Public Service Company of Oklahoma

Black Fox Station

Units One and Two

Preliminary Safety Analysis Report

Emergency Response Report

Addendum I

STATE OF OKLAHOMA

COUNTY OF TULSA

Martin E. Fate, Jr., being first duly sworn, deposes and states: That he is Executive Vice President, PUBLIC SERVICE COMPANY OF OKLAHOMA, the Applicant herein; that he has read the following Amendment 16 to the Black Fox Station Units One and Two Preliminary Safety Analysis Report and knows the contents thereof; that the same is true as he verily believes.

DATED: This 1st day of September, 1981

Signed s/ Martin E. Fate, Jr.
Martin E. Fate, Jr.
Executive Vice President

Subscribed and sworn to before me
this 1st day of September, 1981

s/ Lina P. Holm
Notary Public in and for the County of
Tulsa, State of Oklahoma

My Commission expires February 21, 1983

ERRATA AND ADDENDA SHEET
AMENDMENT 16, SEPTEMBER 1, 1981

REMOVE	INSERT PAGE
ALL OF SECTION 13.3	13.3-1
Table of Contents, VOLUME I, page 38a dated 3-051476	38a dated 16-090181
Table of Contents, Volume I, page 39 dated 3-051476	39 dated 16-090181
Section 13.0, Table of Contents, page 1a dated 3-051476	1a dated 16-090181
Section 13.0, Table of Contents, page 2 dated 3-051476	2 dated 16-090181

Instructions

Place Amendment 16 instructions directly behind Amendment 15 instructions.

Amendment 16 begins a new PSAR volume designated Addendum I.

13.3 SITE EMERGENCY PLAN

13.3.1 General

This section superseded by the Black Fox Station Emergency Response Report. 16

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1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this report is to address the revised rules and regulations on emergency planning for nuclear power plants as is applied to the Black Fox Station (BFS). On August 19, 1980 the Federal Register published final rules revising Sections 50.33, 50.54 and Appendix E and added a new Section 50.47 to Title 10 of the Code of Federal Regulations. These rules became effective on November 3, 1980. In particular, Section II of Appendix E has been revised requesting specific information on the new emergency response planning bases for the Preliminary Safety Analysis Report (PSAR) stage. This report specifically addresses the PSAR portion of the new rules and is not intended to represent an operating license emergency response plan.

Prior to the issuance of the new emergency planning rules and regulations, PSO was in receipt of a NRC letter dated October 23, 1979 (See Appendix E) which requested information regarding the new concepts of broadened emergency planning zones and greater informational details. This letter, even though it has been superseded by the rule, still provides useful guidance for the preparation of this report.

The emergency planning criteria provided for this report also supersedes the previous emergency planning criteria used for the initial submittal of the BFS PSAR. Therefore, the information contained in this report supersedes the information supplied by the Section 13.3 of the PSAR.

1.2 BACKGROUND

The requirements for emergency response planning on nuclear power facilities has greatly expanded since the accident at Three Mile Island Unit 2 on March 28, 1979. However, prior to the TMI-2 accident, expanded emergency planning zones were being considered which would envelope responses to accidents including certain core melt accidents (Reference 1).

On September 19, 1979 the NRC published draft guidelines (NUREG-0610) on emergency action levels which expanded and redefined previously accepted action levels (Reference 2). NUREG-0610 was incorporated in NUREG-0654 Appendix 1 (Reference 4).

All nuclear power plant emergency response planning had been previously handled by the NRC, however, on December 7, 1979 the President proclaimed that all off-site response authority actions and state emergency preparedness plan review would be handled by the Federal Emergency Management Agency (FEMA).

On December 19, 1979 the Federal Register published a notice of proposed rulemaking to revise the rules governing emergency planning for nuclear power plants (Reference 3). This included changes to 10CFR Section 50.33, 50.47, 50.54 and Appendix E to Part 50. The proposed rulemaking provided a more formal basis for the October 23, 1979 request letter. Due to the expanded requirements for emergency preparedness, additional guidance and criteria were necessary. On December 26, 1979 guidelines for providing evacuation time estimates were received from the NRC (See Appendix E).

Additionally, in support of the proposed rule, the NRC and FEMA, in a joint effort developed NUREG-0654, "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants". The intent of this document is to provide complete guidance for all emergency planning and preparedness efforts for nuclear power plants and, therefore, expanded or superseded previous guidance. NUREG-0654 (FEMA-Rep-1) Revision 1 was issued on November 1980 (Reference 4).

In July, 1980, the NRC issued draft NUREG-0696 entitled "Functional Criteria for Emergency Response Facilities". This document expanded or changed the design considerations for such emergency facilities as the Technical Support Center, Emergency Operations Facility, Safety Parameter Display System and Nuclear Data Link which are further discussed in this report. NUREG-0696 was issued as a final report in February 1981 (Reference 15).

The final rulemaking on emergency planning for nuclear power plants was published in the Federal Register on August 19, 1980 (Reference 16). This rulemaking followed closely to the proposed rulemaking previously noticed on December 19, 1979.

1.3 EMERGENCY PLANNING ZONES BASIS

All present emergency planning is based on expanded emergency planning zones to cover potential accidents including core melt accidents. The size of the Emergency Planning Zones (EPZ) radii represents a judgment using detailed planning to assure that an adequate response base exists for all potential radiological releases.

The plume exposure EPZ of a 10 mile radius was based primarily on the following considerations (Reference 4):

- Projected doses from the traditional design basis accidents would not exceed Protective Action Guide levels outside the zone;
- Projected doses from most core melt sequences would not exceed Protective Action Guide levels outside the zone;
- For the worst core melt sequences, immediate life threatening doses would generally not occur outside the zone;
- Detailed planning within 10 miles would provide a substantial base for expansion of response efforts in the event that this proved necessary.

The ingestion exposure EPZ of a 50 mile radius was based on the following considerations (Reference 4):

- The downwind range within which contamination could occur would generally be limited to about 50 miles from a power plant because of wind shifts during the release and travel periods;
- There may be conversion of atmospheric iodine (i.e., iodine suspended in the atmosphere for long time periods) to chemical forms which do not readily enter the ingestion pathway;
- Much of any particulate material in a radioactive plume would have been deposited on the ground within about 50 miles from the facility;
- The likelihood of exceeding ingestion pathway protective action guide levels at 50 miles is comparable to the likelihood of exceeding plume exposure pathway protective action guide levels at 10 miles.

1.4 SUMMARY AND COMPATIBILITY OF BFS EMERGENCY RESPONSE PLANNING

The Black Fox Station will be Oklahoma's first nuclear powered generating facility and, therefore, no previous emergency response plans have been required prior to BFS for responding to a potential nuclear power plant accident. Detailed planning, staffing and resources will be provided at the FSAR stage to demonstrate that in the event of an accident, effective emergency response actions can be taken at BFS.

This report denotes that a workable plan presently exists for development of an effective emergency response between the proposed site and the surrounding emergency planning zones with respect to proposed station facilities, manpower, resources, and the offsite response capabilities. The planning capability will include the specific features within the EPZ's such as population distributions, land use, neighboring jurisdictional boundaries and access routes. In addition, the standards referenced in 10 CFR 50.47(b), as applicable to the information required of this report, are compatible for preparation of future emergency preparedness planning.

The following discussions summarize the text of this report and indicates how the total report culminates to assure that adequate preparation has been acco[illegible] the construction permit stage to provide emergency response plans in the future. Emergency response compatibility will include the PSO response capability, the offsite response authority preparedness capability, the PSO/response authority interaction, and the BFS site/environ emergency response relationship. Each one is important in the functioning of an effective emergency response operation. Both the BFS and state plan (Section 2.1.2) will be complementary and independent. In this

report PSO demonstrates a comprehensive emergency response plan can be developed for the future operation of BFS.

The BFS emergency response fitness is demonstrated by providing dose and accident assessment capability including the advanced control room design (Section 3.4.1), radiation monitoring (Section 3.4.2), a Safety Parameter Display System (SPDS) (Section 3.4.5), and a Technical Support Center (TSC) (Section 3.1.1). BFS will have an emergency organizational capability by assigning personnel to serve as Shift Technical Advisor and Emergency Coordinator (Section 3.5). An Emergency Operations Facility (EOF) will be designed and constructed to coordinate protective action response (Section 3.1.2).

An offsite response authority preparedness compatibility has been established by the willingness of all the local and state authorities to develop future emergency preparedness plans for BFS (Section 2.4). The offsite preparedness will be coordinated by the Oklahoma State Department of Health - Radiation Protection Division (OSDH-RPD) (Section 2.2.1.1) with other local, state, and federal support. Response and assessment resources (Section 2.3) will be provided for complete emergency preparedness. Offsite authority protective action determinations will be simplified by use of the BFS EOF. Training will be conducted for designated offsite response authorities to assure needed expertise (Section 4.3.4.1). Offsite medical capability will also be established for radiological related injuries (Section 4.3.5).

A conceptual plan for an early warning system (Section 3.3), and a complete communication system (Section 3.2) for BFS/offsite response authority interactions demonstrates the BFS/offsite response authority compatibility. Specific emergency action levels have been agreed upon for future implementation (Section 4.1) along with offsite authority notification scenarios for each action level class (Section 4.2). Protective action initiations have been recognized for plan implementation (Section 4.3).

The BFS site/environ relationship compatibility has also been shown to be more than adequate by such considerations as reviewing the plume exposure EPZ population density (Appendix B), and having good emergency egress (Appendix C). The topographical features have been considered through the analysis performed for evacuation time estimates (ETE's) (Appendix C). These analyses have demonstrated reasonable evaluation times. Land usage (Appendix B) is not considered to hamper any emergency response actions. Review of the political jurisdictional boundaries (Section 2.1) has been made and does not pose any recognizable problems.

1.5 CROSS REFERENCES

CROSS REFERENCE
TO NUREG-0654
AND
10 CFR 50.47

10 CFR 50.47(b)	NUREG-0654		BFS Emergency Response Report Section
1	A.	Assignment of Responsibility (Organizational Control)	2.1, 2.2
2	B.	Onsite Emergency Organization	3.5
3	C.	Emergency Response Support and Resources	2.3
4	D.	Emergency Classification System	4.1
5	E.	Notification Methods and Procedures	4.2
6	F.	Emergency Communications	2.3, 3.2
7	G.	Public Education and Information	4.3.3
8	H.	Emergency Facilities and Equipment	3.1, 3.4, 2.3
9	I.	Accident Assessment	3.4
10	J.	Protective Response	3.3, 4.3, 5.0
11	K.	Radiological Exposure Control	4.3
12	L.	Medical and Public Health Support	2.4.3, 3.1.4, 4.3.5
13	M.	Recovery and Re-entry Planning and Post-accident Operation	N/A for PSAR
14	N.	Exercises and Drills	N/A for PSAR
15	O.	Radiological Emergency Response Training	4.3.4
16	P.	Responsibility for the Planning Effort: Development, Periodic Review and Distribution of Emergency Plans	N/A for PSAR

CROSS REFERENCE
TO 10CFR50 APPENDIX E
SECTION II (AUGUST 19, 1980)

10CFR50 Appendix E, Section II	BFS Emergency Response Report Sections
A. (1) Onsite and (2) offsite organizations for coping with emergencies and (3) the means for notification, in the event of an emergency, of persons assigned to the emergency organizations.	(1) 3.5 (2) 2.2 (3) 2.1, 4.2, 3.2
B. (1) Contacts and arrangements made and documented with local, state, and federal governmental agencies with responsibility for coping with emergencies, (2) including identification of the principal agencies.	(1) 2.4 (2) 2.2
C. (1) Protective measures to be taken within the site boundary and (2) within each EPZ to protect health and safety in the event of an accident; (3) procedures by which these measures are to be carried out (e.g., in the case of an evacuation, who authorizes the evacuation, how the public is to be notified and instructed, how the evacuation is to be carried out); and (4) the expected response of offsite agencies in the event of an emergency.	(1) 4.3.2.1, 4.1 (2) 4.3.1, 4.3.2, 4.1 (3) 4.1, 4.2, 3.3 (4) 4.3.2

10CFR50, Appendix E. Section II (continued)	BFS Emergency Response Report Sections
D. Features of the facility to be provided onsite emergency first aid and decontamination and for emergency transportation of onsite individuals to offsite treatment facilities.	3.1.4
E. Provisions to be made for emergency treatment at offsite facilities of individuals injured as a result of licensed activities.	2.4.3, 4.3.5
F. Provisions for a training program for employees of the licensee, including those who are assigned specific authority and responsibility in the event of an emergency, and for other persons who are not employees of the licensee but whose assistance may be needed in the event of a radiological emergency.	4.3.4

10CFR50, Appendix E. Section II (continued)	BFS Emergency Response Report Sections
G. (1) A preliminary analysis that projects the time and means to be employed in the notification of State and local governments and the public in the event of an emergency. (2) A nuclear power plant applicant shall perform a preliminary analysis of the time required to evacuate various sectors and distances within the plume exposure pathway EPZ for transient and permanent populations, noting major impediments to the evacuation or taking of protective actions.	(1) 3.3, 4.3.2 (2) 5.0, Appendix C
H. (1) A preliminary analysis reflecting the need to include facilities, systems, and methods for identifying the degree of seriousness and potential scope of radiological consequences of emergency situations within and outside the site boundary, (2) including capabilities for dose projection using a real-time meteorological information and for dispatch of radiological monitoring teams within the EPZs; and (3) a preliminary analysis reflecting the role of the onsite technical support center and of the near-site emergency operations facility in assessing information, recommending protective action, and disseminating information to the public.	(1) 3.1, 3.4, 4.1 4.2, (2) 3.4, 3.2, 2.3 (3) 3.1, 3.4, 3.3.2, 4.3.2

2.0 OFFSITE EMERGENCY PREPAREDNESS AUTHORITIES

2.1 JURISDICTIONAL AUTHORITY FOR EMERGENCY PREPAREDNESS

As in most states, Oklahoma operates within three levels of government; state, county and municipal. Each level is given certain authority and jurisdictional responsibilities. The normal operation and duties of the overall governmental system in Oklahoma is delineated in the Oklahoma statutes and is conducted in accordance with these laws and implementing regulations.

Jurisdictional authority in an emergency situation generally follows the authority assigned by the Oklahoma statutes. Under some conditions an overlapping of authority does exist. However, this is normally controlled by the higher level of authority or by availability of manpower and resources. One such condition where all three levels of government may be involved is in the area of law enforcement. If any jurisdictional authority overlaps and hinders the effectiveness of the emergency response, then agreements can be established as discussed in Section 2.1.1.

The plume exposure pathway EPZ for BFS includes portions of three counties and one incorporated town. The counties are Wagoner, Rogers and Mayes counties which occupy approximately 50%, 40% and 10% respectively of the total area in this 10 mile EPZ. The Town of Inola is located in Rogers County, approximately three miles N.E. of the BFS site (see Figure 1).

The ingestion exposure pathway EPZ is located totally within the state of Oklahoma and encompasses seven counties and portions of ten other counties, including Tulsa which is approximately 23 miles west of the site

(see Figure 2). Jurisdictional authority within the ingestion EPZ will not require special coordination between counties for protective response actions. The local, state and county authorities who will be performing emergency response actions will be primarily concentrated on providing sampling and protective action recommendations as directed by the OSDH-RPD authorities for potential radiological contamination.

2.1.1 Response Authority Jurisdiction

The Oklahoma State Department of Health, Radiation Protection Division (OSDH-RPD) is the responsible authority in Oklahoma for developing the Oklahoma Radiological Emergency Response Plan and coordinating the interagency response efforts. This is clarified in the OSDH-RPD letter of agreement in Appendix A. Given this authority by the Governor's office and through state statutes, (63 O.S. Supp 1971 Section 1-1503(a)), emergency response agencies within Oklahoma are responsible to conduct their efforts under the guidance of the OSDH-RPD.

The Oklahoma Civil Defense (OCD) has responsibility for all natural, man-made and war time emergency preparedness activities and will have the secondary authority for emergency preparedness in case of a radiological emergency at BFS. The OCD will work closely with the OSDH-RPD to develop and conduct the total planning and response effort for the state from the nonradiological aspects of emergency preparedness.

The remaining state, county and local authorities involved in the planning and response effort will receive guidance during an emergency from the OSDH-RPD and the OCD. During the actual developmental stage for the state plan, formal agreements will be prepared between any

emergency response agencies, as determined to be necessary. Title 70 of the Oklahoma Statutes Sections 1001-1008 provides for agreement contracts between any state, county and local political jurisdictions for a predesignated objective or function. Such an agreement can provide a better understanding of interagency and intergovernmental coordination and response coverage to avoid duplicative efforts during an emergency. Any such agreements will be determined upon preparation of the Oklahoma Radiological Emergency Response Plan.

Notification of offsite emergency response authorities for a particular emergency action level as discussed under Section 4.1 may be different depending on the level of the accident. The OSDH-RPD, under nearly all conditions, will be the primary offsite authority to be contacted. However, under severe accident conditions initial notification of the local authorities for immediate response action may be required.

The emergency action levels for "notification of unusual event", "alert" and under most circumstances of a "site" emergency do not require an immediate public protective response action. Response time for these levels would allow the OSDH-RPD adequate time to respond. However, emergencies of the more severe "site" emergency and likely all "general" emergency action levels that develop quickly, especially if the early warning system (See Section 3.3) requires actuation, would dictate a procedure for immediate offsite authority response. The constraints on travel time would limit the effectiveness of the OSDH-RPD response and therefore would require initial local authority action. The Sheriff's departments of each County will be the most likely local authority to take the initial response actions with the

aid of the County Civil Defense Directors. Immediate response action in Inola would primarily be conducted by the Inola Police Department.

Notification scenarios for alerting offsite emergency response personnel are discussed in Section 4.2.

Federal emergency response organizations within such agencies as the DOE, EPA, FEMA and NRC which have been established for the purpose of responding to nuclear power plant emergencies will be addressed at the FSAR stage.

2.1.2 Oklahoma Radiological Emergency Response Plan

The Oklahoma Radiological Emergency Response Plan will be developed to cover all aspects of offsite response authority emergency preparedness for a potential radiological accident at Black Fox Station. Each local, county, and state emergency response authority will have specific plans and procedures that will be included by this plan.

