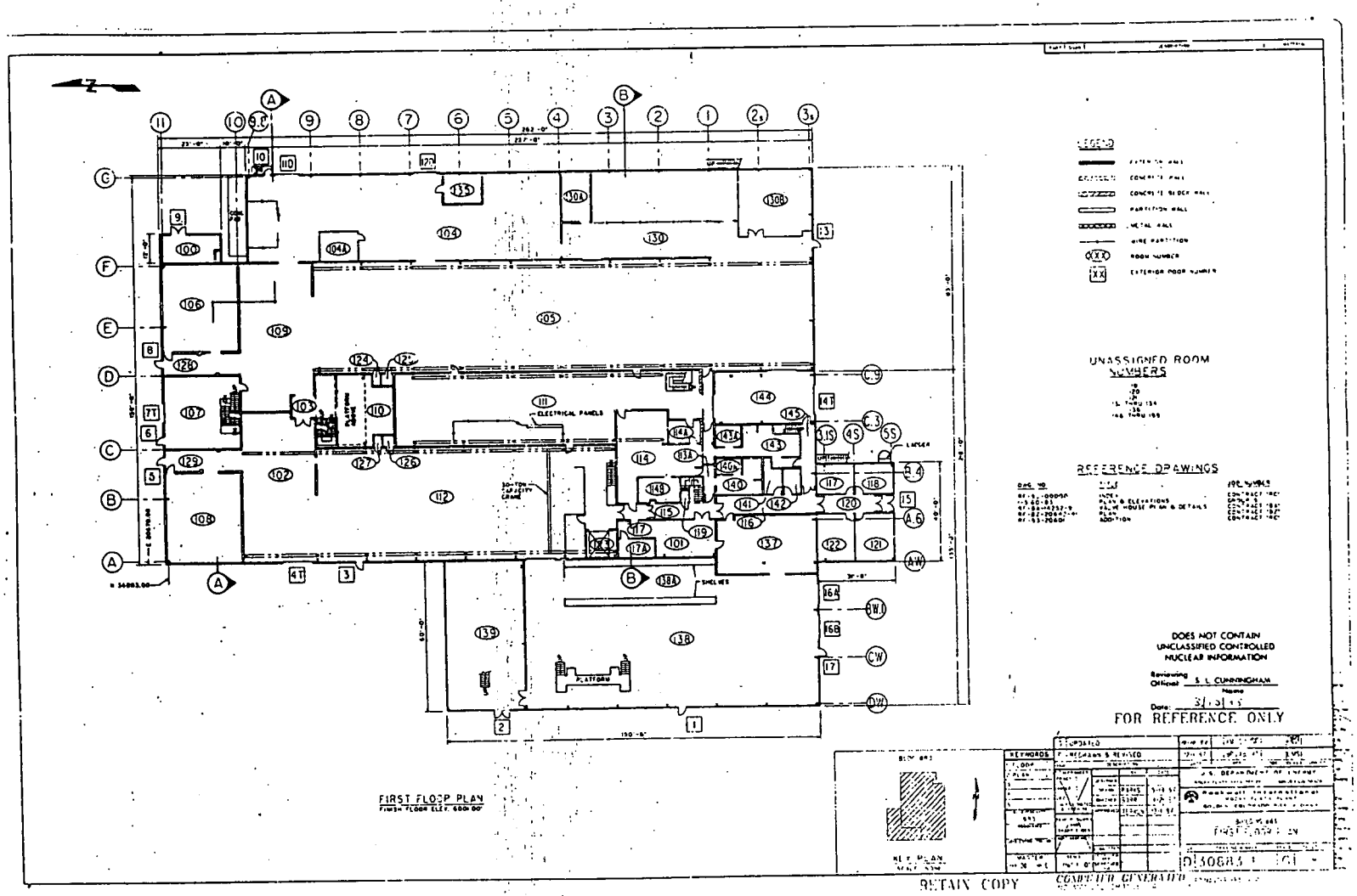
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FOR REFERENCE ONLY
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FIRST FLOOR PLAN
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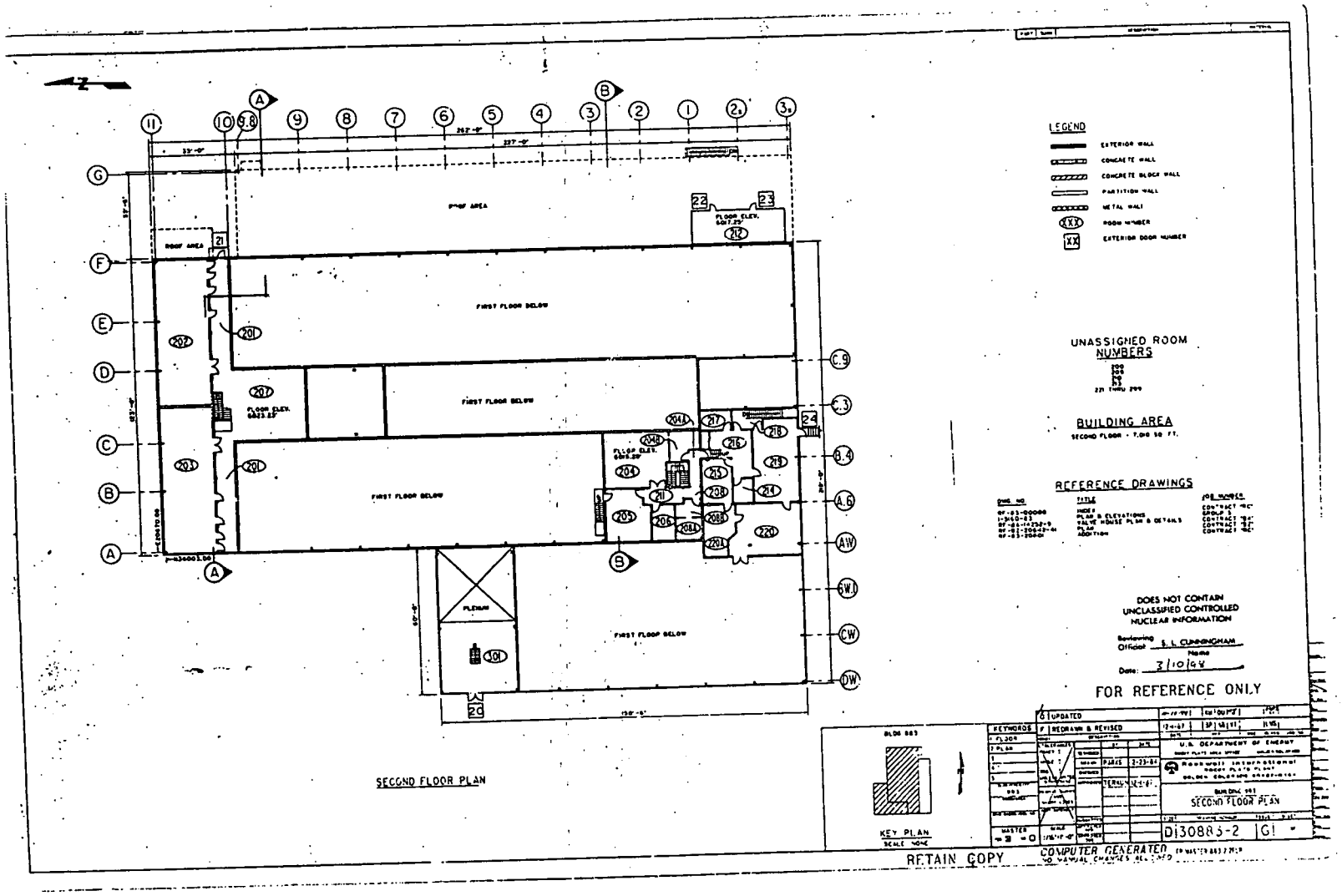
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ROOM NUMBER
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UNASSIGNED ROOM NUMBERS
BUILDING AREA
REFERENCE DRAWINGS
DOES NOT CONTAIN UNCLASSIFIED CONTROLLED NUCLEAR INFORMATION
Reviewing Official: S. L. CUNNINGHAM
Date: 3/10/94
FOR REFERENCE ONLY
ROOF AREA
FIRST FLOOR BELOW
PLENUM
SECOND FLOOR PLAN
KEY PLAN
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U.S. DEPARTMENT OF ENERGY
SECOND FLOOR PLAN
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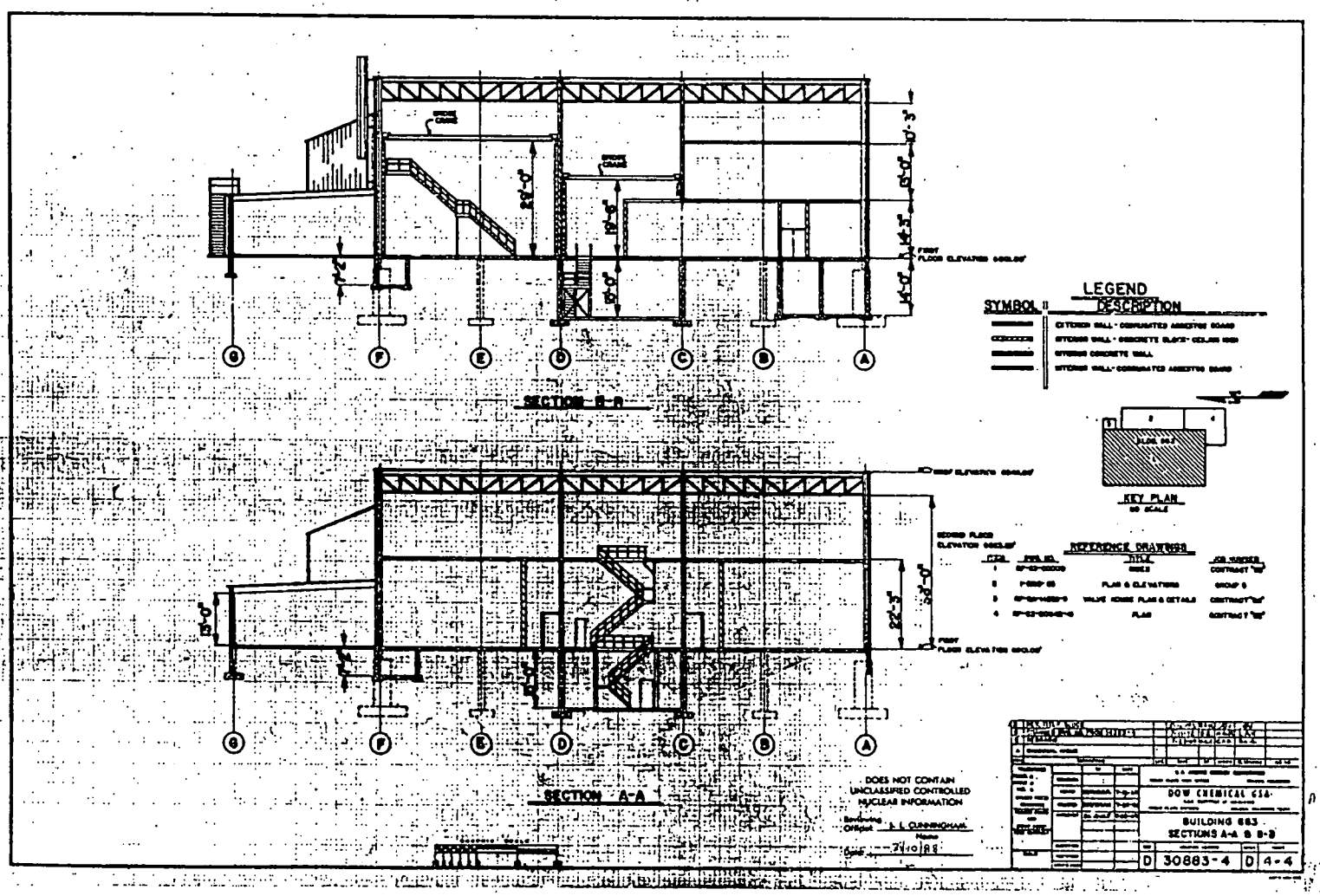
SECTION B-B
SECTION A-A
LEGEND
SYMBOL
DESCRIPTION
KEY PLAN
REFERENCE DRAWINGS
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DOW CHEMICAL CSA
BUILDING 683
SECTIONS A-A & B-B
D 30883-4 D 4-4

HISTORIC AMERICAN ENGINEERING RECORD
(HAER No. CO-83)

for the

ROCKY FLATS PLANT
HISTORIC DISTRICT

Volume 4 of 4

Completed by:
engineering-environmental Management
e^2M
7000 South Yosemite, #295
Englewood, Colorado

For
Kaiser-Hill Company, L.L.C.
Rocky Flats Environmental Technology Site
Golden, Colorado

March 31, 1998

HAER No. CO-83-S

ROCKY FLATS PLANT,
EMERGENCY MEDICAL SERVICES FACILITY
(Rocky Flats Plant, Building 122)
Located on the southwest corner of the intersection of Central and Third avenues.
Golden Vicinity
Jefferson County
Colorado

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Rocky Mountain System Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

ROCKY FLATS PLANT,
EMERGENCY MEDICAL
SERVICES FACILITY
(Rocky Flats Plant, Building 122)

HAER No. CO-83-S

Location: Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County, Colorado. Building 122 is located on the southwest corner of Central and Third avenues. Building 122 is connected to Building 121.

Date of Construction: 1953.

Fabricator: Austin Co., Cleveland, Ohio.

Present Owner: United States Department of Energy (USDOE).

Present Use: Emergency Medical Services.

Significance: This building was a primary contributor to the National Register eligible Rocky Flats Plant historic district, associated with the United States (U.S.) strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack. Building 122 was used to provide medical services to employees.

Historians: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M), 1997. Judith Berryman, Ph.D., Archaeologist, e^2M, 1997.

Project Information:

In 1995, an inventory and evaluation was conducted of facilities at the Rocky Flats Plant (Plant) for their potential eligibility for listing in the National Register of Historic Places. The primary goal of this investigation was to determine the significance of the Cold War era facilities at the Plant in order to assess potential effects of the long-term goals and objectives of the USDOE. These goals and objectives have not been finalized, but include waste cleanup and demolition. Recommendations regarding National Register of Historic Places eligibility were developed to allow USDOE to submit a formal determination of significance to the Colorado State Historic Preservation Officer for review and concurrence and to provide for management of historic properties at the Plant.

From this determination and negotiations with the Colorado State Historic Preservation Officer, the Advisory Council, and the National Park Service, a Historic American Engineering Record project began in 1997 to document the Plant's resources prior to their demolition. The Plant was listed on the National Register of Historic Places in 1997. The archives for the Historic American Engineering Record project are located in the Library of Congress in Washington, D.C.

Introduction:

The Plant is one of thirteen USDOE facilities that constitute the Nuclear Weapons Complex, which designed, manufactured, tested, and maintained weapons for the U.S. arsenal. The Plant was established in 1951 to manufacture triggers for use in nuclear weapons and to recycle plutonium recovered from retired weapons. Each trigger consisted of a first-stage fission bomb that set off a second-stage fusion reaction in a hydrogen bomb. Parts were formed from plutonium, uranium, beryllium, stainless steel, and other materials.

A tense political atmosphere both at home and abroad during the Cold War years drove U.S. weapons research and development. By the 1970s, both the U.S. and the Soviet Union maintained thousands of nuclear weapons aimed at each other. These weapons were staged on submarines, aircraft, and intercontinental ballistic missiles. Both the North Atlantic Treaty Organization and Warsaw Pact countries in Europe had small nuclear warheads called theater weapons used as part of the Mutually Assured Destruction program. (The Mutually Assured Destruction program acted as a deterrent in that if one side attacked with nuclear weapons, the other would retaliate and both sides would perish.) The final nuclear weapons program at the Plant was the W-88 nuclear warhead for the Trident II missile. This mission ended in 1992 when President Bush canceled production of the Trident II missile.

The Plant was a top-secret weapons production plant, and employees worked with a recently man-made substance, plutonium, about which little was known concerning its chemistry, interactions with other materials, and shelf life. The Historic American Engineering Record documentation effort focused on four aspects of the Plant and its role in the Nuclear Weapons Complex; manufacturing operations, research and development, health and safety of workers, and security.

Chronology of Building 122:

1953 Construction completed

1971 Addition

1973 Addition

1994 Office space addition

Building History:

Building 122 houses the on-site medical facilities of the Plant and the occupational health and internal dosimetry organizations. Emergency medical services, diagnosis, decontamination, first aid, x-ray, minor surgical treatment, and ambulatory activities (including coordination with St. Anthony Hospital's Flight for Life) are carried out in this building. The building also contains appropriate clinical and examination facilities to support routine employee and subcontractor physical examinations. Body counting is conducted in this building to measure radioactive material in the body. The facility contains three general areas: administration, internal dosimetry, and medical/health.

Building 122 is built on a concrete slab and is one-story high. The exterior walls are concrete and concrete block. The interior walls are primarily concrete block or gypsum board.

The body counting rooms are of special construction, designed to minimize external sources of radiation. The walls, floors, and ceilings of the body counting rooms are constructed of pre-World War II steel, and provided with graded shielding to eliminate external sources of radiation. Pre-war steel was used, since it is lower in radioactivity than steel created after World War II (not affected by nuclear fallout). Two of the body counting rooms are constructed of steel from battleship hulls, one of the rooms is constructed of steel from the wheels and axles of old freight cars. The graded shielding of lead, tin, and zinc eliminates radioactivity in the room from cosmic sources. When cosmic radiation hits the steel, an x-ray is emitted. This x-ray hits the lead lining of the room, and is stopped. However, the lead lining then emits an x-ray of lower energy, which is stopped by the tin lining. Similarly, the tin lining emits an x-ray of even lower energy, which is stopped by the zinc lining. By this time, the energy is too low to create another emission. This shielding is necessary because of the extreme sensitivity of the body counting equipment.

Building 122 has two decontamination rooms with separate entrances. These rooms provide medical facility access to personnel that have potentially been exposed to radioactive contamination. Medical personnel attending these patients follow specific protective procedures ranging from cleaning with decontaminating solutions to donning respirators and protective suits.

To the west, Building 121 joins Building 122 and there is an L-shaped exterior area between the buildings at the north end. Emergency Exit 3 opens onto this area. The wall separating Building 122 from Building 121 is concrete. The roof is cast-in-place concrete over metal decking.

The exterior dimensions are approximately 100' along the north and south walls and 130' along the east and west walls. The approximate floor space is 12,000 square feet.

Building 122 will remain open and functioning while the Plant is being decommissioned until the risk of exposure and accidents is significantly reduced.

Building Operations:

Building 122 was used to provide medical services to Plant personnel. One of the services was to remove metals from the blood stream of exposed employees, using a procedure called chelation therapy. This procedure used a variety of techniques, however, early success rates in removing metals such as plutonium and uranium were limited.

To improve the success of chelation therapy, the Plant, in collaboration with Colorado State University, performed a study on dogs to develop better methods of removing metals from the blood stream. This study was successful, yielding new therapies for exposed workers.

The subject of another study was the interaction of a solvent with plutonium. This solvent was proposed for use in Plant processes. The study determined that the solvent combined with plutonium, allowed toxic exposure through a dermal pathway. As a result of the study, the solvent was not approved for use, preventing what could have become a significant health risk for employees.

Cytogenetic studies performed at the plant resulted in a method to calculate plutonium exposure by measuring cell damage, and to identify beryllium exposure by the identification of beryllium antibodies.

Two medical studies were begun to monitor the long-term effects of exposure to beryllium and radioactive materials such as plutonium, enriched uranium, americium, and others. These studies, mandated by Federal Law (the National Defense Act of 1993), involve all former Plant workers, and are currently being used to detect early signs of disease. The programs include a complete physical every three years.

In addition to research studies and providing medical care to Plant workers, personnel in building 122 were involved in research and development of radiation detection equipment. The first patent awarded at the Plant was for a radiation wound counter to detect and quantify the presence of radioactive materials inside a wound.

Another significant item developed by medical building personnel was the body counter. This equipment was extremely sensitive, and detected minute amounts of radiation emanating from a person as a result of inhalation of radioactive particles.

Sources: Bistline, Robert, employed at the Plant since 1966 by the site contractor, personal communication, November 12, 1997, and January 1998.

Falk, Roger, employed at the Plant since 1966 by the site contractor, personnel communication, January 1998.

Rockwell International Energy Systems Group Rocky Flats Plant, 1994, *Rocky Flats Plant, Interim Safety Analysis Report.*

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HAER No. CO-83-S-1

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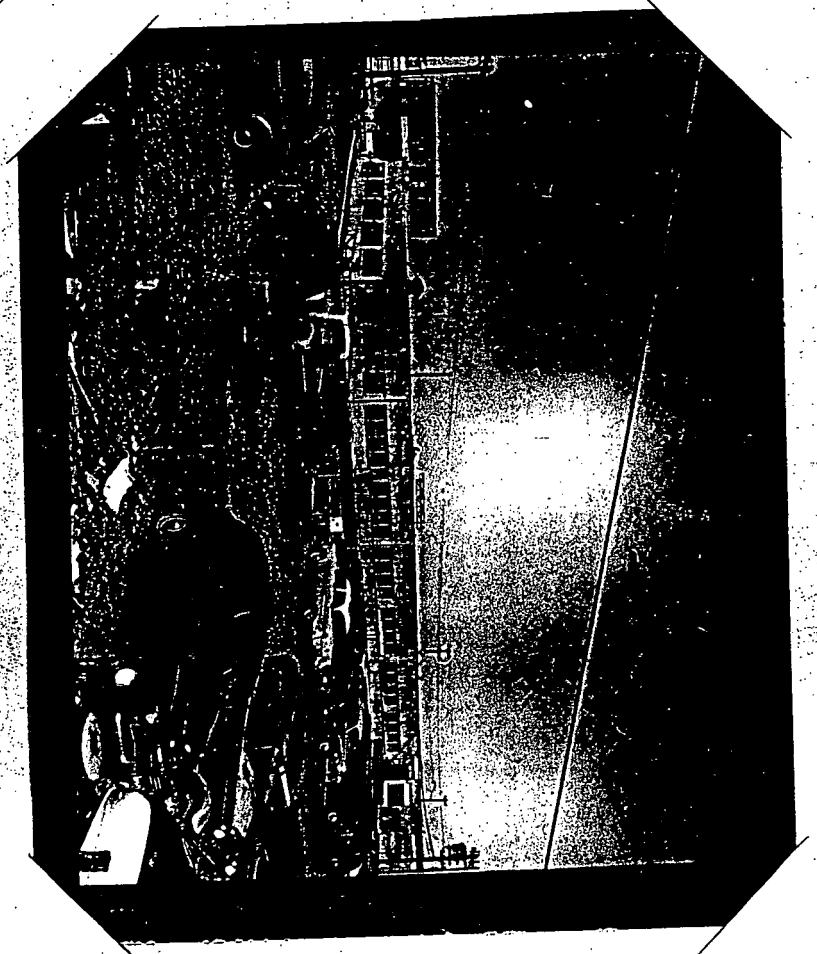
HAER No. CO-83-S-2



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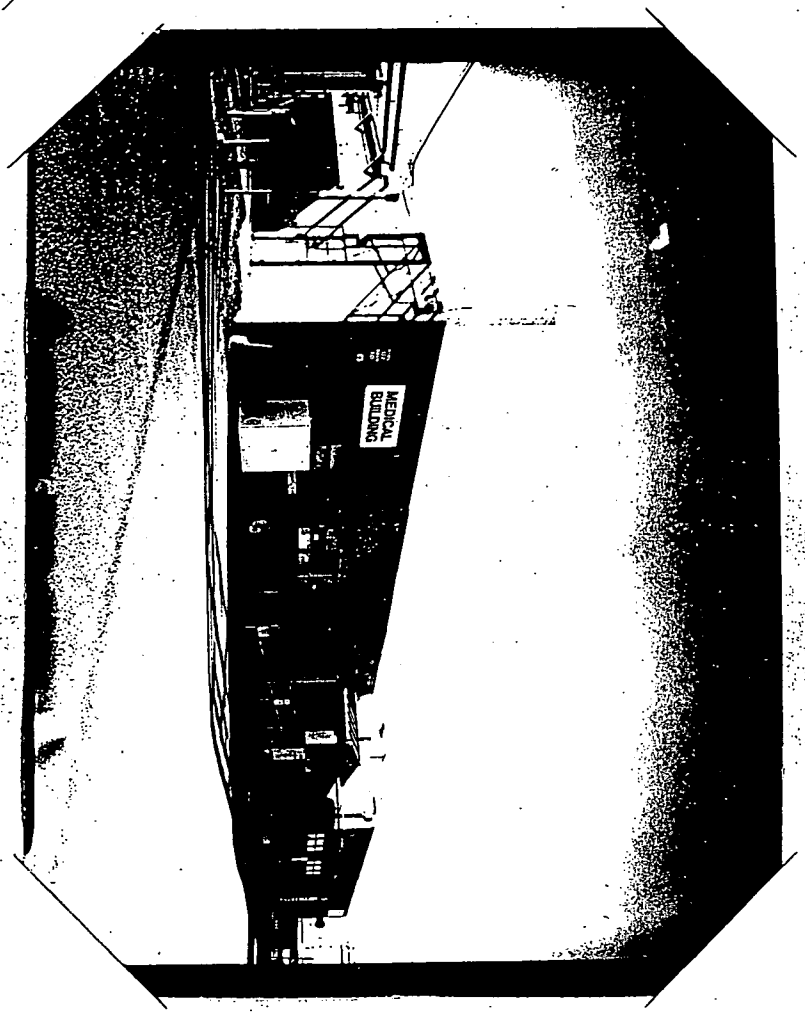

