DOE/EIS-0098-D

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Draft
Environmental Impact Statement

Pantex Plant Site

Amarillo, Texas

December 1982

U.S. Department of Energy

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U.S. Department of Energy
Washington, D.C. 20545

COVER SHEET

DRAFT ENVIRONMENTAL IMPACT STATEMENT

DOE/EIS-0098-D

(a) Lead Agency: The Department of Energy

(b) Proposed Action: Pantex Plant Site, Amarillo, Texas

(c) For further information contact: (1) Mr. Alex Griego, Environmental Engineer, Operational Safety Division, Department of Energy, Albuquerque Operations Office, P.O. Box 5400, Albuquerque, New Mexico, 87115, (505) 846-1108, (2) Dr. Robert J. Stern, Director, Office of Environmental Compliance, Office of the Assistant Secretary, Environmental Protection, Safety, and Emergency Preparedness (202) 252-4600. For copies of the Draft Environmental Impact Statement contact: Mr. Alex Griego at the address noted above.

(d) Designation: Draft Environmental Impact Statement

(e) Abstract: This Environmental Impact Statement evaluates the impact of continuing operations and constructing additional facilities at the Pantex Plant near Amarillo, Texas, in order to meet Department of Energy's continuing responsibilities for nuclear weapons assembly; stockpile monitoring, maintenance, and modifications; and retirements (disassembly) as mandated by Presidential direction and Congressional authorization and appropriation. The Environmental Impact Statement analyzes a range of alternatives to the proposed action. Alternatives identified include continued operations and construction of new facilities at the Pantex Plant; relocation of some or all of Pantex operations to existing facilities (which would require refurbishing) or new facilities at a formerly utilized nuclear weapons assembly plant site near Burlington, Iowa; relocation of all operations to new facilities at the Hanford Site near Richland, Washington; and impact mitigation alternatives.

(f) Comments on this Draft Environmental Impact Statement should be directed to Mr. Alex Griego at the address noted above in item (c), March 15, 1983 is the date by which comments must be received.

FOREWORD

This draft environmental impact statement (DEIS) analyzes the environmental effects of the Department of Energy's proposal to continue operations and to construct additional facilities at the Pantex Plant near Amarillo, Texas, to meet the Department of Energy's continuing responsibilities for nuclear weapons assembly, stockpile monitoring, maintenance, modifications, and retirements (disassembly) as mandated by Presidential direction and Congressional authorization and appropriation. The DEIS analyzes a range of alternatives to the proposed action. The alternatives identified include continued operations to existing facilities (which would require refurbishing) or to new facilities at a formerly used nuclear weapons assembly plant site near Burlington, Iowa; relocation of all operations to new facilities at the Hanford Site near Richland, Washington; and impact mitigation alternatives. This DEIS addresses those environmental impacts associated with Pantex Plant operations, proposed construction projects, and alternatives identified to those operations and projects, and related transportation operations. Both normal operations and potential credible accidents are evaluated for significant environmental consequences. The DEIS does not address either the United States nuclear weapon complex as a whole nor national policies regarding nuclear weapons.

This DEIS was prepared in accordance with the regulations of the Council on Environmental Quality (40 CFR Parts 1500-1508) and the Department of Energy Guidelines for Implementation of those regulations (45 FR 20694). A Notice of Intent to prepare a DEIS and conduct public scoping meetings regarding continuing operations and constructing additional facilities at the Pantex Plant was published in the Federal Register on April 24, 1981 (46 FR 23285-23286), and was provided directly to a number of Texas State agencies, other organizations, and local news media. A total of 18 communications were received prior to the scoping meetings in response to the Notice of Intent. These included eight written communications that had comments and nine written and one telephone communication with no comments. Two scoping meetings were held in Amarillo, Texas, on May 28, 1981. A total of 37 persons (other than DOE or DOE Contractor personnel) registered attendance at those meetings. Two persons made formal oral statements at the scoping meetings. Five other short questions or comments were received from the floor.

This DEIS is being made available to appropriate Federal, State, and local entities and members of the general public in order to provide those parties with an opportunity to review and comment on the document. The comments received on this DEIS will be assessed and considered by the Department of Energy in its preparation of the final environmental impact statement. The final environmental impact statement will be transmitted to commenting agencies, made available to members of the public, and filed with the Environmental Protection Agency. The Environmental Protection Agency will publish a notice in the Federal Register indicating that the Department of Energy has filed the final environmental impact statement. The Department of Energy will make a decision on the proposed action not earlier than 30 days after the Environmental Protection Agency has published the Federal Register notice. The Department of Energy will record its decision in a publicly available Record of Decision.

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SUMMARY

This document evaluates the environmental impacts of actions being considered by the Department of Energy in conjunction with its nuclear weapons operations at the Pantex Plant near Amarillo, Texas. The Department proposes to continue the nuclear weapons operations at the Pantex Plant and to construct additional facilities for nuclear weapons operations.

The proposed action is to continue operations and to construct additional facilities at the Pantex Plant near Amarillo, Texas, to meet the Department of Energy's continuing responsibilities for nuclear weapons assembly, stockpile monitoring, maintenance, modifications, and retirements (disassembly) as mandated by Presidential direction and Congressional authorization and appropriation. The Environmental Impact Statement analyzes a range of alternatives to the proposed action. The alternatives identified include continued operations and construction of new facilities at the Pantex Plant; relocation of some or all of Pantex operations to existing facilities (which would require refurbishing) or to new facilities at a formerly used nuclear weapons assembly plant site near Burlington, Iowa; relocation of all operations to new facilities at the Hanford Site near Richland, Washington; and impact mitigation alternatives.

I. PURPOSE AND NEED FOR THE PROPOSED ACTION

The purpose of the Department of Energy's proposed actions is to meet its continuing responsibilities for nuclear weapons operations under the Atomic Energy Act of 1954. Part of this responsibility is to provide new facilities to meet future military stockpile requirements established by Presidential directive. In the process of evaluating various means of carrying out its obligation, the Department is considering new or modified facilities that would provide improved operational reliability and additional mitigation of potential accidents for protecting workers, the general public, and the environment.

In 1978 the Department of Energy started to plan for construction of new facilities at the Pantex Plant similar to existing ones for handling increased workload schedules. Construction of some of these planned facilities was started in 1982. In addition to providing for increased workloads, the Department of Energy initiated a comprehensive planning and analysis effort in 1980 for the entire plant with goals for improving operational reliability and mitigation of potential accidents. These continuing studies include evaluating master plans to upgrade or replace many of the existing facilities.

II. BACKGROUND ON THE PANTEX PLANT

The Pantex Plant, located in the Panhandle of Texas in Carson County near Amarillo, was first used in 1942 by the Army Ordnance Corps for loading conventional ammunition shells and bombs. In 1950 the Atomic Energy Commission started rehabilitating portions of the original plant and building new facilities for nuclear weapons operations.

The Pantex Plant is primarily an assembly facility that receives conventional high-explosive materials (conventional means nonnuclear) and prefabricated weapons components from external suppliers. There are three major operations: (1) production of new nuclear weapons; (2) maintenance, modification, and quality assurance testing of nuclear weapons already in the military stockpile; and (3) retirement by disassembly of nuclear weapons no longer required in the military stockpile. The terms "nuclear weapons operations" and "workload" are used to refer collectively to all three types of operations throughout this document.

The high explosives are shipped to the Pantex Plant and fabricated into the required shapes for use in nuclear weapons. All other nuclear weapon components are supplied by other manufacturers. At the Pantex Plant these components are assembled to produce nuclear weapons for delivery to the Department of Defense.

Maintenance and modification of weapons in the military stockpile involves partial disassembly to permit replacement, modification, or inspection of components. A statistically selected number of nuclear weapons from the military stockpile or from initial production of a new weapons system receives a series of inspections and component evaluations.

When a weapon is completely disassembled for retirement, the conventional high-explosive components are separated from the nuclear components and disposed of at the Pantex Plant by burning. The nuclear materials components are returned to the original manufacturer. All other components are returned to the manufacturers or sent elsewhere for reuse, salvage, or ultimate disposal.

The Pantex Plant also conducts research and development work on conventional high explosives to support weapons design and development programs for the Department of Energy.

III. ALTERNATIVES

This Environmental Impact Statement includes analyses of either upgrading the Pantex Plant or replacing it at its current site or at another location. Two alternative sites were considered and options including either total or partial relocation of the nuclear weapons operations at each site were analyzed. These sites were selected on the basis of their suitability with respect to such features as (1) existing facilities and structures, (2) low population density, and (3) availability of land for major construction efforts.

The local environs differ greatly among the three sites. However, each is located within relatively flat open country away from major mountain ranges. All three locations have agricultural areas onsite under cultivation. Each site is located relatively close to urban areas.

The three basic alternatives are identified according to sites. These alternatives and their options are identified below and summarized in Table I.

A. The Pantex Plant Alternative

The Pantex Plant Alternative includes four options, the first three of which consider different combinations of new facilities that could provide three levels of improved operational reliability and also would reduce the likelihood of occurrence or mitigate the consequences of potential accidents. The fourth option considers continuing operations in existing facilities and constitutes the "No Action Alternative" for the purpose of comparison in this Environmental Impact Statement.

TABLE I

SUMMARY OF ALTERNATIVES

Action	Estimated Dates for Completion of Construction	Estimated Cost ($ Millions) (1981 values)	Operational Reliability Design Level
PANTEX PLANT ALTERNATIVE			
Option 1: New construction of specifically identified facilities	1982-1987	198	Existing facilities and Current Criteria applied to new construction only
Option 2: Major upgrade of existing facilities including significant new construction	1991-1993	664	Current Criteria applied to ugrading and new construction
Option 3: Complete replacement of certain major plant facilities with new construction	1993-1996	1239	Enhanced Goals for new construction
Option 4: Existing facilities and facilities currently under construction ("No Action")	--	53	Existing facilities, Current Criteria applied only to facilities currently under construction
IOWA ARMY AMMUNITION PLANT ALTERNATIVE			
Option 1: Partial relocation of workload (includes portion of Pantex Option 1)	1985	216	Existing facilities, Current Criteria applied only to new construction
Option 2: All-new Plant (complete relocation of workload)	1993-1996	1488	Enhanced Goals for new construction
HANFORD SITE ALTERNATIVE			
All-new Plant (complete relocation of workload)	1993-1996	1552	Enhanced Goals for new construction

- Pantex Plant Alternative Option 1 - New Construction to Meet Future Workload. This option assumes continuing operations in existing facilities and includes construction of 11 new facility projects. The new projects will be designed to currently applicable criteria for new construction. Six of the projects will be under construction by the end of 1982, four more are expected to start construction in 1983, and a new central power plant for heating and cooling is proposed to start construction in 1984 to replace the current gas-fired facility.

- Pantex Plant Alternative Option 2 - Major Upgrade. This option would upgrade the entire plant to meet Current Criteria applicable to design of new construction. This option assumes the prior completion of Option 1 described above. It proposes additional new construction and refurbishment of existing facilities. Many existing facilities would be replaced by new construction or modified to accommodate less hazardous operations. Upon completion, the entire plant would have improved operational reliability and efficiency compared with Option 1.

- Pantex Plant Alternative Option 3 - Major Replacement. This option would replace essentially all facilities housing high-explosive fabrication and nuclear weapon operations with new structures designed to meet more stringent or Enhanced Goals for operational reliability and mitigation of accidents. This option first assumes the completion of substantial portions of Option 1 described above. Additional new construction would completely replace the facilities in the nuclear weapons operations area and the high-explosives research and development area. Upon completion, the all-new facility would have the highest reliability and operational efficiency as well as the greatest accident mitigation features of the first three Pantex options.

- Pantex Plant Alternative Option 4 - Continue Operations in Existing Facilities. This option assumes continuation of current operations in only the existing facilities and those new facilities already under construction by the end of 1982.

B. The Iowa Army Ammunition Plant Alternative

The Iowa Army Ammunition Plant near Burlington, Iowa, is now operated for the U.S. Army to produce conventional munitions for the military. Because a portion of this plant was used from 1947 through 1975 by predecessors of the Department of Energy for nuclear weapons operations, existing special function facilities, similar to those at the Pantex Plant, are being considered for reuse.

This Alternative includes two options described below that represent either partial relocation or total relocation of the Pantex Plant operations. Both options assume common use of as many support facilities as would be practicable under a joint management agreement between the U.S. Army and the Department of Energy.

- Iowa Army Ammunition Plant Alternative Option 1 - Partial Relocation to Formerly Used Plant Facilities. This option assumes the reuse of facilities at the Iowa Army Ammunition Plant to accommodate about 25% of future workloads. Replacement facilities would be required for the Army if the Department of Energy required the nuclear weapons operations facilities. About 75% of the workload would be accommodated at the Pantex Plant in existing facilities and the new facilities already under construction in 1982.

- Iowa Army Ammunition Plant Alternative Option 2 - Complete Relocation to New Plant. The all-new plant is assumed to be of the same conceptual design as proposed for the all-new plant option at the Pantex Plant (Pantex Alternative, Option 3). Construction would be in a currently undeveloped portion of the Iowa Army Ammunition Plant site. The Pantex Plant, including the new facilities already under construction, would continue to be used until the new plant could be built after which the Pantex Plant would be closed.

C. The Hanford Site Alternative

The Hanford Site Alternative assumes building an entirely new plant on the Department of Energy's Hanford Site near Richland, Washington, with relocation of all nuclear weapons operations from the Pantex Plant. The new construction is assumed to be of the same conceptual design as proposed in the Pantex Plant Alternative, Option 3. Related support facilities also would have to be constructed at Hanford, as no such facilities currently exist there. The Pantex Plant, including the facilities already under construction, would continue to be used until the new plant could be built after which the Pantex Plant would be closed.

D. Termination of Operations at the Pantex Plant

Termination of operations at the Pantex Plant by the Department of Energy is defined to provide a basis for evaluating the impacts in the Amarillo area that would result from implementing the Iowa Army Ammunition Plant Option 2 or the Hanford Site Alternative that include closing the Pantex Plant.

IV. ENVIRONMENTAL IMPACTS

The major findings presented in the Environmental Impact Statement are summarized here for the alternatives and their options. Additionally, mitigative measures are described. The environmental impacts of the alternatives are categorized into four major areas: impacts from normal plant operation, risk to the public from potential plant accidents, impacts from directly related transportation operations, and impacts from construction.

A. Environmental Effects from Normal Operation

1. Pantex Plant Alternative, All Options

Studies of the environment in and around the Pantex Plant, which has operated for more than 30 years, found no significant accumulations of pollutants (including radioactive materials), no significant adverse effects on air or water, and no significant adverse impacts on the use of surrounding lands. None would be expected from normal operations under any option.

Current and future operations at the Pantex Plant under Options 1, 2, or 3 have low potential for adverse impacts because of improved waste management procedures and other routine operations that generate pollutants.

No radioactive wastes are now disposed of at the Pantex Plant site and none would be under any option. Radioactively contaminated materials and soil are compacted in metal drums and are sent offsite for disposal or storage. A few containers of radioactive residue from cleanup of military accidents with nuclear weapons at other locations are still being held at the Pantex Plant pending decisions on their offsite destination.

An epidemiology study revealed no indication of unusual cancer mortality patterns in counties near the Pantex Plant or any effect attributable to the Plant.

Special sampling studies of surface water and sediments found no significant accumulation of high explosives or other pollutants. Subsurface soil samples did not contain any significant contaminants. No important changes in quality of groundwater and no indications of contamination were found by studying analyses dating back to 1942. All current and future discharges of liquid wastes are onsite and conform to State of Texas permit requirements. If significant contaminants were present, geohydrologic conditions in the area preclude any movement of the contaminants from the land surface to groundwater.

Projected water needs for future operation of the Pantex Plant are less than 1% of the total expected for Carson County. No significant impact on water availability has occurred from past use and none would be expected.

Nonradioactive air emissions associated with routine operations are not considered significant for any option. All emissions are well within limits of Federal and State air quality standards and would continue to be so under any option. Radioactive emissions from routine operations include depleted uranium and tritium. These emissions do not result in any detectable increment of airborne concentrations or measurable doses above natural background beyond the Plant boundary. Theoretical calculations of potential maximum doses from expected future emissions show they are negligibly small fractions of those from natural background.

Agricultural land use in the surrounding areas has not been and is not expected to be impacted by normal operations at the Pantex Plant. More than 80% of the plant site is leased for agricultural use.

The availability of energy resources is considered adequate for current and projected needs at Pantex.

The Pantex Plant has no known endangered or threatened species as listed by the U.S. Fish and Wildlife Service. There are no pollutants that would pose any significant concern for wildlife. There are no archeological or historic sites listed on the National Register of Historic Places at the Pantex Plant. An archeological survey of the site identified 42 prehistoric Indian Camps and 3 farmstead sites, but none would be impacted by proposed construction.

The permanent work force increases associated with any option are no more than 200 for the Amarillo area and would pose no adverse impacts. The combined payroll (basic and nonbasic) and purchases associated with the current Pantex Plant operations are about $106 million; the expansion would increase area retail sales by 0.3%.

2. <u>Iowa Army Ammunition Plant Alternative, Both Options</u>.

If a partial or total relocation of the workload from the Pantex Plant to the Iowa Army Ammunition Plant were to occur, the environmental impacts of normal operation at the new site would be similar to the impacts of normal operation at the Pantex Plant under Pantex Plant Options 1, 2, or 3. Therefore, it is expected that the increase in total routine emissions from the Iowa Army Ammunition Plant resulting from either option will be small.

The largest impacts of either partial or total relocation of the workload to the Iowa Army Ammunition Plant would be socioeconomic in nature. The permanent work force would increase by about 1000 and 2600 workers with annual payrolls (basic and nonbasic) of $37 to $96 million, with partial or total relocation, respectively. Complete relocation would result in the loss of a comparable number of jobs and economic input in the Amarillo area.

3. Hanford Site Alternative

If the total relocation of the workload from the Pantex Plant to the Hanford Site were to occur, the environmental impacts of routine operations at the Hanford facility would be no greater than those projected under the Pantex Option 3. The Hanford Site proposed construction area is considerably more remote than either the Pantex Plant or Iowa Army Ammunition Plant proposed construction area and allows more atmospheric mixing and dispersion to occur before the small quantities of pollutants reach the site boundary. The impacts of routine air emissions are not considered significant. Adequate water is available from the Columbia River and no significant changes in surface or ground water will occur if relocation to the Hanford Site occurs. Any solid radioactive wastes produced would be disposed of at current waste disposal facilities at the Hanford Site.

The largest impact of complete relocation to an all-new plant at the Hanford Site would be socioeconomic in nature because the permanent (basic) work force would decrease by about 2400 workers at the Pantex Plant and increase comparably at the Hanford Site.

B. Risks from Potential Plant Accidents

The only accidents that were found to be credible and that could have a significant impact on the environment were those that could release radioactive materials beyond the plant site and result in radiation exposure to the general public. Accidental detonation of conventional high explosives was found to be the only significant mechanism for dispersing substantial quantities of radioactive material beyond the Plant boundaries. The evaluation of the likelihood of such potential accidents focused on credible events that could initiate accidental detonations.

Nuclear detonation is not a credible accident at any Alternative site or during Department of Energy transportation operations because of fail-safe design and redundant protective systems.

Many other types of accidents were evaluated that were found not to be credible or found not to have the potential for significant environmental impact. For example, spills of process chemicals or fuel would be relatively small, would be contained within the plant site, and could be cleaned up with no long-term effects. Potential accidents involving only conventional high explosives with no radioactive materials are not significant in terms of risk to the environment or the general public. The airborne releases from such accidents would be no different than those from the routinely conducted test detonations.

A summary of maximum risks from environmentally significant potential accidents is presented in Table II. Indicators of both the maximum likelihood of such accidents occurring and the maximum consequences that would result are given for each of the Alternatives and Options. The first two columns include probabilities, or chance of occurrence, for (1) any radioactivity releasing accident occurring and (2) the chance that the maximum release accident would occur in conjunction with the worst-case wind direction. The last two columns give indications of the maximum consequences that would be associated with the maximum release accident for which the probability was given in column 2. The maximum consequence

TABLE II

SUMMARY OF RISKS OF MAXIMUM CONSEQUENCES

Alternative/Option	1. Overall Chance of Occurrence of any Plutonium-Releasing Accident (chance per year)[a]	2. Combined Chance of the Maximum Release Accident Occurring and Wind Being Toward Largest City (chance per year)[b]	3. Maximum Number of Possible Eventual Cancer Deaths Attributable to Maximum Release Accident with Likelihood Given in Column 2 (number)[c]	4. Upper Limit on Costs to Clean Up Contamination from Maximum Release Accident (millions of 1981 dollars)[d]
Pantex Alternative				
Option 1 - New construction	1 in 5100	1 in 2,800,000	68	890
Option 2 - Major upgrade	1 in 6100	1 in 2,800,000	68	890
Option 3 - Major replacement	1 in 23,000	1 in 2,800,000	68	890
Option 4 - Existing facilities only	1 in 5900	1 in 2,800,000	68	890
Iowa Army Ammunition Plant Alternative				
Option 1 -Partial relocation (risk in Iowa only, Pantex Option 4 gives risk in Texas)	1 in 59,000	1 in 20,000,000	69	740
Option 2 - All new Plant	1 in 53,000	1 in 4,200,000	69	740
Hanford Alternative				
All new Plant	1 in 1,000,000	1 in 16,000,000	1	21

[a]This is the combined overall chance of any one of the three types of credible initiating events (aircraft crash, tornado, or operational) resulting in the dispersal of plutonium by an accidental detonation of conventional high explosives. (Aircraft crash-induced accidents were found to account for 87 to 99 per cent of the overall chance for the Pantex Options and to be responsible for the largest consequences. Mitigating measures to reduce this risk are now being examined.)

[b]This is the chance per year of plant operation that the accident releasing the largest amount of plutonium would occur and that the wind would be blowing in the direction of the largest metropolitan area. This would result in the largest number of people being exposed and would result in the largest number of eventual cancer cases. It is the probability of occurrence of the maximum release accident multiplied by the fraction of the time the wind blows in the direction of Amarillo for the Pantex Plant Alternatives, Burlington for the Iowa Army Ammunition Plant Alternatives, and Richland for the Hanford Site Alternative.

[c]This is the total number of cases of lung, liver, and bone cancer that might occur after latency periods of 5 to 20 years in the potentially exposed populations as a result of inhaling plutonium dispersed by the maximum release accident and assuming the wind direction toward the largest metropolitan area as indicated for Column 2. All cases of these types of cancer are assumed to result in death because cure rates are low. These numbers may be compared to the normally expected number of deaths from the same three types of cancer from all other causes. In the Amarillo, Texas, area, 4900 such cancer deaths would be normally expected from all other causes in the 142,000 population potentially affected by the maximum release accident; in the Burlington, Iowa, area, 1180 such cancer deaths would be normally expected in a population of 34,400, and in the Richland, Washington, area, 4100 such cancer deaths would be normally expected in a population of 119,000.

[d]These are the highest estimated costs for removal of contamination from structures, vegetation, and soil, and other measures necessary to assure that the dose guidelines for transuranium contamination in the environment proposed by the Environmental Protection Agency would be met.

indicators are (1) the maximum number of fatal cancer cases that might be expected and (2) the maximum costs of cleaning up the land areas that could be contaminated.

The maximum number of eventual fatal cancer cases that might occur after latency periods of 5 to 20 years are given as an upper limit on the risk of maximum consequences to society. It can be compared with the number of cancer deaths expected from all other causes as given in the notes in the table for each location. No member of the public would receive sufficient exposure to result in any short-term effects. The maximum exposed individual that might be near a plant boundary where the exposures were calculated to be the highest would have an annual chance of about 1 in 14 million of eventually dying of cancer from any potential accident associated with any of the alternatives. This upper limit individual risk may be compared with the overall United States average chance of death from all other types of accidents, which is 1 chance in 2000 per year.

Specific aspects of accident risks are discussed below.

1. Pantex Plant Alternative

Credible events that could lead to an accidental detonation of high explosives and dispersal of radioactive material include an aircraft crash, a tornado, and an operational accident for Options 1 and 4. For Options 2 and 3, tornados would be eliminated as a credible initiating event. Aircraft crashes are the dominant factor in overall likelihood of an accident for any of the options. Operational accidents have the smallest chance of occurring, about one chance in a million per year of plant operation.

Because the most likely, as well as the larger consequence accidents are associated with aircraft crashes, mitigating measures now are being investigated that could reduce the likelihood or the consequences of such accidents. One of these measures is a proposal to extend the existing prohibited airspace to be vertically unlimited and reach horizontally out to 4 kilometers (2.5 miles) beyond the plant boundary and to relocate the Federal Aviation Administration VORTAC radio navigation aid so that no airways pass closer than this same distance from the plant boundary. Other measures being considered include the modification or rebuilding of structures to reduce or eliminate any offsite consequences should an aircraft crash occur.

2. Iowa Army Ammunition Plant Alternative

Credible events that could lead to a release of radioactive materials by an accidental detonation of conventional high explosives include only aircraft crashes or an operational accident for either of the Options. Under Option 1, Partial Relocation, the risks listed in the table are only those that would be added in Iowa. The potential risks from accidents associated with the continuing operations at the Pantex Plant would be those given for the Pantex Plant Alternative Option 4. Aircraft crashes dominate the overall chance of any plutonium-dispersing accident for both options. Operational accidents have the smallest chance of occurring.

3. Hanford Site Alternative

The only credible event that could lead to a plutonium-dispersing accident would be an operational accident. Aircraft crashes are eliminated as credible events that could lead to an accidental detonation because the flight frequency over the area is lower than either of the other sites and all facilities are assumed to be constructed so as to limit the consequences should an aircraft crash occur.

C. Impacts from Directly Related Transportation Operations

Evaluation of transportation operations directly related to nuclear weapons operations included (1) transportation of nuclear weapons or their components in special Safe-Secure Trailers and Safe-Secure Railcars, (2) transportation of certain components not containing plutonium in exclusive-use aircraft, and (3) shipment of conventional high explosives and hazardous chemicals by commercial carriers.

These modes were examined for impacts resulting from normal operations that include vehicular emissions and possible radiation doses to the public. The potential risk to the public from transportation accidents also was evaluated.

1. Pantex Plant Alternative

The environmental impacts of normal transportation, including normal exhaust emissions, represent less than 1% of the impacts from comparable vehicular traffic in the Amarillo area. Radiological impacts of Pantex Plant-related normal transportation are limited to radiation doses received by individuals in the vicinity of the shipments. The maximum possible annual radiation dose is less than one-half of 1% of typical annual background.

Two types of transportation accidents that could release radioactive material and result in radiation exposure to the public were found to be credible. The crash of an aircraft carrying tritium-containing components was estimated to have a likelihood of 1 chance in 25,000 per year. The likelihood of a plutonium release from an accident involving the crash of a Safe-Secure Trailer with a loaded fuel tanker truck leading to a long-burning fire was found to be about 1 chance in a million per year on the basis of total distance traveled nationwide. About 5% of the travel takes place within 80 kilometers (50 miles) of the Pantex Plant, and the chance of such an accident within that area is about 1 chance in 20 million a year. Mitigating measures are now being investigated to reduce this likelihood still further.

Assuming that the most serious of these low-likelihood accidents occurred and plutonium was released, the consequences to the public would be the potential for up to 38 eventual deaths from lung, liver, and/or bone cancer occurring over the lifetimes of the exposed population of persons. The cost to clean up the contaminated area would range up to $500 million.

Potential transportation accidents involving shipments of conventional high explosives or fuel were found to have possibilities of occurrence ranging from 1 chance in 300 per year (aircraft carrying high explosive), down to 1 chance in 20,000 per year (truck carrying gasoline or diesel fuel). The Pantex Plant-related contribution to overall risks of truck explosives shipments in the United States is no more than one-hundredth of 1%.

2. Iowa Army Ammunition Plant Alternatives

Under Iowa Options 1 and 2, the environmental impacts resulting from normal transportation operations would not be expected to exceed those associated with the Pantex Plant alternative; radiation dose is a function of shipments rather than distance traveled. The risk of transportation accidents would not increase because the distance traveled would approximate that to and from the Pantex Plant assuming all other destinations remained the same.

3. Hanford Site Alternative

Total relocation to the Hanford Site would not increase impacts of normal transportation operations. However, the risk to the general public from transportation-related accidents would be approximately doubled because of the greater distance to be traveled assuming all other destinations remained the same.

D. Impacts from Construction

Any impacts from the proposed construction associated with the various alternatives and their options will be largely socioeconomic. Effects on the environment itself at any of the three locations would be minimal.

1. The Pantex Plant Alternative

Construction work force requirements for the first three options under this alternative could be met locally, and no significant adverse effects on community resources would be expected. The extreme case, total plant replacement (Option 3), would result in peak annual construction payrolls of around $64 million and an increase in retail sales for the area of about 1.9% above current totals.

2. Iowa Army Ammunition Plant Alternative

As with the Pantex alternative, no negative impacts resulting from construction are expected with the proposed partial (Option 1) or total (Option 2) relocation of operations to the Iowa Army Ammunition Plant. The extreme case, Option 2, would result in a peak annual payroll of $79 million and an increase in retail sales for the area of about 6.0% above current totals.

3. Hanford Site Alternative

No negative impacts are expected with a total relocation to the Hanford Site. Total annual construction payrolls are expected to range between $70 million and $83 million, with retail sales projected to rise around 4% above current totals. Labor work force requirements would be met locally, with no migration of workers, because of the recent cancellation of major industrial programs in the area.

E. Comparison of Alternatives

The environmental impacts resulting from normal operations are summarized in Figure 1 for the various alternatives and their options. There are few significant differences between the impacts of those alternatives and the current conditions. The primary differences in impacts are socioeconomic, reflecting the costs and labor requirements associated with the construction efforts.

More significant bases for comparison are the potential environmental impacts because of accidents and the effect of mitigative measures on risk to the public. Some indicators of likelihood and consequences of maximum release accidents are given in Table II. The overall annual chance of a

TYPE OF ENVIRONMENTAL IMPACT

ACTION	AIR	WATER	TERRESTRIAL RESOURCES	ECOLOGY	LAND USE AND AGRICULTURE	RADIATION AND RADIOACTIVITY	ENERGY RESOURCES	EMPLOYMENT AND POPULATION	ECONOMICS	COMMUNITY RESOURCES	CULTURAL RESOURCES	CONSTRUCTION
PANTEX PLANT ALTERNATIVE												
OPTION 1: NEW CONSTRUCTION	Low						Low		Low			Low
OPTION 2: MAJOR UPGRADE	Low							Moderate	Moderate			Moderate
OPTION 3: MAJOR REPLACEMENT	Low							Moderate	Moderate	Low		Moderate
OPTION 4: EXISTING FACILITIES												
IOWA ARMY AMMUNITION PLANT ALTERNATIVE												
OPTION 1: PARTIAL RELOCATION							Low	Moderate	Moderate			Low
INCLUDES PORTION OF PANTEX OPTION 1	Low						Low					
OPTION 2: ALL NEW PLANT	Low				Low			High	High	Moderate		Moderate
HANFORD SITE ALTERNATIVE												
ALL NEW PLANT	Low		Low					High	High		Low	Moderate
TERMINATION												
CLOSE PANTEX AS PART OF IOWA OPTION 2 & HANFORD ALTERNATE								High	High			

LEGEND: NO IMPACT (blank) · LOW IMPACT · MODERATE IMPACT · HIGH IMPACT

Figure 1. Comparison of environmental impacts from normal operations and construction.

plutonium-releasing accident is lowest for the Hanford Site Alternative (1 chance in 1 million), intermediate for the Iowa Army Ammunition Plant Alternative (1 chance in 53,000 to 1 chance in 59,000), and highest for the Pantex Plant Alternative (1 chance in 5100 to 1 chance in 23,000). Maximum consequences to the public or the environment are essentially the same for the Pantex Plant and Iowa Army Ammunition Plant Alternatives in terms of the maximum number of possible eventual cancer deaths or the extent of decontamination that might be required as shown in Table II. Under the Hanford Site Alternative, maximum consequences would be significantly smaller.

The chance of an aircraft crash-induced accidental release under any of the Pantex Plant Options could be reduced by a factor of about 40 by implementing the mitigating measure to expand the prohibited airspace. This would significantly reduce the accident risk because aircraft crash-induced accidents represent 87 to 99 per cent of the overall chance of occurrence of plutonium-releasing accidents for the Pantex Plant Options. Furthermore, aircraft crash-induced accidents were evaluated to result in the greatest consequences with maximum eventual cancer deaths ranging up to 68, or more than 7 times as many as from other types of accidents.

The chance of occurrence of transportation accidents is closely proportional to the distance traveled. The Hanford Site Alternative would, at most, double the occurrence probability for accidents that exist for the Pantex Plant or Iowa Army Ammunition Plant locations.

V. PREFERRED ALTERNATIVE

The first three options for the Pantex Plant encompass the range of possible actions currently preferred by the Department of Energy. Features of more than one of these options may be desirable. The largest adverse environmental impacts of the preferred action would result from aircraft crash-induced accidents. The mitigative measures identified in the course of preparation of this Environmental Impact Statement could reduce this risk significantly and are being examined for possible implementation.

1. INTRODUCTION

1.1 PURPOSE AND NEED FOR THE PROPOSED ACTION

This Environmental Impact Statement evaluates the impact of continuing operations and constructing additional facilities at the Pantex Plant near Amarillo, Texas, to meet the Department of Energy's continuing responsibilities for nuclear weapons assembly; stockpile monitoring, maintenance, and modifications; and retirements (disassembly) as mandated by Presidential direction and Congressional authorization and appropriation. The Environmental Impact Statement analyzes a range of alternatives to the proposed action. The alternatives identified include:

- continued operations and construction of new facilities at the Pantex Plant;
- relocation of some or all of Pantex operations to existing facilities (which would require refurbishing) or new facilities at a formerly used nuclear weapons assembly plant site near Burlington, Iowa;
- relocation of all operations to new facilities at the Hanford Site near Richland, Washington; and
- impact mitigation alternatives.

In 1978 the Department of Energy started to plan construction of specific new facilities at the Pantex Plant to handle an increasing workload. Providing these expanded facilities is the fundamental purpose of the proposed action. These new facilities would be similar to existing plant facilities and would permit increasing nuclear weapons operations. However, they would not change the basic nature of operations carried out at the Pantex Plant for the past 30 years. The new facilities would provide greater operational reliability than that afforded by many of the existing facilities.

Additional new construction to replace or modify outmoded existing structures also is being considered as part of the proposed action. Concepts for such facilities have been developed as part of a comprehensive planning and analysis task initiated in 1980 by the Department of Energy to review the status of the entire Pantex Plant. These continuing planning efforts are evaluating the possibilities and benefits of various types of structures and overall plans for future development of the Pantex Plant. The purpose is to develop plans for the entire plant that would provide for increased workloads, improved operational reliability and efficiency, and additional mitigation of potential accident consequences for the protection of workers, the general public, and the environment. Several of the alternatives discussed in this Environmental Impact Statement are based on the range of approaches being considered by the Department of Energy in its ongoing planning and evaluation process.

This Draft Environmental Impact Statement is part of that evaluation process. After public review and consideration of comments received, a Final Environmental Impact Statement will be published. It will aid Department of Energy officials in the decision-making process regarding modes and locations of continued nuclear weapons operations.

The requirement for the Department of Energy to provide for nuclear weapon operations is provided in Section 91 of the Atomic Energy Act of 1954 as amended (42 U.S.C. 2121). That act authorized the Atomic Energy Commission "to engage in the production of atomic weapons... to the extent that the express consent of the President of the United States has been obtained, which consent and direction shall be obtained at least once each year." The general authority of the Atomic Energy Commission was forwarded to the Energy

Act of 1974 and the Department of Energy Organization Act, respectively. The consent and direction of the President are given each year in a classified Presidential Stockpile Paper (jointly prepared for the President by the Department of Defense, the National Security Council, and the Department of Energy). Each Presidential Stockpile Paper addresses nuclear weapons operations requirements for current and future years. Annual appropriations to carry out the Presidential directives then are provided through the combined action of the House of Representatives, the Senate, and the President. It is the Department of Energy's responsibility to meet the nuclear weapons operations requirements.

1.2 RELATIONSHIP TO OTHER FEDERAL ACTIONS

One major proposed Federal action receiving some consideration recently that would result in cumulative impacts in the Panhandle of Texas is the M-X Missile deployment. A Draft Environmental Impact Statement on the multiple shelter basing concept was issued by the U.S. Air Force in December 1980, and public hearings were held. The Air Force has recently initiated a new Environmental Impact Analysis Process in conjunction with a new effort to evaluate the United States for potential M-X siting areas (47 FR 34816 1982).

The Department of Energy's Office of Nuclear Waste Isolation is performing some siting studies including some exploratory drilling in the Permian basin salt formations within the Dalhart and Palo Duro Basins in the Texas Panhandle. Two Panhandle locations for additional characterization as potential bedded-salt sites have been identified, one each in east-central Deaf Smith County and north-central Swisher County, Texas. These activities are part of the National Waste Terminal Storage Program being conducted nationwide by the Department of Energy in an effort to develop the necessary technology and to identify sites possible for mined geologic repositories for the disposal of commercially generated high-level radioactive waste. A draft National Plan for Siting High-Level Radioactive Waste Repositories and Environmental Assessment was issued in 1982 (USDOE 1982B), which explains the site characterization and selection process.

1.3 SCOPING PROCESS

Interested agencies, organizations, and the general public were requested to submit comments or suggestions to help identify significant environmental issues and develop the appropriate scope of this Draft Environmental Impact Statement. The scoping period extended from Publication of the Notice of Intent on April 24, 1981, through June 5, 1981, and included two public scoping meetings held in Amarillo on May 28, 1981 (USDOE 1981B).

Fifteen main categories of issues or concerns were identified in either the written comments received or the statements made at the scoping meetings. These categories are summarized in Table 1.3-1 together with the sections of this Draft Environmental Impact Statement where relevant information on the environmentally significant aspects may be found.

1.4 GENERAL DESCRIPTION OF DEPARTMENT OF ENERGY NUCLEAR WEAPONS ACTIVITIES

The Department of Energy is responsible for the design and development, testing, manufacture, maintenance, and disassembly of nuclear weapons. Any given weapon program proceeds through a series of stages starting with conceptual design, engineering feasibility, and cost studies. If the weapon is adopted by the military, there will be extensive development and production engineering of fabrication

TABLE 1.3-1

ISSUES RAISED DURING SCOPING PROCESS

Category of Issue or Expressed Concern	Sections of This Document Containing Relevant Information on Significant Environmental Aspects
1. Existing or potential radioactive contamination	2.3.2, 2.3.5, 2.3.6, 3.2.6, 4.1.6, 4.2.4, 8.1
2. Water quality degradation	2.3.2, 3.2.2, 4.1.2
3. Movement of contaminants through ecological pathways	2.3.4, 2.3.5, 3.2.4, 3.2.5.1, 4.1.4, 4.1.5, 4.2.7, 4.2.8, 8.1
4. Cumulative environmental impacts from past or other Federal actions	1.2, 3.2
5. Impacts of potential accidents	2.4, 2.5, 4.2, 4.3
6. Human health impacts or risks	2.3.6, 2.3.12, 2.4.3, 3.2.6, 3.2.12, 4.1.6, 4.1.12, 4.2.6, 4.2.8
7. Water availability	2.3.2, 3.2.2, 4.1.2
8. Impacts on agriculture	2.3.5, 3.2.5, 4.1.5
9. Impacts on wildlife	2.3.4, 3.2.4, 4.1.4
10. Social and economic impacts	2.3.8, 2.3.9, 2.3.10, 3.2.8, 3.2.9, 3.2.10, 4.1.8, 4.1.9, 4.1.10
11. Alternate siting considerations	2.2, 2.2.3
12. Offsite transportation	2.5, 4.3
13. Construction impacts	2.3.3, 2.3.4, 2.3.5, 4.1.1.1
14. Energy use	2.3.7, 3.2.7, 4.1.7
15. National Security Policy	1.1

processes, equipment, and facilities. The required numbers of weapons are then produced for the military stockpile. While in the stockpile, some weapons are returned periodically to the Department of Energy from the military for required maintenance and modifications, and others are returned for testing or evaluation to assure reliability. When no longer required by the military, the weapons are retired from the stockpile and disassembled.

The three main types of nuclear weapons operations discussed in this Environmental Impact Statement are (1) production of new nuclear weapons; (2) maintenance, modification, and quality assurance testing of existing nuclear weapons in the military stockpile; and (3) retirement or disassembly of nuclear weapons no longer needed by the armed forces. The terms "nuclear weapons operations" and "workload" are used throughout this Environmental Impact Statement to refer collectively to all three types of operations. These are the operations that now are performed at the Pantex Plant and would be conducted in new facilities at the Pantex Plant or elsewhere under the various alternatives.

A related activity now conducted at the Pantex Plant is research and development work on high explosives in support of weapon design and development and production engineering for the Department of Energy. This activity also would be carried out in the future at the Pantex Plant or in conjunction with one of the other alternatives.

1.4.1 Nuclear Weapon Production

Producing nuclear weapons involves the fabrication of conventional high-explosive components. This starts with raw chemical high explosive and other materials, such as plastic binders, in a granular or powdered form supplied by chemical manufacturers and shipped by common carrier. These materials are mixed, heated, and pressed into various solid shapes. The shapes are machined to final dimensions. Quality and tolerances are monitored by testing (including radiography), inspections, and test detonations of high-explosives samples. Most test detonations involve only conventional high explosives; a small number include depleted uranium. Scraps and unacceptable pieces of high explosives are burned.

In the next phase, chemical high-explosive parts are assembled with nuclear material components and encased in a protective shell. The nuclear material components are received in sealed or encapsulated form for assembly. They are shipped from other manufacturers in special Department of Energy vehicles designed to safely transport nuclear materials and classified components. Work with bare (or uncased) high explosives is carried out with many safety precautions because it is more susceptible to being accidentally detonated before being placed in the protective shell. The operations involving uncased high explosives together with plutonium-containing nuclear material components (which also may include enriched uranium and tritium) are performed in an "assembly cell." Assembly cells are special structures designed to mitigate the consequences of an accidental detonation of the high explosive, including both physical blast effects and dispersion of radioactive materials. Once the high explosive/nuclear material component unit is enclosed in a protective shell, it is called a "physics package."

The remaining operations include adding other components to the cased physics package and placing the completed unit into a bomb case or warhead. All of these additional components are supplied by other manufacturers. Extensive quality assurance checks and testing are carried out at many points in the sequence. These operations involving cased nuclear explosive assemblies or physics packages are carried out in "assembly bays." The potential for an accidental detonation during these operations is less than in the operations described earlier where bare high explosive is involved. Nonetheless, assembly bays are intended to provide mitigation of consequences from an accidental detonation should one occur. They would limit the physical blast effects (such as overpressures and flying debris) that could injure workers or induce additional explosions in adjacent work areas.

Weapons are delivered to or returned from the military in special Department of Energy vehicles called Safe Secure Trailers or Safe Secure Railcars.

1.4.2 Weapons Maintenance, Modification, and Reliability Evaluation Programs

Maintenance and modification of weapons in the military stockpile require replacement of components. For these purposes, disassembly only proceeds far enough for access to the particular components. After replacement, the weapon is reassembled, given quality assurance tests, and returned to the military.

Reliability assurance programs for nuclear weapons from the military stockpile include both laboratory tests of weapons and preparation of special flight test units for the military. The laboratory tests are performed on a statistically selected number of nuclear weapons. Inspections and safety checks are performed to determine if any flaws exist. After disassembly, each component is subjected to a series of functional reliability tests. Testing of some components includes destructive testing to determine how a component behaves. Nondestructive testing is performed with advanced instruments to detect hidden flaws. Finally, the weapons are reassembled, given quality assurance tests and inspections, and returned to the military stockpile.

The preparation of flight test units follows the same pattern as laboratory tests through the disassembly stage. Then actual nuclear components are replaced by simulated components and the weapon is reassembled with instrumentation to measure the weapon components' response to dynamic tests. This reassembled device is called a joint test assembly and is given all quality assurance tests and inspections that a real weapon receives. When the joint test assembly passes all inspections, it is delivered to the Department of Defense to be tested at a military range.

1.4.3 Weapons Retirement

Weapons retirement is the complete disassembly of a weapon no longer desired in the military stockpile. The disassembly proceeds beyond that described for maintenance and modification. The high explosive components are separated from other components and then disposed of by burning. The nuclear material components are returned to other Department of Energy facilities for reclamation or recycling. The other weapon components are disposed of by returning them to other manufacturers for refurbishment, salvage, or ultimate disposal.

1.4.4 High-Explosives Research and Development Activities

This research and development work is to prepare high explosives that have specific performance characteristics and other desirable physical, chemical, and thermal properties for use in nuclear weapons. No nuclear material components are involved. This research requires the synthesis of new high explosives by chemically processing raw materials available from commercial sources. These new explosives then are subjected to a variety of tests and formulation processes to determine their compatibility with fabrication processes. Safety tests are performed to determine detonation sensitivity under various conditions. Explosives are tested for machining characteristics and explosive performance.

1.5 SAFEGUARDS AND SECURITY FEATURES

The objectives of the Department of Energy Safeguards and Security program are to protect the health and safety of the public and to assure program continuity. Protection is afforded against intentional threats or acts of theft.

The Department of Energy weapons production facilities are protected in accordance with the safeguards and security requirements of USDOE Orders:

- DOE Order 5630.1: Control and Accountability of Nuclear Material,
- DOE Order 5630.2: Control and Accountability of Nuclear Materials, Basic Principles,
- DOE Order 5632.1: Physical Protection of Classified Matter, and
- DOE Order 5632.2: Physical Protection of Special Nuclear Material.

The Safeguards and Security program is an integrated plan intended to prevent a breach of security. Furthermore, the program is designed such that the consequences of a security breach would be minimized.

The Safeguards and Security progam for the Pantex Plant is specifically designed to prevent loss, theft or diversion of materials; to protect classified information, and to protect against damage,theft, loss, or other harm to government property. The Safeguards and Security function includes: physical security, material control and accountability, and emergency preparedness.

Specific details of the Safeguards and Security program as it would apply to the proposed action are classified. The program is continuously evaluated to assure adequacy.

2.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

This chapter has four main objectives.

- To provide background information on the Pantex Plant to establish a context for criteria being considered as a basis for facility designs included in some of the alternatives (Section 2.1).

- To identify the alternatives considered in this Environmental Impact Statement (Section 2.2). These descriptions include the major assumptions for each alternative and form the basis for analysis of impacts.

- To present conclusions regarding environmental impacts of Normal Operations and Construction, Potential Accidents, and Related Transportation (Sections 2.3, 2.4, and 2.5). These summary conclusions are given in comparative form to highlight issues and provide a basis for judging significant differences between the alternatives. The conclusions are based on the more detailed information found in Chapter 3, which covers descriptions and analyses of existing environmental conditions, and Chapter 4, which covers evaluations of environmental impacts expected in the future from each of the alternatives.

- To identify the Department of Energy's preferred alternatives and mitigating measures identified during the course of the study (Section 2.6).

2.1 BACKGROUND INFORMATION

2.1.1 Background Information on Existing Pantex Plant Facilities

The 3700 hectare (9100 acre) Pantex Plant is located in the Panhandle of Texas in Carson County about 27 kilometers (17 miles) northeast of downtown Amarillo, and 16 kilometers (10 miles) west of downtown Panhandle (See Figures 2.1.1-A and 2.1.1-B). It was first used in 1942 by the Army Ordnance Corps for loading conventional ammunition shells and bombs during World War II. In 1950 the Atomic Energy Commission started rehabilitating portions of the original plant and building new facilities for fabricating chemical high explosives used in nuclear weapons and for final assembly of nuclear weapons. During the 1960s and 1970s similar operations from facilities at Clarksville, Tennessee; Medina, Texas; and Burlington, Iowa; were consolidated at the Pantex Plant. During the entire history of the Pantex Plant, new construction has been undertaken periodically to provide additional facilities or to upgrade or replace outmoded structures.

The major operational areas and facilities include

- the High Explosives Fabrication and Weapon Assembly/Disassembly facilities where the operations described in Sections 1.4.1, 1.4.2, and 1.4.3 are carried out;

- the Temporary Holding facilities where high explosive supplies are kept and where weapons are temporarily held;

- the High Explosives Research and Development Area where the operations described in Section 1.4.4 are carried out;

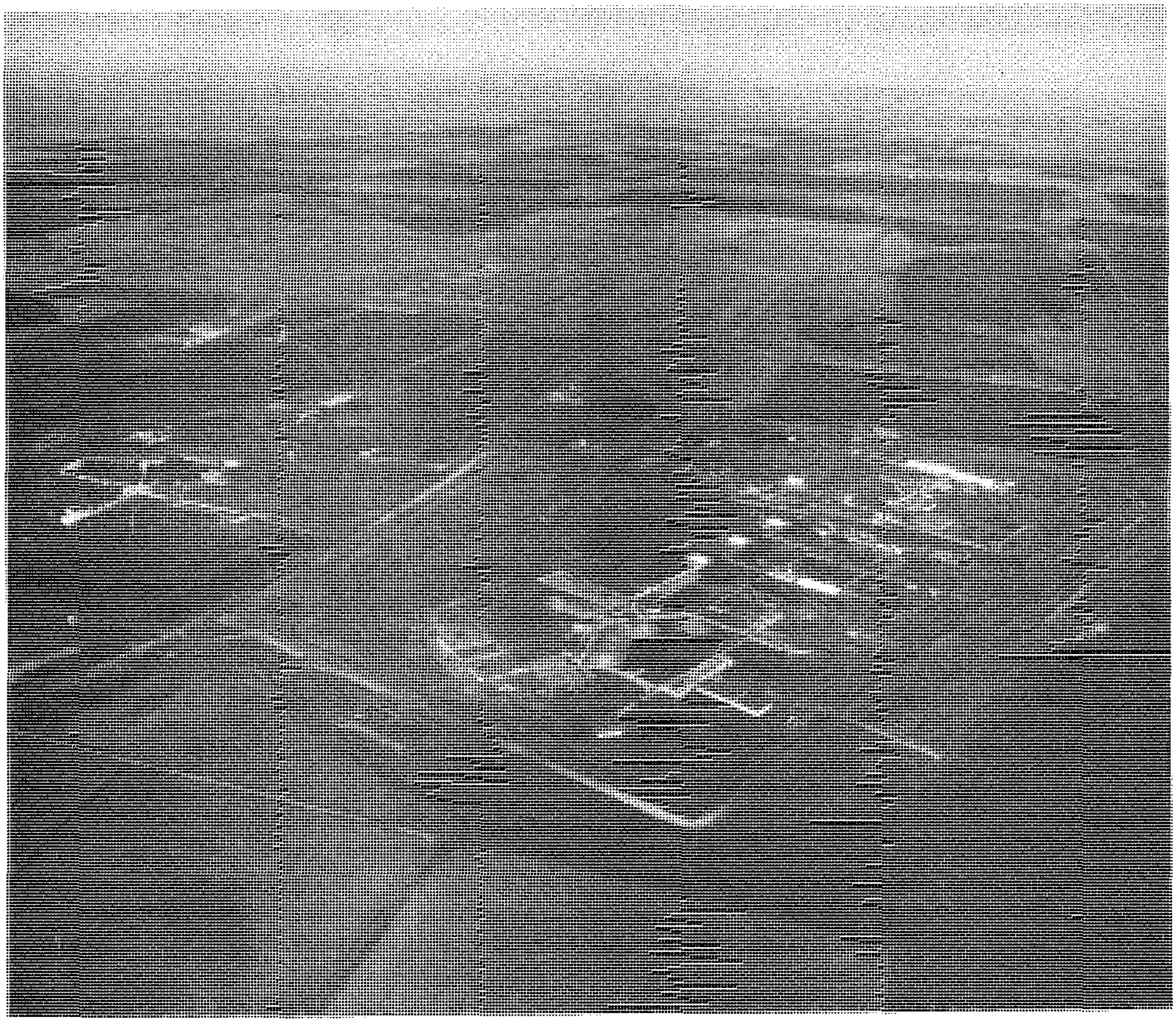


Figure 2.1.1-A. Pantex Plant, view to the northwest.

- the Firing Sites where quality assurance test detonations including those involving depleted uranium, and experimental detonations related to research described in Section 1.4.1 and 1.4.4 are carried out;
- the Burning Ground where high explosives wastes are disposed; and
- the Water Supply and Sewage Treatment facilities.

Figure 2.1.1-B. Regional setting of Pantex Plant. The circle is an 90 mile (130 kilometer) radius centered on the Pantex Plant site.

