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Thermal Treatment of High Explosives at Mason & Hanger/Pantex Plant

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ABSTRACT

The Pantex plant presently processes about 45,000 kg (100,000 lb) of high explosives annually by outdoor burning. About half of the explosives are weapon components weighing over 5 kg (10 lb) which come directly out of nuclear weapons being removed from the stockpile. The other half is generated from various support processes, special tests, etc.

Burning serves the three-fold purpose of demilitarizing, removing all classified characteristics, and eliminating the severe hazard posed by the explosives themselves. Transporting such large quantities of classified high explosives for such processing at another site would be prohibitive.

Computerized atmospheric modelling of the burning process was conducted during the past year. The results were somewhat surprising in that oxides of nitrogen and carbon monoxide, two "criteria pollutants," were not of great concern even though it is known that high explosives contain significant amounts of nitrogen and they generate measureable amounts of carbon monoxide when they are burned. Rather, it was determined that hydrogen fluoride gas is of much greater concern, and stringent controls on the burning operation have been implemented to address this concern.

Although the amount of fluorine-containing explosive must be restricted, other kinds of air emissions are not a great concern. This favorable situation is largely due to the flat, featureless, sparsely inhabited terrain, the distance to the nearest plant boundary, the wind, the lack of stagnant atmospheric conditions, and the tremendous rate of heat release.

INTRODUCTION

History of Pantex Plant

Pantex Plant, currently operated by Mason & Hanger for the

MASTER

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Department of Energy, has manufactured explosives for many years. Built originally as an ordnance plant in 1942, the plant manufactured high explosives from the basic ingredients, fabricated shaped charges, and assembled the final munitions for the nation's war effort.

The plant was closed briefly after World War II only to be brought into production again at the outset of the Cold War. Its new mission was to fabricate the explosives used in nuclear weapons and to perform the final assembly steps in the production of the weapons themselves. This continued to be the main task of the plant until quite recently.

New Role for Pantex Plant

Now, however, the plant's primary mission is to disassemble nuclear weapons and disposition the parts safely. This is nearly as complicated as building such weapons. The work is challenging because the weapons were never designed for easy disassembly, and it is exacting because of the dangers inherent in handling high explosives. Then, too, the parts and pieces of the weapons must be disposed of in an environmentally safe manner. Numerous regulations, imposed by the EPA, the State of Texas, and the DOE must be followed.

Classified Material

The large amount of excess high explosive presents another problem. Typically, disassembly operations at Mason & Hanger/Pantex produce about 45,000 kg (100,000 lb) of high explosives annually. About half of it is from nuclear weapons. Such material cannot be sold to industry, because it provides information about weapon design that is classified. In addition, the pieces are still components of nuclear weapons. The Atomic Energy Act requires that such components be demilitarized and their classified characteristics be removed (a process called "sanitization") before they are either sold, or discarded, or otherwise released to the public.

Simply accumulating the high explosives is not desirable, and reclaiming them would not be economical. The best solution at present is to burn the material, because that destroys the classified nature, and, obviously, burning renders it useless for making a new weapon. Burning, of course, has the additional benefit that it renders the material non-explosive.

Regulatory Issues

Burning of the material from weapons is regulated by a site air burning permit issued by the Texas Air Control Board. Burning of waste high explosive (e.g., milling scrap) is regulated under a

RCRA Part B permit issued by the Texas Water Commission. The limits imposed by the permits are important, especially because some of the high explosives contain Viton A, a polymer that contains fluorine. Of the pollutants found in the smoke, fluorine (as hydrogen fluoride) is the only one that is regulated by the site air emissions permit.

Ash that results from either the demilitarization and sanitization of high explosive components or from treatment of waste high explosives can be managed either as a hazardous waste or a non-hazardous waste, depending on the characteristics of the ash.

DISCUSSION

Why Outdoor Burning

Although there are other ways to destroy high explosives, burning them outdoors is preferred at present. It is the safest method and is the only methodology currently approved by the EPA for disposal of explosives. Should a piece of high explosive detonate while it is burning, no harm is done because it is not inside a building or inside an incinerator, nor is it close to any personnel or other facilities.