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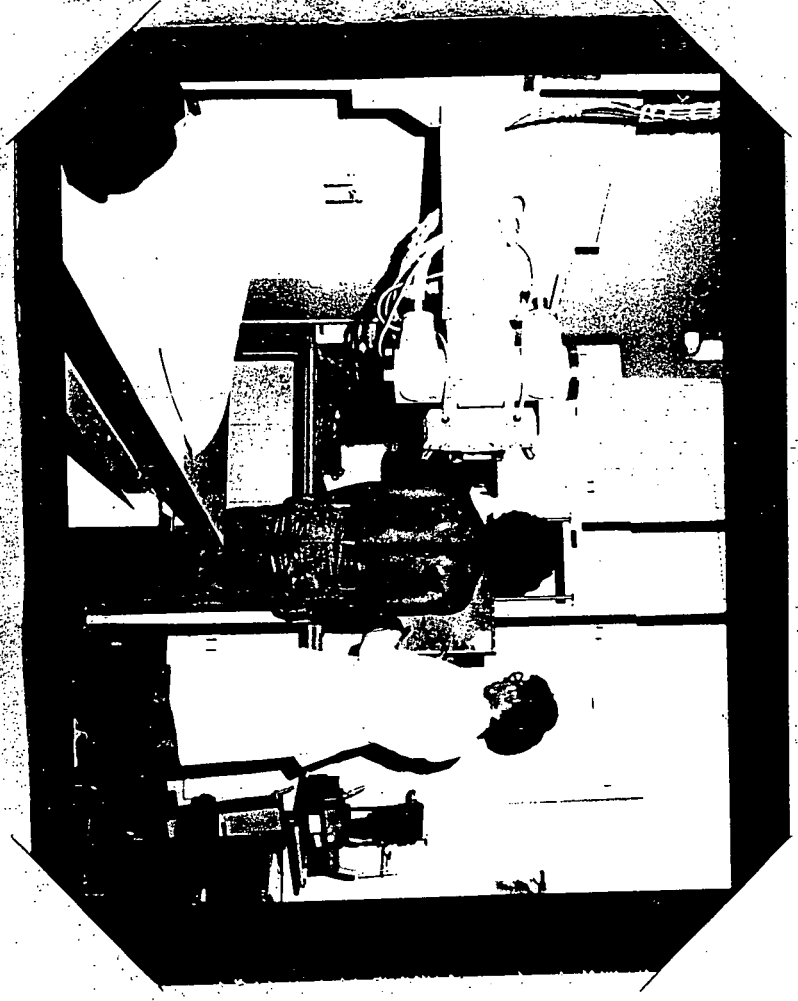

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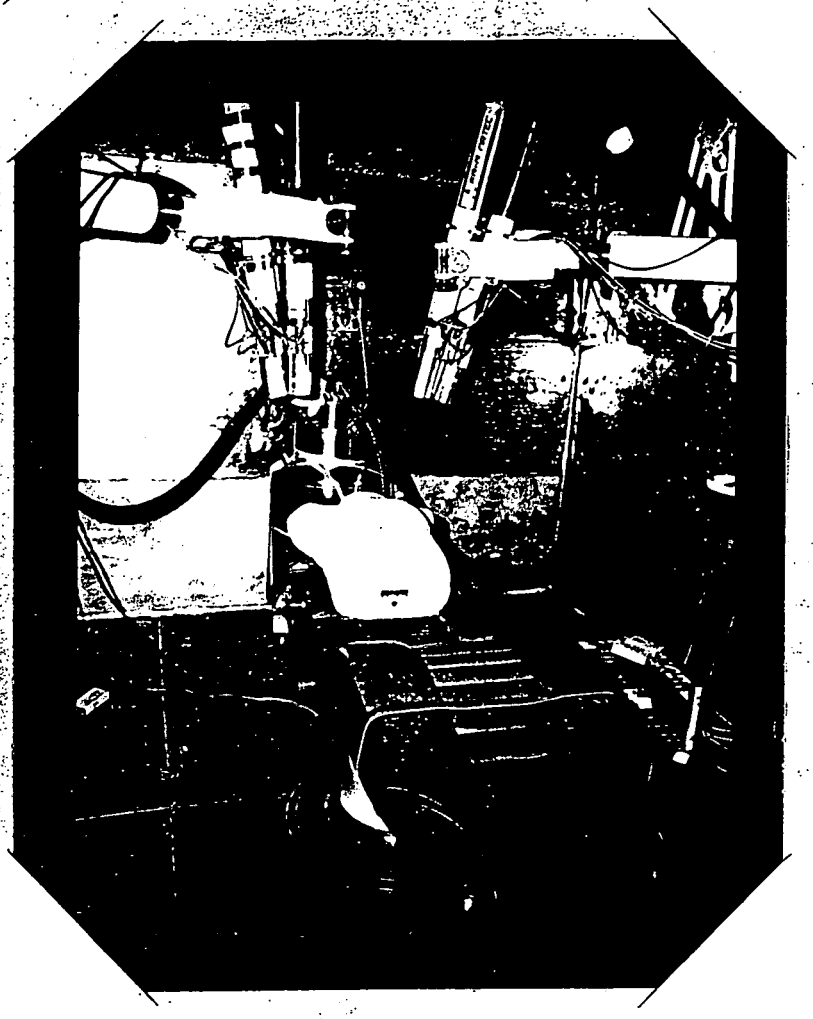

ROCKY FLATS PLANT,
STAINLESS STEEL AND NON-NUCLEAR
COMPONENTS MANUFACTURING
(Rocky Flats Plant, Building 460)
Southeast corner of the intersection of Cottonwood Avenue and Third Street,
Golden Vicinity
Jefferson County
Colorado

HAER No. CO-83-T

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Rocky Mountain System Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

ROCKY FLATS PLANT,
STAINLESS STEEL AND NON-NUCLEAR
COMPONENTS MANUFACTURING
(Rocky Flats Plant, Building 460)

HAER No. CO-83-T

Location: Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County Colorado. Building 460 is located in the southeast corner of the intersection of Cottonwood Avenue and Fourth Street.

Significance: Building 460 was a primary contributor to the National Register eligible Rocky Flats Plant historic district, associated with the United States (U.S.) strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack. Building 460 was a non-nuclear manufacturing facility for the manufacture of stainless steel components such as reservoirs, tubes, and non-fissile trigger components.

Description: The total area of Building 460 is approximately 230,000 square feet, divided between the first floor and two second floor mezzanines. The first floor (150,000 square feet) was used primarily for manufacturing. The south mezzanine, with dimensions of 240' (north-south) x 260' (east-west), houses offices and a cafeteria. The north mezzanine, with dimensions of 80' (north-south) x 260' (east-west), contains an electrical substation; control centers; vacuum pumps; a water distillation system; storage areas; and heating, ventilation, and air conditioning units. Overall building dimensions are 483' (north-south) x 362' (east-west), with a notch out of the southeast corner. Building 460 houses Rooms 122, 132, 134, 135, 141, 142, and 156-158, which are discussed in more detail below.

Building 460 is a pre-engineered metal building constructed of single-gabled, multi-span rigid-framed steel with concrete floors. The primary building structure consists of tapered rigid steel bents running east to west, spaced on 40' intervals. A reinforced concrete grade beam around the perimeter connects the spread footings and forms the foundation for the exterior walls. Cross bracing on the east and west exterior walls is used for lateral stability. Additional cross bracing is found on the mezzanine columns. The mezzanines are concrete on corrugated metal decking, supported by bar joists. Structural steel columns are used to provide intermediate support for the roof frame and mezzanine floors. The roof is supported on bar joists, with the roof ridge peaking approximately 35' above ground level. The roof system includes a corrugated metal liner, rigid insulation, and ribbed metal roof panels.

The lower exterior walls of the building are insulated pre-cast concrete panels with an architectural finish on the exterior surfaces. The upper walls are corrugated metal inner panels and ribbed exterior panels, separated by 6" metal studs and fiberglass insulation. The interior walls are concrete masonry supported on independent footings, which are as much as 9' below the finished floor elevation. Permanent mezzanine office partition walls are gypsum board over metalstuds. Interior walls and ceilings for the high-pressure test cells and radiography vaults are reinforced concrete. The high-pressure test cell walls are steel-lined.

The exterior doors are metal. The windows are fixed, single panes in metal sashing. Windows are present only on the mezzanine levels, except on the east end of the south wall where there are windows on the ground level.

Two concrete loading docks are located along the eastern side of the building, and a small loading dock is located at the west end of the north side of the building.

Utilities include steam, raw and potable water, and electricity. Building 462 is a cooling tower, which provides cooling process water for both supply and return. Liquid wastes are collected in sump tanks, then filtered and sampled in Room 140 prior to transfer to Building 374 for waste processing.

History: Building 460 was constructed in 1984 to handle non-nuclear War Reserve and special order parts and assemblies. The building was designed to consolidate all non-nuclear manufacturing at the Plant into one facility. The stainless steel operations conducted in Building 881 and some non-nuclear metal working operations from Building 444 were transferred to Building 460 after its completion. In addition to stainless steel, parts were also manufactured from aluminum, vanadium, copper, gold, silver, magnesium, titanium, Teflon®, and plastics. Manufactured components were used in the tritium reservoir-to-pit delivery system in nuclear weapons. No major modifications have been made to the building structure since it was commissioned, although several pieces of equipment have been disassembled for shipment to a U.S. Department of Energy (USDOE) facility located in Kansas City. The final production run was completed in September 1994.

Operations: Building 460 housed equipment, systems, and personnel for fabrication, assembly, and testing of stainless steel components such as reservoirs, tubes, and non-fissle trigger components. Manufacturing, testing, and inspection processes occupied most of the ground floor. The facility was described as the most modern non-nuclear manufacturing building in the USDOE complex.

Operation processes included fabrication, assembly, and inspection. Fabrication of stainless steel and other non-nuclear metal parts included mechanical machining, electrochemical machining and grinding, electric discharge machining, and crush grinding. Mechanical machining took place in Room 134 and consisted of production machining and hardware machining. The electrochemical machining operations were located in Room 141. Various grinding processes took place in Room 142.

Assembly took place in Rooms 122, 132, 134, and 135 and included a combination of machining, joining, grit blasting, and cleaning. Cleaning processes, including acid, aqueous, and final, were conducted in Rooms 156, 157, and 158. Acid cleaning consisted of a detergent wash, followed by a series of acid and water washes and rinses. Aqueous cleaning consisted of a detergent wash, followed by a deionized water rinse. The final cleaning process was the last cleaning the part or assembly underwent, and consisted of a detergent wash, followed by a series of deionized water or isopropyl alcohol rinses.

Assembly testing, non-destructive testing, and product inspection were conducted during inspection of the machined parts. Assembly testing subjected parts and subassemblies from various fabrication processes to pressure and leak tests. Non-destructive testing included ultrasonic testing, holographic pressure testing, radiographic testing, and dye-penetrant testing. Ultrasonic testing used water and ultrasonic pulses to detect voids and other defects in welded joints of parts and subassemblies. Holographic testing used a holographic plate to record expansion or distortion of a tested part or subassembly placed under pressure in a test cell. Radiographic testing used x-rays to detect internal flaws (i.e. cracks, lack of fusion, and inclusions) in parts and subassemblies. Dye-penetrant testing used dye penetrant oil to detect surface cracks and other defects in parts and subassemblies. Product inspection, used to provide quality assurance for parts fabricated in the building, or purchased from off site, consisted of a series of cleaning and non-dimensional inspection processes.

Other activities conducted in Building 460 included research and development on prototype fixtures, and parts and materials development. Support operations housed in the building included machining and gauging, production control, product definition, deionized water production, test cell compression, laboratories, maintenance, and utilities.

Sources: ChemRisk, 1992, *Project Tasks 3 and 4. Final Draft Report- Reconstruction of Historical Rocky Flats Operations and Identification of Release Points,* prepared for Colorado Department of Health.

EG&G, 1994, *Final Historical Release Report*, Rocky Flats Plant Repository.

USDOE, 1995, *Final Cultural Resource Survey Report Rocky Flats Environmental Technology Site, The Industrial Area,* Rocky Flats Plant Repository.

Historians: D. Jayne Aaron, Environmental Designer, engineering-environmental Management Inc. (e^2M), 1997. Judith Berryman, Ph.D., Archaeologist, e^2M, 1997.

HISTORIC AMERICAN ENGINEERING RECORD

INDEX TO PHOTOGRAPHS

ROCKY FLATS PLANT,
STAINLESS STEEL AND NON-NUCLEAR
COMPONENTS MANUFACTURING HAER No. CO-83-T
(Rocky Flats Plant, Building 460)
Southeast corner of the intersection of Cottonwood Avenue and Third Street.
Golden Vicinity
Jefferson County
Colorado

Photographs CO-83-T-1 through CO-83-T-5 were taken by various site photography contractors, dates are indicated in parentheses.

CO-83-T-1 AERIAL VIEW OF BUILDING 460, LOOKING NORTHEAST. THE BUILDING WAS CONSTRUCTED TO CONSOLIDATE ALL NON-NUCLEAR MANUFACTURING AT THE ROCKY FLATS PLANT INTO ONE FACILITY. (6/13/85)

CO-83-T-2 VIEW OF THE PRODUCTION FLOOR OF BUILDING 460. BUILDING 460 WAS CONSTRUCTED FOR THE MANUFACTURE OF STAINLESS STEEL COMPONENTS SUCH AS RESERVOIRS, TUBES, AND NON-FISSILE TRIGGER COMPONENTS. MANUFACTURING, TESTING, AND INSPECTION PROCESSES OCCUPIED MOST OF THE GROUND FLOOR. (2/20/96)

CO-83-T-3 VIEW FROM THE PRODUCTION FLOOR OF BUILDING 460, LOOKING WEST. THE BUILDING 460 HOUSED EQUIPMENT, SYSTEMS, AND PERSONNEL FOR FABRICATION, ASSEMBLY, AND TESTING OF STAINLESS STEEL COMPONENTS SUCH AS RESERVOIRS, TUBES, AND NON-FISSILE TRIGGER COMPONENTS. THE PHOTOGRAPH SHOWS A T-BASED LATHE WITH AN OPTICAL COMPARITOR FOR MACHINING OF STAINLESS STEEL IN THE LOWER LEFT CORNER. THE DRUM IN THE LOWER RIGHT CORNER CONTAINS STAINLESS STEEL TURNING COLLECTED FROM THE LATHE. (9/11/85)

CO-83-T-4 VIEW OF PRECISION EQUIPMENT USED IN STAINLESS COMPONENT MANUFACTURING. THE FACILITY WAS DESCRIBED AS THE MOST MODERN NON-NUCLEAR MANUFACTURING BUILDING IN THE U.S. DEPARTMENT OF ENERGY COMPLEX, WITH MANY PRECISION INSTRUMENTS. (9/21/83)

CO-83-T-5 VIEW OF MICRO-MACHINING, HIGH PRECISION EQUIPMENT USED TO CUSTOM MAKE SMALL PARTS. LUMPS OF CLAY, SHOWN IN THE PHOTOGRAPH, WERE USED TO STABILIZE PARTS BEING MACHINED. (11/1/87)

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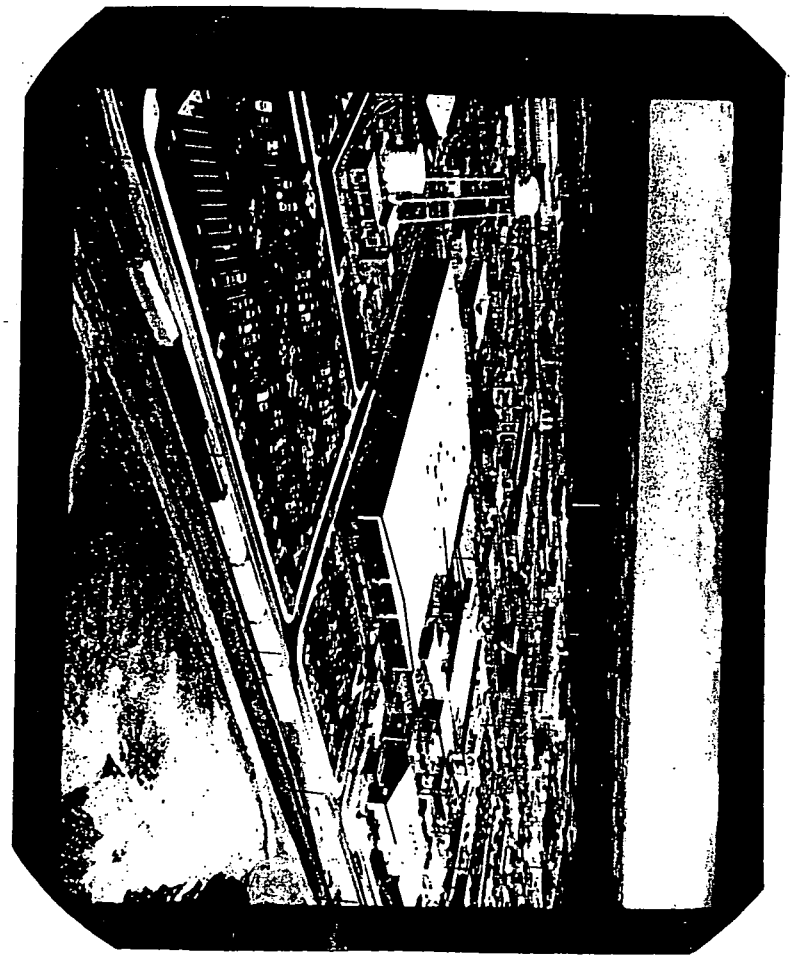

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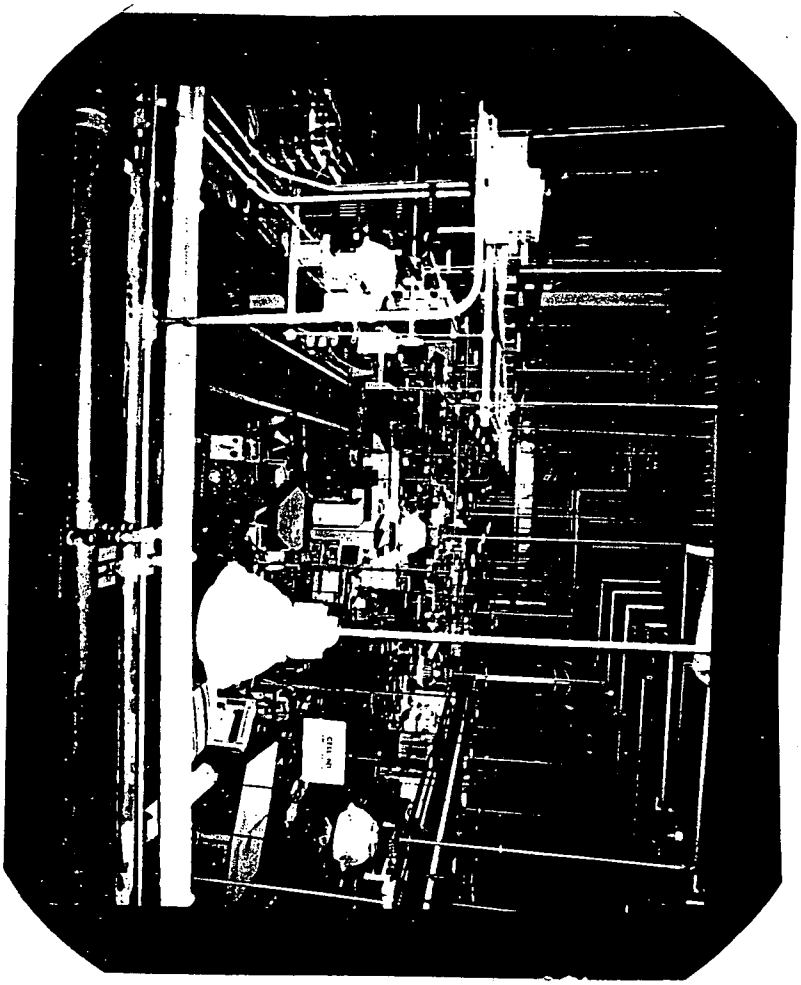

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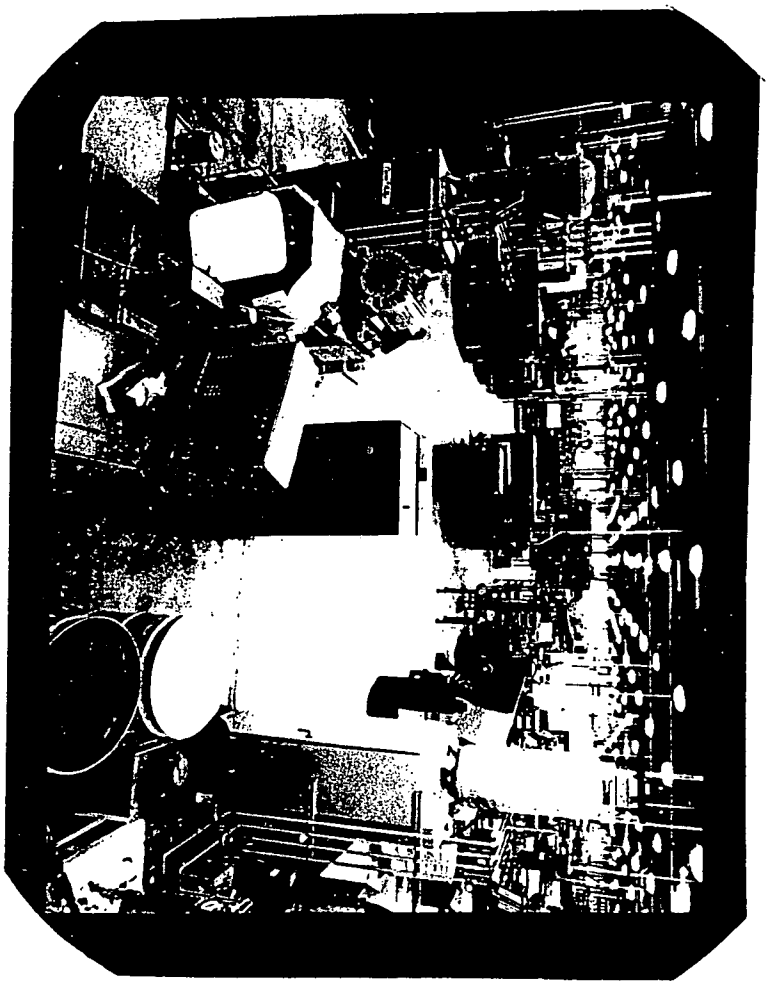

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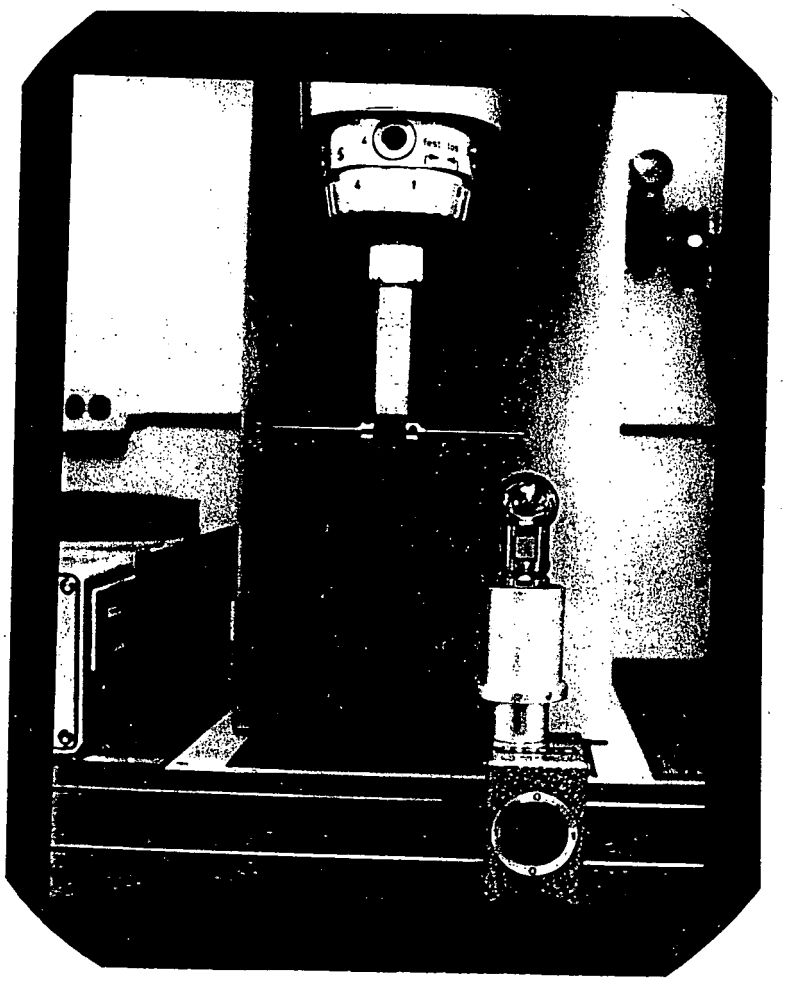

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HAER No. C

ROCKY FLATS PLANT, FINAL ASSEMBLY AND SHIPPING

HAER No. CO-83-U

(Rocky Flats Plant, Building 991)
(Rocky Flats Plant, Plant D)
(Rocky Flats Plant, Building 91)
Located in the eastern portion of the Plant site, south of Spruce Avenue, east of Tenth Street, and north of Central Avenue,
Golden Vicinity
Jefferson County
Colorado

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Rocky Mountain System Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

ROCKY FLATS PLANT,
FINAL ASSEMBLY AND
SHIPPING FACILTY
(Rocky Flats Plant, Building 991)
(Rocky Flats Plant, Plant D)
(Rocky Flats Plant, Building 91)

HAER No. CO-83-U

Location: Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County, Colorado. Building 991 is located in the eastern portion of the Rocky Flats Plant (Plant). The building is located south of Spruce Avenue, east of Tenth Street, and north of Central Avenue.