The basic objective of the plan is 1) to provide reasonable assurance that appropriate measures can and will be taken to protect public health and safety in the event of an emergency, 2) to limit public radiation exposure in the event of an emergency, 3) to identify and use the supportive and protective resources available to the local and state authorities, and 4) to provide timely dissemination of accurate information to local, state and Federal authorities and to the public.

On May 29, 1979 a preliminary draft of the Oklahoma Radiological Emergency Response Plan was prepared and sent out by the OSDH-RPD for general review to various

State agencies, PSO, and to the U.S. Nuclear Regulatory Commission, Office of State Programs. This draft was acknowledged by the Governor of Oklahoma in a letter to Joseph Hendrie, Chairman of the NRC, dated June 20, 1979 (attached in Appendix E). This letter expresses Oklahoma's commitment to respond to the need for an effective response plan in a timely manner. The initial draft of the Oklahoma Radiological Emergency Response Plan was written to cover all radiological emergencies, however, the future plan will be written to cover the BFS.

The above letter indicated that a final plan would be available in early 1980. However, since the initial draft was issued, new planning bases, expanded criteria, a change from the NRC as the governing Federal review agency to FEMA, and a substantial revision to the Code of Federal Regulations for emergency response planning on fixed nuclear facilities has taken place.

The revised state plan will be developed in accordance with NUREG-0654 (Revision 1). Federal review and concurrence for the plan will be in accordance with the final rulemaking of 44 CFR Part 350.

2.2 OFFSITE RESPONSE AUTHORITIES

2.2.1 Primary Authorities

The primary offsite emergency preparedness authority will be the following local, county and state agencies who will participate in the overall planning, development and implementation of the Oklahoma Radiological Emergency Response Plan as it specifically applies to the Black Fox Station. This will include an authority with 24 hour a day notification capability in the event of an accident at BFS.

2.2.1.1 Oklahoma State Department of Health, Radiation Protection Division (OSDH-RPD)

The Oklahoma State Department of Health is the official state agency within Oklahoma for the protection of the public with regard to the uses of atomic energy and sources of radiation. The Radiation Protection Division (RPD), under the Occupational and Radiological Health Service, is the specific office within the OSDH that is responsible for handling radiological emergencies and will act as the primary agency for response to a radiological concern at BFS. As part of their responsibility, they have been directed to develop the Oklahoma Radiological Emergency Response Plan. The OSDH-RPD will coordinate the jurisdictional planning activities to assure an effective comprehensive plan. This office will also be responsible for implementing protective actions to limit public exposure during an emergency. Their office headquarters are located in Oklahoma City, Oklahoma.

2.2.1.2 Oklahoma Civil Defense Agency (OCD)

The Oklahoma Civil Defense Agency (OCD) has been designated as the second authority within Oklahoma for nuclear accident response and will also act as the alternate state authority for notification of an incident. The OCD receives their authority from the Oklahoma Civil Defense and Emergency Resources Management Act of 1967 as regulated by O.S. 63 §683.

Their responsibilities for emergency preparedness in the event of an accident at BFS will be to mitigate the consequences to the public health by conducting a coordinated over-all response effort. This will include directing and coordinating fire fighting services, police

services, medical and health services, and rescue and warning services. The OCD will also aid the conduct of evacuation and welfare services along with emergency transportation provisions.

The OCD will guide and direct local and county civil defense plans to include response functions for BFS. They will also receive guidance from the Federal Emergency Management Agency (FEMA) on conducting emergency preparedness and planning for primarily non-radiological response activities. Radiological protective action will also be implemented by the OCD as directed by the OSDH-RPD.

The OCD offices are located in Oklahoma City, Oklahoma.

2.2.1.3 Oklahoma Department of Public Safety (DPS)

The Oklahoma Department of Public Safety will provide certain policing powers and emergency response through the Oklahoma Highway Patrol as provided by 47 O.S. §117. Their responsibilities will include traffic and access control within the area around BFS in the event of an emergency. They will also be capable of providing emergency transportation, law enforcement, and communications response. The DPS will receive directives from either the OCD or the OSDH-RPD in the event of an emergency at BFS.

The DPS is located in Oklahoma City with twelve patrol headquarters located throughout the state including one in Tulsa. These headquarters would be available for operation and dispatch of patrol units during an emergency. In addition, a DPS command post can be set up within safe distance of the site for immediate DPS operations for more effective response.

2.2.1.4 Rogers, Wagoner and Mayes County Sheriffs' Offices

The county sheriffs' offices will be the primary county authority for protection of the public by providing policing actions and emergency activities on a county level as established by 19 O.S. §516. The sheriffs' offices for each county are located in the county seats which are Claremore (Rogers County); Wagoner (Wagoner County); and Pryor (Mayes County).

In the event of an emergency, each sheriff's office which includes the sheriff, deputy sheriffs, and dispatch personnel, will be the primary county authority to be notified of an accident at BFS. Their responsibilities would include implementing protective actions recommended by the OSDH-RPD or OCD such as evacuation implementation, evacuation confirmation and individual emergency notification to the public. In an extreme situation the sheriffs' offices will likely be the initial offsite response authority for public notification and protective actions initiation with notification to the OSDH-RPD to follow.

2.2.1.5 Rogers, Wagoner and Mayes County Civil Defense Directors

Civil Defense preparedness on a county level for a radiological hazard will be handled by the county civil defense directors. The directors will prepare county emergency preparedness planning within their counties through the coordinated direction of the Oklahoma Civil Defense and the OSDH-RPD. The county civil defense directors are located in each of the county seats as are the sheriffs' offices.

Each county civil defense director will be responsible for preparing for an emergency within their respective county and assuring that their emergency resources

and manpower are activated in the event of an emergency. This would include coordinating and activating such resources as fire and police protection, health and Red Cross services, and relation services. The directors will work closely with the sheriff's office and with the Oklahoma Civil Defense authorities for proper implementation of protective actions.

2.2.1.6 Inola Police Chief

The Inola Police Chief has the responsibility within the Inola city limits to protect the public which may involve implementing any protective or policing actions as necessary.

Since Inola is the only incorporated town within the plume exposure EPZ, individual consideration for initiating protective actions will be developed for Inola. The Inola Police Chief, along with the Mayor and Inola civil defense officer, is responsible for conduct of implementing protective actions within the city limits of Inola. The OSDH-RPD and OCD will aid and instruct them in development of effective plans and recommendations of these implementing protective actions.

In the event of an accident at BFS, his specific responsibilities would include assuring recommended protective actions are recognized by the public, coordinating evacuations and confirming evacuations. Detailed efforts will be developed for the schools and churches in the area.

2.2.2 Support Authorities

These authorities will be available and will participate in emergency preparedness exercises, but will not be directly involved in the emergency plan preparation. Each of these agencies will provide a response for

protecting the public health as directed by the primary authorities.

2.2.2.1 Oklahoma National Guard

The Oklahoma National Guard consists of both an Army National Guard and Air National Guard, however, the Army National Guard's 45th Infantry Brigade will be the primary section to respond in the event of an emergency at BFS. The Army National Guard operates 102 units throughout the state including infantry troops in Tulsa, Broken Arrow and Claremore. The state headquarters is located in Oklahoma City.

The Operations and Military Support Officer conducts and performs the planning within the National Guard for emergency and civil defense operations. He will work with the OCD and OSDH-RPD for developing emergency coordination in relation to BFS.

The Oklahoma National Guard will support the OCD by providing such activities as physical security, access control and emergency evacuation. Actuation of National Guard in an emergency can be through the Civil Defense even though the ultimate authority will be by the Governor.

2.2.2.2 Oklahoma State Department of Health - Consumer Protection Service (OSDH-CPS)

The OSDH-CPS is the principal State authority for inspection and control of milk and foodstuffs as provided by Title 63 of the Oklahoma Statutes. Part of their responsibility as provided by the adopted rules and regulations is to assure protection of the public health by minimizing injury or illness from contaminated milk, food, drugs and other consumer products. Two of the

OSDH-CPS divisions that will be of significance to emergency preparedness in relation to BFS are the Milk Sanitation Division and the Food and Lodging Division.

The Milk Sanitation Division under Article 13 of the Oklahoma Statutes has the authority to inspect and test raw milk from state dairies to assure the minimum quality of the product. Normal testing by the Milk Sanitation's Division does not include analysis of radiological contamination at this time; however, in cooperation with the OSDH-RPD such milk samples can be easily obtained for baseline and post accident analysis. Any such sample would be provided to the OSDH-RPD for laboratory analysis. Following an accident where potential contamination is expected, samples can either be taken at the processing dairy where samples are normally taken or at the producing dairies if isolated contamination is suspected.

The Food and Lodging Division under Article 11 has the authority to inspect and test meat and foodstuffs for contamination or possible public health hazards. Foodstuffs are routinely inspected at the packaging facility or processing house; however, in the event of an accident at BFS, product inspections could be performed in a broadened pattern to obtain potential source contamination.

Samples collected by either OSDH-CPS division could be taken in the plume exposure or ingestion exposure EPZ's from suspected or actual contamination as determined by the OSDH-RPD. Sixty of the seventy seven Oklahoma counties have established County Health Departments which are responsible for performing inspection and sampling of milk and food products. All counties within the plume exposure EPZ have health departments and only

two of the peripheral counties in the ingestion exposure EPZ do not have individual health departments. In the event of an emergency where additional sampling and investigation is required, outlying State counties will be directed to send personnel into the affected counties for additional support.

2.2.2.3 Oklahoma State Department of Agriculture

The Oklahoma State Department of Agriculture (OSDA), under Title 2, has authority to protect the health and safety of the public by preventing unfit agricultural products from entering the market. Of the eight divisions of the OSDA, the Agriculture Laboratory Division, the Animal Industry Division and the Dairy Division will be of importance during the emergency response planning stage for BFS. In both the plume exposure EPZ and ingestion exposure EPZ the OSDA, by request of the OSDH-RPD, could obtain meat, dairy, poultry and vegetable product samples for analysis that are suspected of potential contamination.

Even though the OSDA and OSDH-CPS will perform similar functions for radiological emergency preparedness, each has distinct authority for inspection and control of consumable products for public health protection.

2.2.2.4 Tulsa City-County Civil Defense

The Tulsa City - County Civil Defense has shown a willingness to aid PSO and other surrounding jurisdictions in the preparation of the future emergency planning effort for BFS. Tulsa, which is outside of the plume exposure EPZ but is within the ingestion EPZ, could provide capabilities which could be of value.

The Tulsa City-County Civil Defense, in cooperation with the Oklahoma Civil Defense, has developed a Crisis Relocation Plan for the Tulsa area. This plan provides for relocation of Tulsa area residents into neighboring (host) counties in the event of a nuclear attack. The plan is presently functional and agreements have been developed with the neighboring counties which include Rogers, Mayes and Wagoner Counties. This plan as discussed in Section 4.3.1.7 can be expanded to host evacuees from the plume exposure EPZ around BFS in the event of an accident.

2.2.2.5 Other Local, County and State Authorities

Other local, county and state authorities will be available to supply emergency response activities if necessary. Included are the U.S. Army Corps of Engineers, the Oklahoma Department of Transportation, local and neighboring fire departments and any others which will be able to respond, if called upon. Table 4 provides emergency responsibilities that will be conducted by offsite emergency response authorities.

2.3 OFFSITE AUTHORITY RADIOLOGICAL ASSESSMENT RESOURCES

The offsite authorities which will be involved in radiological dose assessment will have adequate resources to identify and provide needed protective actions to the public. The OSDH-RPD will be the responsible State authority for radiological dose assessment. The OCD will aid the OSHD-RPD efforts either directly or indirectly for monitoring, as required. Federal support by agreement from the Federal Radiological Monitoring and Assessment Plan (FRMAP), formerly the Interagency Radiological Assistance Program (IRAP), will also provide radiological assessment assistance. Each group will have sufficient equipment to perform monitoring tasks within the amount of responsibility required of them.

The specific equipment to be used by state and county offsite response agencies in the event of an accident at BFS has not been identified at this time due to the preconstruction status of BFS. Section 2.3 will address the general provisions of necessary equipment for future use. The monitoring equipment supplied by FRMAP will be generally the same for all nuclear stations throughout the U.S. and therefore, will not be discussed further.

2.3.1 Oklahoma State Department of Health - Radiological Protection Division Resources

The OSDH-RPD will have both portable and fixed radiological monitoring capability which will be operated by the OSDH-RPD Radiological Response Teams (RRT).

2.3.1.1 OSDH-RPD Radiological Response Team

The Radiological Response Team (RRT) will be comprised of the staff of the OSDH-RPD who upon notification of an accident at BFS will respond by assessing the effects of the accident and taking necessary actions to protect the public.

The RRT will include the senior OSDH-RPD staff member who becomes the team coordinator (Chief of the Occupational and Radiological Health Service or the Director of the Radiation Protection Division) and their immediately available staff. It will be the Coordinator's responsibility to receive and evaluate the initial information and to take the initial steps necessary to direct response activities. He will also be responsible for coordinating with the other response agencies such as the Oklahoma Civil Defense and the Department of Public Safety.

The team will be made up of several subteams which will perform various functions. The Response Team Headquarters will be established at the BFS Emergency Operations Facility, and will assume the responsibility for direction of the offsite technical operations. The Emergency Field Teams will perform monitoring and survey operations, sample collection, and supervision of offsite decontamination. The Communication Section, which can be made up of members from other subgroups, will establish communications between mobile units and fixed facilities. The Laboratory Section, as discussed in Section 2.3.1.2 will perform analyses, and report and record results from samples collected by applicable state agencies.

Response equipment to perform all functions of the RRT will be maintained and tested to assure adequate response capability. This includes portable dose assessment equipment, air samplers and personal protection equipment for the team members, complete communications equipment to direct all response activities and laboratory equipment for field sample analyses.

2.3.1.2 OSDH - Laboratory

The OSDH-RPD Laboratory is located in Oklahoma City, Oklahoma at the OSDH offices. The lab presently performs general radio-chemical analyses of field samples collected from both radiological and nonradiological activities being monitored by the department. Prior to the commencement of the operation of BFS, the lab will be evaluated by the OSDH-RPD to determine whether the existing laboratory resources will be sufficient to adequately support an emergency at BFS and improvements made as necessary.

The lab will have the capability to perform isotopic analysis on the radiological field samples collected within the plume exposure pathway and ingestion exposure pathway EPZ's. The actual equipment and staffing of lab will be determined during the critical planning for the BFS emergency response plan.

2.3.2 Other State and County Radiological Assessment Resources

The resources that will be provided by the Oklahoma Civil Defense (OCD) will consist primarily of coordination and emergency response direction activities, however, the OCD personnel will have and will be trained to use dose rate survey meters which will provide gross gamma and beta radiation levels from plume or ground contamination. The neighboring county civil defense directors will also be provided with similar dose rate meters.

Specific Highway Patrol units of the Oklahoma Department of Public Safety will be trained in the use of survey meters, radiation protection and protective action response. Survey instruments will be provided to patrol units as the individual situation requires.

Oklahoma is also a member of the Southern Mutual Radiological Assistance Plan (SMRAP) through the Southern States Energy Board. This plan is an agreement between 17 southern states including Oklahoma, Arkansas, Louisiana and Texas where radiological monitoring and personnel resources would be shared between states. State resource lists are maintained by all states whereby specific resources can be requested in the event of an emergency. This system is activated by request between state Governors.

2.4 CONSTRUCTION PERMIT STAGE AGREEMENT LETTERS

Agreement letters have been received from the primary local, county and state agencies who will be involved in emergency preparedness activities for Black Fox Station. These agencies, as discussed under Section 2.2, are the Oklahoma State Department of Health--Radiation Protection Division, Oklahoma Civil Defense, Oklahoma Department of Public Safety, Rogers, Wagoner and Mayes County Sheriffs' Offices and Civil Defense Directors and the Inola Police Department. These letters have been requested by the NRC to demonstrate that no jurisdictional or interagency obstructions are presently recognized for developing the future Oklahoma Radiological Emergency Response Plan. Other local state and county agencies will also be involved in emergency preparedness, but to a lesser degree. Appendix A contains a copy of these agreement letters.

2.4.1 Content of Agreement Letters

Each agreement letter, at a minimum, contains a statement that the agency will provide necessary planning and response activity from their office to assure a workable state plan. This includes coordinating with the other response agencies for jurisdictional continuity. The second requirement of the letter was that each agency understand and agree to a standard emergency action level criteria for future response planning. These standard action levels were referenced to NUREG-0610 "Draft Emergency Action Level Guidelines for Nuclear Power Plants", as discussed in Section 4.1.

2.4.2 Agreement Letter Process

To assure that the State and lc _ officials were completely familiar with the ongoing PSO efforts on emergency planning for BFS, an informational and instructional program was conducted as shown in Figure 3.

Through a series of formal and informal contacts, each agency was notified of the present emergency response planning guidelines, expected future activity and the required content of the agreement letters. Initial discussions with the OSDH-RPD and the OCD began in December, 1979 to inform them of the need for agreement letters and the latest emergency preparedness requirements for nuclear power stations.

On January 15, 1980 all agreement letter participants were formally contacted by letter describing the activities and efforts being conducted for BFS on emergency preparedness. (See January 15, 1980 correspondence in Appendix E.) This was also transmitted to other officials and agencies, who were not directly involved with the agreement letters. They were contacted for information purposes, with an open invitation to be involved in future planning discussions. This invitation was sent to local mayors, county commissioners, city and surrounding county civil defense directors, county health officials and the Governor's office. A list of the local, county and state offices who were invited to participate in this effort is given on Table 1.

After receiving acknowledgment from the OSDH-RPD and the OCD regarding their understanding on the near-term BFS requirements, the remaining agreement letter participants were contacted. A representative from PSO and OCD met with the remaining agreement letter agencies in their offices. The need for the agreement letters was explained including the recent emergency preparedness activities and each office's duties in relation to fixed nuclear power facilities. This provided the groundwork for future contacts to be made formally.

On February 7, 1980 and February 28, 1980 transmittals were sent to the OSDH-RPD and OCD, respectively, requesting their letters of agreement. The agreement letters were received on February 25, 1980 and March 13, 1980 respectively.

Agreement letter requests were subsequently sent to the remaining state, county and local agreement agencies. Each agreement letter participant was requested to attend one of three emergency preparedness presentations which would be conducted by PSO on April 17 and 18, 1980. A letter was also sent to the other potentially interested officials and agencies previously contacted as an invitation to attend the presentations.