Special facilities at the Pantex Plant include Assembly Cells, Assembly Bays, and Igloos. Additional information on the existing facilities is in Section 3. Assembly cells are where the chemical high-explosive materials and nuclear materials are joined to form a physics package (Section 1.4.1). The existing assembly cells are specially designed structures called "Gravel Gerties." Assembly cells are designed to mitigate the consequences of an accidental detonation of the high explosive. The Gravel Gertie would limit the physical blast effects, such as overpressures or flying debris, that could injure workers or induce additional explosions in adjacent work areas. The gravel roof is intended to limit potential release of radioactivity by filtering out much of the nuclear material that could be dispersed by the detonation of the chemical high explosive.

Assembly bays are where the physics packages from the assembly cells are put together with the rest of the weapon (Section 1.4.1). The Assembly Bays include two structure types that differ significantly in their capability to mitigate the potential consequences of an accidental detonation. Bays of the first type are rooms in World War II munitions buildings adapted by constructing reinforced concrete separating walls. These bays are housed in buildings with exterior walls designed to blow out and relieve blast pressure without structural collapse of the building. The second type was constructed in the 1960s. These are reinforced concrete rooms separated by earth and have concrete slab roofs covered by earth. They are designed to withstand fully the effects of an accidental detonation in an adjacent work place.

Igloos include several types of earth-covered bunker structures where high-explosive supplies are kept and where weapons are held temporarily.

2.1.2 Background on Design Features Included in the Alternatives

Two of the biggest differences between the types of facilities incorporated in the definitions of the various alternatives are the degree of improved operational reliability they would provide and the degree to which they would reduce the likelihood of occurrence or mitigate the consequences of accidental detonations of high explosives. This section provides the basic descriptions of the features incorporated in existing structures or assumed to be incorporated in the proposed structures. The structural design differences are the principal reason for the differences in the amount and cost of construction associated with the various alternatives.

Three levels of operational reliability and mitigation of potential accidents are encompassed by the various alternatives.

- Existing Facilities--characterized by the capabilities of existing facilities at the Pantex Plant and the Iowa Army Ammunition Plant.

- Current Criteria--characterized by the expected capabilities of new facilities designed to meet the Department of Energy's current criteria applicable to new construction.

- Enhanced Goals--characterized by the expected capabilities of new facilities designed to meet enhanced goals for operational reliability and accident mitigation. The goals were identified as part of the Department of Energy's planning process and are being considered for future projects based on feasibility and benefits derived (Section 1.1). These goals are more stringent than those required by the current criteria and in most cases involve significantly higher costs for replacement facilities than current criteria.

The significance of each of these levels is discussed briefly below.

Existing Facilities

Many of the structures at the Pantex Plant and the Iowa Army Ammunition Plant were designed and built during World War II for conventional munitions operations. The criteria used at that time addressed the safety aspects of conventional high explosives. They provided features to prevent propagation of accidental explosions in other high explosive work areas and to limit injury from blast pressure or flying debris in nonexplosive operations areas, plant boundaries, or major personnel concentration areas. These structures were not built to protect workers within the structure or specifically to contain the release of radioactive materials in the event of an accident.

The facilities built during the 1950s and 1960s were built to increase operational reliability and provide additional accident mitigation. These facilities addressed additional factors applicable to nuclear weapons operations and were designed to limit the effects of an accident so that operations could continue without disruption in the rest of the plant. Examples include the Gravel Gertie Assembly Cells, with capability for limiting release of radioactive material dispersed by an accidental detonation, and the Earth-Covered Assembly Bays, with the capability for protecting workers in one bay against blast pressures from an accidental detonation in an adjacent bay.

Current Criteria

The Current Criteria contain specific operational reliability design requirements for structures housing certain classes of operations involving high explosives (USDOE 1981D). These requirements prevent disruption of operations given an accident and result in improved plant safety. These requirements are

(1) preventing propagation of accidental explosions,

(2) preventing fatalities or injuries to workers by limiting pressure pulses in regularly occupied work areas outside the room in which an accidental explosion occurs,

(3) preventing fatalities or injuries to workers by limiting structural collapse or flying debris in regularly occupied work areas outside the room in which an accidental explosion occurs,

(4) limiting the amount of radioactivity that could be released from an Assembly Cell in which an accidental explosion occurs, and

(5) providing special protection for Assembly Cells and Assembly Bays to prevent the initiation of an accidental detonation by a tornado or earthquake.

Most of the Current Criteria design requirements were refinements of designs used for the facilities built during the 1950s and 1960s. As a result, most of these existing facilities meet some aspects of the Current Criteria.

Enhanced Goals

Some design goals providing operational reliability features in addition to Current Criteria are now being evaluated by the Department of Energy for feasibility and benefits as part of the ongoing planning and evaluation process described in Section 1.1. These enhanced goals address the same five principal requirements described for the Current Criteria but would provide higher levels of operational reliability and accident mitigation (MHSM 1979C). The Enhanced Goals would protect people from pressure pulses, structural collapse, and flying debris in all areas outside the room of occurrence in addition to the regularly occupied work areas as required by the Current Criteria. The Enhanced Goals would require Assembly Bays, as well as Assembly Cells, to limit the release of radioactivity that could be dispersed by an accidental detonation. Finally, the Enhanced Goals would require more types of operations involving high explosives to be housed in structures providing the highest level of overall reliability and greatest protection from potential accidents.

2.2 DESCRIPTION OF ALTERNATIVES

Three basic alternatives are considered in this environmental impact statement. These alternatives include possible actions that would meet the requirements both for continued operations and for new facilities to accommodate established increased workload schedules. They provide a range of options for levels of improvement in reliability, safety, and environmental protection. These three alternatives encompass (1) continued operation and construction of new facilities at the present Pantex Plant, which currently is considered the preferred alternative, (2) resuming operations at the formerly used Iowa Army Ammunition Plant, and (3) relocating all operations to the Department of Energy's Hanford Site. A consideration treated as part of Alternatives 2 and 3 is terminating all Department of Energy nuclear weapons operations at the Pantex Plant.

The alternatives are identified by the associated site name as shown in the first column in Table 2.2-1, Summary of Alternatives. The table summarizes the major features of the alternatives, including various options within each alternative, the approximate period of construction, the total estimated construction costs, and the design goals for operational reliability and mitigation of impacts on the environment and workers if an accident were to occur. All estimated construction costs are given in constant 1981 dollars. This allows the economic implications and relative feasibilities of the alternatives to be compared directly. Actual expenditures in future years may be higher because of inflation. Additional detail on the definitions of the alternatives and cost estimating is provided in Schnurr 1982B.

The all-new plant options under the Iowa Army Ammunitions Plant and Hanford Site Alternatives are assumed to be designed to meet the Enhanced Goals for operational reliability. This was considered appropriate because the incremental difference in total cost between constructing an all-new plant (as opposed to major replacement of key facilities such as in Pantex Plant Option 3) based either on Current Criteria or Enhanced Goals is relatively small. Consequently, assuming the options based on Enhanced Goals would be the most reasonable basis for analysis. This cost consideration between the two levels of operational reliability does not necessarily hold for the Pantex Plant Option 3, because there are other existing facilities that would continue to be used.

2.2.1 Pantex Plant Alternative

The Pantex Plant Alternative includes four options. The first three options provide various levels of operational reliability. The fourth option assumes continuing operations in the existing facilities and that no new construction is begun after 1982. It is defined as the "No Action" alternative for the purpose of this environmental impact statement. The cost indicated for this option is associated with the construction projects that currently are underway.

TABLE 2.2-1

SUMMARY OF ALTERNATIVES

Action	Estimated Dates for Completion of Construction	Estimated Cost ($ Millions) (1981 values)	Operational Reliability Design Level*
PANTEX PLANT ALTERNATIVE			
Option 1: New construction of specifically identified facilities	1982-1987	198	Existing facilities and Current Criteria applied to new construction only
Option 2: Major upgrade of existing facilities including significant new construction	1991-1993	664	Current Criteria applied to upgrading and new construction
Option 3: Complete replacement of certain major plant facilities with new construction	1993-1996	1239	Enhanced Goals for new construction
Option 4: Existing facilities and facilities currently under construction ("No Action")	--	53	Existing facilities, Current Criteria applied only to facilities currently under construction
IOWA ARMY AMMUNITION PLANT ALTERNATIVE			
Option 1: Partial relocation of workload (includes portion of Pantex Option 1)	1985	216	Existing facilities, Current Criteria applied only to new construction
Option 2: All-new Plant (complete relocation of workload)	1993-1996	1488	Enhanced Goals for new construction
HANFORD SITE ALTERNATIVE			
All-new Plant (complete relocation of workload)	1993-1996	1552	Enhanced Goals for new construction

*See Section 2.1.2.

2.2.1.1 Option 1--New Construction

Option 1 assumes continuing operations in existing facilities and construction of 11 new projects. These projects are expected to be constructed in the period from 1982 through 1987 as shown in Table 2.2.1-1. These projects are intended to meet the Current Criteria. Existing structures will continue to be used and would not necessarily meet all the requirements of the Current Criteria for new construction. The total cost for the 11 projects is estimated at $196 million. Razing the old buildings would cost approximately $2 million, bringing the total cost for this option to $198 million.

TABLE 2.2.1-1

PANTEX ALTERNATIVE, OPTION 1: NEW CONSTRUCTION

No.	Facility	Cost ($M)	Approximate Construction Period
1	Production and Assembly Facilities, 2 assembly cells, 7 assembly bays, 1 linac bay, HE service magazine, 7 production magazines	23.0	09/81 - 07/83
2	Weapons Assembly Facilities, 1 assembly cell, 7 assembly bays, 1 linac bay	41.0	09/83 - 09/85
	Damaged Weapon Complex		Not determined
3	Weapons Assembly Facilities, 1 assembly cell, 4 assembly bays	24.5	09/83 - 09/85
4	Weapon Assembly Facilities, 1 assembly cell, 9 assembly bays	28.3	09/83 - 09/85
5	Remote Hole Drilling Facility and Aging Facility	5.6	12/82 - 03/34
6	High-Explosives Development Machining Facility	10.6	07/82 - 03/84
7	Universal Pilot Plant	12.6	09/82 - 03/84
8	Alternate Energy Source Project	46.6	05/84 - 12/87
9	Main Substation	3.3	08/83 - 04/85
10	Explosives Staging Facility	0.7	03/82 - 11/82
11	Interim Test Fire Facility	0.7	01/82 - 07/82

Projects 1 through 5 and Project 10 are nuclear weapons operations facilities. They include the construction of additional Assembly Cells and Assembly Bays and various related support facilities as listed.

The two Assembly Cells now under construction as part of Project 1 will be similar in design to the existing Gravel Gerties. These two assembly cells are intended to limit the potential release of radioactive materials to the degree required by the Current Criteria. Detailed quantitative information on the filtering capabilities of the gravel roof will be provided by tests including an actual field test to be conducted in the near future at the Nevada Test Site.

The additional new assembly cells in the other projects will be either a new-design, heavily laced (interwoven heavy steel reinforcing bars), reinforced concrete structure or a new-design Gravel Gertie structure. The choice will be based on further evaluation of performance, including the Gravel Gertie tests noted above. The new-design, heavily laced reinforced concrete cell concept would have blast doors and fast-acting blast valves to contain the physical effects of an accidental detonation preventing propagation and protecting workers in adjacent areas. The blast valves would provide the capability for nearly eliminating the potential release of radioactive material from an accidental detonation. The new-design Gravel Gertie structure concept would have the same type of blast doors but would depend on the energy absorbing and filtering capability of a suspended gravel roof to prevent propagation, to provide worker protection in adjacent areas, and to limit the release of radioactive material from an accidental detonation.

The Assembly Bays now under construction as part of Project 1 have heavily laced, reinforced concrete walls. The remainder of the new Assembly Bays will be essentially the same as the existing earth-separated Assembly Bays. Both types of new Assembly Bays will have concrete slab, earth-covered roofs similar to those on the existing earth-covered Assembly Bays. This design meets current criteria.

The proposed Damaged Weapon Complex would be a larger new-design Assembly Cell to house operations for the handling of damaged nuclear weapons.

Projects 6 and 7 are facilities to be built in the High Explosives Research and Development area. These facilities will include remote-controlled high-explosive machining bays to provide greater operational reliability and will be used for synthesis of high explosives and development of new high-explosive manufacturing processes.

Project 8 is a small cogeneration plant producing electrical power (up to 2.9 megawatts) and hot water by burning low sulfur coal. Coal storage and handling facilities would include a new rail line, a railroad coal car unloading facility, a coal pile, conveyors, a dry-ash handling facility, and an ash-settling area. This new plant would be designed to meet the applicable Environmental Protection Agency and Texas Air Control Board standards. Baghouse filters would clean flue gas before discharge. The Department of Energy also is considering an Alternate Energy Source Plant that would use a fuel other than coal. A natural gas-fired or oil-fired plant is expected to be less costly to construct and easier to operate. These options are currently under consideration, but of the options under consideration, the coal-fired plant would have the most relative impact.

Project 9 is a new power substation including switchgear, a transformer, a capacitor bank, utility metering, distribution equipment, and onsite power lines for connection to local utility and existing Plant distribution systems.

Project 11 is a new high-explosive test-fire facility. It would contain emissions generated by a new type of test shot involving beryllium in addition to depleted uranium. (Beryllium has not been involved in previous test shots.) The proposed facility will comply with Texas State Air Quality Standards. The facility is being designed to contain only the new test shots with beryllium and relatively small amounts of high explosives. The test shots involving only depleted uranium will continue to be performed in the open as has been done in the past.

2.2.1.2 Option 2--Major Upgrade

The Pantex Plant Alternative Option 2 would involve a major upgrading of the nuclear weapon operations area and the high explosives development area. This option assumes the prior completion of Option 1 (new construction) described above and proposes additional new facilities and refurbishment of existing facilities. Many of the existing facilities would be replaced or modified to accommodate less hazardous operations. Once replaced, the older facilities could be decommissioned and removed. The additional new construction could be started between 1986 and 1988. Construction would take about 5 years and could be completed between 1991 and 1993. Upon completion, the entire plant would meet the Current Criteria applicable to new construction for protective design features (Section 2.1.2). The estimated costs for the additional construction are about $466 million, bringing the total estimated cost, including prior completion of Option 1, to about $664 million.

The existing high-explosive fabrication area now housed in World War II structures would be totally replaced by a new fabrication complex. This new complex would have bays for high accident potential high explosive operations similar in design to the monolithic reinforced concrete new-design cells. The new bays for moderate accident potential high-explosives operations would be earth covered and roof vented.

The weapons assembly/disassembly area would use the existing Gravel Gertie assembly cells and the existing earth-covered assembly bays for lower-hazard operations or with lower limits on allowable quantities of high explosives. The new assembly cells would be one of the two new-design concepts. The new assembly bays would be similar to the existing earth-covered bays. Operational efficiency would improve compared with the current facilities because material handling distances would decrease by approximately 80% in most new facilities. With some modification and expansion, most of the support facilities would continue to be used.

Most of the existing facilities in the High Explosives Development Area would be replaced by new facilities. New facilities would include a high-explosives formulation facility, a high-explosive pressing facility, a special projects facility, a material analysis laboratory, and a high-explosives analysis facility.

2.2.1.3 Option 3--Major Replacement

This option assumes the completion of substantial portions of Option 1 (new construction) to meet established workload schedules on an interim basis.

Option 3 is a complete replacement of portions of the Pantex Plant: the high-explosive fabrication area, the nuclear weapon assembly/disassembly area, and the high-explosives development area.

In all cases, the new facilities would meet the Enhanced Goals for operational reliability design features. Operational efficiency would improve the most compared with existing facilities because material handling distances would decrease by 80%. In addition, these new facilities would provide the highest degree of accident mitigation.

The new construction could be started between 1986 and 1988. Construction would take 7 to 8 years and could be completed between 1993 and 1996. As part of Option 3, the existing facilities would be decommissioned and removed. Estimated costs for the additional construction are $1139 million, bringing the total estimated costs, including prior completion of some projects in Option 1, to $1239 million.

The high-explosives fabrication portion of the all-new facility would be similar to the new structures proposed under Option 2. All of the bays would be similar in design to the monolithic reinforced concrete new-design cells.

The weapons assembly/disassembly area of the all-new facility would employ some of the same types of structures proposed under Option 2. The new assembly cells would be one of the two new-design concepts. Assembly bays in the all-new facility also would be similar in construction to the monolithic reinforced concrete new-design assembly cells.

The high-explosives development area would be replaced completely by a modular structure based on the same type of bay design described above for the high-explosives fabrication area. All facilities would meet the Enhanced Goals for protective design features.

Option 3 assumes the continued use of existing facilities in other parts of the Plant. These include the temporary holding area, the test fire and burning grounds, the water supply system and sewage treatment plant, and some warehouses. The Alternate Energy Source Project from Option 1 also would be used.

2.2.1.4 Option 4--Existing Facilities Only

This option assumes continuation of current operations at the Pantex Plant in the existing facilities (mid-1981) and those new facilities already under construction by the end of 1982 (Table 2.2.1-1). For analyzing socioeconomic impacts, the work force is assumed to remain at the current size.

Option 4 represents the "No Action" alternative. The Pantex Plant has been in operation for 30 years; continued operations in the existing facilities represent the least change from current conditions, that is, maintenance of the status quo. The facilities and operations are those described in the introductory part of Chapter 1. Option 4 provides no improvements in operational reliability design features for the existing facilities. The existing facilities do not offer the full level of protection that would be required of new facilities constructed to meet the Current Criteria (Section 2.1.2).

2.2.2 Iowa Army Ammunition Plant Alternative

The 7800 hectare (19,300 acre) Iowa Army Ammunition Plant, approximately 16 kilometers (10 miles) west of downtown Burlington (Fig. 2.2.2-A), Iowa, is now operated for the U.S. Army to produce conventional munitions for the military. A portion of this plant was used from 1947 through 1975 by predecessors of the Department of Energy for production of nuclear weapons before consolidating the nuclear weapons operations at the Pantex Plant. Thus, some of the special function facilities--assembly cells and assembly bays--similar to those existing at the Pantex Plant could be considered for reuse. Also, there are many related support facilities that could be considered for joint use in support of continuing Army operations and relocated Department of Energy nuclear weapons operations.

The Iowa Army Ammunition Plant Alternative includes two options. Both options assume common use of as many support facilities as would be practicable under a joint management agreement between the U.S. Army and the Department of Energy. The facilities that would fall under this category include existing temporary holding bunkers, high-explosives waste disposal incinerators, and existing basic utilities systems. The first option also assumes reuse of the special purpose facilities. The second option assumes construction of an all-new facility. Both options meet the requirement for continued nuclear weapons operations and the established increased workload schedule.

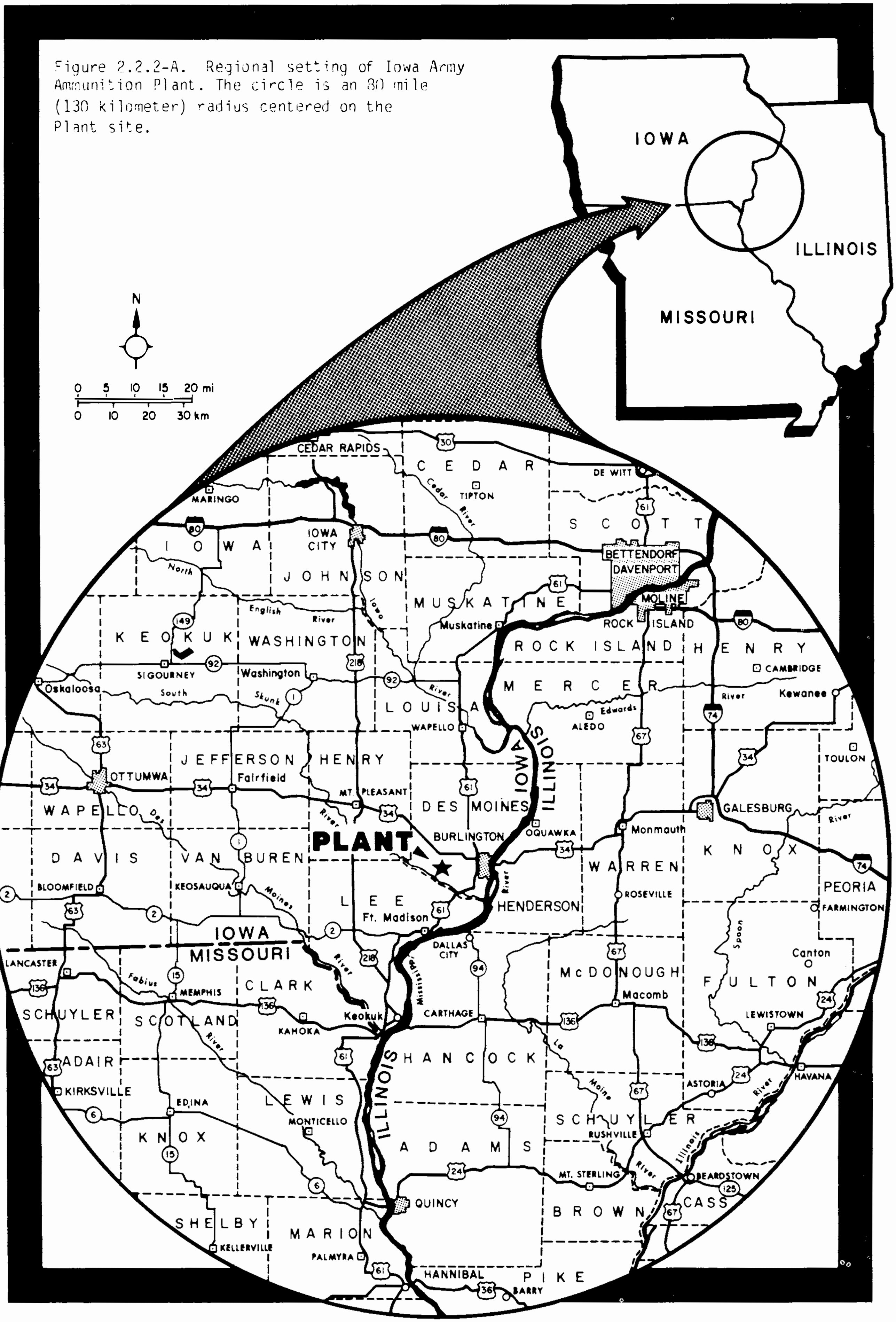


Figure 2.2.2-A. Regional setting of Iowa Army Ammunition Plant. The circle is an 80 mile (130 kilometer) radius centered on the Plant site.

2.2.2.1 Option 1--Partial Relocation of Workload

Option 1 is a partial relocation of nuclear weapons operations from the Pantex Plant to the Iowa Army Ammunition Plant. In addition to the joint use of support facilities, this option assumes the reuse of the portion of the Iowa Army Ammunition Plant formerly used for nuclear weapons operations. This would include both direct reuse of existing facilities with varying degrees of refurbishment and some new construction. Thus, the operational reliability and accident mitigation capabilities of the structures would be a mixture of Existing Facilities and Current Criteria (Section 2.1.2). This option assumes that approximately 25% of the workload projected for 1985 and beyond would be handled at the Iowa Army Ammunition Plant and 75% would be handled at the Pantex Plant.

The special-purpose and other previously used facilities are being used currently for a variety of U.S. Army operations including munitions production, research, warehousing, and reserve facilities for mobilization. Several of the existing Gravel Gertie structures, identical to those at the Pantex Plant, would be refurbished with improved blast doors and used as assembly cells; the other Gravel Gerties would be used as assembly bays. Some of the existing earth-covered assembly bays would be reused and additional assembly bays would be constructed.

High explosives fabrication would be accomplished in facilities previously used for such operations. The best remaining structures would be selected from the existing below-ground and above-ground bays to provide an adequate number of bays for high-explosives fabrication. Other structures that would be reused include inert assembly and storage areas, laboratory areas, radiography facilities, machine shop and repair facilities, a steam generation plant, a changehouse and cafeteria, and several administrative and technical buildings.

The Pantex Plant would continue to operate in its existing facilities and the new facilities already under construction in 1982 (Table 2.2.1-1). These structures are assumed to be completed and used at the Pantex Plant.

The final major feature of the Iowa Army Ammunition Plant Option 1 is the need to provide alternative replacement facilities for the displaced U.S. Army operations. In particular, the Army has identified specific loading capabilities and press loading capacities important to their production requirements (USDOE 1981B). The review of facilities undertaken for this environmental impact statement also identified research and development functions and significant space being maintained in readiness for mobilization. These would have to be replaced. A preliminary evaluation indicates that the Army replacement facilities would cost about $100 million.

The estimated costs for refurbishment and new construction to resume nuclear weapons operations are about $63 million. The costs for the new construction assumed to be completed at the Pantex Plant under this option are about $53 million. Therefore, the estimated total costs for implementation of all of this option would be about $216 million. Most of the required construction probably could be accomplished by 1985.

2.2.2.2 Option 2--All-New Plant

This option assumes the complete relocation of all Department of Energy nuclear weapons operations from the Pantex Plant to an all-new plant located within the Iowa Army Ammunition Plant. The all-new plant is assumed to be the same conceptual design as proposed for the major replacement option at the Pantex Plant (Pantex Plant Alternative, Option 3). The entire facility would meet the Enhanced Goals for operational reliability and accident mitigation. This option would not require moving the Army operations from the formerly used nuclear weapons facilities. Test fire areas, high-explosive disposal facilities, explosive holding areas, and other support functions would be shared with the Army.

The all-new plant would be located in a currently undeveloped portion of the Iowa Army Ammunition Plant. To provide space and process heating, a coal-fired cogeneration plant (the same as identified as Project 8 in Pantex Plant alternative, Option 1) would be built close to the all-new plant. A new sanitary sewage treatment facility would also be required. Depending on when a decision could be made to implement this option, some portions of the Pantex Plant Alternative, Option 1, would already be under construction. These facilities would be used for continuing operations over the next several years. Thus, some construction impacts and additional costs would be incurred at the Pantex Plant before all operations could be transferred to the Iowa Army Ammunition Plant. The termination of operations at the Pantex Plant is discussed in Section 2.2.4. This option could probably be completed within the same period estimated for implementing the major replacement option at the Pantex Plant (Pantex Plant Alternative, Option 3).

The estimated cost for the construction and refurbishment of facilities at the Iowa Army Ammunition Plant is $1318 million. Additional estimated costs include $32 million for temporary holding facilities, $7 million for security, $16 million for additional roads, $42 million for electrical and water distribution systems and a sanitary sewage treatment plant, and $20 million for decontamination and decommissioning of the Pantex Plant. The costs for new construction assumed to be completed at the Pantex Plant are $53 million. The total estimated cost of this option is $1488 million.

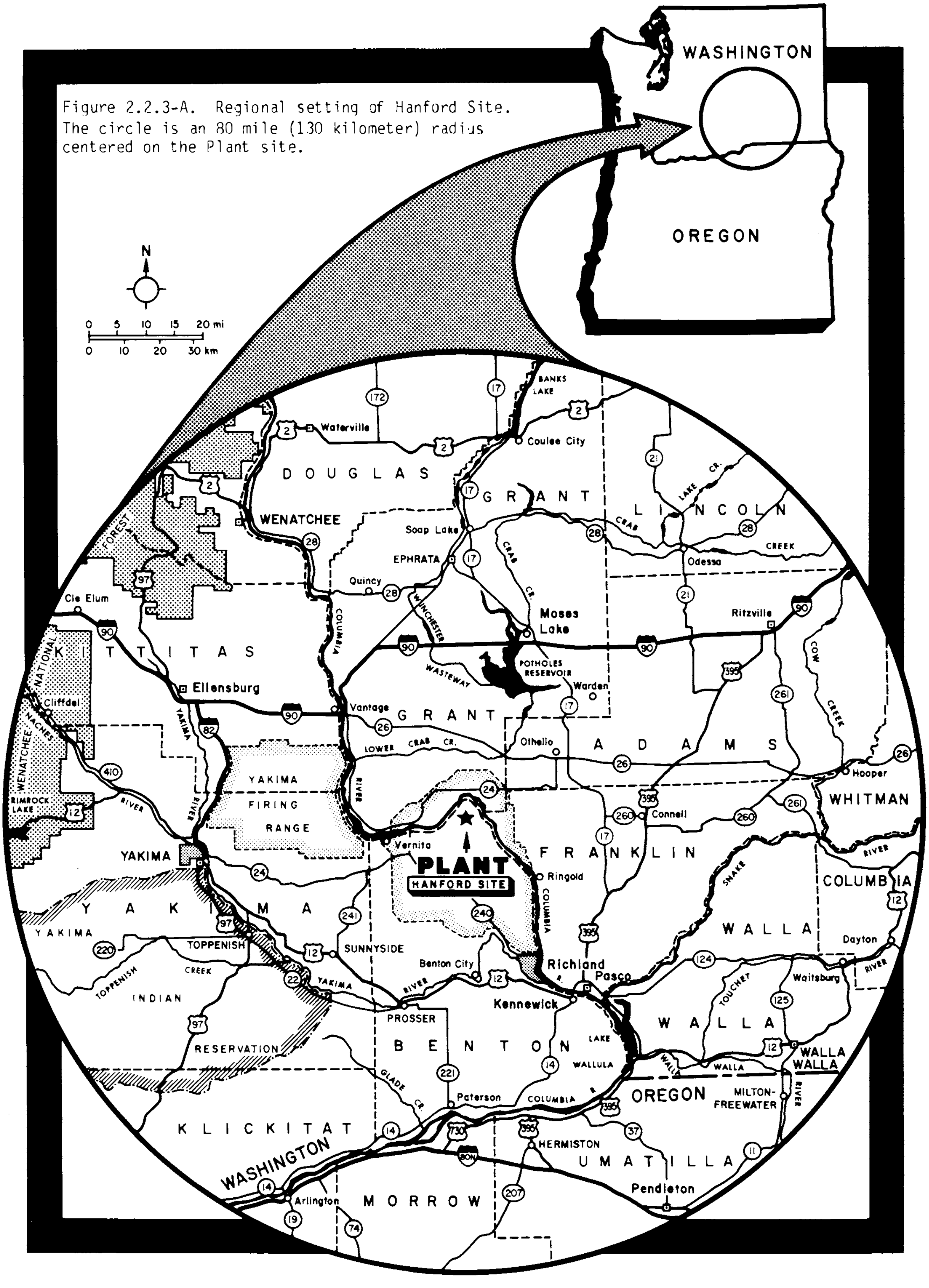
2.2.3 Hanford Site Alternative

The Hanford Site alternative assumes building an all-new plant within the 147,800 hectare (360,100 acre) Department of Energy Hanford Site near Richland, Washington (Fig. 2.2.3-A). The Hanford Site was selected as a new location for an all-new plant by a detailed suitability evaluation of potential sites (LATA 1981).

The new construction would be essentially identical to that proposed in Pantex Plant Alternative, Option 3 (Major Replacement, Section 2.1.1.3). This option would result in meeting the Enhanced Goals for operational reliability and protective design features. Related support facilities also would have to be constructed at the Hanford Site, as no such facilities now exist there. These include temporary holding areas, test firing sites, and waste high explosives disposal facilities. A coal-fired, cogeneration plant (the same as identified as Project 8 in the Pantex Plant Alternative, Option 1) would be built close to the all-new plant for electricity and space and process heating. A sanitary sewage treatment facility also would be built.

Some portions of the Pantex Plant Alternative, Option 1 (New Construction), would be under construction already. These structures would be needed for continuing operations over the next several years. Thus, some construction impacts and additional costs would be incurred at the Pantex Plant before all operations could be transferred to the Hanford Site. The termination of operations at the Pantex Plant is discussed in Section 2.2.4. This option probably could be completed within the same 10- to 13-year period estimated for implementing the major replacement option at the Pantex Plant (Pantex Plant Alternative, Option 3).

Figure 2.2.3-A. Regional setting of Hanford Site. The circle is an 80 mile (130 kilometer) radius centered on the Plant site.



The estimated costs of the Hanford Site alternative include $1379 million for nuclear weapons operation facilities, $33 million for temporary holding facilities, $7 million for security, $16 million for additional roads, $44 million for electrical and water distribution systems and a sanitary sewage treatment plant, and $20 million for the decontamination and decommissioning of the Pantex Plant. The costs for new construction assumed to be completed at the Pantex Plant under this option are $53 million. The total cost of this alternative is $1552 million.

2.2.4 Termination of all Department of Energy Nuclear Weapons Operations at the Pantex Plant for Comparison Purposes

Termination of operations at Pantex Plant is addressed to provide a basis for evaluating the environmental consequences of the Iowa Army Ammunition Plant Option 2 and the Hanford Site Alternative that includes closing the Pantex Plant. An immediate shutdown of the Pantex Plant would involve removal of all equipment, shutting down power systems, locking doors, and leaving and is estimated to cost $13 million. This would keep the facility potentially usable for other government operations, subsequent remobilization to perform nuclear weapon maintenance and retirement operations, or the possible sale or lease to private industry. A more extensive shutdown would involve cleanup of all high explosives residues and demolition of all structures. Limited cleanup and restoration of some portions of the site (such as depleted uranium in the test firing areas and the high-explosives disposal areas) would be needed. This action is estimated to cost at least $20 million. Once such a cleanup and demolition were accomplished, the site could be used safely for almost any purpose, from farming and ranching to some entirely different industrial operation. The cost of construction that is already underway at the Pantex Plant is $53 million. The estimated total cost of termination is $73 million.

2.3 ENVIRONMENTAL EFFECTS OF NORMAL OPERATIONS IN PLANT FACILITIES AND NEW CONSTRUCTION

This section summarizes environmental impacts from normal operations and construction associated with each of the alternatives. The evaluations are presented in comparative form to emphasize contrasts or similarities between the alternatives.

Major environmental topical areas are treated in separate subsections with comparative information on all alternatives contained within that topic. This same pattern is used in Chapters 3 and 4 to aid in cross-referencing for additional detail. The major topical areas include the following.

Air
Water
Terrestrial Resources
Ecology
Land Use and Agriculture
Environmental Radiation and Radioactivity
Energy Resources
Employment and Population
Economics
Community Resources
Cultural Resources and Native Americans
Health and Safety

Most of the information in this impact statement pertaining to current conditions is based on data for calendar year 1981. This was done to provide a common basis for comparisons. In the case of economic conditions particularly, some changes have occurred in 1982 that undoubtedly have affected quantitative values for such things as unemployment and sales. However, for economics as well as other areas of the natural or social environment, there is no reason to believe that use of 1982 calendar year data would change any fundamental conclusions.

2.3.1 Air

Air quality at all three sites is generally good. Ambient air concentrations of pollutants from nuclear weapons operations are quite small (typically less than 1%) compared with Federal or state standards (Section 3.2.1.1). This increment would not cause a violation of ambient air standards for any location considered under the various alternatives.

2.3.2 Water

Water Supply

An adequate water supply for nuclear weapons operations exists at all three locations. Normal plant activities will not significantly affect the availability of either surface or groundwater at or adjacent to the sites. The expected annual use of about 1.5 billion liters (400 million gallons) is about the same at all three sites.

Water pumpage for the Pantex Plant is about 1% of the total for Carson County. The use at the Pantex Plant is about the same as is used to irrigate 490 hectares (1200 acres) of crop land under typical limited irrigation practices in the area. An area equal to the entire Pantex Plant site uses about 8 times more water for agricultural irrigation than is used for the plant operations (Sections 4.1.2.1 and 4.1.2.4).

Water usage at the Iowa Army Ammunition Plant would essentially double. Water availability from the city of Burlington presents no problem. The shallow water table will require fitting buildings with waterproof foundations and drainage tile systems (Sections 3.2.2.2 and 4.1.2.2).

The additional water usage at the Hanford Site would represent less than 1% of current use; moreover, an abundant supply is available from the Columbia River.

Liquid Wastes

The Pantex Plant liquid effluents have no significant impacts on water quality and conform to Texas discharge requirements. The effluents would be similar in quantity and quality for each alternative. These effluents do not create a toxic chemical problem for the Pantex Plant, and no problem is expected at either alternative site.

Liquid effluents are discharged and contained onsite at the Pantex Plant. Most evaporate; some accumulate in an onsite playa and have been used for irrigation. Plant operations have produced no significant effects on the quality of surface or groundwater. The quality of water produced by onsite supply wells in the Ogallala aquifer shows no evidence of any change in chemical quality since 1942, when the first well was drilled.

Treated liquid waste effluents would be discharged into surface water at the Iowa Army Ammunition Plant (Section 4.1.2.2). These would require an Environmental Protection Agency National Pollutant Discharge Elimination System permit for discharge to surface water (Section 3.2.2.2). At the Hanford Site, infiltration ponds would be constructed for disposal of the treated effluents (Section 4.1.2.3).

2.3.3 Terrestrial Resources

Natural resources will not be affected by normal plant operations at any alternative site. If there were contamination of surface or groundwater, soil, or sediment by radioactive, or chemical constituents, contamination could be retained onsite and would not become a hazard to the offsite environment.

The largest volume of solid waste generated at the Pantex Plant is uncontaminated ordinary trash, cafeteria waste, and construction debris. These are adequately handled by a sanitary landfill operation. Similar operations could be established at either alternate site for this kind of waste without creating significant environmental impacts. The options involving major construction and demolition of old buildings would contribute larger volumes of construction debris for limited periods of time.

Only one unique terrestrial resource is found at any of the three sites. The last free-flowing reach of the Columbia River passes through the Hanford Site (Section 3.2.4.3). In addition, the Hanford Site has shallow groundwater aquifers that currently receive recharge from surface ponds and show some contamination from radioactive wastes (Section 3.2.3.3)..

No geologic hazards (such as major faults, land subsidence, or high seismic potential) are found at either the Pantex Plant or Iowa Army Ammunition Plant. However, three surface faults have been recently found on the Hanford Site considered capable of triggering earthquakes (Section 3.2.3.3). None of the three sites are known to have mineral deposits that could be profitably mined. None of the sites currently have erosion or drainage problems that might be aggravated by plant activities (Sections 3.2.3.1, 3.2.3.2, 3.2.3.3).

2.3.4 Ecology

All three sites are equally acceptable from a purely ecological standpoint. Though species diversity varies greatly among sites and three distinctly separate ecosystems are involved, none of the sites contain unique habitats required for known threatened or endangered species. In addition, none of the proposed sites adversely restricts known or established migratory corridors used by wildlife.

An active ecological management program exists at the Iowa Army Ammunition Plant; however, a detailed threatened and/or endangered species evaluation has not been performed. To insure that no problems exist, such a study of the proposed construction site would be necessary before construction. Further studies are not needed at the other two sites (Section 3.2.4).

Despite temporary construction-related disruption, releases to the environs will not constitute a health hazard nor will the releases adversely affect the established natural food chains at any of the three alternate sites. Small portions of the ecosystems would be destroyed by construction; however, none of the undisturbed portions of the ecosystems would show significant adverse impacts from the destruction of the anticipated 20 hectares (50 acres) of habitat.

2.3.5 Land Use/Agriculture

Land Use

None of the Alternatives or their Options should result in any significant changes in land uses surrounding the Federal Government-owned sites. No new land would have to be acquired to implement any of the construction alternatives. Normal plant operations will not result in negative land-use impacts.

Agriculture

Normal plant operations should not affect agricultural practices surrounding any of the three sites. A special study was done to evaluate the impacts of potential contaminants on agricultural products grown on or near the Pantex Plant (Wenzel 1982A, Buhl 1982). This study has shown that normal operations at the Pantex Plant do not result in radioactivity measurable above background levels in any of the agricultural products (Section 3.2.5.1).

The Hanford Site is the area least valuable from an agricultural standpoint. All crops in the region surrounding the Hanford Site require supplemental irrigation to grow well. The carrying capacity of natural range for supporting grazing livestock is quite low (Section 3.2.5.3).

The area around the Pantex Plant is intermediate in agricultural value. Rainfall is variable and crops frequently require supplemental irrigation. Ranching in the region is characterized by cow-calf operations. Natural ranges have an intermediate carrying capacity for grazing (Section 3.2.5.1).

Of the three alternate sites, the Iowa Army Ammunition Plant is located on the most productive agricultural land. The growing season and rainfall patterns permit growing nearly any row crop. No supplemental irrigation is required for crops. Livestock operations are run typically as small feedlots; the carrying capacities of ranges for grazing are very high (Section 3.2.5.2).

Prime and Unique Farmland, as defined by the U.S. Soil Conservation Service, exists at both the Pantex Plant and Iowa Army Ammunition Plant. This classification at the Pantex Plant is applicable only when the land is irrigated (Section 3.2.5.1).

2.3.6 Environmental Radiation and Radioactivity

Radiological Effects

All three basic alternatives are equally acceptable from a radiological standpoint in that the effects of normal operations are negligible. The average added lifetime risk of cancer to an individual would be less than 1 chance in a billion per year of exposure for each of the three sites. The average added risk of genetic disorder in all subsequent generations is less than 1 disorder per billion offspring for each site per year of exposure. For comparison, these risks are all less than 0.001% of those from natural background radiation.

The highest added lifetime risk of cancer for the maximum exposed individual for any option considered here is 1 chance in 31 million per year of exposure. Estimates of the corresponding genetic risk for the maximum exposed individual ranged from 1 disorder in 500 million offspring to 1 disorder in 31 million offspring per year of exposure.

Radiological Doses

The incremental radiation dose from normal plant operations is extremely small compared with natural background radiation. Table 2.3.6-1 presents the background doses and operational doses for the maximum exposed individual at each site.

TABLE 2.3.6-1

RADIOLOGICAL DOSES FROM BACKGROUND AND NORMAL OPERATIONS
Dose in millirems per year of exposure*

	Pantex Plant			Iowa Army Ammunition Plant			Hanford Site		
	Whole Body	Lung	Bone	Whole Body	Lung	Bone	Whole Body	Lung	Bone
Background	106	306	291	85	285	270	82	282	267
Current operations**	<0.01***	<0.01	0.08	<0.01	<0.01	<0.01	0.4	0.02	1.3
Future operations** including maximum impact from any option	0.23	0.68	3.1	0.19	0.56	2.5	0.03	0.08	0.35

*The Department of Energy Radiation Protection Standard for individuals in the general public is 500 millirem a year whole body and 1500 millirem a year lungs and bone.

**Doses are 50-year dose commitments per year of exposure.

***< means "less than."

Radiological Releases

The doses in the previous section are based on all the releases discussed in the next three paragraphs. No releases of plutonium would occur under normal operations regardless of location.

Depleted Uranium. Routine releases of depleted uranium result from explosive test shots and to a much lesser extent, from operations at the burning ground. The number of tests has declined significantly in recent years. Test shots are expected to result in future releases of depleted uranium of less than 10 kilograms (22 pounds) a year. A special air sampling program conducted for this environmental impact statement showed current ambient air concentrations of depleted uranium at and beyond the boundary of the Pantex Plant to be less than 0.01% of the Department of Energy Concentration Guides. Similar releases of uranium would be expected under any of the alternatives.

Tritium. Tritium emissions from nuclear weapons operations would be negligible under any of the alternatives. Evaluation of current operations at the Pantex Plant have shown annual airborne emissions to be less than 0.1 Curie.

Coal-Fired Power Plant. Naturally occurring radioisotopes of uranium and thorium and their decay products would be released by the proposed coal-fired power plant under any of the alternatives. These radioisotopes are found in trace amounts in all coal.

Radiological Wastes

The Pantex Plant generates about 6 to 7 cubic meters (200 to 250 cubic feet) of solid waste with low levels of radioactive contamination annually from nuclear weapons operations. This waste is currently shipped to the Nevada Test Site for disposal. Future wastes from operations at either the Pantex Plant or the Iowa Army Ammunition Plant would be sent to the Nevada Test Site. For the Hanford Site Alternative, the wastes could either be disposed of onsite or shipped to the Nevada Test Site for disposal.

2.3.7 Energy Resources

Energy resources exist at all three sites at levels adequate to support nuclear weapons operations (Section 3.2.7). Expansion of operations may require installing new energy distribution systems; however, regional resources appear to be adequate to handle any anticipated needs. The total energy requirements for a nuclear weapons plant are relatively modest compared with most manufacturing plants having comparable total floor space.

Electricity from the proposed coal-fired cogeneration plant would not supply all the power needed. However, the additional electrical energy needs could be purchased from local utilities, and this purchase would not require the construction of new offsite power lines.

Major components of the energy budget for a nuclear weapons facility include heating and cooling of buildings, lighting, and process energy. Process energy (about 10% of the total used) and lighting requirements are largely independent of location. Major differences in energy consumption for the various alternatives depend on requirements for heating and cooling buildings. Thus, with energy-efficient new buildings, energy requirements will go down for almost all options.

Several alternatives require the continued use of old buildings. For those alternatives, it was assumed that an automated energy management system would be installed and ceiling insulation would be added where appropriate. The only exception was the "No Action" alternative at the Pantex Plant, which does not include these energy-saving measures.

The results of the energy use analyses are presented in Table 2.3.7-1. The savings resulting from the energy conservation measures and/or new buildings designed to meet current energy conservation standards can be approximated by comparing each alternative with the "No Action" alternative. The energy savings would range from a low of 3 million kilowatt-hours annually for partial relocation at the Iowa Army Ammunition Plant to a high of 56 million kilowatt-hours annually for a totally new plant at the Pantex Plant.

The effect of weather on energy use can be seen by comparing the energy use of a totally new facility at each alternate site. The last column of Table 2.3.7-1 shows that the energy use would be 7 million kilowatt-hours higher annually at the Hanford Site and 28 million kilowatt-hours higher annually at the Iowa Army Ammunition Plant for a totally new facility than at the Pantex Plant.

TABLE 2.3.7-1

COMPARISON OF TOTAL ANNUAL ENERGY CONSUMPTION* FOR ALL ALTERNATIVES AND OPTIONS
(expressed in millions of kilowatt-hours)

	Total	Difference From No Action	Difference From Replacement Plant at the Pantex Plant
Pantex Plant			
New construction	112	-41	15
Upgrade Plant	127	-26	30
Replace Plant	97	-56	0
No action	153	0	56
Iowa Army Ammunition Plant			
Partial relocation	145	-8	48
Total relocation	125	-28	28
Hanford Site			
Total relocation	104	-49	7

*This total includes natural gas and electricity and is based on heating and cooling requirements for all facilities plus process energy consumption.

2.3.8 Employment and Population

The construction of new facilities or refurbishment of existing facilities to meet any of the alternatives would result in positive impacts on local employment without excessive increases in local populations. All three siting locations have access to large unskilled labor pools, and skilled crafts are available in all locations currently associated with local construction projects. Analyses indicate that any of the locations would benefit from the necessary construction activities (Section 4.1.8).

Employment levels and population effects expected to be associated with the various basic Alternatives and their Options are summarized in Table 2.3.8-1.

2.3.9 Economics

The economy at any of the three alternate sites would experience increased material purchases and payrolls associated with construction activities. Permanent jobs associated with normal operations would contribute to local economies at either the Hanford Site or Iowa Army Ammunition Plant areas. Relocation to either of those two sites would eliminate $106 million per year in direct and indirect payrolls from the local economy in the Pantex Plant area.

The Pantex Plant alternative would have the least overall economic impact. The options associated with this alternative would avoid disruption of the current permanent work force. They would avoid loss of a significant cash flow into the local economy. In addition, once the peak of construction-related cash flow passed, relatively few new permanent employees would be required (about 200) and the economy would quickly stabilize.

TABLE 2.3.8-1

SUMMARY OF EMPLOYMENT AND POPULATION IMPACTS

	Normal Operations		Construction Period		
	Operational Work Force	Induced Population Growth (per cent)	Peak Construction Work Force Basic and Nonbasic: Onsite	Peak Construction Work Force Basic and Nonbasic: Induced	Related Population Increment (per cent)
PANTEX PLANT ALTERNATIVE					
Option 1: New construction	2600	negligible	459	312	0
Option 2: Major upgrade	2600	negligible	1000	680	0
Option 3: Major replacement	2600	negligible	1600*	1088	2.1
Option 4: Existing facilities only	2400	0	217	148	0
IOWA ARMY AMMUNITION PLANT ALTERNATIVE					
Option 1: Partial relocation of workload includes portion of Pantex Option 1	1000 (Iowa) 2500 (Texas)	negligible negligible	100 217	68 148	0 0
Option 2: All-new Plant	2600	negligible**	1800	1224	4.3
HANFORD SITE ALTERNATIVE					
All-new Plant	2600	negligible**	1800	1224	3.9
TERMINATION					
Close Pantex; occurs with Iowa Army Ammunition Plant Option 2 and Hanford Alternative	-2400	-4.7%	0	0	0

*The peak construction work force for the Pantex Plant Option 3 is 200 workers less than that required for the all-new Plants at either the Iowa Army Ammunition Plant or the Hanford Site because of support facility construction not required at the Pantex Plant.

**These are considered negligible because virtually all of the operational work force could be recruited locally.

Direct economic impacts projected to be associated with the various basic Alternatives and their Options are summarized in Table 2.3.9-1. For a complete discussion of economics, see Sections 3.2.9 and 4.1.9.

2.3.10 Community Resources

Community resources at all locations could accommodate the transient work force associated with new construction without major changes in basic services (Section 4.1.10). The area surrounding the Hanford Site may be the least impacted.

The Pantex Plant and Iowa Army Ammunition Plant alternatives would result in minor perturbations to local community resources by inducing a small population increase resulting from the construction activities. Current community resources surrounding both the Iowa Army Ammunition Plant and the Pantex Plant are capable of handling anticipated population increases.

TABLE 2.3.9-1

SUMMARY OF ANNUAL DIRECT ECONOMIC CHANGE FROM CURRENT 1981 OPERATIONS

	Normal Operations		Construction Period		% Contributed to Retail Sales 1980	
Action	Payroll ($ millions)	Other Operating Expenditures ($ millions)	Peak Construction Payroll ($ millions)	Total Construction Expenditures ($ millions)	Operating Work Force	Construction Work Force
PANTEX ALTERNATIVE						
Option 1: New construction	+8.68	+0.02	18.36	198	0.3	0.54
Option 2: Major upgrade	+8.68	+0.02	39.93	664	0.3	1.2
Option 3: Major replacement	+8.68	+0.02	63.89	1239	0.3	1.9
Option 4: Existing facilties only	0	0	8.67	53	0	0.3
IOWA ARMY AMMUNITION PLANT ALTERNATIVE						
Option 1: Partial relocation, includes portion of Pantex Option 1	+37.1	1.75	4.39	163	2.8	0.3
	+4.34	0	8.67	53	0.1	0.3
Option 2: All-new plant	+96.4	+3.52	79.03	1488	7.6	6.0
HANFORD SITE ALTERNATIVE						
All-new plant	+114.0	+3.52	83.03	1552	6.0	4.3
TERMINATION						
Close Pantex, also occurs with Iowa Army Ammunition Plant Option 2 and Hanford Alternative	-106.4	-3.5	0	0	-2.8	0

2.3.11 Cultural Resources and Native Americans

None of the alternate siting locations contain archaeological or cultural resources listed on the National Register of Historic Places that could be impacted by new construction. However, all locations were used by native American hunters before settlement, and all sites contain artifacts (Section 3.2.11).

Though none of the alternate siting locations impact known shrines or other areas of religious significance, the Hanford Site contains many campsites and fishing grounds used from prehistoric times until forced evacuation in 1943. As groups of native Americans still live near the Hanford Site, the potential exists for negative public sentiments about use of this site. Neither of the other two locations, the Iowa Army Ammunition Plant or the Pantex Plant, have groups of native Americans still living near the considered sites (Section 3.2.11).

The Pantex Plant is the only considered location that has been examined for cultural resources by a detailed archaeological survey. The State Historic Preservation officers from Iowa and Washington would require cultural resource surveys for either the Iowa Army Ammunition Plant or Hanford Site before construction. At the Hanford Site, a historic irrigation ditch (the Hanford ditch) passes through the proposed construction area. This ditch is a potential candidate for inclusion on the National Register of Historic Places, and special handling of this resource would be required (Section 4.1.11.3).

2.3.12 Health and Safety

An epidemiology study investigated cancer mortality in counties near the Pantex Plant and found no indication of unusual cancer patterns or any effect attributable to the plant (Section 3.2.12.1). Data from the 1970s received the most intense scrutiny because that decade would be most likely to show any effects allowing for cancer latency periods, yet no significant differences were found in comparison with statistics for the State of Texas as a whole. As discussed in Section 2.3.6, the small quantities of radioactive emissions expected in the future lead to estimated risks of cancers or genetic effects that are negligibly small fractions of similar effects from natural background radiation. Therefore, no effects on public health would be expected in the future from normal operations at the Pantex Plant or from nuclear weapons operations conducted at the other sites.

A detailed epidemiological study of mortality patterns of the current and historic work force at the Pantex Plant has been undertaken. The final results of this study are expected in 1983, and major conclusions from this study are expected to be available for the Final Environmental Impact Statement.