Significance: This building was a primary contributor to the National Register eligible Rocky Flats Plant historic district, associated with the United States (U.S.) strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack. Building 991, the first building constructed at the Plant, was initially used for assembly of nuclear weapon triggers, and was later used as a point for shipping, receiving and storage of special nuclear materials.

Description: Building 991 is a rectangular, concrete, one-story structure encompassing approximately 40,600 square feet (35,400 square feet on the first floor, and 5,200 square feet in the basement). Three major additions have been built since the original construction in 1952: a loading dock on the west side in 1957, a radiography vault in the northwest corner in 1959, and a covered loading dock and storage area on the southeast side in 1964.

The building is set on a concrete foundation with a partial basement. The foundations are composed of footings (individual spread footings, combined footings, and wall footings) and foundation walls.

The exterior walls and intermediate concrete columns constitute the structural framing for the building. The exterior walls contain reinforced concrete, varying in thickness from 12 to 18". The building walls vary in height from 14' on the south, to 27' in the center, to 18' on the north side. Interior bearing walls are reinforced concrete. The walls of the covered dock and shop located at the eastern end of the structure are constructed of reinforced concrete. Four feet of the walls are above-grade.

Depending on the location and function, four different roof types are present. These roof types include reinforced concrete slab supported by concrete beams, structural steel roof frame covered with corrugated asbestos, open-web steel with metal decking, and reinforced cement. Ceilings consist mostly of the undersides of the various roofs.

Doors in the building are either hollow metal or wood. The south wing of the structure contains the only windows (multi-paned within metal sashings).

Building 991 is the main structure of the 991 complex. Additional structures in the complex include three underground tunnels (Tunnels 996, 997, and 998), four underground vaults (Vaults 996, 997, 998, and 999), a guard post (Building 992), an emergency generator building (Building 989), and a filter plenum building (Building 985). Vaults 996, 997, 998, and 999 are connected to the building via Tunnels 996, 997, and 998. Tunnels and vaults in the complex are maintained at a slight negative air pressure by the building heating, ventilating, and air conditioning system.

Support operations located in Building 991 included laboratories, utilities, and maintenance operations. The metallurgical laboratory, located in Rooms 109, 110 and 111, was used to perform metallographic analysis. A modular laboratory was located in Room 143. This area supported the inspection of glove box gloves and supplied air-breathing garments. Maintenance alarms are located in Rooms 140 and 141. The utilities groups, located in Rooms 130 and 137, operated the building ventilation system.

In terms of operation, the building was divided into the following areas: north of the main floor, center section, and south side.

North of the Main Floor: The north side of the main floor contained a storage area for packed plutonium, enriched uranium, and depleted uranium components fabricated at the Plant and received from other U.S. Department of Energy (USDOE) facilities; packaged final assemblies of nuclear weapon triggers; and incoming raw nuclear materials certified for distribution. Room 150 was used as a storage vault for radioactive materials; Room 158 was used for document storage.

Center Section: The center section of the main floor, between the north and south corridors, contains a covered loading dock at either end. The east loading dock has a small room for maintenance storage. Specialized rooms within the building include: Room 130, which houses most of the building utility equipment; Room 134, which contains facilities for metal machining and ultrasonic non-destructive testing; Room 137, the boiler room; and Room 166, which houses a non-destructive test area for barrels, liners, and waste boxes used for shipping.

South Side: The southern end of the building contains administrative offices, plant protection and safe secure transport personnel offices, and non-destructive testing areas.

History: The Plant was originally divided into four separate areas: Plant A (Building 444, depleted uranium), Plant B (Building 881, enriched uranium), Plant C (Building 771, plutonium), and Plant D (Building 991, assembly and shipping). Building 991, constructed between 1951 and 1952, was the first to be completed.

Building 991 was designed for shipping and receiving and for final assembly of weapon components. Plutonium, enriched uranium, and depleted uranium components fabricated on-site, along with components manufactured from the Hanford Site and Oak Ridge Reservation were assembled into final products, inspected, tested, and placed back in storage prior to off-site shipment in Building 991. Administrative services for the Plant were also carried out in Building 991 until Building 111 was completed in 1953.

Initially, radioactive components were coated in nickel or encased in plastic allowing assembly of the early concept design products in open rooms, not in enclosed glove boxes or B-boxes (similar to a lab hood). In 1957, production began on a new weapon design, requiring changes in the amount of materials used in the trigger, the amount of machining and handling required, and the need for tighter controls. Because of the new design, final trigger assembly took place in the newly constructed Building 777. Assembly of older uranium-based weapons continued in Building 991 until the 1960s. A limited number of plutonium-based triggers may have been assembled in Building 991 during the early 1960s.

After 1957, the mission of Building 991 focused on shipping, receiving, and storage. Materials handled included special nuclear, non-radioactive raw, and classified materials, other metal components, partially finished products, purchase order items, special order items, samples, instruments, and documents. All radioactive materials received and stored in Building 991 were in Department of Transportation, USDOE, or intraplant-approved shipping containers. For a brief period of time, between 1975 and 1976, shipping was moved to Buildings 439 and 440. Due to security concerns, shipping was moved back to Building 991 after 1976.

In addition to material shipping, receiving, and storage, a number of research and development projects were conducted in Building 991 from the 1960s to the mid-1970s. These projects included radiation studies, beryllium coating processes, and an explosives-forming project. Most special projects and research and development operations were moved out of the building by 1976.

Building 991 was used to test the quality of non-nuclear raw material and non-nuclear non-classified parts fabricated by off-site vendors. A metallography laboratory was used for the testing. In the mid-1970s, Building 991 took over storage and inventory functions from Building 881 for these non-nuclear raw materials and non-nuclear, non-classified parts. In the late 1980s, handling of non-classified materials parts was moved to Buildings 130 and 460. Materials and parts ready for assembly were moved directly to Building 460.

Until the mid-1980s, materials were shipped and received from the eastern dock areas (Room 166). The west dock was added in the mid-1980s to provide a covered shipping area specifically designed for the safe secure transports used to ship production materials.

Until 1994, when a special loading dock was added to Building 371, Building 991 had the only shipping/receiving dock at the Plant capable of handling off-site shipments of special nuclear and classified materials. The building also housed non-destructive testing operations and other support operations. Radioactive and non-radioactive raw materials, special order items, packaging items, components, and samples were stored in the Building 991 vaults. All non-nuclear and nuclear materials sent to Building 991 were handled in Rooms 170 (shipping dock) and 134. Primary materials handled include 55-gallon and 30-gallon drums of uranium and plutonium parts from off- and on-site parts.

The final activity in Building 991 was waste storage.

Sources: ChemRisk, 1992, *Project Tasks 3 and 4 Final Draft Report. Reconstruction of Historical Rocky Flats Operations and Identification of Release Points,* prepared for the Colorado Department of Health.

EG&G, 1994, *Historical Release Report*, Rocky Flats Plant Repository.

USDOE Public Affairs, n.d. *Tour Information,* Rocky Flats Facilities, Golden, Colorado: USDOE, Office of Communications and Economic Development.

USDOE, 1995, *Final Cultural Resource Survey Report Rocky Flats Environmental Technology Site, The Industrial Area,* Rocky Flats Plant Repository.

Weaver, Jack, employed at the Plant since 1961 by the site contractor, personal communication, January 1998.

Historians: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M), 1997. Judith Berryman, Ph.D., Archaeologist, e^2M, 1997.

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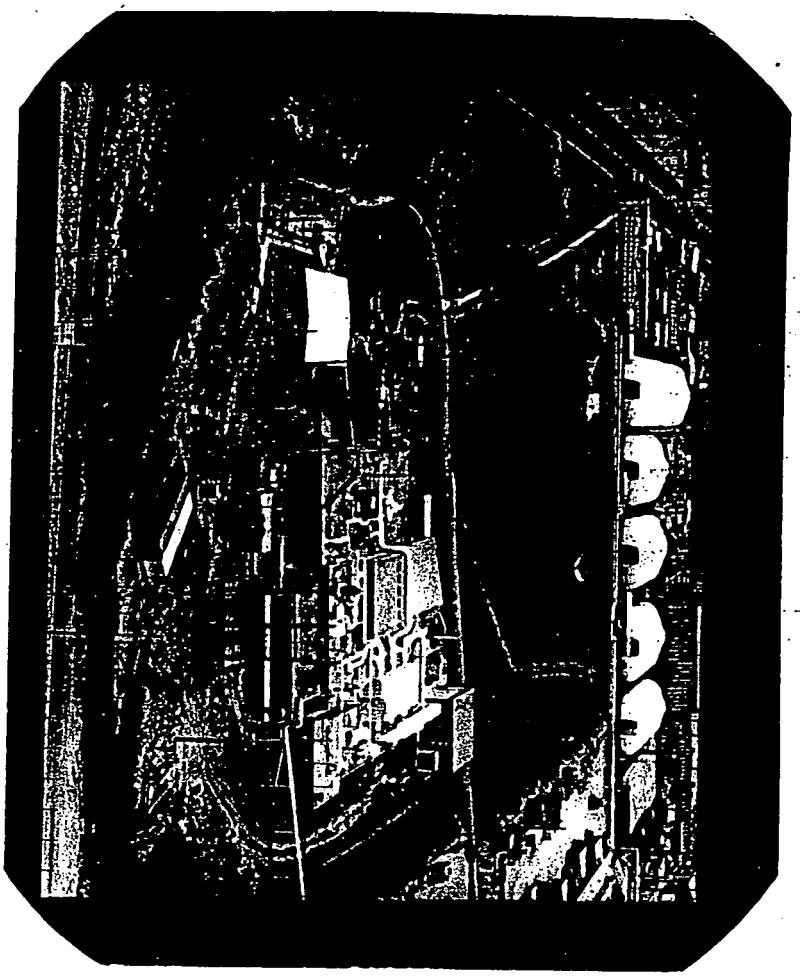

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HAER No. CO-65-U-8

HISTORIC AMERICAN ENGINEERING RECORD
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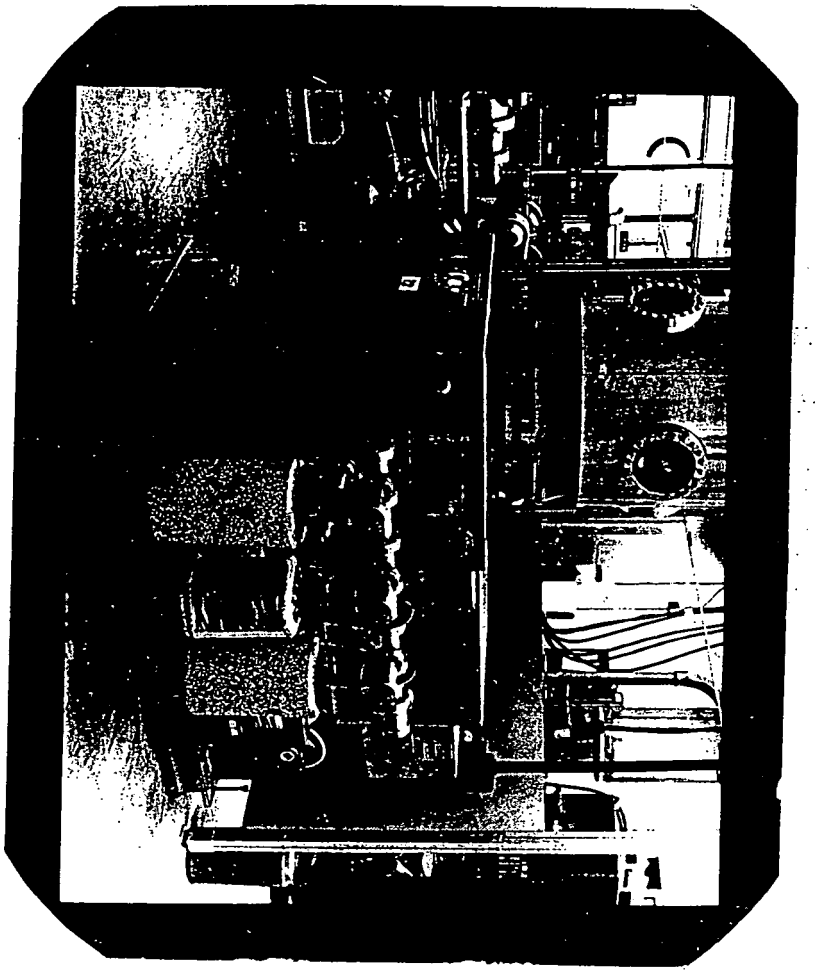

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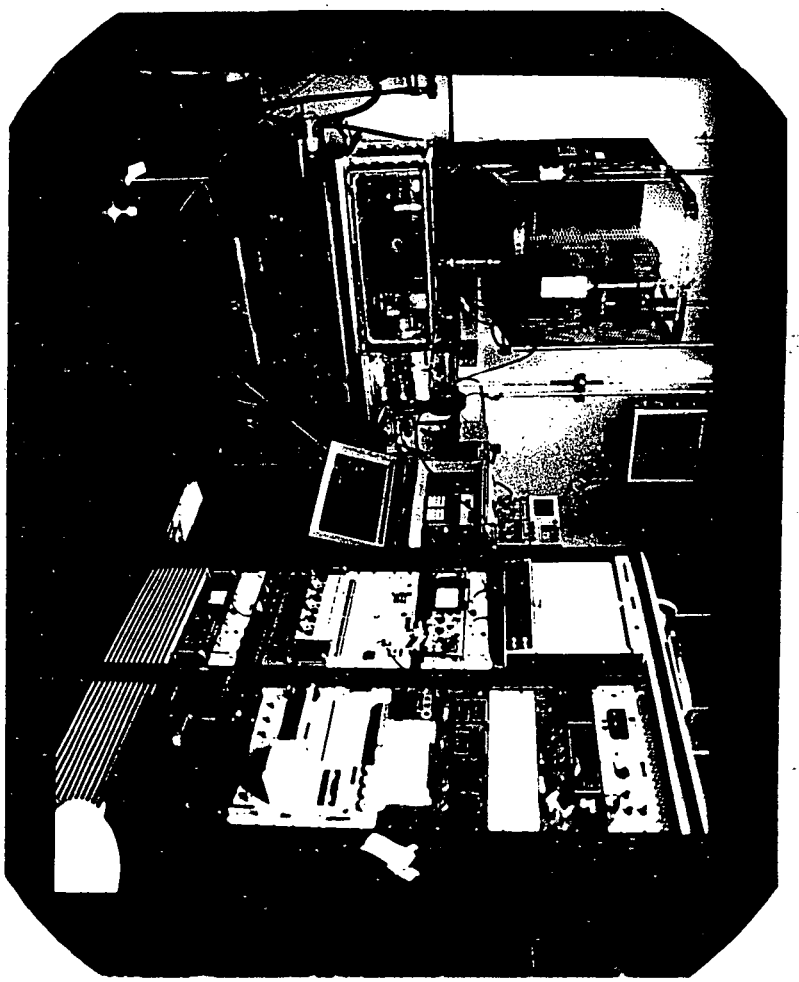

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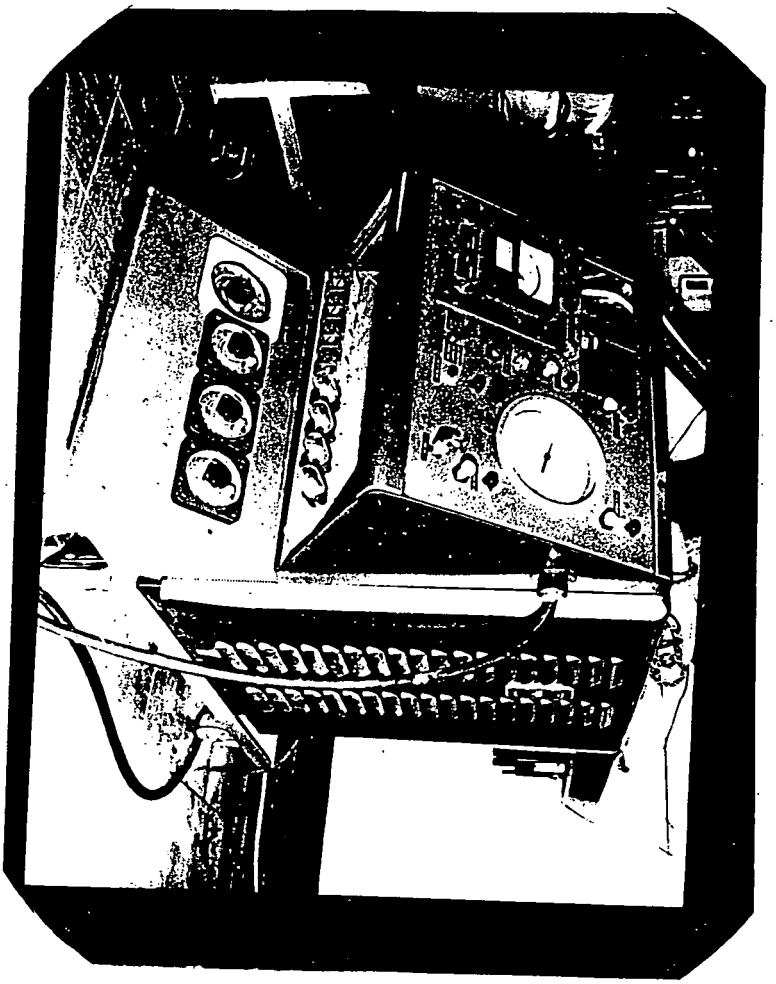


ROCKY FLATS PLANT

HAER No. CO-83-V

OFFICES, PRINT SHOP, AND PHOTOGRAPHY LAB

(Rocky Flats Plant, Building 111)

Located in the northwest quadrant of the Plant near the terminus of Central Avenue.

Golden Vicinity

Jefferson County

Colorado

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Rocky Mountain System Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

ROCKY FLATS PLANT,
OFFICES, PRINT SHOP,
AND PHOTOGRAPHY LAB
(Rocky Flats Plant, Building 111)

HAER No. CO-83-V

Location: Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County, Colorado. Building 111 is located in the northwest quadrant of the Rocky Flats Plant (Plant) near the west terminus of Central Avenue, north of the Health Physics area.

Significance: This building is a primary contributor to the National Register eligible Rocky Flats Plant historic district, associated with the United States (U.S.) strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack. Building 111, built in 1953, was one of the first ten permanent structures on the Plant. This building was the original point of entry for plant employees, and also housed the print shop and photography lab.

Description: Building 111 houses offices for senior personnel of the Management and Operating Contractor, as well as U.S. Department of Energy (USDOE) management. The main printing shop and photography lab for the Plant are located in the basement.

Building 111 is an L-shaped structure. The north-south section is two stories high, with dimensions of 258' x 50'. The east-west section is 267' x 49' and only one story. A basement is below the north-south section with dimensions of 172' x 50'.

The exterior walls of Building 111 are concrete block, with the exception of the auditorium, which is poured concrete. The interior walls are concrete block, gypsum board, or wood paneling. The windows are industrial, metal sash, fixed, with four horizontal muntins. The roof is built-up asphalt over concrete. The addition at the west end is concrete with no windows.

History: Built in 1953, Building 111 was one of the first ten permanent buildings constructed at the Plant. Two additions at the south end of the building were completed in the late 1960s. One of the additions houses an auditorium, the other houses offices.

One of the primary functions of the building was to serve as the entry point for site employees. Most employees were cleared for work only in their own buildings and were required to have a separate badge for each area entered. Workers were required to park outside the Plant area, at the west end (the sole entry point), and were bused from the front gate to Building 111. There they checked in at the clock room, where they stood in lines according to badge number, then they proceeded to their respective buildings. The clock room was located in the southern-most end of the north-south wing. After the Plant implemented a time-sheet policy in the early 1970s, clocking in and out every day became unnecessary, so the clock room was converted into offices.

Print Shop
The print shop at the Plant is a government-authorized printing plant that reproduced forms, reports, letters, brochures, drawings, illustrations, calendars, posters, charts, and the Plant newspaper. The print shop began operations in the early 1950s. The first printing equipment at the Plant was an AB Dick® printing press. Photostat copiers were not installed until the 1960s.

The Plant newspaper was originally printed on a weekly basis. The newspaper published information concerning Plant operations, such as when and where to turn in dosimeters, updates on the communication systems, building upgrades, safety reminders, and other community information. The newspaper also routinely featured stories concerning employee special achievements, such as patent awards or other milestones.

In the early years of the Plant, certain documents were classified as secret and top-secret. These documents had special administrative controls to ensure that unauthorized document reproduction did not occur. An armed escort generally accompanied top-secret documents that were to be copied. By the mid-1970s, top-secret documents were no longer maintained at the Plant.

Control of secret documents relied upon what was termed "accountability." Accountability was a unique numbering and marking system applied to each secret document to be copied. Additionally, requests for document reproduction had to be authorized by the controller of the document, and two people were required to complete the print job. One person ran the equipment, while the other person acted as a witness and supervisor to ensure that misprints and overruns were shredded, and that the job was accurately counted. The document storage facility that received the copied documents also recounted the documents with a witness to verify the numbering was correct.

Other administrative controls used to prevent unauthorized document reproduction included the requirement for a security (Q) clearance to enter the print shop. Secret and top-secret documents were kept in secured areas.

Photography Lab
During the production years at the Plant, the photography lab was the only authorized entity for taking photos on the site; the use of personal cameras was prohibited. Until the late 1990s, the act of bringing a camera onto the Plant site without an authorized camera pass was prohibited, and could result in a security infraction being issued. Photography was used primarily for documentation of production, research and development activities, products, and building construction. Photographs of product were taken to document production levels and quality, and to illustrate production techniques, difficulties, and successes. Photographs were taken of research and development activities for similar purposes. Photographs of building construction were taken to document progress of building completion.

Later uses of photography included documentation of decontamination and demolition activities and environmental investigation and cleanup activities, which supported the new mission of environmental restoration.

Sources: Buffer, Pat, employed at the Plant since 1984 by the site contractor, personal communication, November 1997.

EG&G Rocky Flats, Inc., 1994, *Site Safety Analysis Report, Notebook 11-Security*, Rocky Flats Repository.

Krieg, Dolores, employed at the Plant for 40 years by the site contractor, personal communication, November 1997.

Ellison, Ruth, employed at the Plant for 7 years by the site contractor, personal communication, January 1998.

Abeyta, Katherine, employed at the Plant for 27 years by the site contractor, personal communication, January 1998.

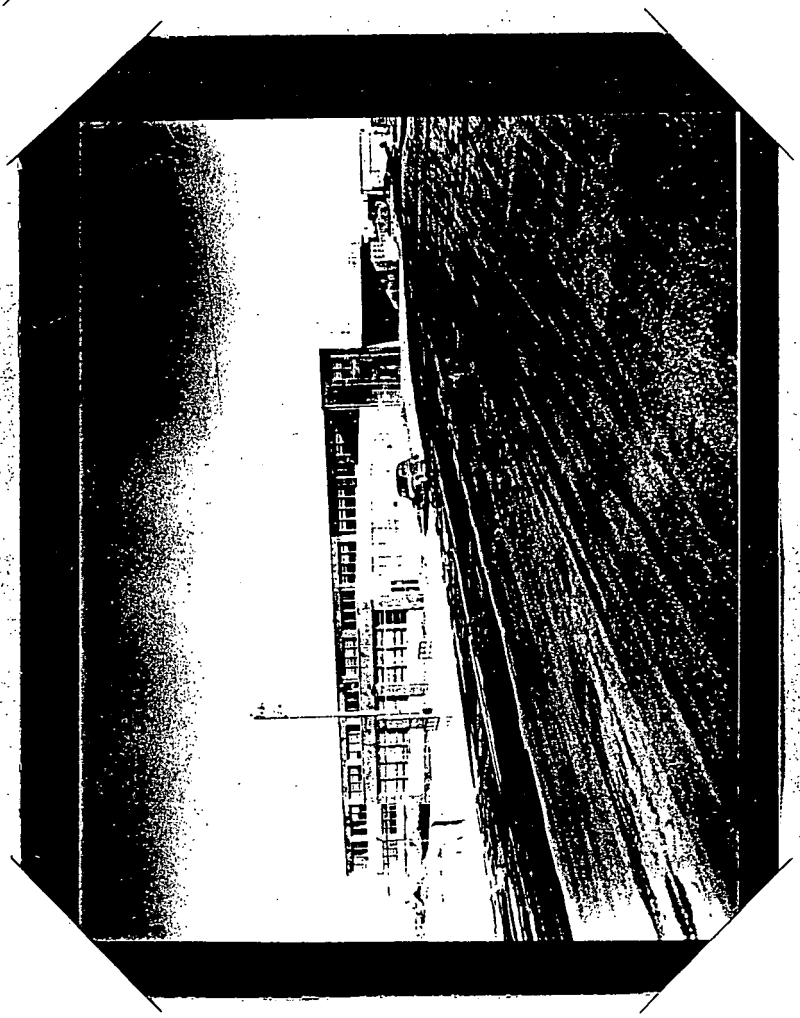
Rockwell International Energy Systems Group, Rocky Flats Plant, 1989, *Rocky Flats Plant, Interim Safety Analysis Report.*

USDOE, 1995, *Final Cultural Resource Survey Report Rocky Flats Environmental Technology Site, The Industrial Area*, Rocky Flats Plant.