Special Handling

Before the high explosives leave the weapon disassembly areas, they are packed in special containers, then they are transported by truck to special buildings that are, really, bunkers. They are held in these special buildings until they can be demilitarized and "sanitized."

The bunkers are similar to the one depicted in Figure 1. Note that its walls are made of reinforced concrete, and it is flanked by hills of dirt that would deflect the force of a blast upwards in the unlikely event that the material stored there were to detonate.

Remote Location

From storage, the explosives are carefully reloaded aboard specially-designed trucks and carefully transported to the area where they will be demilitarized and "sanitized," an area known as the "burning ground." The area is quite remote; in fact, the entire Pantex plant is in a rather remote area. As shown in Figure 2, the facility is in the center of the Texas Panhandle, about twenty miles from Amarillo, Texas, a city of 165,000 population. The facility is situated on a reservation occupying about 25 square miles, and the burning ground is in the northern part of the reservation, as the figure indicates. An aerial view of the Pantex

Plant's buildings is presented in Figure 3. In that figure, the burning ground occupies a small region between the labels "Transportation" and "Staging." It is well away from inhabited buildings and public roads.

Strict Procedures

Once at the burning ground, the high explosives are handled according to strict, written procedures by trained personnel who work in pairs under the guidance of a supervisor. Such care is for two reasons. One is to ensure the safety of the workers; the other is to ensure the facility remains in compliance with all rules and regulations.

The containers of explosives are first unloaded from the truck either by hand or by means of a forklift truck, depending on the size of the containers. The containers are placed beside "burning trays" such as those shown in Figure 4, then the containers are opened one at a time, and the explosives are carefully removed by hand. The material is placed in the trays and distributed well over the floor of the trays, with large charges -- frequently up to 23 kg (50 lb) each -- being kept well separated. Finally, the workers prepare the explosives for burning by spreading excelsior among the charges then dousing the entire mass with diesel fuel.

The workers ignite the fire from inside a second bunker by electrically actuating a squib that was placed among the explosives. The squib communicates with the bunker by wires. This safely ignites the diesel fuel, excelsior, and explosives without causing the latter to detonate.

The fire burns for only 2 to 5 minutes, but the workers wait thirty minutes before going to visually inspect the tray for any unburned explosives.

Typically, 91 kg (200 lb) of explosive will be burned at a time, but amounts up to 682 kg (1,500 lb) can be safely accommodated.

The Burning Ground

The burning ground is a 58-acre site, secured with a locked gate and a fluorescent-orange crossing gate to prevent unauthorized personnel from entering the area. Warning signs are posted at the entrance.

Nine burning trays are regularly used. They are widely separated, as shown in a photo taken from the bunker (Figure 5), and they are surrounded by a strip of plowed earth that guards against fire spreading beyond the immediate area. A site plan is provided in Figure 6.

Construction of the Trays

Returning to Figure 4, note that the burning trays are made of steel, measure about 1.2 m wide by 6.1 m long (4 ft by 20 ft), and have walls lined with firebrick. Several cm of sand cover the floor and provide insulation. The roof-like structure on wheels at the end of the tray is a cover that is rolled over the tray at the end of the day to protect the trays and the ash from rain.

Air Emissions

The burning ground operates under the auspices of the Texas Air Control Board with a written grant of authority to burn high explosives outdoors. Although high explosives burn rapidly and cleanly, some explosives contain fluorine as previously mentioned. As shown in Table I, the allowable concentration of hydrogen fluoride is the most restrictive of the pollutants that might be found in the smoke. For this reason, the amounts of fluorine-containing explosives are carefully regulated.

The products of combustion from a typical fluorine-containing explosive are listed in Table II. Although carbon monoxide and oxides of nitrogen are largely absent, the amount of hydrogen fluoride is 2% of the total. Because the allowable concentration of hydrogen fluoride is only 4.9 microgram per cubic meter (per Table I), this is the limiting factor when such explosives are burned. Accordingly, fluorine-containing explosives are burned only once every three hours, and the amounts that are burned are carefully limited. By contrast, the explosives that contain no fluorine can be burned in almost any amount, subject only to the self-imposed limitations that have been established because of safety considerations.