The purpose of the three BFS emergency preparedness presentations was to assure that each response office understood the future response activities and responsibilities in which they would be involved and to answer any remaining questions concerning emergency preparedness.

The presentations were given in the county seats of each of the three counties within the plume exposure pathway EPZ. Each presentation was identical and consisted of a slide presentation with copies of the presentation material distributed for reference. Representatives from the OSDH-RPD and the OCD were in attendance at all sessions to answer questions from a state perspective. Representatives from every agreement letter office were present as well as many of the interested participants previously invited. Upon completion of each presentation, questions were answered with regard to all aspects of present and future emergency planning efforts for BFS. A list of the attendees at the presentations is given on Table 2.

The remaining letters of agreement were transmitted to PSO, as shown in Appendix A to this report.

2.4.3 Emergency Medical Aid

Competent medical assistance from neighboring hospitals will need to be established for potential radiation related injuries in the event of an accident at BFS. Adequate professional and facility resources will therefore need to be assured prior to BFS operation and concurrently with the development of the emergency response plan. The primary area that will require special expertise or equipment will be for decontamination and treatment of radiological injuries.

In 1975, two Tulsa area hospitals were contacted with regard to providing potential emergency medical aid. Both St. Francis Hospital and Hillcrest Medical Center have radiological facilities within their hospitals and have shown willingness to further discuss the provision for services that would meet BFS needs. This was discussed by letters dated June 20, 1975 and July 2, 1975 respectively. Due to the subsequent time span from receipt of letters until preparation of this report the letters were updated to reconfirm the hospitals willingness to respond. Both hospitals were contacted through their administration offices for verification of their previous letters. Re-confirmation letters were transmitted to PSO from St. Francis Hospital on September 15, 1980, and from Hillcrest Medical Center on September 24, 1980 which are enclosed in Appendix A.

Other hospitals in the Tulsa area which could be considered for emergency medical treatment include St. John's Hospital, Oklahoma Osteopathic Hospital and City of Faith Hospital which is under construction.

3.0 EMERGENCY RESPONSE FACILITIES

This section will discuss the Black Fox Station control centers, organization, systems and equipment necessary to respond and mitigate the effects of any radiological emergency at the site.

3.1 CONTROL CENTERS

Specific control centers have been identified as being necessary to support an effective emergency response plan which will act to protect the public and provide technical support to safely maintain the station in case of a radiological emergency at Black Fox Station. The Technical Support Center, Emergency Operations Facility and the Operational Support Center are the primary centers recognized as important to the workability of an emergency response plan. These centers will be linked closely and may perform some overlapping functions to assure complete response at all times during an accident. Table 3 shows the functional objectives of each facility that will be used for emergency control. PSO will meet the objectives as described in NUREG-0696 with the exception of the two-minute interface for the control room by the TSC and the distance location for the backup EOF. PSO requests the NRC Staff to grant exceptions to these two items. Justification and bases are provided in Subsections 3.1.1 and 3.1.2. The staffing for these facilities is discussed in section 3.5.2 and communications are discussed in section 3.2.

Figure 4 shows the preliminary location of the Emergency Response Facilities (ERFs) with respect to the plant. Figure 5 shows an expanded view of the major plant buildings.

3.1.1 Technical Support Center (TSC)

General Description

The Technical Support Center (TSC) is an onsite facility located close to the control room that will provide plant management and technical support to the reactor operating personnel located in the control room during emergency conditions. It will have technical data displays and plant records available to assist in the detailed analysis and diagnosis of abnormal plant conditions and any significant release of radioactivity to the environment. The TSC will be the primary onsite communications center for the plant during an emergency. A senior plant official, designated in the BFS Final Emergency Response Plan, will use the resources of the TSC to assist the control room operators by handling the administrative items, technical evaluations, and contact with offsite activities, relieving them of these functions.

TSC Activation and Use

The TSC will be activated for the Alert, Site Area, and General Emergency as described in the BFS Final Emergency Response Plan.

When the TSC is functional, emergency response functions, except direct supervision of reactor operations and manipulation of reactor system controls, will shift to the TSC. Plant administration, technical support functions, and contact with offsite activities to assist the control room operator will be performed in the TSC throughout the course of an accident.

TSC Data Systems Reliability

The data systems of the TSC will be designed and constructed to provide a very high degree of reliability.

The operational unavailability goal of 0.01 is applicable to the TSC data systems when the reactor is above cold shutdown status. The term unavailability is used to express a complete loss of system function. Mathematically, it is expressed as a ratio of time duration when a function is lost to the total duration when the function is required to be available.

TSC Function

The onsite TSC will provide the following functions:

- Provide plant management and technical support to plant operations personnel during emergency conditions.
- Relieve the reactor operators of peripheral duties and communications not directly related to reactor system manipulations.
- Prevent congestion in the control room.
- Perform EOF functions for the Alert, Site Area, and General Emergency classes until the EOF is functional.

The TSC will be the emergency operations work area for designated technical, engineering, and senior plant management personnel; and other PSO designated personnel required to provide the needed technical support; and a small staff of NRC personnel.

The TSC will have facilities to support the plant management and technical personnel and will be the primary onsite communications center for the plant during the emergency. TSC personnel will use the TSC data system to analyze the plant steady-state and dynamic behavior prior to and throughout the course of an accident.

The conceptual layout of the TSC may be found on Figure 6.

TSC Staffing and Training

Upon activation of the TSC, designated personnel will report directly to the TSC and achieve full functional operation within 30 minutes. The TSC staff will consist of sufficient technical, engineering, and senior PSO personnel to provide the needed support to the control room during emergency conditions. A PSO senior plant official will coordinate activities in the TSC and interface with the control room, the OSC, and the EOF.

TSC Size

The TSC will be large enough to provide:

- Approximately 75 square feet per person;
- Space for the TSC data system equipment needed to acquire, process, and display data used in the TSC;
- Sufficient space to perform repair, maintenance and service of equipment, displays and instrumentation;
- Space for data transmission equipment needed to transmit data originating in the TSC to other locations;
- Space for personnel access to functional displays of TSC data;
- Space for access to communications equipment by all TSC personnel who need communications capabilities to perform their functions;
- Space for storage of and/or access to plant records and historical data; and
- A separate room adequate for at least three persons to be used for private NRC consultations.

The TSC working space will be sized for a minimum of 25 persons, including 20 persons designated by PSO and 5 NRC personnel.

TSC Structure

The TSC will be able to withstand reasonably expected adverse conditions during the design life of BFS including adequate capabilities for (1) earthquakes, (2) high winds (other than tornadoes), and (3) floods.

TSC Habitability

The TSC will be radiologically habitable to the same degree as the control room under accident conditions, but the ventilation system will not be safety-related.

The TSC ventilation system will function in a manner comparable to the control room ventilation system and will include high efficiency particulate air (HEPA) and charcoal filters. The TSC ventilation system will not be seismic Category I qualified, redundant, or instrumented in the control room.

To ensure adequate radiological protection of TSC personnel, radiation monitoring equipment will be provided. Protective equipment will also be provided for the staff who must travel between the TSC and the control room under adverse radiological conditions. Should the TSC become uninhabitable, the TSC plant management function will be transferred to the control room.

TSC Communications

The TSC will have reliable voice communications to the control room, the OSC, the EOF, and the NRC. The TSC voice communications facilities will include means for reliable primary and backup communication.

The TSC voice communications equipment will include:

- Hotline telephone (located in the NRC consultation room) on the NRC Emergency Notification System (ENS) to the NRC operations center;
- Telephone (located in the NRC consultation room) on the NRC Health Physics Network (HPN);
- Telephones for management communications with direct access to the control room, the OSC and the EOF;
- Telephones that provide communication to onsite and offsite locations;
- Communications to PSO mobile monitoring teams and to state and local operations centers prior to EOF activation.

The TSC communications system will also include designated telephones (in addition to the ENS and HPN telephones) for use by NRC personnel. PSO will provide two telephone lines for NRC use when the TSC is activated. In addition, PSO will furnish the onsite access facilities and cables to NRC for the ENS and HPN telephones.

<u>TSC Instrumentation, Data System Equipment and Power Supplies</u>

Plant data will be available for display in the TSC. Hard copies of any display can be made by the video copiers or line printer located in the work area.

The TSC electrical equipment load will not degrade the capability or reliability of any safety-related power source. Sufficient alternate or backup power sources will be provided to maintain continuity of TSC functions and to resume display of TSC data if loss of the primary TSC power sources occurs.

TSC Data Systems

The TSC technical data system will receive and display information acquired from the plant as needed to perform the TSC function. The data available for display in the TSC will enable the plant management, engineering, and technical personnel to aid the control room operators in handling emergency conditions.

Data that is available for display in the TSC will be available without interference to the control room during emergency operations. The data selected system variables specified in Regulatory Guide 1.97, Rev. 2, Table 1 will be available for display and printout in the TSC.

The TSC displays will include:

- Plant systems variables,
- In-plant radiological variables,
- Meterological information, and
- Offsite radiological information.

Data trending capability and SPDS formats will be available in the TSC.

TSC Records Availability and Management

The TSC will have access to plant records to aid in a technical analysis and evaluation of emergency conditions. The plant records, operational specifications, and procedures include:

- Plant technical specifications,
- Plant operating procedures,
- Emergency operating procedures,
- Final Safety Analysis Report,

- Plant operating records,
- Plant operati... reactor safety committee records and reports,
- Records needed to perform the functions of the EOF when it is not operational.

And up-to-date, as-built drawings, schematics, and diagrams showing:

- Conditions of plant structures and systems down to the component level,
- In-plant locations of these systems.

The Technical Support Center will be fully discussed in the FSAR.

3.1.2 Emergency Operations Facility (EOF)

General Description

The EOF is a nearsite support facility for the management of PSO's over-all emergency response (including coordination with federal, state and local officials, coordination of radiological and environmental assessments, and determination of recommended public protective actions. The E... ill have appropriate technical data displays and plant records to assist in the diagnosis of plant conditions and to evaluate the potential or actual release of radioactive materials to the environment.

EOF Function

The BFS Emergency Operations Facility will be controlled and operated by PSO and will serve as the location for performing the following functions:

- Management of over-all PSO emergency response,
- Coordination of radiological and environmental assessment,

- Determination of recommended public protective actions, and
- Coordination of emergency response activities with federal, state and local agencies.

The EOF space may be used for other purposes during normal operations. Provisions will be made to assure the emergency functions of the EOF are not degraded by those activities and will ensure all necessary systems meet required availability.

Activation and Use

The EOF will be activated for the Site Area Emergency or a General Emergency as defined in the BFS Final Emergency Response Plan.

EOF Location

The EOF will be located approximately 0.9 miles east of the plant.

A conceptual layout for the EOF is shown on Figure 7.

Location, Structure, and Habitability

The EOF is located within ten (10) miles of the TSC; Therefore, the following habitability criteria will be met:

- The EOF will be well engineered for the design life of BFS in accordance with the Uniform Building code. The EOF will be able to withstand the expected adverse conditions of high winds (other than tornadoes) and floods.
- A radiation reduction factor greater than or equal to five (5) will be provided to those areas of the EOF in which dose assessments, communications, and decision making take place.

- Ventilation protection will be accomplished with HEPA filters (no charcoal) and will function in a manner comparable to the control room and TSC systems.

The nearsite EOF is located within ten (10) miles of the TSC; therefore, a preliminary location for a backup EOF will be provided at the PSO Corporate Offices in Tulsa, approximately twenty-three (23) miles west of the TSC. The additional three (3) miles beyond the twenty (20) mile siting requirement will not impair movement between the nearsite and backup EOF nor will it impede communications with emergency response personnel.

EOF Staffing and Training

The EOF will be staffed to provide the over-all management of PSO offsite resources and the continuous evaluation and coordination of PSO activities during and after an accident. Upon EOF activation, designated personnel will report directly to the EOF to achieve full functional operation within one hour. A PSO senior management official will be in charge of all PSO activities in the EOF. The EOF staff will include personnel to manage PSO onsite and offsite radiological monitoring, to perform radiological evaluations, and to interface with offsite officials. The specific number and type of personnel assigned to the EOF may vary according to the emergency class. The staffing for each emergency class will be fully detailed in the BFS Final Emergency Response Plan. The EOF staff will participate in EOF activities drills, conducted periodically in accordance with the BFS Final Emergency Response Plan. These drills will include operation of all facilities that will be used to perform the EOF functions.

EOF Size

The EOF building complex will be large enough to provide the following:

- Working space for the personnel assigned to the EOF as specified in the BFS Final Emergency Response Plan, including federal, state and local agency personnel. A working space of approximately 75 square feet per person will be used as a basis for size and layout of the EOF. The conceptual EOF layout provided in Figure 7 assumes approximately 25 persons from PSO, 10 persons from state and local agencies, 9 persons from NRC and 1 person from FEMA.
- Space for EOF data system equipment needed to transmit data to other locations.
- Sufficient space to perform repair, maintenance, and service of equipment, displays and instrumentation.
- Space for ready access to communications equipment by all EOF personnel who need communications capabilities to perform their functions.
- Space for ready access to functional displays of EOF data.
- Space for storage of plant records and historical data or space for means to readily acquire and display those records.
- Separate office space to accommodate at least five NRC personnel during periods that the EOF is activated for emergencies.
- A space to brief select groups of approximately 50 persons.
- A secured entrance.
- Sufficient space outside the EOF for parking PSO, federal, state, and local vehicles.

EOF Communications

The EOF will have reliable voice communications facilities to the TSC, the control room, NRC, and state and local emergency operations centers. The normal communication path between the EOF and the control room will be through the TSC. The primary functions of the EOF voice communications facility will be:

- EOF management communications with the designated senior PSO plant official in charge of the TSC,
- Communications to manage PSO emergency response resources,
- Communications to coordinate radiological monitoring,
- Communications to coordinate offsite emergency response activities, and
- Communications to disseminate information and recommended protective actions to responsible government agencies.

The EOF voice communications facilities will include reliable primary and backup means of communication. PSO will provide a means for EOF telephone access to commercial telephone common-carrier services that bypass any local telephone switching facilities that may be susceptible to loss of power during emergencies. PSO will insure that space commercial telephone lines to the plant are available for use by the EOF during emergencies. The EOF voice communications equipment will include:

- Hotline telephone (located in the NRC office space) on the Emergency Notification System (ENS) to the NRC operations center;

- Dedicated telephone (located in the NRC office space) on the NRC Health Physics Network (HPN);
- Telephones for management communications with direct access to the TSC and the control room;
- Telephones reserved for EOF use to provide access to onsite and offsite locations;
- Radio communications to PSO mobile monitoring teams;
- Communications to state and local operations centers; and
- Communications to facilities outside the EOF used to provide supplemental support for EOF evaluations.

The EOF communications system will also include designated telephones (in addition to the ENS and HPN telephones) for use by NRC personnel. PSO will provide at least three telephone lines for NRC use while the EOF is activated. PSO will also furnish the access facilities and cables to the NRC for the ENS and HPN telephones. Facsimile transmission capability between the EOF, the TSC, and the NRC operations center will be provided.

EOF Instrumentation, Data Systems Equipment, and Power Supplies

The EOF will contain equipment for the acquisition, display, and evaluation of radiological, meterological and plant system data necessary to determine protective measures recommended to offsite authorities. This equipment will also be used to evaluate the magnitude and effect of potential or actual radioactive releases and to project offsite doses. Data will be transmitted to the EOF from plant computer systems. The data will be presented in the EOF using equipment such as CRTs and a

printer/plotter. The details of the data system will be provided in the FSAR.

The data system will display the Safety Parameter Display System (SPDS) formats and data needed in the EOF to analyze and exchange information needed on plant conditions with the designated senior PSO plant official in charge of the TSC. The system will perform these functions independently from actions in the control room without degrading or interfering with control room and plant functions. Trend information display capability will be available in the EOF.

The total EOF data system will be designed to achieve and operational unavailability goal of 0.01 during all plant operating conditions above cold shutdown.

The term unavailability is used to express a complete loss of system function. Mathematically, it is expressed as a ratio of time duration when a function is lost to the total duration when the function is required to be available.

The EOF electrical equipment load will not degrade the capability or reliability of any safety related power source. Circuit transients or power supply failures or fluctuations will not cause a loss of any stored data, vital to the EOF functions.

<u>EOF Technical Data and Data Systems</u>

The EOF data set will include radiological, meterological and other environmental data as needed to:

- Assess environmental conditions,

- Coordinate radiological monitoring activities, and
- Recommend implementation of offsite emergency plans.

A sufficient number of data display devices will be provided in the EOF to allow all EOF personnel to perform their assigned tasks. They include:

- Plant systems variables,
- Inplant radiological variables,
- Meteorological information, and
- Offsite radiological information.

As a minimum EOF data set, selected variables specified in Regulatory Guide 1.97, Rev. 2, Table 1, and selected meteorological variables specified in proposed Rev. 1 to Regulatory Guide 1.23 will be available for display in the EOF. Plant system data that is available for display in the TSC will be available in the EOF. The sample frequency will be chosen to be consistent with the use of the data.

Records Availability and Management

The EOF will have access to up-to-date plant records, procedures, and emergency plans needed to exercise over-all management of PSO emergency response resources. The EOF records will include:

- Plant technical specifications,
- Plant operating procedures,
- Emergency operating procedures,
- Final Safety Analysis Report
- Up-to-date records related to PSO, state and local emergency response plans,

- Offsite population distribution data,
- Evacuation plans,
- Environs radiological monitoring records,
- Licensee employee radiation exposure histories,

And up-to-date drawings and schematics showing:

- Conditions of plant structures and systems down to the component level, and
- Inplant locations of these systems.

These records will either be stored and maintained in the EOF (such as a hard copy or microfiche) or will be available via transmittal to the EOF from other records storage locations.

3.1.2 Public Relations Center

The Public Relations Center will be adjacent to the EOF and will function as the central location for disseminating information to the news media and public. This will include capacity for approximately 50 press representatives. In the event of a major accident, a larger nearby existing facility such as local school gymnasiums, or meeting halls will be designated for press briefings of up to several hundred media members.