Historians: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M), 1997. Judith Berryman, Ph.D., Archaeologist, e^2M, 1997.

HISTORIC AMERICAN ENGINEERING RECORD
SEE INDEX TO PHOTOGRAPHS FOR CAPTION

HAER No. CO-83-V-1



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SEE INDEX TO PHOTOGRAPHS FOR CAPTION

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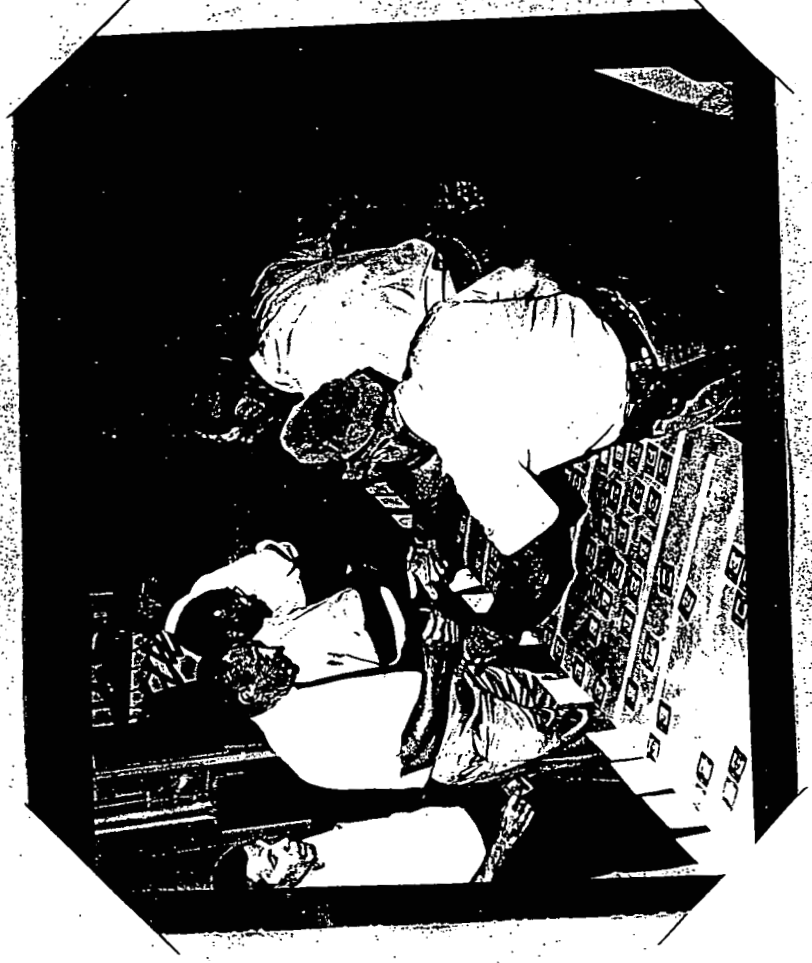

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SEE INDEX TO PHOTOGRAPHS FOR CAPTION

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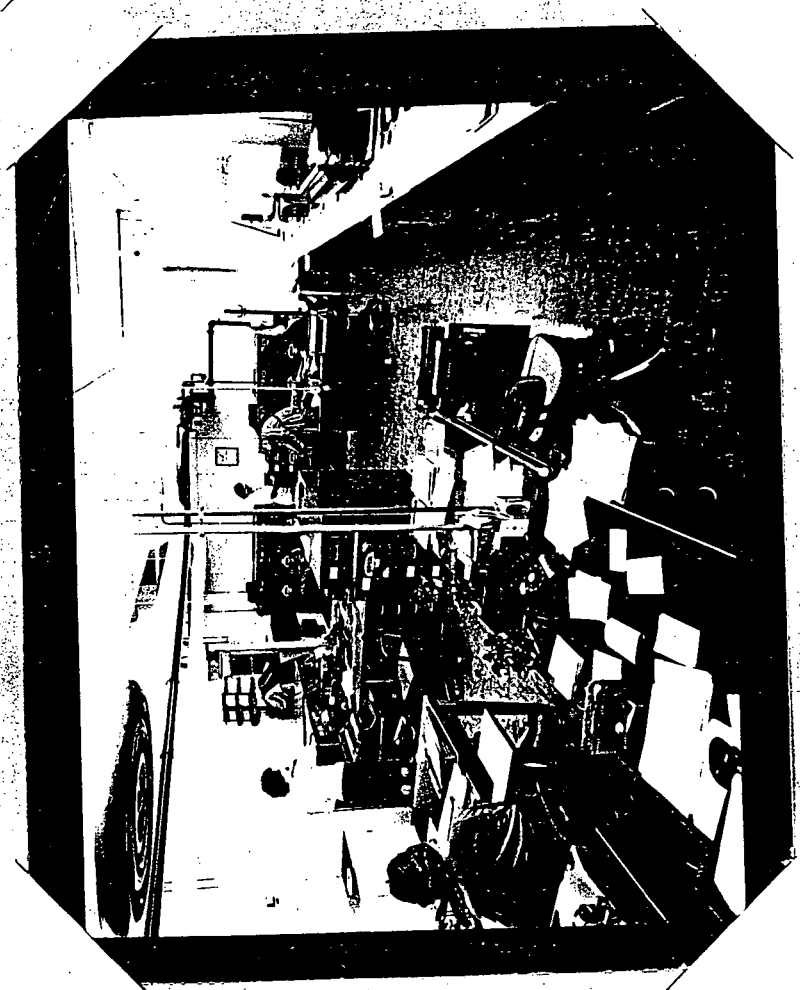


ROCKY FLATS PLANT, GENERAL CAFETERIA
(Rocky Flats Plant, Building 112)
Main entrance on Highway 93.
Golden Vicinity
Jefferson County
Colorado

HAER No. CO-83-W

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Rocky Mountain System Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

ROCKY FLATS PLANT,
GENERAL CAFETERIA
(Rocky Flats Plant, Building 112)

HAER No. CO-83-W

Location: Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County, Colorado. Building 112 is located in the northwest quadrant of the Rocky Flats Plant (Plant) near the west terminus of Central Avenue.

Significance: This building was a primary contributor to the National Register eligible Rocky Flats Plant historic district, associated with the United States strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack. Building 112 was built in 1952, was one of the first ten buildings constructed on site, and provided the first cafeteria services for the Plant.

Description: Building 112 encompasses a total of 9,280 square feet and is rectangular in shape. The interior walls are constructed of concrete block with gypsum board over wood frame and wood panel separation partitions. Exterior walls are constructed of concrete on a reinforced-concrete foundation. The roof is constructed of tar and gravel over concrete. There are multi-paned metal sash windows on all sides. The doors on the south end are metal with a full single pane of glass.

Building 112 is a cafeteria, with a series of offices and conference rooms along the north side of the building.

Built in 1952, Building 112 was one of the first ten permanent buildings constructed on the Plant site. Building 112, is located on Central Avenue close to Building 444, the least radioactive of the production buildings. The building is located in this area to minimize potential exposure to radiation.

History: Building 112 provided the first cafeteria services on-site. Breakfast service began in November 1952, but was discontinued in April 1953. Initially, the cafeteria was not profitable, and a staff reduction to save money resulted in decreased services. Breakfast service was later reinstated.

Breakfast services included a range of hot and cold items, including eggs, bacon, potatoes, toast, and beverages. A variety of cereals were also offered for breakfast. Lunch service included hot and cold items, such as soup and sandwich, chili, hamburgers and hotdogs, salads, and several choices of hot plates.

Late shift union workers and salaried personnel working overtime were offered meal vouchers that could be used to purchase meals, or could be turned in for cash. The vouchers were generous enough to provide for a full-size meal and beverage. Since the cafeteria was not open

in the evening, workers would place their meal order earlier in the day. The meals would be prepared ahead of time and delivered to the building.

Other activities in Building 112 included Plant events, such as retirement parties, and off-hour meetings.

There are a series of offices located on the north side of the building. These offices have housed functions ranging from the transportation department to the labor relations office. Some of the offices have been converted to conference rooms.

As new production facilities were built, a cafeteria was generally included in the production building design. Building 112 continued to prepare all meals and transported them to the cafeterias located in production buildings. The employees working in the administrative section of the plant continued to eat their meals in Building 112. When Building 750 (a 500-seat cafeteria) began services in October 1968, meal preparation ceased in Building 112. In October 1996, the cafeteria function of Building 112 stopped entirely. The final use of the building was to house offices and conference rooms.

Sources: Buffer, Pat, employed at the Plant for 7 years by the site contractor, personal communication, November 1997 and January 1998.

Krieg, Dolores, employed at the Plant for 40 years by the site contractor, personal communication, November 1997.

EG&G Rocky Flats, Inc., 1994, *Site Safety Analysis Report, Notebook 11-Security*, Rocky Flats Plant.

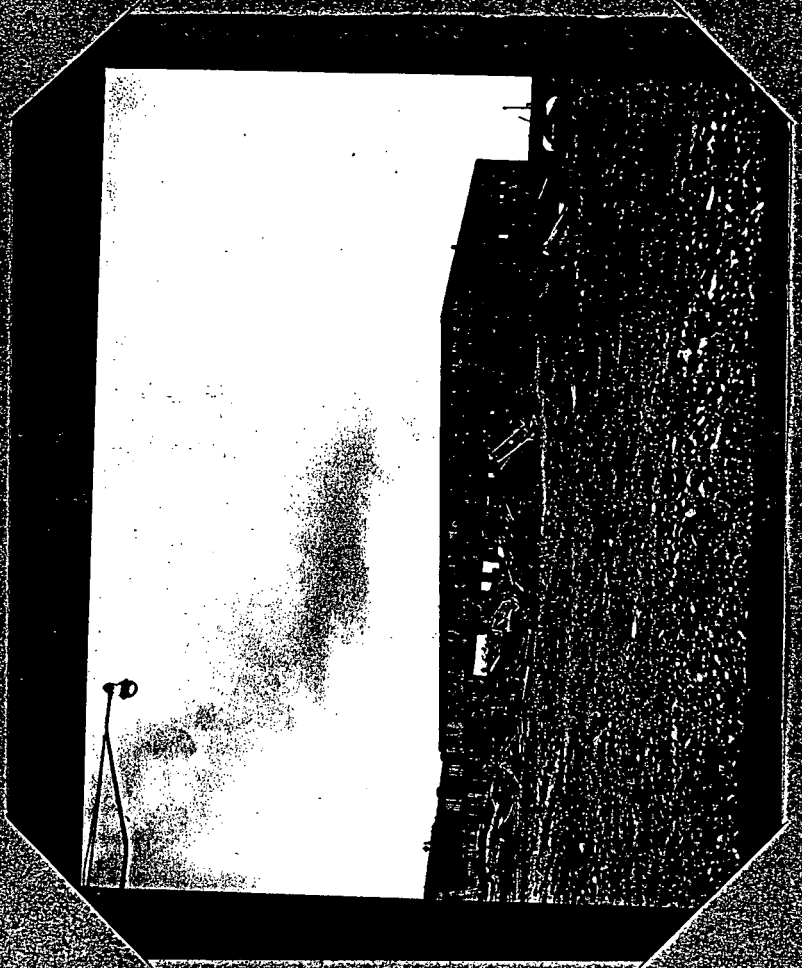
Lowe, Jean, employed at the Rocky Flats Plant for 25 years by the site contractor, personal communication, January 1998.

Science Applications International Corporation, 1995, *Final Cultural Resources Survey Report*.

Historians: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M), 1997. Judith Berryman, Ph.D., Archaeologist, e^2M, 1997.

HISTORIC AMERICAN ENGINEERING RECORD
SEE INDEX TO PHOTOGRAPHS FOR CAPTION

HAER No. CO-33-W-1



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SEE INDEX TO PHOTOGRAPHS FOR CAPTION

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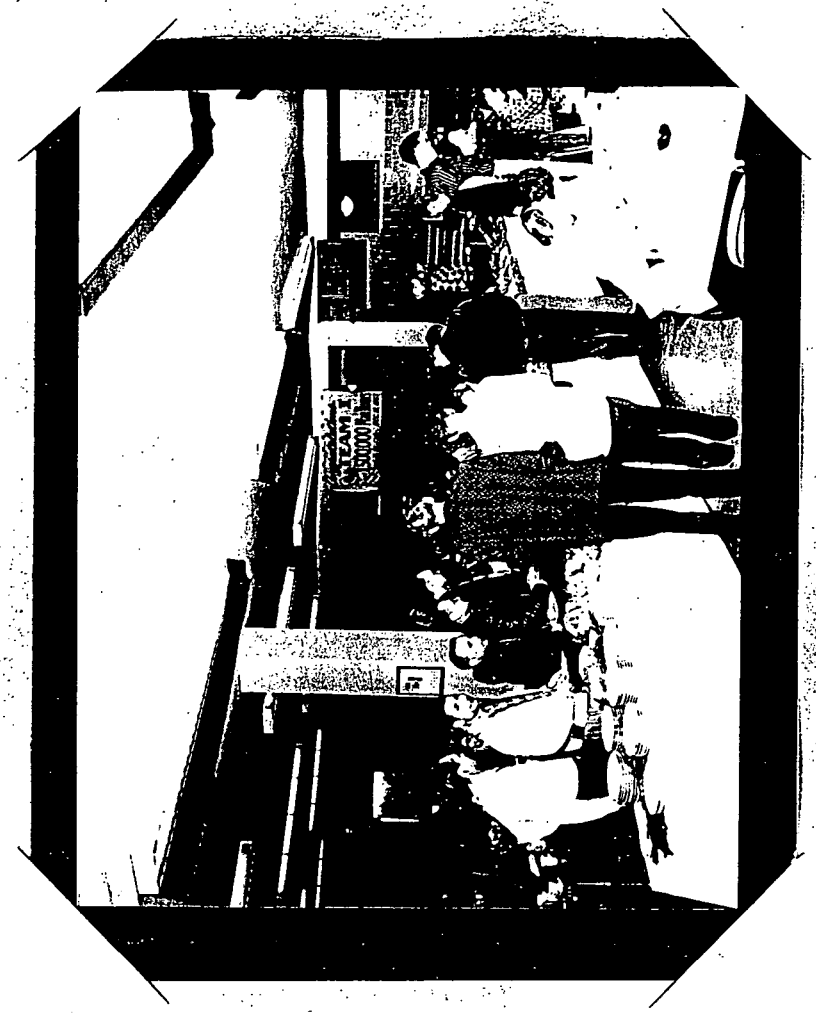

ROCKY FLATS, PLANT SECURITY AND ARMORY
(Rocky Flats Plant. Building 121)
Located west of Third Street, south of Central Avenue
Golden Vicinity
Jefferson County
Colorado

HAER No. CO-83-X

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Rocky Mountain System Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

ROCKY FLATS PLANT,
PLANT SECURITY AND
ARMORY
(Rocky Flats Plant, Building 121)

HAER No. CO-83-X

Location: Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County, Colorado. Building 121 is located west of Third Street and south of Central Avenue.

Significance: This building was a primary contributor to the National Register eligible Rocky Flats Plant historic district, associated with the United States (U.S.) strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack. Building 121 was one of the original structures at the Rocky Flats Plant (Plant), and was used for the site security central office.

Description: Building 121 is a two-story high, 6,530 square foot building built on a concrete slab on-grade foundation. Exterior walls are constructed of concrete and concrete block. Interior walls are concrete, concrete block, gypsum board, and ceramic tile. The facility has a flat roof covered by neoprene-hypalon and butyl rubber over plastic foam insulation. The roof structure is cast-in-place concrete over corrugated metal decking and bar joists. Floors are covered with 12" square vinyl asbestos tiles or short pile industrial carpet. The windows are fixed, double-panes in metal sashing. The doors are metal.

Building 121 is irregularly shaped, extending approximately 100' north-south, 130' east, and 120' west.

The building houses offices, the Plant central alarm station, alarm consoles, the armory, the lock and key section, a computer room (on the second floor), a utility room, separate men's and women's change/locker rooms with showers and attached restrooms, and security management offices.

History: Building 121 was constructed in 1953 as part of the original plant to serve as the central office building for site security. By 1971, the security force had grown in numbers to the point that Building 121 was too small. The locker rooms and briefing room could no longer accommodate the force. The supply room, where uniforms and equipment were stored and issued, was inadequate. Additions were made to the building to increase the size of the locker rooms on the first floor, and a second floor was added for central dispatch and communications systems. The supply room was moved to another building.

Protection strategies for the Plant included maintenance of a weapons arsenal, training new security police officers, investigating violations of Federal laws, and maintaining liaisons with Federal and local law enforcement agencies. The security contractor had a highly trained special response team that could respond to actual or potential terrorist incidents, hostage barricade incidents, and other emergencies.

Sources: Cunningham, Steven, employed at the site since 1977 by the site security contractor, personal communication, March, 1998.

EG&G Rocky Flats, Inc., 1995, *Site Safety Analysis Report, Notebook 13-Security*, Rocky Flats Repository.

Science Applications International Corporation, 1995, *Final Cultural Resources Survey Report.*

Historians: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M), 1997. Judith Berryman, Ph.D., Archaeologist, e^2M, 1997.

HISTORIC AMERICAN ENGINEERING RECORD
SEE INDEX TO PHOTOGRAPHS FOR CAPTION

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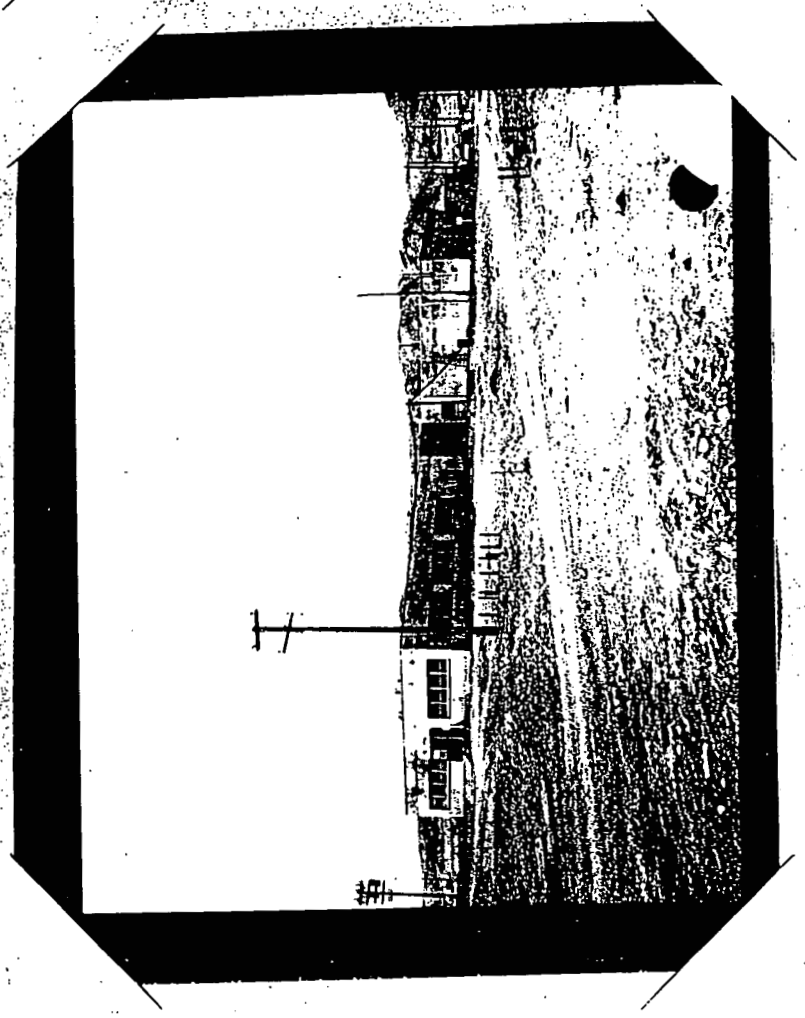

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SEE INDEX TO PHOTOGRAPHS FOR CAPTION

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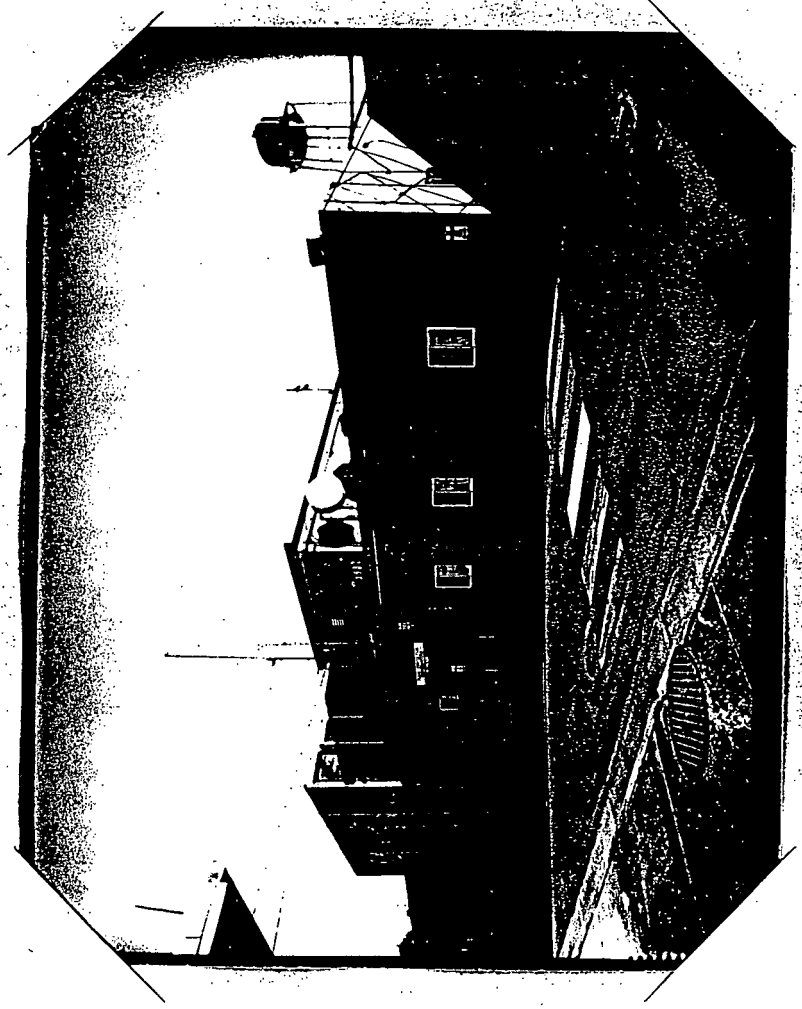

ROCKY FLATS PLANT

HAER No. CO-83-Y

VEHICLE MAINTENANCE GARAGE AND FIRE STATION
(Rocky Flats Plant, Building 331)
Northeast corner of Fourth Street, south of Central Avenue
Golden Vicinity
Jefferson County
Colorado

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Rocky Mountain System Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

ROCKY FLATS PLANT, VEHICLE MAINTENANCE GARAGE AND FIRE STATION (Rocky Flats Plant, Building 331)

HAER No. CO-83-Y

Location: Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County, Colorado. Building 331 is located in the northeast corner of the intersection of Fourth Street and Central Avenue.

Significance: This building was a primary contributor to the National Register eligible Rocky Flats Plant historic district, associated with the United States strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack. Building 331, one of the original structures at the Rocky Flats Plant (Plant), was used as a warehouse.

Description: Building 331 is, generally, one-story high and built on concrete footings. Some portions of the building extend to two stories. The floor is an on-grade concrete slab. Exterior walls are constructed of either cast-in-place concrete or concrete block walls. The walls of the eastern portion of the facility (offices and bunkrooms) are of concrete block construction; the roof and second story floors in this area are pre-cast concrete. The remainder of the facility, including the fire station bay area and the vehicle maintenance garage, is constructed of cast-in-place concrete walls. A small addition at the northeast corner of the garage is constructed of plywood, corrugated asbestos-cement sheets, and/or corrugated metal panels.

The roof and floors in the east addition are pre-cast concrete T-beams. The roof over the rest of the building consists of cast-in-place concrete slabs, beams, and girders.

Floor coverings are either 12" vinyl floor tiles, painted concrete, bare concrete, or short-pile industrial carpet.

The windows on the eastern portion of the building are fixed within metal sashes. The west and north sides have multi-pane metal sash windows, arranged in sets of four. The west side has one overhead metal door and the east and north sides each have two overhead doors. The south side of the building has a central bay containing three metal overhead doors.

The building area is approximately 19,760 square feet on the first floor and 3,780 square feet on the second floor for a total of 23,540 square feet. The building is configured in an L-shaped layout with the sides of the L being unequal in length and area. The dimensions are approximately 196' along the Central Avenue frontage and approximately 161' along the Fourth Street frontage.