Atmospheric Modelling

Extensive computerized modelling of the smoke plume has been conducted by Mason & Hanger to estimate the "fenceline" concentrations of airborne emissions that might be expected under a variety of atmospheric conditions. The results confirmed that, while carbon monoxide and nitrogen oxides are not of concern, hydrogen fluoride concentrations could exceed permit conditions if not controlled.

The most important conditions that were incorporated into the computerized model were: 1) the terrain is flat and featureless, 2) the atmosphere is seldom stagnant, and 3) the rate of heat release during a burn is tremendous -- about 0.5 billion calories in three minutes is typical, and 4) the prevailing wind is out of the southwest, causing the plume to move north towards the nearest plant boundary.

Guidelines

The results of the modelling also provided some guidelines for how the burning operation should be conducted, and these are now conditions of our present permit. For example, burning is conducted only during daylight hours, and only when the wind speed is less than 13 m/s (29 mi/hr). In addition, these fluorine-containing materials are burned simultaneously with fluorine-free materials to maximize the rate of heat generation and, thereby, the plume height.

Alternatives

Although open burning is a process approved by regulatory agencies, the Department of Energy and Mason & Hanger have committed to investigating several alternatives. Perhaps the best alternative is to recycle the high explosives by selling them to civilian makers of explosives. However, the explosive material will still have to be demilitarized and desanitized so that it no longer has any military utility nor contains any classified information.

Another process being reviewed is chemical hydrolysis which appears to be a promising technique. A more detailed discussion of these approaches is beyond the scope of this paper, however.

CONCLUSION

The new role of the Mason & Hanger/Pantex Plant is as important and challenging as it has ever been. The processing of high explosives is just one of the issues associated with dismantling nuclear weapons, but one of the more interesting. Presently, outdoor burning is the preferred method and, although it is simple and very cost-effective, it must be done with care for the safety of the workers and the public. Alternatives are on the horizon but cannot be implemented quickly or without considerable cost.

REFERENCES

1. F. I. HONEA, J.L. BARNARD, W.A. BULLERDIEK, and T.K. MEHRHOFF, "Disposal of Waste or Excess High Explosives," MHSMP-73-11, Mason & Hanger - Silas Mason Co., Inc., Pantex Plant, Amarillo, Texas, (Jan.-Mar., 1973).

**Table I. Allowable Fenceline Concentrations
of Various Air Pollutants**

Gases	$\mu\text{g}/\text{m}^3$
Carbon Monoxide	40,000 (1 hour) ^a
Nitrous Oxides	100 (annual) ^a
Hydrogen Chloride (HCl)	70 (30 minutes) ^b
Hydrogen Fluoride (HF)	4.9 (3 hours) ^b

^aNational Ambient Air Quality Standard
^bTexas Air Control Board, Emission Standards Limitations

**Table II. Products of Combustion of a Common
Viton-Containing High Explosive**

Gases	%
Carbon Dioxide	47
Nitrogen	32
Water Vapor	10
Ash	7
Hydrogen Fluoride	2
Nitrous Oxides	<1
Carbon Monoxide	<1