Worker safety receives major attention in operation of the Pantex Plant and would continue to receive major attention under any of the alternatives or their options. The Pantex Plant has a well-defined health and safety program for protecting worker health. There is no evidence of significant exposure of workers to toxic chemicals or radiation from x-ray procedures or radioactive materials (section 3.2.12.2). Attention to safety is of primary concern in worker training, development of operating procedures, routine medical examinations, and review of procedures. Investigations of incidents regularly lead to improvements designed to lower the likelihood and severity of similar accidents recurring. In the future, a larger proportion of explosives that are less sensitive to accidental detonation will be used.

A statistical study of the historic worker injury and property loss records for Pantex was conducted (Section 3.2.12.3). Overall, the injury and loss rates are less than the United States explosives industry as a whole, other Department of Energy operations, and most private industry. The record has shown steady improvement over the last several years. Part of this improvement is attributed to an intensified review and modification of procedures following a serious accident in March 1977 in the high-explosives research and development area that killed three workers. These were the only fatalities resulting from a detonation of high explosives in the 30 years of operations at the Pantex Plant and about 25 years of similar operations at the Iowa Army Ammunition Plant.

The new facilities and operations also are being planned with the radiation protection philosophy of limiting planned exposures to radiation workers at levels as low as can be reasonably achieved. The specific goal adopted for the new facilities is 1 rem a year or less for radiation workers (Federal standards for workers permit up to 5 rem a year). Further, as technology changes and new chemicals are required for operations, they will be reviewed for health and safety considerations so that the most suitable protective equipment and procedures can be adopted.

Studies of the existing Pantex Plant have not shown any direct measurable effects on the health and safety of the general public (MHSM 1982, Macdonell 1982, Wiggs 1982). Evaluations indicate that all alternatives meeting production requirements are equally acceptable for the health and safety of the general public (Section 4.1.12).

2.4 ENVIRONMENTAL IMPACTS OF POTENTIAL PLANT ACCIDENTS

2.4.1 Types of Accidents Considered

Potential accidents that could result from nuclear weapons operations were evaluated from two perspectives. These are (1) the probability, or likelihood, of occurrence and (2) the potential consequences should the accident occur. This impact statement summarizes findings for those potential accidents determined to be both credible and having significant environmental impacts. (Section 4.2.2 lists the types of accidents considered.) For the purpose of this document, credible accidents were defined as those potential accidents with a chance of at least one in a million of happening in a year of operation. Significant environmental impact accidents were defined as those with some combination of important offsite effects, uncorrectable consequences, or long-term implications. These definitions served the practical purpose of focusing attention on those types of potential accidents that represent the upper limits of environmental risks associated with the various alternatives and those that may be amenable to additional mitigating measures.

Many types of accidents were evaluated that were not credible or did not have the potential for any significant environmental impact. For example, spills of process chemicals or fuel would be contained within the plant site and could be cleaned up with no long-term effects. Potential accidents involving only high explosives with no radioactive materials are not significant in terms of risk to the environment or the general public. The airborne releases from such accidents would be no different than those from the routinely conducted test explosions.

Risk of Nuclear Detonation

The physics of a nuclear explosion requires precise timing mechanisms for even a very small nuclear yield. Therefore, a nuclear chain reaction can occur only if all the high explosives are ignited at precisely timed intervals. This careful timing can only be accomplished by sophisticated, specially designed electronic equipment. Any ignition of the high explosives that does not meet the timing requirement will result in dispersal of the radioactive material but no chain reaction. Nuclear weapons also incorporate redundant, fail-safe electronic equipment that preclude normal functioning of the electronic timing circuits in the event of accidents. Therefore, the probability of an accidental nuclear detonation of a nuclear weapon at the Pantex Plant, even given the occurrence of a major accident such as an airplane crash, accidental detonation of other high explosives, or fire, is well below the limit of credibility.

2.4.2 Analysis of Potential Accidents

All types of potential plant accidents were evaluated. The only ones assessed to be both credible and having possible significant environmental impacts involved the accidental detonation of conventional high explosives resulting in the offsite dispersal of radioactive material (Sections 4.2.1 and 4.2.2). No member of the general public would be expected to experience any short-term effects. The greatest risk would be the potential for contracting cancer after a latency period of 5 to 20 years and eventually dying from that cancer. The maximum exposed individual would have an overall risk of 1 chance in 14 million of eventually dying of cancer as a result of a plutonium-dispersing accident under any Alternative.

Three types of initiating events that could lead to an explosion resulting in release of radioactive material were found to be credible. These initiating events are (1) an aircraft crash, (2) a tornado, and (3) an accidental drop of high explosives. Aircraft crashes could penetrate structures with the resultant damage leading to a detonation of high explosives. A tornado could cause sufficient structural damage to result in an explosion. An accidental drop of high explosives components during one phase of operations could result in a detonation (Sections 4.2.2 and 4.2.3).

Each of these initiating events could lead to an explosion in areas where nuclear materials are present and could result in the spread of radioactivity. The explosion would aerosolize, or cause to become airborne, the nuclear material components as mostly small particles. The particles would be expelled from the structure by the physical effects of the explosion (Section 4.2.4). They then would be spread or dispersed by wind beyond the plant boundaries where they could be inhaled or deposited on the ground (Section 4.2.5). If inhaled or deposited, the radioactivity could result in radiation doses that could lead to possible health effects (Sections 4.2.6, 4.2.7, and 4.2.8). Radiation doses are given only for the plutonium that could be dispersed by accidents. The doses from other radioactive materials, such as uranium and tritium, that could be involved in such accidents were all found to contribute less than 1% of the doses attributable to plutonium.

Each of the steps in this general chain of possible events was analyzed for the particular sites, types of structures, operating conditions, and meteorological dispersion. At each step, the analyses included methods or assumptions that would overestimate adverse consequences whenever directly applicable data were not available. Therefore, the final estimates of likelihood and possible consequences represent upper limits or "extreme case" evaluations. These estimates were calculated by the same methods for each alternative and option to provide a uniform basis for comparing the risk from potential accidents.

2.4.3 Comparative Summary of Accident Risks

Two aspects of accident risk were evaluated for each type of credible, environmentally significant potential accident for each alternative: first, the likelihood of such an accident occurring and, second, the possible consequences should such an accident occur. This section summarizes selected indicators of these two aspects of risk for each alternative.

Two indicators of likelihood are given in the first two divisions of Table 2.4.3-1 for each of the alternatives and options.

TABLE 2.4.3-1

COMPARATIVE SUMMARY OF UPPER LIMITS ON ACCIDENT RISK

Alternative/Option	1. Overall Chance of Occurrence of Plutonium-Releasing Accident in One Year of Operation	2. Chance Attributable to Accident Type			3. Maximum Number of Possible Eventual Cancer Deaths Attributable to Most Serious Release From Accident Caused by:			4. Upper Limit on Chance for Maximum Exposed Individual of Eventual Cancer Death from any Plutonium-Releasing Accident in One Year of Operation	5. Maximum Costs to Clean Up Contamination Area by Type of Accident (millions, 1981 dollars)		
	(chance)	Aircraft	Tornado	Operational	Aircraft	Tornado	Operational	(chance)	Aircraft	Tornado	Operational
Pantex Alternative Option 1: New construction	1 in 5100	1 in 5700	1 in 50,000	1 in 1,000,000	68	1	9	1 in 14,000,000	890	890	590
Option 2: Major upgrade	1 in 6100	1 in 6200	--	1 in 1,000,000	68	--	2	1 in 25,000,000	890	--	22
Option 3: Major replacement	1 in 23,000	1 in 24,000	--	1 in 1,000,000	68	--	2	1 in 45,000,000	890	--	22
Option 4: Existing facilities	1 in 5900	1 in 6700	1 in 50,000	1 in 1,000,000	68	1	9	1 in 15,000,000	890	890	590
Iowa Army Ammunition Plant Alternative Option 1: Partial relocation (risk in Iowa added to Pantex Option 4)	1 in 59,000	1 in 59,000	--	1 in 4,000,000	69	--	1	1 in 125,000,000	740	--	17
Option 2: All-new Plant	1 in 53,000	1 in 55,000	--	1 in 1,000,000	69	--	1	1 in 55,000,00	740	--	17
Hanford Reservation Alternative All-new Plant	1 in 1,000,000	--		1 in 1,000,000	--	--	1	1 in 500,000,000,000	--	--	21 (all onsite)

1. Overall Chance of Occurrence of Plutonium-Releasing Accident in 1 Year of Operation. This is the overall chance of any one of the three types of credible initiating events resulting in the dispersal of plutonium by an accidental detonation of conventional high explosives. This is expressed as a chance in any 1 year of plant operation.

2. The Chance Attributable to Accident Type. This is the chance attributable to each of the three types of credible initiating events. It is expressed as the chance in any 1 year of operation.

Three indicators of possible consequences are given in the next three divisions of Table 2.4.3-1.

3. The Maximum Total Number of Eventual Cancer Deaths. These are the total lung, liver, and bone cancer deaths that might occur after latency periods of 5 to 20 years in the potentially exposed populations as a result of inhaling plutonium dispersed in an accident. No short-term or acute effects would be expected in any member of the general public. Separate values are given for the most serious potential accidents resulting from each of the three types of initiating events. The values resulted from analyses that included assumptions of wind direction toward the largest metropolitan area and unfavorable atmospheric dispersion conditions. These wind directions occur 2.5% of the time in the Pantex Plant area, 4% of the time in the Iowa Army Ammunition Plant Area, and 6.1% of the time in the Hanford Site area. The unfavorable atmospheric conditions assumed for calculating consequences occur during only part of the time these wind directions occur. For other wind directions and more favorable dispersion conditions, the maximum numbers of potential cancers are smaller. The maximum total number of eventual cancer deaths that might result at each location under the extreme case assumptions were estimated to be 68 for the Pantex Plant Alternative, 69 for the Iowa Army Ammunition Plant Alternative, and 1 for the Hanford Site Alternative. These values may be compared with the normally expected number of deaths from the same three types of cancer from all other causes. In the Amarillo, Texas, area, 4900 such cancer deaths normally would be expected from all other causes in the 142,000 persons potentially affected by the most serious accident. The comparable figures for the Burlington, Iowa, area are 1180 normally expected lung, liver, and bone cancer deaths in a population of 34,400 and for the Richland, Washington, area, 4100 normally expected deaths from such cancers in a population of 119,000.

4. The Chance that a Maximum Exposed Individual Might Eventually Die of Cancer. This is the chance that an individual near the plant boundary where exposures were calculated to be the highest might eventually contract and die from lung, liver, or bone cancer after a latency period of 5 to 20 years as a result of inhaling plutonium dispersed by an accident. The values given are expressed as chance per year of plant operation that an individual at the location might die of cancer from any of the credible accidents. It is the sum of the maximum individual risks for all credible accidents analyzed for each option and includes the probabilities of individual accidents, the fraction of the time the wind blows in the particular direction, and the chance of contracting cancer assuming the accident actually happened. The greatest chance that a maximum exposed individual might eventually die of cancer from a plutonium-dispersing accident at each location was estimated to be 1 chance in 14 million a year for the Pantex Plant Alternative (Option 1), 1 chance in 55 million a year for the Iowa Army Ammunition Plant Alternative (Option 2), and 1 chance in 500 billion a year for the Hanford Site Alternative. These values can be compared with the overall United States average chance of death from all other types of accidents, which is 1 chance in 2000 per year.

5. <u>The Estimated Maximum Costs to Clean Up Residual Contamination in the Area Affected by an Accident</u>. Separate values are given for the most serious potential accidents resulting from each of the three types of initiating events. The estimates considered contamination of structures, removal of vegetation and soil, and other measures necessary to assure that the dose guidelines for transuranium contamination in the environment proposed by the Environmental Protection Agency would be met. If no decontamination were conducted, higher levels of residual plutonium would remain. These levels, assuming no decontamination, could increase average individual risks from the maximum release accident as much as 49% in the case of the Pantex Plant, about 10% for the Iowa Army Ammunition Plant, and insignificantly for the Hanford Site.

In summation, the overall risk of the Alternatives can be compared by considering the different probabilities associated with the range of accidents that can result in different consequences. One such comparison is presented in Figure 2.4.3-1 as a graphic representation of the probabilities of the different numbers of maximum likely eventual cancer deaths associated with all of the different accidents that could release different amounts of plutonium. The horizontal scale shows the possible maximum numbers of eventual cancer deaths associated with the range of accidents analyzed and are based on wind directions and dispersion conditions that would maximize adverse effects. The vertical scale shows the probability, in chances per year of plant operation, that the maximum number of deaths might eventually occur. It is the combined probability of a particular accident occurring and the probability that the wind will be blowing in the direction to maximize consequences.

The bands shown in the figure encompass the upper limits of maximum consequence risks for the various alternatives. The left-hand portion of the Pantex Plant Alternative shaded band is broken into two parts; the upper part represents Pantex Plant Options 1 or 4, the lower part represents Pantex Plant Options 2 or 3. The dominant factor in that difference in risk is that from tornado-induced accidents. The structures proposed under Options 2 or 3 would eliminate tornados as a credible event leading to an accident and would provide more mitigation of consequences from potential operational accidents. The main part of the Pantex Plant Alternative shaded band encompasses the upper limits for any of the four options. For all options, the upper limit on risk from accidents that could result in maximum numbers of about 10 or more eventual cancer deaths is dominated by aircraft crash and does not vary greatly between options. The lower edge of the band is generally associated with Option 3, which would have the most reliable facilities and would mitigate consequences to the greatest degree.

The unshaded bands for the Pantex Plant Alternative in Figure 2.4.3-1 show the effect on risk if the mitigation measure involving expanding the prohibited airspace at the Pantex Plant and moving the VORTAC navigation aid was implemented. As indicated in the figure, that mitigating measure would reduce by a factor of about 40 the chance that the larger consequence accidents might occur for any option. The lower consequence accidents, those that could be induced by tornado (Options 1 or 4) or operational accidents (all options), would still dominate the shape of the risk curves.

The upper limit risk for the Iowa Army Ammunition Plant Alternative is shown by a single band. In general, the lower edge of the band is associated with Option 1, Partial Relocation. This figure shows only the added risk in Iowa for the Partial Relocation Option 1. Option 2 has somewhat higher risk in spite of better facilities mainly because all operations would be located in Iowa. The general level of risk of maximum number of eventual cancer deaths is similar to that associated with Pantex Options 2 or 3. The maximum consequence accident could result in about the same maximum number of eventual cancer deaths as for any Pantex Plant Option.

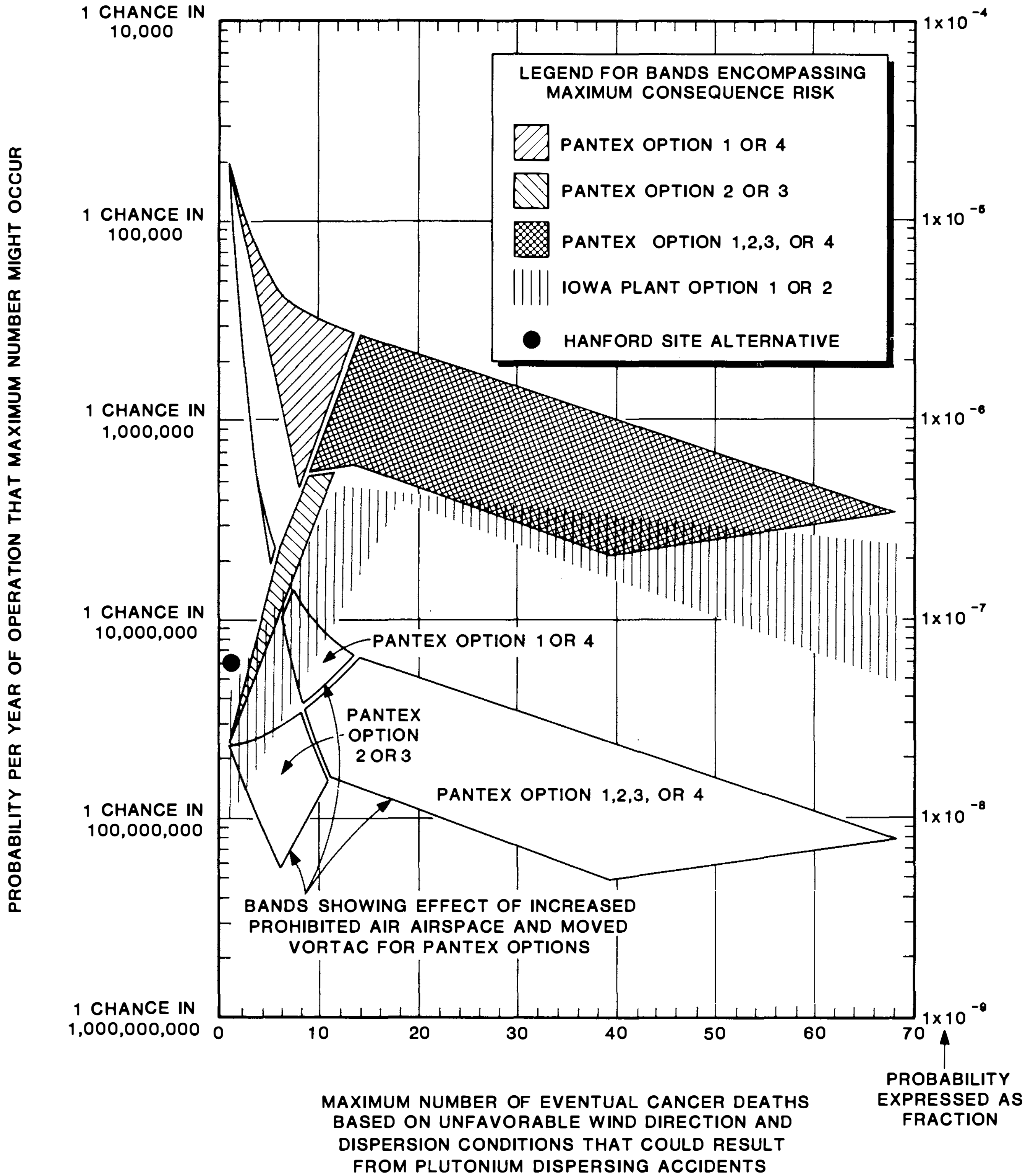


Figure 2.4.3-1. Comparison between alternatives of maximum consequence risks.

The Hanford Site Alternative is represented by a single point on the graph because only one credible accident was found in the analysis of that alternative. It was estimated to result in no more than 1 eventual cancer death even assuming an unfavorable wind direction.

2.5 ENVIRONMENTAL IMPACTS OF RELATED TRANSPORTATION OPERATIONS

This section summarizes major conclusions on environmental impacts associated with transportation operations. Section 4.3 contains a more detailed discussion of the topic.

Environmental impacts resulting from related transportation operations fall into either of two major categories--normal operations or accidents. Consequences were calculated for normal operations as they are now associated with Pantex Plant operations. Accidents were treated statistically by calculation of a probability of occurrence. If the probability was found to be greater than 1 chance in a million per year, the consequences were calculated to determine the significance. This is the same approach that was used for evaluating plant operations. See Section 2.4.1 for a discussion of credibility and significance definitions.

2.5.1 Normal Transportation Operations Related to Pantex Plant Alternatives

The impacts for normal operations and accidents are further separated into those that result in a radiological effect and those that are nonradiological in nature. All impacts associated with normal transportation operations were assessed to be negligible.

Radiological

The radiological impacts of Pantex Plant-related normal transportation are limited to radiation doses received by couriers, other employees, and the general public. The maximum radiological dose for a nonoccupational individual was assessed to be less than 0.5 millirem per year.

Nonradiological

Nonradiological impacts are comparable to impacts resulting from the equivalent types of traffic; that is, cars, trucks, trains, and aircraft. In all cases, for all affected areas, the Pantex Plant contribution was calculated to be less than 1%.

2.5.2 Transportation Accidents Related to Pantex Plant Alternatives

Radiological

The primary concern for transportation accident impacts (as it was for plant impacts) is the detonation of conventional high-explosive components that could result in the release of plutonium to the atmosphere. The crash of a Safe-Secure Trailer containing nuclear weapons with a loaded fuel tanker truck and resulting in a long-burning fire near the Safe-Secure Trailer was the only such accident calculated to have a likelihood of about 1 chance in a million per year considering the distances traveled nationwide. The probability of such an accident occurring within a 50-mile radius of the Pantex Plant is about 1 chance in 20 million a year, or about 5% of the nationwide risk. The assessment of potential consequences of such an accident was based on the assumption that it occurred on an interstate highway at a major exit in a large metropolitan area (population between 1/4 and 1/2 million) while enroute between the Pantex Plant and a military destination. Wind direction and atmospheric dispersion conditions were chosen to maximize effects. This evaluation estimated that as many as 38 additional cancer deaths could eventually occur in the exposed population. About 52 square kilometers could be contaminated at levels that could require cleanup to assure that proposed Environmental Protection Agency guidelines would be met. The cleanup cost could be as much as $500 million.

All other hypothesized transportation accidents involving nuclear weapons had probabilities less than the occurrence probability threshold. The Department of Energy does not ship nuclear weapons by air.

In addition to those involving nuclear weapons, accidents may be associated with shipments of nuclear weapons components containing radioactive material and shipments of nonweapon radioactive materials. All of these with one exception have a chance of occurrence less than 1 in a million per year. The exception is a crash and resulting fire from a chartered aircraft carrying nuclear components containing tritium. The probability of release of tritium to the atmosphere from an aircraft crash was calculated to be less than 1 chance in 25,000 per year. A consequence evaluation that assumed release of all of the tritium from all of the components predicted a maximum individual dose of less than 1 rem.

Nonradiological

Nonradiological impacts were assessed for hazardous materials shipped to and from the Pantex Plant. Two postulated accidents involving high explosives and one postulated accident involving gasoline or diesel fuel were assessed to have a chance of occurrence greater than 1 in a million per year.

High explosives are shipped to and from Pantex by contractor aircraft and by commercial truck. For air shipments, the likelihood of a crash of a plane carrying high explosives to or from the Pantex Plant is about 1 chance in 300 per year. A consequence assessment of explosive damage potential and aircraft damage potential indicates that for the amounts of explosives transported, the hazards are essentially those that result from the crash of the plane itself. For commercial truck shipments, fire is the only credible circumstance that could cause detonation of the high explosives. The probability of an accident involving a fire is less than 1 chance in 1700 per year. Approximately 25 shipments of gasoline and diesel fuel are made per year with the probability of a fire being less than 1 chance in 20,000 per year. For all of these nonradiological incidents, consequences represent a small proportion (less than 1%) of that type of accident in the affected area.

2.5.3 Iowa Army Ammunition Plant and Hanford Site Alternatives

All of the transportation impacts are closely proportional to distance traveled. The Iowa Army Ammunition Plant Alternative would result in an insignificant change in transportation impacts. The Hanford Site Alternative would, at most, double the normal transportation impacts and double the occurrence probability for accidents.

2.6 PREFERRED ALTERNATIVE AND ADDITIONAL MITIGATING MEASURES

2.6.1 The Preferred Alternative

The preferred alternative is to continue nuclear weapons operations and construct new facilities at the Pantex Plant in order to meet increased workload schedules. The Department of Energy intends to pursue completion of the projects identified in Option 1 and additional new facilities that would at least provide all of the operational reliability design features represented by Option 2. For some operations it is possible that operational reliability features represented by Option 3 will be found desirable or necessary.

Thus, the first three Pantex Plant Options encompass the actions considered most likely and illustrate the range of possible costs, improvements in safety, and environmental impacts. While each of the options is precisely defined to provide a sound basis for evaluation, it should be clear that they are not mutually exclusive and that features from more than one option could be combined. This Environmental Impact Statement will be instrumental in formulating the decisions regarding the implementation of these options.

2.6.2 Additional Migating Measures Identified for Consideration

Additional mitigating measures to address specific environmental issues were identified during the detailed evaluation of the basic alternatives.

These measures are not now part of any of the Alternatives described earlier. However, some are already being actively investigated by the Department of Energy. The measures are organized into two categories: (1) those that could reduce the probability or consequences of potential accidents and (2) those that could reduce the degree of impact from some routine operations.

Possible Mitigating Measures for Potential Accidents

- The potential accidents with the highest probabilities and the highest potential consequences are aircraft crashes. The possibilities of such accidents occurring may be decreased by enlarging the prohibited airspace out to 4 kilometers (2.5 miles) and unlimited altitude in the vicinity of the Pantex Plant, by moving the VORTAC radio navigation device to a different location, and by modifying the standard approach patterns for the Amarillo Airport. Preliminary calculations indicate that the chance of an aircraft-crash-induced accident would be reduced by factors of more than 40 if these measures were implemented by the Federal Aviation Administration.

TABLE 2.6.2-1

CHANCE OF AIRCRAFT CRASH INDUCED PLUTONIUM-RELEASE ACCIDENT
(chance per year)

Alternative/Option	With Option as Defined	With Increased Prohibited Air-Space and Moved Vortac
Pantex Alternative		
Option 1	1 in 5700	1 in 250,000
Option 2	1 in 6200	1 in 250,000
Option 3	1 in 24,000	1 in 1,000,000
Option 4	1 in 6700	1 in 280,000

Other measures being investigated are the modification or rebuilding of structures to reduce or eliminate any offsite consequences should an aircraft crash occur. These measures include berming or burying the structures.

- Gravel Gerties are special structures with ceilings made of a suspended, thick layer of gravel designed to filter out plutonium should an accident occur in the workspace. Engineering studies have shown that the existing access blast doors may fail under the accidental detonation of the maximum allowable amount of high explosive, thereby permitting unfiltered debris to be expelled. (The accident analysis for Pantex Option 1 and 4 assumed such a failure would occur.) The Department of Energy currently is investigating various methods to refit or replace these blast doors to assure against blast door failure. If the doors and entrance way could be modified to assure withstanding an accidental detonation, the maximum release of plutonium from such an accident could probably be reduced by a factor of about 40.

- Only one credible postulated offsite transportation accident could result in the release of plutonium. This accident involves a long-burning fuel fire resulting from an accident between a Safe-Secure Trailer transport vehicle and a tanker truck. Possible mitigating measures including modifications to either procedures or equipment are being investigated.

Possible Mitigating Measures for Normal Operation. Although various normal operations were found to have some degree of environmental impact, none were considered significant. Some mitigating measures are being considered to reduce further those already small impacts.

- A new Test Firing Facility is being considered. This possible facility is in addition to the Interim Test Firing Facility now under construction. The new facility would provide containment of all emissions from all high-explosive test shots involving either depleted uranium or beryllium.

- Recycling of solvents may be accomplished in the future, reducing emissions from solvent evaporation to nearly zero.

3.0 AFFECTED ENVIRONMENTS

This chapter describes the environments of three locations (the Pantex Plant, the Iowa Army Ammunition Plant, and the Hanford Site) that might be affected by the alternative actions. Emphasis is on discussions and information deemed necessary to understand the analyses in Chapter 4 and comparisons of alternatives in Chapter 2. More detailed material is referenced or published as a separate document.

Chapter 3 has two major sections. Section 3.1 describes general conditions (within a regional context), existing facilities, and current operations at all three sites. Section 3.2 deals with the existing environmental conditions. It emphasizes those areas deemed important by the public or those areas most likely to be affected by the alternatives. The discussions of the existing environment at the Pantex Plant reflect the cumulative effects of nuclear weapons operations there over the past 30 years. The topical sections are organized in the same fashion used for Section 2.3. Each topical subsection presents information for each site in the same sequence.

3.1 GENERAL SETTINGS OF THE SITES

All three alternative sites are now under some form of Federal government control and are restricted from public access. The Pantex Plant site near Amarillo, Texas, is the location of current nuclear weapons operations and proposed new construction. The Iowa Army Ammunition Plant site near Burlington, Iowa, has facilities previously used for nuclear weapons operations and currently is used for conventional munitions operations. The Hanford Site near Richland, Washington, was selected as an example site for an all-new plant. This selection was based on a detailed study that evaluated regional and site-specific criteria to select suitable candidate sites for nuclear weapons operations facilities (LATA 1981). The Pantex Plant and Iowa Army Ammunition Plant sites also were evaluated in that siting study for comparative purposes.

3.1.1 General Environs

The local environs differ greatly among the three sites. However, each is located in relatively flat open country away from major mountain ranges. All three locations have agricultural areas onsite under cultivation. Each site is located relatively close to urban areas and has potential ecological pathways for pollutant transfer to man through agricultural practices and game management programs.

3.1.1.1 Pantex Plant--General Environs

The 3700 hectare (9100 acre) Pantex Plant Site is located in the Panhandle of Texas, Carson County, approximately 27 kilometers (17 miles) northeast of downtown Amarillo (Fig. 2.1.1-A). In addition to the Pantex Plant, the Department of Energy owns a 440 hectare (1100 acres) portion of a large playa approximately 6 kilometers (4 miles) northeast of the Plant. This property, known as Pantex Lake, is currently being used for private agricultural purposes and is being held by the Department of Energy for its long-term potential development as a water supply well field. No plans are contemplated for such development in the foreseeable future. The water wells used to supply Amarillo with drinking water border this property.

The Pantex Plant is located in the treeless high plains of Texas; it lies on the transition zone between the North Central Plains and the Llano Estacado (staked plains) to the south. The region, settled in the late 1800s and early 1900s, is a semiarid farming and ranching area. The few trees currently there were planted for wind breaks, shade, or fruit production. The Pantex Plant is surrounded by agricultural land. Ownership is both private and institutional. Approximately 80% of the land within the Plant boundary is used for agricultural purposes by land lease arrangements with Texas Technological University Agriculture Research Station. Broken or rolling land is typically kept in native grass pasture and seasonally grazed whenever rainfall is sufficient to produce grass growth. Wheat fields are grazed in the late fall, winter, and early spring to stimulate tillering; grain sorghum is grazed in the fall after the crop is combine-harvested. Although dryland farming dominates this region, some fields are irrigated from local playas or from deep wells pumping water from the Ogallala aquifer.

The climate at the Pantex Plant is typical of the high great plains. It is characterized by hot summers and relatively cold winters (USDC 1981). The Pantex Plant is in a windy area with the prevailing wind direction from the south through southwest (Fig. 3.1.1.1-A). Rainfall is variable, averaging 50 centimeters (20 inches) per year with individual annual totals ranging from less than 25 centimeters (10 inches) to greater than 90 centimeters (35 inches). Thunderstorms occur about 49 days per year and can produce tornadoes. The design criteria tornado windspeed for the Pantex Plant is 112 meters per second (250 miles per hour) (Texas Tech 1974).

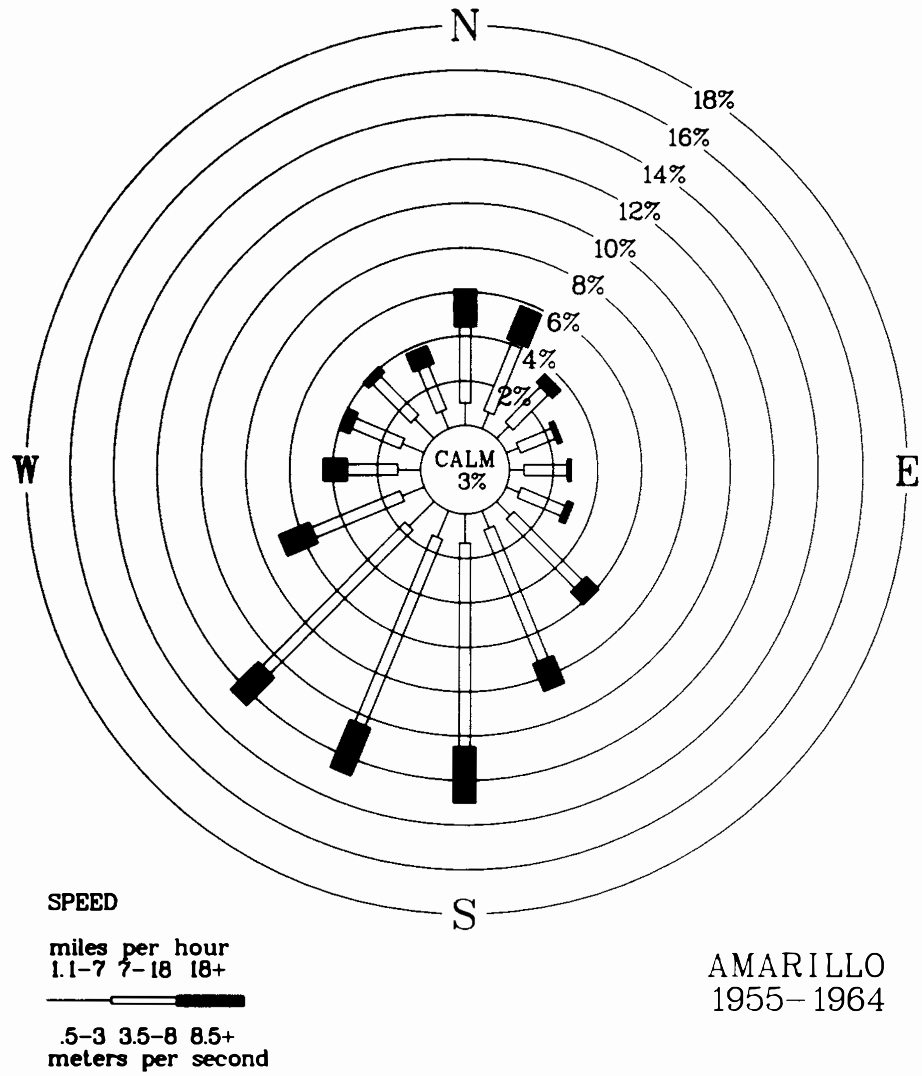
3.1.1.2 Iowa Army Ammunition Plant--General Environs

The 7800 hectare (19,300 acre) Iowa Army Ammunition Plant is located in southeastern Iowa, Des Moines County, approximately 16 kilometers (10 miles) west of downtown Burlington. Plant headquarters are adjacent to the town of Middletown on the main line of the Burlington Northern Railroad (Fig. 2.2.2-A). This area was settled in the early 1800s and has several points of interest dating back to the Civil War era. However, no historic sites registered with the National Register of Historic Places exist within Plant boundaries.

The region contains some of the most productive farmland in the world. The terrain is mostly level to gently sloping; however, it is broken by rougher topography along drainage ravines and stream channels. The landscape, both within and surrounding Plant boundaries, is a mosaic of fields and hardwood forests. An excellent growing season is coupled to an annual rainfall pattern that eliminates most requirements for irrigation, and almost any acclimated crop can be grown. Most level land is cultivated. Corn and soybeans, the preferred crops, are planted on a crop rotation schedule to maintain high levels of soil fertility.

Approximately 70% of the land within the Plant boundaries is farmed (row crops or improved pastures). Land is leased to private farmers or maintained for wood production under an aggressive forest management plan. In addition, an active wildlife management plan encourages production and use of wildlife species.

The climate at the Iowa Army Ammunition Plant is typical of continental, mid-latitude locations. It is characterized by hot, humid summers and cold, relatively snowy winters (USDC 1980). The prevailing wind direction at the Iowa Army Ammunition Plant is from the south to southwest with stronger winds from the north and northwest (Fig. 3.1.1.2-A). Rainfall averages 90 centimeters (35 inches) per year with two-thirds falling during the growing season; snowfall averages 60 centimeters (25 inches) per year. Thunderstorms occur about 50 days per year, primarily in the spring and summer, and can produce high winds, hail, and tornadoes. The continental U.S. has been assessed to determine a regional design-basis tornado (ANSI 1980); the tornado design wind speed for Iowa is 112 meters per second (250 miles per hour). The design criteria wind speed used at the Iowa Army Ammunition Plant for new facilities is 160 meters per second (360 miles per hour) (MHSM 1971B).



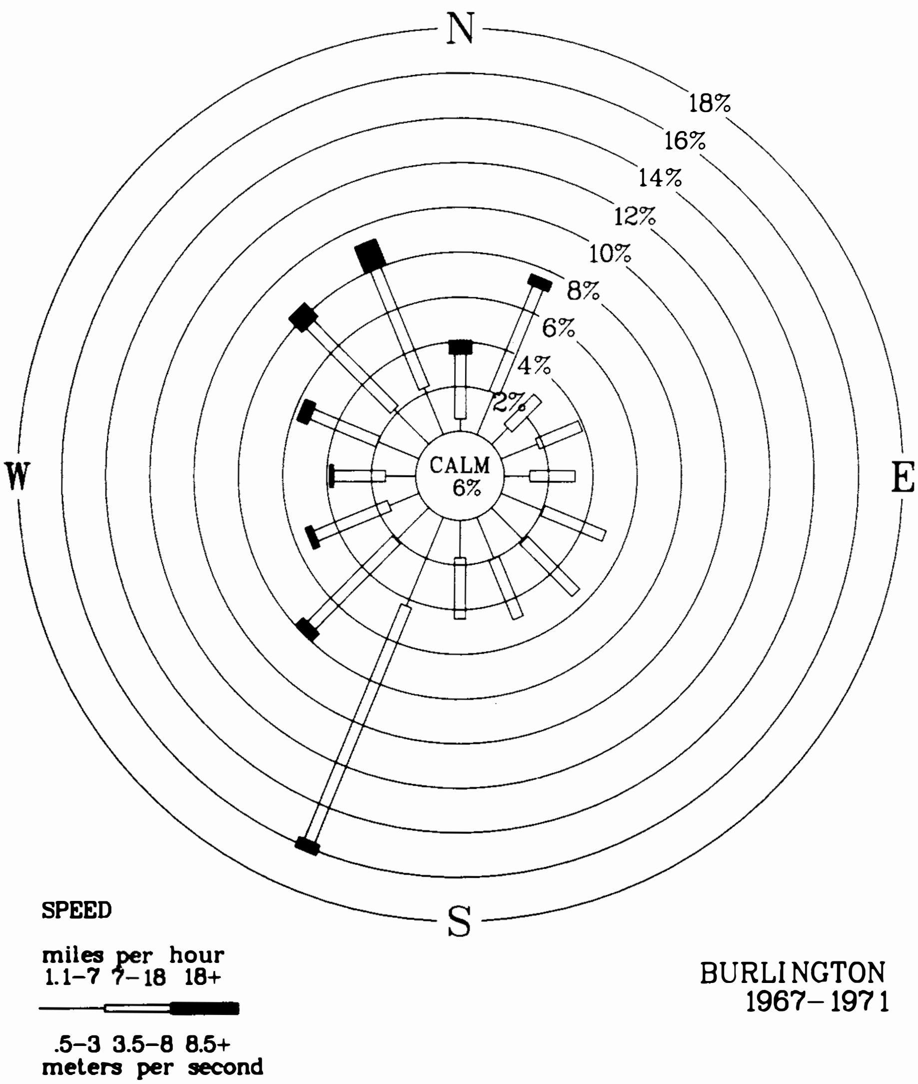
The lines and bars coming from the center of the wind rose represent the frequency of the wind speed interval coming from that particular direction. Sixteen wind directions (N ,NNE, NE, Etc.) are presented, each covering 22.5 degrees of the circle.

Figure 3.1.1.1-A. Wind rose for Pantex Plant area.

3.1.1.3 Hanford Site--General Environs

The 147,800 hectare (360,100 acre) Hanford Site is located in semiarid southeastern Washington just north of the junction of the Yakima, Snake, and Columbia Rivers (Fig. 2.2.3-A). This area was settled in the late 1800s and early 1900s by farmers who developed local irrigation districts using the Columbia River. Average rainfall is low; however, as is typical of most desert communities, a wide variety of crops can be grown when water is supplied. A truck farm industry thrives on the irrigated fields. There is also wheat farming and forage production for a livestock industry.

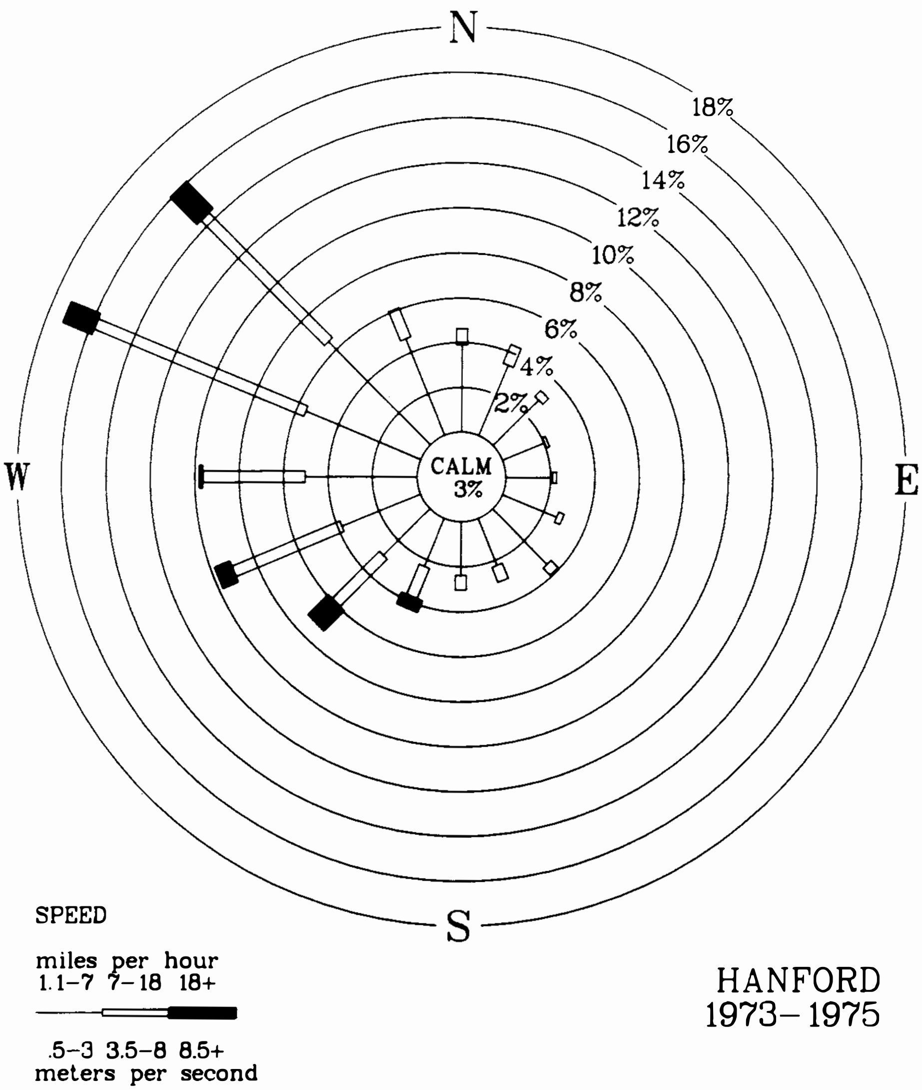
The proposed site is located in the north central portion of the Hanford Site approximately 32 kilometers (20 miles) northwest of Richland. This area supports sagebrush and native grasses that provide wildlife habitat.



The lines and bars coming from the center of the wind rose represent the frequency of the wind speed interval coming from that particular direction. Sixteen wind directions (N ,NNE, NE, Etc.) are presented, each covering 22.5 degrees of the circle.

Figure 3.1.1.2-A. Wind rose for Iowa Army Ammunition Plant area.

The climate is dominated by the rain shadow of the Cascade Mountain range (Stone 1972). Moisture-laden storms originating from the Pacific during winter and spring tend to rain-out as they cross the Cascades, resulting in a relatively low annual rainfall [an average total of 16 centimeters (6.3 inches)] at the Hanford Site. Winters are relatively cold, averaging 1°C (33°F); snowfall totals average only 33 centimeters (13 inches) per year. Summers are sunny, dry, and warm. The prevailing wind direction is from the west-northwest caused by air draining off the Cascade range across eastern Washington (Fig. 3.1.1.3-A). Thunderstorms occur about 11 days per year, but severe thunderstorms are rare. One tornado has been observed (in 60 years) on the Hanford Site. The design criteria for nuclear reactors or structures for the storage of plutonium at the Hanford Site require the facility to withstand tornado wind speeds of 78 meters per second (175 miles per hour) (USAEC 1974).



The lines and bars coming from the center of the wind rose represent the frequency of the wind speed interval coming from that particular direction. Sixteen wind directions (N ,NNE, NE, Etc.) are presented, each covering 22.5 degrees of the circle.

Figure 3.1.1.3-A. Wind rose for Hanford Site area.

3.1.2 Existing Facilities

3.1.2.1 Pantex Plant--Existing Facilities

General Characteristics

The facilities at the Pantex Plant include some 288 buildings totaling approximately 139.5 thousand square meters (1.5 million square feet) of floor space (USERDA 1976). The Plant was established in 1951 on a portion of the former Pantex Army Ordnance Plant constructed in 1942. The original Plant was used during World War II for loading conventional ammunition shells and bombs. Several of the original buildings [55.8 thousand square meters (600 thousand square feet)] were converted in 1951 to nuclear weapons operations facilities and are still in use. All other nuclear weapons operations facilities being used were built since 1952 and are designed specifically for nuclear weapons operations work (USERDA 1976).

The Plant is divided into several major working areas. The manufacturing area is devoted to fabrication of high explosive components and weapon assembly/disassembly operations (Section 2.1). The high-explosives development area is devoted to high-explosive development work required to support various Department of Energy nuclear weapon design agencies. The temporary holding area is a safe, secure place for high explosives and nuclear weapons not actively being worked on. Other important facilities include test-firing sites for testing high explosives, a landfill disposal area, a burning ground for disposal of scrap high explosives, a water treatment plant, a steam generation plant, and a sewage treatment plant.

The manufacturing area in which nuclear weapons operations are conducted covers approximately 80 hectares (200 acres) and contains more than 100 buildings. This area is surrounded by a security zone. Descriptions of the weapons operations performed in the manufacturing area are presented in Chapter 1, Section 1.4.

The high-explosive development area consists of facilities that contain several bays with heavy reinforced-concrete walls. These facilities are used for synthesizing new high explosives and fabricating these new high explosives into experimental shapes. See Chapter 1, Section 1.4.4, for a description of developmental high-explosives operations.

The test firing site has several reinforced-concrete bunkers containing control rooms and camera areas. Experimental high-explosive configurations are detonated on firing pads surrounded by earthen bunkers. Selected samples of high-explosive components also are detonated for quality assurance testing.

Support facilities at the Pantex Plant include a cafeteria, change house, tool and die shop, water treatment plant, sewage treatment plant, photography laboratory, central health facility, plastic shop, garage and vehicle maintenance facility, and steam generation plant.

3.1.2.2 Iowa Army Ammunition Plant--Existing Facilities

General Characteristics

The Iowa Army Ammunition Plant at Burlington, Iowa, contains 1210 buildings with a total floor space of 407 thousand square meters (4.4 million square feet). The Plant has 11 assembly lines that have been used for production of various munitions such as artillery shells and mines (USARMY 1980).

In 1947 the Burlington Atomic Energy Commission Plant was created within the confines of the Iowa Army Ammunition Plant to fabricate chemical explosives and perform nuclear weapons operations. Some Army facilities were transferred to the Atomic Energy Commission and some new facilities were constructed at that time. The mission of the Burlington Atomic Energy Commission Plant included nuclear weapons operations and other weapons program work as directed by the Atomic Energy Commission.

Those areas of the Iowa Army Ammunition Plant used by the Burlington Atomic Energy Commission Plant included the manufacturing area, the temporary holding area, the firing site, and the explosive disposal area. The manufacturing area housed all high-explosive fabrication and nuclear weapons assembly/ disassembly operations. It contained 28 buildings [total floor area--39.9 thousand square meters (430 thousand square feet)] classified as production facilities. These included the assembly cells and bays of heavy reinforced concrete construction. In addition, there were 83 support buildings [35.9 thousand square meters (387 thousand square feet)]. These included laboratories, shops, offices, storage, equipment rooms, control rooms, pump houses, guard stations, personnel shelters, change houses, and a steam generation building.

The temporary holding area contained 43 reinforced-concrete, earth-covered buildings, all of which were accessible by railroad track and road. These structures were used for temporary holding of nuclear weapons. A test-firing site having several control rooms, camera rooms, and test-firing pads was used for testing high explosives. A waste disposal area was used for burning waste high explosives.

By 1975, all nuclear weapon operations were shifted to the Pantex Plant and all facilities at the Iowa Army Ammunition Plant were returned to the Army. Some of the buildings in the manufacturing area currently are being used for high-explosive production and conventional ammunitions assembly. These buildings are all in good condition. The remaining buildings in the manufacturing area are not in active use, but are maintained for possible mobilization. They are in relatively good condition, and may require only painting and air conditioning system (heating and ventilation) maintenance to be returned to usable condition. There is sufficient space available within the plant boundaries for the construction of new high-explosive fabrication and nuclear weapon operation facilities.

3.1.2.3 Hanford Site--Existing Facilities

General Characteristics

Current major operations on the Hanford Site include an operating plutonium production reactor, fuel reprocessing and waste management facilities, the Fast Flux Test Facility, and support facilities (Jamison 1981). Purex, a fuel reprocessing facility, was used from 1955 to 1972 and is planned to restart operations in the future (USDOE 1982C). The Washington Public Power Supply System has three commercial nuclear power plants under construction on an area of the Reservation leased from the Department of Energy. Work on two of them has been stopped.

The Hanford Site is used for nuclear reactor operations or nuclear reactor related operations. This includes the operation of the plutonium-producing reactor and generation of electricity using the byproduct steam. Other operations include the maintenance of Purex for restart of reprocessing of irradiated plutonium production reactor fuels, fission product separation, criticality research, and radioactive waste storage. In addition, there is the production of uranium oxide, plutonium purification and conversion, plutonium storage, N-Reactor fuel fabrication, reactor fuels research and development, liquid metal technology development, life science research, and Fast Flux Test Reactor support activities.

3.2 EXISTING ENVIRONMENTAL CONDITIONS

3.2.1 Air

3.2.1.1 Pantex Plant--Air

Air quality at the Pantex Plant meets all Federal and Texas primary air quality standards (Texas 1981) for sulfur dioxide and particulates. The Pantex Plant has no industrial processes that are significant sources of these pollutants, or of carbon monoxide, ozone, lead, nitrogen dioxide, and hydrocarbons (MHSM 1982). The high annual average wind speed of 6 meters per second (14 miles per hour) provides one of the lowest air stagnation potentials in the U.S. (Holzworth 1972).

Texas Air Control Board measurements at Amarillo for 1981 show total suspended particulates and sulfur dioxide to be within both state and Federal limits. These values are presented in Table 3.2.1.1-1.

The major sources of pollutants from operations at the Pantex Plant are waste high-explosive burning, steam generation from an existing natural gas-fired plant, and waste organic solvent evaporation. For these sources, air concentrations were estimated by theoretical calculation for both onsite and offsite locations (Macdonell 1982). None of these estimated values exceeded applicable standards. Table 3.2.1.1-2 lists data on all pollutants emitted at the Pantex Plant that are regulated by either Federal or State Ambient Air Standards. Table 3.2.1.1-3 presents air concentrations of waste organic solvents that are regulated for worker exposure but not regulated by national or state ambient air standards. Yearly totals for all the Pantex Plant major emissions are presented in Table 3.2.1.1-4. The largest single source of primary air pollutants (those assigned a National Air Quality Standard) is from vehicles used by workers driving to and from work. These releases are about 36 times greater than emissions from the gas-fired power plant and approximately 180 times greater than emissions from burning waste high explosives.

Waste high explosives and high explosive contaminated material are disposed of by burning. There are three methods of burning: open earth pads, open air incinerator cages, and a burn tank. The method used depends on the form and content of the material. Permission for open air burning activities has been granted by the Texas Air Control Board (TACB 1976). Given worst-case meteorological conditions, maximum burning emissions could have levels of nitrogen oxides (NO_x) of about 46 parts per million for 3-1/2 minutes (estimated time of burn) at the nearest site boundary. This would result in an estimated annual average concentration of 0.0004 parts per million. When NO_x comes in contact with moisture, nitrous acid and nitric acid are formed, which can cause discomfort to humans standing at the nearest boundary (Macdonell 1982). These effects could include irritation to the eyes and mucous membranes. No other effects would be expected.

Gaseous emissions from high explosive test shots are at least 100 times smaller than those from burning of waste high explosives (Macdonell 1982). Thus, air concentrations from high-explosive test shots meet all applicable standards.