The garage side of the facility houses approximately eight offices, seven workstations for vehicle repairs, an automotive parts and warehouse area, a break room, and changing rooms for Plant

personnel. The vehicle maintenance garage is the only site-wide vehicle service center and motor fuel distribution location at the Plant.

All vehicles from the General Services Administration's Plant fleet and skid- or trailer-mounted internal combustion engines are serviced in the vehicle maintenance garage. The types of vehicles and equipment serviced include passenger cars and light trucks, heavy equipment (bulldozers, dump trucks, backhoes), and roads and grounds equipment (box scrapers, lawnmowers, mowing machines, tractors, weed eaters, snow blowers, and road cleaners). Vehicle maintenance personnel also provide routine preventive and predictive maintenance service on several large equipment items permanently located on-site, including diesel electric generators, compressors, etc. Complex jobs that require specialized equipment, such as engine overhauling and rebuilding, forklift maintenance, body work, and repairs valued at more than $100 are sent off-site via subcontract arrangements.

The Fire Station side of the facility is divided into areas consisting of: offices; a high-bay area that houses up to six fire fighting and emergency response vehicles; three dormitory-type sleeping quarters; a lounge and kitchen area; a self-contained breathing apparatus compressor room; a building utility room with heating, ventilating, and air conditioning distribution equipment, a steam-supplied hot water heater, motor control center panels, and an uninterruptible power supply battery bank; a dispatch office; a training room with audio-visual support equipment; and a vertical hose cleaning/drying station.

All site-wide fire alarm signals, including all fire phones, fire pull boxes, heat and smoke detectors, and suppression system flow alarms, are transmitted to the Building 331 dispatcher's office. There are 361 manual alarm transmitters (fire phones) on site. Lifting the receiver from the switch hook on any fire phone initiates a fire alarm in the building where the fire phone is located, in the dispatcher's office, and in the central alarm station in Building 121. The scanners at the fire station and the central alarm station automatically show the location of the fire phone that initiated the alarm and the type of alarm being received (smoke or heat).

History: Building 331, originally constructed in 1953, was designed and utilized as a warehouse. When the building became too small for parts storage, a new warehouse was constructed at another site location and Building 331 then became the site maintenance garage. Additions to the structure, including the fire department structure, were completed in 1967.

At one time, the northeast corner of the vehicle maintenance garage housed a technical staff and a uranium research and development laboratory. Rolling of enriched uranium foil was conducted there in 1964. This area may also have been used for the development of depleted uranium coating studies. After Building 865 came on-line in 1970, the area was converted for the development of remote handling techniques such as robotics and remote manipulator arms.

Sources: Cable, Jerry, employed at the Plant for 16 years by the site contractor, personal communication, December 1997.

EG&G Rocky Flats, Inc., 1994, *Site Safety Analysis Report, Notebook 3*, Rocky Flats Repository.

Science Applications International Corporation, 1995, *Final Cultural Resources Survey Report.*

Historians: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M), 1997. Judith Berryman, Ph.D., Archaeologist, e^2M, 1997.

HISTORIC AMERICAN ENGINEERING RECORD
SEE INDEX TO PHOTOGRAPHS FOR CAPTION

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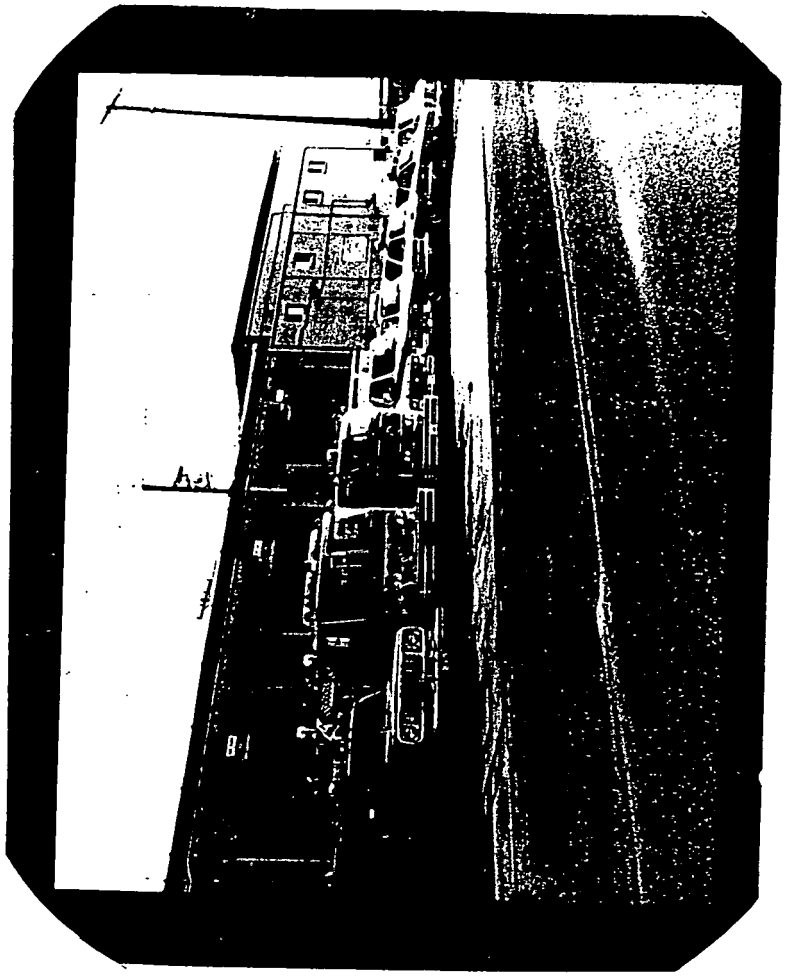

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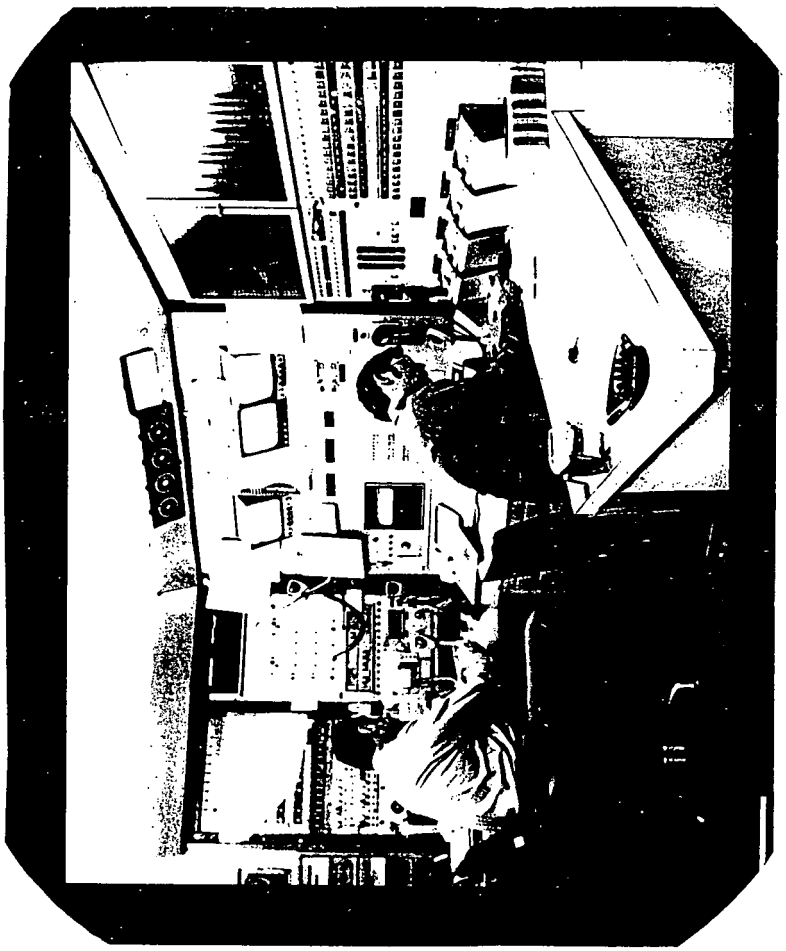
SEE INDEX TO PHOTOGRAPHS FOR CAPTION

HAER No. CO-83-V-L



ROCKY FLATS PLANT,

TRANSPORT MODIFICATION CENTER

(Rocky Flats Plant, Building 440)

Located north of Cactus Avenue, approximately 400' east of Third Street,

Golden Vicinity

Jefferson County

Colorado

HAER No. CO-83-Z

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Rocky Mountain System Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

ROCKY FLATS PLANT,
TRANSPORT MODIFICATION CENTER HAER No. CO-83-Z
(Rocky Flats Plant, Building 440)

Location: Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County, Colorado. Building 440 is located inside the 400 Area security fence, north of Cactus Avenue, approximately 400' east of Third Street.

Significance: Building 440 was a primary contributor to the National Register eligible Rocky Flats Plant historic district, associated with the United States (U.S.) strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack. Building 440 was used for packaging and staging special nuclear materials and depleted uranium for shipment, and later for the modification of safe secure transports.

Description: Building 440 is comprised of several multi-height structures attached to each other, forming a building of variable height. Room 105, 106, 112, 113, 114, and 123 are the primary rooms contained in Building 440, and are discussed in more detail below. The northwest portion of Building 440 consists of four high-bay, corrugated-metal, prefabricated structures linked together. Each of these four prefabricated structures is constructed of rigid, tapered north-south steel bents, with no intermediate columns. The bents are cross-braced. Two one-story structures with shallow-pitched gable roofs form the eastern portion of Building 440. Two structures with medium-pitched gable roofs, and one flat-roofed, single-story area form the southwest portion of Building 440. The roof is corrugated metal decking, supported by cold-formed steel purlins, insulated with fiberglass and vapor-barrier facings.

The east and west portions of the building each have two metal overhead doors. The foundation contains spread footings connected by concrete grade beams. The exterior walls and some of the interior walls between the structures are metal sandwich-type panels with fiberglass insulation. Most of the interior walls are concrete masonry. The floors are on-grade concrete slabs.

The outline of the building measures 276' (east-west) x 142' (north-south), covering approximately 41,320 square feet. Two railroad spurs enter the building at the eastern end.

Room 106 contains a grid of wide flange steel beams 10' above the floor. These beams, originally used to support weapons components awaiting shipment to the Pantex Plant in Amarillo, Texas, currently support electrical bus ducts and fluorescent light fixtures.

A 5-ton bridge crane is located in Room 112. Unlike other bridge cranes at the Rocky Flats Plant (Plant), the rails for the crane in Room 112 are supported on steel columns, independent of the building. The crane was added after the building was constructed to aid in the modification of rail cars.

Room 114 is a railcar bay. The railroad tracks and the majority of the floor slab are approximately 5' lower than the main building floor. The tracks enter the room from the east; an entry dock is located at the north end. Gantry cranes present in Rooms 105 and 114 were used to move equipment and materials used in the modification of safe secure transports.

Industrial-sized paint booths are located in Rooms 113 and 123. These paint booths are large enough to hold a semi-truck trailer, and are equipped with special air vents to carry air in and out of the booths.

History: Building 440 was constructed in the late 1960s for production control and shipping of products for final assembly and wastes for disposal. Special nuclear materials and depleted uranium were staged and shipped out of this building by truck and railcar.

For a brief period, Building 440 was used as a general warehouse and storage area for non-nuclear construction and fabrication materials.

In the early 1970s, Building 440 was used to modify and repair vehicles to meet specific U.S. Department of Energy (USDOE) requirements for transport of special nuclear materials and radioactive wastes. Building 440 was expanded three times to include a railcar bay, a high bay, paint booths, storage areas, and locker rooms in support of transport modification efforts. A Plant employee, Walter Coven, is credited with developing the concept of modifying railroad cars, semi-truck trailers, and escort vehicles to carry radioactive waste materials for storage and disposal and to transport weapons components to the Pantex Plant. Armor, communication equipment, and comfort features were added to transport vehicles to aid personnel assigned to ensure the safe and secure movement of the cargo. Vehicle modification work in Building 440 continued until 1994, when the mission was transferred to another USDOE facility in Kansas City. Most of the original equipment associated with this activity has been shipped to other USDOE plants.

Railcars for material shipping were among the first types of transports modified in the building, followed by rail escort cars for personnel. The use of railcars was replaced by the use of specially modified tractor trailers called safe secure transports. The tractor trailers could take advantage of the highway system which offered increased flexibility in shipment schedules and routing, and also offered the possibility of evasive action, if necessary.

Operations: Production processes in Building 440 included various welding, painting, machining, pipe fitting, metal working, and electrical work used to modify transports. Modification efforts focused on developing entry deterrents. Paint booths were used to coat fabricated, non-nuclear components and the transports. The gantry and 5-ton cranes were used to move materials associated with the transport modification effort.

Sources: EG&G, 1994, *Historical Release Report*, Rocky Flats Plant Repository.

USDOE, *Final Cultural Resource Survey Report, Rocky Flats Environmental Technology Site*, Rocky Flats Plant Repository.

Swenson, Peter, employed at the Plant since 1982 by the site contractor, personal communication, December 1997.

Coven, Walter, employed at the Plant from 1955 to 1988 by the site contractor, personal communication, January 1998.

Roberts, Jim, employed at the Plant from 1967 to 1997 by the site contractor, personal communication, January 1998.

Healy, Terry, employed at the Plant since 1976 by the site contractor, personal communication, January 1998.

Weaver, Jack, employed at the Plant since 1961 by the site contractor, personal communication, January 1998.

Historians: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M), 1997. Judith Berryman, Ph.D., Archaeologist, e^2M, 1997.

HISTORIC AMERICAN ENGINEERING RECORD
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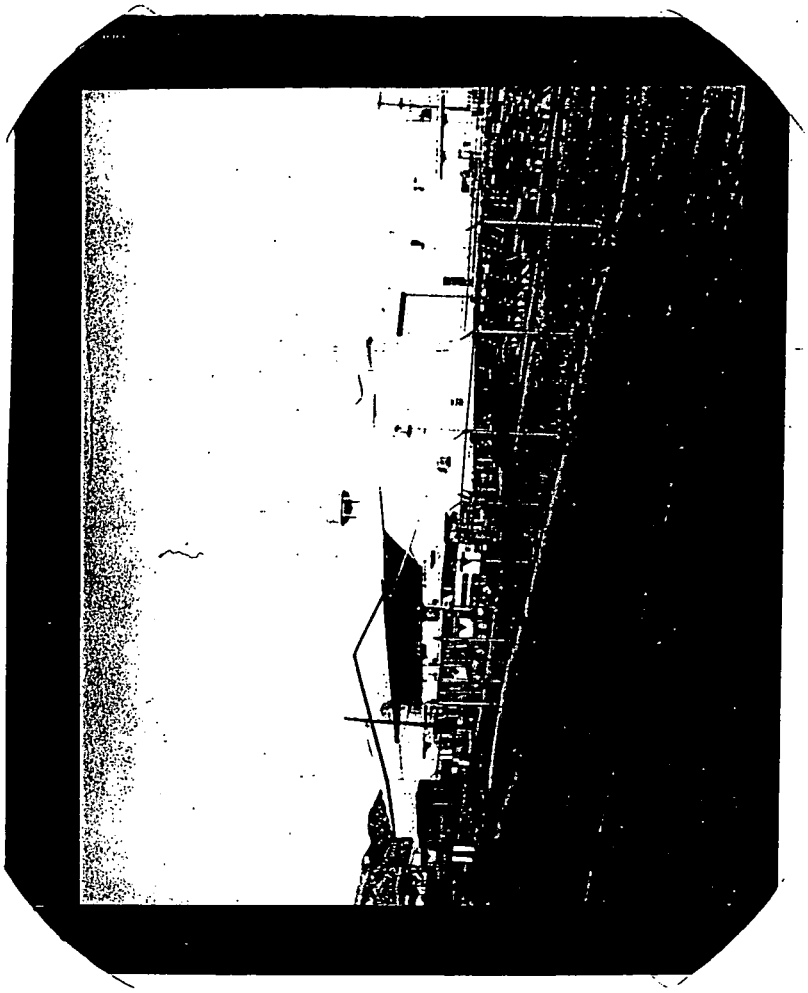
HAER No. CO-83-Z-1



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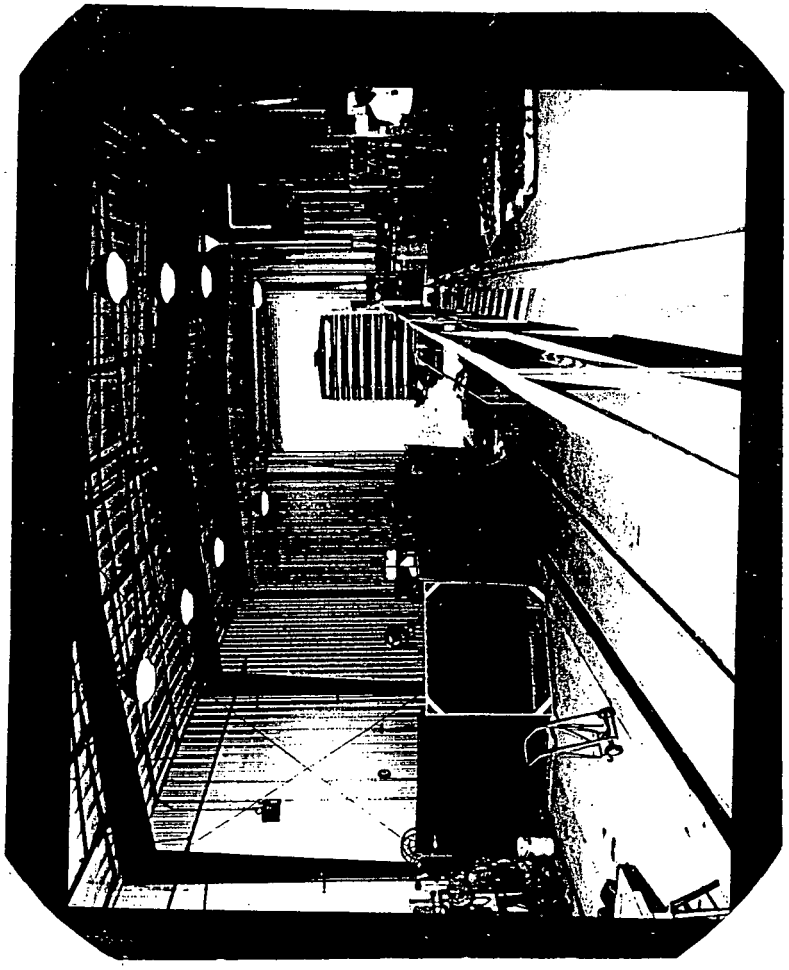

ROCKY FLATS PLANT, METAL RESEARCH AND DEVELOPMENT LABORATORY
(Rocky Flats Plant, Building 865)
Located south of Central Avenue, at the south end of the terminus of Ninth Avenue,
Golden Vicinity
Jefferson County
Colorado

HAER No. CO-83-AA

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Rocky Mountain System Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

ROCKY FLATS PLANT,
METAL RESEARCH AND DEVELOPMENT
LABORATORY HAER No. CO-83-AA
(Rocky Flats Plant, Building 865)

Location: Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County, Colorado. Building 865 is located south of Central Avenue, at the south end of the terminus of Ninth Avenue.

Significance: This building was a secondary contributor to the National Register eligible Rocky Flats Plant historic district, associated with the U.S. strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack. The building was used for metallurgical research and development, and fabrication of prototype parts.

Description: Building 865 is a one-story, rectangular structure. Overall floor space is approximately 37,980 square feet. The building is divided into two areas. The north side of the building (12,000 square feet) houses offices, a laboratory, a machine shop, a maintenance shop, and a utility room. The north side of the building covers an area of 82' x 152'. The south side of the building is a high-bay area (23,000 square feet) that houses metal working operations. The high-bay area, twice as high as the north area, contains a small mezzanine that supports ventilation equipment. The high-bay area was a radiological control area, where the use of personal protective equipment was required.

Building 865 is built on a concrete slab on-grade. The exterior walls are made of up-ended precast concrete T-beams. The roof is precast concrete with polyurethane foam insulation and neoprene topping. Interior walls are precast concrete, concrete block, or gypsum board. The mezzanine has a structural steel frame. Windows present in the bay are industrial multi-paned with metal sashes.

Upgrades to the building include the addition of a second high-efficiency particulate air filter system (located in Building 867), and the addition of Rooms 171 and 172.

Building 865 has two supporting structures: Building 827, which houses a diesel generator; and Building 865A, a process-water cooling tower. Buildings 867 and 868 are exhaust plenums for Building 865.

History: Building 865, built in 1970, is part of the Plant research and development program. The building houses metalworking equipment for the study of non-plutonium metals and the development of alloys and prototype hardware. The building serviced not only Plant requests, but also handled developmental work for other U.S. Department of Energy (USDOE) facilities such as Los Alamos Laboratory in New Mexico and Lawrence Livermore National Laboratory in California. Alloys and prototype hardware developed at the request of the Plant were used to

were used to evaluate new or proposed Plant processes. Alloys and prototype hardware developed for other USDOE facilities were used to aid in the development of new process or weapon designs for the USDOE Complex.

A beryllium electrorefining cell, operated briefly during the early 1980s was designed as a one-half scale beryllium recovery experimental cell.

Operations: The building is used for fabricating prototype hardware, and developing metal alloys and processes. Operations include metalworking, machining, and metallurgical laboratory operations.

The most common metals processed were depleted uranium, steel, and aluminum. Other metals worked in the building included copper, molybdenum, beryllium, titanium, silver, niobium, tantalum, gold, iridium, platinum, vanadium, tungsten, and alloys of these metals.

Metalworking

All metalworking operations were conducted in the high-bay area. Metalworking processes included arc and vacuum induction melting, hammer forging, press forming, hydrospinning, swaging, extruding, drawing, rolling, diffusion bonding, furnace heat treating, salt bath and glove box operations, and cutting and shearing.

Metals were melted using one of two methods: arc melting and vacuum furnace melting. In arc melting, the furnance is evacuated of air. With the power turned on, an arc is struck between the electrode and a starting block placed in the mold. Heat from the arc progressively melts the end of the electrode; the molten metal is transferred across the arc and deposited on top of an ingot situated in the mold. Materials melted with this process included stainless steel alloys, depleted uranium, depleted uranium alloys, and beryllium. In vacuum melting, an electrical current is induced into the metal by an induction coil connected to a power supply. The metal charge acts as a secondary circuit for the current. The melted metal (including beryllium, depleted uranium, copper, aluminum, lead, steel) is then cast into molds.

There were several processes used to create forms or shapes for parts. Hammer forging was used to force heated metal to conform to the shape of a metal die by hammer blows. The press forming process pressed hot or cold beryllium, uranium, steel, and other ferrous and nonferrous metals into the desired shape. Hydrospinning formed hot or cold metals into desired shapes using rollers while the metal was rotated at a high speed. Swaging subjected stock (bar or tube) to a series of blows from two or four dies which rotated around the stock so that the piece was hammered from all sides.

Other methods were used to produce specific types of shapes. Extrusion was used to produce cylindrical bars, hollow tubes, and shapes with irregular cross-sections by forcing preheated

metal through a die orifice under high pressure. Drawing was used to change the cross-section of metal wire, rods, or tubing by pulling the metal through a die. The rolling process, used to reduce cross-section, shaped metals by passing them between two rollers revolving at the same speed in opposite directions.

Metal parts were joined in a bonding process where thin layers of bonding material were plated on the surfaces of materials being joined. Pressure was applied to the joined surfaces (under an inert atmosphere or a vacuum) to create the bond.

Formed metal parts were furnace heat-treated in an argon or air atmosphere, or under a vacuum using electric resistance-type furnaces. Salt baths were used to heat metal pieces to a high temperature in preparation for forging, rolling, or some other type of working.

Operations involving beryllium powder were conducted inside of glove boxes. High-purity beryllium was produced, and canned (sealed in a can) in glove boxes. Beryllium chips from lathe operations were processed in two types of mills (ball mill and a fluid energy mill) to form a powder. The powder was then sealed into stainless steel containers in preparation for further processing.

A large abrasive wheel was used to reduce large billets and bar stock to a useable size for further fabrication. Sheet metal was cut to the desired shape and size using a shear press.

Machining
Machining operations included milling, grinding, drilling, and cutting operations. The machine shop was equipped with standard equipment including surface grinders, drill presses, and saws. Other equipment in the machine shop was specialized; lathes and milling machines in the shop were equipped with tracers.

Metallurgy

A metallurgy laboratory, located in the northeastern corner of the building, conducted mechanical testing of metals and prepared metal samples for examination. Mechanical tests determined the tensile properties of the metals at room, elevated, and at very low temperatures. Other tests measured hardness of the metals and alloys using various methods (Brinell, Rockwell, Knoop, and diamond pyramid). These test methods used the depth of indentation of a steel ball, or a diamond pyramid under pressure, to measure hardness.

Samples were prepared for macroscopic and microscopic examination by sawing, cutting, mounting, grinding, polishing, and etching operations. After preparation, the samples were visually examined at various magnifications and optical conditions to identify structural details, including the crystalline structure of alloys.

Miscellaneous Operations
The final use of the building was to conduct metallography laboratory work and decontamination activities for the product research and development group.