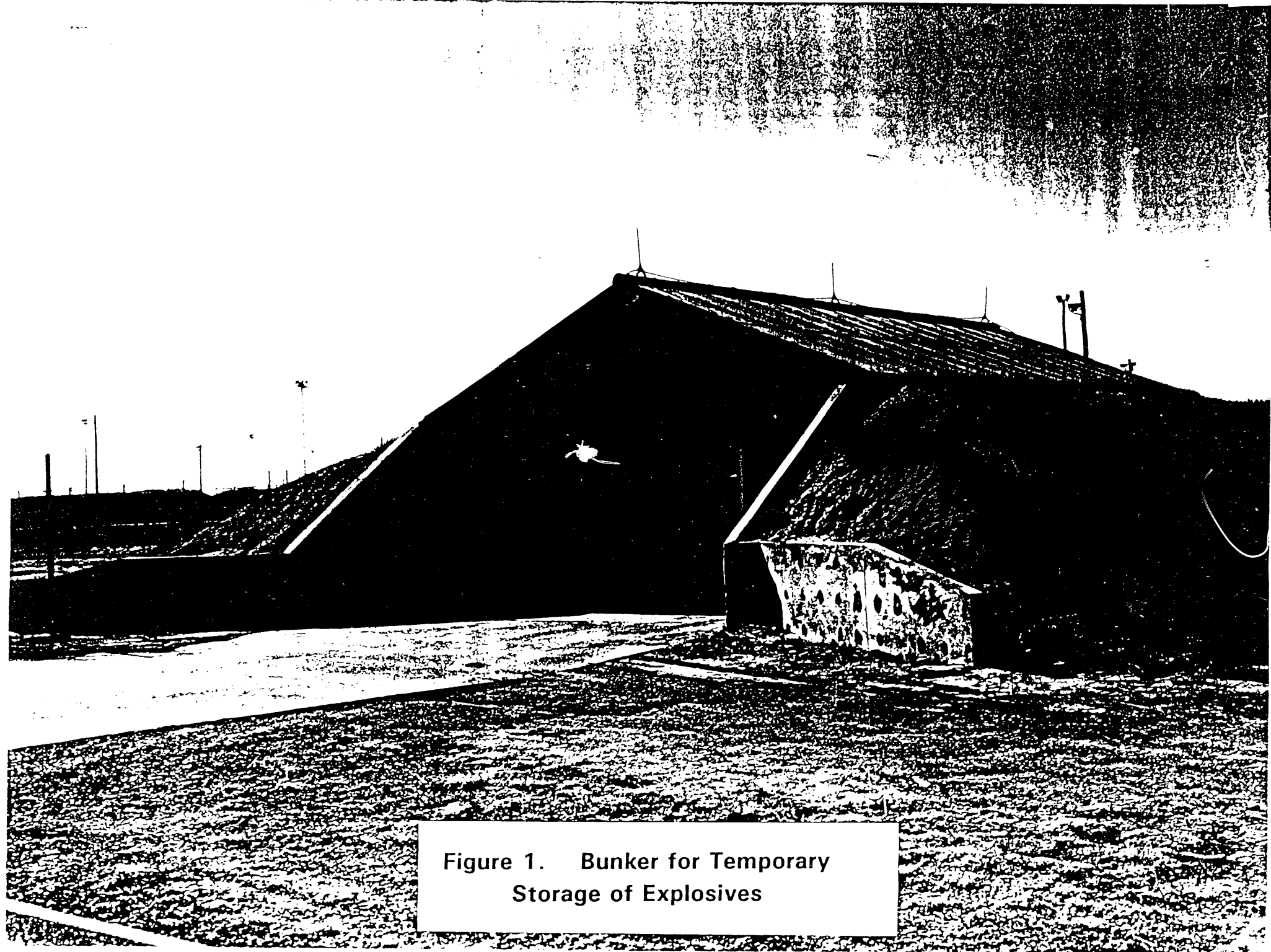
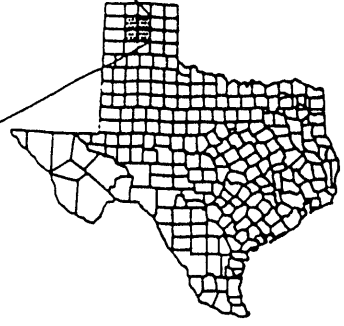
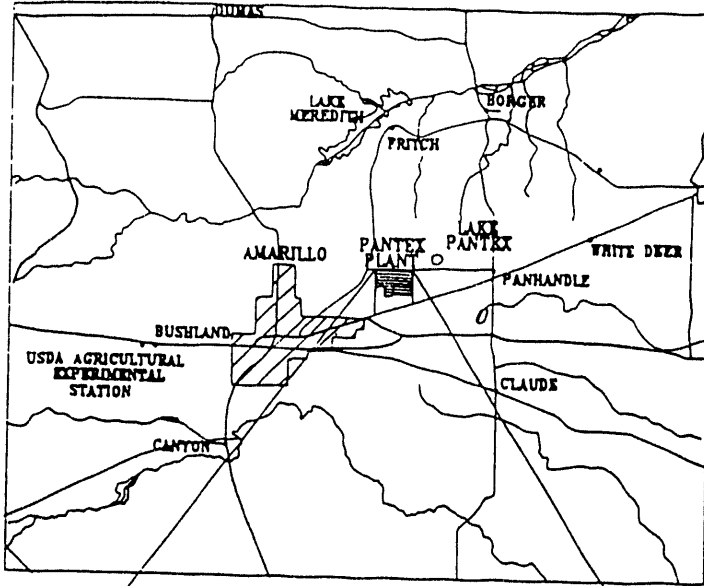