Potential releases of toxic air contaminants are controlled (where deemed necessary) with air cleaning apparatus, such as high-efficiency particulate air filters. With the exception of burning waste high explosives and evaporation of waste organic solvents at the burn site, most nonradioactive atmospheric releases are from fume hoods and building exhaust systems. The limited quantities released and infrequent nature of these releases do not constitute an environmental, worker, or public health

TABLE 3.2.1.1-1

AMBIENT AIR MEASUREMENTS AT AMARILLO FOR 1981

Pollutant	Time Period	1981 Measured Concentration	Units	Federal Primary Standard	Secondary Standard	Texas Standard
Total suspended particulates	24 hour	112	micrograms per cubic meter	260	150	150
	Annual	60	micrograms per cubic meter	75	60	75
Sulfur dioxide	3 hour	Not measured	parts per million	No standard	0.5	0.5
	24 hour	0.008	parts per million	0.14	No standard	0.14
	Annual	0.003	parts per million	0.03	No standard	0.03

TABLE 3.2.1.1-2

CALCULATED MAXIMUM OFFSITE AIR CONCENTRATIONS FOR PRIMARY AIR POLLUTANTS*
EMITTED FROM PANTEX PLANT
(All concentrations expressed in parts per million)

Source	Pollutant	Concentration	Time Period	Environmental Protection Agency Ambient Air Standard	Texas Ambient Air Standard
High explosive burning	CO	3.2	1 hour	35.0	35.0
		0.4	8 hours	8.75	8.75
	NO	0.0004	Annual	0.05	0.05
	HF**	0.006	3 hours	No standard	0.006
Steam generation	CO	0.0027	1 hours	35.0	35.0
		0.0027	8 hours	8.75	8.75
	NO_2	0.00053	Annual	0.05	0.05

*Primary air pollutants are those for which a National Ambient Air Standard Exists.
**Hydrogen fluoride was included because of State standards.

TABLE 3.2.1.1-3

AIR CONCENTRATIONS FOR SOLVENT EVAPORATION AT PANTEX PLANT
(all concentrations in parts per million)

Solvent	Onsite* Solvent Concentration	Occupational Exposure Limits***		Offsite** Solvent Concentration
		15 minutes	8 hours	
Ethyl acetate	0.02	NS+	400	0.21
Acetone	0.05	1000	750	0.61
Methyl ethyl ketone	0.02	300	200	0.24
Toluene	0.01	150	100	0.08
Methanol	0.05	250	200	0.59
Butyl acetate	<0.005	200	150	0.03
Methyl Isobutyl ketone	<0.005	75	50	0.05
Dimethylformamide	<0.005	20	10	0.01
Tetrahydrofuran	0.03	250	200	0.34
Isobutyl acetate	<0.005	187	150	0.05

*Onsite concentrations were calculated at the closest major occupied area (approximately 4300 meters distant).
**Offsite concentrations were calculated at the closest site boundary (approximately 800 meters distant).
***From ACGIH 1981.
+NS means no standard.

TABLE 3.2.1.1-4

ANNUAL EMISSIONS FOR PANTEX PLANT MAJOR AIR POLLUTANT SOURCES*

	Estimated Annual Emissions (1981) (kilograms)
Automobile Commuter Traffic	
Hydrocarbons	51,300
NO_x	679,300
CO	57,300
Gas-Fired Power Plant	
NO_x	14,300
CO	3,200
Waste High-Explosive Burning (69,000 kilograms	
NO_x	3,250
CO	1,200
Organic Solvent Evaporation	
Toluene	16,100
Acetone	20,800
Dimethylformamide (DMF)	12,200
Others	10,200

*Much of this information from Laseter 1982.

hazard (MHSM 1973, MHSM 1975A, MHSM 1975B, MHSM 1976, MHSM 1977A, MHSM 1977B, MHSM 1978, MHSM 1979A, MHSM 1979B, MHSM 1980A, MHSM 1980B, MHSM 1982).

The amounts of solvents evaporated at the Pantex Plant are relatively small. For comparison, a small independent paint company would have uncontrolled emissions of approximately twice the amount of hydrocarbons [145 thousand kilograms (320 thousand pounds)] per year as the waste solvent evaporation operation at the Pantex Plant [60 thousand kilograms (132 thousand pounds)] (USEPA 1976).

Electric power at the Pantex Plant is provided by Southwest Public Service Company. Air pollutant emissions from Southwest Public Service Company Plants that resulted from Pantex Plant electricity usage were only 0.3% of Southwest Public Service Company's total air emissions and are a negligible contribution to regional air pollution.

3.2.1.2 Iowa Army Ammunition Plant--Air

The air quality in the Iowa Army Ammunition Plant area is generally very good, reflecting moderate annual average wind speeds and few major industrial air pollution sources. Measurements taken by the State of Iowa indicate that the Burlington area is in compliance with Federal secondary standards for particulates (Johnson 1981). Routine monitoring data for other primary air pollutants are not available.

The major sources of emissions for the Iowa Army Ammunition Plant are several small boilers, the coal-fired main heating plant, burning high-explosive wastes, and high-explosive test shots.

Fuel oil is burned in several small boilers at the Iowa Army Ammunition Plant. A limitation of 2.2% sulfur content was included in the purchase agreement with a supplier. This percentage prevents exceeding sulfur dioxide concentration limits as stated in state and Federal emission regulations. The coal-fired main heating plant is currently inoperable because of the inability of the existing boilers to function properly with a recently installed electrostatic precipitator and a new 45-meter (150-foot) stack. Rehabilitation of this plant will permit it to operate in compliance with emission standards.

Until 1982 the Iowa Army Ammunition Plant burned explosive wastes and explosive-contaminated wastes in the open air. Ambient air sampling during high-explosive burns indicated compliance with nitrogen oxide standards (Honea 1973). Two new incinerators equipped with pollution control devices to reduce particulate emissions have been installed to replace open air burning. Successful compliance tests before full-scale operations were conducted in 1982 by the Army Environmental Hygiene Laboratory (US Army 1982).

High-explosive test shots are performed for quality assurance and to determine detonation characteristics. Quantitative measurements at the site boundary for air pollutants from these shots at the Iowa Army Ammunition Plant have not been taken. However, test shots release smaller amounts of nitrogen oxides than waste high-explosive burns and measurements of high-explosive burns indicate compliance with ambient air standards (Honea 1973).

An incinerator for pathological wastes is used at the Iowa Army Ammunition Plant. The material burned includes hospital wastes and some chemical wastes from the chemical laboratory. This incinerator is used for several hours about once a week.

3.2.1.3 Hanford Site--Air

The Columbia Basin has a relatively high potential for air pollution because of frequent inversions and the air-trapping effect of the topography (Stone 1972); however, the Hanford Site is in compliance with Federal ambient air quality standards (Sula 1982). Particulate emissions from the Hanford Site operations constitute less than 0.2% of the particulate emissions in the Tri-county (Benton, Franklin, and Walla Walla counties) Air Pollution Control District (Sula 1981B). Routine emissions from the Hanford Site operations meet Federal emissions standards (Sula 1981B). Two onsite coal-fired power plants have recently had baghouses installed to control particulates. Tests are now being conducted to ensure compliance with emission standards.

3.2.2 Water

3.2.2.1 Pantex Plant--Water

The major surface water source near the Pantex Plant is the Canadian River. The Canadian River is impounded at Lake Meredith about 40 kilometers (25 miles) north of the Plant. Water from the lake is diverted, mixed with groundwater pumped from the Ogallala Formation, and used for municipal and industrial supplies for cities and towns in the High Plains.

All surface water drainage at the Pantex Plant is into playa basins; major runoff is into three onsite playas. The drainage from a small southeast area is into an offsite playa and portions of drainage along the northern boundary of the Plant go into a playa beyond the Plant boundary (Becker 1982B). There is no hydrologic connection that could transport potential contaminants into the Canadian River or Lake Meredith.

The Pantex Plant is underlain in ascending order above the Precambrian Basement Rocks by sediments of the Permian, Triassic, Tertiary, and Quaternary systems. The Ogallala Formation of the Tertiary system is of major importance. Deep wells completed at depths of about 180 to 260 meters (600 to 850 feet) into the gravels of the Ogallala Formation have provided the water supply at Pantex for more than 30 years. The Ogallala Formation also furnishes municipal and industrial water to nearby towns and cities and irrigation water to nearby farms. There has been little or no development of water supply from sediments of the Permian or Triassic systems because of low yield and poor water quality (Cronin 1964; Long 1961).

The Ogallala aquifer is not recharged by surface waters in the Pantex Plant area. The soil zone [upper 15 meters (50 feet)] is composed of caliche with interbedded clay and silty clay that restrict the infiltration of water. This restricted water infiltration, the high evaporation and evapotranspiration rates, and low rainfall result in essentially no recharge to the aquifer. This lack of recharge virtually eliminates any potential for contamination, if available, of the aquifer from surface sources. It also results in the aquifer being depleted through time as more water is pumped from the aquifer than is returned to it.

Since 1942, the average annual water level decline in the Pantex Plant Well Field has been about 0.5 meter per year (1.8 feet per year) (Purtymun 1982B). Most of the water-level decline can be attributed to heavy pumpage from the Amarillo field north of the Plant. The Amarillo municipal supply wells produced about 96 billion liters (25.5 billion gallons or 78.3 thousand acre-feet) during the period 1975 through 1980 or almost 12 times the Pantex Plant pumpage of about 8.3 billion liters (2.2 billion gallons or 6.8 thousand acre-feet) during the same period (Purtymun 1982B).

Water usage at the Pantex Plant has generally declined from about 2.08 billion liters (550 million gallons or 1.7 thousand acre-feet) in 1965 to about 1.3 billion liters (345 million gallons or 1.06 thousand acre-feet) in 1980 (Stewart 1980). The main reason for this decrease is less water usage by the Texas Technological University Research Farm for agricultural purposes. Operational processes and sanitary effluents account for about 89% of the water used.

The water supply at the Pantex Plant contains principally ions of calcium and bicarbonate. The quality of the water is good; the total dissolved solids are below a concentration of 400 milligrams per liter. The concentrations of chemical constituents are low, meeting Federal criteria or standards for municipal water supplies (Purtymun 1982B). The first wells for the Pantex Plant (Army Ordnance Plant) were drilled and in operation by 1942. A comparison of the water quality from one of the wells in 1942 with the chemical quality of the water from wells in 1981 indicated no significant change in water quality. Neither the withdrawal of water from the aquifer nor operations of the Pantex Plant has resulted in deterioration of the water quality (Purtymun 1982B).

Industrial and Sanitary Liquid Wastes

There are no liquid, industrial, or sanitary waste discharges from the Pantex Plant into offsite surface waters.

The Pantex Plant has a sewage treatment plant that consists of two primary clarifiers, two trickling filters, two secondary settling tanks, and an anaerobic digester. At the present time, the treatment plant operates at less than 25 per cent of its design capacity. The sanitary sewage system receives primarily domestic waste. In addition, diluted plating shop wastes and cooling tower water are routed to the system. Effluent from the treatment plant is discharged into Playa Basin Number 1 where it can be used to irrigate experimental crops. The quality of the effluent meets permit limits issued by the Texas Department of Water Resources under provisions of Chapter 26 of the Texas Water Code (Permit Number 02296, May 19, 1980).

Several types of industrial liquid wastes are disposed of onsite. All these discharges conform to the limits in the permit (Permit Number 02296, May 19, 1980) issued by the Texas Department of Water Resources. No Environmental Protection Agency National Pollutant Discharge Elimination System permit is required because none of the discharges reach offsite surface waters.

Analysis of water and sediments from drainage ditches into Playa Basin Number 1 and from the playa itself for Environmental Protection Agency priority pollutants indicate they are at or near background levels. Based on the low levels of these pollutants and hydrologic characteristics of the playa deposits, no impact is foreseen on the aquifer in the Ogallala Formation (Purtymun 1982B).

High-explosive contaminated wastewater is collected in troughs in each machine shop bay. This wastewater results from using water for cooling in high-explosives machining, so it contains no other pollutants besides high-explosive particles. This wastewater runs through settling and filtering equipment to remove the suspended particles of high explosives. The treated water then is routed to a playa basin.

Several types of organic solvents are used in high-explosive formulation. During the formulation, these solvents become contaminated with high explosives. Contaminated solvents are collected in drums or a portable 1900 liter (420 gallon) tank and removed to the burning ground for disposal by evaporation from metal tanks followed by burning of the residue.

Boiler blowdown from the main steam boilers contains some salts of sulfuric acid and sodium hydroxide plus other various treatment chemicals. The blowdown is discharged into an open ditch and conveyed to a playa.

Solvents from degreasing and wastewater from electroplating are collected in a subsurface storage tank. The waste solution is neutralized before discharge to the sanitary sewage system.

Acid wastewaters from manufacture of chemical high explosives are neutralized with calcium carbonate, collected in a plastic sheet-lined pond, and discharged to an open ditch. This effluent is mixed with filtered cooling water in the ditch and routed to Playa Basin 1. Discharges from the pond are minimal because they occur only when the wastewater level in the pond reaches the level of the discharge pipe. Because the pond has a very high evaporation rate, little wastewater from the pond is discharged to the open ditch that leads to Playa Basin No. 1 (MHSM 1980E).

Monitoring of surface runoff in the playa basins indicates the presence of only small amounts of chromates (less than 0.01 milligrams per liter) and small amounts of high explosives (less than 0.4 milligrams per liter) (MHSM 1982, Purtymun 1982A). The chromates are below the criteria for drinking water. High explosives are at the lower limits of detection. The water in the playa basins is not used for municipal supply and its quality is good enough to have no known detrimental effects when used for onsite irrigation.

3.2.2.2 Iowa Army Ammunition Plant--Water

The Iowa Army Ammunition Plant uses about 1.09 billion liters (288 million gallons or 884 acre-feet) of water annually. Water, which comes from the Mississippi River, is purchased from the city of Burlington. An additional 1.09 billion liters (288 million gallons or 884 acre-feet) could be acquired annually, according to an agreement with Burlington (USDOD 1975). The plant also has three standby wells that could furnish up to about 2.98 billion liters (788 million gallons or 2.4 thousand acre-feet) annually. Surface water could also be obtained from a manmade reservoir on the Plant site, if needed.

Groundwater resources at the Plant come from a shallow, water-table aquifer in glacial sediments and numerous deeper water-bearing zones in a thick Paleozoic sedimentary layer. Below the shallow (within 5 to 10 feet of ground surface in many places around the site) water table is a layer (aquiclude) that will yield little to no water to a well. At the Iowa Army Ammunition Plant, this aquiclude is a series of shale layers 82 to 100 meters (270 to 325 feet) thick between the shallow and deep aquifers (Day 1942). Because of the presence of these shale layers, which are expected to be relatively impermeable, the possibility of contamination of the lower Devonian and Cambrian-Ordivician aquifers from the shallow aquifer and ground surface is small. This is confirmed by permeability and potentiometric (water level) data collected onsite in conjunction with a subsurface contamination investigation (Terracon 1981).

A potential for flooding occurs about once a year at the mouth of Long Creek (USGS 1964). This flooding is not considered a danger to Plant operations (Becker 1982B).

Recent studies indicate that past Plant operations have had an effect on surface and shallow ground water. Elevated levels of barium, nitrates, sulfates, and phosphates have been reported. In addition, there is evidence of high explosives and decomposition products of high explosives in both the surface and shallow groundwaters at selected locations within the Plant boundaries (ERG 1981).

The Skunk River, a tributary to the Mississippi River, flows directly beyond the Plant's southern boundary. All drainage from the Plant discharges either directly or indirectly into the Mississippi River, which is located 10 kilometers (6 miles) to the east.

Industrial and Sanitary Liquid Waste

Industrial and sanitary waste treatment is provided by two sewage plants equipped with chlorination facilities and eight septic tank systems. The sewage treatment plants operate at about 35% of capacity.

Industrial wastewater includes some contaminated with metals and some contaminated with explosives. Systems for removing metals at the industrial waste treatment facilities eliminate the discharge of metal wastes to streams within the Iowa Army Ammunition Plant. Systems for removal of explosives contamination from industrial waters exist for all operating water lines flowing from high-explosive areas.

Treated process water and liquid sewage effluent from the Plant's sewage treatment facilities are discharged into onsite streams. These effluents flow through a tributary-river network that eventually drains into the Mississippi River. The Iowa Army Ammunitions Plant monitors water quality at the outfalls of two wastewater treatment plants and eight industrial wastewater discharge points quarterly in compliance with their National Pollutant Discharge Elimination System permits. Most discharges meet the permit conditions. Occasionally, limits are exceded for pH, suspended solids, Biological Oxygen Demand, and iron in runoff from the coal pile of the Main Heating Plant, according to quarterly monitoring reports submitted to the Environmental Protection Agency. As of August 1982, the regulatory and enforcement responsibilities of the National Pollutant Discharge Elimination System permit were being switched from Environmental Protection Agency to the State of Iowa.

3.2.2.3 Hanford Site--Water

The water supply for the Hanford Site is mainly from the Columbia River. In 1980, 613 billion liters (162 billion gallons or 497 thousand acre-feet) were diverted from the Columbia River for coolant, sanitary, and irrigation water. Wells tapping shallow water table aquifers furnish small quantities of water (about 190 liters per second or 50 gallons per minute) for sanitary and irrigation uses at outlying technical areas (USERDA 1975). A confined aquifer in the basalts can supply water but is currently unused.

A potential for flooding exists at the Hanford Site along the Columbia River; however, this flooding potential only exists along the river up to about 3 miles inland. Flooding would not occur at the proposed location for the nuclear weapons operations plant (Jamison 1981).

Industrial and Sanitary Liquid Waste

Wastewater is discharged at eight points along the Hanford Site reach of the Columbia River. These discharges consist of backwash water from water intake screens, cooling water, water storage tank overflow, and the fish laboratory wastewater. Effluents from each of these outfalls are routinely monitored under the National Pollutant Discharge Elimination System permit. During 1980, effluents were within the limitations stipulated in the permit with the exception of a single discharge point that experienced random temperature excesses on several occasions. An engineering study is now underway to determine the cause(s) for the violations and develop corrective measures (Sula 1981B). There is some thermal impact resulting from industrial discharge into the Columbia River, but the effect is localized over a small area and is not apparent in the river at Richland (Houston 1980).

3.2.3 Terrestrial Resources

3.2.3.1 Pantex Plant--Terrestrial Resources

Normal operations at the Pantex Plant for the past 30 years have not adversely affected the terrestrial resources of the area. The Pantex Plant is located on a near-level plain of windblown sand broken by shallow playas or basins. The Plant site is underlain by a thick section of sediments of Permian, Triassic, and Tertiary Age. The geologic structure is simple with a general thickening of the sediments to the northeast and thinning of the sediments to the southwest. To the northeast, the lower or older sediments of Permian age contain oil and gas and are part of the large Panhandle Oil and Gas Field. Fifty kilometers (31 miles) to the west, limestone (caliche) in the upper part of rocks of Tertiary Age is used for manufacture of cement (Purtymun 1982B).

The Pantex Plant lies within Zone 1 on the Seismic Risk Map (UBC 1979). Zone 1 earthquakes may cause minor damage, that is, broken windows, falling plaster, and disturbance of tall objects (corresponds to intensity V and VI on the Modified-Mercalli Intensity Scale, 1931). Zone 2 earthquakes, by comparison, may cause moderate damage, that is, damage to buildings varies depending on the quality of construction (corresponds to intensity VII on the Modified-Mercalli Intensity Scale, 1931).

Seismic studies specifically for the Pantex Plant defined a maximum credible earthquake as having 320 centimeters per second per second (0.33 gravity) horizontal acceleration and 220 centimeters per second per second (0.22 gravity) vertical acceleration. The probability of experiencing that magnitude of earthquake was judged to be no more than 1 chance in 10 thousand a year. There are no known faults that extend through or displace the sediments of the Ogallala Formation. Thus, there is little, if any, hazard from surface rupture at or adjacent to the Pantex Plant (Blume 1976).

Industrial Wastes

A sanitary landfill (Fig. 3.1.2.1-A) covers about 3 hectares (7 acres) and receives approximately 2300 cubic meters (3000 cubic yards) of waste each month. No explosives, explosive-contaminated materials, or radioactive materials are included in landfill wastes. Near the sanitary landfill is a smaller [about 1.8 hectares (4.5 acres)] landfill for construction debris. About 75 cubic meters (100 cubic yards) of construction rubble is disposed of monthly; this volume varies with the level of construction activity (USERDA 1976A).

Hazardous chemical disposal is based on the nature of the chemical (MHSM 1980E). Chemicals considered too hazardous to bury or burn (for example, mercury-contaminated materials) are shipped to an Environmental Protection Agency approved offsite disposal area (USEPA 1981). About 0.3 grams (0.01 ounce) of beryllium residue from machining operations is shipped to the Nevada Test Site for disposal every 2 years.

Hazardous or toxic solid wastes currently are handled in accordance with State and Environmental Protection Agency requirements (Environmental Protection Agency permit TX4890110527 and State of Texas permit 30459). They represent relatively small volumes.

Residue ash left after burning waste high explosives is buried in a burn residue landfill. Sludge from filtering suspended particles of high explosives from cooling water, about 7300 kilograms (16,100 pounds) per year, is burned. High-explosive contaminated waste materials (gloves, rags, and so on) are burned in a cage at the burning ground. About 500 kilograms (1100 pounds) of such materials are burned each year.

Past disposal operations included burning solvents containing some explosives in open pits. Now these solvents are evaporated in tanks and the remaining residues containing high explosives are burned. Analyses of cuttings from test holes adjacent to the pit formerly used to burn solvents and explosives indicated no movement of explosives into the underlying soil zone. Analyses of the soil for solvents indicated some solvents from 4 to 14 meters (13 to 48 feet) deep immediately adjacent to the pit (Purtymun 1982A). The solvents may be in the vapor phase as the solvents are highly volatile (Purtymun 1982A). Solvents in the vapor phase will not migrate to the Ogallala Aquifer.

3.2.3.2 Iowa Army Ammunition Plant--Terrestrial Resources

The Iowa Army Ammunition Plant is located on a plain of glacial sand, gravels, and clays. The topography varies from rather flat landscape on the northern sector to gently rolling terrain with steep slopes on the southern portion. Three streams flowing from north-northwest to south-southeast cross the Plant site. Beneath the glacial sediments is a thick sedimentary sequence of rocks of Paleozoic age.

Studies have indicated that Plant operations have caused elevated concentrations of heavy metals such as barium, chromium, copper, lead, zinc, and high explosives in the soil and sediment. These occur mainly in the vicinity of the landfill, the demolition area, the explosives disposal area, and at suspected former burial sites (ERG 1981).

The Iowa Army Ammunition Plant lies within Zone 1 on the Seismic Risk Map issued by the Uniform Building Code (MHSM 1971B). In Zone 1, distant earthquakes will cause minor damage to structures through the vibration (of buildings) with periods greater than 10 seconds. This damage would include broken windows, fallen plaster, and disturbance of tall objects. By comparison, in Zone 2, earthquakes may cause moderate damage, such as damage to buildings depending on the quality of construction.

Industrial Wastes

The Iowa Army Ammunition Plant has an extensive program to recover and recycle waste materials. Waste products are collected, sorted, and stockpiled for later sale. About $400 thousand was realized in calendar year 1980 from scrap sales of over 1500 metric tons (1650 tons).

The Iowa Army Ammunition Plant management currently controls the production, procurement, storage, handling, use, and disposal of hazardous materials. The methodology for handling hazardous materials at Iowa is detailed in a Spill Prevention, Control, and Countermeasure Plan (IAAP 1981).

All waste oil generated by the Iowa Army Ammunition Plant is collected and classified as burnable or nonburnable. The nonburnable oil is sold to a refinery; the burnable oil is used to help fire plant boilers.

A sanitary landfill is operated by the Plant and monitored by the Iowa Department of Environmental Quality. The landfill's area is approximately 10 hectares (25 acres). The depth of fill is about 7.5 meters (25 feet), as stipulated in the operating procedures (IAAP 1979).

3.2.3.3 Hanford Site--Terrestrial Resources

The Hanford Site is located on a partly eroded floodplain of the Columbia River. The land surface slopes upward from the Columbia River onto a central plateau. North of this plateau, within the site, are two ridges, Gable Mountain and Gable Butte. The Columbia and Yakima Rivers form portions of the site boundary (Fig. 2.2.3-A).

The surface at the Site is a cover of sand dunes and eolian (windblown) sands ranging up to 12 meters (40 feet) in thickness. The Site is underlain stratigraphically by semi- and unconsolidated sands and gravels with a deeper sequence of basaltic lava flows. It is estimated currently that this basalt sequence is at least 3700 meters (12,000 feet) thick (Gephart 1979).

Environmental monitoring studies have shown that some soil on the Hanford Site is contaminated with strontium, cesium, and plutonium. Studies of onsite ponds also have shown elevated concentrations of radioactivity (Sula 1981A). There also appears to be some contamination of Columbia River water with radioactive iodine (Sula 1981B).

The Hanford Site is located in an area that is still undergoing seismic deformation, and resultant earthquake activity. The largest maximum earthquake calculated in the Hanford Site regional vicinity is located on the Rattlesnake-Wallula alignment of the Cle Elum zone of deformation. This earthquake would have a magnitude of 6.5 M on the Richter scale and a probability of occurrence of 1 chance in 50,000 a year. In relation to the proposed relocation area, the closest maximum earthquake would be located on Gable Mountain on the Hanford Site. This earthquake would have a magnitude of about 5 M on the Richter scale and a probability of occurrence of about 1 chance in 17,000 a year. Although the fault on Gable Mountain was recently found to be capable of triggering an earthquake, the area's design ground motion values of 245 and 125 centimeters per second per second (0.25 and 0.125 gravity) as the zero period limit of appropriate response spectra for the Safe Shutdown Earthquake and Operating Basis Earthquake, respectively, has remained unchanged (Knight 1982).

Industrial Wastes

Toxic nonradioactive wastes (beryllium, asbestos, mercury, and so on) are disposed of in different ways. Beryllium waste is packaged and buried in retrievable storage (USDOE 1980D). Nonburnable solid or liquid toxic materials are packaged and buried in an onsite disposal area.

Other nonradioactive, nontoxic solid waste is buried in an onsite sanitary landfill. The waste volume is reduced by a factor of 3 by compaction before being buried. The total compacted volume for the waste is about 12,000 cubic meters (15,700 cubic yards) per year.

3.2.4 Ecology

3.2.4.1 Pantex Plant--Ecology

Aquatic Ecology

No known aquatic or aquatically associated threatened or endangered species are known to exist within the boundaries of the Pantex Plant according to the United States Fish and Wildlife Service (Stephens 1981, USFWS 1981).

Lake Meredith, a manmade impoundment on the Canadian River, is the only perennial aquatic ecosystem near the Plant. This ecosystem, approximately 40 kilometers (25 miles) north of the Plant, supports a warm water sport fishery, and thus, provides a potential ecological pathway to man. However, Pantex operations have not impacted this ecosystem adversely as pollutant emissions are below toxic or harmful levels and are essentially contained onsite. (See Sections 3.2.1 on Air and 3.2.2 on Water.) In addition, runoff from severe storms or melting snows is collected in playa basins on or adjacent to the site and does not enter the Lake Meredith aquatic ecosystem (Becker 1982B).

Aquatic ecosystems that exist on or immediately adjacent to the Pantex Plant are High Plains Playas (small catchment basins) that accumulate water during wet seasons and serve as stock watering ponds or as occasional water sources for irrigation. These ponds typically dry up on an annual basis; therefore, the most common macro invertebrates found are aquatic insects. These ponds also serve as resting, feeding, and nesting habitat for migratory waterfowl and shorebirds.

The most important playa onsite is Playa Lake Number 1, which receives wastewater discharges from the Plant in addition to runoff. Water from this pond is used for irrigation, and this playa has enough inflow that it does not go dry annually. The environmental monitoring reports (MHSM 1973, MHSM 1975A, MHSM 1975B, MHSM 1976, MHSM 1977A, MHSM 1977B, MHSM 1978, MHSM 1979A, MHSM 1979B, MHSM 1980A, MHSM 1980B, MHSM 1981G, MHSM 1982) show that most elements and pollutants measured are below the desired maximum levels for irrigation waters (Dawson 1974) and also are below the proposed Environmental Protection Agency criteria for agricultural usage (USEPA). Additional water and sediment sampling done specifically for this Environmental Impact Statement (Purtymun 1982A, Purtymun 1982B) also show priority pollutants to be at or near background levels. Based on the low levels of pollutants seen, no environmental impacts would be expected. Wildlife using this playa or the other playas would not ingest heavy metals or other pollutants at levels considered harmful. Therefore, further field studies of the various food chains or ecological pathways associated with these aquatic ecosystems were deemed unnecessary.

Terrestrial Ecology

Flora. According to the United States Fish and Wildlife Service, no plant species federally recognized as endangered or threatened exist at the Pantex Plant (Stephens 1981, USFWS 1981). An unofficial potential list of rare and endangered plants native to Texas was prepared by the Rare Plant Study Center of the University of Texas at Austin 1974 (RPSC 1974). This listing contains four species (Panhandle Prickly Pear, Bracted Milkweed, Cylinder Spikesedge, and Bottle Brush) having the potential to exist at Pantex; however, the chance of finding one is remote as no identifiable prime habitat for these species is found at Pantex.

A detailed survey of plant species was prepared for the Amarillo International Airport Environmental Impact Assessment report (CBA 1981), and because of the location and habitat types, it is considered applicable to the Pantex Plant. That study did not identify any of the four mentioned species on the Rare Plant Study Center list.

The Pantex Plant is located within a treeless portion of the High Plains that is classified as mixed prairie by Allred (1956). It originally was characterized by climax stands of bluestems, wildrye, and other bunchgrasses such as buffalo grass and grama grass. Today, extensive tracts of this native vegetation have been converted into irrigated cropland. Most of the remaining range has been overgrazed, allowing less desirable grasses, forbs, and shrubs to dominate these areas both onsite and on the surrounding rangelands.

Pesticides. Herbicides and pesticides are routinely used at Pantex to control specific target species of undesirable vegetation and insects. During 1979 the following were used: Hyvar X [1400 kilograms (3,100 pounds)], 2,4-D [250 liters (66 gallons)], Malathion [45 liters (12 gallons)], Chlordane [20 liters (5 gallons)], and Isotox [1 liter (0.25 gallons)]. All pesticides used are registered under the Federal Insecticide, Fungicide, and Rodenticide Act and are used in accordance with labeled directions at concentrations, application rates, and frequencies that have been approved. Pesticides are stored in secured areas and application is supervised by a trained State-certified employee.

Fauna. No Federally recognized threatened or endangered species are known to live onsite. However, the black-footed ferret (a Federally recognized endangered species) might be expected; according to the United States Fish and Wildlife Service, this species is "assumed to be extirpated in Texas" (Stephens 1981). Two raptors, the southern bald eagle and the peregrine falcon (both Arctic and American), migrate through this area and occasionally might be found onsite (USFWS 1981). One whooping crane has been observed near the Plant in the last 15 years; however, it is thought that the bird was blown off the normal migratory path (CBA 1981).

The State of Texas has adopted lists of protected endangered species, protected nongame species, and protected game species under subtitle B of the Texas Parks and Wildlife Code. Some of these species may exist onsite or migrate across the site; however, no unique habitat that would require special attention exists onsite.

Based on the results of the threatened and endangered species evaluation, the low levels of liquid and airborne emissions and the detailed survey of wildlife done for the Amarillo International Airport (CBA 1981), further ecological studies are not needed for the Pantex Plant.

3.2.4.2 Iowa Army Ammunition Plant--Ecology

Aquatic Ecology

No known rare or endangered aquatic or aquatically associated species are known to exist within the Iowa Army Ammunition Plant's boundary (USARMY 1973A). However, there are numerous aquatic ecosystems present.

Most of the aquatic ecosystems within the Iowa Army Ammunition Plant exist as small ponds [surface area less than 0.5 hectare (1.2 acre)] or as drainage ditches. In addition, there are three streams and two manmade lakes (Carl Anderson Lake and Long Lake Reservoir) onsite that support sport fisheries or otherwise provide recreational activities (USARMY 1973A).

The shoreline vegetation of these ecosystems is typified by dense stands of hydrophytic (plants requiring moist habitat) and phreatophytic (plants whose roots penetrate the water table) species. Commonly found plants include cottonwoods, willows, red osier dogwood and button ball bush. Most of these ecosystems support healthy populations of warm-water fish (USARMY 1973A).

Terrestrial Ecology

No known rare or endangered plant or animal species are known to reside within the Plant (USARMY 1973B). However, bald eagles have been observed nesting on the Mississippi River and could occasionally enter Plant boundaries searching for food.

Flora. What was once tall grass prairie composed of warm-season grasses with mixed forbs broken by woodland communities of white oak and hickory has become some of the most productive agricultural lands known anywhere in the world (Section 3.2.5, Agriculture). Today the vegetative community types are a man-influenced mosaic of rowcrops, improved pastures, woodland shrub transition zones, and mixed deciduous hardwood forests.

Current releases of air and water pollutants (Sections 3.2.1.2 and 3.2.2.2) are below levels considered to be phytotoxic (Davis 1973, Skelly 1974).

Fauna. Linked to the high productivity and diversity of habitat types is an equally diverse and abundant spectrum of animal life. Current releases of air and water pollutants (Sections 3.2.1.2 and 3.2.2.2) are below levels that would cause significant bioaccumulations of toxic elements in wildlife populations.

3.2.4.3 Hanford Site--Ecology

Much of the following information has been adapted from the document "Standardized Input for Hanford Environmental Impact Statements" (Jamison 1981).

Aquatic Ecology

No aquatically associated rare or endangered species are known to exist within the proposed project area on the Hanford Site (Elle 1981). Robinson's Onion, an onion-like member of the lily family, occurs on gravel bars along the Columbia River but is well removed from the interior of the Site. This plant is a candidate for listing as a Federal threatened or endangered species (Rickard 1981A).

The Columbia River is the most important aquatic ecosystem on the Hanford Site, and the last free-flowing reach of the Columbia River in the United States passes through the Hanford Site (Jamison 1981).

Operations at the Hanford Site have resulted in small radioactive releases and thermal discharges to the Columbia River (USERDA 1975). The Columbia River supports a cold-water fishery, and the Hanford reach contains both fall Chinook salmon and steelhead trout spawning grounds. These spawning grounds now produce 15% to 20% of the total fall Chinook salmon hatch in the river. Thirty-nine species of fish are found in the Hanford site reach of the Columbia.

Terrestrial Ecology

No rare and/or endangered plant or animal species are known to exist year round within the proposed project area (Elle 1981). However, bald eagles winter along the Columbia River, and from November to February, they would be frequently found flying over or hunting on the proposed plant construction site (Fitzner 1979).

Flora. The Hanford Site is located in a region that has been variously classified as cool desert, winter-wet cool steppe, or midlatitude desert. Vegetation types are those tolerant of dry hot summers followed by cold wet winters. As a result, productivity is low. However, the region has wide diversity of habitat types and a very diverse species composition.

The proposed project site is within a sagebrush/cheat-grass vegetation type that covers approximately 75% of the Hanford Site. This vegetation type is conducive to rodent populations, which in turn support a wide variety of raptors (Fitzner 1980).

In addition to Robinson's Onion, three plant species (Columbia Milk Vetch, Rosy Balsamroot, and Persistent Sepal Yellow Cress) exist on the Site and are candidate species for federal listing as threatened or endangered. None of these species are expected to be found in the interior of the Hanford Site at or near the proposed project site (Rickard 1981A).

Fauna. A wide variety of wildlife exists at the Hanford Site. Most of this wildlife has access to radioactively contaminated onsite ponds and vegetation growing in or near the ponds. The ingestion of radioactively contaminated water or vegetation by wildlife provides a transfer mechanism away from these designated waste areas. Ingestion of contaminated material by game animals provides a potential pathway for contamination to man (Sula 1981A).

The wildlife sampling program for 1980 included waterfowl, upland game birds, deer, and rabbits (Sula 1981A).

3.2.5 Land Use/Agriculture

3.2.5.1 Pantex Plant--Land Use/Agriculture

Land Use

Most land surrounding the Pantex Plant is dryland or irrigated farmland on broad flat plains interspersed with grassland pastures and water ponds (playas) in natural drainage areas. The average-sized farm is 518 hectares (1280 acres) or 2 square miles. These large tracts of land are interrupted only by U.S. Highway 60, a railroad, a few gravel roads, and an occasional farmstead or rural home site. Rural housing development is greater several miles south and southwest of Pantex Plant boundaries toward Amarillo and the Amarillo International Airport.

Other major developments in the immediate vicinity of Pantex Plant are the Texas Technological University Agriculture Research Station, the Iowa Beef Packing Plant, and the industrial park adjoining

Amarillo International Airport. These facilities are located about 8 kilometers (5 miles), 10 kilometers (6 miles), and 12 kilometers (7-1/2 miles) southwest of the Pantex Plant.

General Agriculture

Agricultural land within the Pantex Plant boundary [about 3270 hectares (8070 acres)] is managed by the Texas Technological University Research Farm through an agreement with the Department of Energy. The research farm itself consists of about 400 hectares (1 thousand acres) of farmland and a feedlot located southwest of the Pantex Plant boundary. Farmland on the site generally is planted under limited irrigation and dryland conditions in a 3-year winter wheat-fallow-grain sorghum sequence. Two sources of irrigation water are used (water from the Ogallala aquifer and surface water from the playa basins including Playa Lake Number 1) to irrigate crops depending on rainfall (Section 3.2.2.1).

The major soil type, the Pullman series, is finely textured and easily eroded. These soils require careful cropping practices (Unger 1981) to minimize wind loss and sheet erosion under fallow conditions. Because of the fine texture and low permeability of these soils, irrigation is limited to about 13 to 15 centimeters (5 to 6 inches) per application. These soils, when irrigated, have been considered as potentially prime farmland by the Soil Conservation Service (USDA 1978, USDA 1981A, USDA 1981B).

Hard red winter wheat is planted in early September after irrigating or when soil has stored sufficient rainfall. Wheat is typically irrigated once in October/November, once in March/April, and again in May/June depending on rainfall.

Drought-resistant grain sorghum and forage canes are grown under limited irrigation or dryland conditions. Corn is not a major crop because extensive irrigation is necessary for maturation. About half the crops grown in Carson County are strictly dryland because of the high cost of pumping water from the Ogallala aquifer.

Cow/calf operations are maintaned in the Panhandle area on large (several sections) ranches. Stocking rates of one animal unit per 2 to 4 hectares (5 to 10 acres) of rangeland are typical and substantial supplemental feeding is necessary at times during the winter months. Calves also are grazed from November to March on young winter wheat. The native short-grass prairie feed is highly nutritious and is characterized by a grass maixture of blue gramma and buffalo grass.

Radioactivity Measurements in Agricultural Products

A special study was undertaken for this Environmental Impact Statement to evaluate food and agricultural pathways. Foodstuffs (garden vegetables and beef cattle) from the Pantex Plant site were sampled and analyzed for several radionuclides (tritium, uranium, and plutonium). All foodstuffs sampled were found to be at background levels. There are no indications of any contamination of garden and livestock products grown on or near the Pantex Plant site (Wenzel 1982A, Buhl 1982).

3.2.5.2 Iowa Army Ammunition Plant--Land Use/Agriculture

Land Use

The Iowa Army Ammunition Plant is located on a combination of high quality, almost flat, agricultural land (about 60% of the area) and hilly, rough pasture land (40%) traversed by three small creeks. Terrain beyond plant boundaries is characterized by an escarpment leading to Mississippi River bottomlands. The upland is generally flat to moderately rolling plains with pastures on the poorer, steeper slopes. Timber covers the rougher areas along waterways. The Skunk River valley forms the irregular southern boundary of the Plant site.

Two major cities, Burlington and West Burlington, border the Plant site on the east. Six villages and small towns are located adjacent to or within 3 miles of the Plant boundary on the north, west, and south. The surrounding rural area is composed of about 61% cropland, 11% pasture, 15% woodland, and 13% urbanized home sites. This area is interspersed with open space, state and Federal lands, waterways, or other nonagricultural land masses. Heavy rainfall in the area permits intensive farming practices on units that average about 100 hectares (250 acres) in size. As a result, it is common to observe three or more homes on a square mile of highly productive farmland.

Agriculture

This region is one of the most productive farming areas of the United States producing upwards of 180 bushels of corn per acre. The Army leases 2800 hectares (7000 acres) of prime agricultural land within Plant boundaries to private farmers, which totals 40% of the site. Crop sequences and practices are closely supervised with assistance from the Soil Conversation Service and United States Department of Agriculture (SCS 1972). An additional 800 hectares (2000 acres) is leased for pasture. Improved meadows carry 1-1/2 to 2 animal units per acre (IAAP 1974).

The major row crops are field corn and soybeans. Corn and soybeans are rotated with improved pastures of alfalfa/grass grown under nursery crops of winter wheat or oats. Livestock is typified by corn-fed cattle and hogs. There are some dairy operations geared to local markets.

3.2.5.3 Hanford Site--Land Use/Agriculture

Land Use

Land use within 8 kilometers (5 miles) of the proposed construction site includes portions of the Columbia River, the area managed by the U.S. Bureau of Sports, Fisheries, and Wildlife, the Washington Public Power Supply System generating plant, the meteorology station, the Near-Surface Test Facility, and a central fire station. Also included are the associated roadways, railroads, and transmission facilities and corridors. Much of the land between existing facilities is open desert range . The nearest public highway (State Highway 24) traverses the northwest corner of the Hanford Site about 12 kilometers (7-1/2 miles) from the proposed construction site. Land use surrounding the Hanford Site includes irrigated farmland near the river, dryland farms, and large tracts of grazing land. The nearest population center is Richland, approximately 32 kilometers (20 miles) southeast of the proposed construction site.

Agriculture

Agriculture is a primary industry in eastern Washington. The Columbia Basin Project north and east of the Hanford Site has opened more than 500 thousand acres to irrigated farming. The growing season is long, with 175 frost-free days.

The soils of the region are characterized by their high silt and sand content. They are loess soils with low exchange capacity. Gravel is a major component in the river flood plain area (Hagood 1970).

Benton County (to the west of the Hanford Site) includes most of the Yakima River Valley. This area is well known for apple, cherry, and peach orchards, vineyards, alfalfa, field corn, and irrigated and dryland wheat. The orchards are grown close to the Yakima River, whereas the wheat is grown on the tops of the Horseheaven Hills, which are several hundred feet higher in elevation. In Franklin County (to the east of the Hanford Site), field corn, wheat, alfalfa, potatoes, and asparagus are the major crops.

Cattle are grazed on cheatgrass and native vegetation in the winter months from January through May, then the cattle are placed on irrigated improved pastures for the rest of the year or trucked to mountain pastures. Dairy herds are numerous and are fed local silage and alfalfa. There are two large feedlots in the area that use local grain and alfalfa as major feeds.

No farming or grazing is practiced currently on the Hanford Site south of the Columbia River. Extensive farming was practiced historically surrounding the abandoned townsites of White Bluffs and Hanford as well as along the Columbia River before the site was purchased by the government.

3.2.6 Environmental Radiation and Radioactivity

Environmental radiation levels in the areas surrounding the Pantex Plant site and the two alternative sites are dominated by natural background radiation and radiation resulting from worldwide fallout from nuclear weapons testing.

3.2.6.1 Pantex Plant--Environmental Radiation and Radioactivity

Radioactive Releases

Two principal radioactive materials are emitted to the atmosphere from operations at the Pantex Plant, depleted uranium and tritium. Plutonium is handled at the Pantex Plant only in solid form. No release of plutonium results from routine plant operations.

There are no existing or expected radioactively contaminated liquid effluents at the Pantex Plant.

To evaluate the radiological effects of current and past operations on the environment at the Pantex Plant, several special studies were done. These included

- measuring external penetrating (charged particle and photon) radiation around Pantex at 24 locations for 15 months and resolving these radiation fields into natural background and fallout components (Buhl 1982);

- monitoring air concentrations of uranium and plutonium at 14 locations for 1 year (Buhl 1982);

- measuring depleted uranium air concentrations following an explosive test shot (Buhl 1982);

- sampling and analyzing soil at five locations onsite, at five perimeter locations, and 17 regional locations (Purtymun 1982A, Buhl 1982, Wenzel 1982A);

- sampling and analyzing sediments at five locations onsite and eight locations offsite (Purtymun 1982A);

- sampling and analyzing ground and surface water both onsite and offsite including the Canadian River drainage and Lake Meredith (Purtymun 1982A); and

- sampling and analyzing foodstuffs, including produce, vegetation, and livestock produced in the Pantex area (Buhl 1982, Wenzel 1982A).

Analysis of these air, soil, water, and foodstuff samples found no detectable above-background offsite concentrations of uranium, plutonium, or tritium, the radionuclides that would be associated with the Pantex Plant. Additional detail on some of these results is presented in Appendix 8.1.

Air sampling for radioactivity at Pantex routinely is accomplished through the use of continuously operating air samplers located around the plant. Measured ambient concentrations of uranium from both the routine sampling programs and special studies are very small, less than 0.01% of the Department of Energy Radioactivity Concentration Guide. Measured air concentrations of radioactivity including plutonium reflect no discernible impact from the Pantex Plant operations.

Radiological Doses

The results of the above studies showed that the component of 1981 radiation dose resulting from current or previous operations is so small that it cannot be detected above the background radiation dose component by environmental field measurements. The inability to directly measure this plant operation dose component is of particular importance in evaluating the environmental impacts of the proposed action because the proposed action involves essentially continuing the type of operations at the Pantex Plant that have occurred for the last 30 years and that were part of the Iowa operation for about 25 years. Nevertheless, to provide some basis for analysis of impacts, the radiation dose component in 1981 resulting from current or previous operations has been theoretically calculated from demographic, agricultural, and meteorological data and uranium and tritium release rates (Buhl 1982). Table 3.2.6.1-1 shows the estimated doses to the maximum exposed individual living next to the Pantex Plant from exposure during 1981 to facility releases. Doses calculated for facility releases are 50-year dose commitments per year of exposure. The 50-year dose commitment to an organ is the total dose that an organ would receive from internally deposited radioactive material during the 50 years following intake. For comparison, doses from natural background radiation and the U.S. Department of Energy's Radiation Protection Standards are also presented.

These calculated doses do not increase existing doses from natural background radiation by more than 0.03%. The highest 50-year organ dose commitment per year of exposure to the maximum exposed individual was calculated to be 0.08 millirem per year to the bone, or 0.005% of the Radiation Protection Standard (USDOE 1980A). The 80-kilometer (50 mile) 50-year population dose commitment is 0.012 person-rem per year

TABLE 3.2.6.1-1

PANTEX PLANT VICINITY ESTIMATES* OF CURRENT BACKGROUND AND FACILITY-ASSOCIATED RADIATION DOSES (millirem) PER YEAR OF EXPOSURE TO A HYPOTHETICAL INDIVIDUAL

	Whole Body	Lung	Bone
Background	106	306	291
Maximum individual dose from facility releases**	<0.01	<0.01	0.08
Radiation Protection Standards***	500	1500	1500

*Estimates include a 10% reduction in cosmic radiation and a 20% reduction in external terrestrial radiation because of shielding by buildings and an additional 20% reduction in external terrestrial radiation because of self-shielding by the body (NCRP 1975).

**Doses are 50-year dose commitments per year of exposure (Buhl 1982).

***Radiation Protection Standards for an individual in the general public (USDOE 1980A).

of exposure (whole body), 0.05 person-rem per year of exposure (lung), and 0.16 person-rem per year of exposure (bone).

The population dose from natural background radiation within an 80-kilometer (50 mile) radius is 27,200 person-rem per year (whole body), 78,600 person-rem per year (lung), and 74,700 person-rem per year (bone). In calculating these doses, a 10% and 20% reduction was applied to the cosmic and external terrestrial radiation dose components, respectively to account for shielding by housing, and an additional 20% reduction was applied to external terrestrial radiation for self-shielding by the body (NCRP 1975).

Radiological Effects

Potential somatic and genetic health effects from natural background radiation and routine Plant operations were calculated using risk factors from BEIR III (BEIR III 1980) and the computer model estimates of doses. (See Appendix 8.1 for additional discussion of calculation procedures.)

The average added risk of cancer mortality to a member of the public living within 80 kilometers of Pantex resulting from 1 year's operation is less than 1 chance in a billion. For comparison, the risk of dying from cancer as a result of exposure to natural background radiation for 1 year is 1 chance in 45,000 (Buhl 1982). These risk estimates, which predict no observable increase in cancer mortality because of plant radioactive emissions, appear to be consistent with the conclusions of the epidemiological study (Wiggs 1982A) discussed in Section 3.2.12.1.

The average added risk of genetic disorders in offspring in all subsequent generations as a result of Pantex radionuclide emissions for 1 year is less than 1 chance in a billion. This can be compared with the estimates of risk ranging from 1 disorder in 5000 to 1 in 90,000 expected annually from natural background radiation, and the risk of 1 disorder in approximately 10 offspring because of spontaneous incidence of genetic defects (Buhl 1982).

Solid Wastes with Radioactive Contamination

No radioactive waste is disposed of or permanently stored at the Pantex Plant. Approximately 6 to 7 cubic meters (200 to 250 cubic feet) of solid waste with low levels of radioactive contamination are generated annually from operations and high-explosives testing involving depleted uranium. The bulk of this waste is vacuum filters, paper toweling, and rubber gloves. Some is soil and other residue picked up around the test firing sites. This waste is sealed in plastic bags, compacted in 0.5-cubic-meter (55 gallon) steel drums, and temporarily held at the Pantex Plant in an above-ground, secured igloo. The drums are shipped to the Nevada Test Site on a semiannual or annual basis for permanent disposal.

Approximately 75 cubic meters (2.7 thousand cubic feet) of radioactive residue from past military accidents has been held at the Pantex Plant since the mid-1960s. Steel containers and fiberglass-coated wooden boxes containing this residue were retrievably stored in underground concrete cylinders and an earthen trench. In 1981, all containers were retrieved and moved to an above-ground igloo for radiological assaying and characterization. Containers determined to include radioactive waste are being overpacked and shipped to the Nevada Test Site for disposal or storage. Some other containers are still being held for evaluation of possible recycling of the radioactive residue. Once decisions on these possibilities are made, these remaining containers will be shipped from the Pantex Plant. The trench where this residue from military accidents was held was sampled for any remaining radioactivity. Analyses of samples by the Texas Department of Health and other laboratories found no remaining contamination problem.

3.2.6.2 Iowa Army Ammunition Plant--Environmental Radiation and Radioactivity

Radioactive Releases

There are no radiological releases from current operations at the Iowa Army Ammunition Plant.

A limited area of onsite contamination, identified as depleted uranium, was found at the firing site where test firing similar to that now being conducted at the Pantex Plant was conducted by the Atomic Energy Commission from 1965 to 1974. Resuspension and transport of dust from this area were considered in evaluating the radiological impact of past operations. However, offsite soil surveys for uranium, plutonium, and tritium and field gamma ray spectroscopic measurements (field studies undertaken for this Environmental Impact Statement) detected no manmade radionuclides other than those associated with worldwide fallout (Buhl 1982).

Radiological Doses

Table 3.2.6.2-1 shows the estimated doses (50-year dose commitments) to the maximum exposed individual resulting from exposure in 1981 to past releases from the Iowa Army Ammunition Plant. Both background doses and the Department of Energy's Radiation Protection Standards also are shown. Doses from Plant operations were estimated using the computer code AIRDOS-EPA (Moore 1979) and site-specific parameters. The 50-year population dose commitments resulting from past operations at the Iowa Army Ammunitions Plant are 0.00012 person-rem (whole body), 0.0015 person-rem (lung), and 0.0011 person-rem (bone).

Population doses resulting from exposure to natural background radiation are 31.6 thousand person-rem per year (whole body), 106 thousand person-rem per year (lung), and 100 thousand person-rem per year

TABLE 3.2.6.2-1

IOWA ARMY AMMUNITION PLANT VICINITY ESTIMATES*
OF CURRENT BACKGROUND AND FACILITY-ASSOCIATED RADIATION
DOSES (millirem) PER YEAR OF EXPOSURE TO A HYPOTHETICAL INDIVIDUAL

	Whole Body	Lung	Bone
Background	85	285	270
Maximum individual dose from facility releases**	<0.01	<0.01	<0.01
Radiation Protection Standards***	500	1500	1500

*Estimates include a 10% reduction in cosmic radiation and a 20% reduction in external terrestrial radiation because of shielding by buildings and an additional 20% reduction in external terrestrial radiation because of self-shielding by the body (NCRP 1975).

**Doses are 50-year dose commitments per year of exposure (Buhl 1982).

***Radiation Protection Standards for an individual in the general public (USDOE 1980A).

(bone). In calculating the population and individual doses, reductions of the 10% and 20% were applied to the cosmic and external terrestrial radiation to compensate for shielding by housing. An additional 20% reduction in terrestrial radiation was applied to account for self-shielding by the body.

Radiological Effects

The lifetime risk of cancer mortality from natural background radiation is 1 chance in 53,000 per year of exposure. Estimates of the risk of genetic disorder in offspring from annual exposure to background radiation ranges from 1 disorder in 6200 offspring to 1 disorder in 110,000 offspring, whereas the total risk of spontaneous incidence of genetic disorder resulting from all causes is 1 disorder in 10 offspring.

Residual contamination resulting from previous explosive testing involving depleted uranium is found in a limited area around a firing site at the Iowa Army Ammunition Plant. The added lifetime risk of cancer mortality to the average individual living within 80 kilometers (50 miles) of this site that results from this contamination is less than 1 chance in 1 billion per year of exposure. The added risk of genetic disorder in offspring is also less than 1 chance in a billion per year of exposure.