Sources: ChemRisk, 1992, *Project Task 3 and 4 Final Draft Report. Reconstruction of Historical Rocky Flats Operational and Identification of Release Points*, prepared for the Colorado Department of Health.

EG&G, 1994, *Historic Release Report*, Rocky Flats Plant Repository.

U.S. Department of Energy, 1995, *Final Cultural Resource Survey Report Rocky Flats Environmental Technology Site, The Industrial Area*, Rocky Flats Plant Repository.

Historians: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M). Judith Berryman, Ph.D., Archaeologist, e^2M, 1997.

HISTORIC AMERICAN ENGINEERING RECORD

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ROCKY FLATS PLANT, METAL RESEARCH
AND DEVELOPMENT LABORATORY HAER No. CO-83-AA
(Rocky Flats Plant, Building 865)
Located south of Central Avenue, at the south end of the terminus of Ninth Avenue.
Golden Vicinity
Jefferson County
Colorado

Photographs CO-83-AA-1 through CO-83-AA-2 were taken by various site photography contractors, dates are indicated in parentheses.

CO-83-AA-1 VIEW OF THE INSTALLATION OF AN EXTRUSION PRESS IN THE HIGH BAY AREA OF BUILDING 865. THE EXTRUSION PRESS WAS USED TO PRODUCE CYLINDRICAL BARS, HOLLOW TUBES, AND SHAPES WITH IRREGULAR CROSS-SECTIONS BY FORCING PREHEATED METAL THROUGH A DIE ORIFICE UNDER HIGH PRESSURE. (5/22/70)

CO-83-AA-2 VIEW OF THE HYDROSPINNING EQUIPMENT IN BUILDING 865. THE HYDROSPINNING PROCESS FORMED METALS INTO DESIRED SHAPES BY ROLLERS WHILE THE METAL WAS ROTATED AT HIGH SPEED. BERYLLIUM, URANIUM, REFRACTORY METALS, AND OTHER NONFERROUS METALS WERE SPUN EITHER HOT OR COLD, INTO A VARIETY OF SHAPES. (11/9/73)

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ROCKY FLATS PLANT, METAL RESEARCH
AND DEVELOPMENT LABORATORY HAER No. CO-83-AA
(Rocky Flats Plant, Building 865)
Located south of Central Avenue, at the south end of the terminus of Ninth Avenue.
Golden Vicinity
Jefferson County
Colorado

Photographs CO-83-AA-1 through CO-83-AA-2 were taken by various site photography contractors, dates are indicated in parentheses.

CO-83-AA-1 VIEW OF THE INSTALLATION OF AN EXTRUSION PRESS IN THE HIGH BAY AREA OF BUILDING 865. THE EXTRUSION PRESS WAS USED TO PRODUCE CYLINDRICAL BARS, HOLLOW TUBES, AND SHAPES WITH IRREGULAR CROSS-SECTIONS BY FORCING PREHEATED METAL THROUGH A DIE ORIFICE UNDER HIGH PRESSURE. (5/22/70)

CO-83-AA-2 VIEW OF THE HYDROSPINNING EQUIPMENT IN BUILDING 865. THE HYDROSPINNING PROCESS FORMED METALS INTO DESIRED SHAPES BY ROLLERS WHILE THE METAL WAS ROTATED AT HIGH SPEED. BERYLLIUM, URANIUM, REFRACTORY METALS, AND OTHER NONFERROUS METALS WERE SPUN EITHER HOT OR COLD, INTO A VARIETY OF SHAPES. (11/9/73)

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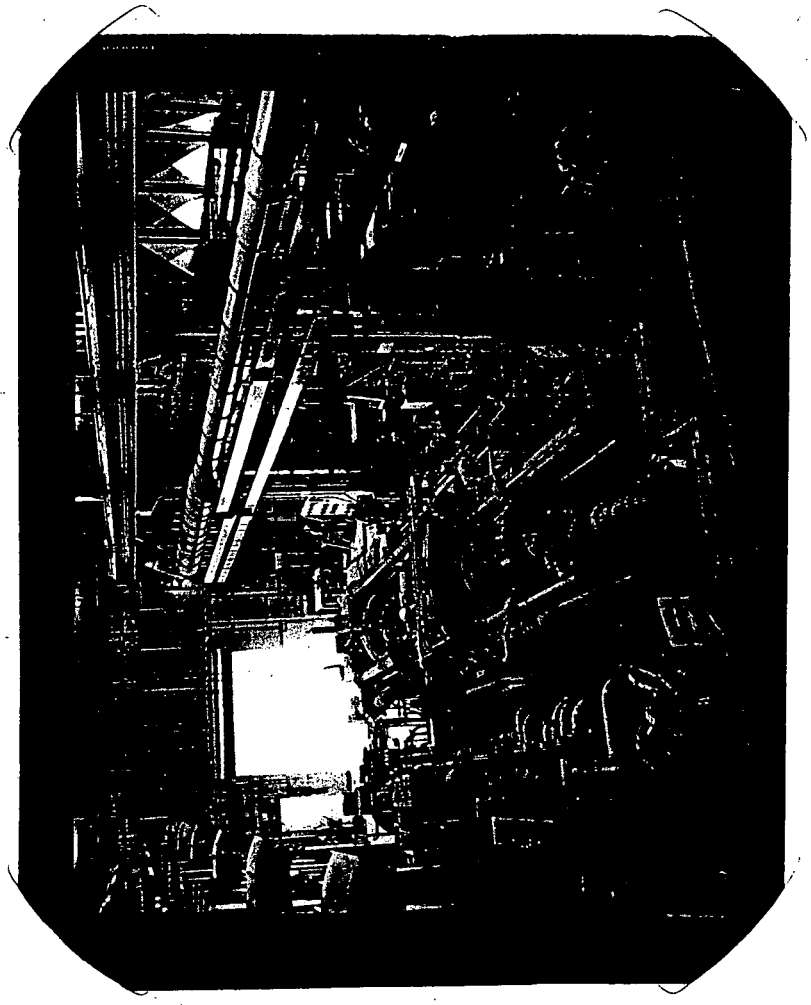
HAER No. CO-83-AA-1



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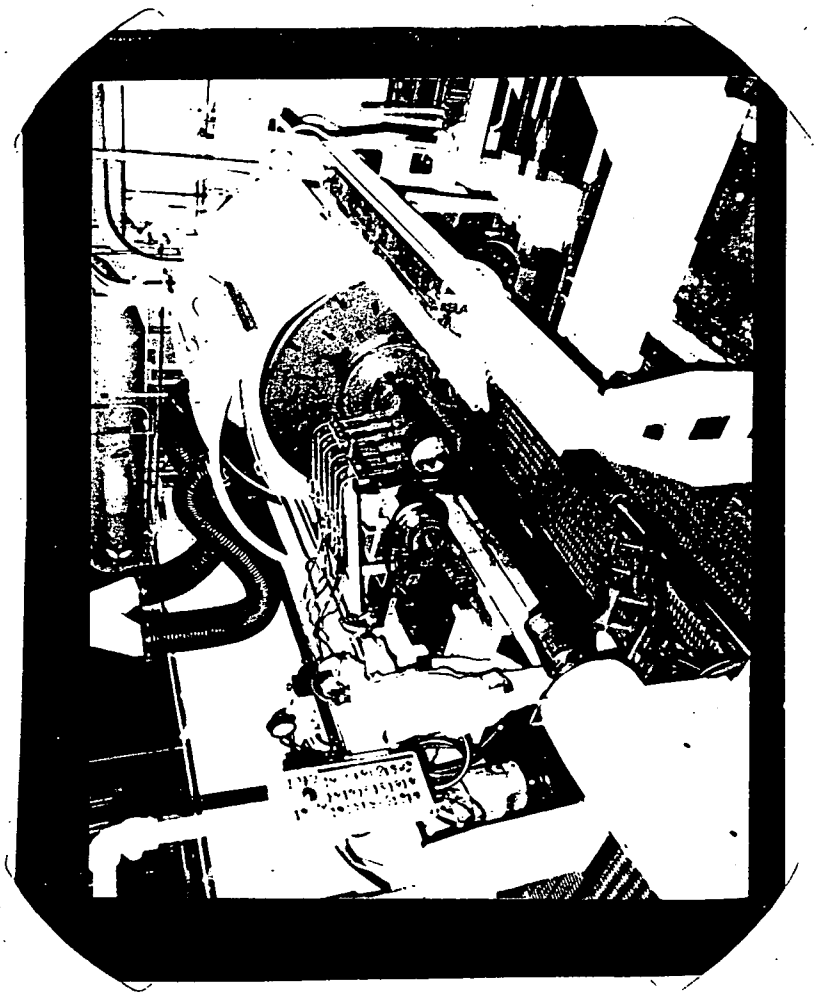
HAER No. CO-83-AA-2



ROCKY FLATS PLANT, LAUNDRY FACILITY

HAER No. CO-83-AB

(Rocky Flats Plant, Building 778)

Located in the northeast quadrant of the Plant between Buildings 776/777 and 707.

Golden Vicinity

Jefferson County

Colorado

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WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Rocky Mountain System Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

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ROCKY FLATS PLANT,
LAUNDRY BUILDING
(Rocky Flats Plant, Building 778)

HAER No. CO-83-AB

Location: Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County, Colorado. Building 778 is located in the northeast quadrant of the Rocky Flats Plant (Plant) between Buildings 776/777 and Building 707.

Significance: This building was a primary contributor to the National Register eligible Rocky Flats Plant historic district, associated with the United States (U.S.) strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack. Building 778 was used to launder white clothing and respirators worn by employees who worked in plutonium-related buildings.

Description: Building 778 is a long, thin rectangular building connected to Buildings 776/777 and Building 707 by corridors. The building has a reinforced concrete slab foundation with corrugated metal and concrete block exterior walls. Interior walls are constructed of concrete, concrete block, gypsum board on metal studs, and ceramic tile. The roof is metal. It is a one-story building encompassing approximately 31,200 square feet.

Building 778 houses laundry facilities as well as showers, locker rooms, sanitary facilities, electric, machine, and sheet metal shops, and inert gas storage.

Building 778 is traversed by an overhead sealed chain conveyor used for transport of radioactive material between Buildings 777 and 707. The chain conveyor is under negative pressure to prevent leaks into the building.

History: Building 778 was constructed in 1957 as a support facility for the 700 complex plutonium production buildings. It was used to launder the white clothing (coats, pants, hats, underwear, socks, and booties) and respirators required to be worn by Plant employees. All employees, except those working in low contamination areas such as the laboratories, were required to wear this protective clothing.

Originally, Buildings 771, 881, and 991 had their own laundries, with Building 442 laundering the clothing from Building 444. After Building 778 was constructed, laundry from these four buildings was washed there. After 1976, when Building 442 was turned over to the filter installation group, all laundry on the site was handled in Building 778. Building 778 went out of service in 1991, with all laundry being processed through Building 566.

Laundry personnel washed, sorted, mended, folded, checked for contamination, and redistributed company-supplied clothing to locker rooms throughout the Plant. The clothing consisted of undershirts and shorts, socks, coveralls, shop coats, booties, caps, and bath towels. The laundry processed approximately 125,000 to 150,000 pounds of clothing each month. The laundry equipment included three 400-pound-capacity washer-extractors and six 100-pound-capacity dryers.

Decontaminated respirators were also cleaned in Building 778. Half-mask respirators were cleaned and dried in a spray-type washer with a steam-heated drying hood. Full-face masks were washed in a converted 100-pound-capacity clothes washer and dried in a 50-pound-capacity dryer with tumbler removed.

The exhaust air from all clothes dryers and washers was exhausted through a high-efficiency particulate air filter plenum. The exhaust stack downstream of the filters was routinely checked by radiation-monitoring personnel for any possible plutonium release. Laundry water was sent to the forced evaporation operations in Building 374. Prior to Building 374 becoming operational in 1980, laundry water was sent to Building 774 second-stage aqueous waste operations and then through the evaporator located there if the radioactivity of the water was above 1,667 picoCuries per liter. If radioactivity was below this level, the wastewater was sent to Pond B-2. When the Plant first began operations, laundry wastes were discharged directly to North Walnut Creek.

Sources: ChemRisk, 1992, *Reconstruction of Historical Rocky Flats Operations & Identification of Release Points, Final Draft Report.*

Hackman, Laverne, employed at the Plant since 1985 by the site contractor, personal communication, November 12, 1997.

Lily, Chris, employed at the Plant since 1990 by the site contractor, personal communication, November 12, 1997.

Rockwell International Energy Systems Group Rocky Flats Plant, 1989, *Rocky Flats Plant, Interim Safety Analysis Report.*

U.S. Department of Energy, 1995, *Final Cultural Resource Survey Report Rocky Flats Environmental Technology Site, The Industrial Area*, Rocky Flats Repository Plant.

Historians: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M), 1997. Judith Berryman, Ph.D., Archaeologist, e^2M, 1997.

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ROCKY FLATS PLANT, LAUNDRY FACILITY HAER No. CO-83-AB
(Rocky Flats Plant, Building 778)
Located in the northeast quadrant of the Plant between Buildings 776/777 and 707.
Golden Vicinity
Jefferson County
Colorado

Photographs CO-83-AB-1 through CO-83-AB-2 were taken by various site photography contractors, dates are indicated in parentheses.

CO-83-AB-1 VIEW OF BUILDING 778, LOOKING NORTH-NORTHEAST. BUILDINGS 776/777, IN THE BACKGROUND, AND BUILDING 707 ARE CONNECTED TO BUILDING 778 BY CORRIDORS AND AN OVERHEAD CHAIN CONVEYOR FOR MOVING RADIOACTIVE MATERIALS. (1/98)

CO-83-AB-2 VIEW OF BUILDING 778 LOOKING WEST-SOUTHWEST. BUILDING 778 HOUSED LAUNDRY FACILITIES, SHOWERS, LOCKER ROOMS, SANITARY FACILITIES, AN ELECTRIC SHOP, MACHINE SHOP, SHEET METAL SHOP, AND INERT GAS STORAGE. (12/7/90)

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(Rocky Flats Plant, Building 778)
Located in the northeast quadrant of the Plant between Buildings 776/777 and 707.
Golden Vicinity
Jefferson County
Colorado

Photographs CO-83-AB-1 through CO-83-AB-2 were taken by various site photography contractors, dates are indicated in parentheses.

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CO-83-AB-2 VIEW OF BUILDING 778 LOOKING WEST-SOUTHWEST. BUILDING 778 HOUSED LAUNDRY FACILITIES, SHOWERS, LOCKER ROOMS, SANITARY FACILITIES, AN ELECTRIC SHOP, MACHINE SHOP, SHEET METAL SHOP, AND INERT GAS STORAGE. (12/7/90)

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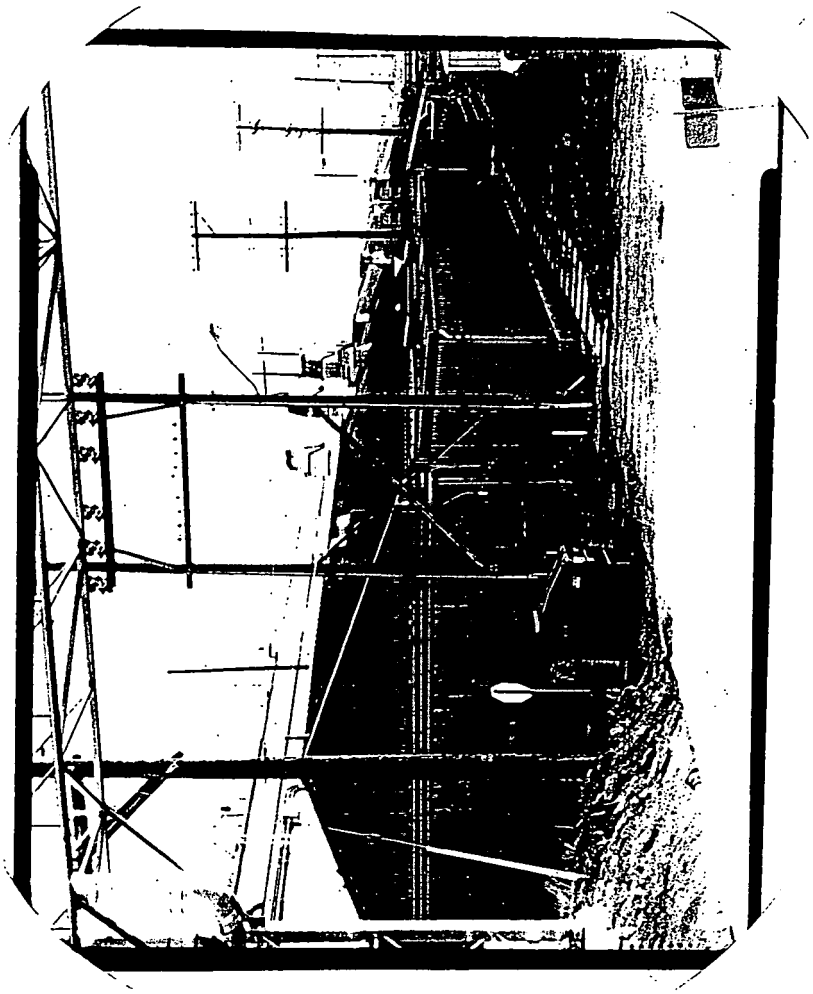
HAER No. CO-83-AB-1



ROCKY FLATS PLANT, WATER TREATMENT PLANT
(Rocky Flats Plant, Building 124)
Golden Vicinity
Jefferson County
Colorado

HAER No. CO-83-AC

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Rocky Mountain System Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

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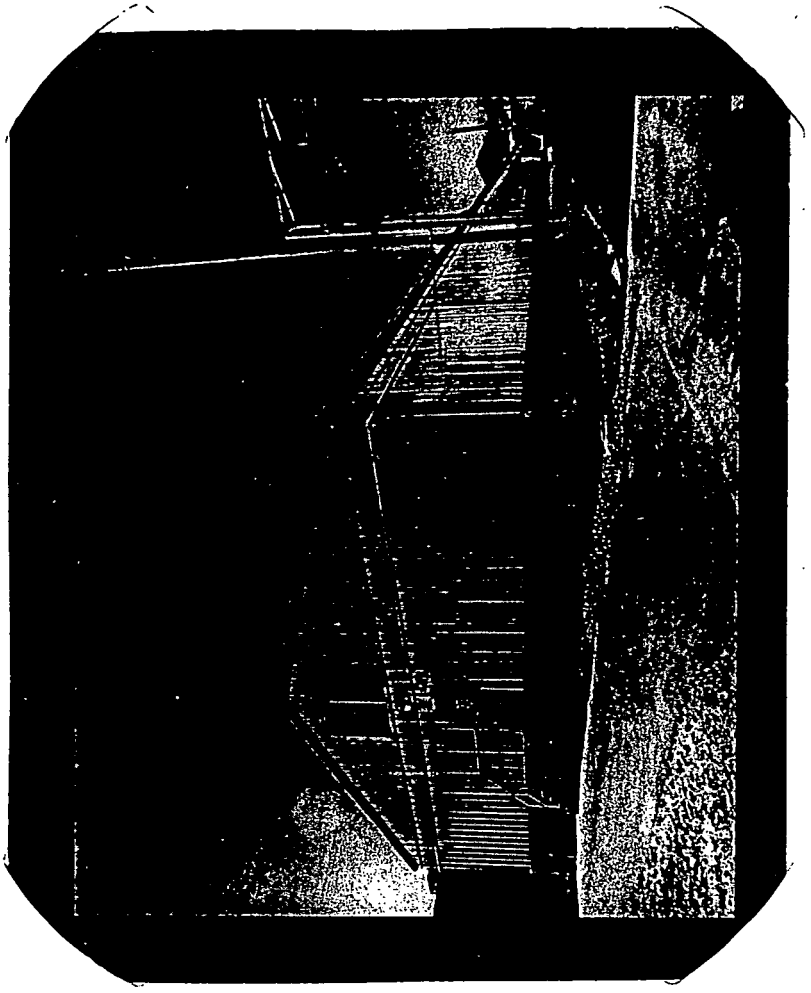
HAER No. CO-83-AB-2



HISTORIC AMERICAN ENGINEERING RECORD

ROCKY FLATS PLANT,
WATER TREATMENT PLANT
(Rocky Flats Plant, Building 124)

HAER No. CO-83-AC

Location: Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County, Colorado. Building 124 is located in the northwest quadrant of the Rocky Flats Plant (Plant), north of Cedar Avenue, east of First Street.

Significance: This building was a secondary contributor to the National Register eligible Rocky Flats Plant historic district, associated with the United States strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack. Building 124 was built in 1952, and has treated, stored, and distributed all Plant water since 1953.

Description: Building 124, the Water Treatment Plant, has a concrete foundation and walls, and metal, shallow-pitched gable roofs. It encompasses approximately 4,250 square feet in a roughly rectangular shape. The windows are industrial, multi-pane with metal sash. The doors are metal.

Raw water is purchased from the City and County of Denver and is drawn from two Denver-owned sources, Ralston Reservoir and the South Boulder Diversion Canal. Water from these two sources is typically pumped to a raw water storage pond on the west side of the Plant before entering the water treatment system.

Building 124 has a nominal treatment capacity of 700 gallons per minute (gpm). It is comprised of a flocculation tank, gravity-sand filters, chemical feeders, chlorination equipment, distribution pumps, and facilities for recycling backwash water. Alum, lime, and chlorine are added to the water as it flows into a coagulation and clarification basin. After clarification, the water flows through rapid-sand filters and is chlorinated prior to entering the finished water storage system. Blowdown water from the clarifier and backwash water from the microstrainer and filters is processed through settling basins for removal of solids. The clarified water from this operation is pumped back into the raw water system while the solids are pumped to drying beds and then are taken to the landfill. Treated water flows from Building 124 to a clear well. From there it is pumped into a ground-level tank (Building 215B) and then either into an elevated tank (Building 215A) or the Plant distribution mains, according to demand. Potable water is distributed for domestic, process, and fire protection uses throughout the Plant site.

Pumping capability for the treated water at Building 124 relies upon five electric pumps. A 1,000-gpm pump moves treated water from the clear well to the ground-level tank, which has a capacity of 500,000 gallons. One 700-gpm and two 500-gpm pumps deliver water from the clear well or the ground-level tank to either the elevated tank or the Plant treated water distribution

system. These three distribution pumps cycle automatically to maintain a minimum of 220,000 gallons in the 300,000-gallon capacity, 155-foot-high storage tank. Normally, only two of these three pumps are on line at one time. A fifth pump can pump water from either the clear well or the ground-level tank to the distribution system at 1,500 gpm in the case of fire or emergency. In case of a power outage, there is a 225-kilowatt emergency generator to keep the pumps operational.

Filter backwash water from Building 124 is reprocessed in a facility that has two 60,000-gallon storage tanks, two drying beds, and several pumps. This facility permits reuse of this highly turbid water, eliminating its discharge off site.

An alarm system, dedicated to the Water Treatment Plant, is maintained in Building 124. Alarms sound when water levels in the tanks are too low or too high, when flow to the distribution system is excessive, or when various operations in the backwash cycle malfunction.

Near Building 124 there is a connection whereby, in an extreme emergency, the incoming raw water main can be connected directly to the treated water distribution main, bypassing all storage tanks and the treatment plant. To make this change, it is necessary to manipulate valves and physically rebolt a flange.

History: Construction of Building 124 began in 1952. The complete Plant water supply, treatment, storage, and distribution system went into production in 1953 and has operated, uninterrupted, since that time. Until the system was operational, water was brought to the Plant from Boulder in tank trucks. The water system was designed to meet all existing and future Plant needs and will remain in production until the Plant goes out of operation.

Sources: EG&G Rocky Flats, Inc., 1994, *Site Safety Analysis Report, Notebook 11-Security*, Rocky Flats Plant Repository.

U. S. Department of Energy, 1995, *Final Cultural Resource Survey Report Rocky Flats Environmental Technology Site, The Industrial Area*. Rocky Flats Plant.

Web, David, employed at the Rocky Flats Plant since 1977 by the site contractor, personal communication, November 1997.

Historians: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M), 1997. Judith Berryman, Ph.D., Archaeologist, e^2M, 1997.

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ROCKY FLATS PLANT, WATER TREATMENT PLANT HAER No. CO-83-AC
(Rocky Flats Plant, Building 124)
Golden Vicinity
Jefferson County
Colorado

Photograph CO-83-AC-1 was taken by Rockwell International on 10 October 1988.

CO-83-AC-1 VIEW OF BUILDING 124, THE WATER TREATMENT PLANT, LOOKING NORTHEAST. THE ROCKY FLATS PLANT WATER SUPPLY, TREATMENT, STORAGE, AND DISTRIBUTION SYSTEM HAS OPERATED CONTINUOUSLY SINCE 1953.

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ROCKY FLATS PLANT, WATER TREATMENT PLANT HAER No. CO-83-AC
(Rocky Flats Plant, Building 124)
Golden Vicinity
Jefferson County
Colorado

Photograph CO-83-AC-1 was taken by Rockwell International on 10 October 1988.

CO-83-AC-1 VIEW OF BUILDING 124, THE WATER TREATMENT PLANT, LOOKING NORTHEAST. THE ROCKY FLATS PLANT WATER SUPPLY, TREATMENT, STORAGE, AND DISTRIBUTION SYSTEM HAS OPERATED CONTINUOUSLY SINCE 1953.