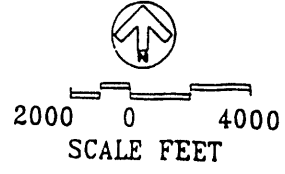
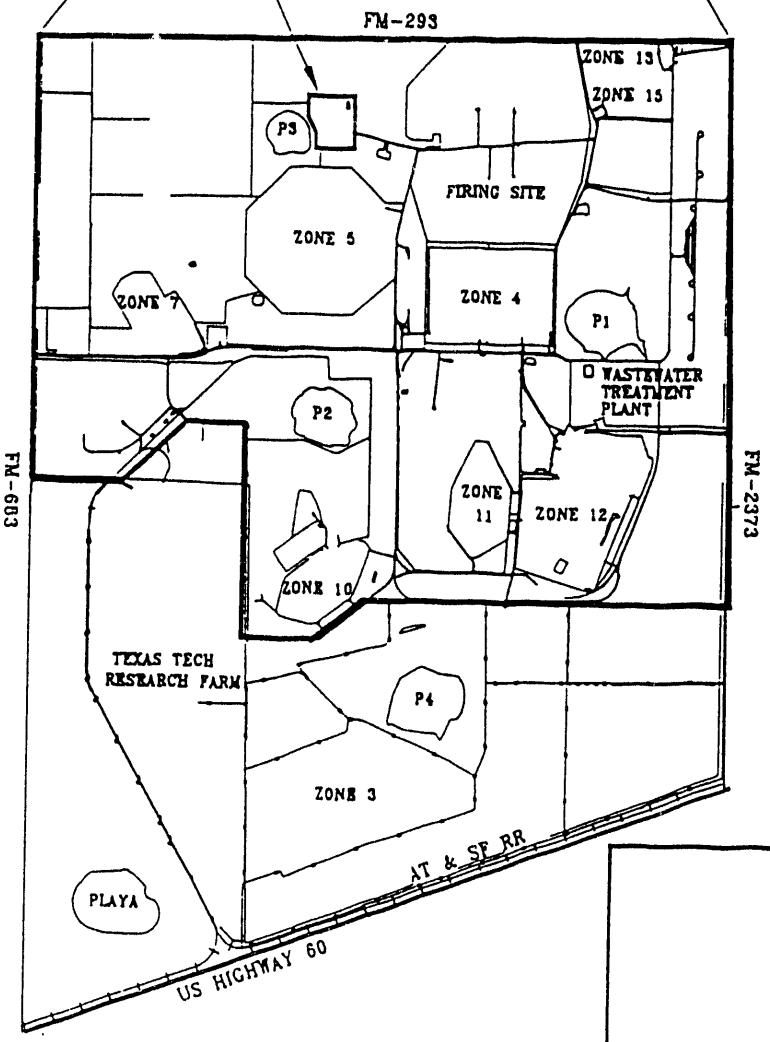