3.2.6.3 Hanford Site--Environmental Radiation and Radioactivity

Radioactive Releases

The radioactive materials discharged to the atmosphere at the Hanford site are detailed annually in their Environmental Surveillance Report (Sula 1982). Radioisotopes released to the atmosphere consist of fission and activation products normally associated with the uranium fuel cycle. In 1981 about 78 thousand Curies were released, with argon-41 (65 thousand Curies, 1.8-hour half-life), cesium-138 (11 thousand Curies, 32-minute half-life), and xenon-135 (490 Curies, 76-minute half-life) representing the bulk of this total.

Radiological Doses

Table 3.2.6.3-1 shows the estimated doses incurred in 1981 by a member of the public living next to the Hanford Site from both background and site operations. These dose were taken from the 1981 Environmental Surveillance Report for the Hanford Site (Sula 1982).

TABLE 3.2.6.3-1

HANFORD SITE VICINITY ESTIMATES*
OF CURRENT BACKGROUND AND FACILITY-ASSOCIATED RADIATION
DOSES (millirem) PER YEAR OF EXPOSURE TO A HYPOTHETICAL INDIVIDUAL

	Whole Body	Lung	Bone
Background	82	282	267
Maximum individual dose from facility releases**	0.4	0.02	1.3
Radiation Protection Standards***	500	1500	1500

*Estimates include a 10% reduction in cosmic radiation and a 20% reduction in external terrestrial radiation because of shielding by buildings and an additional 20% reduction in external terrestrial radiation because of self-shielding by the body (NCRP 1975).
**Doses are 50-year dose commitments per year of exposure (Sula 1982)
***Radiation Protection Standards for an individual in the general public (USDOE 1980A).

Radiation doses to the public caused by the current operations of the Hanford Site in 1981 were estimated by computer modeling and, where possible, from field measurement. A 50-year dose commitment of 1.3 millirem to bone of an hypothetical maximum exposed individual was the highest dose calculated for 1981 operations. This dose represents 0.09% of the Radiation Protection Standard (USDOE 1980A). All other calculated organ doses were less than 0.09% of their respective Radiation Protection Standard. The 50-year population dose commitments are 4 person-rem (whole body), 3 person-rem (lung), and 6 person-rem (bone) (Sula 1982).

Exposures to natural background radiation results in estimated population doses of 27,000 person-rem per year (whole body), 93,200 person-rem per year (lung), and 88,200 person-rem per year (bone). Components of these doses from cosmic and external terrestrial radiation have been reduced by 10% and 20%, respectively, because of shielding by housing. The external terrestrial radiation dose was reduced an additional 20% because of self-shielding by the body.

Radiological Effects

Exposure to background radiation levels would result in a risk of dying from cancer of 1 chance in 53,000 per year of exposure. The risk of genetic disorder in offspring ranges from 1 disorder in 6700 to 1 disorder in 120,000 per year of exposure. The risk of spontaneous genetic disorder from all causes is about 1 disorder in 10 offspring. Risk of cancer mortality resulting from facility operations in 1981 is calculated to be 1 chance in 500,000,000. Corresponding estimates of the risk of genetic disorder in all subsequent offspring are from 1 chance in 50,000,000 to 1 chance in 800,000,000.

Radioactive Wastes

Locations within the Hanford Site are used for radioactive waste disposal by the Department of Energy. Support facilities include complexes of underground storage tanks for high-level liquid radioactive waste, as well as cribs, ditches, and ponds used for discharge of liquid radioactive wastes, and solid radioactive waste burial grounds. Detailed accounts of these disposal operations may be found in USERDA 1975. Contamination of the shallow ground water and the Columbia River has resulted from the liquid radioactive disposal. The contamination plumes are monitored and reported annually (Eddy 1981). Onsite soil contamination by strontium, cesium, and plutonium also has been measured (Sula 1981B).

3.2.7 Energy Resources

3.2.7.1 Pantex Plant--Energy Resources

In 1981, the Pantex Plant used 39.8 million kilowatt hours (136 billion British thermal units) of electricity and 10.5 million cubic meters (370 billion British thermal units) of natural gas (MHSM 1981C). The natural gas is used primarily for generating steam for space heating of buildings. The electricity is used mostly for space cooling and lighting. The Pantex Plant electricity consumption represents about 0.3% of the generating capacity of Southwest Public Service Company of Amarillo, Texas (SPSC 1981). The natural gas consumption is equivalent to the usage of 3 to 5 thousand single-family dwellings.

The consumption of electricity at the Pantex Plant increased at an average rate of 1.8% per year for the period of 1975 to 1980. Natural gas usage declined at a rate of 7% per year. The total energy usage has decreased 5.4% per year during that 5-year period. Approximately 10% of the total energy is used in the various production and assembly processes.

3.2.7.2 Iowa Army Ammunition Plant--Energy Resources

Electrical energy for the Iowa Army Ammunition Plant is purchased from the Union Electric Company of St. Louis, Missouri. The Plant is serviced by two separate lines from the utility company. The total annual electrical energy consumption at the Iowa Army Ammunition Plant is approximately 17 million kilowatt-hours. This is less than 0.03% of the total generating capacity of Union Electric (UEC 1981).

The facilities at the Iowa Army Ammunition Plant are steam heated. The primary fuel of the steam plant is natural gas supplied by Iowa Southern Utilities on an interruptable basis. The standby fuel is Number 2 fuel oil.

3.2.7.3 Hanford Site--Energy Resources

The Hanford Site receives electricity from the Bonneville Power Administration system, which has a total generating capacity of 17 million kilowatts. Power plants (nuclear and coal fired) on the Hanford Site have a capacity of 860 thousand kilowatts. A system for delivering coal to the Plant site is operational and is now delivering coal to steam-generating plants on the site.

3.2.8 Employment and Population

3.2.8.1 Pantex Plant--Employment and Population

Employment

The Pantex Plant is the largest employer in the Amarillo area employing nearly 2400 workers. The composition of the current work force is approximately 80% male and 20% female. Pantex Plant employment represents approximately 2.7% of the total 1980 labor force (about 87.6 thousand) reported by the Texas Employment Commission. Approximately 87% of Pantex Plant employees reside in the Amarillo metropolitan area. The remainder reside in small rural communities or on farms.

Employment Forecast

The employment forecast for the Pantex Plant study area [the 80 kilometer (50 mile) area around the Pantex Plant] was based on 1981 employment data for counties and on discussions with the Texas Employment Commission concerning future economic and employment growth in the Amarillo area (TEC 1981).

A conservative estimate of growth (1.35%) in annual employment was used to forecast 1990 employment in the Amarillo Standard Metropolitan Statistical Area. This is an increase of 9900 workers from July 1981 to 1990. July 1981 employment in the portion of the counties within the Pantex Plant study area excluding the Amarillo Standard Metropolitan Statistical Area is approximately 34,700. A much lower annual growth rate in these counties is assumed because of the probable decline in agriculture-related employment resulting from higher water costs. Using an annual growth rate of 0.4%, employment in the non-Standard Metropolitan Statistical area portion of the Pantex Plant study area is estimated to increase between 1981 and 1990 by 1300 jobs to a total of 36,000. In summary, the total labor force in the study area is expected to increase from 87,600 to 124,400 between 1981 and 1990 (LATA 1982).

Population

A study of the 1980 residential population surrounding the Pantex Plant shows that the majority of the population is located west-southwest of the Pantex Plant in the Amarillo metropolitan area. The 1980 residential population surrounding the Pantex Plant is somewhat evenly distributed at a density of about 1 person per square kilometer (3 people per square mile) except for concentrations within and near larger cities and towns. The total population within an 80-kilometer (50-mile) radius of the Pantex Plant was 259,300 in 1980 (LATA 1982).

Population Forecasts

The predicted 1980 to 1990 change in residential population indicates that the greatest change will occur west and southwest of the Pantex Plant in the Amarillo metropolitan area. Very little residential growth is expected within 16 kilometers (10 miles) of the Pantex Plant site (LATA 1982).

Figure 3.2.8.1-A summarizes the 1990 total population of 288,900 for the 80-kilometer (50-mile) radius around Pantex Plant. This figure indicates that the largest population center will continue to be the Amarillo metropolitan area. Smaller but still significant population concentrations are shown for the Dumas, Borger, and Pampa sectors. The only substantially populated area within 16 kilometers (10 miles) of the Pantex site is the 8- to 16-kilometer (5- to 10-mile) southwest sector with a population of approximately 5 700 persons (LATA .1982).

3.2.8.2 Iowa Army Ammunition Plant--Employment and Population

Employment

In 1981 Mason and Hanger-Silas Mason Company, Inc., employed about 1030 workers at the Iowa Army Ammunition Plant. The Plant is the second largest employer in the area. The work force composition is about 80% male, 20% female. The Plant work force represents about 1.6% of the total employment in the four surrounding counties (Des Moines, Henry, Lee, and Louisa). Plant records indicate that over 86% of the work force lives in these four counties; the remainder reside in Illinois and commute across the Mississippi River.

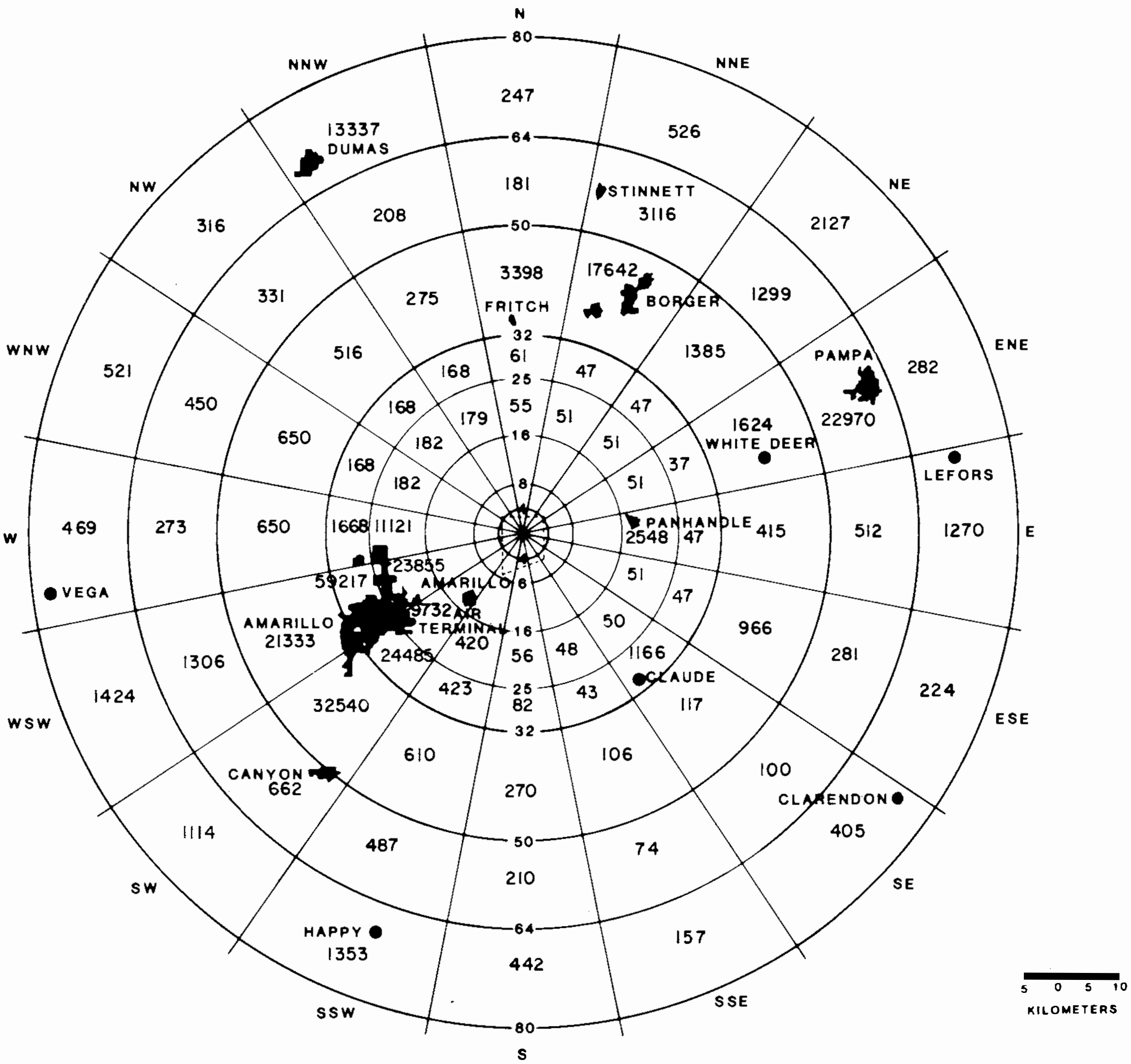


Figure 3.2.8.1-A. Projected 1990 population for Pantex Plant study area.

Employment Forecast

The Iowa Army Ammunition Plant study area [80-kilometer (50-mile) area around the Plant] includes portions of three bordering states. Economic and employment data from all three states were analyzed. This analysis indicates that no significant change will occur and that the 1990 employment levels will be similar to 1980 employment levels within the study area (LATA 1982).

Population

The 1980 residential population between 16 kilometers (10 miles) and 80 kilometers (50 miles) of the Iowa Army Ammunition Plant is quite evenly distributed (LATA 1982). Population densities in rural areas are about 10 people per square kilometer (26 people per square mile). Rural populations within 16 kilometers (10 miles) of the Iowa Army Ammunition Plant are slightly higher with about 12 people per square kilometer (31 people per square mile). The sectors with the largest concentrations of population are east and east-northeast of the Iowa Army Ammunition Plant. These sectors include most of the residential population in the cities of Burlington and West Burlington. The total population within an 80-kilometer (50-mile) radius of the Iowa Army Ammunition Plant was 378,800 in 1980 (LATA 1982).

Population Forecast

The net in-migration for the Iowa Army Ammunition Plant study area between 1980 and 1990 is estimated to be 2849 persons (LATA 1982).

The 1990 total population forecast of 383,600 for the 80-kilometer (50-mile) radius around the Iowa Army Ammunition Plant is shown in Figure 3.2.8.2-A. The largest concentrations of people are found in the Burlington, Fort Madison, and Mount Pleasant areas. Rural population densities remain about the same with densities of 10 to 12 people per square kilometer (26 to 31 people per square mile).

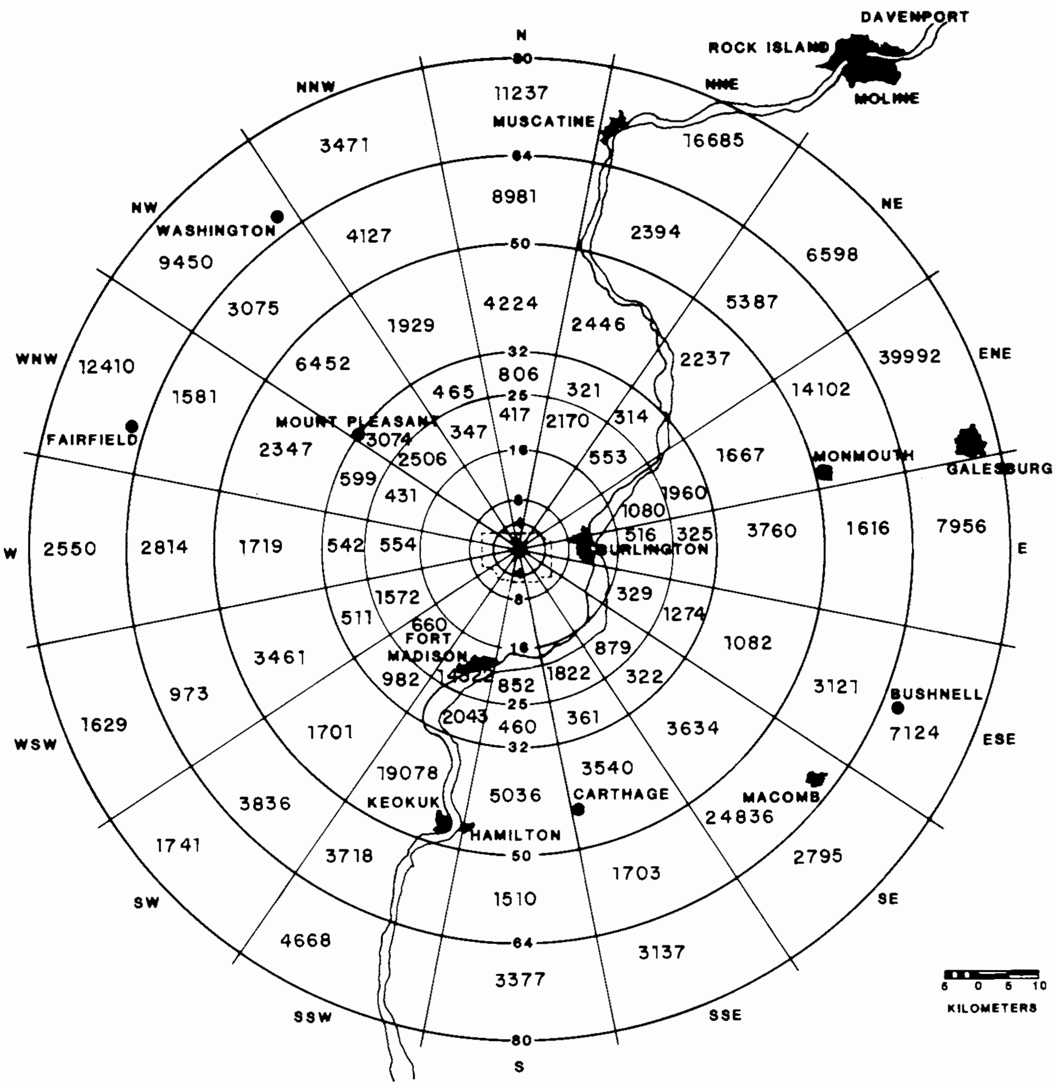


Figure 3.2.8.2-A. Projected 1990 population for Iowa Army Ammunition Plant study area.

3.2.8.3 Hanford Site--Employment and Population

Employment

As of January 1981, the Hanford Site and related Department of Energy operations in Franklin and Benton Counties employed approximately 12,000 workers. In addition, 11,500 workers currently are employed by the Washington Public Power Supply System to construct three nuclear power generation plants on the Hanford Site. The total employment on the Hanford Site represents about 30% of the total resident labor force (77,200) in 1981 (USDOE 1981C, WJS 1981A, WES 1982).

Employment Forecast

Employment data and growth information for counties in the Hanford Site area were obtained from the Pasco office of the Washington State Employment Security Department. The Employment Security Department believes that the Tri-Cities (Richland, Kennewick, and Pasco) area will experience substantial employment growth in the 1980 to 1990 decade, but this growth will not be as spectacular as that seen in the recent past. An employment growth rate of 30% is anticipated during the 1980 to 1990 period. This compares with the 1970 to 1979 period during which nonagricultural wage and salary employment in the Tri-Cities area more than doubled. This 1980 to 1990 employment forecast is also consistent with a 1980 Tri-Cities transportation study that predicted a 36% increase in employment in the area (LATA 1982). However, large portions of the Hanford Site study area [80 kilometer (50 mile) area around the proposed construction site] are predominantly agricultural with few people and little potential for growth. Employment growth rates between 0% and 5% were assigned to each of these agricultural counties; 5% growth rates were used for those counties with urbanized areas where growth might occur (LATA 1982).

Population

The largest residential population concentration occurs southeast and south-southeast of the Hanford Site in the Tri-Cities area (Richland, Kennewick, and Pasco). Lesser concentrations are found south-southwest of the Hanford Site in Prosser, west-southwest in Toppenish, west in Yakima, and north-northeast in the Moses Lake area (LATA 1982). The rural population between 16 kilometers (10 miles) and 80 kilometers (50 miles) of the proposed construction site has a density of about 5 people per square kilometer (13 people per square mile). There are essentially no people within 16 kilometers (10 miles) of the proposed construction site because over 95% of this land belongs to the Hanford Site. The total population within an 80-kilometer (50-mile) radius of the Hanford Site was 323,900 in 1980 (LATA 1982).

Population Forecast

Approximately 62,600 persons are expected to migrate into the Hanford study area between 1980 and 1990. Of these, over 54,000 are forecast to migrate to the Tri-Cities area, and 6200 will go to Yakima County. Almost 2000 new migrants are expected to settle in Grant County during the decade (LATA 1982).

1990 Total Population

Figure 3.2.8.3-A shows the 1990 total population forecast of 388,600 for the 80-kilometer (50-mile) radius around the Hanford Site. The largest concentration of population still exists in the Tri-Cities

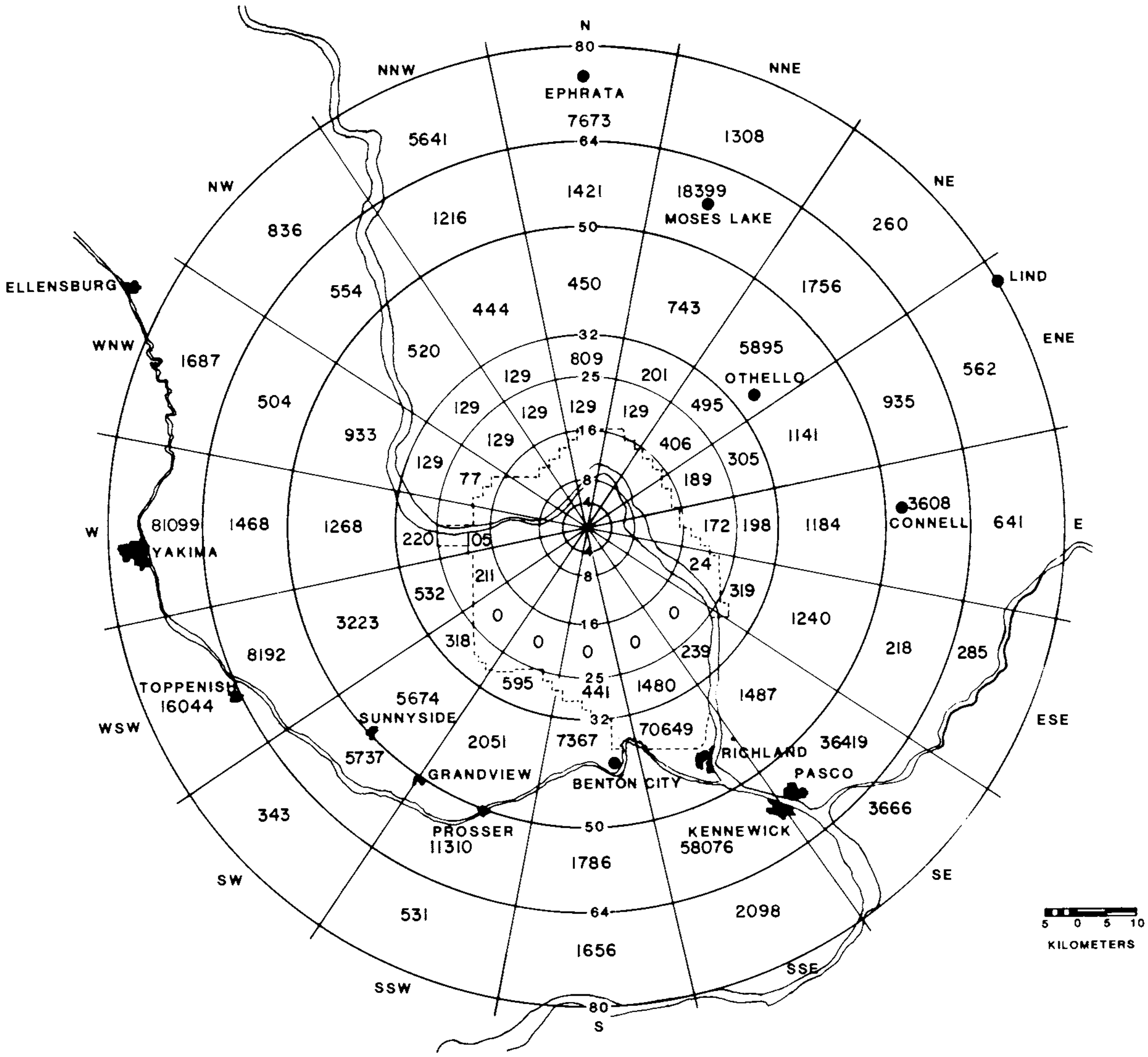


Figure 3.2.8-3-A. Projected 1990 population for Hanford Site study area.

area. The second largest concentration is found in the Yakima sector; other areas with significant populations are found to the north-northeast, south-southeast, and west-southwest of the Hanford Site (LATA 1982).

3.2.9 Economics

3.2.9.1 Pantex Plant--Economics

The combined payroll and purchases associated with the Pantex Plant operation are estimated to contribute about 3% of the 1981 retail sales in Amarillo trade areas. The total payroll at the Pantex Plant (reported at $54.4 million in 1981) plus local purchases for materials and services ($3.5 million) totals $57.9 million. Nonbasic or induced employment is estimated to increase this total by $48.5 million.

In 1981 Amarillo schools received about $56,500 federal impact funds because of the Pantex Plant operation. Other school systems serving students of Pantex Plant employees received an estimated $8500 in federal impact funds in 1981 (Rapp 1982).

3.2.9.2 Iowa Army Ammunition Plant--Economics

The 1980 payroll at the Iowa Army Ammunition Plant was about $20.2 million. In addition, estimated purchases of materials and services from local suppliers totaled $1 million. Total wages for nonbasic employment were estimated at $18 million. Using current marketing data, the combined payroll and purchases attributed to the Iowa Army Ammunition Plant are estimated at $18.4 million in 1981 retail sales in the four county Southeast Iowa trade area (Des Moines, Henry, Lee, and Louisa). This is about 3% of the 1981 retail sales in the Southeast Iowa trade area (Rapp 1982).

In 1981 the Burlington Community School District received an estimated $38 thousand in federal impact funds for children of employees at the Iowa Army Ammunition Plant. A district official estimates that 98% of employee children enroll in area schools within the District.

3.2.9.3 Hanford Site--Economics

Payroll directly attributed to Hanford Site operations varies because of various work force fluctuations. A conservative estimate of the 1980 to 1981 basic payroll totals $545 million. Nonbasic employment was estimated to add an additional $485 million (Rapp 1982).

Total retail sales for the Tri-Cities area in 1981 were $924 million. The combined payrolls for basic and nonbasic employment at the Hanford Site generated about $490 million or about 53% of the 1981 retail sales (Rapp 1982).

In 1981 the three independent school districts in the Tri-Cities area received an estimated $782 thousand in federal impact funds for children of federal workers employed at the Hanford Site. This represents approximately 97% of all federal impact funds paid to area school districts (Rapp 1982).

3.2.10 Community Resources

3.2.10.1 Pantex Plant--Community Resources

Housing

Housing in the Amarillo area has kept up with demand since the closing of the Amarillo Air Force Base in the late 1960s. However, major expansion of the population over a short period of time may result in temporary shortages of housing (Amarillo 1980).

Utilities

The Southwestern Bell Telephone Company serves the Amarillo area. Natural gas is supplied to the Pantex Plant by the Pioneer Corporation, which is headquartered in Amarillo. There is no shortage of natural gas foreseen in the region with assured reserves of 11.7 years, which is considerably higher than most companies in the nation (Rapp 1982). Electrical power is supplied by the Southwestern Public Service Company. Their service area covers 45,000 square miles with a 3660-megawatt interconnected system. In June 1980 a third 350-megawatt coal-fired generating unit was added to the Amarillo service area.

In July 1982 the first of two 561-megawatt coal-fired units at the Harrington Station came on line. The Southwestern Public Service Company is exporting power through the Southwest Power Pool, and users are assured of adequate power supplies in the foreseeable future (Rapp 1982).

Education

Total enrollment (1981 to 1982) for the Amarillo Independent School District was 26.4 thousand. Of that number, 898 students (3.4%) were children of Pantex Plant employees. In addition, school systems in surrounding counties provide services to an estimated 180 children of Pantex Plant employees.

Health Services

Amarillo provides a full range of health and medical care. Hospitals in the metro area now provide about 5 beds per 1000 residents compared with Federal guidelines that recommend 4 beds per 1000. The 25-county health planning region has a total of 300 medical doctors serving a population of 234 thousand people. The Amarillo Standard Metropolitan Statistical Area has 210 physicians. Thus, the doctor-to-patient ratio in the service area ranges from about 1 per 750 to 1 per 780 persons. When compared with the Federal guidelines, which recommend one primary care physician per 2500 population, the ratio is considered adequate within the commuting area of Pantex Plant (Rapp 1982, PRPC 1981).

Public Safety

The Amarillo metropolitan area is protected with the full range of public safety services. In 1980 there was 1 sworn officer per 645 residents and 1 fireman per 730 residents. The Amarillo Police Department advised the authorized strength of the department was 234 sworn officers. However, in 1981, the corps was 12 officers below full strength. Actual street patrol was about 1 per 1000 population; however, this ratio was deemed adequate for the current needs of the population. The sheriffs' offices in both Potter and Randall Counties reported their authorized strength for road patrol was adequate for the needs of their respective jurisdictions (Rapp 1982).

Transportation

Transportation services in and around Amarillo are very good. The area is served by Interstate Highway 40, Interstate Highway 27, and several major United States highways. There are 18 motor freight companies, 4 intercity bus lines, and 3 railroad companies. In addition, 7 airlines operate at the Amarillo International Airport. The airport can handle all large military aircraft (Rapp 1982).

3.2.10.2 Iowa Army Ammunition Plant--Community Resources

Housing

A housing surplus currently exists in the city of Burlington. Vacant hotels could be reopened for bachelor housing, and space is available in mobile home parks. In some cases, the surrounding rural communities have a shortage of housing because younger families, willing to commute longer distances, have acquired many of the older homes. However, most communities allow placing of mobile homes in fringe areas (Burlington 1981B, IJS 1980A).

Utilities

The Burlington area is supplied with natural gas via the Michigan Wisconsin Pipeline and the Iowa Southern Utility Company. The Iowa Army Ammunition Plant currently is converting a standby electric generation plant from oil to coal, which may in time become the principal power source there. However, the Union Electric Power Company has ample capacity for the power requirements. The Iowa Army Ammunition Plant is supplied by two independent, 69-kilovolt supply lines with interconnects to the Mid-America Interpool Network with principal transmission lines through Illinois and Missouri. Other supplies are assured through Iowa Southern Utility Company. Therefore, electrical power seems assured for the foreseeable future (Rapp 1982).

Education System

Iowa enjoys a reputation for quality schools and facilities. Burlington, in particular, has several surplus school buildings (Rapp 1982).

Health Services

The Iowa Army Ammunition Plant has access to very good health services. The area is serviced with hospitals in Burlington, Fort Madison, Keokuk, and Mount Pleasant. There are a total of 714 beds or an average of nearly 6 beds per 1000 population compared with Federal guidelines that recommend 4 beds per 1000 population.

The ratio of primary care physicians to population is approximately 1 per 1000. Although distribution of doctors in the area is a problem, the ratio compared favorably with Federal guidelines that recommend a ratio of 1 per 2500. Therefore, the health services within commuting distance of the Iowa Army Ammunition Plant are considered adequate (Rapp 1982, SIRPC 1981).

Public Safety

The communities surrounding the Iowa Army Ammunition Plant have adequate public safety services. At present, the Burlington police and fire departments employ about 1 person per 580 population. The Des Moines County Sheriffs' Department employs about 1 per 1000 population (Burlington 1981A). The Burlington Police Department advised the Department had an authorized strength of 36 sworn officers supported by 13 sworn reserve officers. The authorized strength was deemed adequate for the current needs in Burlington (Rapp 1982).

Transportation

The transportation facilities serving the Burlington area are adequate. Medium-sized jet aircraft flown by commercial airlines serve the area (for example, DC-9). However, the Burlington Airport cannot handle large commercial (for example, DC-10) or military aircraft.

Rail freight service and rail passenger service is available at Burlington. Ozark Airlines also serves the region. Trucking service is provided by 31 common carriers and passenger bus service is provided by Continental Trailways. Two United States highways cross the area north-south and a third crosses east-west. Water transportation is available on the Mississippi River about 10-1/2 months of the year (Burlington 1981B).

3.2.10.3 Hanford Site--Community Resources

Housing

No significant housing shortage is anticipated in the Tri-Cities area because of the recent construction activities at the Hanford Site. A recent real estate report indicates no shortage of housing units in the Tri-Cities area. The study noted a 16.7% vacancy rate among some 6000 apartment units. Many construction workers provide their own mobile housing as may be seen by numerous mobile home parks in the area (TCRERC 1981).

Utilities

The natural gas and electrical power facilities serving the Tri-cities area are adequate. The Tri-Cities area provides municipally owned water and sewer services. Natural gas is supplied to the area by Cascade Natural Gas Company. Cascade Natural Gas Company obtains its supply from the Northewest Pipeline Company of Salt Lake City, which has the highest assured supply (21.3 years) of any gas company in the nation. The relatively new high-pressure distribution system is expected to assure adequate service for the foreseeable future (Rapp 1982).

Electric power is supplied in the area by the Franklin County and Benton County Public Utility Districts and by Richland Energy Services. Telephone service is provided by General Telephone Compnay of the Northwest, Inc. in Kennewick and Richland and by the Pacific Northwest Bell Telephone Company in Pasco (WSDCED 1980).

Education

School facilities in the Tri-Cities are very adequate with an average teacher ratio of 1 teacher for 19 students.

Health Services

The Tri-Cities are served by three hospitals with a total of 276 beds or about 1.9 beds per 1000 population as compared with Federal guidelines that recommend 4 beds per 1000 residents. However, hospitals reported occupancy rates of 63%, 69%, and 80% in the past year. The Kadlec Hospital in Richland currently is seeking certification of need for 64 additional beds in 1982. Further, they plan to add 80 beds in 1983, 80 more in 1986, and still another 80 about 1991 (Tri-Cities Health Care Needs Assessment and Washington State Hospital Guide).

The Tri-Cities area supports over 100 physicians and surgeons and over 50 dentists. The ratio of primary care physicians in the service area is about 1 per 1500 population, which compares favorably with Federal guidelines that recommend 1 per 2500 population. Therefore, the health services in the Tri-Cities area are considered adequate (Rapp 1982).

Public Safety

Continued construction activities on the Hanford Site over a long period of time will very likely require the enlargement of the public safety forces serving the Tri-Cities area. At present, the three cities support their own police and fire departments, averaging about 1 police officer per 715 residents and 1 fireman per 752 residents. Senior police officers in Pasco, Kennewick, and Richland reported the ratio of sworn officers to population ranged from 1.3 to 1.5 officers per 1000 residents. All considered the authorized strength was adequate to deal with the public safety needs of their community. However, the sheriffs of Franklin and Benton Counties reported their departments were undermanned at this time. Franklin County, with 17 sworn sheriffs' officers, reported the need for 7 more deputies (41%) in order to meet national averages for counties of similar classification (Rapp 1982).

Transportation

The Tri-Cities are connected by U.S. Highway 12. Other major roads serving the region are U.S. 395 and State Highways 14, 24, and 240. Interstate Highways I-82 and I-182 are still in the planning stages. In September 1981, Amtrak service was restored to the area. Rail service includes the Burlington Northern and the Union Pacific Railroad companies. Air service is provided at the Tri-Cities Airport at Pasco by Republic Airlines and a commuter airline, Cascade Airways. However, the airports can not handle very large aircraft. The commuter airline also serves the Richland Airport. The Kennewick Airport serves only general aviation traffic. Motor freight service is provided by over 20 interstate and intrastate trucklines. Passenger service is provided by Greyhound Bus Lines. Barge service on the Columbia River and Snake River is provided by three companies. The Tri-Cities area supports three functioning river port facilities (Rapp 1982).

3.2.11 Cultural Resources and Native Americans

3.2.11.1 Pantex Plant--Cultural Resources and Native Americans

Cultural Resources

A detailed archaeological survey was conducted at Pantex Plant in 1981 (Hughes 1981). This survey located remains of 42 prehistoric Indian camps and 3 pre-World War II farmsteads. One historic site is on the uplands, and all other sites are in or near four playa basins located on Plant property.

Although these sites do not appear to be historically or archaeologically significant enough to qualify for the National Register of Historic Places (Hughes 1981), all prehistoric sites are cultural resources worthy of protective measures. However, none of these sites are located in areas that would be impacted by construction activities.

In addition to the archaeological survey, the Texas Historic Commission was contacted to determine if any National Register sites existed within the area. In February 1982 the Acting State Historic Preservation officer sent notification that no sites were recorded (Herrington 1982A).

Native Americans

Today, there are no Indians that identify Carson County, Texas, as homeland or as religiously significant (Herrington 1982B). During the 1800s the Panhandle of Texas was occupied by Kiowas, Kiowa Apaches, and Comanche Indians (Newcomb 1961). These Indians were removed in the late 1800s when the military established reservations for tribes of the Comanche and Apache Nations in Oklahoma, New Mexico, and Arizona.

3.2.11.2 Iowa Army Ammunition Plant--Cultural Resources and Native Americans

Cultural Resources

No known archaeological resources exist; however, a detailed archaeological survey of the Iowa Army Ammunition Plant has not been performed. The State Historic Preservation officer (Iowa State Historical Department, Division of Historic Preservation) sent notification in March 1982 that over 60 prehistoric sites have been recorded in surrounding townships (Anderson 1982). Based on this information and site topography, the State Historic Preservation officer determined that a cultural resource survey should be conducted before any construction activities (Anderson 1982).

Native Americans

No Indians currently exist that claim the Iowa Army Ammunition Plant or surrounding area as homeland or as religiously significant. The western Illinois-eastern Iowa region was occupied by the Fox and Sauk Indians in the early 1800s. The Black Hawk War ended in 1832, and the surviving Fox and Sauk Indians were placed on a reservation in Iowa. Most of these Indian populations have ceased to exist, however, remnants of the Fox are still found in central Iowa (Oswalt 1978).

3.2.11.3 Hanford Site--Cultural Resources and Native Americans

Cultural Resources

There are 17 historic sites listed on the Washington State Register of Historic Places, the National Register of Historic Places, or the National Register of Historic Landmarks that are within about 80 kilometers (50 miles) of the Hanford Site (Jamison 1981). Of these, 10 are archaeological sites or archaeological districts. Within the Hanford Site itself, there are 9 cultural resource areas listed with the National Register of Historic Places. Many less unique sites are in the area. Most of these sites are found on the Columbia River shoreline and are campsites associated with fishing grounds (Jamison 1981).

The considered project site is over 3 kilometers (2 miles) from the river, and no archaeological sites are expected. However, because of the abundance of archaeological sites in the general area and a known cultural resource (the Hanford Ditch), the State Historic Preservation officer determined that a detailed cultural survey should be performed before construction (Stump 1982).

Native Americans

No known shrines or places of Native American worship exist at the considered project site; however, existing tribes may consider this area to be homeland or as having religious significance.

Indians used some places on the Hanford Site as traditional wintering grounds from prehistoric times till 1943 when the area was evacuated by the United States Government (Jamison 1981). Four major tribes (the Yakima, Cayuse, Walla Walla, and Umatilla) live near the Hanford Site (Elle 1982).

3.2.12 Existing Health and Safety Conditions

Worker and public health and safety is addressed for current operations at the Pantex Plant. The other two sites are not addressed because nuclear weapons operations are not performed currently at either of these two sites.

Past operating experience at the Pantex Plant has shown that public health and safety is ensured by controlling effluents to appropriate standards (MHSM 1973, MHSM 1975A, MHSM 1975B, MHSM 1976, MHSM 1977A, MHSM 1977B, MHSM 1978, MHSM 1979A, MHSM 1979B, MHSM 1980A, MHSM 1980B, MHSM 1982). Public access to those areas where inadvertent exposure to radioactive materials, explosives, toxic materials, and/or physically dangerous situations could occur is restricted. Control of public access is accomplished by means of security measures.

The processes involved in nuclear weapons operations bring the work force into potential contact with a broad variety of hazards. In addition to hazards common to any light industrial activity, there are hazards associated with handling high explosives and radioactive materials. To meet health and safety concerns and to comply with applicable Department of Energy regulations, the Pantex Plant has a well-developed health and safety program.

Operations with conventional chemical high explosives carry an implied risk of accidental detonation. This is true for chemical high explosives in components for nuclear weapons as well as in other common uses such as conventional munitions (including ammunition for rifles or handguns), explosives for mining and construction, and fireworks displays. Therefore, plants handling chemical high explosives are usually designed with protective physical features to minimize consequences of accidental explosions. The consequences of most concern are physical blast effects such as overpressures (high-pressure pulse) or flying fragments. These consequences could injure workers or induce additional explosions in adjacent or nearby work areas. Common protective features are separation of facilities, barriers such as berms, blowout panels or walls to direct blast effects, and high-strength structures. All of these are used at the existing Pantex Plant.

3.2.12.1 Epidemiologic Investigations

Regional Study

Regional epidemiological studies around the Pantex Plant do not show unusual trends or patterns of cancer related mortalities that could be attributed to the cumulative effect of Plant operations (Wiggs 1982).

Mortality for 18 cancer categories that have either been associated with radiation or chemical exposures or that have been the focus of public concern were investigated. Meteorological data (Bowen 1981) was used to define the study region, which included the two counties (Carson and Potter) adjacent to the Plant and the three "downwind" counties (Hutchinson, Gray, and Roberts) to the north and east of the Plant. Because of public interest, Randall County, southwest of the plant, also was included.

Mortality rate ratios (county rates divided by state rates) were used to compare age-adjusted cancer mortality rates for these counties with rates for Texas over three time periods: 1950 to 1959, 1960 to 1969, and 1970 to 1978. A standard statistical technique was used to determine if rates differed significantly between the counties and the state. Cancer mortality was not unusual in any of the three time periods examined.

Work Force Study

An epidemiologic study of past and present Pantex Plant workers is currently in progress. This study will compare cause-specific mortality observed among Pantex Plant workers with mortality expected on the basis of United States rates. The results of this study are expected to be available for the Final Environmental Impact Statement.

3.2.12.2 Health and Safety Evaluations

The Pantex Plant has a well-defined health and safety program for protecting worker health. There is no evidence of chronic overexposures of workers to radiation (Elder 1982A). A detailed review of Pantex medical and industrial hygiene records also indicates no overexposures to other toxic materials. Safety- and health-related activities are actively directed at compliance with applicable regulations (USDOE 1980A). All purchase requests for toxic chemicals are reviewed to assure that appropriate control measures will be taken before purchase is approved.

The health and safety program at Pantex Plant provides the essential elements of worker protection: routine inspections and monitoring of workplaces, employee health and safety training, preemployment and routine medical examinations, accident investigation and reporting, plans and procedure review, employee complaint review, and active enforcement of regulations. The Department of Energy routinely audits the Pantex Plant program to assure compliance with applicable standards and regulations. Written standards and procedures prescribe the acceptable methods of accomplishing potentially dangerous activities. Strict adherence to these safety instructions limits contact with toxic materials and minimizes the probability of an accident.

Progress toward improved worker health and safety has been significant in the last 10 years. Recently, high-explosive materials with a much lower sensitivity to initiating events have been introduced in some weapons systems. Special control measures, such as local exhaust ventilation (with exhaust air cleaners where deemed necessary to protect the environment), have been provided to prevent worker exposure to toxic and radioactive materials. Solvent storage and pumping stations have been installed outside of buildings to reduce personnel contact with solvent vapor. Shielding, tools, fixtures, reduction of time spent near radiation sources, and design features to reduce penetrating radiation from nuclear components have served to reduce worker doses (Elder 1982A).

Records of radiation doses during routine operations show that doses are maintained well within limits established by the Department of Energy. Details of the review of Pantex Plant radiation dose records are provided separately (Elder 1982A). Table 3.2.12.2-1 summarizes the dose distribution of all Pantex Plant workers since 1966, when uniform compilation of doses at Department of Energy (or Atomic Energy Commission or Energy Research and Development Administration) facilities was initiated. The 5 rem per year limit (set by the Department of Energy for radiation workers) on whole body dose was exceeded only once at the Pantex Plant in this period.

Over the period 1979 to 1981, a major workload increase caused integrated doses among workers to increase into the range of 150 to 204 person-rem. This was substantially above the 50 to 72 person-rem range of previous years. Over this same period, efforts were accelerated to reduce worker doses to "as low

TABLE 3.2.12.2-1

PANTEX PLANT ANNUAL WHOLE BODY DOSES FOR 1966 TO 1981*

Year	Number of Workers with Dose in Each Range of Measurement							Total Number of Workers Monitored	Integrated Dose*** (person-rem)
	<Meas**	<1 rem	1-2 rem	2-3 rem	3-4 rem	4-5 rem	5-6 rem		
1966		526	15	3				544	
1967		496	17	4	1			518	
1968		393	6					399	
1969		397	2	1				400	
1970		352	15	7	1			375	
1971		426	21	8	2			457	
1972		407	10	6				423	
1973		296	7					303	
1974		472	9					481	72
1975	45	457	6					508	56
1976	31	406	3	1				441	50
1977	20	419	4	1				444	62
1978	68	426	2	1				497	57
1979	27	610	28	10	1	4	1+	681	185
1980	106	641	27	10	2			786	153
1981	355	512	49	8				924	204

*Compiled from "Annual Report of Radiation Exposure for DOE and DOE Contractor Employees," USDOE Office of Nuclear Safety.

**Dose was below the measurement limit of dosimeters (approximately 0.01 rem). Uniform reporting not begun until 1975.

***Summed doses of all workers receiving a measurable dose. Data not reported from 1966 to 1973.

+The 5-rem per year limit was exceeded in this one case. Underestimation of the rate of dose received by a male worker resulted in a dose of 5.14 rem in 1979. An incident report was prepared and corrective measures taken.

as reasonably achievable." These efforts included improved shielding, procedures, and worker training. A recently established administrative limit of 2.5 rem per year (50% of the Department of Energy limit) has produced a favorable trend of lower doses distributed among a higher number of workers (MHSM 1981B).

Doses that are kept below the 5-rem per year limit for ionizing radiation should not cause any effects exceeding an average risk of eventual cancer mortality of 1 chance in 10,000 per rem (ICRP 1977). For toxic chemicals, exposures kept below the threshold limits specified by the American Conference of Government Industrial Hygienists (ACGIH 1981) and the Occupational Safety and Health Administration should not cause "adverse effects," although a small percentage of workers may experience some discomfort or even develop an occupational disease (OSHA 1978).

3.2.12.3 Historic Safety Record

The Systems Safety Division of EG&G-Idaho analyzed accident and injury statistics for the Pantex Plant. This analysis indicates that the Pantex Plant is extremely safe (Briscoe 1981). This section presents the major conclusions of the safety analysis study.

There have been four fatalities from accidents at the Pantex Plant since the start of operations in 1951 by the Atomic Energy Commission. An accidental electrocution occurred on February 13, 1971, resulting in the loss of one life. An accidental explosion occurred in the high-explosives research and development area (not part of the nuclear weapons operations) on March 30, 1977, resulting in the loss of three lives (Poole 1982).

In spite of these two accidents, historical records show that both Plant injury rate and time lost from injury are below those seen in other Department of Energy installations, the explosives industry, and most private industry. In addition to this good record, the data show a steady decline in both worker injuries and damaged property from 1975 through 1980, except for the 1977 accidental explosion.

Table 3.2.12.3-1 shows a comparison between the Pantex Plant and other industries. The Pantex Plant loss rates are lower in every category than rates for all Department of Energy operations. The Pantex Plant injury rate for 1981 is 68% less than the average total United States explosives industry and 43% less than the rest of the Department of Energy.

Pantex Plant property loss rates for 1980 are one-seventh the property loss rates for all Department of Energy operations and their contractors. The average loss rates from 1975 to 1980 show Pantex Plant higher; however, the single accident in high-explosive development (loss of 3 lives and 1 building) accounts for 82% of all the Pantex Plant losses over the 6-year period.

TABLE 3.2.12.3-1

INJURY LOSS RATES--OSHA INCIDENCE RATES
(based on 200,000 man-hours)

		TRC*	LWC**
1981	Pantex Plant	1.3	0.6
	All Department of Energy	2.3	1.0
	DuPont (S.R.) Production	0.5	0.1
	Hercules Powder (to June 1981)	--	1.4
1977-1979*** Average	U.S. Explosives Industry+	4.1	1.7
	All U.S. Industry+	7.9	3.5
	DuPont Corporation++	1.1	0.1

*Total recorded cases.
**Lost work cases.
***This time frame was chosen because data was available from Accident Facts (NSC 1981).
+Accident facts (NSC 1981).
++DuPont Corporation (Petrochemical Division about the same).

4.0 ENVIRONMENTAL IMPACTS

This chapter summarizes the potential environmental impacts of possible future actions at each of three alternative siting locations. The emphasis is on changes in environmental impacts from existing conditions (described in Chapter 3) that would be expected in the future. The results of technical analyses are summarized. Assumptions and analytic procedures are briefly described. The reader is referred to supporting documents or appendixes for details.

The first section of Chapter 4 presents the impacts for all three alternatives (Pantex Plant, Iowa Army Ammunition Plant, and Hanford Site) assuming normal operations (Section 4.1). The second section of Chapter 4 considers potential plant accidents (Section 4.2), and the last section considers related transportation operations (Section 4.3).

4.1 ENVIRONMENTAL IMPACTS OF PLANT FACILITIES, CONSTRUCTION, AND NORMAL OPERATIONS

The impacts are discussed under the same 12 environmental topical areas used in Section 2.3. Each topical subsection presents information for each site in the same sequence.

4.1.1 Air

4.1.1.1 Pantex Plant--Air

Table 4.1.1.1-1 presents the estimated changes between 1981 and 1985 in annual emissions for future major routine releases at Pantex Plant. This table shows that all existing source terms will remain about the same or decrease in the future. Thus, future emissions from existing sources will meet all applicable Federal and state ambient air emission standards.

The largest potential change that would affect air quality is construction of a new coal-fired cogeneration plant. The coal-fired plant will be designed to comply with the National Ambient Air Quality Standards. Fugitive dust from coal and ash storage will be minimized through handling procedures such as windbreaks and water sprays. As presented in Table 4.1.1.1-2, preliminary air quality impact analysis indicates that downwind air concentrations would not exceed Environmental Protection Agency Ambient Air Quality Standards or Prevention of Significant Deterioration increments (UNENG 1979). This coal-fired plant would release several naturally occurring radionuclides normally present in all coal (see Section 4.1.6.1).

In the future, plastic bonded high explosives will be burned that contain significant quantities of fluorine. When burned, hydrogen fluoride gas will be emitted. New administrative controls on quantities burned or possibly a new location for burning are being implemented to ensure continued compliance with the Texas State hydrogen fluoride standard at the site boundary.

Some fugitive dust would result from earthwork during construction of new facilities. Various control strategies (such as watering) would be employed to minimize emissions during the construction period.

TABLE 4.1.1.1-1

FUTURE ANNUAL EMISSIONS FOR PANTEX PLANT MAJOR AIR POLLUTANT SOURCES FOR ALL OPTIONS

Source	Estimated Change Between 1981 and 1985	Estimated Emissions** (kilograms)
Automobile Commuter Traffic		
Hydrocarbons	-58%	21,600
NO_x	-52%	334,700
CO	-48%	29,800
Gas-Fired Power Plant		
NO_x	0%	14,300
CO	0%	3,200
Coal-Fired Cogeneration Power Plant*		
Hydrocarbons	New source	4,500
NO_x	New source	254,600
CO	New source	13,600
SO_2	New source	164,000
Particulates	New source	3,400
Waste High Explosive Burning		
NO_x	-30% to -50%	2,280 - 1630
CO	-30% to -50%	840 - 600
Solvent Evaporation		
Toluene	0%	16,100
Acetone	0%	20,800
Dimethylformamide (DMF)	0%	12,200
Others	0%	10,200

*This plant would not be operational until 1988 but is included for comparison.
**Much of this information is from Laseter 1982.

4.1.1.2 Iowa Army Ammunition Plant--Air

Neither partial relocation nor total relocation of nuclear weapons operations to the Iowa Army Ammunition Plant would have a significant effect on air quality. Iowa State ambient air quality standards are identical to Texas State ambient air quality standards except for hydrogen fluoride, which is not regulated by the State of Iowa.

If all emissions shown for the Pantex Plant (Section 4.1.1.1) were moved to the Iowa Army Ammunition Plant, offsite concentrations from these emissions would be lower because of greater distance to the site boundary. As these emissions have been shown to be a negligible fraction of the ambient air standards (Section 3.2.1.1), their incremental addition to current ambient air concentrations would not result in a violation of either the Federal or state standards.