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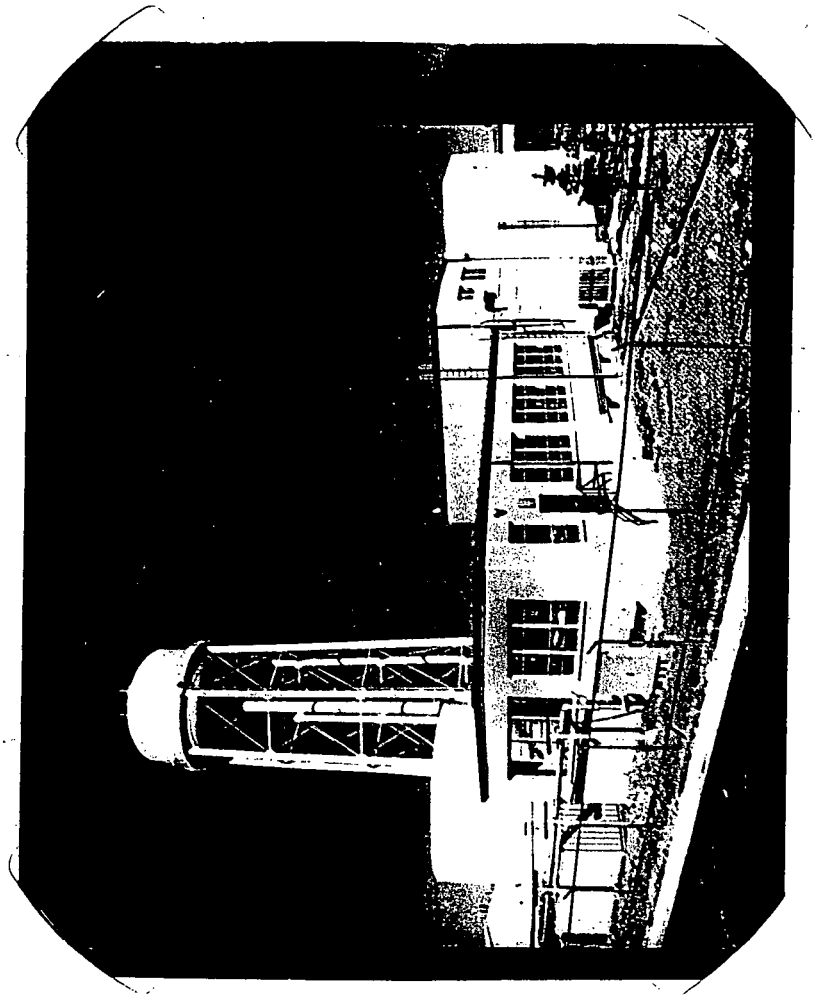

ROCKY FLATS PLANT, STANDARDS LABORATORY
(Rocky Flats Plant, Building 125)
Located immediately north of the 0215A water tower and adjacent to Third Street.
Golden Vicinity
Jefferson County
Colorado

HAER No. CO-83-AD

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Rocky Mountain System Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

ROCKY FLATS PLANT,
STANDARDS LABORATORY
(Rocky Flats Plant, Building 125)

HAER No. CO-83-AD

Location: Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County, Colorado. Building 125 is located immediately north of the 215A water tower and adjacent to Third Street.

Significance: This building was a secondary contributor to the National Register eligible Rocky Flats Plant historic district, associated with the United States strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack. Building 125 was constructed in the mid-1960s, and was one of four service laboratories.

Description: Building 125 houses the Standards Laboratory, offices for Metrology Laboratory management personnel, and the Metrology Systems Group. The Standards Laboratory, a function of Metrology, is comprised of several component labs, including physical, dimensional, chemical, and electrical. The Standards Laboratory provides National Institute of Standards and Technology traceable calibration equipment and standards for the Measurements and Test Group.

The Standards Laboratory is a one-story, rectangular-shaped, steel-framed, prefabricated building with a 6" slab-on-gravel foundation. Outside dimensions measure 90' x 143' (12,870 square feet). The overall building height is 16' from slab to roof. The exterior walls are sandwich-type metal-on-glass fiber insulation. The interior walls have dropped ceilings and are constructed of concrete block, gypsum board, or stainless steel/polystyrene panels. Windows, on the east side only, are fixed, multi-paned, with metal sash. The roof is metal with a medium pitched gable. The boundaries for Building 125 are generally defined by the exterior walls of the facility.

Specific work areas include Rooms 104, 105, 110, and 111 (laboratory and calibration areas). Rooms 115, 116, 117, 118, and 119 represent "modulabs" or specialized labs that required precise climate controls. Support areas include Room 103 (computer room), 109 (receiving/shipping and storage), and 125 (utility/service area). Door 1, located on the north end of the building, serves as the normal egress and entrance for the building. On the south exterior, there is a concrete pad with a steel supported roof over the exterior of doors 2 and 3 of Room 109. This area is used to store flammable materials in fire resistant storage cabinets. A system of monorails is used to move materials in and out of Room 109.

Utilities, located on the western exterior of the building, include domestic water, fire protection water, steam, telecommunications, drain systems, and electrical power. Equipment includes the

fire protection water standpipe, an evaporative cooler, electrical transformers, and an air conditioning unit.

History: Building 125, Standards Laboratory, is one of four main service laboratories at the Rocky Flats Plant. The other service laboratories include: Building 123, the Health Physics Laboratory; Building 559, the Plutonium Laboratory; and the General Laboratories contained in Building 881.

The primary function of the Standards Laboratory is to ensure and implement a system of quality control for incoming materials used in manufacturing processes. The Standards Laboratory is used to prepare stock solutions for the other labs, and to perform analyses on incoming radiological sources for quality assurance/quality control purposes. Calibration and standardization of equipment is also performed to assure that operations are in accordance with manufacturer specifications. One section of the lab certifies dimensional measurements such as length, angles, and roundness of equipment. Occasionally the lab acted as a referee when discrepancies arose regarding dimensional measurements of non-nuclear product. In those instances, the non-nuclear component in question was transferred to the lab for final measurement.

Construction of Building 125 began during the second phase of expansion, occurring between the years 1964-65. Eleven (11) buildings were built during this time period and included research/development laboratories, guard houses, and waste water facilities. Actual construction of Building 125 began around 1965; two later additions were added in the late 1960s to the southern end of the building.

Sources: ChemRisk, 1992, *Reconstruction of Historical Rocky Flats Operations & Identification of Release Points, Final Draft Report.*

EG&G, 1994 *Historical Release Report (HRR)*, Rocky Flats Plant.

Hahn, Jim, employed at the Plant since 1978 by the site contractor, personal communication, November 18, 1997.

U.S. Department of Energy, 1995, *Final Cultural Resource Survey Report Rocky Flats Environmental Technology Site, the Industrial Area.* Rocky Flats Plant.

Historians: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M), 1997. Judith Berryman, Ph.D., Archaeologist, e^2M, 1997.

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ROCKY FLATS PLANT, STANDARDS LABORATORY HAER No. CO-83-AD
(Rocky Flats Plant, Building 125)
Located immediately north of the 215A water tower and adjacent to Third Street.
Golden Vicinity
Jefferson County
Colorado

Photograph CO-83-AD-1 was taken by Rockwell International on 20 October 1987.

CO-83-AD-1 VIEW OF THE INTERIOR OF BUILDING 125, THE STANDARDS LABORATORY. THE PRIMARY FUNCTION OF THE STANDARDS LABORATORY WAS TO ENSURE AND IMPLEMENT A SYSTEM OF QUALITY CONTROL FOR INCOMING MATERIALS USED IN MANUFACTURING PROCESSES. SEVERAL ENGINEERING CONTROLS WERE USED TO ASSURE ACCURACY OF THE CALIBRATION PROCESSES INCLUDING: FLEX-FREE GRANITE TABLES, AIR LOCKED DOORS, TEMPERATURE CONTROLS, AND A SUPER-CLEAN ENVIRONMENT.

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ROCKY FLATS PLANT, STANDARDS LABORATORY HAER No. CO-83-AD
(Rocky Flats Plant, Building 125)
Located immediately north of the 215A water tower and adjacent to Third Street.
Golden Vicinity
Jefferson County
Colorado

Photograph CO-83-AD-1 was taken by Rockwell International on 20 October 1987.

CO-83-AD-1 VIEW OF THE INTERIOR OF BUILDING 125, THE STANDARDS LABORATORY. THE PRIMARY FUNCTION OF THE STANDARDS LABORATORY WAS TO ENSURE AND IMPLEMENT A SYSTEM OF QUALITY CONTROL FOR INCOMING MATERIALS USED IN MANUFACTURING PROCESSES. SEVERAL ENGINEERING CONTROLS WERE USED TO ASSURE ACCURACY OF THE CALIBRATION PROCESSES INCLUDING: FLEX-FREE GRANITE TABLES, AIR LOCKED DOORS, TEMPERATURE CONTROLS, AND A SUPER-CLEAN ENVIRONMENT.

HISTORIC AMERICAN ENGINEERING RECORD
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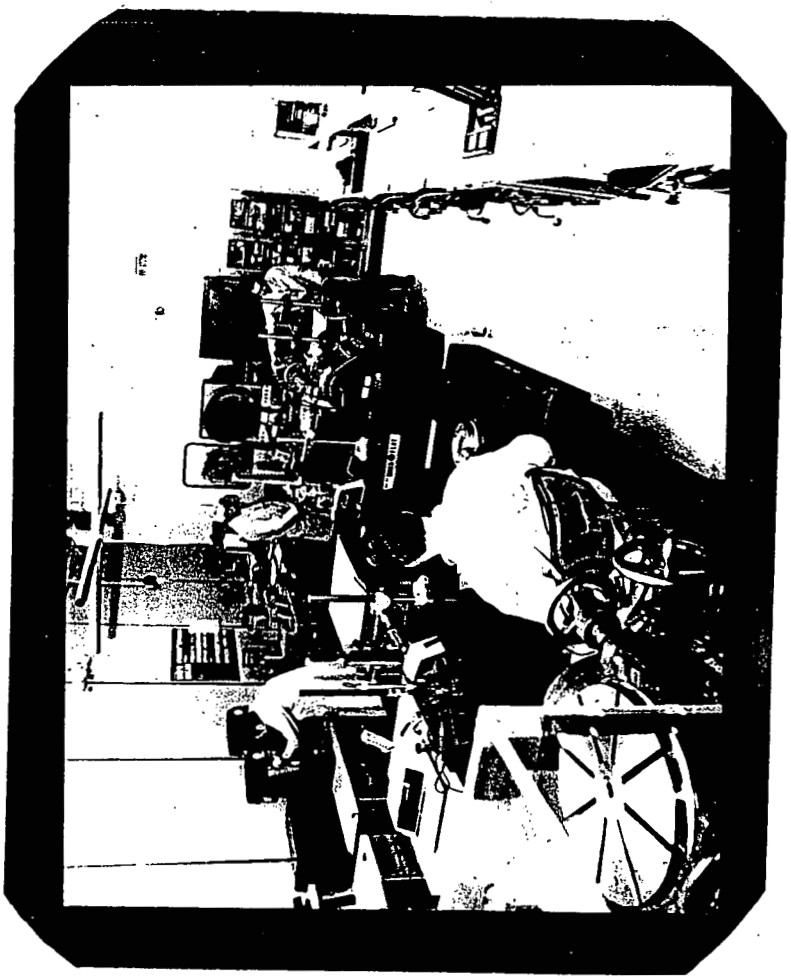
HAER No. [illegible]



ROCKY FLATS PLANT,
SOURCE CALIBRATION LABORATORY
(Rocky Flats Plant, Building 126)
Located between Second and Third streets and Central and Cedar avenues.
Golden Vicinity
Jefferson County
Colorado

HAER No. CO-83-AE

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Rocky Mountain System Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

ROCKY FLATS PLANT,
SOURCE CALIBRATION LABORATORY
(Rocky Flats Plant, Building 126)

HAER No. CO-83-AE

Location: Rocky Flats Environmental Technology Site, Highway 93. The facility is located between Second and Third streets (to the west and east) and between Central and Cedar avenues (to the north and south).

Significance: This building is a secondary contributor to the National Register eligible Rocky Flats Plant historic district. It is associated with the United States (U.S.) strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack. Building 126 was used to calibrated radiation dosimeters worn by employees.

Description: The Source Calibration Laboratory (Building 126) is a small, flat-roofed, rectangular building, measuring 28' north-south x 16' feet east-west (448 square feet). The building is divided into two rooms with a common hallway on the south side (at the entrance). The structure is built on a concrete slab-on-grade and is one story high. Ceiling heights are approximately 12 feet. The roof is flat and is constructed of 24-gauge rock deck. Exterior walls are constructed of 12' thick concrete. Interior design elements include a series of seven small-diameter neutron source storage wells along the east wall. Three small-diameter neutron source storage units are located along the north side of the interior-shielding wall (in the east room).

The structure contains no windows, except for a small window in the metal door, located on the south side of the building.

Site utilities include a heating, ventilation and air conditioning system, located on the roof. Various vents and utility boxes exist on the top of the roof.

History: Building 126 was part of the radiation protection program. Other buildings within this complex include 123, the Health Physics/Analytical Laboratory, and 125, the Standards Laboratory. In the past, this facility was used to expose and calibrate radiation detection devices worn by employees to detect radiation exposure. This building, constructed during the transition period from film dosimeters to thermoluminescent dosimeters, was used to calibrate both types of dosimeters.

Film dosimeters were calibrated by exposing the film within the dosimeter to gamma and neutron radiation, which darkened the film. Employee exposure was calculated by comparing the amount of darkening between the calibrated dosimeter and that worn by the employee.

Thermoluminescent dosimeters were calibrated by exposing the crystal within the dosimeter to gamma and neutron radiation. The exposed crystal was then heated to release stored energy in the form of light. The amount of light emitted was then measured. Employee exposure was calculated by comparing the amount of light emitted between the calibrated dosimeter and that worn by the employee.

At the present time, the building is inactive although sealed radioactive sources are stored in the facility.

Building 126 was constructed between 1968 and 1969.

Sources: EG&G, 1994, *Historical Release Report (HRR)*, Rocky Flats Plant.

U.S. Department of Energy, *Final Cultural Resource Survey Report, Rocky Flats Environmental Technology Site*, Rocky Flats Plant.

Falk, Roger, employed at the Rocky Flats Plant since 1966 by the site contractor, personal communication, January 1998.

Historians: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M), 1997. Judith Berryman, Ph.D., Archaeologist, e^2M, 1997.

HISTORIC AMERICAN ENGINEERING RECORD

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ROCKY FLATS PLANT,
SOURCE CALIBRATION LABORATORY HAER No. CO-83-AE
(Rocky Flats Plant, Building 126)
Located between Second and Third streets and Central and Cedar avenues.
Golden Vicinity
Jefferson County
Colorado

Photograph CO-83-AE-1 taken by Timothy McGrath and Katherine T. Abeya, Source One, site photography contractor, January 1998.

CO-83-AE-1 VIEW OF BUILDING 126, LOOKING NORTH. BUILDING 126, THE SOURCE CALIBRATION LABORATORY, WAS USED TO EXPOSE AND CALIBRATE RADIATION DETECTION DEVICES, INCLUDING THERMOLUMINESCENT DOSIMETERS, WORN BY EMPLOYEES TO DETECT RADIATION EXPOSURE.

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ROCKY FLATS PLANT,
SOURCE CALIBRATION LABORATORY HAER No. CO-83-AE
(Rocky Flats Plant, Building 126)
Located between Second and Third streets and Central and Cedar avenues.
Golden Vicinity
Jefferson County
Colorado

Photograph CO-83-AE-1 taken by Timothy McGrath and Katherine T. Abeya, Source One, site photography contractor, January 1998.

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HISTORIC AMERICAN ENGINEERING RECORD
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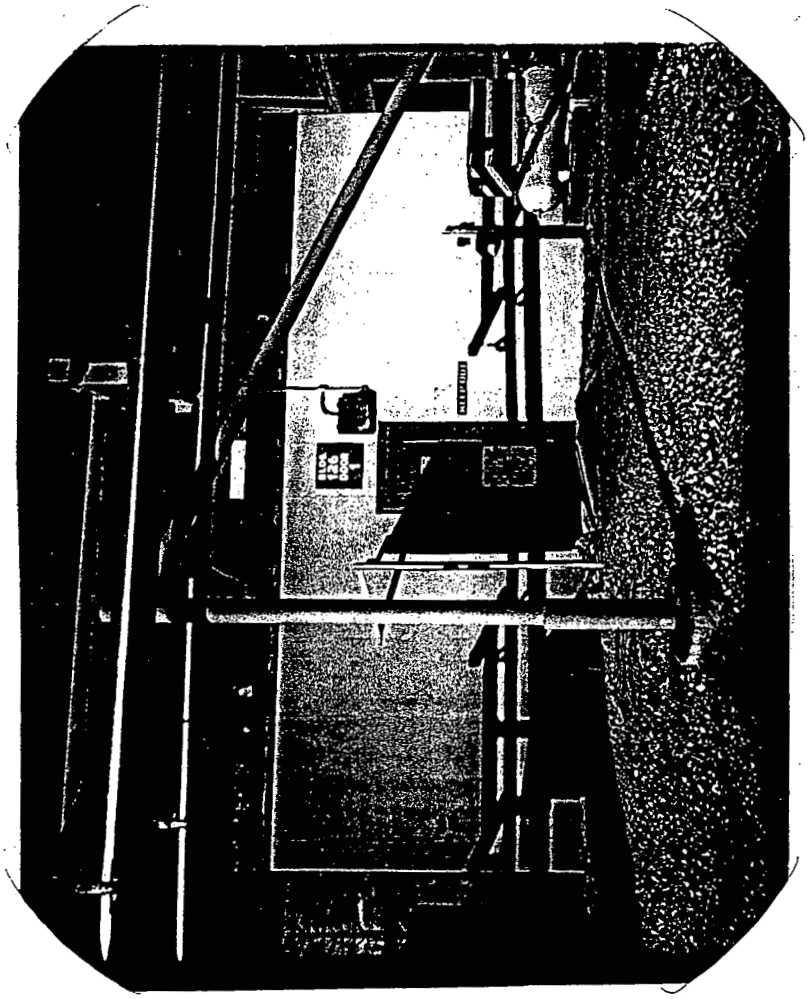
HAER No. CO-83-AE-1



ROCKY FLATS PLANT,
WATER TOWER
(Rocky Flats Plant, Building 215 A)
Located in the northwest quadrant of the Plant near the west terminus of Central Avenue, north of the Health Physics area.
Golden Vicinity
Jefferson County
Colorado

HAER No. CO-83-AF

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Rocky Mountain System Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

ROCKY FLATS PLANT,
WATER TOWER
(Rocky Flats Plant, Building 215A)

HAER No. CO-83-AF

Location: Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County, Colorado. Building 215A is located in the northwest quadrant of the Rocky Flats Plant (Plant) near the west terminus of Central Avenue, north of the Health Physics area.

Significance: This building was a secondary contributor to the National Register eligible Rocky Flats Plant historic district, associated with the United States (U.S.) strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack. This building is the primary supply for the Plant treated water distribution system.

Description: Building 215A is a 300,000-gallon elevated tank that receives treated water from Building 124, the water treatment plant, for site-wide distribution. The tank is constructed of steel and is supported by a center metal pipe and six metal perimeter legs. One 700- and two 500-gallon-per-minute pumps deliver water from the clear well in Building 124 or from Building 215B, the ground-level tank, to the elevated tank. The elevated tank can be bypassed, and water sent directly to the treated water distribution system, as demand warrants. An alarm sounds in the central alarm station in Building 121 for low or high water levels in the elevated tank.

Building 215A was the primary supply for the treated water distribution system. If the tank was out of service for any reason, water was supplied to the distribution system by the three service pumps, drawing from either the clear well or the ground level tank.

At a height of 155', Building 215A is the tallest structure at the Plant, and is the most visible structure from off-site. The top of the tower is at approximately the same elevation as Highway 93, which runs to the west of the Plant. From the top of the tower, on a clear day, visibility extends to Limon, Colorado, approximately 90 miles to the east.

History: Construction on Building 215A began in 1952. The Plant complete water supply, treatment, storage, and distribution system went into production in 1953 and has operated on a daily basis ever since. Due to its visibility off-site, it is anticipated that demolition of the water tower will demonstrate progress of the cleanup effort to surrounding communities.

Sources: Rockwell International, Energy Systems Group, Rocky Flats Plant, 1989, *Interim Safety Analysis Report*.

U.S. Department of Energy, 1995, *Final Cultural Resource Survey Report, Rocky Flats Environmental Technology Site, The Industrial Area*, Rocky Flats Plant.

Web, Dave, employed at the Plant since 1977, personal communication, November 1997.

Historians: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M), 1997. Judith Berryman, Ph.D., Archaeologist, e^2M, 1997.

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ROCKY FLATS PLANT,
WATER TOWER HAER No. CO-83-AF
(Rocky Flats Plant, Building 215A)
Located in the northwest quadrant of the Plant near the west terminus of Central Avenue, north of the Health Physics area.
Golden Vicinity
Jefferson County
Colorado

Photograph CO-83-AF-1 was taken by DOW Chemical Company in November 1963.

CO-83-AF-1 VIEW OF BUILDING 215A, THE WATER TOWER, LOOKING WEST, SOUTHWEST. CONSTRUCTION ON BUILDING 215A BEGAN IN 1952. THE WATER TOWER IS 155 FEET TALL AND IS THE TALLEST STRUCTURE AT THE ROCKY FLATS PLANT.

HISTORIC AMERICAN ENGINEERING RECORD

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ROCKY FLATS PLANT,
WATER TOWER HAER No. CO-83-AF
(Rocky Flats Plant, Building 215A)
Located in the northwest quadrant of the Plant near the west terminus of Central Avenue, north of the Health Physics area.
Golden Vicinity
Jefferson County
Colorado

Photograph CO-83-AF-1 was taken by DOW Chemical Company in November 1963.

CO-83-AF-1 VIEW OF BUILDING 215A, THE WATER TOWER, LOOKING WEST, SOUTHWEST. CONSTRUCTION ON BUILDING 215A BEGAN IN 1952. THE WATER TOWER IS 155 FEET TALL AND IS THE TALLEST STRUCTURE AT THE ROCKY FLATS PLANT.

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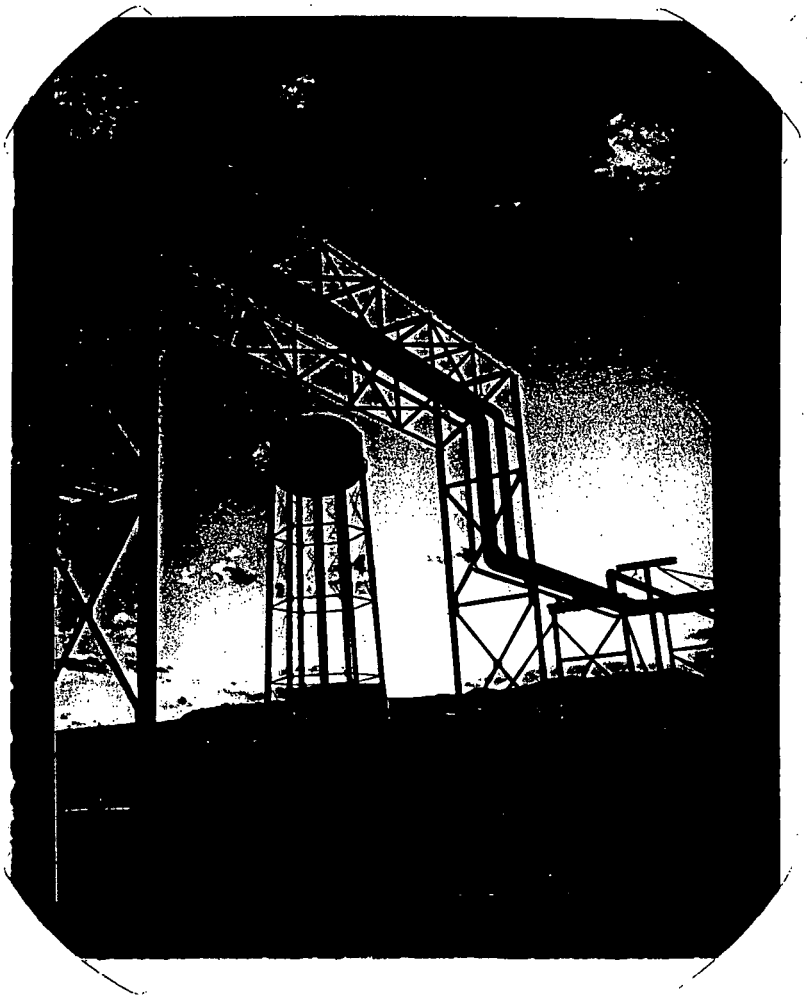
HAER No. CO-83-AF-1



ROCKY FLATS PLANT FILTER TEST LABORATORY AND WAREHOUSE
(Rocky Flats Plant Building 453)
(Rocky Flats Plant Building 453)
Located in the southeast corner of Central Avenue and Fifth Street
Golden Vicinity
Jefferson County
Colorado

HAER No. CO-63-AG

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Rocky Mountain System Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

ROCKY FLATS PLANT,
FILTER TEST LABORATORY
AND WAREHOUSE
(Rocky Flats Plant, Building 442)
(Rocky Flats Plant, Building 42)

HAER No. CO-83-AG

Location: Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County, Colorado. Building 442 is located at the southeast corner of the intersection of Central Avenue and Fifth Street.