Figure 1. Bunker for Temporary Storage of Explosives



BURNING GROUND



- LEGEND**
- +—+— RAIL ROAD
 - FENCE
 - PANTEX SITE BOUNDARY
 - PANTEX PLANT BOUNDARY
 - P1 PLAYA #1

NOTE:
BASE MAP INFORMATION FROM PANTEX
DRAWING NO. G00082011.DGN

FIGURE 2
PANTEX PLANT
VICINITY MAP

PANTEX PLANT AMARILLO, TEXAS

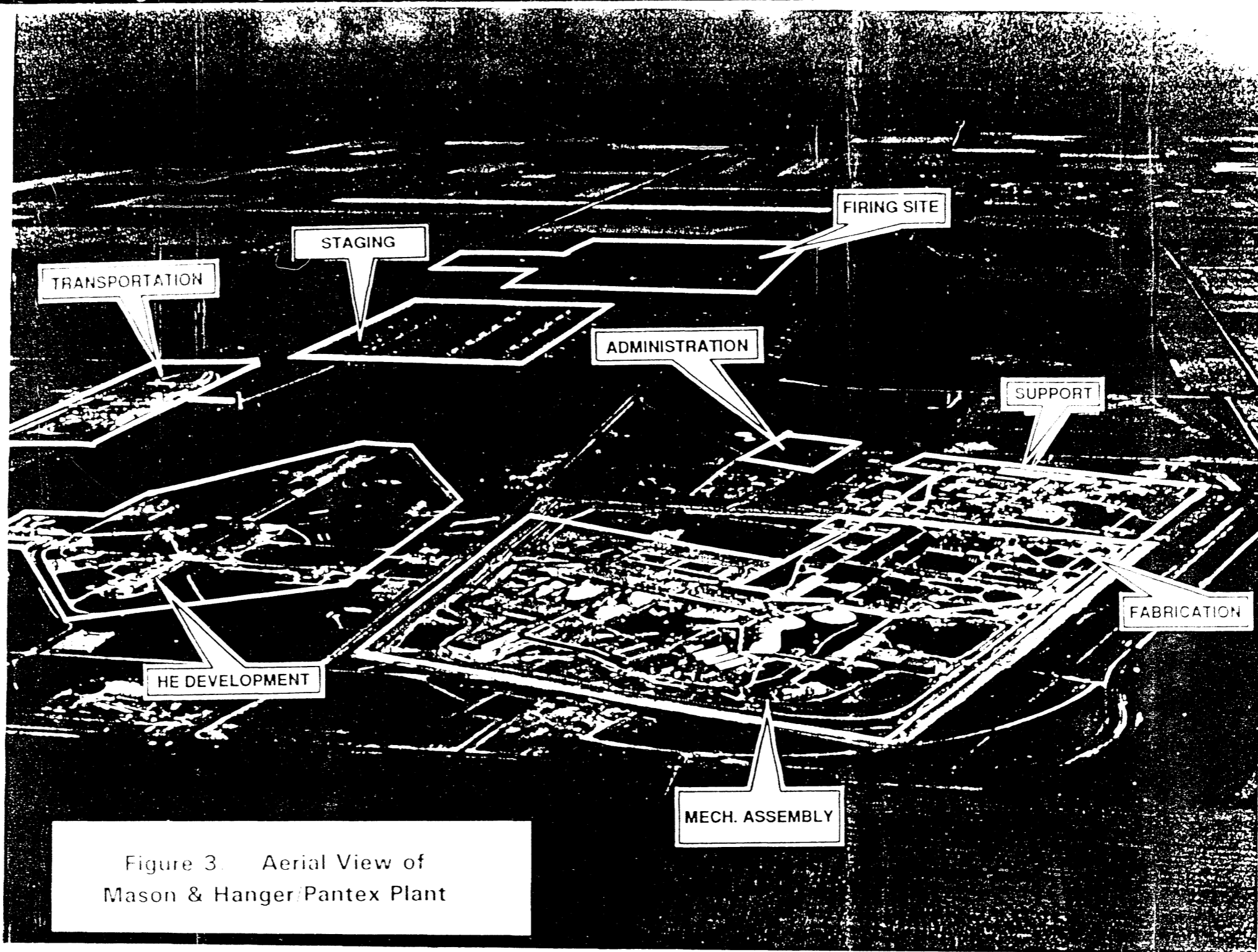


Figure 3. Aerial View of
Mason & Hanger/Pantex Plant

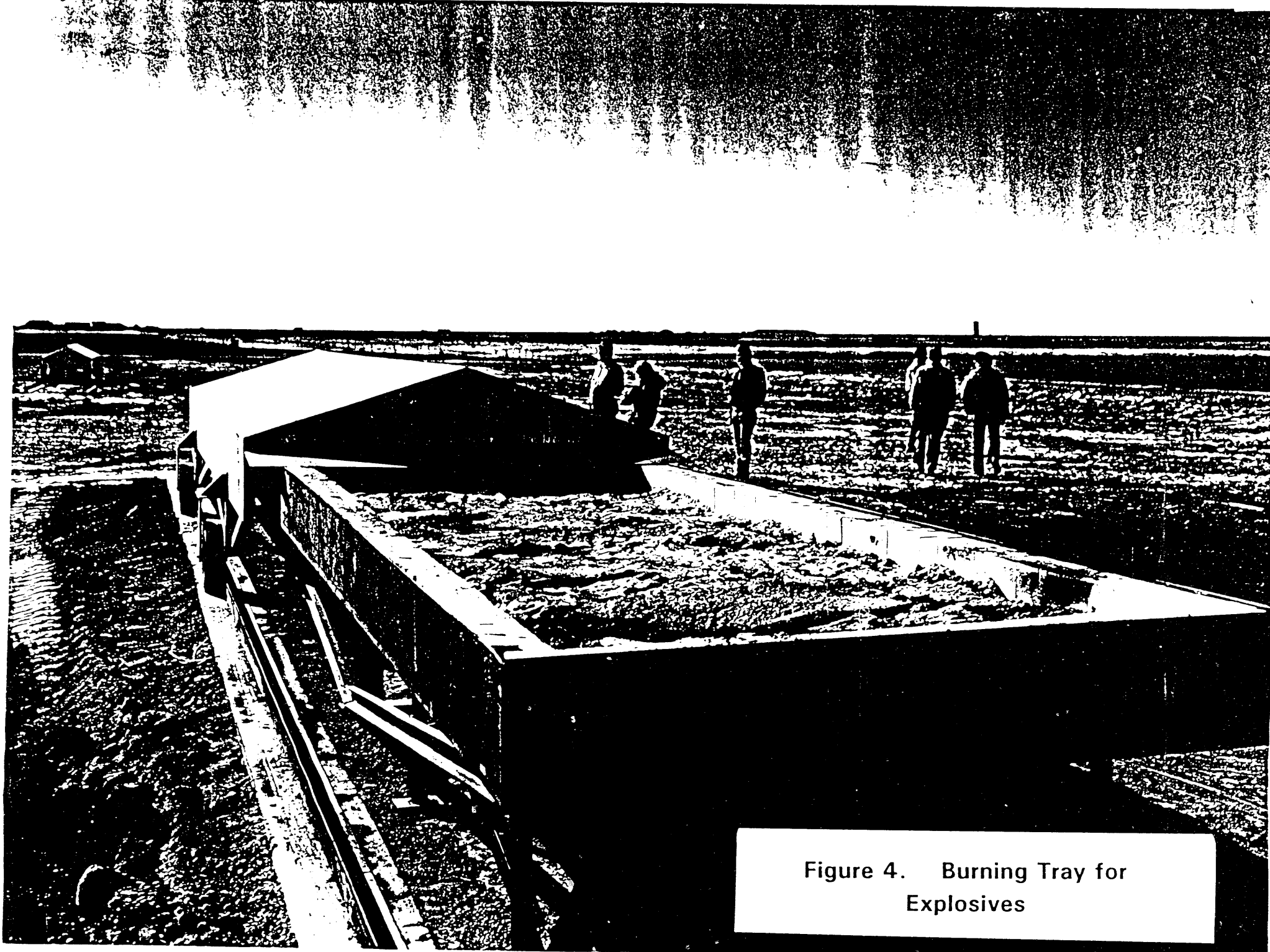