TABLE 4.1.1.1-2

COMPARISON OF PREDICTED MAXIMUM AMBIENT AIR CONCENTRATIONS AND APPLICABLE STANDARDS FOR THE COGENERATION COAL-FIRED POWER PLANT

Pollutant	Predicted Concentration	Units	Time Period	National Ambient Air Quality Standards	Prevention of Significant Deterioration Increments
SO_2	0.10	parts per million	3 hour	0.5	0.2
	0.03	parts per million	24 hour	0.14	0.035
	<0.03*	parts per million	Annual	0.03	0.008
Total suspended particulates	<1.0	micrograms per cubic meter	24 hour	150	37
	<1.0	micrograms per cubic meter	Annual	75	19
NO_2	0.06	parts per million	1 hour	No standard	No increments
	<0.05**		Annual	0.05	

*Based on comparison with 24-hour value.
**Based on comparison with 1-hour value.

Excess and waste high explosives are burned in incinerators at the Iowa Army Ammunition Plant to reduce particulate emissions. These incinerators have the capacity to handle the increased amounts of waste high explosive; however, their use may not be compatible with the large pieces of high explosives generated by nuclear weapons operations. A safe way to reduce these large pieces of explosives into smaller sizes would have to be developed.

The largest impact on air quality would be the addition of the coal-fired power plant. Emissions from this Plant would be similar to those discussed for the Pantex Plant (Section 4.1.1.1). Nevertheless, this coal-fired power plant would be in compliance with both Federal and state ambient air standards.

Some fugitive dust would result from earthwork during construction of new facilities. Various control strategies would be employed to minimize emissions during the construction period.

Effects in the vicinity of the Pantex Plant expected after relocating operations at the Iowa Army Ammunition Plant are in Section 4.1.1.4.

4.1.1.3 Hanford Site--Air

Relocation of nuclear weapons operations to the Hanford Site would not significantly affect air quality. Washington State ambient air quality standards are identical to Texas State ambient air quality standards except for particulates and sulfur dioxide. The differences are that Washington has adopted more stringent standards of 60 micrograms per cubic meter for particulates, and 0.02 parts per million annual average and 0.10 parts per million 24-hour average for sulfur dioxide.

If all emissions shown for the Pantex Plant (Section 4.1.1.1) were moved to the Hanford Site, offsite concentrations from these emissions would be lower because of greater distance to the site boundary. Because these emissions have been shown to be a negligible fraction of the ambient air standards (Section 3.2.1.1), their incremental addition to current ambient air concentrations would not result in violations of either the Federal or state standards.

The largest impact on air quality would be the addition of the coal-fired power plant. Emissions from this plant are shown in Table 4.1.1.1-2 and would be similar in type to those emissions from each of the two existing coal-fired steam plants at Hanford Site. This plant would meet all state ambient air quality standards.

Effects in the vicinity of the Pantex Plant expected after relocating operations at the Hanford Site are discussed in Section 4.1.1.4.

4.1.1.4 Termination--Air

Terminating nuclear weapons operations at the Pantex Plant would eliminate its emissions from open air testing of high explosives, from burning excess and waste explosives, and from evaporation of waste solvents. Decontamination and decommissioning activities would produce some fugitive dust. After decommissioning, air quality in the vicinity of the Pantex Plant would depend on the use of the land. As the whole operation at Pantex Plant emits few air pollutants, shutting down operations would improve air quality imperceptibly.

4.1.2 Water

4.1.2.1 Pantex Plant--Water

An adequate water supply for the Pantex Plant is available for any of the proposed options. The projected annual water use for operations of the Pantex Plant during 1981 to 1990 regardless of option is about 1.45 billion liters (383 million gallons or 1180 acre-feet). This is slightly less than the average annual water use in the period 1971 to 1980 of 1.46 billion liters (387 million gallons or 1190 acre-feet) (MHSM 1980C).

By comparison, the annual amount of water pumped from the Ogallala aquifer, as computed by the State of Texas, for irrigation, municipal, and industrial supply for the next 10 years is estimated at 182.2 billion liters (48.2 billion gallons or 148 thousand acre-feet) in Carson County (Bell 1979). Of this pumpage, about 71% or 127.6 billion liters (23.8 billion gallons or 103.6 thousand acre-feet) will be used for irrigation, 15% or 27.3 billion liters (7.2 billion gallons or 22.2 thousand acre-feet) for municipal supply, mainly for Amarillo, and 27.3 billion liters (7.2 billion gallons or 22.2 thousand acre-feet) for industrial supply. The projected annual use of about 1.45 billion liters (3.83 million gallons or 1180 acre-feet) at the Pantex Plant is about 1% of the total projected amount of water pumped in Carson County or about 6% of the projected annual amount of water pumped for industrial supply.

The water level decline in the Ogallala aquifer projected by Texas Department of Water Resources for the next 40 years ranges from 0.6 to 0.9 meter (2 to 3 feet) per year (Bell 1979). In the year 2020, the saturated thickness of the aquifer will still be more than 30 meters (100 feet) permitting wells to produce about 50 to 63 liters per second (800 to 1000 gallons per minute) (Bell 1979). Based on hydrologic characteristics of the aquifer projected by the Texas Department of Water Resources, the water supply at the Pantex Plant from the Ogallala Formation still should be adequate in the year 2020 (the practical limit of projections for this environmental impact statement).

Pantex Lake [a large dry playa of about 440 hectares (1080 thousand acres)] is retained by the Pantex Plant as a potential area for drilling additional water wells into the Ogallala aquifer if needed for future operations. Pantex Lake is adjacent to the Amarillo water well field and is located at one of the better geologic locations for drilling wells into the aquifer (Purtymun 1982B).

There are no additional groundwater sources that can be developed at the plant (Purtymun 1982B). The formations underlying Ogallala at the site contain water of a poor quality. Hydrologic characteristics of these formations indicate the yield from wells in the formations would be low (Cronin 1964, Long 1961).

4.1.2.2 Iowa Army Ammunition Plant--Water

Adequate water is available to the Iowa Army Ammunition Plant if either option is implemented. This will be true even if the Iowa Army Ammunition Plant increases its conventional munitions workload to levels similar to those in the late 1960s and early 1970s. In addition, onsite ground and surface water is available (Section 3.2.2.2).

No major changes in surface or groundwater quality will occur provided adequate measures are taken in operation, treatment, and disposal of effluent wastes. The additional volume of sewage effluents could overload the current sewage treatment facilities. Therefore, a new sewage treatment plant would have to be constructed (Becker 1982A).

Buildings constructed by the Atomic Energy Commission were fitted with waterproof foundations and drainage tile systems to drain shallow groundwater away from the buildings. Buildings constructed by the U.S. Army were not. Buildings not fitted with drains and waterproofing may need to be outfitted with a drainage system to lower the water table to alleviate flooding. New buildings constructed in this area may need to be fitted with waterproof foundations and drain systems.

Under Option 2, total relocation, new facilities located above elevation 650 near the shoreline of Long Lake would probably not be flooded by the 100-year flood (Becker 1982C). This and smaller floods would be passed through the spillway.

Shallow groundwater is present on the Iowa Army Ammunition Plant site, and it is advisable that exploratory holes to locate these areas be drilled within the proposed construction site before construction begins.

Effects in the vicinity of the Pantex Plant expected after relocating operations at the Iowa Army Ammunition Plant are discussed in Section 4.1.2.4.

4.1.2.3 Hanford Site--Water

There is ample water available from the Columbia River to implement the Hanford Site alternative. At present, about 613 billion liters (162 billion gallons or 497 thousand acre-feet) of water is removed annually from the Columbia River for Hanford Site operations, 93% of which is used for coolant water. The additional 1.5 billion liters (400 million gallons or 1200 acre-feet) required for relocation of nuclear weapons operations to the Hanford Site is less than 1% of the current Hanford Site water usage requirement. The basalt (confined) aquifers are not being used currently as a water supply source and could be tapped for additional water supply if needed.

No further changes in surface or groundwater quality will occur with implementation of any of the Hanford Site options provided adequate measures are taken in operation, treatment, and disposal of effluent wastes. A complete sewage treatment plant capable of handling about 757 million liters (200 million gallons) of waste water annually will need to be built to accommodate the associated wastes. Industrial waste water treatment of high-explosives waste should be handled exactly as at the Pantex Plant; infiltration ponds will need to be constructed for disposal of the sanitary and industrial effluents.

The risk of flooding is small in the area designated for proposed construction on the Hanford Site. Flooding by the Columbia and Yakima Rivers is nearly eliminated by dams. Neither the highest flood on record nor the probable maximum flood (magnitude determined by a meteorological estimate of the physical limit of precipitation over the drainage basin) would flood the proposed area.

Effects in the vicinity of the Pantex Plant expected after relocating operations at the Hanford Site are discussed in Section 4.1.2.4.

4.1.2.4 Termination--Water

In the case of termination of operations at the Pantex Plant, the pumpage from the Ogallala Aquifer for industrial use at the Pantex Plant would cease. This would have very little effect in the general overall water level decline. The Plant uses only an estimated 1% of total pumpage from the Ogallala Aquifer in Carson County. The projected annual use at the Plant is about 1.45 billion liters (383 million gallons or 1180 acre-feet). If the entire Plant were taken over for irrigated farming, the water production from the Ogallala Aquifer could reach 11.2 billion liters (3 billion gallons or 9100 acre-feet) assuming a 30-centimeter (12-inch) application to the 3680 hectares (9100 acres). This would be nearly eight times more pumpage of water from the aquifer to support irrigated farm land when compared to pumpage for use at the Pantex Plant.

Plant operation does not affect the water quality in the Ogallala Aquifer (MHSM 1982). Thus, if operation of the Plant were to end, there would be no change in water quality of the aquifer. However, with Plant operations terminated and release of sanitary effluents ended, the playas would be dry part of the year. Water that has been used for irrigtion or to support waterfowl or wildlife would not be available.

4.1.3 Terrestrial Resources

4.1.3.1 Pantex Plant Terrestrial Resources

There are no unique terrestrial resources at Pantex Plant that would be impacted by any of the options considered.

With continued operations at Pantex Plant, there will be contamination of the soil with depleted uranium at the firing site, and soil contamination with high explosives in the ditch system leading to and into Playa Basin Number 1. However, the level of contamination is expected to remain unchanged. Monitoring of the soil and groundwater at the Pantex Plant has shown no apparent movement of high explosives into the environment (Purtymun 1982A). Little, if any, high explosives have been detected in the ground water (RDX, cyclotrimethylene trinitramine, less than 0.01 milligram per liter, HMX, cyclotetramethylene tetranitramine, less than 0.05 milligram per liter) (MHSM 1982). This is due in part to the insolubility of high explosives in water (Dobratz 1981). Similarly, depleted uranium has not leached into the groundwater nor is it found in the site's perimeter soil (Purtymun 1982A, Buhl 1982).

The site of the coal pile (low- or high-sulfur coal) for the proposed cogeneration power plant will be planned before coal is used. The area beneath the coal pile will require a compacted clay or other type of impermeable blanket and will be equipped with a drainage system to channel all runoff from the coal pile into a leachate pond. The runoff will require little or no treatment if the coal has a low sulfur content.

If the coal has a high sulfur content, a lime water treatment will increase the alkalinity of the runoff allowing noxious elements and chemicals to precipitate out. Then, the precipitate will be packaged and disposed of with other chemical wastes produced at the Pantex Plant. The treated effluents will be released into the playas along with other treated waste waters.

4.1.3.2 Iowa Army Ammunition Plant--Terrestrial Resources

There are no unique terrestrial resources at the Iowa Army Ammunition Plant that would be impacted by any of the options considered.

Monitoring of the soil, sediment, surface, and groundwater has shown some contamination with high explosives. In addition, several heavy metals were found. The levels of contamination found and the results of investigations at the Pantex Plant indicate that neither Iowa Army Ammunition Plant option will result in contamination outside of Plant boundaries. A small increment of pollution will be added, but it will not be environmentally significant.

Industrial solid wastes, such as building and construction materials, will be disposed of in trenches. Other waste, such as cafeteria refuse, will be disposed of in a landfill. Combustible solid waste contaminated with explosives will be burned. These buried or burned wastes would not affect the environment outside of the Iowa Army Ammunition Plant.

The coal pile would be placed on a compacted clay or other type of impervious blanket. Drainage off of the coal pile would be channeled into a leachate pond, so that the runoff could be treated before release into the environment.

4.1.3.3 Hanford Site--Terrestrial Resources

There are no unique terrestrial resources at the Hanford Site that would be impacted.

As shown by studies at the Pantex Plant and Iowa Army Ammunition Plant, depleted uranium associated with dynamic testing would be localized in the firing site area (Purtymun 1982B, Buhl 1982). It is expected that relocation of all nuclear weapon operations to Hanford Site would not affect the offsite environment.

Solid wastes, such as building material or paper waste, would be disposed of in a sanitary landfill. Solid waste contaminated with explosives would be burned.

The coal pile associated with the proposed cogeneration plant would require placement on a compacted clay or other type of impervious blanket. Drainage off of the coal pile would be channeled into a leachate pond so that this runoff could be treated before release into the environment.

4.1.4 Ecology

4.1.4.1 Pantex Plant--Ecology

The only measurable impacts will be those associated with construction activities and minor changes in land-use patterns.

Future burning of high explosives that release hydrogen fluoride may result in a limited measurable impact. Hydrogen fluoride is highly toxic to plants. Part per billion concentrations at the burning pads could potentially cause limited damage to plants adjacent to burning operations under worst case meteorological conditions (Lacasse 1969, Jacobsen 1970). However, this situation is highly unlikely because of the short burn times and length of exposure needed to produce damage.

None of the other operations would release pollutants at levels considered biologically harmful (Sections 3.2.2 and 3.2.6). Any of these releases could be increased by several times and they still would not cause noticeable environmental effects.

The addition of a coal-fired power plant would represent the largest impact to the local environs. Long-term environmental effects from such facilities (such as creation of acid rain) are just now being scientifically examined. The implications of incremental pollutant releases of this power plant for long-term environmental regional effects (either positive or negative) are essentially unknown, but would be a small fraction of those attributable to commercial power plants in the region.

4.1.4.2 Iowa Army Ammunition Plant--Ecology

Implementation of either option at the Iowa Army Ammunition Plant would not result in significant environmental impacts other than some minor changes in land use. Releases of harmful pollutants would be very low and similar to those seen at Pantex Plant (Sections 3.2.1, 3.2.2, 3.2.6).

Effects in the vicinity of the Pantex Plant expected after relocating operations at the Iowa Army Ammunition Plant are discussed in Section 4.1.4.4.

4.1.4.3 Hanford Site--Ecology

Implementation of the Hanford Site alternative would not result in significant impacts on the local environs other than those associated with construction and noise from high-explosive test firing. Here, as at the other siting alternatives, the coal-fired cogeneration power plant would represent the largest project-related impact on the local environs.

The addition of test firing high explosives at the proposed location within the Hanford Site would disrupt current patterns of winter use by bald eagles along the Columbia River. Past experience with eagles indicates that they would be disturbed enough to move to more isolated (quieter) locations up or down river. There are ample locations nearby for the eagles to relocate.

Effects in the vicinity of the Pantex Plant expected after relocating operations at the Hanford Site are discussed in Section 4.1.4.4.

4.1.4.4 Termination--Ecology

Termination of operations at the Pantex Plant could result in negative impacts to local wildlife populations. Currently, the Pantex Plant serves an effective wildlife sanctuary because of restricted access and the prohibition of hunting. If this land were converted into agricultural production, some extensive tracts of natural habitat could be lost.

4.1.5 Land Use/Agriculture

4.1.5.1 Pantex Plant--Land Use/Agriculture

Land Use

Overall land use at the Pantex Plant will not be changed significantly with any construction option. Even with total replacement, the use of new land areas within the Pantex Plant site could be offset with restoration of currently used land areas to agriculture uses.

Termination of operations at the Pantex Plant would only alter current land uses in the event of total demolition and removal of all facilities. Mothballing or similar shutdown procedures would result in very little if any net changes in land use at Pantex Plant.

Agriculture

New construction would have very little effect on agriculture. Plant expansion would remove approximately 2 hectares (5 acres) from agricultural production. Completely rebuilding the Plant would remove a greater amount--about 20 hectares (50 acres). These acreages are negligible and represent 0.1% and 1.0%, respectively, of land currently used on the Pantex Plant site for agricultural production.

Consumption of agricultural products grown on or adjacent to Pantex Plant will not impact human health. Anticipated future releases of radioactive and nonradioactive pollutants will remain at such small levels (Sections 4.1.1.1, 4.1.2.1, 4.1.6.1) that no agricultural problems are expected.

4.1.5.2 Iowa Army Ammunition Plant--Land Use/Agriculture

Land Use

Construction of a totally new facility at the Iowa Army Ammunition Plant would convert some farmland, brushland, and deciduous forest into an industrial park. However, the total change would be insignificant in terms of current land use patterns.

Agriculture

Reuse of existing facilities at the Iowa Army Ammunition Plant (Option 1) for nuclear weapon operations would not affect any of the existing leased agricultural land. Detonation of devices containing some depleted uranium would be expected to resume at the firing site; however, deciduous forest exists between the firing site and the farmland. This forest provides a natural barrier to contain releases.

Relocating all operations to the Iowa Army Ammunition Plant and closing the Pantex Plant would remove some leased land from agricultural use. The amount of land removed is less than 15% of the leased farmland and does not present a significant impact.

Consumption of agricultural products grown on or adjacent to the site will not impact human health. Computer simulation of crops and livestock at Iowa Army Ammunition Plant indicates no expected uptake of radionuclides above normal background levels (Wenzel 1982D).

Effects in the vicinity of the Pantex Plant expected after relocating operations at the Iowa Army Ammunition Plant are discussed in Section 4.1.5.4.

4.1.5.3 Hanford Site Alternatiave--Land Use/Agriculture

Land Use

Construction of a nuclear weapons operations facility at the Hanford Site will change a portion of the desert into roads, parking lots, and buildings. This action will not change current land-use patterns because other facilities currently dot the landscape at widely separated intervals. The proposed construction would be similar in size and be separated by about the same distance (several miles) as current facilities on the Hanford Site.

Agriculture

Based on the low level of potential emissions and the remote location of the proposed site with respect to current offsite agriculture, no agricultural impacts are expected.

Effects in the vicinity of the Pantex Plant expected after relocating operations at the Hanford Site are discussed in Section 4.1.5.4.

4.1.5.4 Termination--Land Use/Agriculture

Land Use

Land-use impacts upon termination of operations at the Pantex Plant would depend on ultimate use. The facility could be shut down and maintained in a readiness condition for remobilization. This would result in essentially no change from current conditions. The Plant could be decommissioned and used by private interests. Land-use impacts then could vary from total agricultural usage to total industrial park, depending on the user.

Agriculture

Terminating the Pantex Plant operations would not change current agricultural land-use patterns in the surrounding area. After decontamination and demolition of some of the existing facilities, additional onsite land could be released to the public. As most of the site is used already for agriculture, the site would probably revert to private farms and ranches.

Because the acreage is small compared to the 65 thousand hectares (160 thousand acres) already under cultivation in Carson County, no noticeable changes in agricultural economics would be seen in the area (USDA 1980).

4.1.6 Environmental Radiation and Radioactivity

4.1.6.1 Pantex Plant--Environmental Radiation and Radioactivity

Radioactive Releases

Emissions of radionuclides from normal operations at the Pantex Plant would continue to be negligible and indistinguishable from background radiation.

Depleted Uranium. Dynamic testing involving depleted uranium is expected to include no more than 10 kilograms a year of depleted uranium in the future. Releases of depleted uranium in test shots would be less than 232 microcuries per year of the uranium radionuclides.

Tritium. Tritium releases are expected to remain constant at about 0.1 Curies per year.

Plutonium. No releases have occurred, and no releases are expected to occur.

Coal-Fired Power Plant

The proposed coal-fired power plant would release several naturally occurring radionuclides. These radionuclides are principally members of the thorium and uranium decay chains and include over 25 different radionuclides (Buhl 1982).

Some of the major emissions are listed below.

Radionuclides	Microcuries Released per Year
Uranium-238	80
Uranium-234	80
Thorium-232	33
Thorium-228	33
Thorium-230	40
Radium-228	50
Radium-224	50
Radium-226	60
Radon-222	16,000
Polonium-210	200
Lead-210	200

Radiological Doses

All Options. Radiation doses from depleted uranium releases will be approximately the same as those from current operations. The dose estimates presented here were calculated using the computer model AIRDOS-EPA (Moore 1979). These dose estimates are higher than those given in Section 3.2.6.1 because of additional conservative assumptions made in these calculations to maximize the potential future dose. The maximum 50-year dose commitment is 3.1 millirem to bone per year of exposure for the maximum exposed individual. This dose is 0.2% of the Radiation Protection Standard (USDOE 1980A), and 1.1% of the natural background dose. The maximum theoretical 50-year population dose commitment to bone is 2.6 person-rem per year (Buhl 1982).

The continued constant release rate for tritium of 0.1 Curie a year would result in a 50-year dose commitment of less than 0.01 millirem to the whole body per year of exposure to the maximum exposed individual, which is less than 0.001% of the Radiation Protection Standard, and a 50-year population dose commitment to whole body of 0.00005 person-rem per year from all tritium releases (Buhl 1982).

Coal-Fired Power Plant

The organ whose dose is the largest fraction of its Radiation Protection Standard is bone. The maximum exposed individual would receive a 50-year dose commitment to bone of 0.02 millirem for each year of exposure, or 0.001% of the Radiation Protection Standard (USDOE 1980A). The annual 50-year population dose commitment to bone would be 0.19 person-rem per year (Buhl 1982).

Radiological Effects

All Options. An average member of the public within an 80 kilometer (50 mile) radius of the Pantex Plant would incur an added lifetime risk of cancer of less than 1 chance in a billion per year from Pantex plant operations because of the routine release of depleted uranium and tritium. The added risk of genetic disorder in all subsequent generations is less than 1 disorder in a billion offspring per year of exposure. These risks are less than 0.001% of natural background radiation rates. These conclusions are based on the field studies undertaken in support of this impact statement, as well as estimates of future effects using projected release rates and computer modeling (Buhl 1982).

Coal-Fired Power Plant

Emissions of naturally occurring radioactivity from the coal-fired power plant would result in an added risk of cancer mortality of less than 1 chance in a billion per year of exposure. The added risk of genetic disorders in offspring in all subsequent generations is less than 1 disorder in a billion offspring per year of exposure. These risks are less than 0.001% of those estimated to occur from one year's exposure to natural background radiation (Buhl 1982).

Solid Radioactive Wastes

Solid radioactive wastes will continue to be packaged and shipped to the Nevada Test Site for disposal.

4.1.6.2 Iowa Army Ammunition Plant--Environmental Radiation and Radioactivity

Radioactive Releases

Relocating part or all of the nuclear weapons operations to the Iowa Army Ammunition Plant would result in three sources of radioactive emissions. These sources are small atmospheric releases of depleted uranium from dynamic testing, tritium releases from facility operations, and naturally occurring radioactivity from the coal-fired power plant (Buhl 1982).

If all nuclear weapons operations were relocated to the Iowa Army Ammunition Plant, the maximum 50-year dose commitment of the maximum exposed individual and the maximum 50-year population dose commitment would be 2.5 millirem (to bone) and 0.94 person-rem (to bone), respectively, for each year of exposure. The maximum individual bone dose is 0.2% of the Radiation Protection Standard (USDOE 1980A) and 0.9% of natural background bone dose. The 50-year dose commitments to all other organs are less than 0.2% of the Radiation Protection Standard.

These doses would be accompanied by a reduction at the Pantex Plant of maximum individual and population 50-year dose commitments. The doses at the Pantex Plant after relocating operations to the Iowa Army Ammunition Plant are discussed in Section 4.1.6.4.

Radiological Effects

If all nuclear weapons operations were performed at the Iowa Army Ammunition Plant, there would be an average added lifetime risk of cancer mortality of less than 1 chance in a billion per year of exposure and added average risk of genetic disorder in offspring of less than 1 disorder in a billion offspring per year of exposure. The added risks would be caused principally by the release of depleted uranium in explosive testing and from the release of naturally occurring radionuclides in coal. This would be accompanied by a reduction in the Amarillo area of the added risk of cancer mortality and of genetic disorder in offspring. These risks are given in Section 4.1.6.4.

The added risks of cancer and genetic disorder in offspring to the 80 kilometer (50 mile) population around the Iowa Army Ammunition Plant would be less than 0.001% of those from one year's exposure to natural background radiation (Buhl 1982).

Solid Radioactive Wastes

A program for handling solid radioactive wastes would be established similar to the existing program at the Pantex Plant. All solid radioactive wastes would be packaged and sent to an approved radioactive waste disposal site or the Nevada Test Site.

4.1.6.3 Hanford Site--Environmental Radiation and Radioactivity

Radioactive Releases

Relocating all nuclear weapons operations to the Hanford Site would result in three new sources of radioactive emissions. These would be small atmospheric releases of depleted uranium from dynamic testing, tritium releases from operations, and naturally occurring radioactivity from the coal-fired power plant.

Radiological Doses

The Hanford Site alternative would result in small projected doses from operational releases of radioactive materials. The maximum individual and population 50-year dose commitments are 0.35 millirem to bone and 0.4 person-rem to bone, respectively, for each year of exposure. This maximum individual bone dose is 0.02% of the Radiation Protection Standard (USDOE 1980A). All other organ 50-year dose commitments, including whole body, are smaller percentages of their respective Radiation Protection Standard (Buhl 1982). Radiation dose at the Pantex Plant after relocation of operations is discussed in Section 4.1.6.4.

Radiological Effects

Relocation of nuclear weapons operations to the Hanford Site would result in an added lifetime risk of cancer mortality to an average member of the public living within 80 kilometers (50 miles) of the proposed facility of less than 1 chance in a billion for each year of exposure. The corresponding added risk of genetic disorder in offspring in the Hanford Site area is estimated to be less than 1 disorder in a billion offspring. Over 99% of the added risks would result from releases of depleted uranium in explosives testing and the release of naturally occurring radionuclides in coal. The risks of cancer mortality and genetic disorder in offspring are less than 0.001% of those from a 1-year exposure to natural background radiation. This would be accompanied by a reduction of risks in the Amarillo area as discussed in Section 4.1.6.4.

Solid Radioactive Wastes

A program for handling these additional solid radioactive wastes at Hanford Site would be established. These wastes would be packaged and disposed of at Hanford Site or some other approved radioactive waste disposal area.

4.1.6.4 Termination--Environmental Radiation and Radioactivity.

There would be essentially no radioactive releases from the Pantex Plant after relocation of operations to alternative sites, except for normal transport of windblown uncontaminated background soil. It is assumed that the firing sites and burning ground would be decontaminated to background levels. Decontamination of these areas eliminates a source of depleted uranium that could have been resuspended from the soil and transported offsite.

Minute radioactive material releases may occur from resuspension of soil during excavation of the firing sites and burning ground, but these releases would be negligible because of procedures for controlling dust and the radionuclide release rates.

Radiological Doses

Since radioactive releases from the Pantex Plant would be negligible, the only possible radiation doses would result from depleted uranium, and to a lesser extent from tritium, assumed to have been deposited offsite during past operations. Even though measurements cannot detect any offsite increments of uranium or tritium above natural background (Section 3.2.6.1), this evaluation assumed some must have been deposited and computer modeling was used to estimate the amounts. Based on these theoretical calculations, the organ receiving the highest fraction of the Radiation Protection Standard is bone. The 50-year dose commitment to bone for the maximum exposed individual was estimated to be less than 0.01 millirem per year of exposure. This bone dose is less than 0.001% of the Radiation Protection Standard and is approximately 0.001% of the dose to bone from natural background radiation.

The 50-year population dose commitment to bone is 0.05 person-rem per year of exposure for the population living within an 80-kilometer (50-mile) radius of the Pantex Plant. This dose is less than 0.001% of the natural background radiation dose to bone received by this population.

Radiological Effects

The average added risk of both cancer mortality and of genetic disorder in offspring for the population living within 80 kilometers (50 miles) of the Pantex Plant would be less than 1 chance in a billion per year of exposure. The cancer and genetic risks are less than 0.001% of the cancer and genetic risks incurred by this population from one year's exposure to background radiation.

4.1.7 Energy Resources

4.1.7.1 Pantex Plant--Energy Resources

Table 4.1.7.1-1 shows the total energy requirements predicted for the various options (Schnurr 1982A). Any construction option will result in an energy savings for operations because new facilities would be built to meet Department of Energy Building Energy Performance Standards (USDOE 1978). It is assumed that ceiling insulation and an automated energy management system will be added to the remaining old buildings. Predicted total annual energy use for the Pantex Plant options were obtained by adding the annual lighting and process energy consumption to the heating and cooling energy requirements.

TABLE 4.1.7.1-1

TOTAL ENERGY CONSUMPTION FOR PANTEX PLANT OPTIONS*
(expressed as million kilowatt hours)

Option	Natural Gas	Electricity	Total
1. New construction	75	37	112
2. Major upgrade	83	44	127
3. Major replacement	61	36	97
4. Existing facilities	112	41	153

*Based on the heating and cooling requirements for all facilities plus process energy consumption.

The peak demand for electricity in 1980 was 7800 kilowatts. The coal-fired cogeneration plant would produce 2900 kilowatts of electricity. The addition of that plant along with proposed energy conservation measures would reduce demand for electricity generated offsite by more than 50%.

4.1.7.2 Iowa Army Ammunition Plant--Energy Resources

For Option 1 (partial relocation) the assumption is made that energy conservation measures are applied to old buildings at both Pantex Plant and Iowa Army Ammunition Plant and that the new construction meets building energy performance standards. For Option 2, the totally new plant is similar to Pantex Plant Alternative, Option 3. Based on these assumptions, the results of the energy utilization analysis are presented in Table 4.1.7.2-1.

TABLE 4.1.7.2-1

TOTAL ENERGY CONSUMPTION* FOR IOWA ARMY AMMUNITION PLANT OPTIONS
(expressed as million kilowatt hours)

Option	Natural Gas	Electricity	Total
Partial relocation**	99	46	145
Total relocation	82	43	125

*Based on the heating and cooling requirements for all facilities plus process energy consumption.
**This includes usage at both the Iowa Army Ammunition Plant and the Pantex Plant.

The peak demand for electricity generated offsite would be in the range of 5000 to 8000 kilowatts for Option 1 and less than 2500 kilowatts for Option 2. This could be supplied by the Union Electric Company of St. Louis without additional generating capacity. The demand at the Iowa Army Ammunition Plant would be about 0.1% of Union Electric's total generating capacity of 6.967 million kilowatts.

For Option 2, the addition of the coal-fired cogeneration plant would replace natural gas as an energy source with coal. The cogeneration plant would provide steam for heating and process use as well as electrical energy at a rate of 2900 kilowatts.

Effects in the vicinity of the Pantex Plant expected after relocating operations at the Iowa Army Ammunition Plant are discussed in Section 4.1.7.4.

4.1.7.3 Hanford Site--Energy Resources

The Hanford Site Alternative (total relocation) requires the construction of all new facilities. The total energy requirements for this alternative are given in Table 4.1.7.3-1.

TABLE 4.1.7.3-1

TOTAL ENERGY CONSUMPTION FOR HANFORD SITE ALTERNATIVE*
(expressed as million kilowatt hours)

Option	Natural Gas	Electricity	Total
Total relocation	69	35	104

*Based on the heating and cooling requirements for all facilities plus process energy consumption.

The addition of a coal-fired cogeneration plant would provide all steam requirements and 2900 kilowatts of electrical energy. The peak demand for offsite electricity would be approximately 1000 kilowatts. This could be supplied by the Bonneville Power Administration system (total 1981 generating capacity, 17 million kilowatts) without additional generating capacity.

Effects in the vicinity of the Pantex Plant expected after relocating operations at the Hanford Site are discussed in Section 4.1.7.4.

4.1.7.4 Termination--Energy Resources

No energy for heating and cooling at the Pantex Plant would be required. The net annual energy saving compared to the "no action" alternative would be 153 million kilowatt hours.

4.1.8 Employment and Population

4.1.8.1 Pantex Plant--Employment and Population

Option 1 (New Construction)

The combined construction and operating employment levels at the Pantex Plant will increase by approximately 8% above current levels. In view of the relatively small increase in the entire Amarillo trade area (11 counties: Hartley, Moore, Hutchinson, Oldham, Potter, Carson, Deaf Smith, Randall, Armstrong, Castro, and Swisher), no negative population impacts are projected from construction or operation activities. In all probability, work force requirements can be met by the local resident labor supply (Rapp 1982).

Option 2 (Major Upgrade)

All labor force requirements could be met by local workers; thus, no negative population impacts are projected. If the project is constructed over a 5-year period, the basic employment is projected to peak at 1000 jobs in the third year construction. Nonbasic employment would add 680 service-related jobs. However, if the same tasks are completed in 8 years, employment would be about 858 basic workers and 583 nonbasic workers. The operating work force would rise from the present 2400 workers to approximately 2600 employees (TEC 1982).

Option 3 (Major Replacement)

There would be few, if any, significant population changes in the Amarillo trade area from either the 5 or 8-year construction scenarios evaluated for this option. Several local officials believe an ample supply of workers can be found within commuting distance (Rapp 1982). However, an extreme case scenario projects the in-migration of about 2110 basic and nonbasic workers adding a total of 5800 workers and their families to the area. The construction could result in a temporary increase of about 2% in the population of the Amarillo trade area under extreme conditions. As with Options 1 and 2, the permanent operating work force would increase by 200 jobs (TEC 1981, TEC 1982).

Option 4 (No Action)

No new population and employment impacts would occur.

4.1.8.2 Iowa Army Ammunition Plant--Employment and Population

Option 1 (Partial Relocation)

No negative employment or population impacts are expected. To complete the project in 2 years, the construction work force would employ an estimated 100 basic workers and 68 nonbasic workers during peak construction periods. If the same project was completed in 3 years, peak employment would level off at 85 basic and 58 nonbasic workers. The permanent operating work force is projected to add 1000 new jobs at Burlington and 100 new jobs at Amarillo. The resident labor supply is adequate to meet all needs without in-migration of new population (Rapp 1982).

Option 2 (Total Relocation)

No negative population changes are projected even under the hypothetical extreme case scenario. During the peak construction period, the population could be expected to rise less than 5% above the 1980 census count in the southeast Iowa trade area. This evaluation considered the implication of completing the construction in either 5 or 8 years. The fairly large construction work force required to complete the project in 5 years would employ approximately 1800 basic workers and 1224 nonbasic workers during peak periods. In contrast, an 8-year period would employ an estimated 1526 basic and 1038 nonbasic workers. The extreme case scenario projects in-migration of 740 single workers and about 1400 families totaling about 5100 persons, including 960 school-age children. The expected distribution of in-migrant workers and families projects a one-time growth in population of less than 8% in Burlington and West Burlington and a 4.6% increase in school enrollments. The balance of the new growth is projected in settlement patterns similar to the present Iowa Army Ammunition Plant work force. This growth is within acceptable annual growth guidelines as discussed in detail in Rapp 1982 (IJS 1980A, IJS 1981B).

Upon completion, the new plant would employ a permanent work force of 2600 workers. The labor force (except for special skills) would be filled by local residents presently found within commuting distance of the plant site (IJS 1981A).

Effects in the vicinity of the Pantex Plant expected after relocating operations at the Iowa Army Ammunition Plant are discussed in Section 4.1.8.4.

4.1.8.3 Hanford Site--Employment and Population

The Tri-Cities trade area (Franklin and Benton Counties) could supply the construction work force required for construction activities. This is particularly true in view of the cancellation of proposed construction activities of the Washington Public Power Supply System.

In the summer of 1980, Washington Public Power Supply System employed a temporary construction work force that was nearly three times the size of the largest requirement projected to construct a new plant. A decision to relocate nuclear weapon operations at Hanford Site would permit an orderly transition of needed workers with little or no in-migration of construction workers to the Tri-Cities trade area (WES 1982).

This evaluation considered a 5-year and an 8-year scenario. The shorter period is projected to employ 1800 basic workers and 1224 nonbasic workers during peak construction periods. The 8-year scenario would employ about 460 fewer workers. The extreme case scenario would represent about a 2.5% net growth in the total population of the Tri-cities trade area over the 1980 census count (Rapp 1982).

Upon completion of the construction, the new plant would employ a permanent work force of 2600. The job requirements are expected to be filled by local workers (WES 1982).

Effects in the vicinity of the Pantex Plant expected after relocating operations at the Hanford Site are discussed in Section 4.1.8.4.

4.1.8.4 Termination--Employment and Population

Termination of nuclear weapons operations at the Pantex Plant would result in the direct loss of 2400 jobs at the Pantex Plant. As each Pantex Plant job generates about 1 additional job, the termination would also impact another 2400 workers in the Amarillo trade area. Therefore, this alternative would affect 4800 workers or about 5.5% of the labor force in the Amarillo trade area and about 4.7% of the population residing within commuting distance of the Pantex Plant (Rapp 1982).

4.1.9 Economics

4.1.9.1 Pantex Plant--Economic Assessment

Option 1 (New Construction)

No negative economic impacts are projected. Employment of an estimated 459 basic construction workers and 312 nonbasic workers would add a total of $18.4 million in annual payrolls during the peak construction period. The new payrolls would add approximately 0.5% to the total retail sales reported for the Amarillo trade area in 1981. The local share of supplies and construction material purchases has not been determined (Rapp 1982).

This Option would add about 200 new permanent jobs at the Pantex Plant. The 8.3% increase over present Pantex Plant levels in both basic and nonbasic annual payrolls totals nearly $8.7 million. The economic benefit in terms of retain sales could add about 0.3% to retail sales of the area (Rapp 1982).

Option 2 (Major Upgrade)

No negative economic impacts are projected. Total annual payroll and related economic benefits would range from $34 million to $40 million, depending upon length of the construction period (5 years or 8 years). Similarly, retail sales in the Amarillo trade area could increase approximately 1.0% to 1.2% above the 1981 total sales (Rapp 1982).

This option also would add 200 new permanent jobs, resulting in combined basic and nonbasic annual payrolls estimated to total $6.5 million. The increase would add only 0.2% to the total retail sales in the trade area (Rapp 1982).

Option 3 (Major Replacement)

No negative economic impacts are projected. The annual payroll for the peak construction activity varies with the length of the construction period (5 to 8 years). Thus, peak annual payrolls could range from $59 million to $64 million. Retail sales are projected to range between 1.4% to 1.9% above the 1981 totals in the Amarillo trade area (Rapp 1982).

As with Pantex Plant Options 1 and 2, this option would add only 200 new permanent jobs resulting in an increase in basic and nonbasic annual payrolls totalling $8.7 million. The increase would add only 0.3% to the total retail sales in the Amarillo trade area (Rapp 1982).

Option 4 (No Action)

No negative economic impacts are projected. The peak annual payroll for construction already underway would be about $8.7 million. Retail sales would be about 0.3% above the 1981 level in the Amarillo trade area.

4.1.9.2 Iowa Army Ammunition Plant--Economic Assessment

Option 1 (Partial Relocation)

No negative economic impacts are projected.

A 2-year construction scenario generates $4.4 million in annual payrolls during peak construction years versus a $3.7 million peak year payroll in a 3-year scenario. Increases in retail sales would be about 0.3% in the Southeast Iowa trade area (Rapp 1982).

Partial relocation would add approximately 1000 permanent new jobs at the Iowa Army Ammunition Plant. The increase almost exactly doubles the current Iowa Army Ammunition Plant work force and would result in an economic benefit of $37 million in basic and nonbasic annual payrolls. The economic benefit in retail sales would add about 2.8% to the 1981 retail sales of the Southeast Iowa trade area (Rapp 1982).

Option 2 (Total Relocation)

No negative economic impacts are projected for the area.

The evaluation considered completion of the project in two time frames, either 5 years or 8 years. The longer time period would permit smaller work force levels in peak construction years. Payrolls would vary from $67 million to $79 million in peak construction years and related retail sales would vary from 5.1% to 6.0% above the 1981 level reported for the Southeast Iowa trade area (Rapp 1982).

Upon completion, the new plant would employ about 2600 permanent workers. The new payroll generated by these permanent jobs at the plant and nearly 2600 nonbasic jobs is estimated to total $96 million annually (Rapp 1982). Retail sales in the Southeast Iowa trade area would increase an estimated 7.6% above the 1981 levels.

In Amarillo, the effects of closing the Pantex Plant would be as described in Section 4.1.9.4.

4.1.9.3 Hanford Site--Economic Assessment

No negative economic impacts are projected.

The evaluation considered completion of construction in either 5 or 8 years. Total annual payrolls are projected to range between $70 million to $83 million. Similarly, retail sales in the trade area are projected to rise from 3.6% to 4.3% above 1981 levels. Implementation of this option cannot ignore the reality of declining construction at the Hanford Site, which recently employed a work force three times the size of that projected in the extreme case scenario. Current construction activities provide the potential for an economic "bust cycle" by 1983. However, relocation of nuclear weapons operations at Hanford Site could reduce the potential bust by slowing the population decline with new construction opportunities in the Tri-Cities trade area (Rapp 1982).

The new payroll generated by 2600 permanent jobs at the Plant and nearly 2600 nonbasic jobs is estimated to total over $117 million annually. The new payrolls would increase the retail sales in the area by about 6.0% above the 1981 level (Rapp 1982).

Effects in the vicinity of the Pantex Plant after relocating at the Hanford Site are discussed in Section 4.1.9.4.

4.1.9.4 Termination--Economic Assessment

Significant negative economic impacts are projected in the Amarillo area if the Pantex Plant operations were terminated. Based upon a ratio of buying income to retail sales (64.5%), closing the Pantex Plant would cost $54.9 million to annual retail sales (3% of the 1981 total) in the Amarillo trade area. Other losses would include approximately $65 thousand per year in Federal impact funds paid to the local school districts (Rapp 1982).

The Pantex Plant provides important economic stability to the entire Panhandle Region of Texas. Although it is difficult to measure the full economic implications of termination, especially in view of the current economic changes taking place in the nation, the action would negatively impact the economy of the area for at least 5 years under any foreseeable circumstances (Rapp 1982).

4.1.10 Community Resources

4.1.10.1 Pantex Plant--Community Resources

Option 1 (New Construction)

No additional demands on community resources are projected.

Option 2 (Major Upgrade)

All jobs will be filled by local labor; this avoids negative impacts upon community resources.

Option 3 (Major Replacement)

Housing. In early 1982, there were many homes on the market in Amarillo. However, high prices and costly apartment rentals also were noted. Therefore, housing shortages may occur in Amarillo until mobile home park construction catches up to new demand. In an extreme case scenario during the peak construction period, the Amarillo trade area would gain approximately 5800 new residents (an estimated 740 single workers and about 1400 families). Typically, about 50% of migrant construction workers bring their mobile homes; the balance rent or buy housing. Approximately 90% of the migrant work force and family members (about 5200 total) are expected to locate in the Amarillo Standard Metropolitan Statistical area (Potter and Randall Counties). This will increase the population 2.9% above the 1980 United States census count. The balance of the work force and families would probably locate in rural areas or in Borger, Canyon, Panhandle, or perhaps White Deer. At Panhandle, the lack of new housing will require that virtually all new growth be accommodated in worker-owned mobile homes (TEC 1982).

Utilities. Utility services in the Amarillo trade area are adequate for all proposed actions (Amarillo 1979, Amarillo 1980).

Educational System. No adverse impacts are expected within the educational systems serving Pantex Plant employees (Rapp 1982). Approximately 900 additional students are projected for the Amarillo Independent School District (an increase of 3.4% over the 1981 to 1982 enrollment). At Panhandle, younger families with few children of school age are expected if mobile home space can be found. The extreme case scenario places an estimated 25 to 30 additional students of school age in the community. This represents a 4.4% increase over the current enrollment of 687 in the Panhandle Independent District (Rapp 1982).

During the peak construction period, another 65 to 70 students of construction worker families are expected to be enrolled in still other school districts within commuting distance of Pantex Plant.

Health Services. Health services in the Amarillo area are considered adequate to meet any projected growth associated with alternative actions at the Pantex Plant (PRPC 1981).

Public Safety Services. During the construction period, the Amarillo Police and Fire Departments will need to add at least six additional police officers and five firefighters in order to maintain the current ratio of public safety officers per capita. During peak construction, commuter traffic to the Pantex Plant may increase 100% and, therefore, would require additional law enforcement because of increased congestion at intersections and railroad crossings near the Plant. Required car pooling and bussing by the general contractor may be justified especially during the peak construction period (Rapp 1982).

Transportation. No significant impacts on transportation facilities are projected.

Option 4 (No Action)

No community resources are affected.

4.1.10.2 Iowa Army Ammunition Plant--Community Resources

Option 1 (Partial Relocation)

No negative impacts are expected on any community resources.

Option 2 (Total Relocation)

Housing. Only Burlington, West Burlington, and Middletown are expected to experience temporary housing shortages in an extreme case Iowa Army Ammunition Plant scenario. Surrounding counties will be impacted less than 5%. Housing needs will be met largely by existing surplus housing and mobile home sites. Many single workers may rent rooms at several hotels in Burlington or in the large homes in older residential areas of the city (Burlington 1981B).

Utilities. No negative impacts are expected (Burlington 1981B).

Educational Systems. Few problems would occur as surplus capacity in existing school buildings will permit timely renovation as needed. Under the extreme case Iowa Army Ammunition Plant scenario, an estimated 350 additional school-age children will attend Burlington schools through the peak construction period. This represents about 4.6% increase over 1981 enrollment counts in Burlington area public and private schools (Burlington 1981B). The remainder of the school children of workers (610) would be expected to be distributed in school districts surrounding Burlington in about the same proportions as for the present Iowa Army Ammunition Plant work force.

Health Services. No negative impacts are projected (Burlington 1981B).

Public Safety. Under the extreme case scenario, the Burlington city government may need to add two police officers and three firefighters in order to maintain the present ratio per capita. No other jurisdiction is expected to be significantly impacted (Burlington 1981A).

Transportation. The potential for an additional 2100 commuters in the Burlington area would create temporary new traffic problems. Required car pooling and bussing may be justified, especially during the peak construction period.

Effects in the vicinity of the Pantex Plant expected after relocating operations at the Iowa Army Ammunition Plant are discussed in Section 4.1.10.4.

4.1.10.3 Hanford Site--Community Resources

Until recently, the Tri-Cities area supported a construction work force three times the size of that anticipated for the Hanford Site alternative. Impacts upon community resources are expected to be negligible (TCCC 1981, TCRERC 1981, USDOE 1980A, USDOE 1980B, WJS 1980, WJS 1981A, WJS 1981B).

Effects in the vicinity of the Pantex Plant expected after relocating operations at the Hanford Site are discussed in Section 4.1.10.4.

4.1.10.4 Termination--Community Resources

Termination of the Pantex Plant would have a direct effect on community resources as evidenced by employment and economic repercussions discussed in Sections 4.1.8.4 and 4.1.9.4. The public schools would lose nearly 1100 students and about $65 thousand per year in Federal impact fund payments. The loss in tax revenue could exceed $21.2 million annually (Rapp 1982).

4.1.11 Cultural Resources and Native Americans

4.1.11.1 Pantex Plant--Cultural Resources and Native Americans

No known archaeological or historical resources or shrines or places of Native American religious worship would be impacted. All sites located in the Pantex Plant archaeological survey were outside of potential construction areas (Hughes 1981). Further archaeological work at this site is currently unwarranted.

4.1.11.2 Iowa Army Ammunition Plant--Cultural Resources and Native Americans

No known historical or archaeological resources or shrines or other places of Native American worship would be impacted. However, this area has never had a detailed cultural resource survey. The State Historic Preservation Officer determined that such a survey of the proposed construction sites would be required prior to construction activities (Anderson 1982).

4.1.11.3 Hanford Site--Historic and Archaeological Resources/Native Americans

No known historical or archaeological resources or shrines or other places of Native American worship would be impacted. Native Americans living in the vicinity of the Hanford Site may consider portions of the Site as homeland or as having religious significance.

The Hanford Ditch (a potentially eligible candidate for the National Register of Historic Places) crosses the proposed firing site area, and a large number of archaeological sites exist adjacent to the Columbia River. Therefore, the State Historic Preservation Officer determined that a detailed cultural resources survey would be required before any construction activities (Stump 1982). A formal request for a National Register Determination of Eligibility for the Hanford Ditch would have to be made, and measures would have to be taken to avoid impacting this resource.

4.1.12 Future Health and Safety Considerations

Based on the studies done for this Environmental Impact Statement, no significant public or worker health and safety impacts are expected from normal operations. No releases of any material were found that would be expected to cause measurable effects on the general public. This finding is supported by the epidemiological study of the public, which found no observable effects on county cancer mortality patterns from Plant operations.

The Department of Energy is constantly striving to achieve improved operational reliability and better working conditions for all its operations. For any alternative, a primary concern would be preventing the accidental detonation of high explosives or mitigating possible consequences to facilities, workers, and the general public.

Another principal concern for protecting the health and safety of workers is limiting radiation exposures. The amount of radioactive materials handled in all types of operations was used as an approximate indicator of potential occupational exposures. Doses are expected to remain about the same as the 1979 to 1981 levels over the next 5 or 6 years. Thus, no significant changes in health and safety impacts from occupational exposures would be expected from routine Plant operations. A work force epidemiological study is underway and results are expected to be available for the Final Environmental Impact Statement.

The other health and safety concerns of nuclear weapons operations are common to all site alternatives and are similar to those health and safety concerns found in many light industries. A similar work force health and safety program as currently implemented at Pantex Plant would meet or exceed existing and foreseeable standards given any of the alternatives. However, as technology advances, health and safety programs must continue to evaluate chemicals and operations used in the advanced technologies. As warranted, new health and safety procedures would be established. Future changes in weapon systems and high-explosive technology may result in changes in different toxic releases and will require continued attention from a Health and Safety standpoint.

If complete relocation to the Iowa Army Ammunition Plant or the Hanford Site were to occur, potential health and safety impacts from operations would be eliminated in the Amarillo area upon Pantex Plant termination. Routine releases would cease. All equipment would be examined for toxic materials before public release; areas with toxic materials such as the solvent evaporation tanks would be cleaned to acceptable environmental standards before Plant decommissioning.

4.2 IMPACTS OF POTENTIAL PLANT ACCIDENTS

Identifying potential accidents and then estimating the probabilities and consequences of postulated accidents required the application of several disciplines. Figure 4.2-A indicates the major interactions between the steps in the analysis.

Identification of possible accidents to be studied was based on previous studies of the safety of nuclear weapons operations and new evaluations conducted for this Environmental Impact Statement (Section 4.2.1). Accident scenarios were devised to represent each abnormal circumstance (Section 4.2.2). These scenarios provided a basis for computing estimated probabilities of occurrence of each accident (Section

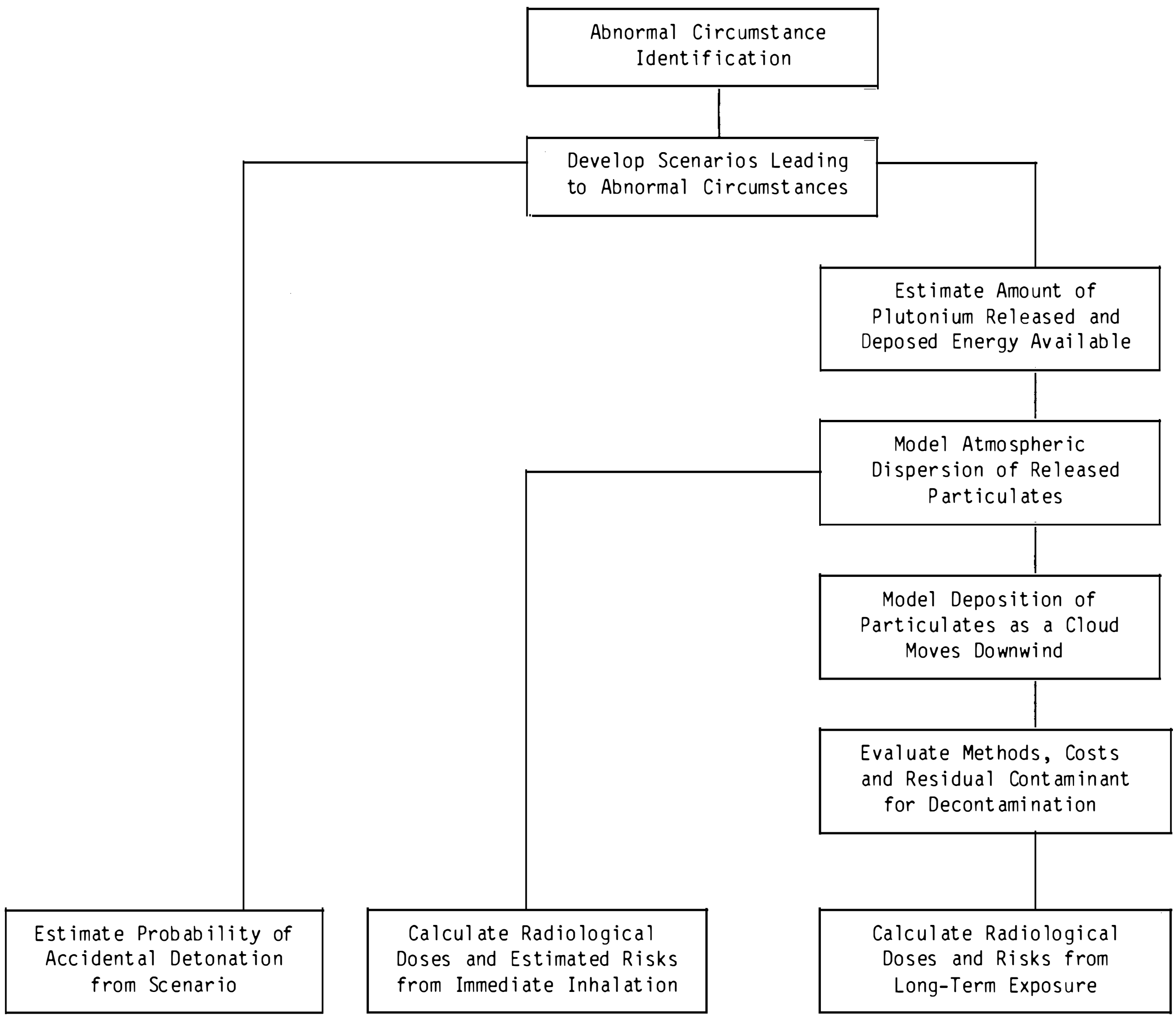


Figure 4.2-A. Accident analysis procedures showing interactions of analyses.