3.1.3 Onsite Operational Support Center (OSC)

General Description

The Operational Support Center (OSC) is an onsite assembly area separate from the control room and the TSC where PSO operations support personnel will report in an emergency. There will be direct communications between the OSC and the control room and between the OSC and the TSC so that the personnel reporting to the OSC can be assigned to duties in support of emergency operations.

Activation and Use

The OSC will be activated for the Alert, Site Area, and General Emergency classes.

OSC Function

The OSC is an onsite area separate from the control room and the TSC where PSO operations support personnel will assemble in an emergency. The OSC will:

- Provide a location where plant logistic support can be coordinated during an emergency.
- Restrict control room access to those support personnel specifically requested by the Shift Supervisor. When the OSC is activated, it will be supervised by PSO operations management personnel designated in the Black Fox Station Final Emergency Response Plan to perform these functions.

OSC Location

The preliminary location selected for the OSC is the training area large classroom at the north end of the General Services Building on the fourth floor. Figure 8 illustrates the preliminary OSC location. This area provides sufficient space in a central location. Its location does not interfere with access to the control room, the TSC, or the unaffected unit.

OSC Habitability

The OSC's habitability is not comparable to that of the control room; therefore, the Black Fox Station Final Emergency Response Plan will include procedures for evacuation of OSC personnel in the event of a large radioactive release. The BFS Final Emergency Response Plan will include provisions for the performance of the OSC

functions by essential support personnel from other onsite locations.

OSC Communications

The OSC will have direct communication with the control room and with the TSC so that the personnel reporting to the OSC can be assigned duties in support of emergency operations. The OSC communications system will consist of one telephone extension to the control room, one telephone extension to the TSC, and one telephone capable of reaching onsite and offsite locations.

OSC Details

Details concerning the OSC final location, backup assembly area, station access control, staffing requirements, conduct of operations, training, and equipment storage locations will be provided in the BFS Final Emergency Response Plan.

3.1.4 Onsite Emergency Medical Facilities

The Black Fox Station will provide a single first aid center for both radiological and non-radiological injuries. It is expected that most treatment rendered at the onsite medical facilities will be for non-radiological injuries. However, medical personnel will be trained and equipment supplied to cope with radiological contaminated injuries. Radiological first aid will consist mostly of survey and decontamination facilities. Surface contamination of station personnel without injury will normally require only special showers and decontamination agents to remove contamination. This treatment will be supplied by the onsite first aid center; therefore, no offsite treatment is normally necessary. Information from personnel dosimetry will be available for reviewing exposures.

Severe exposure and radiation related accidents with injury will require hospital emergency facilities and professional care as discussed in Section 4.3.5. The main function of the BFS first aid facility for severe radiation related injuries will be to survey and prepare the person for transporting to offsite health care facilities.

Emergency transportation to offsite treatment centers will be supplied by designated vehicle or helicopter. BFS will maintain an emergency transportation vehicle onsite with the capacity to transport injured personnel to the established medical center for offsite treatment. An emergency medical helicopter called "Life Flight" is presently available which is sponsored by the two Tulsa hospitals with which agreement letters exist (Section 2.4.3). The helicopter has capacity for transporting two injured persons and one nurse. The estimated travel time for a round trip transport to BFS is about 30 minutes.

3.2 COMMUNICATIONS SYSTEMS

A reliable communication system between the main facilities at the station, and with the offsite authorities who are responsible for responding to a radiological emergency at the BFS is crucial to the effective conduct of an emergency plan. Both fixed and portable communications equipment, including dedicated and backup systems will be utilized. The following discusses the basic aspects of the systems which are considered effective for use at BFS.

The control room is the initial location for all onsite and offsite emergency response communications. This requires a communication link to all offsite

response authorities and the NRC along with normal inplant communications. Upon activation, the TSC becomes the central communication location for inplant emergency response. The EOF is the BFS facility which will be available to coordinate the onsite/ offsite response for protection of the public in the event of an emergency condition. All EOF communication systems will be available as soon as the facility can be activated by the BFS Emergency Coordinator.

3.2.1 <u>BFS Fixed Communications Systems</u>

Fixed communication systems will be established throughout the station facilities in order to maintain complete contact with station personnel. The Technical Support Center will be the central location for BFS communications and information exchange. Dedicated priority voice communication links will be provided between the TSC, EOF, control room and the designated offsite response networks. Dedicated communication links will be supplied between BFS and the NRC along with separate communication capability for NRC personnel between emergency facilities. Even though the station status through the SPDS will be available by callup display to the EOF, the station condition as determined by the TSC or control room personnel will be verbally transmitted to the EOF for protective action initiation.

The primary fixed communication system for the station will be the in-plant telephone system which will be operated and controlled within BFS. The system will consist of telephone receptacles distributed and interconnected throughout the the plant including the TSC and EOF for immediate connection with other inplant lines.

A two-way public address system will be supplied within the plant to alert and notify personnel which cannot be reached by the primary inplant phone system. This paging system will have multi-channel capability for simultaneous communication as well as paging.

Both of these systems will use normal inplant power systems with emergency back up in case of loss of normal ac power.

3.2.2 BFS Portable Communications Systems

Contact and communications will be maintained with station personnel in the field (i.e., field monitoring teams and security) by the use of hand held or vehicular two-way radios. An effective range of ten miles will be provided by repeaters to assure complete communication capability within the plume exposure EPZ.

3.2.3 BFS/Offsite Fixed Communication Systems

In order to initiate and maintain communication links between the site and the offsite emergency response agencies, a primary and backup communication system will be provided. The basic requirement of these systems is that notification to the predesignated offsite response agencies (see Section 4.2) be immediate and that continued effectual communication can be maintained throughout the duration of the accident. This can be attained through several individual systems, or a combination of systems. The specific systems will be determined during the final design for BFS. The following systems will be investigated for potential use.

The National Warning System (NAWAS) is a proven and reliable communication system which has been recognized as being available to private facilities (such as nuclear

power stations) for emergency notification. The NAWAS system, which has been primarily used by military, public safety and civil defense authorities, has been shown to be an effective communications network for alerting authorities of emergency situations. The NAWAS system presently being utilized by emergency response authorities in Oklahoma would only require approval for a NAWAS drop at the EOF, TSC, and control room. Contacts could be initiated simultaneously to county and state agencies by predetermining selected drops.

The commercial telephone system, as presently supplied by the Oklahoma Communications Telephone System, will be available as a primary means of offsite communications to the response agencies. This system would be reliable during initial contact of offsite agencies; however, during an emergency condition it could become overburdened with extraneous phone calls thereby reducing its effectiveness. This system will primarily function as the routine communication system for everyday usage.

Dedicated tie lines, upon request, will be purchased to establish non-interruptable communications with appropriate offsite response agencies and the NRC.

Microwave communications systems which are being used at BFS during construction and operation could also serve as a useful system for emergency response during operation. This system will provide communications between the PSO corporate headquarters in Tulsa and BFS,but the same system could be used for emergency communications. As a primary system, it would have a backup power supply to protect against loss of availability.

Satellite communications represent a potential method for a secure and relatively reliable communication link. This system utilizes a communications satellite for signal conveyance and satellite earth terminals for receivers and transmitters. It is limited, however, by the earth terminals provided for exchange points.

3.2.4 Offsite Response Authority Communications Systems

The OSDH-RPD, OCD, DPS and the County Sheriff's office and County Civil Defense Directors will have portable radio communication systems which will be used to conduct protective actions in the event of an accident at BFS. A potential system which could be used is the Department of Public Safety vehicle radio system which has 24-hour manned dispatching capability.

Special portable communication equipment is available throughout the Federal Radiological Monitoring and Assessment Plan (FRMAP) using a microwave system for telephone and control communication which is installed on aircraft transporation pads for quick airlift to BFS. This can be supplied upon request in the event of an emergency at BFS.

For emergency medical treatment, communications systems will be capable of being established between the site and the hospitals. Similar communications are also available in the Tulsa area hospitals. Normal microwave telephone communications could also be available for direct communications.

3.3 EARLY WARNING SYSTEM

This section will discuss the requirement of an early warning system to the public within the 10 mile plume exposure pathway EPZ. It is the intent of an early

warning system to have the capability to alert the public within 15 minutes after determination by the offsite authorities that protective action needs to be taken.

The system to be installed at BFS will meet the requirement of 10CFR50, Appendix E. The early warning system consists of the alerting portion and the instructional portion as discussed below.

3.3.1 Alerting System

The alerting system will consist of the actual hardware to be installed within the plume exposure pathway EPZ to notify the public in order to receive protective action instructions. Several systems or a combination of systems have been identified that may be acceptable to comply with this requirement. This includes siren systems, tone alert systems, automatic dialers and public address systems. Each of these systems have inherent capabilities that make them more appealing for specific applications than the other systems.

3.3.1.1 Siren Systems

Siren systems are generally considered throughout the industry as the primary means to fulfill the early warning system criteria. This is especially true in higher populated areas where many residents, businesses and institutions can be alerted through a single siren. The demography within the plume exposure pathway EPZ around BFS, even though fairly thin, would require at least a partial coverage of sirens for several areas (see Section 5.0 for existing demography characteristics).

A preliminary early warning system using USGS topographical maps of the 10-mile area around BFS has been

prepared by a reputable warning system manufacturer (Appendix D). The purpose of this initial warning system layout is to allow PSO the preliminary knowledge of the general siren system coverage that would be required for BFS. The area within the 10-mile radius has terrain variances and a population distribution sufficiently dispersed so that a combination of various-sized sirens will serve to provide general coverage for public alerting. Other methods which provide notification are mentioned in this section. This survey was prepared from USGS topographical maps and does not represent a detailed study that would need to be performed for actual siren placement coverage.

Final placement of sirens for the BFS area will be performed using accepted guidance as FEMA's Publication CPG 117, "Outdoor Warning Systems Guide" (Reference 5).

3.3.1.2 Tone Alert and Other Systems

Radios and receivers which are capable of receiving a prerecorded message from a local transmitter similar to that supplied by the National Oceanic and Atmospheric Administration (NOAA) weather alert system will also be considered. In lightly populated areas where a siren would not be the most cost effective method, separate receivers can be supplied and maintained for individual usage.

The other types of emergency alert systems which are available include automatic telephone dialers and loudspeakers; however, these systems will be primarily considered for special applications.

3.3.2 Instructional System

Upon alerting the public that an emergency situation exists at Black Fox Station, instructions as to the actions they need to take must be forthcoming. To prevent potential overreaction by the public, the instructional portion of the total system must be fully understood by the public and must be immediately available for public access.

The instructional system will consist of (1) pre-emergency information supplied to educate the public which resides within the plume exposure pathway EPZ and any workers or transients that can be readily identified and (2) post-accident availability of preprepared and live instructional messages to notify the public of specific actions to be taken.

3.3.2.1 Pre-Emergency Information

During the FSAR development of the emergency response plan for BFS and prior to operation, PSO will develop and distribute educational information to the public within the plume exposure pathway EPZ concerning basic aspects of the station and actions to be taken in the event of an emergency at BFS.

Included in this educational information will be simplified station design and health effects literature, description of the early warning system, a discussion of the actions to be taken after being alerted, radio and television stations where instructional information can be obtained, types and effectiveness of various protective actions and evacuation routes and sectors if an evacuation is considered necessary.

Public meetings, periodic redistribution of information, and effectiveness surveys will be performed to assure public awareness of established emergency procedures for the public. These efforts will be conducted with the approval and recognition of the responsible state emergency preparedness agencies.

3.3.2.2. Post-Accident Information Availability

Once the public is alerted by the early warning system, protective action instructions must be available for public advisory. The most effective means to accomplish this is to have available prerecorded broadcast messages for dissemination through the media. Prerecorded messages would consist of (1) notification of an emergency; actions to be taken by the public or (2) a standby notice followed by live broadcasts.

The Emergency Broadcast System (EBS) has been established to provide an expeditious method for communication with the public in the event of an emergency of any type including an emergency at a nuclear facility. The EBS is provided through voluntary participation by designated broadcast stations as a public service. Verified emergency messages will be transmitted by request of authorized state officials or other designated individuals as pre-established.

Upon activation of the Emergency Broadcast System normal programming will cease. The designated key EBS station will carry the broadcast message while the non-EBS stations will only carry periodic stand-by emergency notification messages. The public will be notified through appropriate messages of actions to be taken. EBS messages pertaining to BFS will be included in the procedures of the Oklahoma EBS Operational Plans.

The Key EBS station that will be transmitting the initial EBS message in the BFS area will be KELI located in Tulsa (approximately 20 miles west). This station transmits at a frequency of 1430 KHz with 5kw output. This station will be responsible for transmitting appropriate EBS messages as supplied by designated authorities and will then act as the program source for the surrounding counties in the "program area." The KELI program area includes Wagoner County. Rogers and Mayes counties fall under a different program area, however, they receive their source message from KRMG in Tulsa (740 kHz, 50 kw) who is the backup Key EBS station to KELI.

The county EBS stations in the BFS area are KWPR (1770 KHz, [illegible] kw), for Rogers County, KOLS (1570 KHz, 1 kw), in Mayes County and KJEM (1530 KHz, .25 kw) in Wagoner County.

3.3.2.3 Special Public Notification

Within the plume exposure pathway EPZ some special conditions may exist where a standard "alerting system" or "instructional system" will not be applicable. Within this 10 mile radius there does not presently exist any hospitals or nursing homes, where special arrangements must be made. This area does, however, have campground areas and some populations which will require special attention in the development of the emergency response plan.

The Corps of Engineers maintains recreational areas along the Verdigris River for camping, fishing and hiking. Rocky Point is such an area which borders the BFS site to the north. During an emergency that would require activation of the early warning system, the visitors to such area could be alerted adequately by a siren

system, but the instructional portion could not be effectively provided through the public broadcast networks due to the potential lack of radio systems. Therefore, posted instructions, bullhorns, a public address system or similar means of instructions would be provided.

Certain Mennonite populations are present approximately five to six miles northeast of the BFS site. These households are generally separated from each other due to larger acreages owned by the families. Many of these families typically have rejected electric service to their homes and therefore do not have radios or televisions to receive instructional broadcasts after an alert. Similarly, many do not own automobiles or on-road motorized transportation for evacuation. Their primary means of travel is by buggy or by farm tractors.

For these cases, special provisions will be arranged for protective action instructions and also for means of evacuation. The instructional provision can be similar to that discussed for the recreational areas above. The means for evacuation will likely include a procedural requirement in the overall emergency plan to supply alternate transportation to these families. Arrangements with neighboring residents could be made to provide transportation to these people as will be individually identified. The evacuation time estimates (Appendix C) allow for adequate preparation time prior to evacuation to encompass the extra time necessary to handle these special conditions. Evacuation time estimates for the FSAR submittal stage will include these conditions due to the added protective action steps involved.

3.4 DOSE AND ACCIDENT ASSESSMENT EQUIPMENT

In order to determine what protective actions should be taken in the event of an emergency at BFS, it is necessary to have adequate instrumentation to evaluate station conditions and the radiological considerations for personnel and public protection. Providing protective actions to the public and plant personnel requires both dose rate measurement instrumentation and accident assessment instrumentation. The station status instrumentation will exist in the control room and the Technical Support Center to monitor various parameters for accident assessment. Actual dose rate measurements for areas in the station or for releases from the station are important for integrating with existing environmental/meteorological conditions at the nearsite EOF to estimate potential offsite consequences. In addition, even though no direct release of radiation may have occurred from the station, accident assessment instrumentation can be used to determine the potential for offsite consequences.

The control room, Technical Support Center, and Emergency Operations Facility will all perform various emergency response functions and will require proper dose and accident assessment capability. The specific instrumentation to be used for this function will be selected from the requirements of Regulatory Guide 1.97 for final station design.

3.4.1 Accident Assessment

The control room and the Technical Support Center will be the primary locations for readout of the station parameters to determine accident assessment. The TSC displays and indicators will be isolated from the control room instrumentation. The purpose of this instrumentation is to provide information to the operator for safe

shutdown, determination of whether the engineered safety features are properly functioning, determine cause and response actions for degraded systems, and for the purpose of initating actions to protect the public.

The BFS control room will be based on the General Electric BWR/6 Nuclenet control complex. This system uses multiple color video CRTs for station analysis and monitoring. Station system status displays may be obtained on the control panel CRT's or can be available by separate isolated recording and indication.

The BFS TSC may have similar callup display characteristics but will not have any control capability. Included in the TSC system will be the ability to display system trends and to record and indicate station operating conditions prior to the accident. The TSC will also be able to callup displays and information calculated within the EOF. Pertinent portions of Regulatory Guide 1.97 (Reference 6) will be used as the basis for these instrumentation provisions.

3.4.2 Dose Assessment

Inplant dose assessment will be based on radiological monitoring instrumentation supplied throughout the station. The process radiation monitoring system will be used to determine source levels and potential effluent releases. This instrumentation monitors the radiation levels in selected liquid and gaseous process streams. When the radiation level exceeds predetermined setpoints, alarm and trip signals initiate annunciation in the control room and automatically close isolation valves to control the release of radioactivity within the plant or to the environment. Process radiation monitoring data will be input into the dose projection models

available within the EOF for predicting offsite exposures and doses.

In a similar manner, area radiation monitoring data will also be available in the TSC and EOF. Monitors will be located in various locations throughout the station to monitor gross gamma/beta radiation levels. Area radiation monitoring information from station structures such as the auxiliary building, radwaste building, and containment, along with the station ventilation and exhaust systems will be available in the TSC and EOF.

3.4.3 Meteorological Monitoring

Meteorological data will be supplied from an onsite meteorological tower with instrumentation at 10, 53 and 100 meter levels. The measurement program will consist of wind direction, wind speed and temperature sensors at all three levels; relative humidity at 10 meters; and precipitation and barometric pressure at ground level. This system will meet the criteria provided by Regulatory Guide 1.23 (Reference 7) and NUREG-75/087 (Reference 8).

In order to determine diffusion and dispersion from an accidental release of radioactive material to the atmosphere, real time data from the meteorological instruments will be input into a station computer for storage and for usage in calculational analysis with indication in the control room, Technical Support Center and the Emergency Operations Facility. Meteorological information received by the additional instrumentation location on the meteorological tower will provide backup data in the event of temporary loss of the other instrumentation.