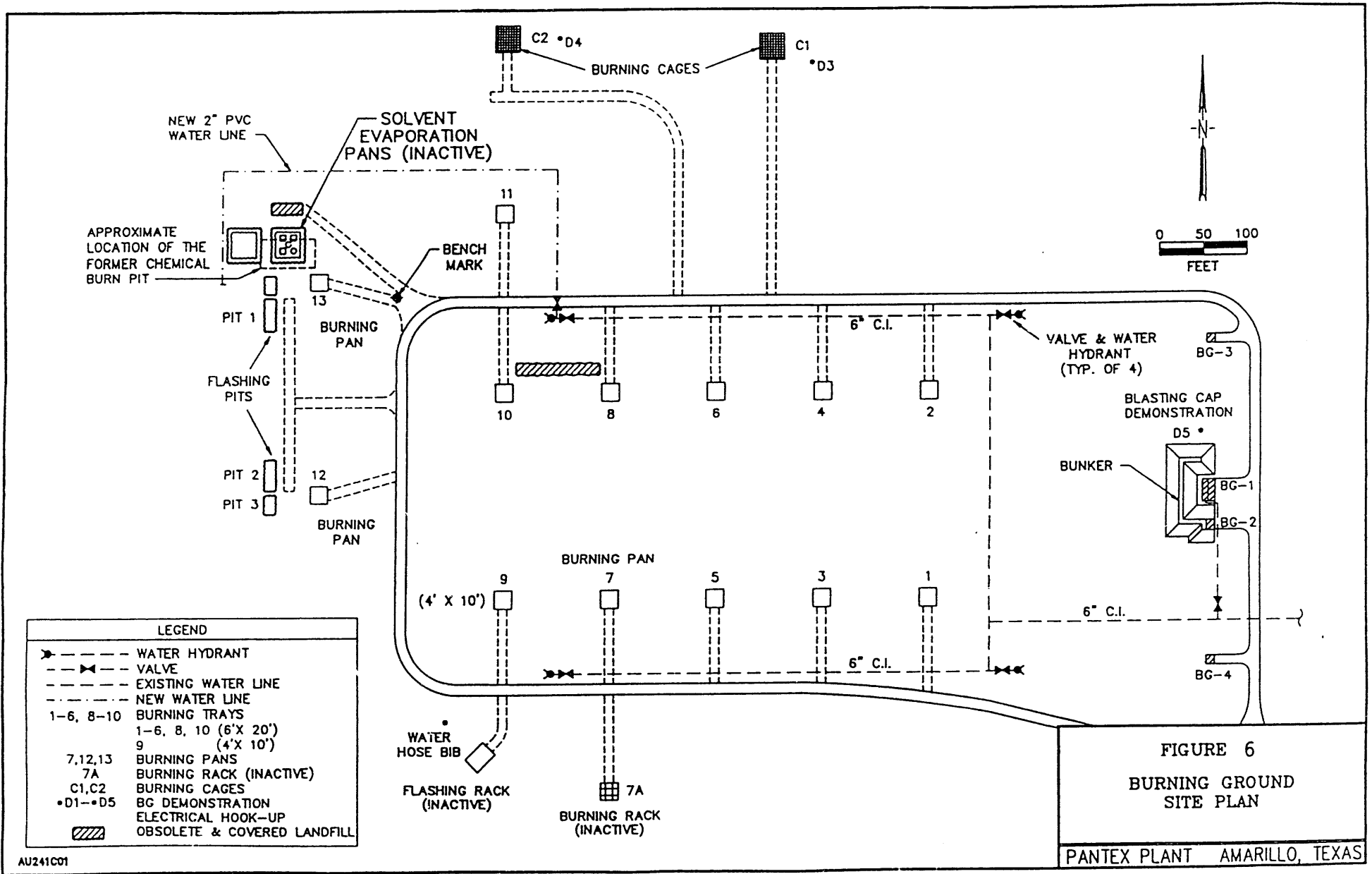


Figure 4. Burning Tray for Explosives

Figure 5. The Burning Ground as
Seen from the Control Bunker





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