4.2.3) and the potential radioactive release (Section 4.2.4) if the accident should happen. The estimated releases for those accidents that were both credible and had significant environmental impact were combined with site-specific statistics for atmospheric dispersion conditions to estimate the dispersion and deposition of radioactive materials (Section 4.2.5). The dispersion estimates were used to estimate potential health effects to the public from the inhalation of the airborne radioactive particles as a debris cloud passes (Section 4.2.6). The cost of decontaminating the exposed area to selected cleanup objectives was determined (Section 4.2.7). The potential health effects from the long-term exposure of the public to residual contamination was determined (Section 4.2.8).

Results of the analysis of accident probabilities are given in Section 2.4.3 for the three site alternatives. Results of the consequence analysis are presented for selected accident scenarios in Sections 4.2.6, 4.2.7, and 4.2.8. In those sections, three sets of results are presented for the Pantex Alternative and the Iowa Army Ammunition Plant Alternative. The results are based on the analysis of accidents with low, intermediate, and maximum releases to illustrate the ranges of possible effects. For the Hanford Site Alternative, results are presented for the single type of accident found credible.

4.2.1 Abnormal Circumstances

The safety of nuclear weapons operations has been and continues to be under exceptional, continuous scrutiny. The safety of new facilities and major modifications to existing facilities is evaluated before construction. Existing facilities are also evaluated by the safety analysis process (USDOE 1981A). Studies of the safety of nuclear weapons operations are conducted by multidisciplinary committees composed of safety experts from the weapons design laboratories, the Department of Energy, and the plant operating contractor. These committees review the written procedures, other documentation, training of personnel, the personnel assurance program, electrical testers, tooling, and all operations that involve nuclear weapons. Operations proceed only when all safety aspects are approved. Special safety studies also are conducted. One important example is a detailed study of the safety history of nuclear weapons operations and the Pantex Plant in which a panel of experts summarized and formalized a list of the abnormal circumstances that might occur during nuclear weapons operations (Johnson 1978). These potentially serious accident situations were sorted into three types: (1) those that were physically plausible, (2) those that were physically impossible, and (3) those the panel was uncertain about.

The accident analyses for this impact statement started with the list of circumstances that the committee found physically possible (though not necessarily credible) or uncertain. These circumstances and some others added during the evaluation are listed in Table 4.2.1-1. Although the definition of these potential circumstances came from a study of the Pantex Plant, they apply equally well to nuclear weapons operations at the other two locations (Chamberlin 1982).

TABLE 4.2.1-1

ABNORMAL CIRCUMSTANCES CONSIDERED

Natural Phenomena	External Events (Manmade)	Operational Accidents
1. Tornado	1. Aircraft crash	1. Impact
2. Hurricane	2. Discharge of firearms	2. Puncture
3. Windstorm	3. Electromagnetic radiation	3. Pressure
4. Earthquake	4. Electromagnetic pulse	4. AC/DC power
5. Grass fire		5. Electromagnetic radiation
6. Lightning		6. Static charge
7. Flood		7. Fire
8. Hail		8. Heat
9. Ice and snow		9. Cold
10. Meteorites		10. Water
		11. Processing chemicals
		12. Criticality

4.2.2 Potential Accident Scenarios

Each of the circumstances given in Table 4.2.1-1 were investigated during the accident analysis. Existing information permitted determination that some of these circumstances were considered not credible or having no potential significant environmental impact (Section 2.4.1).

Evaluation of remaining circumstances began by constructing an accident scenario or scenarios that would cover possible ways that the conditions could occur. For example, a number of scenarios were developed to address mechanical impacts to explosive components. These included dropping explosives onto various surfaces and projectiles striking explosives. Potential causes included such things as equipment failures, human error, and projectiles generated by explosions in adjacent work areas or by a tornado or aircraft crash. The probability of each of these scenarios was estimated.

4.2.3 Accident Probabilities

Probabilities were calculated for scenarios that could produce an accidental detonation of conventional high explosives and thereby release radioactive material to the atmosphere.

There have been no plutonium-dispersing detonation accidents during nuclear weapons operations at the Pantex Plant or the Iowa Army Ammunition Plant. (No nuclear weapons operations have been conducted previously at the Hanford Site.) Because of this absence of actual accident data, theoretical methods of estimation were required.

The method employed was to estimate the frequency of postulated detonation accidents in a two-step process. First, statistical analysis was applied to historic records of similar events that might have caused a detonation. Then, the likelihood of a detonation occurring, given that an initiating event had occurred, was estimated. This second step was accomplished by using the known characteristics of explosives, various mitigating factors, and well-known natural laws. Multiplying these two terms gave the estimated likelihood of a detonation accident.

Tornado

Tornado frequencies were estimated from regional tornado data of the tornado history of each of the three alternative sites (McDonald 1979, Fujita 1979, ANSI 1980). The probability of inducing a detonation by a tornado was based on the wind speeds, the availability of wind-blown projectiles, and the construction of the buildings in which the explosive resides (Chamberlin 1982).

Aircraft Crash

The estimated likelihoods of airplane crashes onto buildings were based on studies of the air traffic over each of the alternative sites (Krivokapich 1976, Biringer 1982A, Biringer 1982B, Biringer 1982C, Biringer 1982D). The air traffic data for all three alternatives was for 1981. In the case of the Pantex Plant this traffic data was compared to earlier data to assure that no major variations were occurring. All types of aircraft were considered. Structural damage was estimated based on the sizes and speeds of aircraft and the structural characteristics of the buildings (Chamberlin 1982).

Operational Accidents

Historical records were used to identify possible initiating events and estimate the frequency of those that might produce a detonation in the future. The records were the reports on unusual occurrences. Such reports are aimed at reducing as much as possible the probability of an accidental detonation of any explosive component. Whenever a situation is found that could be hazardous, steps are taken immediately to rectify the situation. Therefore, there is a continually changing set of procedures in force aimed at providing maximum safety for these operations.

The effect of these changing regulations and procedures should be to improve the safety of nuclear weapons operations, that is, to reduce the frequency of abnormal occurrence and accidents. Incident reports for the 5-year period between May 1976 to May 1981 were used as representative of what can be expected in the near future. (This period includes the 1977 detonation accident at the Pantex Plant and the resulting procedure changes.) The annual frequency of initiating events was estimated from the number of similar abnormal occurrences during the 5-year period. The second factor, the probability that a detonation will be produced if a certain initiating event occurs, was obtained from a combination of experimental data or by analysis of physical phenomena where data were unavailable.

Application of these methods found only one type of operational accident that had a statistical chance of more than 1 in a million a year of producing an explosive detonation that could disperse radioactive material. The accident was the dropping of a piece of high explosive during a particular operation (Chamberlin 1982). This accident is referred to in the remainder of this report as the operational accident. The probability that the explosive might be dropped was obtained by combining the probabilities that the explosive might be dropped from different heights. The probability that a detonation would result from such a drop was obtained from analysis of sensitivity experiments in which pieces of explosive are dropped on metal from various heights. Analytically combining these probabilities led to an estimate of the overall likelihood that a drop might result in a detonation in any one year. The value obtained was adjusted for the changes in both the explosive types and the workload to be expected in the near future. The resulting probability was found to be essentially constant in the near future (Chamberlin 1982).

4.2.4 Potential Releases

The potential release of radioactive materials from detonation accidents was based on the amount and type of explosive, the quantity of radioactive materials, and the structure in which the detonation takes place. This section discusses the amounts of plutonium and high explosive. Plutonium associated with high-explosives accidents would be dispersed as finely divided particles by the hot, high-pressure gases created by a detonation. The ability of a particular structure to contain the explosion determines how much of the plutonium and gas can escape. Other radioactive materials, including enriched uranium and tritium, that could be dispersed by potential accidents were found to contribute no more than 1% of the radiological effects attributable to plutonium (Elder 1982B).

Available experimental data were used to estimate the amount of plutonium that could be released from facilities (Chamberlin 1982). Data from tests with a prototype Gravel Gertie structure were used to estimate potential releases from existing, refurbished, and new-design Gravel Gerties (Cowan 1964). A new series of experiments is now underway, including a test at the Nevada Test Site that is intended to provide more precise information on the Gravel Gertie filtering capability. These results are expected to be available for the Final Environmental Impact Statement.

Results from the Roller Coaster Tests conducted in 1963 were used to estimate releases from temporary holding facilities and the various types of assembly bays (Friend 1965, USERDA 1976, Luna 1969). Even though weapons designs have changed since those tests were performed, they are believed to represent a worst case limit on the way plutonium is dispersed by high-explosive detonation. Experimental work is now underway to develop more precise information. No experimental data were available for the new-design cells. For these a numerical computer model was used to estimate the release (Tang 1981). There are strictly enforced limits to the amounts of plutonium and high explosives that are allowed at any time in each work space. For the purpose of estimating releases, work spaces involved in postulated accidents were assumed to contain the maximum amounts of high explosives and plutonium.

These assumptions lead to overestimating the releases because work spaces are seldom loaded to their operational limits of material (Chamberlin 1982) and not all the explosive in a space may be detonated. The values used were for operations as they are conducted currently at the Pantex Plant. They were assumed to apply to all Alternatives and Options.

The basic results of the release estimates for each credible accident were (1) the mass of plutonium released from the structure and (2) the amount of explosive energy vented outside the structure to characterize the initial conditions for dispersion. The amounts of plutonium that could be released from credible accidents ranged up to 120 kilograms for the Pantex Plant Alternative and the Iowa Army Ammunition Plant Alternative, and up to 0.6 kilogram for the Hanford Site Alternative (Chamberlin 1982).

4.2.5 Atmospheric Dispersion and Deposition

The spread of plutonium particles by detonation of high explosives was evaluated as a puff-type cloud using a computer model (Luna 1969). This model was based on experimental results from the Roller Coaster series of full-scale detonation tests involving weaponlike assemblies (Shreve 1965). The analytical procedure involved estimating the formation of a vertical debris cloud determined by the explosive energy released from a particular structure. The plutonium dispersed by the explosive was assumed to be initially distributed within the cloud and to have particle size distribution based on the measured experimental results (Shreve 1965). Subsequent dispersion of the cloud was calculated by the computer model that estimates Gaussian diffusion for each layer of the cloud. Deposition is calculated based on particle fall velocities as a function of particle size and wind speed. Actual meteorological data for each site was used in the computations of dispersion and deposition.

Two sets of meteorological conditions were used for each site for the nontornado accidents to evaluate the dispersion and deposition of plutonium. The conditions provide a range of possible consequences from an accidental release. These two sets of meteorological parameters represent an "unfavorable" and a "median" (most-likely) dispersion condition. (A single set of conditions selected for tornados is discussed below.) The unfavorable dispersion case assumes that the cloud passes over the largest nearby population center with only limited dilution of the cloud. This represents an "extreme case" that would result in the largest number of people being exposed and would result in the largest population dose. It does not necessarily result in the largest individual dose offsite because the maximum individual may be at different distances for the different wind direction cases. The unfavorable dispersion case also does not necessarily result in the largest decontamination costs because contamination may be dispersed over a greater land area by the median dispersion case. The median case is representative of what would be expected most of the time. The prevailing wind direction for each location (most frequently observed direction) was used for analysis along with meteorological parameters representing typically observed dispersion. The other commonly observed wind directions would give similar results. Depending upon the accident under consideration, the median case meteorological parameters are 10 to 30 times more likely to occur than those for the unfavorable case (Dewart 1982).

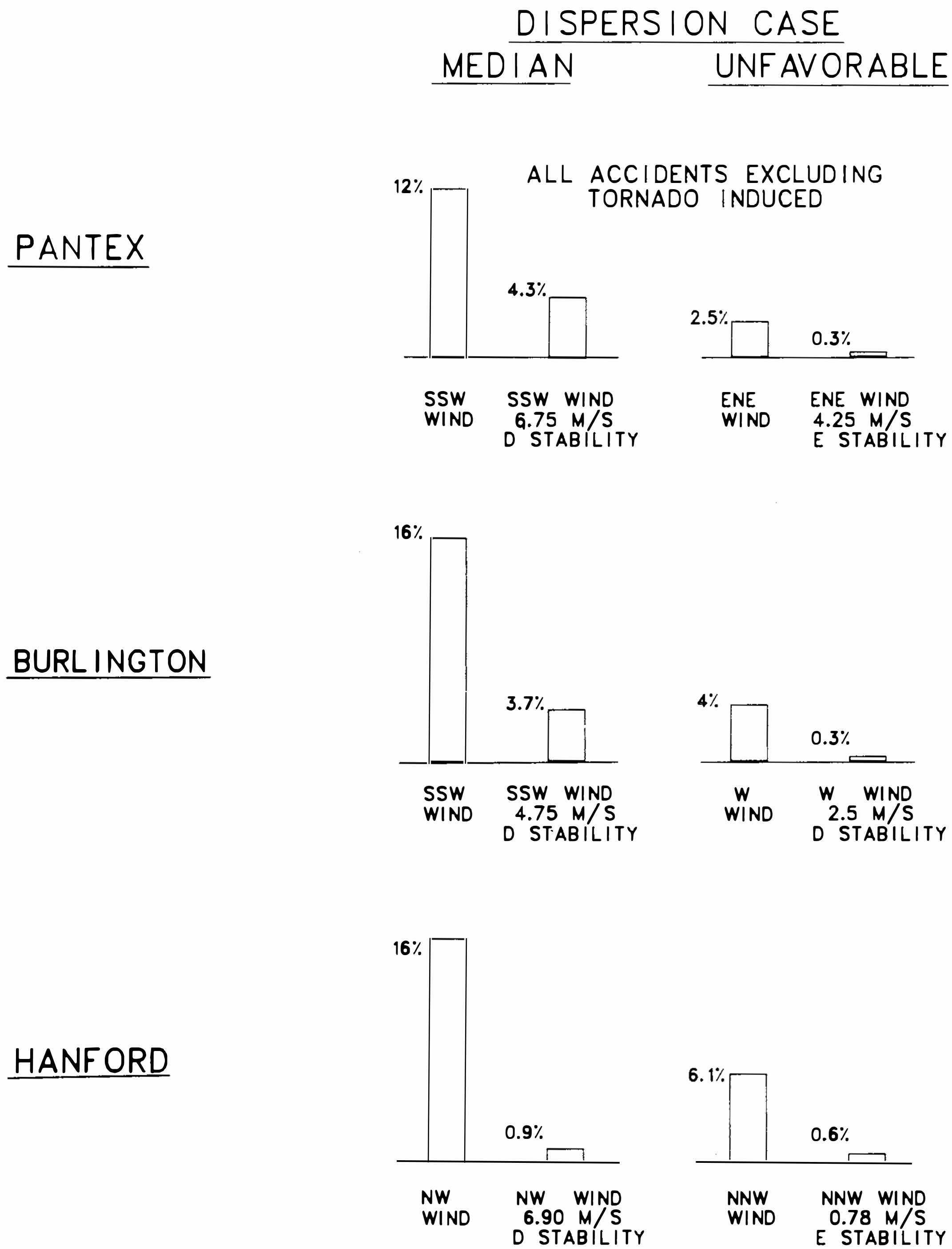


Figure 4.2.5-A. Frequency of occurrence of meteorological conditions for unfavorable and median dispersion cases.

The frequencies of occurrence of the meteorological stability categories used for calculating dispersion at each site and the frequency of wind direction alone are presented in Figure 4.2.5-A. The frequencies of other wind directions at each site are presented in Chapter 3, Section 3.2.1, in Figures 3.2.1.1-A, 3.2.1.2-A, and 3.2.1.3-A.

A different approach was taken to select the meteorological dispersion parameters for tornado-induced accidents. The probability of a tornado-induced accident was determined by a statistical analysis of historic records as noted earlier in Section 4.2.3. Given that a tornado-induced accident has occurred, the dispersion parameters were assumed to be those typical of the winds behind the funnel cloud. (Although the debris could be taken up in the funnel cloud, the resulting consequences are expected to be much lower than for winds behind the funnel cloud because of greater dispersion and dilution.) It is very unlikely that plutonium would be dispersed toward Amarillo (to the west-southwest) following a tornado-induced detonation at the Pantex Plant, because of the much lower probability of a tornado path in that direction (Dewart 1982).

Calculations for estimated dispersion and deposition were carried out to 80 kilometers with the assumption of constant wind speed, direction, and stability conditions. It is likely that these factors would change somewhat with time and distance but there is no way to predict the exact conditions.

4.2.6 Immediate Exposure Health Consequences

Immediate exposure, for the purposes of this document, means the inhalation of plutonium directly from the debris cloud resulting from a postulated accident. Health consequences were evaluated as the increased chance of death from radiation-induced cancers caused by the immediate inhalation of plutonium. Such cancers would occur only after latency periods of several years. No short-term effects would be expected in any offsite person even for the maximum doses calculated (Elder 1982B).

Plutonium delivers a radiation dose to an organ by alpha particles emitted during radioactive decay. Depending on the extent of the damage to the organ, observable health effects in an individual may result. The principal effect in the body of an exposed person is increased possibility of cancer. Such cancers would appear only after a latency period: approximately 10 to 20 years for lung cancer, 4 to 26 years for bone cancer, and 10 to 20 years for liver cancer (BEIR III 1980). For this analysis, all cases were assumed to be fatal because of relatively low cure rates for these forms of cancer.

An upper limit estimate of the amount of plutonium inhaled was made by assuming that all potentially exposed people would be outdoors for the entire time of passage of the cloud and taking no credit for the mitigating effects that could be provided by being inside buildings (see Section 4.2.9). Doses to individuals at specific distances were calculated by multiplying the mass of respirable particles inhaled at that location by an organ dose factor.

The dose factors for the important organs (liver, bone, and lungs) were calculated using a computer dose model (Houston 1974). The model parameters were revised to include recently accepted changes in standard organ masses and the biological effectiveness of alpha particles from plutonium (Elder 1982B). The model employs a particle deposition and clearance model adopted by the International Commission on Radiation Protection Task Group on Lung Dynamics (ICRP 1966, ICRP 1972). Retention of any component of weapons-grade plutonium in appropriate organs of the body was taken into account. The model is based on the organ masses, breathing rates, and clearance times of ICRP reference man (ICRP 1974). The reference man doses were found to not vary from mixed population doses by more than 15% for any important organ (Elder 1982B). A breathing rate corresponding to a moderate work level (0.00035 cubic meters per second) was selected for the analysis. This rate is an overestimate because the actual average breathing rate would probably be between this rate and the resting rate (0.00012 cubic meters per second).

Estimation of the summed dose to the exposed population required data on the number of people at various distances and directions. Population data were projected to the year 1990 for each of the alternative sites from preliminary 1980 census data (LATA 1981). (See Sections 3.2.8.1, 3.2.8.2, and 3.2.8.3 for population discussions.)

Potential radiation-induced health effects in various organs have been evaluated by several radiation protection organizations. The findings of the BEIR Committee (BEIR III 1980), the International Commission on Radiation Protection (ICRP 1977), and the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSC 1977) all were considered (Elder 1982B). The quantitative relationships between radiation dose and expected cases of cancer used in this analysis were primarily based on the BEIR data: 0.000015 cases per person-rem to the liver; 0.0000014 cases per person-rem to the bone; and 0.000043 cases per person-rem to the lungs.

The results of the analyses are presented in Tables 4.2.6-1 through 4.2.6-7 for representative accident scenarios that illustrate the full range of possible consequences for each Alternative as indicated below.

Pantex Alternative

Table 4.2.6-1 Maximum Release (120 kilograms)
Table 4.2.6-2 Intermediate Release (30 kilograms)
Table 4.2.6-3 Low Release (0.6 kilograms)

Iowa Army Ammunition Plant Alternative

Table 4.2.6-4 Maximum Release (120 kilograms)
Table 4.2.6-5 Intermediate Release (30 kilograms)
Table 4.2.6-6 Low Release (0.6 kilograms)

Hanford Site Alternative

Table 4.2.6-7 Maximum Release (0.6 kilograms)

The doses and potential health effects from plutonium estimated as described above are believed to be overestimations and represent the upper limit of a range of conceivable consequences. The results of these calculations include major uncertainties that may overstate consequences by factors of as much as 10 to 100. Furthermore, simple mitiqatinq measures, as described in Section 4.2.9 Emergency Preparedness, could be taken by the public that would be expected to limit inhalation doses.

The significance of health effects that could occur also may be evaluated by comparing the estimated number of potential accident-related health effects with the normal incidence of the same cancer types in the same population. The normal incidence of cancer death in the United States is approximately as follows (NCI 1975):

	Average Annual Number of Deaths per 100,000 Persons	Total Deaths in Average 70-Year Lifetime per 100,000 Persons	
		Total	Per Cent of Deaths
Lung cancer	42	3120	3.1
Liver cancer	2.4	256	0.26
Bone cancer	0.8	50	0.05

Comparisons with these values are presented in Tables 4.2.6-1 through 4.2.6-7 where the estimates of accident-caused health effects are expressed as total numbers and as per cent of the normal incidence (Elder 1982B).

Genetic effects were also considered even though cancer induction is expected to be the overriding health concern following plutonium exposure. The dose to reproductive organs is relatively low because plutonium does not concentrate as it does in liver and bone. The number of genetic effects, including those disorders and traits that cause serious handicap at some time during lifetimes, was estimated by using the range of relations given by the BEIR Committee (BEIR III 1980). The total numbers of genetic effects in all subsequent generations could range from about 2% to 40% of the number of cases of cancers estimated to occur in the exposed population as a result of any particular accident (Elder 1982B).

One perspective on the estimates of potential risk summarized can be gained by comparing them with other risks common in day-to-day living. For example, daily cigarette smoking (one pack or more per day) carries an increase in the chance of death from lung cancer more than 25 times as much as highest estimate of dose to the lungs of the maximum-exposed person for the worst case accident at the Pantex Plant. This example and others are shown in Table 4.2.6-8 in terms of increase in chance of death from common risks (Wilson 1979).

TABLE 4.2.6-1

SUMMARY OF RADIOLOGICAL RISKS TO INDIVIDUALS
FROM IMMEDIATE INHALATION OF RADIOACTIVITY DURING CLOUD PASSAGE

PANTEX PLANT ALTERNATIVE, MAXIMUM RELEASE (120 kilograms)

Location of Individual	Organ	Incremental Risk of Eventual Cancer Death (chances/100,000 for an individual)		Radiological Dose Used in Estimate (50-year commitment, rem)	
		Median Dispersion; Wind to NNE	Unfavorable Dispersion; Wind to WSW	Median Dispersion; Wind to NNE	Unfavorable Dispersion; Wind to WSW
Site Boundary	Lung Liver Bone	740 230 51	590 190 39	170 160 360	140 120 280
(distance, km)		(2.2)	(4.0)	(2.2)	(4.0)
Nearest Residence	Lung Liver Bone	690 220 47	460 150 30	160 140 340	110 97 220
(distance, km)		(2.4)	(5.0)	(2.4)	(5.0)
Major Population Center	Lung Liver Bone	42 14 3	94 28 6	10 9.1 20	22 19 45
(name, distance)		(Borger, 42 km)	(Amarillo, 25 km)	(Borger, 42 km)	(Amarillo, 25 km)
"Average Individual"	Lung Liver Bone	3 1 <.5	35 11 2	0.76 0.68 1.6	8.2 7.4 17
Total Population Exposed		13,540	142,000	13,540	142,000
Potential Cases of Cancer Deaths in Exposed Population	Lung Liver Bone	<.5 (--)* <.5 (--) <.5 (--)	49 (1.1)* 16 (4.3) 3 (4.7)		

*Value in ( ) is number of cases as a percentage of normally expected mortality from the same types of cancer in the given population.

TABLE 4.2.6-2

SUMMARY OF HEALTH RISKS TO INDIVIDUALS
FROM IMMEDIATE INHALATION OF RADIOACTIVE MATERIAL DURING CLOUD PASSAGE

PANTEX PLANT ALTERNATIVE, INTERMEDIATE RELEASE (30 kilograms)

Location of Individual	Organ	Incremental Risk of Eventual Cancer Death (chances/100,000 for an individual)		Radiological Dose Used in Estimate (50-year commitment, rem)	
		Median Dispersion; Wind to NNE	Unfavorable Dispersion; Wind to WSW	Median Dispersion; Wind to NNE	Unfavorable Dispersion; Wind to WSW
Site Boundary	Lung Liver Bone	110 34 7	82 26 5	26 23 50	19 17 39
(distance, km)		(2.2)	(4.0)	(2.2)	(4.0)
Nearest Residence	Lung Liver Bone	94 28 6	74 23 5	22 19 45	17 16 36
(distance, km)		(2.4)	(5.0)	(2.4)	(5.0)
Major Population Center	Lung Liver Bone	5 2 <.5	19 6 1	1.2 1.0 2.4	4.4 4.0 9.0
(name, distance)		(Borger, 42 km)	(Amarillo, 25 km)	(Borger, 42 km)	(Amarillo, 25 km)
"Average Individual"	Lung Liver Bone	1 <.5 <.5	5 2 <.5	0.13 0.12 0.27	1.2 1.2 2.5
Total Population Exposed		13,540	142,000	13,540	142,000
Potential Cases of Cancer Deaths in Exposed Population	Lung Liver Bone	<.5 (--)* <.5 (--) <.5 (--)	7 (0.16)* 3 (0.70) <.5 (--)		

*Value in ( ) is number of cases as a percentage of normally expected mortality from the same types of cancer in the given population.

TABLE 4.2.6-3

SUMMARY OF RADIOLOGICAL RISKS TO INDIVIDUALS
FROM IMMEDIATE INHALATION OF RADIOACTIVITY DURING CLOUD PASSAGE

PANTEX PLANT ALTERNATIVE, LOW RELEASE (0.6 kilograms)

Location of Individual	Organ	Incremental Risk of Eventual Cancer Death (chances/100,000 for an individual)		Radiological Dose Used in Estimate (50-year commitment, rem)	
		Median Dispersion; Wind to NNE	Unfavorable Dispersion; Wind to WSW	Median Dispersion; Wind to NNE	Unfavorable Dispersion; Wind to WSW
Site Boundary	Lung Liver Bone	8 2 1	19 6 1	1.8 1.6 3.6	4.4 4.0 9.0
(distance, km)		(5.0)	(5.4)	(5.0)	(5.4)
Nearest Residence	Lung Liver Bone	7 2 <.5	17 5 1	1.6 1.4 3.4	4.0 3.6 8.1
(distance, km)		(5.2)	(5.6)	(5.2)	(5.6)
Major Population Center	Lung Liver Bone	<.5 <.5 <.5	1 <.5 <.5	0.024 0.022 0.047	0.20 0.19 0.42
(name, distance)		(Borger, 42 km)	(Amarillo, 25 km)	(Borger, 42 km)	(Amarillo, 25 km)
"Average Individual"	Lung Liver Bone	<.5 <.5 <.5	<.5 <.5 <.5	0.0092 0.0082 0.018	0.042 0.038 0.084
Total Population Exposed		13,540	142,000	13,540	142,000
Potential Cases of Cancer Deaths in Exposed Population	Lung Liver Bone	<.5 (--)* <.5 (--) <.5 (--)	<.5 (---)* <.5 (---) <.5 (---)		

*Value in ( ) is number of cases as a percentage of normally expected mortality from the same types of cancer in the given population.

TABLE 4.2.6-4

SUMMARY OF RADIOLOGICAL RISKS TO INDIVIDUALS
FROM IMMEDIATE INHALATION OF RADIOACTIVITY DURING CLOUD PASSAGE

IOWA ARMY AMMUNITION PLANT ALTERNATIVE, MAXIMUM RELEASE (120 kilograms)

Location of Individual	Organ	Incremental Risk of Eventual Cancer Death (chances/100,000 for an individual		Radiological Dose Used in Estimate (50-year commitment, rem)	
		Median Dispersion; Wind to NE	Unfavorable Dispersion; Wind to E	Median Dispersion; Wind to NE	Unfavorable Dispersion; Wind to E
Site Boundary	Lung Liver Bone	1100 340 74	2000 660 130	260 230 530	480 440 950
(distance, km)		(2.45)	(1.8)	(2.45)	(1.8)
Nearest Residence	Lung Liver Bone	1100 340 74	2000 660 130	260 230 530	480 440 950
(distance, km)		(2.5)	(1.8)	(2.5)	(1.8)
Major Population Center	Lung Liver Bone	--- --- ---	850 270 59	--- --- ---	200 180 420
(name, distance)		(none)	(Burlington, 6.6 km)	(none)	(Burlington, 6.6 km)
"Average Individual"	Lung Liver Bone	68 22 5	140 46 10	16 14 34	34 30 70
Total Population Exposed		3,340	34,360	3,360	34,360
Potential Cases of Cancer Deaths in Exposed Population	Lung Liver Bone	2 (2.2)* 1 (8.2) <.5 (--)	50 (4.5)* 16 (18) 3 (20)		

*Value in ( ) is number of cases as a percentage of normally expected mortality from the same types of cancer in the given population.

TABLE 4.2.6-5

SUMMARY OF RADIOLOGICAL RISKS TO INDIVIDUALS
FROM IMMEDIATE INHALATION OF RADIOACTIVITY DURING CLOUD PASSAGE

IOWA ARMY AMMUNITION PLANT ALTERNATIVE, INTERMEDIATE RELEASE (30 kilograms)

Location of Individual	Organ	Incremental Risk of Eventual Cancer Death (chances/100,000 for an individual)		Radiological Dose Used in Estimate (50-year commitment, rem)	
		Median Dispersion; Wind to NE	Unfavorable Dispersion; Wind to E	Median Dispersion; Wind to NE	Unfavorable Dispersion; Wind to E
Site Boundary	Lung Liver Bone	130 40 9	270 86 18	30 27 62	64 57 130
(distance, km)		(2.45)	(1.8)	(2.45)	(1.8)
Nearest Residence	Lung Liver Bone	130 40 9	270 86 18	30 27 62	64 57 130
(distance, km)		(2.45)	(1.8)	(2.45)	(1.8)
Major Population Center	Lung Liver Bone	--- --- ---	100 31 7	--- --- ---	24 21 50
(name, distance)		(none)	(Burlington, 6.6 km)	(none)	(Burlington, 6.6 km)
"Average Individual"	Lung Liver Bone	10 3 1	25 8 2	2.4 2.1 4.8	5.8 5.1 12
Total Population Exposed		3,340	34,360	3,340	34,360
Potential Cases of Cancer Deaths in Exposed Population	Lung Liver Bone	<.5 (--)* <.5 (--) <.5 (--)	8 (0.80)* 3 (3.0) 1 (3.4)		

*Value in ( ) is numbe of cases as a percentage of normally expected mortality from the same types of cancer in the given population.

TABLE 4.2.6-6

SUMMARY OF RADIOLOGICAL RISKS TO INDIVIDUALS
FROM IMMEDIATE INHALATION OF RADIOACTIVITY DURING CLOUD PASSAGE

IOWA ARMY AMMUNITION PLANT ALTERNATIVE, LOW RELEASE (0.6 kilograms)

Location of Individual	Organ	Incremental Risk of Eventual Cancer Death (chances/100,000 for an individual)		Radiological Dose Used in Estimate (50-year commitment, rem)	
		Median Dispersion; Wind to NE	Unfavorable Dispersion; Wind to E	Median Dispersion; Wind to NE	Unfavorable Dispersion; Wind to E
Site Boundary	Lung Liver Bone	100 31 7	26 8 2	24 21 50	6.2 5.5 12
(distance, km)		(1.5)	(3.9)	(1.5)	(3.9)
Nearest Residence	Lung Liver Bone	100 31 7	26 8 2	24 21 50	6.2 5.5 12
(distance, km)		(1.5)	(3.9)	(1.5)	(3.9)
Major Population Center	Lung Liver Bone	--- --- ---	8 3 1	--- --- ---	1.9 1.7 3.9
(name, distance)		(none)	(Burlington, 6.8 km)	(none)	(Burlington, 6.8 km)
"Average Individual"	Lung Liver Bone	1 <.5 <.5	2 1 <.5	0.20 0.19 0.42	0.38 0.34 0.76
Total Population Exposed		3,340	34,360	3,340	34,360
Potential Cases of Cancer Deaths in Exposed Population	Lung Liver Bone	<.5 (--)* <.5 (--) <.5 (--)	<.5 (---)* <.5 (----) <.5 (----)		

*Value in ( ) is number of cases as a percentage of normally expected mortality from the same types of cancer in the given population.

TABLE 4.2.6-7

SUMMARY OF RADIOLOGICAL RISKS TO INDIVIDUALS
FROM IMMEDIATE INHALATION OF RADIOACTIVITY DURING CLOUD PASSAGE

HANFORD SITE ALTERNATIVE, MAXIMUM RELEASE (0.6 kilograms)

Location of Individual	Organ	Incremental Risk of Eventual Cancer Death (chances/100,000 for an individual)		Radiological Dose Used in Estimate (50-year commitment, rem)	
		Median Dispersion; Wind to NE	Unfavorable Dispersion; Wind to E	Median Dispersion; Wind to NE	Unfavorable Dispersion; Wind to E
Site Boundary	Lung Liver Bone	<.5 <.5 <.5	1 <.5 <.5	0.068 0.061 0.14	0.26 0.23 0.50
(distance, km)		(35)	(35)	(35)	(35)
Nearest Residence	Lung Liver Bone	<.5 <.5 <.5	1 <.5 <.5	0.068 0.061 0.14	0.26 0.23 0.50
(distance, km)		(35)	(35)	(35)	(35)
Major Population Center	Lung Liver Bone	<.5 <.5 <.5	1 <.5 <.5	0.040 0.036 0.081	0.14 0.13 0.28
(name, distance)		(Richland, 42 km)	(Richland, 42 km)	(Richland, 42 km)	(Richland, 42 km)
"Average Individual"	Lung Liver Bone	<.5 <.5 <.5	<.5 <.5 <.5	0.016 0.013 0.031	0.046 0.040 0.092
Total Population Exposed		119,000	119,000	119,000	119,000
Potential Cases of Cancer Deaths in Exposed Population	Lung Liver Bone	<.5 (--)* <.5 (--) <.5 (--)	<.5 (---)* <.5 (----) <.5 (----)		

*Value in ( ) is number of cases as a percentage of normally expected mortality from the same types of cancer in the given population.

TABLE 4.2.6-8

RISK COMPARISON
(increase in chance of death from various activities)

Activity or Event	Chance of Death Attributed to Activity or Event (Chances in 100,000)	Lung Radiation Dose* Required for Same Level of Risk (rem)
Cigarette smoking** (cancer and heart disease)	15,000	3600
Maximum individual lung dose, worst case accident under Iowa Army Ammunition Plant Alternative	2,000	480
Working 10 years as a coal miner (black lung)	1,900	460
Maximum individual lung dose, worst case accident under Pantex Plant Alternative	740	170
Working 10 year as a coal miner (accident)	640	150
Dwelling in a large eastern city for 20 year (pollution-related diseases)	360	84
Traveling 300,000 miles by automobile (accidents)	100	23
Average individual lung dose, worst case accident under Pantex Plant Alternative	35	8
Traveling 300,000 miles by commercial jet (accident)	30	7
Traveling 300,000 miles by commercial jet (cosmic radiation)	5	1

*Risk coefficient 0.000043/person-rem.

**Moderate-to-heavy smoking (1 pack per day or more) for 40 years.

4.2.7 Decontamination

Plutonium will be deposited downwind from the passage of a cloud following an accidental release. Amounts deposited were calculated using the methods described in Section 4.2.5. If these concentrations were large enough to exceed contamination limits, the ground would have to be decontaminated.

Two possible plutonium contamination cleanup criteria were evaluated to indicate the range of possibly required actions. The first and more restrictive cleanup level (0.2 microcuries per square meter in the top centimeter of soil) was a screening level recommended as part of a proposed guidance to federal agencies by the Environmental Protection Agency in 1977, but has never been officially adopted (46FR60956). The screening level was recommended as one below which the proposed dose guidance could be presumed to be met and no cleanup need be considered. This guidance was derived from the premise that the risk of developing a radiation-induced cancer from continuous exposure to the contamination should be less than 10 chances in 100,000 during the lifetime of an individual (USEPA 1977).

The second possible cleanup level was derived from the premise that no individual would receive a dose to any critical body organ greater than that recommended by the National Commission on Radiological Protection and Measurement, even after continuous exposure over a 70-year period (Healy 1977). This cleanup level would limit exposure in the maximum year to any organ of an individual to no more than 500 millirem. The two levels are stated in different terms, but, in general, the EPA based level would result in cleanup to levels about 40 times lower than the level based on a 500-millirem-per-year organ dose.

Three types of land use (agricultural, suburban, and commercial) were addressed for the two possible decontamination levels (Wenzel 1982B). The decontamination methods and estimated costs were based on available literature (McGrath 1978, Smith 1978, Finley 1980). Cleanup of the higher levels of contamination would be accomplished by major vegetation and soil removal by farm or road machinery and washing structures with fire hoses. At lower levels, contamination could be reduced and stabilized by some vegetation removal, plowing, and heavy irrigation. Cost estimates ranged from about $500 to more than $100,000 an acre depending on the type of land use and required cleanup. The estimates included, where appropriate, costs of packaging, transportation, disposal of contaminated materials, temporary evacuation during cleanup, and restoration (Wenzel 1982B).

The results of the analyses are presented in Tables 4.2.7-1 through 4.2.7-7 for representative accident scenarios that illustrate the full range of possible consequences for each Alternative as indicated below.

Pantex Alternative

Table 4.2.7-1 Maximum Release (120 kilograms)
Table 4.2.7-2 Intermediate Release (30 kilograms)
Table 4.2.7-3 Low Release (0.6 kilograms)

Iowa Army Ammunition Plant Alternative

Table 4.2.7-4 Maximum Release (120 kilograms)
Table 4.2.7-5 Intermediate Release (30 kilograms)
Table 4.2.7-6 Low Release (0.6 kilograms)

Hanford Site Alternative

Table 4.2.7-7 Maximum Release (0.6 kilograms)

TABLE 4.2.7-1

ESTIMATED DECONTAMINATION AREAS AND COSTS (1981)
PANTEX ALTERNATIVE, MAXIMUM RELEASE (120 kilograms)

	Land Use	Median Meteorology		Unfavorable Meteorology	
		Acres	Cost (1981) $Millions	Acres	Cost (1981) $Millions
Cleanup to level based on Healy proposal	Agriculture Suburban Commercial	198 000 4 290 1 430	160 3.6 1.3	200 400 44 500 11 100	120 54 16
	TOTALS:	204 000	170	256 000	190
Cleanup to level based on EPA Proposed Guidance	Agriculture Suburban Commercial	198 000 4 290 1 430	720 15 5.4	200 400 44 500 11 100	680 160 45
	TOTALS:	204 000	740	256 000	890

TABLE 4.2.7-2

ESTIMATED DECONTAMINATION AREAS AND COSTS (1981)
PANTEX ALTERNATIVE, INTERMEDIATE RELEASE (30 kilograms)

	Land Use	Median Meteorology		Unfavorable Meteorology	
		Acres	Cost (1981) $Millions	Acres	Cost (1981) $Millions
Cleanup to level based on Healy proposal	Agriculture Suburban Commercial	155 300 4 490 1 500	77 2.4 1.6	154 400 23 800 7 930	75 16 5.6
	TOTALS:	161 300	81	186 000	97
Cleanup to level based on EPA Proposed Guidance	Agriculture Suburban Commercial	155 300 4 490 1 500	490 14 5.1	154 400 23 800 7 930	480 78 28
	TOTALS:	161 300	510	186 000	590

TABLE 4.2.7-3

ESTIMATED DECONTAMINATION AREAS AND COSTS (1981)
PANTEX ALTERNATIVE, LOW RELEASE (0.6 kilograms)

	Land Use	Median Meteorology		Unfavorable Meteorology	
		Acres	Cost (1981) $Millions	Acres	Cost (1981) $Millions
Cleanup to level based on Healy proposal	Agriculture Suburban Commercial	5 930 59 14	2.9 0.033 0.0068	4 770 1 540 512	2.3 0.73 0.97
	TOTALS:	6 000	2.9	6 820	4.0
Cleanup to level based on EPA Proposed Guidance	Agriculture Suburban Commercial	5 930 59 14	18 0.18 0.048	4 770 154 512	15 4.9 1.7
	TOTALS:	6 000	18	6 820	22

TABLE 4.2.7-4

ESTIMATED DECONTAMINATION AREAS AND COSTS (1981)
IOWA ARMY AMMUNITION PLANT ALTERNATIVE, MAXIMUM RELEASE (120 kilograms)

	Land Use	Median Meteorology		Unfavorable Meteorology	
		Acres	Cost (1981) $Millions	Acres	Cost (1981) $Millions
Cleanup to level based on Healy proposal	Agriculture Suburban Commercial	193 800 7 630 2 550	160 11 4.3	76 800 9 780 3 260	68 89 36
	TOTALS:	204 000	175	89 860	190
Cleanup to level based on EPA Proposed Guidance	Agriculture Suburban Commercial	193 800 7 630 2 550	700 31 11	76 800 9 780 3 260	320 120 47
	TOTALS:	204 000	742	89 860	490

TABLE 4.2.7-5

ESTIMATED DECONTAMINATION AREAS AND COSTS (1981)
IOWA ARMY AMMUNITION PLANT ALTERNATIVE, INTERMEDIATE RELEASE (120 kilograms)

	Land Use	Median Meteorology		Unfavorable Meteorology	
		Acres	Cost (1981) $Millions	Acres	Cost (1981) $Millions
Cleanup to level based on Healy proposal	Agriculture Suburban Commercial	78 300 3 090 1 030	41 2.7 0.98	70 400 6 750 2 250	36 8.9 3.5
	TOTALS:	82 450	45	79 420	48
Cleanup to level based on EPA Proposed Guidance	Agriculture Suburban Commercial	78 300 3 090 1 030	260 11 3.8	70 400 6 750 2 250	230 25 9.2
	TOTALS:	82 450	270	79 420	260

TABLE 4.2.7-6

ESTIMATED DECONTAMINATION AREAS AND COSTS (1981)
IOWA ARMY AMMUNITION PLANT ALTERNATIVE, LOW RELEASE (0.6 kilograms)

	Land Use	Median Meteorology		Unfavorable Meteorology	
		Acres	Cost (1981) $Millions	Acres	Cost (1981) $Millions
Cleanup to level based on Healy proposal	Agriculture Suburban Commercial	5 200 204 69	2.6 0.11 0.038	2 940 986 328	1.4 0.48 0.16
	TOTALS:	5 470	2.7	4 260	2.0
Cleanup to level based on EPA Proposed Guidance	Agriculture Suburban Commercial	5 200 204 69	16 0.65 0.23	2 940 986 328	9.1 3.1 1.1
	TOTALS:	5 470	17	4 260	13

TABLE 4.2.7-7

ESTIMATED DECONTAMINATION AREAS AND COSTS (1981)
HANFORD SITE ALTERNATIVE, MAXIMUM RELEASE (0.6 kilograms)

		Median Meteorology		Unfavorable Meteorology	
	Land Use	Acres	Cost (1981) $Millions	Acres	Cost (1981) $Millions
Cleanup to level based on Healy proposal	Agriculture Suburban Commercial	6 700 (onsite) None None	3.2 -- --	3 230 (onsite) None None	1.6 -- --
	TOTALS:	6 700	3.2	3 230	1.6
Cleanup to level based on EPA Proposed Guidance	Agriculture Suburban Commercial	6 700 (onsite) None None	21 -- --	3 230 (onsite) None None	10 -- --
	TOTALS:	6 700	21	3 230	10

4.2.8 Long-Term Exposure Health Consequences

Long-term exposure for the purposes of this document means the inhalation and ingestion of plutonium over many years. Plutonium would be initially deposited on the ground by the passage of the dispersion cloud from an accidental explosion. The deposited plutonium could be made available to humans by several natural processes termed "pathways." These pathways are resuspension to the air, ingestion of garden produce, and ingestion of meat products. Several important pathways were evaluated by computer model simulation to determine radiation doses and associated potential health effects. The most significant pathway (over 90% of the long-term radiation dose) to man is direct inhalation of resuspended particles of contaminated soil.

Three computer simulations were performed, one for each of the two levels of decontamination effort described in Section 4.2.7 and one assuming no decontamination for comparison. The uptake of plutonium from the soil to plants, from plants to foraging livestock, and from both plants and livestock to man was analyzed. Figure 4.2.8-A illustrates the major food pathways investigated for the Pantex region. This analysis assumed large areas of farmland are contaminated with plutonium. Both natural and agricultural pathways to man were simulated using appropriate computer codes. Site specific data on climate, soil, vegetation, cropping, and agricultural practices were used in the computer program for these simulations (Wenzel 1982A).

The concentrations of plutonium in air, soil, vegetation, and meat were simulated for 50 years. These simulated concentrations were used to estimate the doses and health effects expected in individuals. For conservative estimates, the individuals were assumed to be living on and farming the contaminated areas. Based on these doses, associated risks of potential health effects were estimated by the same procedure described in Section 4.2.6.

Results for the ranges of accidents evaluated are summarized in Table 4.2.8-1 for the Pantex Plant Alternative and Table 4.2.8-2 for the Iowa Army Ammunition Plant Alternative. For the Hanford Site

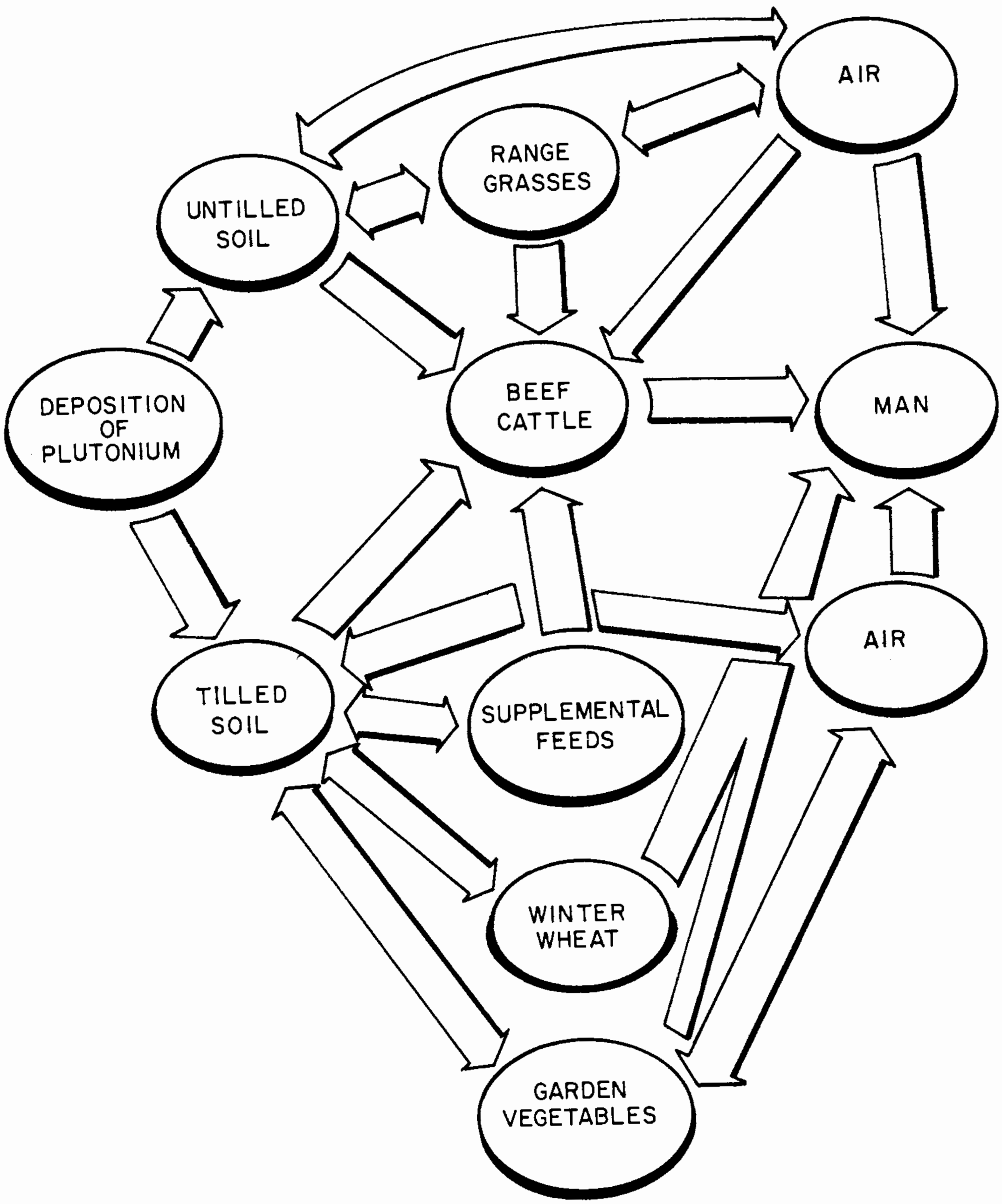


Figure 4.2.8-A. Major Pantex Plant food pathways simulated for potential accidents with plutonium.

Alternative, the offsite contamination levels even without cleanup were near the cleanup level based on the Environmental Protection Agency Proposed Guidance and no incremental risks were calculated. The values given are the incremental risk of cancers (lung, liver, and bone) for average individuals living on and farming the contaminated areas during the first year after deposition and for a total 50-year period. The values may be compared with the average individual incremental risk values given in Tables 4.2.6-1 through 4.2.6-7.

TABLE 4.2.8-1

INCREMENTAL RISK OF EVENTUAL CANCER DEATH* FROM LONG-TERM EXPOSURE TO RESIDUAL CONTAMINATION UNDER THREE CLEANUP ASSUMPTIONS

PANTEX PLANT ALTERNATIVE

(Chances in 100,000 for Average Individual)

Degree of Cleanup	120 Kilogram Release				30 Kilogram Release				0.6 Kilogram Release			
	Median Meteorology		Unfavorable Meteorology		Median Meteorology		Unfavorable Meteorology		Median Meteorology		Unfavorable Meteorology	
	First Year	50-yr Total	First Year	50-yr Total	First Year	50-yr Total	First Year	50-yr Total	First Year	50-yr Total	First Year	50-yr Total
No decontamination	0.85	1.7	3.6	7.2	0.40	0.82	2.0	4.0	0.31	0.65	0.11	0.22
Cleanup to level based on Healy proposal	0.57	1.1	0.92	1.8	0.39	0.78	0.73	1.5	0.31	0.65	0.11	0.22
Cleanup to level based on EPA Proposed Guidance	0.04	0.08	0.04	0.08	0.04	0.08	0.04	0.08	0.04	0.08	0.04	0.08

*Values are chances in 100 000 that an average individual living within the contaminated area for the period of time would eventually die of liver, lung, or bone cancer because of intake of residual plutonium contamination.

TABLE 4.2.8-2

INCREMENTAL RISK OF EVENTUAL CANCER DEATH* FROM LONG-TERM EXPOSURE TO RESIDUAL CONTAMINATION UNDER THREE CLEANUP ASSUMPTIONS

IOWA ARMY AMMUNITION PLANT ALTERNATIVE

(Chances in 100,000 for Average Indiviual)

Degree of Cleanup	120 Kilogram Release				30 Kilogram Release				0.6 Kilogram Release			
	Median Meteorology		Unfavorable Meteorology		Median Meteorology		Unfavorable Meteorology		Median Meteorology		Unfavorable Meteorology	
	First Year	50-yr Total	First Year	50-yr Total	First Year	50-yr Total	First Year	50-yr Total	First Year	50-yr Total	First Year	50-yr Total
No decontamination	5.9	9.6	8.5	14	1.2	2.0	3.1	5.2	0.34	0.54	0.22	0.36
Cleanup to level based on Healy proposal	0.50	0.83	0.70	1.2	0.39	0.52	0.67	1.1	0.34	0.54	0.22	0.36
Cleanup to level based on EPA Proposed Guidance	0.04	0.08	0.04	0.05	0.04	0.06	0.04	0.06	0.04	0.06	0.04	0.06

*Values are chances in 100 000 that an average individual living within the contaminated area for the period of time would eventually die of liver, lung, or bone cancer because of intake of residual plutonium contamination.