Computer models will be developed to simulate atmospheric effluent transport and diffusion due to release of radioactivity. Input into the models will include site area topographical features, onsite real time meteorology, stability classes, and source term description. As defined in NUREG-0654, this system will follow a Class A model to provide basic transport and diffusion predictions. The BFS topography is primarily gently rolling hills; therefore, a simple two dimensional gaussian model should be sufficient. Arrangements will be made with the DOE Atmospheric Release Advisory Capability (ARAC) for use of the three dimensional complex transport and diffusion models for determining long-term estimates. This system can be made available within hours and will serve as a reliable dose assessment program. Such a system will meet the requirements of the Class B model described by NUREG-0654.

3.4.4 Environmental Monitoring

BFS will have a complete environmental monitoring program of both fixed and portable environmental monitors. These environmental monitoring resources will be used to develop baseline data during normal operations to measure dose levels in the field and to confirm modeling estimates.

The normal operational field monitoring system is discussed in Section 6.2.1 of the BFS Environmental Report. This same monitoring system, which includes TLD field monitors and air, water and foodchain sampling, will be used during and after an emergency condition at BFS. This system will provide a basis for long term protective actions and for computer modeling verification.

In addition to the above, PSO will provide portable instruments capable of measuring gamma radiation exposure rates to approximately 50 R/h and air samplers which can discriminate between noble gases, radiohalogens and particulates, and can be evaluated with the gamma instrument in situ. These instrument sets would consist of the following:

a. Low-range gamma survey instruments (range: approximently 0.1 to 50 mR/h).
b. High-range gamma survey instruments (range: approximately 0.05 to 50 R/hr).
c. High-volume airborne radioiodine and particulate sampler.

These instruments will be used to verify plume travel distance, plume diffusion, plume direction and, if possible, plume deposition. The data from these instruments will be radioed to the EOF.

3.4.5 Safety Parameter Display System

The safety parameter display system (SPDS) will be designed to function strictly as an alerting display panel which will assist the BFS control room personnel in evaluating the station safety status. The SPDS will be designed to continuously operate during both normal and abnormal station conditions and will be capable of providing magnitude and parameter trending.

The SPDS, to be located in the BFS control room, will have display visibility to the supervisory and control personnel. Additional callup SPDS displays will also be located in the TSC and EOF.

The data set of the SPDS will consist of those station parameters considered necessary to determine the station status in the event of an accident. A basis for consideration of the data set will be Regulatory Guide 1.97. All data shall be capable of validation, as practical, to insure accurate status of plant condition.

3.4.6 Nuclear Data Link

The Nuclear Data Link (NDL) is being considered by the NRC to provide a data transmission system for sending a specified set of variables from nuclear facilities to the NRC Operations Center in Bethesda, Maryland. The purpose of this system is to provide NRC management personnel timely reliable and accurate station, meteorological, and radiological data for the BFS. The intent of the NDL will be to allow NRC independent review of station status and operator action in order for the NRC to reliably inform offsite state, local and Federal officials and the public of aspects of the incident.

In lieu of a NDL, PSO believes that a dedicated telephone line in connection with a high speed telecopy will serve for data transmission. The voice communications system provided from BFS to the NRC Operations Center will also function for supplemental and backup information exchanges.

3.5 BFS EMERGENCY ORGANIZATION

The emergency organization for BFS will be drawn primarily from personnel assigned to the station during normal operation. Job functions of onsite personnel during an emergency will be expanded and off shift personnel will be utilized. Station personnel will be trained to perform emergency functions outside of their daily routine. The BFS station organization is discussed

under PSAR Section 13.1 and will therefore, only be addressed here as it applies to emergency response activities.

3.5.1 Emergency Personnel

The following BFS facility organization will have direct or indirect responsibilities in the event of an emergency at BFS (See Figure 9).

3.5.1.1 Station Manager

The Station Manager has responsibility and authority for all phases of station operation at the BFS. He will report to the Vice President, Power Generation in the PSO corporate office during normal operation but will report to the Recovery Manager during site and general emergencies. He is directly responsible for the safe, orderly, and efficient operation of the station including administration of the BFS Emergency Response Plan. He serves as the station's liaison to the NRC for all communications concerning station operation. He, or a designated alternate, will assume command of the TSC during an accident.

3.5.1.2 Shift Technical Advisor

The Shift Technical Advisor reports to the Shift Supervisor during normal operation and to the Station Manager after the emergency plan is activated. His primary responsibilities are to provide on-shift advice and assistance to the shift supervisor in the event of a transient or an accident and to provide evaluation of operation experience. The Shift Technical Advisor may perform additional functions during normal operations but will be required to perform these obligations during an emergency.

3.5.1.3 Station Superintendent

The Station Superintendent reports directly to the Station Manager and in an emergency would be an alternate to the Station Manager.

3.5.1.4 Operations Supervisor

The Operations Supervisor supervises the activities of the Shift Supervisors and will be responsible to the Station Superintendent for coordinating the activities of the operating shift during normal operation. Following activation of the emergency plan, he or an alternate would be in charge of the control room and support the Shift Supervisor.

3.5.1.5 Shift Supervisors

The Shift Supervisors report to the Operations Supervisor and will have direct supervision over station operations. Each unit will have a Shift Supervisor assigned to duty at all times. One "onshift" Shift Supervisor will be designated "in charge" of the entire station during normal operation. He will have authority over all direct unit related activities including authority to render the plant in a safe condition when continued operation may jeopardize the station or the health and safety of the public. During an accident he will take charge of the control room until relieved by the Operations Supervisor.

3.5.1.6 Technical Supervisor

The Station Technical Supervisor will be responsible for supervising the facility's Technical Support Staff consisting of reactor engineering, station engineering, instrumentation and control, and quality control. He will coordinate the technical support staff activities with the other facility operating sections. He will

assure that the necessary engineering support to efficiently and safely operate and maintain the station is provided. Personnel under the responsibility of the Technical Supervisor will man the TSC during an accident.

3.5.1.7 Emergency Coordinator

The Emergency Coordinator will be responsible for all emergency response planning onsite. He will maintain and revise emergency procedures, be responsible for the EOF, be the primary coordinator between the facility and offsite agencies, dispatch radiological monitoring teams and be responsible for conducting drills and exercises. The Emergency Coordinator reports to the Station Manager during normal operation or minor emergencies and to the Recovery Manager in the event of an accident where the recovery operations are activated. The Emergency Coordinator will coordinate all activities associated with offsite emergency response. Other key BFS managers or supervisors will serve as alternates.

3.5.1.8 Recovery Manager

The position of Recovery Manager is not an operational position in the BFS organization. This position will be manned only during site and general emergencies. He will be a senior ranking member of the corporate office who has the technical and managerial ability to direct plant recovery. When emergency conditions are in effect, he will be the senior ranking person in charge of BFS.

3.5.1.9 Public Relations Director

The Public Relations Director will be a corporate employee who reports directly to the Recovery Manager as required by the situation. He will be responsible for coordinating onsite news media activity, distributing

news releases and will be the Company spokesman for formal press conferences. He, like the Recovery Manager, will not have an operational position at the BFS site but will be called upon during an emergency only.

3.5.1.10 Radiological Monitoring Teams

The radiological monitoring teams will be made up of two or three men using station health physicists, plant operators, engineers or technicians. The members of the team will report to the Radiation Safety and Chemistry Supervisor or his designee for inplant emergencies and will receive direction from the Emergency Coordinator for offsite monitoring.

3.5.2 Emergency Coordination

The coordination of available onsite personnel and off duty shift personnel during an emergency is of extreme importance to protect the health and safety of the public and station personnel. Since emergency personnel cannot be maintained onsite strictly for the unlikely event of an accident, station manpower must be assigned to both routine and emergency duties. The following will explain those routine positions and the resulting emergency coordination.

At any given time during the operation of BFS, the personnel who are stationed at or readily available to the control room for emergency operations will be a minimum of the Shift Supervisor, Reactor Operator, two Assistant Reactor Operators, and the Shift Technical Advisor. As the senior responsible person present, the Shift Supervisor would be the person who would perform initial emergency response activities prior to other staff members being available.

Initial response activities by the Shift Supervisor will be to evaluate station condition, notify other on-duty and off-duty personnel of the emergency condition, and to notify offsite local, county, and state response agencies for standby or immediate action and to notify the NRC.

3.5.2.1 Facility Activation

The TSC will be the first emergency support center to be activated in the event of an accident with subsequent priority given to the EOF. The amount of time to activate these centers depends on the available onshift personnel and the emergency action level determined. The availability of manpower varies substantially between shifts which will effect the method of initially responding to an accident. These response actions are discussed in Section 4.2.

To better assure facility manning availability, specific plant personnel will be trained to manage the TSC and/or EOF. The primary person to supervise the TSC will be the Station Manager and likewise the EOF will be managed by the Emergency Coordinator until the Recovery Manager assumes that responsibility. Additional plant personnel will be trained to activate and operate either facility, including the Station Superintendent, Operations Supervisor, Technical Supervisor, Shift Supervisors, and Maintenance Supervisor.

This provides a pool of personnel which can be selected for initial facility manning and for shift manning should the accident be extended. If the primary or assigned first alternates to man each facility are unavailable within a reasonable amount of time, other personnel can be activated from the pool to provide the

initial manning of either the TSC or EOF. Up-to-date call lists of all trained facility manpower will be kept at the control room, TSC and EOF.

If manpower resources are immediately available within the station, the on-shift supervisor will notify through inplant communications that these individuals' assistance is required. In the event that responsible personnel are not immediately available, off-duty resources must be notified. Under the direction of the Shift Supervisor these persons will be alerted for activation via the call list. Residential location will be recognized for travel time in order that the facilities can be manned within approximately 30 to 60 minutes from notification. The available individuals will be directly assigned to the designated emergency center.

3.5.2.2 Activation of BFS Radiological Monitoring Teams

At the same time the activation of the TSC and EOF commences, BFS Radiological Monitoring Teams will need to be activated from available on-duty and off-duty personnel.

During the emergency response planning stage for operation, a methodology will be developed to assemble monitoring teams for onsite and offsite monitoring. Some specialized teams may require predetermined team members with a specific level of expertise required to perform the response function.

The onsite radiological monitoring teams will generally require a higher level of expertise for such actions as health protection and decontamination. The teams will initially be led by the on-duty Health Physists and will have specific functions to be performed. Additional

teams can be assembled from on-duty or off-duty personnel.

The offsite monitoring teams will be made up of other available station personnel who have been trained in offsite monitoring. These teams will be made up of qualified station and/or corporate personnel. These teams will receive their assignments and kits at the EOF as determined by the monitoring needs at that time.

4.0 PROTECTIVE ACTIONS

If an accident should occur at BFS resulting in an uncontrolled release of radiation within the station or into the environment, actions must be taken to best assure that its consequences can be mitigated. These protective strategies to limit or mitigate the radiation exposure and, therefore, the consequences of such exposure to the workers and general public are of prime concern to PSO and the offsite response agencies involved. Preplanned mitigative and surveillance resources, implementation procedures, preestablished protective actions and exercises will be recognized and secured prior to operation of BFS.

The first step neccessary to protect the public is to recognize that an accident has occurred within the station and to determine its actual or potential seriousness. Upon recognition of the accident, measures must be taken to classify it and determine what steps should be taken to protect the public health. This can be best accomplished by use of preestablished standard action levels. Each action level will be based on a certain potential health effect as identified by the station condition or release whereby an expected protective action can be applied.

Protective actions include one or a combination of alternatives such as evacuation, sheltering, thyroid prophylaxis, removal of contaminated foodstuffs and access control. No predetermined single or combination of protective actions can be considered the only ultimate action to be taken for a given action level, but effective response will depend on a well planned but flexible program considering all identified factors.

The emergency action levels, notification scenarios, and protective action scenarios which will be considered are discussed in the following text.

4.1 EMERGENCY ACTION LEVELS

Emergency Action Levels (EAL) are a system of classification of unusual or emergency conditions which cover the spectrum of possible emergency conditions into exclusive groupings. The emergency action levels to be used by BFS are described in NUREG-0610, "Draft Emergency Action Level Guidelines for Nuclear Power Plants." (Reference 2) This document identifies four separate action levels each with a distinct categorization of events and release potentials which are:

- Notification of Unusual Event
- Alert
- Site Emergency
- General Emergency

The potential health hazard to the public included by the levels range from no health hazard to potential life threatening doses. To better explain each action level and how it will interact with expected protective actions, a more extensive breakdown is necessary.

4.1.1 Notification of Unusual Event

This is the least critical of the four Emergency Action Levels. It includes those situations which, unless complicated by other factors, pose no harm to the public, but for which it is prudent to contact state and Federal officials to provide them with current information on unusual events which are occurring or have occurred at the station. Typically, these situations are brought under control and terminated in less time than it takes to activate an emergency response organization.

The purpose of offsite notification is to assure that the first step in any response later found to be necessary has been carried out, provide current information on unusual events, and provide a periodic scheduled test of the offsite communication link. There is little or no potential for release of radiation under this event.

It will be the responsibility of BFS to notify the state of such an event and for them to standby for verbal closeout. The emergency control centers will not be activated for this action level.

4.1.2 Alert

The alert emergency action level includes those situations for which it is necessary to notify station, local, state and federal officials in order to assure that emergency personnel are available to respond should the situation become more serious. These situations, unless upgraded to a more severe Emergency Action Level, pose no harm to the public.

The purpose of an offsite alert is to assure that emergency personnel are readily available to respond if

the situation becomes more serious or to perform confirmatory radiation monitoring, if required. The alert EAL also provides offsite authorities with current status information, and can serve as possible unscheduled tests of emergency control center activation. Only limited releases are expected to occur for the alert class.

Under this condition, BFS will notify the offsite response agencies of an alert, and depending on the accident severity may activate the TSC and the EOF and provide periodic station status, and dose measurements until closeout. If activated, the offsite agencies will man the nearsite EOF and provide confirmatory offsite radiation monitoring and will be prepared to recommend protective actions to the public.

4.1.3 Site Emergency

This emergency action level includes those situations for which it is necessary to mobilize plant, local, state and federal officials so emergency control centers can be manned, and personnel required for evacuation of nearsite areas are made available should the situation become more serious. Situations classified under the Site Emergency Action Level should also be those for which it may be necessary to provide early warning to the population within the Emergency Planning Zone so they may be in a state of readiness should the situation become more serious.

Actions to be taken for the site emergency consist of manning control centers, dispatching monitoring teams, verifying that personnel required for evacuation of nearsite areas are at their duty stations, providing current information for and consultation with offsite

authorities, informing the public, and requesting assistance from federal response agencies such as Interagency Radiological Assistance Program.

This event has the possibility of affecting the public health and would therefore require PSO to quickly notify offsite agencies of a site emergency. If the situation provides an imminent hazard to the public, BFS will recommend activation of the early warning system to notify the public. All resources will be activated, including the TSC, EOF, and radiation monitoring teams. Dose estimates will be performed from real time meteorology and releases. Press briefings and management personnel, along with off-shift personnel, will be called to duty. The recovery organization will be developed to begin station recovery operations.

The offsite response agencies will man the EOF and assess the situation for taking adequate protective actions. Additional offsite response personnel such as the National Guard may be detailed to perform non-radiological emergency activities. Milk, vegetables and soil samples may be taken and monitored by offsite personnel for protective actions recommended. Out-of-state federal resources may be activated such as IRAP, who will perform dose analysis, and ARAC who will perform complex diffusion and transport estimates.

All onsite and offsite assessment and protective actions will be escalated or reduced as the situation requires until closeout of the emergency.

4.1.4 General Emergency

This is the most severe of the four Emergency Action Levels. This Emergency Action Level includes those

situations for which it is necessary to notify station, local, state and Federal officials so they may take predetermined protective actions, such as sheltering or evacuation of the public, in order to minimize the potential for radiological exposure to the public. For these situations it is also prudent to provide early warning to the population within the Emergency Planning Zone so they may be ready to take protective action.

The purpose of the general emergency is to initiate immediate protective actions for the public, provide continuous assessment of information from the licensee and offsite measurements, initiate additional measures as indicated by event releases or potential releases, and provide current information for and consultation with offsite authorities and the public.

Response and protective actions by both BFS and the offsite agencies for a general emergency will be the same as that for a site emergency, but to a greater escalated extent. Additional manpower will be activated and more drastic protective actions will be implemented.

4.2 NOTIFICATION SCENARIOS

This section will discuss the initial notification actions to be taken by BFS to alert the local, county and state emergency response authorities of an accident condition. The notification format will vary with the urgency of the emergency as established by the action levels discussed in Section 4.1. The following notification processes will address the protective actions that will be recommended by BFS and be implemented by the offsite authorities.

The Oklahoma Civil Defense, in their agreement letter of March 13, 1980 has requested that a means be included to automatically alert a 24 hour manned location of any emergencies that fall under the emergency action levels. This would likely consist of an alerting device displayed in a county sheriff's dispatch center or in the OCD Emergency Operations Center which would be initiated by a station condition(s). Notification procedures would be written to require onsite and offsite contact within a set time from alarm actuation. As discussed in Section 3.2, the offsite notification may be by local telephone, NAWAS system or by dedicated ties. This offsite alarm system would be designed to cover as many EAL classifications as possible using the minimum number of station systems.

4.2.1 Notification of Unusual Event

The notification process under this EAL is strictly a notification of an unusual event. Due to the common frequency of this condition and extreme unlikelihood of affecting the public, nothing more than a communication check with the offsite response agencies is necessary with a closeout.

Upon recognition of an event which falls under the notification of unusual event classifications, the BFS on duty supervisor will either place or direct that a call be placed to the location of the automatically initiated offsite alarm or the OSDH-RPD as predetermined. The contact would be logged, and contacts and reports with the other designated response agencies made. A standby or closeout will then be communicated.

Plant notification will consist of notifying personnel responsible for station operations of a condition that is abnormal operation and to take any response action required.

4.2.2 Alert Classification Notification

The alert classification may involve some offsite and onsite exposures to the public and station personnel and will require a somewhat more urgent conduct of notification.