Significance: Building 442 was a secondary contributor to the National Register eligible Rocky Flats Plant historic district, associated with the United States (U.S.) strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack. Building 442 was originally used to launder protective clothing used by employees in the Uranium-handling areas of Building 444.

Description: Building 442, originally known as Building 42, is a one-story, rectangular-shaped structure that was built in two phases. Completed in 1953, the original building is a cast-in-place reinforced-concrete structure and encompasses approximately 2,480 square feet. The newer portion, completed in 1975, is a pre-engineered metal building and encompasses approximately 5,420 square feet. The floor of the building consists of two rectangular sections with overall dimensions of 86' (north-south) x 127' (east-west), and total floor area of approximately 7,900 square feet.

The original structure is constructed of corrugated metal walls and has a flat roof. The windows are multi-paned with metal sashes, arranged in sets of three. The west, south, and north exterior concrete walls each have two window sets; the east wall has one set. The floor is an on-grade slab with vinyl-asbestos tile finish. Partition walls are concrete masonry and fiberboard. The filter laboratory is housed in this section of the building.

The newer part of the building contained the warehouse operation for the staging of filters for the filter test laboratory. Incoming filters that needed to be tested were stored until testing was completed. Filters that had been tested were repacked and stored for distribution.

The structure is constructed of rigid tapered-steel bents with no interior columns. Purlins, girts, and wind columns are constructed of cold-formed steel. The exterior wall and roof sheeting are ribbed metal with fiberglass insulation. The roof slopes down to the north and south from the centerline. The floor is an on-grade slab. Interior partitions are gypsum board over metal studs and prefabricated modular units. A loading dock is located in the southwest corner.

History: Building 442 was originally used to launder uranium-contaminated protective clothing from Building 444. Protective clothing included coats, pants, hats, underwear, socks, and booties provided by the Atomic Energy Commission and later by the U.S. Department of

Energy (USDOE). When Building 442 operations changed to filter testing, laundry operations were moved to Building 778.

The final use of the structure included a filter-testing laboratory and storage area for high efficiency particulate air filters and respirator cartridges. The filter-testing laboratory performed tests on both respirator and equipment-mounted high efficiency particulate air filters. Radioactive sources were used in some of the test equipment.

Sources: ChemRisk, 1992, *Project Tasks 3 and 4 Final Draft Report. Reconstruction of Historical Rocky Flats Operations and Identification of Release Points,* prepared for the Colorado Department of Health.

EG&G, 1994, *Historical Release Report*, Rocky Flats Plant Repository.

USDOE, 1995, *Final Cultural Resource Survey Report Rocky Flats Environmental Technology Site, The Industrial Area,* Rocky Flats Plant Repository.

Historians: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M), 1997. Judith Berryman, Ph.D., Archaeologist, e^2M, 1997.

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ROCKY FLATS PLANT, FILTER TEST LABORATORY
AND WAREHOUSE
(Rocky Flats Plant, Building 442)
(Rocky Flats Plant, Building 42)
Located on the southeast corner of Central Avenue and Fifth Street.
Golden Vicinity
Jefferson County
Colorado

HAER No. CO-83-AG

Photograph CO-83-AG-1 was taken by EG&G, site photography contractor, June 1990.

CO-83-AG-1 VIEW OF THE INTERIOR OF BUILDING 442 OF THE HIGH EFFICIENCY PARTICULATE AIR FILTERS TESTING EQUIPMENT.

HISTORIC AMERICAN ENGINEERING RECORD

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ROCKY FLATS PLANT, FILTER TEST LABORATORY
AND WAREHOUSE HAER No. CO-83-AG
(Rocky Flats Plant, Building 442)
(Rocky Flats Plant, Building 42)
Located on the southeast corner of Central Avenue and Fifth Street.
Golden Vicinity
Jefferson County
Colorado

Photograph CO-83-AG-1 was taken by EG&G, site photography contractor, June 1990.

CO-83-AG-1 VIEW OF THE INTERIOR OF BUILDING 442 OF THE HIGH EFFICIENCY PARTICULATE AIR FILTERS TESTING EQUIPMENT.

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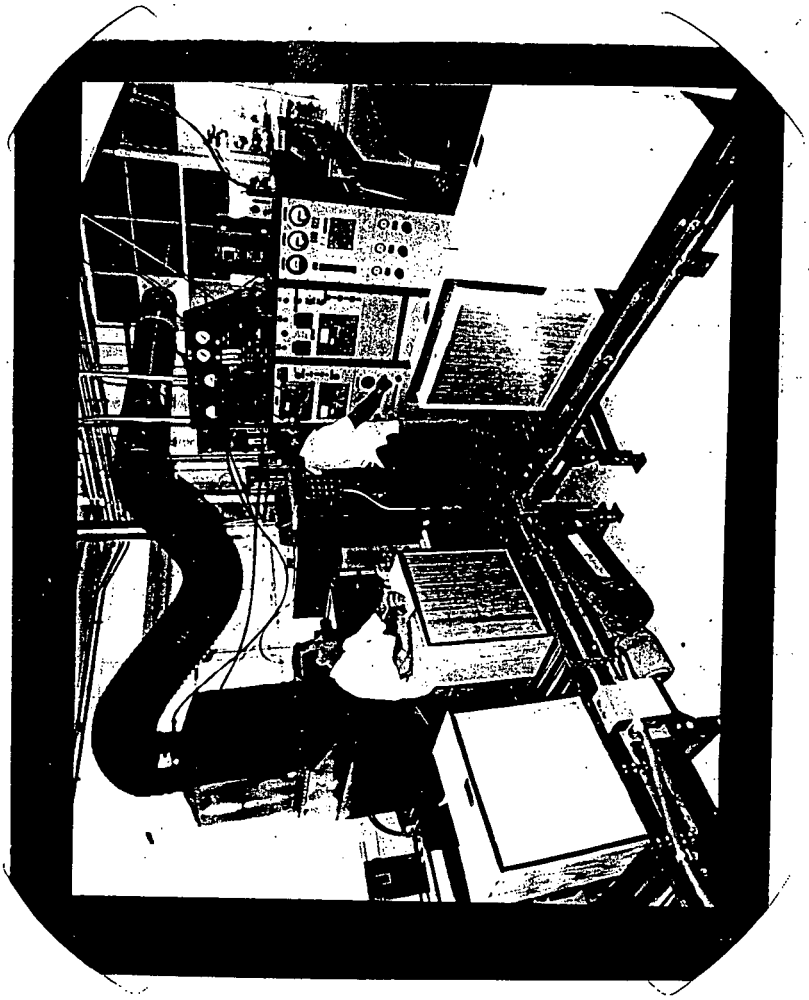
HAER No. CO-83-AG-1



ROCKY FLATS PLANT, CHEMICAL ANALYTICAL LABORATORY
(Rocky Flats Plant, Building 559)
Located in the north central section of the Plant
Golden Vicinity
Jefferson County
Colorado

HAER No. CO-73-A-H

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Rocky Mountain System Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

ROCKY FLATS PLANT,
CHEMICAL ANALYTICAL LABORATORY HAER No. CO-83-AH
(Rocky Flats Plant, Building 559)

Location: Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County, Colorado. Building 559 is located in the north-central section of the Rocky Flats Plant (Plant).

Significance: Building 559 is a secondary contributor to the National Register eligible Rocky Flats Plant historic district, associated with the United States strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack. Building 559, the Chemical Analytical Laboratory, was a plutonium analytical laboratory that served both Plant production and support operations.

Description: Building 559 is a one-story, rectangular-shaped complex containing over 32,600 square feet of floor space. The footprint of the structure measures approximately 240' x 120'. Building 559 is constructed of concrete columns erected on concrete footings. Exterior walls between the columns consist of two thicknesses of unreinforced concrete block. Most of the interior walls are concrete block. The floors are poured concrete, covered with a polyurethane/plastic finish, quarry tile, or vinyl-asbestos tile. The roof is flat and contains pre-stressed single- and double-tee concrete slabs supported by reinforced concrete beams. Small wings extend from the northeast and southwest sides of the structure, forming a rectangular outline. Doors in the laboratory complex are metal. The only exterior windows are located in Room 136, the lunchroom. Interior windows have pressed metal frames with laminated safety glass panes. Later additions to the building include loading docks and ramps, a storeroom, a locker room, a lunch room, an entryway, a receiving and storage area, additional laboratory space, excavation of a waste holding pit, and an underground corridor.

Physical barriers and zones are present to confine the movement and transportation of radioactive materials within the building. The ventilation system created a negative air pressure differential from zones of no radioactivity toward areas of potentially higher radioactivity. Differential pressure sensing instruments maintained the air pressure balance between zones. The outside shell of the laboratory provided additional containment; double-door airlocks are present between passageways. Glove boxes in Building 559 are constructed of stainless steel or carbon steel and lined with Teflon®. Most of the glove box and conveyor line windows contain 0.25" safety glass. Where possible, gloveboxes are designed with a single-level floor. The building is a non-reactor nuclear facility.

Associated buildings within the Building 559 complex include:

- Building 561, the Filter Plenum, was built in 1973 to house the exhaust plenums for the laboratory building. It is connected to Building 559 via underground corridors containing ventilation exhaust ducts. The underground corridor is approximately 26' long and is constructed of multi-plate steel;

- Building 562 was built in 1973. It is a one-story, cement block structure located east of Building 561 and houses the emergency generator for Building 561;
- Buildings 560 and 563, built in 1967 and 1983, respectively, are cooling towers constructed of reinforced concrete; and
- Building 528 is an underground waste holding pit containing two 2,000-gallon tanks that collect waste liquids from Buildings 559 and 561 for subsequent transfer to the waste treatment facility.

History: The plutonium laboratory was constructed in 1967, and first began operations in January 1968. Samples of recovered, cast, and purified materials from the Plant were analyzed in the lab. The building contained laboratory facilities for conducting spectrochemical, chemical, and mass spectrometric analyses. In 1973, the construction of Building 561 expanded the capabilities of the laboratory. Support tasks in Building 559 included primary analytical support for Building 707 production contingency; Raschig Ring analysis and certification; duct remediation; analysis and characterization of low-level waste; and analysis of contaminated polychlorinated biphenyls. Later projects included the Waste Isolation Pilot Project Bin and Alcove test program; the Waste Stream and Residue Identification and Characterization program; and consolidation and stabilization of nuclear materials.

Operations: For administrative purposes, there were two analytical laboratories present in the structure. The production support and plant support laboratories shared equipment and space. The area along the north side of the building was divided into rooms for offices, radiation monitoring, a computer room, restrooms, a locker room, storerooms, and maintenance equipment. Four large areas along the south side and east end of the building were used for mechanical equipment and laboratories. Specific laboratories included the spectrochemical analysis laboratory (Room 101), the chemistry laboratory (Room 102), and the mass spectroscopy laboratory (Room 103). Radioactive materials processed in the laboratories were received and shipped from a loading dock on the south side of the building. A second loading dock at the west end was used to receive building supplies.

In the production support laboratory, quantitative and qualitative chemical analyses for plutonium production operations were performed to ensure raw material used in manufacturing processes were within specifications, that the various processes on the Plant produced materials that met specifications, and that the final products conformed to requirements. Quantitative analyses included: gallium in plutonium alloy, plutonium assay, carbon-hydrogen-nitrogen contents, ion analysis, tritium content, emission spectrometric analysis, atomic absorption, coulometric analysis, x-ray fluorescence spectroscopy, and identification of various isotopes. Samples consisted primarily of plutonium or other metals and their alloys, oxides of plutonium, uranium, solutions of plutonium or other elements, and various gases. Materials in process were held at given stages in their sequence of operations until results of sample analyses were obtained and verified. Small samples of solids or liquids were transferred from production areas to the laboratories, where exact sample aliquots were prepared from the production sample. These samples were transferred to appropriate instruments for analysis.

The plant support laboratory personnel performed analyses on materials from Plant support functions indirectly related to production activities (e.g., radiation monitoring and waste treatment). This group performed mass spectrometry analyses of isotopes of plutonium, uranium, lithium, and boron (thermal ionization); of organic compounds; of gases; of operational processes; and using spark ionization. Other analyses included infrared analysis to determine impurities; thermal characterization analysis to determine changes in phase as a function of temperature; and Karl Fischer titrimetry to determine water content of organic solvents.

Sources: ChemRisk, 1992, *Project Tasks 3 and 4 Final Draft Report, Reconstruction of Historical Rocky Flats Operations and Identification of Release Points*, prepared for the Colorado Department of Health.

EG&G, 1994, *Historic Release Report*, Rocky Flats Plant Repository.

U.S. Department of Energy, 1995, *Final Cultural Resource Survey Report Rocky Flats Environmental Technology Site, The Industrial Area*. Rocky Flats Plant Repository.

Historians: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M), 1997. Judith Berryman, Ph.D., Archaeologist, e^2M, 1997.

HISTORIC AMERICAN ENGINEERING RECORD

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ROCKY FLATS PLANT, CHEMICAL
ANALYTICAL LABORATORY
(Rocky Flats Plant, Building 559)
Located in the north-central section of the Plant.
Golden Vicinity
Jefferson County
Colorado

HAER No. CO-83-AH

Photograph CO-83-AH-1 was taken by Rockwell International on 9 September, 1978.

CO-83-AH-1 VIEW OF THE INTERIOR OF THE PLUTONIUM LABORATORY IN BUILDING 559. THE LABORATORY WAS USED TO ANALYZE THE PURITY OF PLUTONIUM. PLUTONIUM SAMPLES WERE CONTAINED WITHIN GLOVE BOXES.

HISTORIC AMERICAN ENGINEERING RECORD

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ROCKY FLATS PLANT, CHEMICAL
ANALYTICAL LABORATORY
(Rocky Flats Plant, Building 559)
Located in the north-central section of the Plant.
Golden Vicinity
Jefferson County
Colorado

HAER No. CO-83-AH

Photograph CO-83-AH-1 was taken by Rockwell International on 9 September, 1978.

CO-83-AH-1 VIEW OF THE INTERIOR OF THE PLUTONIUM LABORATORY IN BUILDING 559. THE LABORATORY WAS USED TO ANALYZE THE PURITY OF PLUTONIUM. PLUTONIUM SAMPLES WERE CONTAINED WITHIN GLOVE BOXES.

HISTORIC AMERICAN ENGINEERING RECORD
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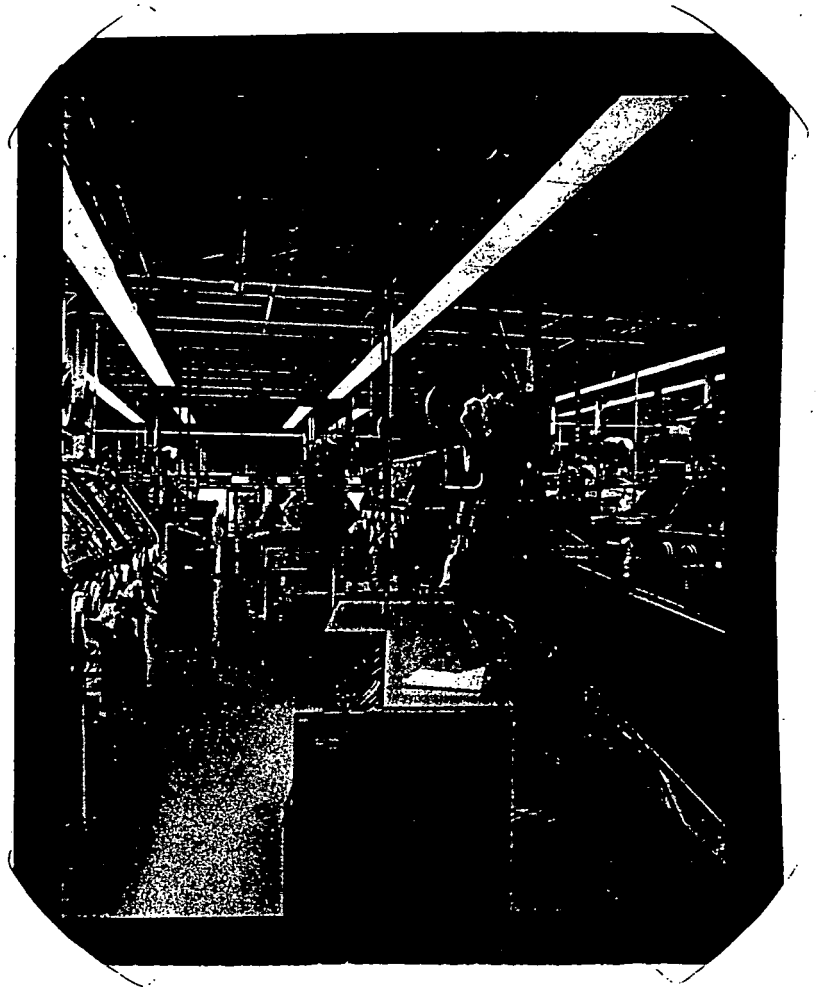
HAER No. CO-83-AH-1



ROCKY FLATS PLANT

HAER No. CO-33-A-I

WASTE TREATMENT FACILITY

(Rocky Flats Plant, Building 374)

Located adjacent to building 771C, in the northern portion of the protected area.

Golden Vicinity

Jefferson County

Colorado

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Rocky Mountain System Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

ROCKY FLATS PLANT
WASTE TREATMENT FACILITY
(Rocky Flats Plant, Building 774)

HAER No. CO-83-AI

Location: Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County, Colorado. Building 774 is located in the northern portion of the protected area. The west side of the building is adjacent to the east side of Building 771C.

Significance: This building was a secondary contributor to the National Register eligible Rocky Flats Plant historic district, associated with the United States strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack. Constructed in 1953, Building 774 was the original liquid process waste water treatment facility at the Rocky Flats Plant (Plant).

Description: Building 774 was originally a two-story rectangular structure designed to treat liquid process waste. The original portion of the building is constructed of poured-in-place concrete. By 1989, seven additions had been made to the building, resulting in a multi-level structure varying from one to four stories in height. The additions are constructed of block wall, reinforced concrete, metal-on-metal framing, and transite. As a result of the additions, floor space increased to 25,000 square feet. The facility is built on a steeply sloping site. The first floor on the north side is 7' 6" below-grade, and the fourth floor on the south side is 4' above-grade.

History: Building 774 was designed to treat the liquid process wastes generated in Building 771. As the Plant expanded to accommodate increased production of nuclear weapon triggers, Building 774 began processing radioactive acidic wastes; caustic, aqueous, and organic wastes; waste oils; and non-radioactive waste photographic solutions. Buildings 111, 112, 130, 371, T371J, 441, 444, 460, 551, 559, 664, 707, 750, 771, 776, 777, 881, and 991 generated one or more waste streams which were processed in Building 774. In 1971, the waste treatment operations in this building were enclosed to provide containment of radioactive airborne particles.

The goal of the waste treatment process which occurred in Building 774 was to reduce liquid radioactive wastes and convert them into a form suitable for transport off-site for storage and disposal. In general, wastes were either piped directly into Building 774, or transferred in drums, containers, or other types of packaging. The waste entered a series of interconnected tanks designed to treat acidic, caustic, and radioactive wastes and separate relatively low-level radioactive effluent from contaminated solids or sludges. Each of the four processes used in the building were tailored to meet certain characteristics of the waste. The waste may have passed through one or more of these processes before entry into the next stage of the operation. These first stage processes included:

- *Neutralization and filtration* of acidic wastes containing large quantities of metal ions or chloride ions. The main purpose of this process was to remove the large quantities of metal hydroxide solids from the waste stream, as these solids hampered the decontamination ability of the succeeding flocculation and clarification processes;
- *Batch neutralization, precipitation, and filtration* of acidic wastes containing only small quantities of metal ions or basic wastes containing large quantities of undissolved solids;
- *Continuous radioactive decontamination* of neutral and caustic wastes; and
- *Solidification* of aqueous wastes containing complexing agents, certain radioactive isotopes, or hazardous chemicals that were undesirable in the regular waste system. These wastes were mixed with an absorbent material and Portland cement in barrels for disposal. This process was eventually replaced by the organic and sludge immobilization system. The organic and sludge immobilization system accepted waste oils from any building at the Plant that contained transuranic material and converted the liquid waste into solid waste.

The second stage of the decontamination process included two separate radioactive waste decontamination processes. The benefit of segregating the wastes was better utilization of the waste storage ponds based on whether or not the wastes met standards for radioactive and/or chemical contamination. The two processes were:

- *Batch precipitation* to remove radioactive materials from wastes containing both radioactive and chemical contaminants in excess of standards. After the radioactive material was separated from the waste, if the remaining liquid met the on-site storage guidelines for radioactivity, it was transferred to asphalt-lined evaporation ponds, otherwise it was reprocessed to reduce contaminant levels; and
- *Continuous precipitation* to remove radioactive materials from wastes meeting the standards for chemical but not radioactive contaminants. After the radioactive material was separated from the waste, if the remaining liquid met drinking water standards, it was transferred to an evaporation pond, otherwise it was reprocessed to reduce contaminant levels.

The slurry from both processes was held in a slurry tank until it was processed by vacuum filtration to separate the solids from the liquid. The separated solids were mixed with a solidifying agent, and packaged for shipment and long term storage as transuranic-mixed (hazardous and radioactive) waste.

Recovery of silver from photographic solution also took place in Building 774. Waste photographic solution flowed through silver recovery units where silver was plated onto an electrically charged metal plate and recovered as silver ingots for resale.

The role of Building 774 diminished with the inauguration of the new process waste treatment facility in Building 374. Building 774 continued to process all contaminated organic wastes that could not be incinerated, and the liquid process wastes generated in Building 771.

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Historians: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M), 1997. Judith Berryman, Ph.D., Archaeologist, e^2M, 1997.

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ROCKY FLATS PLANT, HAER No. CO-83-AI
WASTE TREATMENT FACILITY
(Rocky Flats Plant, Building 774)
Located adjacent to Building 771C, in the northern portion of the protected area.
Golden Vicinity
Jefferson County
Colorado

Photograph CO-83-AI-1 was taken by Rockwell International on 23 August 1977.

CO-83-AI-1 VIEW OF THE INTERIOR OF BUILDING 774, THE ORIGINAL LIQUID PROCESS WASTEWATER TREATMENT FACILITY. THE PHOTOGRAPH SHOWS STORAGE TANKS AND ASSOCIATED PLUTONIUM-CONTAMINATED SOLUTIONS. THE GLOVE BOX IS USED BY OPERATORS TO MANUALLY OPERATE PUMPS AND VALVES THAT REQUIRE PERIODIC ADJUSTMENT. OTHER VALVES IN THE ROOM WERE INFREQUENTLY ADJUSTED, AND ARE SEALED IN PLASTIC WRAP.

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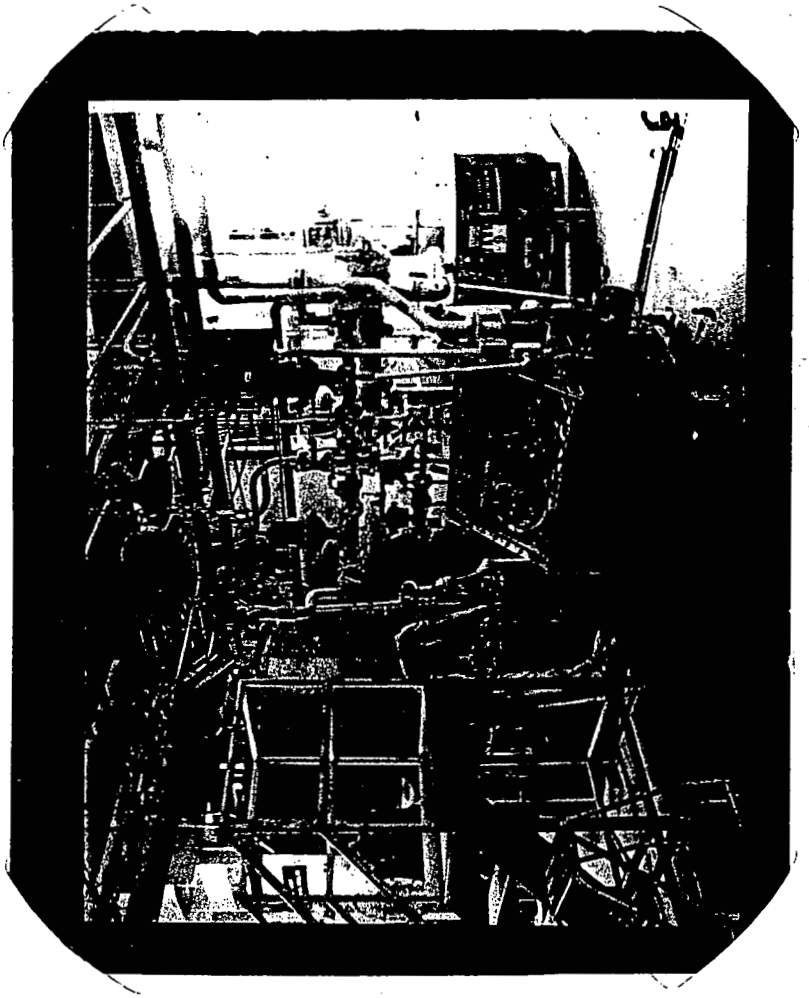

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