4.2.9 Emergency Preparedness

Emergency Preparedness is discussed here only in relation to the Pantex Plant. Similar planning would be done for either the Iowa Army Ammunition Plant or the Hanford Site.

The Pantex Plant has comprehensive emergency plans that provide guidance and procedures designed to protect (1) life and property within the facility, (2) the health and welfare of surrounding areas, and (3) the defense interest of the nation during any credible emergency situation. Formal mutual assistance agreements have been made with the Amarillo Fire Department, the National Guard, and St. Anthony Hospital. Informal agreements have been discussed with local police, sheriff departments, and other emergency agencies who will provide support in line with their respective charters. Planning is in progress with officials of the State of Texas to assure appropriate coordination with the Texas State Emergency Management Plan.

The Pantex Emergency Plan expresses the philosophy that the Pantex Plant be as self-sufficient as possible in handling emergency situations within the facility. Plant emergency response teams are comprised of specialized personnel who are trained and knowledgeable in meeting emergency situations. These include such fields of expertise as fire fighting, security and nuclear materials protection, medical, radiation monitoring and health physics, nuclear safety, and environmental sciences. The groups are further supported by expertise in industrial safety, industrial hygiene, communications, utilities, and transportation. These response groups are responsible for providing the direction and appropriate action required to resolve any emergency situation.

Medical, decontamination, fire fighting, and other emergency facilities and equipment are available onsite. An Emergency Radiation Treatment Facility with equipment is available at St. Anthony Hospital in Amarillo to treat contaminated patients. Periodic exercises are conducted by Pantex Plant personnel with the hospital staff. The facility at the St. Anthony Hospital was the first decontamination facility in the United States designed exclusively for handling contaminated patients in a community hospital (Waldron 1981, Kelly 1972).

In addition to the above response groups, there is an emergency coordinating team composed of Department of Energy and Plant contractor management personnel who conduct training exercises at an onsite emergency control center. Under accident conditions, this team would initiate the Pantex Disaster Plan and coordinate all onsite actions. If offsite areas could be affected, the Texas Department of Public Safety would be notified immediately. The Texas Department of Public Safety will make emergency notification to the public and local governmental agencies in accordance with Annex R of the State of Texas Emergency Management Plan (Texas 1982). The Pantex Plant has in-place communication channels with the Texas Department of Public Safety through the use of telephone (both standard and mobile), two-way radio, and the National Warning System (NAWAS).

The Pantex Plant has Radiological Assistance Teams with a total of 46 personnel who are equipped and trained to respond to an accident involving radioactive contamination either onsite or offsite. Members from this team have participated in the National Nuclear Weapons Accident Exercises in 1979 and 1981. In addition, the Joint Nuclear Accident Coordinating Center (JNACC) in Albuquerque, New Mexico, can be called upon should the need arise. This call would mobilize radiation emergency response teams from the Department of Energy, Department of Defense, and other participating Federal agencies.

As discussed throughout Section 4.2, the only types of credible accidents that could lead to significant consequences for the general public or the environment are those that might disperse radioactive materials beyond the boundaries of the Pantex Plant. The Texas Department of Health has primary responsibility within the provisions of the State of Texas Emergency Management Plan for emergency response to prevent or reduce damage, injury, or loss of life or property from accidents involving radioactive materials. This planning will be documented in a special chapter on the Pantex Plant in the Federal Facility subsection (Tab 3, Appendix 7, Annex L) of the Radiological Emergency Response portion of the State Plan (Texas 1982). This planning will be along the same general patterns used for fixed nuclear facilities in the State of Texas Emergency Management Plan. Additional documentation will cover responsibilities and actions for other State of Texas agencies and local governments.

In the event of an accident resulting in offsite radioactive contamination, sheltering and simple respiratory protection would be effective in significantly reducing both individual and population doses. Where appropriate, the public could seek shelter in permanent structures such as houses or commercial/industrial buildings, which could be made reasonably airtight by closing windows, doors, and external air intakes. Persons traveling by motor vehicle could close windows, vents, and outside heating or cooling ducts, as well as avoid driving to the area where the cloud would be expected to travel downwind. Additional respiratory protection would be achieved by covering the nose and mouth with wet handkerchiefs or towels or by going into a bathroom, closing the door and turning on the water in the shower. If these measures were taken during the time of cloud passage (for example, one to a few hours in Amarillo), the potential maximum radiation doses and the corresponding risks of eventual cancers shown in Section 4.2.6 would be reduced substantially, possibly by factors of as much as 10 (Cohen 1979, Cooper 1981).

Once the initial debris cloud has passed, the remaining potential hazard from deposited radioactivity would be significantly smaller (Section 4.2.7). Because of the lower potential hazard, restoration and recovery could be carried out over a reasonable time period. Actions would probably include some of those discussed in Section 4.2.7, as well as measures such as access restriction or temporary evacuation of areas with the highest levels of contamination until cleanup could be accomplished.

Planning for Pantex emergencies incorporates experience gained from decontamination of sites where plutonium dispersal resulted from high explosives detonation. These decontamination efforts were successful in managing health protection problems and in returning land and facilities to the public domain (USAF 1970, Place 1970).

4.3 IMPACTS OF RELATED DEPARTMENT OF ENERGY TRANSPORTATION OPERATIONS

Environmental impacts resulting from related transportation operations fall into one of two major categories--normal operations or accidents. Radiological and nonradiological consequences are assessed for both categories. The radiological consequences result from atmospheric release of radioactive materials such as plutonium and tritium.

Two transportation related accidents were analyzed to be within the threshold of credibility if total mileage traveled in the United States is considered. One potential accident, a crash of a Department of Energy-chartered aircraft carrying components containing tritium, could result in a release probability of 4 chances in 100,000 per year. The second, a long-burning fuel fire resulting from a crash of a Safe-Secure Trailer with a loaded fuel tanker truck, was assessed to be at the threshold of credibility (1 chance in 1 million per year). All other accidents having potential radiological consequences were found to be not credible. The complete environmental impact assessment of Pantex transportation operations is by necessity classified and is documented in Smith 1982.

4.3.1 Transportation Systems

The Department of Energy transportation safeguards system is used for offsite transportation of nuclear weapons, nuclear components, and special assemblies containing radioactive material. This is a dedicated ground transportation system consisting of Safe-Secure Tractor/Trailers and Safe-Secure Railcars. The Department of Energy does not ship nuclear explosives by air. Safe-Secure Tractor/Trailers and Safe-Secure Railcars have features that make them especially safe in accidents. In addition, they provide security against theft or sabotage attempts. Transportation operations are regulated by Department of Energy standards for special equipment, guard escort, operating procedures, and emergency procedures.

Offsite shipments of high explosives and hazardous chemicals are handled by commercial carriers (truck and aircraft) under Department of Transportation guidelines. Onsite shipments use specific safety equipment and vehicles and comply with Pantex Plant operation and emergency procedures.

4.3.2 Normal Transportation Operations

Negligible environmental impacts result from expected conditions during transportation operations. An example is the radiation dose received by all individuals in the vicinity of nuclear shipments. These impacts are summarized in Table 4.3.2-1.

4.3.2.1 Pantex

Radiological--Nuclear Weapons

This impact is assessed in terms of dose. The dose for nonoccupational individuals is less than 0.01 millirem per year. The nonoccupational subgroups considered include members of the public exposed alongside the transport link, and those nearby while the shipment is stopped.

Radiological--Other Sources

Included in this category are nuclear weapon components, radioactive sources, and radioactive waste. The maximum dose for a nonoccupational individual was assessed to be less than 0.5 millirem per year.

Nonradiological

The total annual traffic contribution for Pantex (Table 4.3.2-1) was calculated to be less than 1% for all affected areas. Therefore, the resultant nonradiological impacts are considered negligible.

TABLE 4.3.2-1

TRANSPORTATION IMPACTS FROM NORMAL OPERATIONS

A. Radiological Impacts - Annual Maximum Individual Dose (millirem)	
Person living along transport link	<0.07
Person sharing transport link while vehicle moving	Negligible
Bystander near stopped vehicle	<0.5
Truck stop employee	<0.01
B. Nonradiological Impacts*	
Pantex Motor Vehicle Traffic [19 million kilometers (12 million miles) per year]	
Amarillo Impact	1.0%
Texas State Impact	0.01%
United States Impact	0.0008%
Pantex Rail Traffic [390 thousand kilometers (240 thousand miles) per year]	
United States Freight Impact	0.006%
Pantex Air Operations (270 per year)	
Amarillo Airport Impact	0.3%

*Expressed as a per cent of the traffic in the affected area.

4.3.2.2 Iowa Army Ammunition Plant Alternative

Radiological

The maximum individual exposure to a nonoccupational individual is a function of numbers of shipments rather than distance traveled so that value would be the same as reported for the Pantex Alternative.

Nonradiological

If all or part of the nuclear weapons assembly operations were relocated to the Iowa Army Ammunition Plant near Burlington, Iowa, the amount of traffic in the local area would be expected to increase from the onset of plant refurbishment. Ultimately, the local motor vehicle traffic would be expected to increase by 9% and the local air traffic would be expected to increase by 1%. The effect on nationwide travel would be negligible.

4.3.2.3 Hanford Site Alternative

Radiological

The maximum individual exposure to a nonoccupational individual is a function of numbers of shipments rather than distance traveled so that value would not be affected by site relocation.

Nonradiological

The total local motor vehicle traffic would be expected to increase by 5%. There would be about a 0.3% increase in local air traffic. The nationwide effects would be negligible.

4.3.3 Transportation Accidents

The primary concern is detonation of the high-explosives components of nuclear explosives with an ensuing aerosolization and release of plutonium to the atmosphere. Other concerns are detonation of conventional high explosives, release of chemical contaminants, burning combustible chemicals, primarily gasoline and diesel fuel, and release of tritium to the atmosphere. The same basic methods used for assessing plant related accidents (described in Section 4.2) were used to evaluate potential transportation accidents.

4.3.3.1 Pantex Plant Alternative

Radiological--Nuclear Weapons

The following abnormal circumstances to which a nuclear explosive could be subjected in a transportation accident were considered: fire, impact, projectiles/shrapnel, spark/electrical discharge, crush, puncture, shearing, friction, pressure, lightning, and immersion.

Only one accident, which could result in a release of radioactive materials, a collision between a Safe-Secure Tractor/Trailer and a fuel tanker truck resulting in a long-burning fire environment, was determined to be credible. On a nationwide basis, the annual probability of such an accident is about 1 chance in a million. About 5% of the total distance traveled is within a 80 kilometer (50-mile) radius of the Pantex Plant. Therefore, the chance of such an accident in the Amarillo area is about 1 chance in 20 million a year.

The consequence assessment for the Safe-Secure Trailer fuel tanker fire accident assumed a maximum authorized vehicle load of nuclear weapons containing plutonium that are most sensitive to the fire accident (Table 4.3.3.1-1). The selected accident location was in a large metropolitan area (population between 1/4 and 1/2 million) on an interstate highway near a major exit. For the worst case wind direction and unfavorable dispersion conditions, the contaminated area was calculated to be 52 square kilometers (20 square miles) with estimated cleanup costs of $500 million based on 1980 dollars. A maximum of 38 eventual cancer fatalities were calculated for this selected accident. Calculations were also made using the most likely wind direction and typical dispersion conditions. For this case, cleanup costs of $120 million and 8 eventual cancer fatalities were estimated.

TABLE 4.3.3.1-1

SAFE-SECURE TRACTOR/TRAILERS PLUTONIUM DISPERSAL CONSEQUENCE ASSESSMENT SUMMARY

Event: High explosive nonnuclear detonation with plutonium dispersal from a fully loaded Safe-Secure Trailer

Location: Interstate Highway, near major exit, large metropolitan area with population between 1/4 and 1/2 million people

Item	Extreme Case Dispersion*	Typical Dispersion**
Risks from Immediate Inhalation		
Maximum individual dose (rem)	31	31
Latent cancer fatalities		
Lung	14	3
Bone	18	4
Liver	6	1
Total	38	8
Potentially affected population	99,000	26,000
Average population density	2700 persons per square kilometer	2700 persons per square kilometer
Decontamination Considerations		
Area contaminated (at greater than 0.2 microCuries per square meter)	52 square kilometers	52 square kilometers
Cleanup cost (in 1980 dollars)	500 million	120 million

*Based on assumptions of stability category F and wind speed 2 meters per second.
**Based on assumptions of stability category D and wind speed 4.2 meters per second.

Nuclear Components and Other Radioactive Materials

The only credible transportation accident involving the shipment of nuclear components and other radioactive materials that could result in a release of radioactivity is a crash and resulting fire from a Department of Energy chartered aircraft carrying nuclear components containing tritium. This accident has a probability of tritium release of less than 4 chances in 100,000 per year. A consequence assessment based upon release and aerosolization of all of the tritium in all of the components predicted a maximum individual dose of less than 1 rem.

Nonradiological--High Explosives

High explosives, exclusive of radioactive materials, are shipped by contractor aircraft and by commercial trucks. For aircraft carrying conventional high explosives to and from Pantex (50 shipments per year) the crash probability is 3 chances in 1000 per year. Because the damage area from detonation of the explosive cargo is always much less than the damage area associated with the plane crash, the hazard from an air crash with high explosives was assessed to be essentially the hazard of the crash.

For truck high-explosive shipments, fire is the dominant abnormal circumstance that could cause a reaction in the explosive cargo. Frequency of fires in trucks carrying high explosives to or from Pantex (10 trucks per year) is less than 6 chances in 10,000 per year. Approximately one-half of the trucks carry sufficient explosives loads to endanger people in unhardened buildings at radii greater than 175 meters (190 yards). Maximum loads have damage radii potential to 400 meters (437 yards). The Pantex Plant contribution to the overall risk of vehicle related explosives shipments in the United States is 0.01%.

Nonradiological--Other Hazardous Materials

Other hazardous matrials used at the Pantex Plant are standard industrial compounds, mainly solvents, cleaning materials, and fuels. Of these, the fuel tanker shipment risks dominate (25 shipments per year). The frequency of fuel tanker accidents resulting in a fire is less than 5 chances in 10,000 per year for Pantex-related fuel transportation in the Amarillo area.

4.3.3.2 Iowa Army Ammunition Plant Alternative

Accidents because of shipping nuclear explosives or hazardous materials to and from the assembly plant are assessed to be directly proportional to the distances traveled. The total miles traveled to and from Burlington would approximate those to and from Pantex. Therefore, moving the plant to Burlington would not affect the risk assessment of transportation-related accidents.

4.3.3.3 Hanford Site Alternative

The likelihood of accidents attributable to shipping nuclear explosives or hazardous materials to and from the assembly plant are assessed to be directly proportional to the distances traveled. Projections are that total distances that nuclear explosives and hazardous materials would be shipped to and from Hanford would be about twice the total to and from Pantex or Burlington. The risk to the general public because of incidents resulting from the transportation of nuclear explosives and hazardous materials would be approximately doubled by moving the plant from Pantex to Hanford.

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7.0 INDEX

This brief index provides a means for cross-referencing sections of the document where different aspects of topics are covered. The references are to section numbers. The topics and concepts emphasize those related to issues raised during the scoping process.

8.0 APPENDIX

8.1 ENVIRONMENTAL RADIATION AND RADIOACTIVITY

Environmental radiation levels at all three sites are dominated by natural background radiation and, to a much lesser extent, by radiation resulting from worldwide fallout from nuclear weapons testing. The radiation dose component due to current or previous operations at all three sites is so small that it cannot be detected above natural background by environmental field measurements. Since the doses cannot be directly measured, they are indirectly estimated by calculation using site specific meteorological, demographic, and environmental pathway data.

Radiation doses are reported in rem or millirem (one thousandth of a rem) dose equivalent. This unit permits comparisons to be made between the different types of radiation (such as alpha particles and gamma rays that deposit energy in tissue in different ways) and appropriate standards. Radiation may be received from both external and internal sources. External sources include such things as cosmic rays, natural radioactivity or worldwide fallout from weapons testing in soil and rocks, or x-ray machines. Dose from external sources depends on where a person is in relation to the sources and occurs only while a person is exposed to the source. Internal sources include natural or manmade radioactivity that enters the body with air, food, or water and may remain in the body or be incorporated into specific tissues for varying lengths of time. Such radioactivity deposited in the body continues to give off radiation and thereby results in an internal dose as long as it is in the body. Both types of sources were evaluated for both background and facility-related doses.

8.1.1 Background Radiation Doses

Background radiation has three components: cosmic, external terrestrial, and internal. The average contribution of each component to natural background was calculated for each site. These calculations are based on standard tables and graphs (NCRP 1975), and field measurements specially performed for this impact statement (Buhl 1982).

Cosmic radiation is influenced by several factors including altitude and latitude of the site and the solar activity cycle (NCRP 1975). The average cosmic radiation dose is subject to annual variations at any location because of changes in solar activity. The principal components of cosmic radiation are charged particles, photons, and neutrons.

External terrestrial radiation is produced by naturally occurring radioactivity in the soil, principally potassium-40, members of the thorium, uranium, and actinium decay series, and to a lesser degree by atmospheric radon daughters. There is also a small contribution from worldwide fallout from atmospheric weapons tests. The terrestrial dose rate at any particular location at any site will vary depending on the local soil concentrations of radionuclides, as well as other factors such as snow cover and soil moisture.

Internal radiation levels are due to the intake into the body of radionuclides in air, food, or water. Internal radiation dose varies from organ to organ based on the ability of the particular organ to accumulate different elements and the way the radionuclide behaves once inside the body. For example, natural tritium and potassium-40 are incorporated in many tissues and contribute to the whole body background dose; while natural radon gas and its daughters inhaled with air contribute much of the lung background dose.

The internal radiation doses for a particular organ were calculated by computer model as 50-year dose commitments, the dose to the organ that an individual would receive during the 50 years following intake of a radionuclide into the body. The 50-year dose commitment is calculated in this impact statement for 1 year of exposure at estimated radionuclide concentrations in air, food, or water.

Radiation doses attributable to natural background for each of the three sites are summarized in Table 8.1.1-1. Values are included for whole body, lung, and bone from cosmic, external terrestrial, and internally deposited sources.

8.1.2 Emissions and Sources of Radioactivity

Two principal radionuclides are routinely emitted from operations at the Pantex Plant: depleted uranium and tritium. Plutonium is also handled at Pantex Plant, but no release of plutonium is possible from normal operations.

8.1.2.1 Depleted Uranium

Routine releases of depleted uranium result from dispersal mainly by explosive test shots. The number of tests and the amount of depleted uranium used has declined significantly in recent years. In

TABLE 8.1.1-1

ESTIMATES OF CURRENT BACKGROUND RADIATION DOSES (millirem) PER YEAR AND EXPOSURE TO A TYPICAL INDIVIDUAL AT EACH SITE*

	Pantex Plant			Iowa Army Ammunition Plant			Hanford Site		
	Whole Body	Lung	Bone	Whole Body	Lung	Bone	Whole Body	Lung	Bone
Cosmic**	37	37	37	28	28	28	27	27	27
External Terrestrial	38***	38	38	26***	26	26	24+	24	24
Internal++	31	231	216	31	231	216	31	231	216
Total	106	306	291	85	285	270	82	282	267

*Estimates include a 10% reduction in cosmic radiation and a 20% reduction in external terrestrial radiation because of shielding by buildings and an additional 20% reduction in external terrestrial radiation because of self-shielding by the body (NCRP 1975).

**From (NCRP 1975).

***From (Buhl 1982).

+From (Miller 1978).

++National average background internal doses based on (NCRP 1975). Doses have been calculated from NCRP values using a quality factor of 20.

1970 about 3500 kilograms (7700 pounds); in 1980 the amount had decreased to about 12 kilograms (26 pounds). Less than 10 kilograms (22 pounds) a year is expected in the future. Depleted uranium released by these explosive tests at Pantex accounts for more than 99% of the doses estimated for annual emissions. Some depleted uranium has also been released in the past by a burning operation, but was no more than a few per cent of the releases from the explosive test shots.

Test shots containing depleted uranium are directed into the ground. As a result, about 83% of the uranium is recovered. Some remains on soil immediately adjacent to the firing site. About 5%, mostly in particulate form, is dispersed with the smoke cloud as uranium oxides.

Depending upon the amount of depleted uranium included in the special test shots each year, the airborne concentrations from the test shots in the past has probably ranged from one-tenth to eight times background values expected from natural uranium in soil. Special air sampling was performed at the Pantex Plant during a recent depleted uranium test shot (January 26, 1982). The maximum downwind concentration, expressed as an annual average, was measured to be less than 0.01% of the Department of Energy annual Radioactivity Concentration Guide (Buhl 1982).

Before 1975 and during 1981 some disposal burning operations of high explosives including depleted uranium were conducted at one of the open earth pads. The burning was done to separate waste high explosives from depleted uranium components. Emissions measured in 1981 by special tests were found to be no more than a few per cent of the annual releases from the test shots just discussed.

Some depleted uranium accumulates on soil in the immediate vicinity of test fire facilities and, to a lesser extent, near one of the waste high-explosives burn areas. Contaminated soil from the firing site is removed periodically, placed in drums, and sent to the Nevada Test Site for disposal. Residual contamination is limited to surface soil. Test holes drilled and sampled to a depth of 8.5 meters (28 feet) in the firing area [approximately 30 meters (100 feet) from the pads] indicated no depleted uranium below the land surface. Some depleted uranium contamination exists on the soil adjacent to the burning pad but the highest levels are about one-tenth those found near the firing sites (Buhl 1982). At greater distances extending to the plant boundary, the accumulations are much smaller.

Outside the site boundary, depleted uranium could not be measured above expected background levels (Buhl 1982). These measurements were made by analyzing for changes from the uranium-235 isotope to uranium-238 isotope ratio that naturally occurs in soil. The ratios measured were those expected for naturally occurring uranium. The 20% variation previously reported for total uranium concentrations in soil is natural variability (USERDA 1976).

Offsite water at Lake Meredith and offsite soil and sediment samples indicate no uranium contamination (Purtymun 1982A).

In addition to the direct dispersal, some of the depleted uranium on soil particles that have accumulated over time is resuspended. About 90% of the resuspension dose is attributed to the firing site and about 10% to the burn pad area. These contributions together result in increments of uranium in air that are so small that they cannot be measured directly in the environment. Therefore, airborne depleted uranium concentrations attributable to Pantex operations were derived by theoretical calculations.

Air sampling for radioactivity at Pantex is routinely accomplished through the use of continuously operating air samplers located around the plant. In addition, a special 12-month air sampling program for radioactive materials was conducted by the Los Alamos National Laboratory (Buhl 1982). Measured ambient annual average concentrations of depleted uranium from both sampling programs were very small, less than 0.01% of the Department of Energy Concentration Guides. The levels are typical of background from natural uranium in resuspended dust.

8.1.2.2 Tritium

Small quantities of tritium, a radioactive form of hydrogen, are occasionally released when shipping drums for tritium containing components are opened. A second source of tritium is routine operations in the quality assurance section of the plant. Total annual releases of tritium are less than 0.1 Curie.

No tritium concentrations above naturally present background tritium was measured by the special 12-month sampling program. Background levels are hundreds of times more than calculated site boundary concentrations for those releases (Buhl 1982).

The small amount of tritium released is about the same as that generated naturally in the atmosphere by cosmic rays over any land area the size of the Pantex Plant. Thus, the amount of tritium released by routine operations is less than a half of a per cent of the naturally produced tritium within an 80 kilometer (50 mile) radius of the Pantex Plant.

8.1.2.3 Plutonium

Plutonium is also handled at Pantex, but only as solid forms in sealed containers. No release of plutonium is expected from normal operations. Monitoring has found no detectable plutonium concentrations in the Pantex Plant vicinity other than that expected from worldwide fallout. The measured values of plutonium on soils both on and off the Pantex site were statistically identical, and they averaged less than one-half of the value determined to be the average for U.S. soils by the Environmental Protection Agency in the mid-1970s (Purtymun 1982A, USEPA 1977).

8.1.3 Food and Agricultural Pathways

A special study was undertaken for this Environmental Impact Statement to evaluate food and agricultural pathways. Foodstuffs (garden vegetables and beef cattle) from the Pantex site were sampled and analyzed for several radionuclides (tritium, uranium, and plutonium). All foodstuffs sampled were found to be at background levels. There are no indications of any contamination of garden and livestock products grown on or near the Pantex site (Wenzel 1982A, Buhl 1982). A brief description of the methodology and the results are presented here. Detailed results and methodologies are presented in the reference documents.

Garden vegetables were sampled from one garden on the Pantex Plant site, six on the perimeter, and nine in Claude, Texas, as a control. Claude is located about 25 miles southeast of the Pantex Plant, a direction unlikely to be affected in any way by Pantex operations. Major vegetables gathered in 1981 were tomatoes, cucumbers, corn, okra, and black-eyed peas. These samples were prepared for analysis by washing in the normal manner as if they were to be eaten. Total uranium, tritium, and plutonium analyses indicated no statistically significant difference between the Pantex garden vegetables and the Claude garden vegetables for these radionuclides (Buhl 1982). These analyses show that foodstuffs grown on or near

Pantex do not contain levels of tritium, total uranium, or plutonium in quantities above normal background levels. Therefore, these foodstuffs show no effect from the Pantex Plant operations.

Another food chain pathway to man was investigated by sampling the soil, native vegetation, grain, cattle tissues, and meat products. A leased Pantex range being grazed by cattle owned by a local rancher was sampled for soil and vegetation. The range was approximately 200 acres in size, east of the Pantex burning site and contained a small, dry playa. Ten heifers were purchased from the range site. Two animals were immediately butchered and dissected; selected tissue and meat samples were taken from these control animals. The remaining eight were placed in the onsite Texas Technological University Research Farm feedlot to be fed on milo raised near the Pantex Plant site. Twenty additional heifers were purchased at auction and four were immediately butchered and dissected as controls. Eight animals went to the Bushland, Texas, USDA feedlot as treatment controls and eight animals went to the Pantex Plant feedlot as a second treatment of feeding livestock grains grown at the Pantex Plant. All samples were analyzed for tritium, total uranium, and plutonium. These analyses showed no detectable differences between the cattle raised on or near the Pantex Plant and those raised in Bushland. The largest source of uranium in the cattle feed was found to be the commercial mineral supplements typically fed to cattle in the area (Wenzel 1982A).

Farming and ranching on and around the Pantex Plant facilities can be considered a land use activity compatible with the Pantex Plant. There is no indication that routine operations result in any effect to the public from consumption of foodstuffs grown there.

8.1.4 Calculation of Doses

Radiation doses to the public from current routine operations of the Pantex Plant and past operations at the Iowa Army Ammunition Plant are so small that they cannot be detected above natural background by environmental field measurements. Since the doses cannot be directly measured, they were indirectly estimated by a computer model AIRDOS-EPA (Moore 1979) using site specific meteorological, demographic, agricultural, and emissions data. Doses due to radioactive material released into the environment were calculated for inhalation and ingestion of deposited material incorporated into vegetables, meat, and milk, and exposure to external radiation due to airborne radiation and radionuclides deposited on the ground (Buhl 1982). Radiation doses in 1981 resulting from Hanford Site operations were taken from Sula et al. (Sula 1982). Those doses were based on evaluation of pathways similar to those considered for the Pantex and Iowa Army Ammunition Plants.

The internal radiation dose for a particular organ calculated by the computer model is the 50-year dose commitment, the dose to the organ that an individual would receive during the 50 years following intake of a radionuclide into the body. The 50-year dose commitment was calculated for 1 year of exposure at estimated radionuclide concentrations in air, food, or water.

Distributions of the population living within 80 kilometers (50 miles) of the Pantex Plant, the Iowa Army Ammunition Plant, and Hanford were determined in a special study undertaken for the dose calculations in this impact statement (LATA 1982). Data describing agricultural practices and productivity were taken from annual reports published by state and Federal agriculture departments (Texas 1980, Iowa 1981, Illinois 1981), and reports by Shor et al. (Shor 1982) and McCormack (McCormack 1981). Meteorological dispersion parameters for test shots releasing depleted uranium were calculated from standard procedures for puff releases (Buhl 1982). Dispersion parameters for the coal-fired power plant and resuspension of soil at firing sites were calculated by standard procedures for plume type releases. Dispersion and dose calculations for the potential accident releases are summarized in Section 4.2 of the impact statement and detailed in several references (Dewart 1982, Elder 1982B, Wenzel 1982D).

8.1.5 Calculation of Health Effect Risks

Potential somatic and genetic health effects from routine radioactive emissions and natural background radiation were calculated using risk factors from BEIR III (BEIR III 1980) and the calculated doses. In calculating added risk of cancer mortality, a linear no-threshold relationship between dose and response was assumed for radiation with high linear energy transfer, such as alpha particles emitted by uranium. The linear-quadratic model was used for low-linear energy transfer radiation from natural background and tritium exposure. In estimating genetic effects, a linear no-threshold dose-response relationship was used. The risk of genetic disorder per live born offspring in all subsequent generations was calculated (Buhl 1982).

The magnitude of risk associated with exposure to ionizing radiation is a point of controversy, especially for low dose or low-dose rate exposures. There is a disagreement over use of a purely linear dose-response model for low-linear energy transfer radiation. However, this debate does not affect conclusions presented in this Environmental Impact Statement for health effects due to Pantex Plant routine releases. This is because the principal Pantex releases are high-linear energy transfer radiations. The principal radioactive material routinely released from Pantex is depleted uranium. Radiation dose from depleted uranium is almost entirely due to its high linear transfer alpha radiation, for which there is general agreement concerning risk. The small amounts of tritium that are released are of secondary importance compared to depleted uranium, which accounts for over 99% of the radiation risk to the public from Pantex operations.

Similarly, the debate does not affect conclusions regarding potential doses or risks calculated for the various accident scenarios. The principal radiological dose would be attributable to weapons grade plutonium, which is also predominantly an alpha particle emitter. The calculational models for the accident analysis are summarized in Section 4.2 of the main report and details are presented in a reference document (Elder 1982B).

The calculation of cancer risk due to natural background radiation is affected by the model used. The reader is referred to Buhl (1982) where added cancer risk is calculated for different dose response models.

8.2 GLOSSARY

Acre-Foot	The amount of water 1 foot deep required to cover 1 acre (43,560 cubic feet, or 326,000 gallons, or 1,234,000 liters).
Activation	The process of inducing radioactivity by bombardment with neutrons or other types of radiation.
Activity	A measure of the rate at which radioactive material is emitting radiation, usually given in terms of the number of nuclear disintegrations occurring in a given quantity of material over a unit of time. The special unit of activity is the curie (Ci).
Airborne Radioactive Material	Radioactive particulates, mists, and/or gases in air.
ALARA	An acronym for the philosophy to maintain exposure to radiation As Low As Reasonably Achievable.
Alpha Particle	A positively charged particle consisting of two protons and two neutrons, identical to the nucleus of a helium atom; emitted by several radioactive substances.
Ambient	Surrounding, especially of or pertaining to the environment about a body but undisturbed or unaffected by it, as in ambient air.
Animal Unit	The grazing equivalent of one mother cow plus her calf.
Aquatic	Living or growing in, on, or near water; having a water habitat.
Aquifer	A subsurface formation containing sufficient saturated permeable material to yield significant quantities of water.
Aquiclude	A porous formation that absorbs water slowly, and will not transmit it fast enough to furnish an appreciable supply for a well or spring.
Artifact	An object or portions of an object produced or shaped by human workmanship, especially a tool, weapon, or ornament of archaeological or historical interest.
Assembly Bay	A specially designed structure used for certain nuclear weapons operations; see Section 1.4.1.
Assembly Cell	A specially designed structure used for certain nuclear weapons operations; see Section 1.4.1.

Background Radiation	The radiation normally present in man's natural environment. It results from cosmic rays and the naturally radioactive elements of the earth, including those from within the human body, and world-wide fallout from nuclear weapons tests.
Backwash Water	Water or waves thrown back by an obstruction.
Beta Particle	An electron or positron emitted from a nucleus during the radioactive transformation of a nuclide in which the atomic number decreases by unity with no change in mass number.
Bioaccumulation	The process of taking up and storing elements or compounds in living tissue (plant or animal).
Biological Oxygen Demand (BOD)	A measure of the organic pollution of water determined by the extent to which bacteria and other organisms in a water sample will use dissolved oxygen in a given period of time; therefore, a measure of the residual oxygen in the water available for use by other organisms such as fish.
Biota	All of the named or namable organisms of an area; fauna plus flora of a region.
Blowdown	The process whereby five to ten per cent of the water within a wet-type cooling tower is continually drained off and replenished with a fresh supply to prevent the excessive concentration of certain salts, minerals, and other constituents within the system.
Caliche	A calcium carbonate deposit formed in the surface rocks of arid regions.
Cased High Explosive	A high explosive encapsulated so that no surfaces of the high explosive remain exposed.
Cold Water Fishery	An aquatic ecosystem that maintains the proper temperature range to support species of the Salmonidae family (soft-rayed fish including the trouts, salmons, whitefishes, and graylings).
Computer Model	A representation or abstraction of a real system in which the important features of the real system and the relationships between these important features are defined quantitatively and expressed in a series of equations from which computer calculations can be performed to make inferences about the behavior of the real system.

Concentration Guide	The average annual concentration of a radionuclide in air or water to which a worker or member of the general public may be continuously exposed without exceeding radiation dose standards.
Contamination (contaminated material)	The deposition or infiltration of radionuclides on or into an object, material, or area, which then is considered to be "contaminated."
Conventional High Explosive	See High Explosive.
Cool Desert	An arid tract that exists far enough from the equator to have cold winters and is incapable of supporting a significant population without an artificial water supply.
Credible Event	An event whose probability of occurrence is above a specified threshold (used in this document to mean 1 chance in a million each year).
Crib	A porous underground structure for disposal of low-level liquid wastes.
Criticality	State of being critical; a self-sustaining neutron chain reaction (where the rates of production and loss of neutrons are exactly equal and there is no other neutron source).
Critical Wildlife Habitat	A habitat that is necessary to sustain the existence and/or perpetuation of a species at critical periods during its life cycle.
Cultural Resource	Nonrenewable remains of human activities, occupations, and endeavors as reflected in sites, buildings, structures, or objects, including works of art, architecture, and engineering. Cultural resources can be either prehistoric or historic, but each period represents a part of the full continuum of cultural values from the earliest to the most recent.
Cultural Resource Survey	An intensive examination of an area for the purpose of discovering and recording archaeological resources.
Curie (Ci)	A unit of radioactivity defined as the amount of a radioactive material that has an activity of 3.7×10^{10} disintegrations per second.
Daughter Products	The nuclides formed in the radioactive disintegration of a first nuclide (parent). In many cases the daughter nuclides also may be radioactive.

Decay chain	The sequence of radioactive disintegrations from one nuclide to another until a stable daughter is reached.
Deciduous	Vegetation on which the leaves are shed or fall off at the end of a growing season leaving bare stems.
Decommissioning	The execution of a planned and orderly program to take something out of service completely or partially.
Decontamination	The removal of radioactive or toxic material from a surface or from within another material.
Depleted Uranium	Uranium having a smaller percentage of uranium-235 than the 0.7% found in natural uranium. (See definition of natural uranium.)
Dispersion	A process of mixing one material within a larger quantity of another. For example, the mixing of material released to the atmosphere with air causes a reduction in concentrations with distance from the source.
Dose	Also referred to as dose equivalent. Expressed in units of rem, implies a consistent basis for estimates of consequential health risk, regardless of rate, quantity, source, or quality of the radiation exposure.
Dose Commitment	The dose commitment refers to the radiation dose received during some period of exposure (normally either the duration of an acute, accidental release of radionuclides to the environment, or for 1 year of a chronic release) plus the dose accumulated over a period of years (50 years used for this document) resulting from radionuclides deposited within the body during the exposure period.
Dose Rate	The radiation dose delivered per unit time and measured, for instance, in rems per hour or millirems per year.
Dryland Farming	Production of agricultural crops using only natural precipitation for watering the crops.
Ecological Pathway	The route within an ecosystem by which a substance or compound is transferred from one level of a food chain to another.
Ecology	The branch of biological science that deals with the relationships between organisms and their environment.
Ecosystem	A habitat and its biota.

Effluent	Liquid that flows away from a discharge point; typically as sanitary sewage or industrial process liquid wastes.
Emission	Any release of materials or compounds into the environment; typically substances discharged into the air.
Endangered Species	Any animal or plant species in danger of extinction throughout all or a significant portion of its range.
Enriched Uranium	Uranium having a higher percentage of uranium-235 than the 0.7% found in natural uranium. (See the definition of natural uranium.)
Environmental Surveillance	A program to monitor changes in a surrounding region.
Eolian	The action or effect of the wind.
Epidemiology	The study of diseases in a population.
Escarpment	A cliff or steep slope of some extent, generally separating two levels or gently sloping areas, and produced by erosion or faulting.
Evapotranspiration	Discharge of water from the earth's surface to the atmosphere by evaporation from lakes, streams, and soil surfaces plus the transpiration from plants.
Exposure	The condition of being made subject to radiation.
Fallow	Land normally used for crop production but unused for one or more growing seasons.
Faulting	The movement that produces relative displacement of adjacent rock masses along a fracture.
Fauna	Animals or animal life.
Federal Impact Funds	Monies paid to local school districts or governments to pay for community services required by the presence of Federal activity.
Fission Products	The nuclides formed by the division of a heavier nucleus, usually in a nuclear reactor.
Floodplain	A level tract of land bordering rivers and formed by alluvial deposits that may be submerged by overflowing river water.
Flora	Plants or plant life.

Food Chain	A linear sequence of successive utilizations of nutrient energy by a series of species.
Forb	Broad-leafed, nonwoody plant.
Fugitive Dust	"Fugitive Emissions" are those emissions released directly into the atmosphere, which could not reasonably pass through a stack, chimney, vent or other functionally equivalent opening. Fugitive dust means particulate matter composed of soil which is uncontaminated by pollutants resulting from industrial activity. Fugitive dust may include emissions from haul roads, wind erosion of exposed soil surfaces and soil storage piles, and other activities in which soil is either removed, stored, transported, or redistributed.
Gamma Ray	A high energy photon such as that emitted by a nucleus in a transition between two energy levels.
Genetic	Information in the nucleotide sequences in deoxyribonucleic acid that controls biological inheritance by determining the nature of all cell substances, cell structures, and cell effects.
Gravel Gertie	A specially designed structure used for certain nuclear weapons operations; see Section 1.4.1.
Groundwater	Water that exists or flows below the earth's surface (within the zone of saturation).
Groundwater Recharge	The process whereby water is fed back into the groundwater system.
Habitat	The natural home or dwelling place of an organism.
Half-life	The time required for the activity of a radionuclide to decay to half its value. It is used as a measure of the persistence of radioactive materials. Each radionuclide has a characteristic constant half-life.
Hectare	A unit of area in the metric system equal to 10,000 square meters.
High-Efficiency Particulate Air (HEPA) Filters	A filter capable of removing from an air stream at least 99.97% of the particulate material that is greater than 0.3 microns in diameter.

High Explosive	Metastable compounds and mixtures that react to give off gas products at high temperatures and pressures at energies of 10^{10} watts per square centimeter on a reaction zone which propagates at a velocity of 5 km/sec to 10 km/sec.
High Linear Energy Transfer	Types of radiation that result in the deposit of energy in a material at a high rate per unit distance traveled, in this document alpha particles are the principal High LET radiation of interest.
Historic Properties	Districts, sites, structures, objects, and other evidence of human use considered to be of cultural and/or historic value; may be eligible for nomination to the National Register of Historic Places.
Hood	A canopy and exhaust duct used to confine hazardous materials and thus reduce the exposure of industrial workers.
Hydrology	The science dealing with the waters of the earth, their distribution on the surface and underground, and the cycle involving precipitation, flow to the seas, evaporation, and so on.
Igloo	An earth-covered facility used to temporarily hold high explosives or nuclear weapons.
Induced Employment	Jobs created in the market place by filling the needs of the new employer and his employees; typically in the area of service-oriented businesses such as restaurants, adding extra help to accommodate the increased business.
In-migration	Movement of population into a community or region.
Inversion	A condition existing when temperature increases with height in the atmosphere.
Isotope	Nuclides with the same atomic number (that is, the same chemical element) but with different atomic masses. Although chemical properties are the same, radioactive and nuclear properties may be quite different for each isotope of an element.
Kilovolt (kV)	The electromotive unit of force equal to 1000 volts.
Kilowatt (kW)	One thousand watts.
Kilowatt-hour (kWh)	A basic unit of electrical energy which equals 1 kilowatt of power applied for 1 hour.

Lithic Scatter	A concentrated area of rock material including projectile points, utilized flakes, cores, and debitage.
Loam	A soil consisting of a mixture of clay, silt, and sand in roughly equal proportions.
Low Linear Energy Transfer	Types of radiation that result in the deposit of energy in a material at a low rate per unit distance traveled, in this document x rays, gamma rays, and beta particles are the principal Low LET radiations of interest.
Macro Invertebrate	The large insects; organisms without a backbone and internal skeleton.
Man-rem	A unit of population dose, calculated by adding together the individual doses (expressed in rems) of a given population.
Maximum Individual	A hypothetical individual whose location and habits tend to maximize his radiation dose, resulting in a dose higher than that received by other more typical individuals in the general population. In this document, the maximum individual is located offsite.
Megawatt (MW)	One million watts or 1 thousand kilowatts.
Meteorology	Science of the atmosphere.
Metric Ton (MT)	1000 kilograms or 2205 pounds.
Mitigation	Any of the following: (1) avoiding the impact altogether by not taking an action or part of an action; (2) minimizing impacts by limiting the degree or magnitude of the action and its implementation; (3) rectifying the impact by repairing, rehabilitating, or restoring the affected environment; (4) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; (5) compensating for the impact by replacing or providing substitute resources or environments.
Mixing Height	The height of the well-mixed atmospheric layer beneath a stable layer.
Monitoring	Making measurements or observations for recognizing the status or adequacy of, or significant changes in, conditions or performance of a facility or area.

National Ambient Air Quality Standards (NAAQS)	The allowable concentrations of air pollutants in the ambient air specified by the Federal government for SO_2, TSP, NO_x, HC, O_3, and CO. The ambient air quality standards are divided into primary standards (based on the air quality criteria and allowing an adequate margin of safety. The primary standards are requisite to protect the public health) and secondary standards (based on the air quality criteria and allowing an adequate margin of safety. The secondary standards are requisite to protect the public welfare from any known or anticipated adverse effects associated with the presence of air pollutants in the ambient air).
National Register of Historic Places	A list of districts, sites, buildings, structures, and objects significant in American history, architecture, archaeology, and culture, maintained by the Secretary of the Interior.
Natural Uranium	Uranium as found in nature, universally distributed in the lithosphere in varying concentrations and usually in equilibrium with its decay products. It contains about 99.3% of uranium-238 and about 0.7% uranium-235.
Neutron	A particle existing in or emitted from the atomic nucleus; it is electrically neutral and has a mass approximately equal to that of a stable hydrogen atom.
Nonattainment Area	An area already characterized by significant levels of air pollution. Any significant increases in certain pollutants caused by new sources (industrial or power plant) are restricted.
Nonbasic Employment	See induced employment.
Nonnuclear Detonation	A chemical reaction within the high-explosive components of a nuclear weapon that results in an explosion that can disperse radioactive materials in the weapon component but with no nuclear yield.
Nuclear Detonation	An energy release through a nuclear process that is equivalent to the detonation of more than four pounds of TNT within a few microseconds.
Nuclear Weapon	A packaged device capable of large energy release through nuclear processes within a few microseconds.
Nuclear Weapons Operations	In this document collectively used to mean all operations associated with the production of new nuclear weapons; the maintenance, modification, and quality assurance testing of existng nuclear weapons in the military stockpile; and the retirement or disassembly of nuclear weapons.

Nuclide	A species of atom characterized by the number of protons, number of neutrons, and energy content of the nucleus; to be regarded as a distinct nuclide the atom must be capable of existing for a measurable time period, generally greater than 10^{-10} seconds.
Nursery Crop	A crop planted to protect the seedlings of a slow-growing crop from exposure to the elements (wind, rain, and sun) until they are strong enough to survive.
Offsite	The area outside the boundary of a facility (that is, outside the property lines of the Pantex Plant, Iowa Army Ammunition Plant, or Hanford Site).
Onsite	The area inside the boundary of a facility (that is, inside the property lines of the Pantex Plant, Iowa Army Ammunition Plant, or Hanford Site).
Operational Reliability	The probability that the nuclear weapons operations system will continue to satisfactorily perform its intended function under various circumstances.
Order-of-Magnitude	Some small multiple of a quantity, usually means within a factor of 10.
Overpacked	Radioactive waste that has been double packaged, sometimes because the original package has been damaged.
Overpressure	The transient pressure, usually expressed in pounds per square inch, exceeding existing atmospheric pressure and manifested in the blast wave from an explosion.
Particulate Matter	Finely divided solid material (for example, minute particles of coal dust, fly ash, and oxides temporarily suspended in the atmosphere).
Penetrating Radiation	A source of ionizing radiation with sufficient energy to go through tissue in the body (such as x rays, gamma rays, and energetic beta particles).
Permeability	A measure of the relative ease of fluid flow through porous rock, sediment, or soil.
Physics Package	The cased high explosive and nuclear material components of a nuclear weapon.
Phytotoxic	A substance toxic to plants.

Playa	A depression on a flat plain relatively free of vegetation in which flood waters may create a lake.
Plutonium	A reactive metallic element in the transuranium series of elements used as nuclear fuel, used to produce radioactive isotopes for research, and used as a fissile agent in nuclear weapons.
Population Dose	The summation of the radiation dose (in rem) received by all individuals in a population group. Its use is principally for total body dose where it has units of man-rem (or person-rem). The technique is also used for collective total doses to specific organs.
Potentiometric	A measure of the static head of groundwater and is defined by the level to which water will rise in an open hole.
Pressure Pulse	See overpressure.
Prevention of Significant Deterioration Regulations	Regulations from EPA intended to protect clean air areas from degradation. Three area classes (I, II, III) are provided, which permit minimal, moderate and maximum increases to air pollution levels above existing conditions. The National Ambient Air Quality Standards may not be exceeded.
Prime Habitat	The optimal natural home or dwelling place of an organism.
Protected Species	Plants or animals that have some degree of state or Federal legal protection. The categories of threatened and endangered are associated with protected species.
Quality Assurance Testing	Testing and inspecting all or a portion of the various products to ensure that the desired quality level is achieved.
Radiation	(1) The emission and propagation of radiant energy: for instance, the emission and propagation of electromagnetic waves, or of sound and eleastic waves. (2) The energy propagated through space or through a material medium: for example, energy in the form of alpha, beta, and gamma emissions from radioactive nuclei.
Radiation Protection Standard	Exposure standards for radiation exposure for an individual in the general public (USDOE 1980A).
Radioactive Material	Any material or combination of materials that spontaneously emits ionizing radiation.

Radioactivity	The property of certain nuclides of spontaneously emitting particles or electromagnetic radiation or of undergoing spontaneous fission. The quantity of radioactivity, usually shortened to "activity," is the number of nuclear transformations occurring in a given quantity of material per unit time. (See also Curie.)
Radioactivity, Natural	The property of radioactivity exhibited by many naturally occurring radionuclides.
Radiography	The technique of producing a photographic image of an opaque specimen by transmitting a beam of x rays or gamma rays through it onto an adjacent photographic film.
Radioisotope	An isotope that exhibits radioactivity.
Radiological Protection	Protection against the effects of internal and external exposure to radiation and radioactive materials.
Radionuclide	A nuclide that exhibits radioactivity.
Raptor	Pertaining to a bird of prey.
Rare and Endangered Species	A species who through the loss of prime habitat or through extreme hunting pressure has declined in numbers to the point where it may be threatened with extinction.
rem	A unit of ionizing radiation, equal to the amount that produces the same damage to humans as 1 roentgen of high voltage x rays. Derived from roentgen equivalent man.
Restricted Area	Any area to which access is controlled.
Roentgen	An exposure dose of x- or y-radiation such that the elections and positions liberated by this radiation produce, in air, when stopped completely, ions carrying positive and negative charges of 2.58×10^{-4} coulomb per kilogram of air.
Safe/Secure Railcar	A special design railcar for transporting nuclear weapons or by railroad.
Safe/Secure Trailer	A special design trailer for transporting nuclear weapons or certain nuclear weapon components.
Seismicity	The relative frequency and distribution of earthquakes.

Shielding	Material used to absorb radiation and thus protect personnel or equipment.
Silage	Green or mature fodder that is fermented to retard spoilage and to produce a succulent winter feed for livestock.
Somatic	Pertaining to the whole body of an individual excluding the germ tract.
Spawning Ground	The bottom of a body of water used by female aquatic life for depositing eggs, which are then fertilized by males of the species.
Standard Metropolitan Statistical Area (SMSA)	A definition employed by the U.S. Bureau of Census. Each SMSA must contain one city of not less than 50 thousand population or two contiguous cities with a combined minimum population of 50 thousand. A SMSA will, in general, encompass one or more entire counties in which the central city is located.
Stability (atmospheric)	A description of the effect of atmospheric forces on a parcel of air following vertical displacement in an atmosphere otherwise in hydrostatic equilibrium. If the forces tend to return the parcel to its original level, the atmosphere is stable; if the forces tend to move the parcel further in the direction of displacement, the atmosphere is unstable; and if the air parcel tends to remain at its new level the atmosphere has neutral stability.
Steppe	A large semiarid grassland.
Stockpile Monitoring	Disassembly, inspection, and component testing of randomly sampled stockpile weapons and the denuclearization of randomly sampled weapons to be used in the joint DOE-DOD flight test program.
Stratigraphically	Pertaining to the form, arrangement, geographic distribution, chronologic succession, classification, correlation, and mutual relationships of rock strata; especially sedimentary rock.
Support Facilities	Those facilities not directly used for nuclear weapons operations such as administration buildings, cafeterias, and garages.
Surface Water	All bodies of water on the surface of the earth.
Surveillance	Those activities necessary to ensure that the site remains in a safe condition (including inspection and monitoring of the site, maintenance of access barriers to radioactive materials left on the site, and prevention of activities on the site that might impair these barriers).

Terrestrial	Inhabiting or pertaining to the land.
Test Detonation	See Test Firing.
Test Explosion	See Test Firing.
Test Firing	The dynamic testing of high explosives or high-exlosive components by detonating them at a firing site.
Test Shot	See Test Firing.
Thermal Contamination	The releasing of heat into the local environment such as hot water from cooling into streams.
Threatened Species	Any animal or plant species likely to become endangered within the foreseeable future throughout all or a significant portion of their range.
Tillering	The process of a plant putting forth additional stalks.
Total Dissolved Solids	An aggregate of carbonates, bicarbonates, chlorides, sulfates, phosphates, and nitrates of calcium, magnesium, manganese, sodium, potassium, and other elements that form salts and are dissolved in water. High TDS values can adversely affect humans, animals, and plants. TDS is often used as a measure of salinity.
Trade Area	The geographic area sharing common general economic and social purpose as identified by the local Chamber of Commerce associations serving the several communities studied in this EIS (Amarillo Area; 11 counties; Burlington Area, 4 counties; and the Tri-Cities Area, 2 counties).
Tritium	The hydrogen isotope having a mass number 3; it is naturally radioactive and is constantly produced by cosmic rays in the atmosphere.
Uncased High Explosive	Bare or exposed high explosive.
Vegetation Type	A plant community with distinguishable characteristics; generally refers to the species or various combinations of species that have similar stature, morphology, and appearance and that dominate or appears to dominate a site.
Warm Water Fishery	An aquatic ecosystem that maintains the proper temperature range to support different species of the Centrarchidae family (spiny-rayed fish including the black basses and several sunfishes).

Wastes, Radioactive	Equipment and materials (from nuclear operations) that are radioactive and have no further known use.
Water Table	Upper boundary of an unconfined aquifer surface below which saturated ground water occurs.
Weapons Maintenance	The periodic checking of all systems on a weapon and replacing components as necessary.
Weapons Retirement	The total disassemby of a weapon no longer required by the armed services.
Wind Rose	A diagram showing the distribution of prevailing wind directions at a given locations; some variations include wind speed groupings by direction.
Workload	See nuclear weapons operations.

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