Upon determining an alert condition at BFS, the on-duty shift supervisor as above will either direct or place a call to the initiation location for the offsite alarm or the OSDH-RPD to notify them of the alert condition. BFS will transmit any information concerning the station condition and radiation releases as determined by the station. Additional offsite communication will be made as determined by the established procedures or if adequate contact had not been previously made. Under this condition, the EOF will be activated, if required, and offsite authorities be dispatched to the center. The remaining offsite response agencies will be contacted by the agencies first alerted by BFS. If the control centers are activated, further communications between BFS and offsite agencies will either be through the EOF or the TSC, whereby information on station conditions, offsite releases and protective action recommendations will be updated regularly.

At basically the same time, the BFS shift supervisor or the station manager will alert the station personnel to take any necessary protective actions. Inplant alarms will be the primary warning to station personnel with confirmation from the control room.

4.2.3 Site and General Emergency Classification Notification

Both the site and general emergency classifications incur inplant and offsite conditions that can affect the public health due to potentially high radiation levels.

Even though these conditions differ in the level of health effects that might be expected, each will have about the same urgency of notification to offsite authorities.

Due to the potential severity of a site and general emergency, prompt notification is of extreme importance. Once it is learned that one of these two conditions exist, the BFS onshift supervisor will be responsible for notifying the response authority manning the offsite alarm (See Section 4.2) to confirm an accident condition exists. Under all conditions of a general emergency and under most conditions of a site emergency, the public early warning system will require activation. The on-duty shift supervisor will briefly describe the conditions of the station and recommend activation of the early warning system on that basis along with the immediately needed emergency protective actions. The prerecorded broadcast messages will be selected depending on the protective actions to be taken by the public.

The OSDH-RPD will be immediately notified of the condition and requested to respond. They will in turn notify the Oklahoma Civil Defense for support and proceed to BFS for conducting response activities at the EOF and for access to dose assessment capability. The EOF will keep all offsite authorities updated on station conditions and radiation releases. Other offsite agencies involved with protective actions and dose analyses within the ingestion exposure pathway EPZ will be called into action.

At the station, all available personnel resources will be put into action to assure personnel protection from contamination in the station. Station communication

will be used to notify personnel of all hazardous areas and assure that access control and personnel accountability are maintained.

4.3 PROTECTIVE ACTIONS

The primary purpose of the BFS and state emergency plans are to best assure that employees and the public are protected against any radiological hazards. Therefore, protective actions which are the heart of the plan, will be established for the area of concern. In the event of an accident at BFS, these protective actions will be primarily planned for within a ten mile radius from the site with secondary protective actions out to 50 miles. The basis for a protective action is to avoid or reduce the hazard to the public health when the benefits derived from such action are sufficient to offset any undesirable features of the protective action itself. There are no hard-set rules for acceptable dose to the public in an emergency whereby protective actions should or should not be taken and no dollar figure applied for public protection.

The following discussions are made to represent the types and levels of protective actions that will be included in the future emergency plans to be prepared by BFS and the State of Oklahoma.

The EPA "Manual of Protective Action Guides and Protective Actions for Nuclear Incidents" (Reference 9) provides guidance on types of protective action options and their initiation during an accident at a nuclear power facility. The basis for the protective actions at BFS are derived from this document along with other published documents. Types of protective action options and the bases for initiation will be the same for all

nuclear facilities, however, the actual initiation and implementation of protective actions will be site and state specific.

4.3.1 Protective Action Options

Many protective action options or combinations of options exist that can be taken during an accident by the offsite response authorities. Included in these options are evacuation, sheltering, population relocation, radioiodine prophylaxis, food and water control and personal protection. Each protective action provides unique levels of protection, however, no one action can be applied to a specific release condition at all times.

Table 4 provides the typical responsibilities of the offsite authorities and BFS for carrying out protective actions in the event of an emergency at BFS.

4.3.1.1 Evacuation

An orderly evacuation should consist of a well planned program to remove the public over specified road systems by personal or public transportation to a distance outside the affected area.

The effectiveness of evacuation in limiting radiation dose is a function of the time required to evacuate. If a radioactive cloud is present, the dose will increase with the time of exposure; if the evacuation is completed before the cloud arrives, then evacuation is obviously 100 percent effective. Anything that delays an evacuation is therefore a constraint, and such constraints will be a function of the site conditions and planning.

While evacuation may seem to be the protective action of choice following a nuclear incident at a fixed

nuclear facility, constraints associated with a specific site could render the evacuation ineffective or undesirable such that other optional protective actions should be considered. The planner must take into consideration all local constraints to determine whether or not evacuation is a viable protective action for the given situation. These considerations will be identified by performing evacuation time estimates for various site specific constraints. The BFS evacuation time estimates are discussed in section 5.0 and in Appendix C.

If the affected population is not completely removed prior to release and passage of a radioactive plume, then some exposure will result to the public and therefore evacuation will not be completely effective. Effectiveness estimates of evacuation are expressed in terms of the dose reduction factor (DRF). This value for evacuation is the ratio of the dosages received during evacuation to that incurred in the open assuming no evacuation.

4.3.1.2 Sheltering

Sheltering is the action of taking advantage of normally inhabited structures to reduce exposure from external radiation sources by utilizing the inherent radiation shielding from the structure itself.

The local contraints on seeking shelter as a protective action, such as time to take action, cost of taking the action, and societal considerations, intuitively tend to support taking such action since the cost in each case is relatively small. However, if one compares the effect of seeking shelter with some other action such as evacuation on the basis of dose savings, it may be concluded that evacuation will save a far greater dose than seeking shelter. Generally, shelter provided by dwellings with

windows and doors closed and ventilation turned off would provide good protection from inhalation of gases and vapors for a short period, but would be generally ineffective after about two hours due to natural ventilation of the shelter.

Not every constraint can be evaluated using established scientific techniques; a certain amount of subjective judgement must be made on the part of BFS and the response authorities. It is important that the decision makers be aware of the constraints associated with each action and that these contraints be balanced on whatever basis possible in order to arrive at an effective decision.

In a similar manner to the evacuation dose reduction factor, DRF's can be calculated for shelters. This value is given by the ratio of the dosage received during shelter protection to that which would be received in the open.

The sheltering dose reduction factors are primarily dependent on the shielding quality of different types of structures. Shielding factors for various structures are available for both airborne and surface deposited radionuclides (Reference 12).

4.3.1.3 Population Relocation

Population relocation is an action taken sometime after passage of the cloud of radioactive material to limit radiation exposure from ground contamination (Reference 12). Before relocation, the exposure that individuals receive from airborne and surface deposited radionuclides depends on the radiation shielding available from the particular structure they are inhabiting.

The time required to implement a sheltering/ population relocation strategy significantly influences the effectiveness of each of the response strategies discussed. Ideally, shelter access by the public would be accomplished prior to the arrival of the cloud of radioactive material. If this cannot be accomplished, the effectiveness (dose reduction) diminishes almost linearly with increasing outside exposure time. Radiation exposure from radionuclides deposited on the ground and other surfaces continues long after cloud passage and, in many instances, in a relatively short time results in a greater dose than the dose from the other exposure pathways. Therefore, the time interval between the cloud passage and the public relocation is very important and should be minimized.

The dose reduction factors for population relocation can be determined by combining the dose reduction factors for sheltering plus evacuation.

4.3.1.4 Thyroid Prophylaxis

The uptake of inhaled or ingested radioiodine by the thyroid gland may be reduced by the ingestion of stable iodine. Potassium iodide as a prophylaxis (blocking agent) is only effective for exposures from radioiodine, and is administered before or shortly after the start of intake of radioiodine. Potassium iodide has been approved in quantities of 130 mg. for adults and 65 mg. for infants to be taken for 10 days to assure complete stable iodine uptake.

For public usage it is difficult to distribute after an accident in the short amount of time required to be completely effective. Additionally, potassium iodide cannot be maintained for long periods of time due to the

relatively short shelf life allowed for potassium iodide. Thyroid blocking agents do not block whole body exposures from other radionuclides and could give the public a false sense of radiation protection. Therefore, thyroid prophylaxis is considered more useful for BFS personnel and offsite radiation response personnel.

4.3.1.5 Food, Water and Milk Control

Control of contaminated or potentially contaminated foodstuffs such as water and milk is applied to both the 10 mile and 50 mile emergency planning zones. The effort involved in taking protection actions on contaminated consumables is proportional to the amount of contamination observed.

Foodstuffs exposed to airborne radioactive materials may become contaminated by deposition of radioiodine and radioactive particulates. To avoid population exposure from ingestion of these foodstuffs, they should either be removed from consumption and substituted with noncontaminated foodstuffs or they should be decontaminated.

The primary constraint on the disposal of foodstuffs will be the availability of adequate substitutes. If substitute foodstuffs are not available or the cost is high, then it may be necessary to implement decontamination procedures. For protection beyond a few days where availability and cost constraints would be more critical, then decontamination may be even more cost effective. The primary means of decontamination would be through washing and peeling of fresh fruits and vegetables.

Foodstocks, such as grains that are only mildly contaminated may be stored until radiation has decayed to reduce exposure to a level safe for consumption.

Animal foodstuffs, as cattle and poultry, can be protected by removing them from contaminated pasture and placing them on stored feed. Planning for this type of action must be considered prior to an accident to assure that adequate stored feed is available and that there are personnel to carry out the feeding actions in the amount of time necessary to prevent stock contamination.

To prevent ingestion of contaminated milk in the event of an accident, certain protective actions are available such as removing cattle from pasture, diverting the milk to other uses as powdering it to (allowing the radioactivity to decay before ingestion), or by destroying the milk and substituting uncontaminated milk. The milk will require monitoring for radioactive contamination and checked at the processing location prior to further distribution. Milk producers in the affected area may be restricted from distributing milk until it has been monitored. If monitoring of all milk supplies becomes constrained, monitoring efforts may be concentrated on milk supplies where pasture and feed control had been implemented and on the fringes of the contaminated area in order to allow distribution of uncontaminated milk.

Water may be contaminated either by direct releases of radionuclides to surface waters or by deposition from an atmospheric release. Reservoirs supplied by streams and lakes would be most affected by contaminated liquid effluents. Spring and well water should not be affected by an accidental release of radioactive material to the atmosphere or to waterways.

The protective actions for water can be to prevent contamination, to decontaminate the water supply or to

temporarily condemn the use of the water for consumption. Reservoirs receiving their supply from a stream or lake normally are filled through pumping and filtration stations which are controlled by operators. These stations could be shut off if the water supply became contaminated.

4.3.1.6 Other Protective Response Actions

Access control may be required to restrict the public and/or BFS personnel from entering contaminated areas. This may include a complete or partial control of movement through or into a contaminated area. Access control whether on station personnel or the general public will be imposed in direct proportion to the expected health hazard that would be experienced if access were allowed.

Access control of BFS personnel within the station can be maintained by use of high radiation alarms, the stations public address system, and by interlocking doors. To limit public access within the plume exposure EPZ, however, requires sufficient manpower resources to cover ingress points, quick mobilization and centralized supervision.

The manpower resources will be supplied through such organizations as the Highway Patrol (Department of Public Safety), County Sheriff's Offices, and the National Guard who have been previously trained to perform this type of emergency response function for other emergencies. Mobilization resources will be supplied by their respective organizations such as patrol cars and National Guard trucks. Supervisory capability will be given by the OSDH-RPD or the OCD to the ranking officers within the organizations who are performing access control measures.

Respiratory protection is effective against exposures due to inhalation of particulates and radioiodine. Respirators are primarily for radiation workers, however, these may be made available to the public under unique conditions where other means of protective action may be restricted. Available household articles, such as handkerchiefs and washcloths, will also provide some protection against particulate inhalation. Information for household aids will be supplied to the local public prior to operation of BFS in order that these actions can be taken without instructions during an emergency.

4.3.1.7 Host Counties After Evacuation

In case of an accident at BFS where the affected public would be requested to evacuate their residences, provisions would be necessary to supply temporary relocation facilities in host areas. These special arrangements will be made during the emergency response and preparedness planning prior to BFS operation. However, at this time the Oklahoma Civil Defense has coordinated similar efforts in their Crisis Relocation Planning (CRP) which would be implemented in case of nuclear attack.

The Tulsa area has been considered a risk area for nuclear attack, therefore, the OCD, in establishing the CRP, has contacted neighboring counties to act as host areas for providing food and lodging facilities. Specific towns in each of the counties are designated as the reception or host locations for that county. Rogers, Mayes and Wagoner Counties have each been designated as a host county with each of the host towns outside the plume exposure EPZ. In addition, several other counties surrounding these three counties have also been designated as being host counties for accepting evacuated persons.

The number of evacuees from the BFS plume exposure EPZ could be easily provided for within the total provisions of the Tulsa CRP.

Provisions have been arranged for coordination of Reception and Care Services and Resource/Supply Services with each of the host towns through their city managers or mayors. Coordination of these two services include housing or shelter, and food and supply provisions. Law enforcement, health and medical, and rescue service have also been provided for in the planning.

4.3.2 Protective Action Initiations

Initiating protective actions for the general public and station personnel in the event of an accident will depend on various factors. Such factors include the determination of the emergency action level (source terms), the wind direction, the characteristics of the plume travel, the response time allowed by the accident, the weather conditions, the population at risk and the manpower available to implement protective actions. All of these combined will enter into the decision making process as to the most effective means of reducing exposure to individuals, communities, and in many instances, farm animals.

The protective action that will be taken at any given time will be the action best determined by the response agencies involved using their knowledge and expertise of the response personnel and using the emergency situation.

Protective action initiation scenarios may be determined for a combination of different variables for each type of exposure pathway. The exposure pathways to be considered are direct exposure and ingestion exposure.

Table 5 provides the recommended initiations for protective actions to be taken at nuclear facilities (Reference 9).

4.3.2.1 Direct Exposure From a Confined Inplant Source

Direct exposure from an inplant source is only a hazard to personnel in the area of the source and will be protected by provisions established within or around the facility.

A high radiation level in a particular building will be generally detected by high radiation alarms for that specific area and will alert all personnel in that area along with reactor operators within the control room. Personnel upon being alerted will take action to remove themselves if possible. At the same time, health physics teams will be dispatched to the hazardous area for back up monitoring, personnel accountability and aid in the removal of injured persons, if necessary. Protective clothing and respirators will be supplied to team personnel. Access into a high exposure area will be limited to removal of injured personnel and to secure plant control. Radiation levels of surrounding rooms and buildings will be monitored for additional personnel protection and access control.

If the inplant source causes an excessively high exposure rate for a large portion of the facility, then a local or station evacuation may be required. If this occurs, nonessential personnel will be moved offsite and the remaining personnel will report to the BFS Onsite Operational Support Center (OSC) for emergency duty. Other off-duty personnel will also report to the OSC for duty. Removal or isolation of the source would be conducted as soon as possible to mitigate further exposure to plant areas.

For personnel that would have to reenter contaminated areas, personnel exposure time limitations would be conducted to reduce the individuals' total exposure. This would depend on the exposure field, the available personnel to perform the job and the allowable exposure that an individual could receive. The time phasing would be performed to reduce each individual's total exposure by allowing as many individuals to perform the job as possible.

4.3.2.2 Direct and Inhalation Exposure from Airborne Plume

For the purposes of this report, direct exposure and inhalation exposure from an airborne plume will be considered together since the initiation of protective actions will not differ substantially between the two.

A radioactive plume will normally consist of both gaseous and particulate material contributing to a whole body dose (direct exposure) and an inhalation dose. The primary contributor to a whole body dose will be the gamma emitting radionuclides in the plume while the primary inhalation dose will be from those plume constituents that the body may uptake as radioiodines and particulates.

An airborne radioactive plume will be the initial concern for the public health after a release of radiation from BFS in the event of a major accident. This will also likely provide the highest dose in the shortest time due to both inhalation and whole body exposures. Protective action response time for plume exposure is of prime importance.

Initiating protective actions can be determined by either actual releases or projected releases considering

the plant condition. During an actual release, less time is available to the emergency response authorities to conduct protective actions and is therefore, less desirable to wait for an actual release if it can be reasonably projected that a major release will occur. Doses and time to release of various core melt accidents have been addressed by WASH-1400 (Reference 13) and will be included along with other lesser accidents for projecting source terms for health effects from BFS.

In the event of a major accident at BFS with the advent of a radioactive plume being dispersed to the environment, it is important to take the proper steps to protect the public health. It will be the responsibility of BFS to contact the offsite response agencies and then determine what specific actions should be taken. If the plume is or may be highly contaminated where doses would approach or exceed the EPA Protective Action Guides (PAG's), the initial reaction will be to evacuate the public and maintain access control. If time allows, this will be the action taken by the offsite response authorities as recommended by BFS.

If it is believed that the plume will be short lived and arrive during the onset of evacuation, then it will be more advantageous to recommend sheltering with relocation after the plume passage. Both actual and projected releases can be used to perform offsite dose estimates at the BFS ECF as discussed in Section 3.1.2.

If plume dose estimates are not substantial enough to require evacuation, but are high enough to require some type of protective action, then sheltering would be the likely response action to be recommended. Actions can then be escalated or reduced as determined by BFS and the offsite authorities.

Table 5 recommends protective actions to be taken for whole body and inhalation doses from an airborne plume as recommended by the EPA (Reference 9). This guide will basically be followed for protective action response, however, protective actions may be initiated at a lower projected dose than recommended by Table 5. The Oklahoma Radiological Emergency Response Plan will follow guidelines for protective action doses as recommended by the EPA.

4.3.2.3 Direct Exposure From Ground Contamination

After passage of the plume and the initial quick radiation exposure has occurred after an accident, it is expected that some of the particulates and solubles will be deposited within the immediately surrounding environment. Higher exposures could be expected due to deposition than from the plume given the longer time that a person may be exposed to contamination. Therefore, certain protective actions must be taken to reduce the long term dose to the public from deposition.

Deposition is difficult to predict due to the nature of the particulates involved and the atmospheric conditions upon release. Deposition can occur by either dry or wet deposition whereby, the percentage of deposition will vary under various conditions and is not necessarily less at greater distances from the nuclear facility. The only sure way to know what protective actions should be taken for the public from ground contamination is to monitor various areas for exposure.

If the resulting depositional dose rates are high due primarily to short lived radionuclides, such as iodines, then temporary relocation of the public with resulting decontamination of roads and buildings would be

conducted to a level that the exposures would not be a health hazard to the public. Thereafter, sheltering could be recommended to further reduce exposure doses.

If the public were not evacuated, but only sheltered during plume passage, the exposure from deposition may cause some long term health hazard. The primary protective action would be to decontaminate and recommend further sheltering.

In the event of an extremely high ground contamination, temporary relocation, sheltering or decontamination efforts would likely be ineffective. In this case property interdiction would be enacted until sufficient isotopic decay has occurred to reduce the contamination to an acceptable level. This action would be extremely unlikely and would be conducted only as a last resort.

4.3.2.4 Ingestion Exposure From Water, Milk, and Foodstuffs Contamination

The same depositional contamination for direct public exposures may also enter the food chains to provide an additional ingestion exposure. Radionuclides such as the iodines and strontiums will concentrate in the foodchain. It is therefore important to analyze food chain products for contamination. In addition, since the smaller amounts of deposited contamination may cause eventual higher doses due to uptake, the radiation levels in the ingestion exposure EPZ will require monitoring and protective action.

Prior to BFS operation, and periodically throughout operation, a listing of all dairies, commercial crops and beef cattle operations will be identified in the plume exposure EPZ for reference in the event of an accident at BFS. Similar major operations will be also identified

within the ingestion exposure EPZ. This listing will allow BFS and the state to quickly recognize the probable contributors to an ingestion exposure. BFS will acquire periodic milk, vegetable, water and meat samples to determine background radiation levels from the neighboring areas.

In the event of an accident with minor radioactive releases, the food chain in the plume exposure EPZ will be the primary area to analyze for contamination. The Oklahoma Department of Agriculture and the Oklahoma State Department of Health, Consumer Protection Service will acquire various food chain samples for analysis under the direction of the OSDH-RPD. If samples indicate that protective actions are necessary, then actions such as placing cattle on stored feed and scrubbing vegetables and fruit products will be performed prior to shipping to a cannery. Subsequent monitoring of decontaminated products would be required. The owners of individual gardens and livestock will be warned against inadvertent consumption without some type of protection. Major water supplies during a minor release will not be significantly contaminated to require any protective action.

Larger releases with more significant ground deposition automatically requires more analyses over a widespread area. Normal manpower and laboratory capability will be excessively strained and would require outside aid. Nearby dairies and farms would be required to retain products for processing until thorough analysis is performed. If significant contamination is present the products would need to be destroyed to avoid public consumption. Livestock would be placed on stored feed or monitored and released for offsite shipment if radiation levels were safe for human consumption. Protection

actions for the more distant and less contaminated areas would be conducted similarly for the minor releases discussed above.

Water supplies under this condition (i.e., Verdigris River) may become significantly contaminated to require a temporary halt to pumping at the treatment facility intakes. Alternate supplies and bottled water would need to be provided to that portion of the public without municipal water. Ground water supplies generally would not be affected. Once the contamination is diluted, normal water supplies would resume.

4.3.3 Public Education

The educating of the public within the plume exposure EPZ prior to a potential radiological concern at BFS is also of prime importance. If proper actions are not being taken by the public as directed then radiological exposure may be increased instead of reduced.

Educational assistance on taking protective action in the event of an emergency for the general public involves discrete postings, mailouts, and public meetings. The public will be previously informed of actions to be taken when directed. Sheltering will include such actions as closing windows, reducing air flow in homes, moving to better available sheltered areas at the residence as basements and storm cellars. For evacuation the public will be previously informed on what items to take, maps on evacuation routes, where to go after leaving, and generally available household items that may reduce exposure. This type of information does not require person to person conveyance and can be easily provided through periodic information distribution.

The majority of the general public will be able to take protective actions to protect themselves without any special outside aid. This includes all persons who have standard communication equipment (televisions, radios, telephones, etc.), transportation means (cars, trucks and or possibly tractors) and are not physically or mentally handicapped.

A small percentage of the public will, however, require special attention due to either a lack of recognition of an emergency, receipt of adequate protective action instruction, or being able to take the recommended protective action. Included in this group will be handicapped persons (blind, deaf, bedridden) special communities (Mennonites), and transients (campers, visitors). Individuals or groups who will require special consideration within the plume exposure EPZ will be identified during the development of the BFS emergency response plans.

Each one of these special conditions will require separate attention depending on location and the specific limitation. Individuals who are limited by transportation will be coordinated with others in the area or separate transportation will be acquired. Instructional limitations will be provided by postings or face-to-face contact with informed individuals. Handicapped persons or institutions with handicaps will be given individual attention to provide whatever steps are necessary to mitigate the limitation.

4.3.4 Emergency Response Training

The ability to respond to an accident at a nuclear power station or any other location not only requires the resources for responding, but, also the knowledge of how

to use them and how to respond. This knowledge will come primarily from training and experience. In order to respond to an accident at BFS both station personnel and offsite response authorities must have adequate training in order to provide an effective response program. This section will discuss the basic types of emergency training that will be conducted in order to respond in the event of an accident at BFS.

4.3.4.1 Training For Offsite Authorities

Radiological - All members of the OSDH-RPD and the OCD who will have the responsibility for emergency preparedness at BFS will maintain training for use of survey meters for determining gross radiation levels or dose rates. Members of the OSDH-RPD will be trained in the use of instrumentation for specific radiological analyses. All OSDH-RPD laboratory personnel will be periodically tested on performing isotopic analysis of water, milk, tissue and soil samples. Local and county level authorites will only be trained for the use of general survey meters.

Members of the OSDH-RPD and the OSDH-CPS will be checked against sampling procedures for radiological analysis.

All local state and county authorities who will likely be involved in the plume exposure EPZ will be trained to use and read personal dosimeters.

Medical Aid - Offsite emergency response authorities will be trained in basic first aid, CPR and rescue operations for both radiological and non-radiological incidents.

Specialized training and procedures will be provided for medical support groups such as hospital personnel and emergency transport personnel in order to handle radiation related injuries to BFS personnel.

Protective Actions - Training for recognizing the need for protective actions and carrying out protective actions will be provided to offsite response authorities. They will be trained to use the resources provided in the BFS EOF. The extent of training will depend on the protective action functions that will be carried out as listed in Table 4.

Training for protective action initiations will be primarily provided for the OSDH-RPD and the OCD. However, similar training will be provided to the Sheriff's Departments, County Civil Defense Directors and Inola Police Department for special conditions as conducting immediate evacuation of the plume exposure EPZ without having the OSDH-RPD or OCD direction.

4.3.4.2 BFS Personnel Training For Emergency Response

BFS personnel will be trained for both onsite and offsite emergency response activities.

Training For Onsite Actions - Training of BFS personnel onsite will include adherence to evacuation procedures, radiological monitoring procedures, rescue and first aid operations, protective actions and plant recovery procedures. This training will provide them the basic ability to recognize and act during an emergency to assure theirs and others safety. Personnel who will be required to provide more technical emergency response actions will be trained for more specific duties as operations of specialized radiological instrumentation,

providing radiological emergency aid, fire protection, and operation of the emergency control centers.

The emergency control centers personnel will require continued training to assure proper activation and operation. This will include access to and operation of the computer for dose assessment, communications with local authorities and the NRC, knowledge of emergency action levels, understanding of SPDS operation and general conduct of the BFS emergency response plan.

Training for Offsite Actions - The primary training of BFS personnel for offsite emergency response will be for radiological dose assessment within the plume exposure EPZ. This will consist of performing dose assessment using portable instrumentation.

4.3.5 Offsite Emergency Medical Support

In the event that an accident were to occur at BFS which caused injury with radiological contamination to station personnel or possibly the public, then specialized offsite medical aid would be required. This aid would be supplied by neighboring hospitals which have been previously trained and facilitated to handle such a condition. Section 2.4.3 mentions two Tulsa hospitals which will consider providing such emergency medical services for BFS.

Minor radiological contamination without injury will be treated at BFS as discussed in Section 3.1.4. For contaminated injuries beyond this, the BFS first aid room will primarily act as a stabilization and preparation area for transport to offsite medical facilities.

Transportation of the contaminated person(s) (Section 3.1.4) will require that a BFS health physics technician accompany him with his available medical records and account of the injury. The hospital(s) which will be receiving the injured person(s) will be contacted by BFS to prepare for admittance and appropriate staffing. Twenty-four hour on call capability will be provided by the hospitals.

Contaminated individuals will be taken directly into a special decontamination area where the external decontamination and the simple internal (wounds) decontamination will be performed. Trained hospital personnel will perform decontamination tasks to thereby reduce any exposure to physicians and nurses who will be performing medical treatment. Radiation monitoring instrumentation will be available for identifying and accomplishing decontamination. An area will also be available to check potential contamination transmitted to the hospital staff and a change area to reduce spread of contamination to other parts of the hospital.

Following the above procedures these patients can now be medically treated as other in-patients with the exception that any treatment will be considered given the internal radiation exposure received. The hospitals may also have the capability to determine radiation dose evaluation from biological analyses. This could include the ability to perform dose analyses by hemotological comparison, excretory evaluation, tissue analyses, mucous analyses and eventual chromosomal analyses.

Provisions for this type of medical treatment will be established by hospital procedures and training prior to operation of BFS.

5.0 POPULATION PROJECTIONS AND EVACUATION TIME ESTIMATES

In support of the efforts for emergency response planning and preparedness for future planning, PSO has developed population projections and evacuation time estimates (ETE). The evacuation time estimates were prepared to determine the length of time necessary for the public to prepare and execute an evacuation from the plume exposure EPZ around BFS. These estimates were based on available demographic and geographic conditions existing around BFS in the pre-construction stage. Therefore, an accurate baseline population location and density was considered necessary to prepare evacuation time estimates for the plume exposure EPZ.

Both the population projections and the ETE's for the ten-mile radius around BFS were performed by a research group at Oklahoma State University as discussed in Appendices B and C. Oklahoma State University was chosen to perform the population projections due to their established expertise in growth and development analysis. Their previous development of a program called the Second Century Project focused on projecting industrial and economic growth patterns in Oklahoma. The University's professional staff provided a technical basis for preparation of the evacuation time estimates.

5.1 POPULATION PROJECTIONS

Prior to preparing the projections the existing population data base was determined by PSO in a survey of the entire plume exposure EPZ for BFS. A ten man PSO team was organized including a team leader to survey the twelve-mile radius around BFS to assure that all population characteristics just beyond the ten-mile radius created no recognizable problems.

The team members were briefed on the type of information that needed to be collected by each member during their survey. The data taken during the survey included pinpointing of residences, description of type of residence, identification of churches, schools, businesses and other public use structures, road networks and traffic control information. Survey forms utilizing a square mile area were used by each member to collect their data and identify its location as shown on Figure B-1 of Appendix B.

To aid the members in their survey, an entire USGS topographical map of the survey area was prepared and portions assigned to each member of the team. Besides the topographical map they were given access to county road maps and a recent set of aerial photos of the survey area. The aerial photos were taken in December 1979 specifically for this purpose. The approximate scale was one inch equals 400 feet and each photo provided a four square mile area on a 42" x 42" map. Each survey sheet was verified using the aerial photos to assure no residences had been overlooked.

Upon completion of the survey a matrix of the population results broken into 1/2 mile squares (quarter sections) was plotted for the 12-mile radius. Since only the residences were counted and not the actual persons, an occupancy rate had to be applied to each household to obtain a total population.

In 1976, PSO conducted a similar survey of all rural residences for dairy operations in the 5-mile radius around BFS which included the number of occupants of each household. Using this survey, an average rate of 4.2 persons/household was estimated for this type of residence. The 4.2 persons/household therefore, were applied

to all residences within the 12-mile radius including apartments and trailers. It should be recognized that the 4.2 occupancy rate may be typical for rural areas but is quite high for average over-all households and therefore provides a conservative population density for this study.

The population density matrix, a complete set of aerial photographs and a set of all of the field survey data sheets were provided to Oklahoma State University warning system is being assumed. Confirmation times were provided on a qualitative basis.

The growth rate projections were determined by standard growth estimates for this area of the state, however, certain special factors were included in the estimates such as the migrational growth effects of suburban Tulsa, along with BFS itself and its economic inducements.

The results of the population projections are shown in Appendix B, Tables B-1 through B-4.

5.2 EVACUATION TIME ESTIMATES

The evacuation time estimates (ETE) for BFS are specifically discussed in Appendix C. The estimates included at minimum the requirements of the NRC December 26, 1979, letter "Request for Information Regarding Evacuation Times" (See Appendix E). Besides the fair weather and severe weather conditions required by the NRC's letter, time of day and day of week (incident-time-of-occurrence) conditions were investigated. In addition, ETE's were provided a broader base for simulating actual conditions.

In order to provide accurate evacuation time estimates, the specific characteristics within the plume exposure EPZ needs to be identified. As a part of the population survey performed by PSO in February 1980, the existing road conditions, traffic control measures, churches, businesses, institutions and any other particulars that might affect an evacuation were identified. A computer model was developed by Oklahoma State University to calculate the total and sectional evacuation times. The program included mobilization time, local road travel time and primary road travel time. The time for notification was not considered in the program since an early warning system is being assumed. Confirmation times were provided on a qualitative basis.

The results of the evacuation times estimates for the four incident-time-of-occurrences using normal and adverse weather conditions is shown on Table C-16 of Appendix C. The evacuation time estimates for the year 1980 through 2020 are shown on Table C-17.

The evacuation time estimates have been reviewed and approved by the Oklahoma Civil Defense. During the early stages of development of the ETE's, the OCD was appraised and attended meetings where the programming and methodology was explained. On September 15, 1980 PSO and Oklahoma State University met in the OCD offices to review the results of the estimates. The nighttime normal and nighttime abnormal weather conditions for the entire plume exposure EPZ were the primary times reviewed. The sector and projected ETE's were also discussed but to a lesser extent. An October 1, 1980 letter from the OCD approving these estimates is attached in Appendix E.

6.0 REFERENCES

1. "Planning Basis for the Development of State and Local Government Radiological Emergency Response Plans in Support of Light Water Nuclear Power Plants", a Report prepared by a U.S. Nuclear Regulatory Commission and U.S. Environmental Protection Agency Task Force on Emergency Planning, Report NUREG-0396, U.S. Nuclear Regulatory Commission, Washington, D.C. (December, 1978).

2. "Draft Emergency Action Level Guidelines for Nuclear Power Plants", NUREG-0610, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, D.C. (September, 1979).

3. "Proposed Rule on Emergency Planning", Federal Register Notice of December 19, 1979 (Vol. 44, No. 245).

4. "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants", Report NUREG-0654, FEMA-REP-1, (Revision 1) U.S. Nuclear Regulatory Commission, Federal Emergency Management Agency, Washington, D.C. (November, 1980).

5. "Outdoor Warning Systems Guide", Publication CPG 117, Federal Emergency Management Agency, Washington, D.C. (March, 1980).

6. "Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant Conditions During and Following an Accident", Regulatory Guide 1.97 (Revision 2) (December, 1979).

7. "Onsite Meteorological Programs", Regulatory Guide 1.23 (February, 1972).

8. "Emergency Planning", Section 13.3, Standard Review Plan, Report NUREG-75/087 (November 24, 1975); also see Appendix A to Section 13.3.

9. "Manual of Protective Action Guides and Protective Actions for Nuclear Incidents", Report EPA-520/1-75-001 (September, 1975).

10. "Evacuation and Sheltering as Protective Actions Against Nuclear Accidents Involving Gaseous Releases", Protective Action Evaluation Part II, EPA 520/1-78-001B, U.S. Environmental Protection Agency (April, 1978).

11. "The Effectiveness of Sheltering as a Protective Action Against Nuclear Accidents Involving Releases", Protective Action Evaluation Part I, EPA 520/1-78-001A, U.S. Environmental Protection Agency (April, 1978).

12. "Public Protection Strategies for Potential Nuclear Reactor Accidents: Sheltering Concepts with Existing Public and

Private Structures", SAND 77-1725, D.C. Aldrich, D.M. Ericson and J.D. Johnson, Sandia Labs (February, 1978).

13. "Reactor Safety Study - An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants", Report WASH-1400 (NUREG-75/014) (October, 1975).

14. "Clarification of NRC Requirements for Emergency Response Facilities at Each Site"; Letter from NRC (D. Eisenhut) to all Power Reactor Licensees, April 25, 1980.

15. "Functional Criteria for Emergency Response Facilities", Final Report, NUREG-0696, U.S. NRC (February, 1981).

16. "Emergency Planning"; Final Regulations, 10CFR50 Federal Register, Vol. 45, No. 162, August 19, 1980.

TABLE 1

LISTING OF OKLAHOMA AGENCIES RECEIVING NOTIFICATION OF EMERGENCY RESPONSE PLANNING

Primary Response Agencies

- Oklahoma State Department of Health Radiological Protection Division
- Oklahoma Civil Defense
- Oklahoma Department of Public Safety
- Rogers County Sheriff
- Wagoner County Sheriff
- Mayes County Sheriff
- Rogers County Civil Defense
- Wagoner County Civil Defense
- Mayes County Civil Defense
- Inola Police Chief

Secondary Interested Agencies (for Information Only)

- Governor's Office
- Rogers County Commissioners (3)
- Wagoner County Commissioners (3)
- Mayes County Commissioners (3)
- Rogers County Health Department
- Wagoner County Health Department
- Mayes County Health Department
- Inola Civil Defense
- City of Wagoner Civil Defense
- Tulsa County Civil Defense
- Broken Arrow Civil Defense
- City of Catoosa Civil Defense
- Tulsa City/County Health Department
- Broken Arrow Police Department
- Oklahoma State Department of Health-Milk Sanitation Division
- Oklahoma National Guard
- Oklahoma Department of Agriculture
- U.S. Representative, District 2
- State Senator, District 2
- State Senator, District 3
- State Representative, District 12
- State Representative, District 8
- State Representative, District 9
- Mayor of Inola
- Mayor of Tulsa
- Mayor of Broken Arrow
- Mayor of Claremore
- Mayor of Catoosa
- Mayor of Coweta
- Mayor of Chouteau
- Mayor of Wagoner
- Broken Arrow City Manager
- Wagoner City Superintendent

TABLE 2

ATTENDEES OF THE
EMERGENCY RESPONSE PREPAREDNESS
PRESENTATIONS APRIL 17-18, 1980

Rogers County - April 17th - 9:30 a.m.

ATTENDEES	REPRESENTING
T.L. Riggs	Mayor of Inola (Police Chief)
Lynn Brown	Rogers County Health Department
Franklin Everytt	Oklahoma Highway Patrol
Denny Lindley	Oklahoma Highway Patrol
Paul Clark	Department of Public Safety
J.C. Conkle	Oklahoma Civil Defense
Hayden Haynes	Oklahoma Civil Defense
Pete Reed	Governor's Office
Fritz Freeman	Rogers County Sheriff's Department
John Miller	Public Service of Oklahoma
Bob Campbell	Public Service of Oklahoma
Dale McHard	OSDH-Radiation Protection Division
Elmer McGuire	Rogers County Commissioner Dist. #3
Erwin Burchette	Rogers County Civil Defense
Dale E. Martin	Oklahoma Army National Guard
John W. Coleman	Oklahoma Army National Guard
J.L. Rhodes	Oklahoma Army National Guard
Robert A. Wilson	Oklahoma Army National Guard
Keith Owens	Tulsa County Civil Defense
Steve Bennett (Presentor)	Public Service Company of Oklahoma

Wagoner County - April 17th - 2:30 p.m.

Spuddy Wright	Wagoner County Special Police
E.E. "Buck" Pratt	Wagoner City Civil Defense
Max Cole	Wagoner County Civil Defense
Dale McHard	OSDH-RPD
Charles Matlock	Oklahoma National Guard
Virginia Lindsey	Wagoner County Health Department
Phil Simpson	Wagoner County Sheriff's Department
Hayden Haynes	Oklahoma Civil Defense
Paul Hagle	Oklahoma State University
Steve Bennett (Presentor)	Public Service Company of Oklahoma

TABLE 2 (Cont'd)

Mayes County April 18th 10:00 a.m.

ATTENDEES	REPRESENTING
Chief Jordon	Mayor of Pryor
Hayden Haynes	Oklahoma Civil Defense
John Baumert	Mayes County Civil Defense
Dale McHard	OSDH-RPD
Dan Rackley	OSDH-Milk Sanitation Division
Mary Jean Sell	Pryor Daily Times
Bob Pierson	Oklahoma National Guard
Michael Wheat	Pryor Jeffersonian
Keith Owens	Tulsa County Civil Defense
Al Boyer	Mayes County Sheriff's Department
Bill Moon	Pryor Police Department
Wiley J. Buckwater	Pryor Police Department
Steve Bennett (Presentor)	Public Service Company of Oklahoma

Table 3

Emergency Response Facilities

Center	Location	Activation Required?	Occupants: In Charge	Occupants: Number	Occupants: Skills	Function	Data Display	Habitability
Control Room	In Plant	No	Operations Supervisor	Utility Variable NRC (1)	Operational & Technical	Plant Control	Complete, SPDS	Wide Accident Spectrum (SRP 6.4 with NUREG-0660)
Operational Support Center (OSC)	Should be near Control Room	Yes, Alert, Site, Emergency and General Emergency Class	Plant Official	25	Operational & Technical Support Personnel	Reporting Location for Operating Support Personnel	No Requirement	None
Technical Support Center (TSC)	Should be near Control Room	Yes, Alert, Site, Emergency and General Emergency Class	Senior Plant Official	25 (including 5 NRC)	Engineering & Senior Plant Management	Accident Assessment by Operations Engineers; Support to Control Room During Accidents	Direct display of plant safety system parameters, call-up display of radiological parameters, SPDS	TSC will be same as Control Room except for system redundancy and safety class design
Emergency Operations Facility (EOF)	One mile ENE of BFS	Yes, for Site Emergency or General Emergency Class	Recovery Manager	10 NRC, 20 Utility 5 State & Local Minimum Occupancy Provided for 50 Persons	Corporate Management, Radiological Accident Assessment	1. Overall Management of Utility Resources. 2. Analysis for offsite action decisions 3. Briefing location for offsite officials & press pools	Direct display of radiological and meteorlogical parameters	Shielding for 0.5 MeV Gammas HVAC HEPA filters (no charcoal) no safety class design

Revised from Reference 14.

TABLE 4

OFFSITE EMERGENCY RESPONSIBILITIES

RADIATION MONITORING - OSDH-RPD, IRAP, OCD, Neighboring State Aid, BFS

COMMUNICATIONS ASSISTANCE - OSDH-RPD, OCD, DPS, County Sheriffs, BFS

ACCESS CONTROL - OCD, DPS, County Sheriffs, Inola Police Department, National Guard

INITIATING EVACUATION & OTHER PROTECTIVE ACTIONS - OSDH-RPD, OCD, County Sheriffs, (Oklahoma Governor, County Government, Inola Mayor)

PUBLIC INFORMATION MEDIA CONTACT - OSDH-RPD, OCD, Governor, BFS

FOODSTUFF ANALYSIS - OSDH-RPD, OSDH-CPS, IRAP, OSDA

PROPERTY & PUBLIC PROTECTION - County Sheriffs, Inola Police Department, DPS

EMERGENCY TRANSPORTATION - National Guard, DPS, Oklahoma DOT, Hospitals, BFS

RECOVERY - OSDH-RPD, OCD, BFS (Governor of Oklahoma, County Government, Inola Mayor)

OSDH-RPD	--	Oklahoma State Department of Health Radiation Protection Div.
OCD	--	Oklahoma Civil Defense
DPS	--	Department of Public Safety
OSDH-CPS	--	Oklahoma State Dept. of Health-Consumer Protection Services
OSDA	--	Oklahoma State Department of Agriculture
DOT	--	Department of Transportation
IRAP	--	Interagency Radiological Assistance Plan
BFS	--	Black Fox Station

TABLE 5

RECOMMENDED INITIATION OF PROTECTIVE ACTIONS

Projected Dose (Rem) to the Population	Recommended Actions	Comments
Whole body < 1 Thyroid < 5	·No protective action required. ·State may issue an advisory to seek shelter and await further instructions or to voluntarily evacuate. ·Monitor environmental radiation levels.	Previously recommended Protective actions may be reconsidered or terminated.
Whole body 1 to < 5 Thyroid 5 to < 25	·Seek shelter and wait further instructions. ·Consider evacuation particularly for children and pregnant women. ·Monitor environmental radiation levels. ·Control Access	
Whole body 5 and above Thyroid 25 and above	·Conduct Mandatory evacuation of populations in the predetermined area. ·Monitor environmental radiation levels and adjust area for mandatory evacuation based on these levels. ·Control access.	Seeking shelter would be an alternative if evacuation were not immediately possible.
Projected Dose (Rem) to Emergency Team Workers		
Whole body 25 Thyroid 125	·Control exposure of emergency team members to these levels except for livesaving missions. (Appropriate controls for emergency workers, include time limitations, respirators, and stable iodine.)	Although respirators and stable iodine should be used where effective to control dose to emergency team workers, thyroid dose may not be a limiting factor for lifesaving missions.
Whole body 75	·Control exposure of emergency team members performing lifesaving missions to this level. (Control of time of exposure will be most effective.)	

Revised from Reference 9

PLUME EXPOSURE
EMERGENCY PLANNING ZONE
(10 MILE RADIUS)

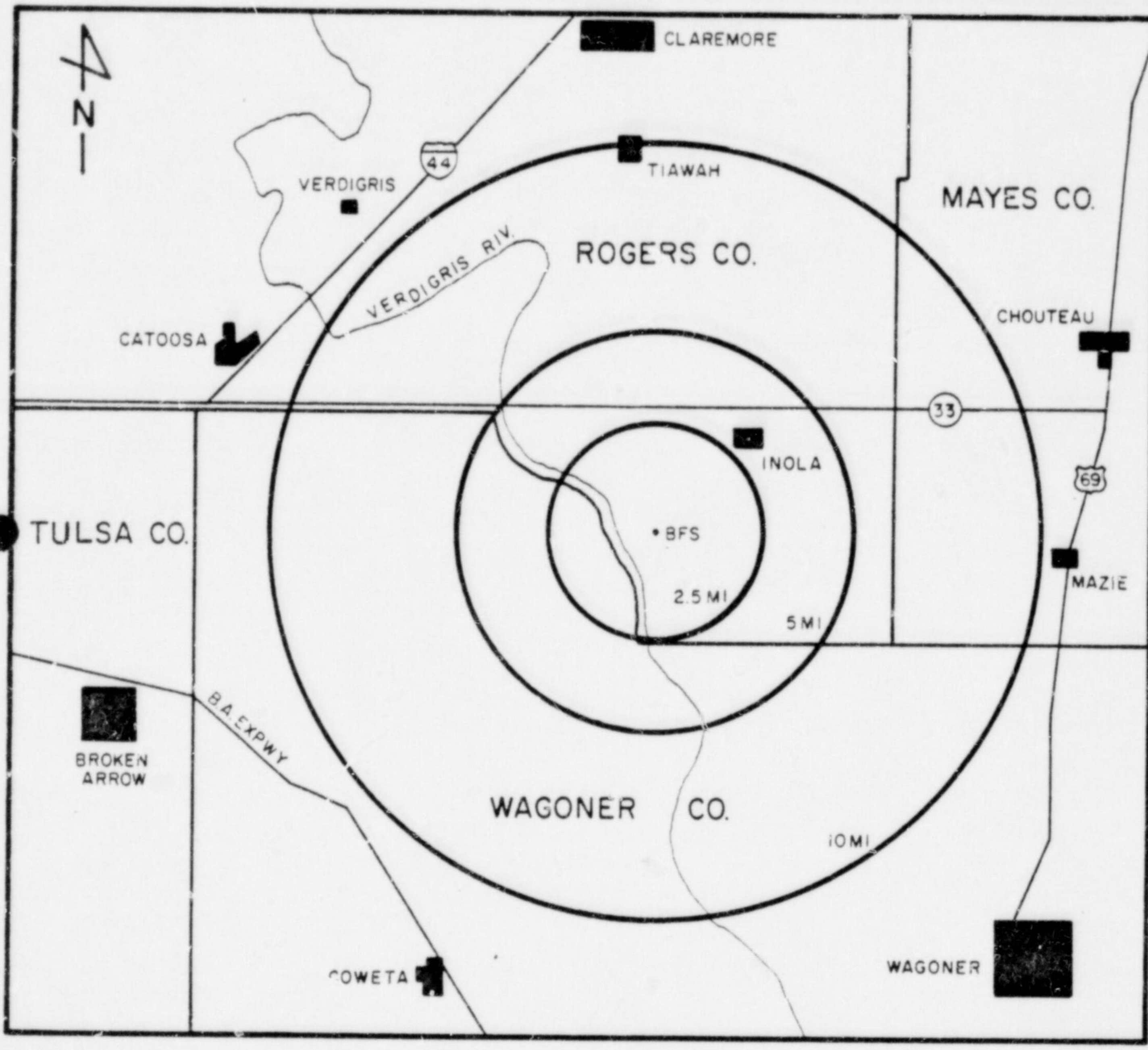
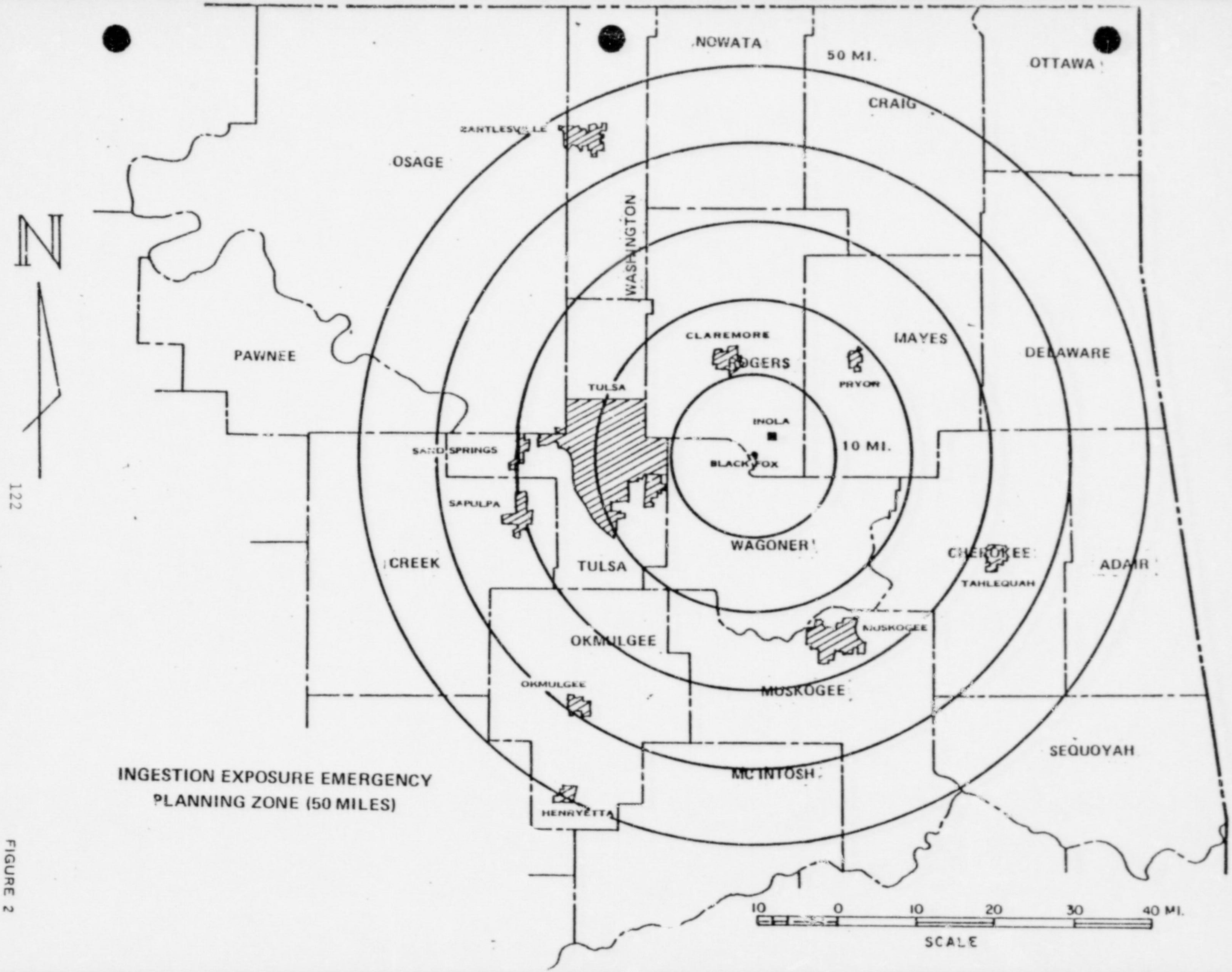
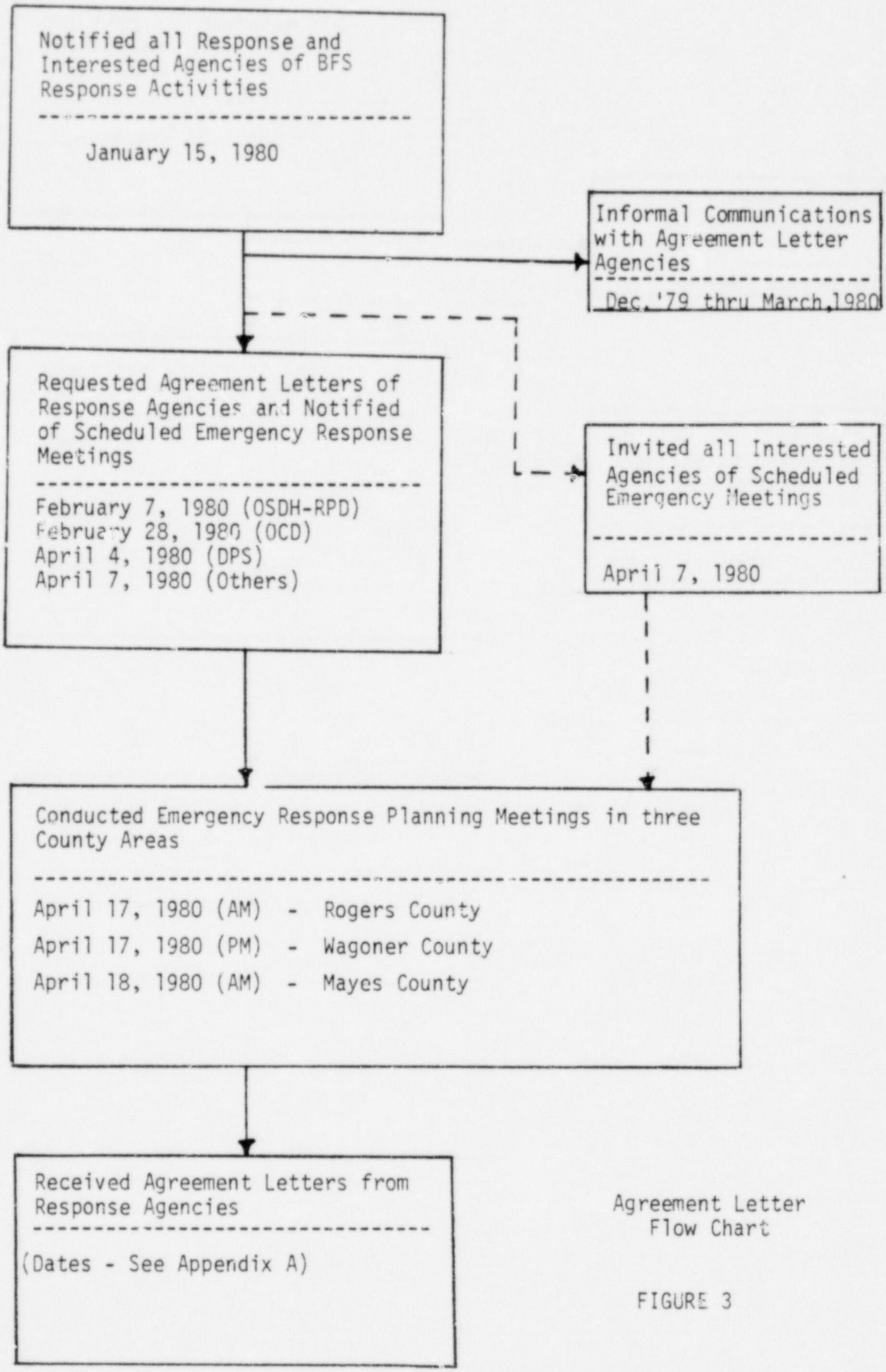


FIGURE 1



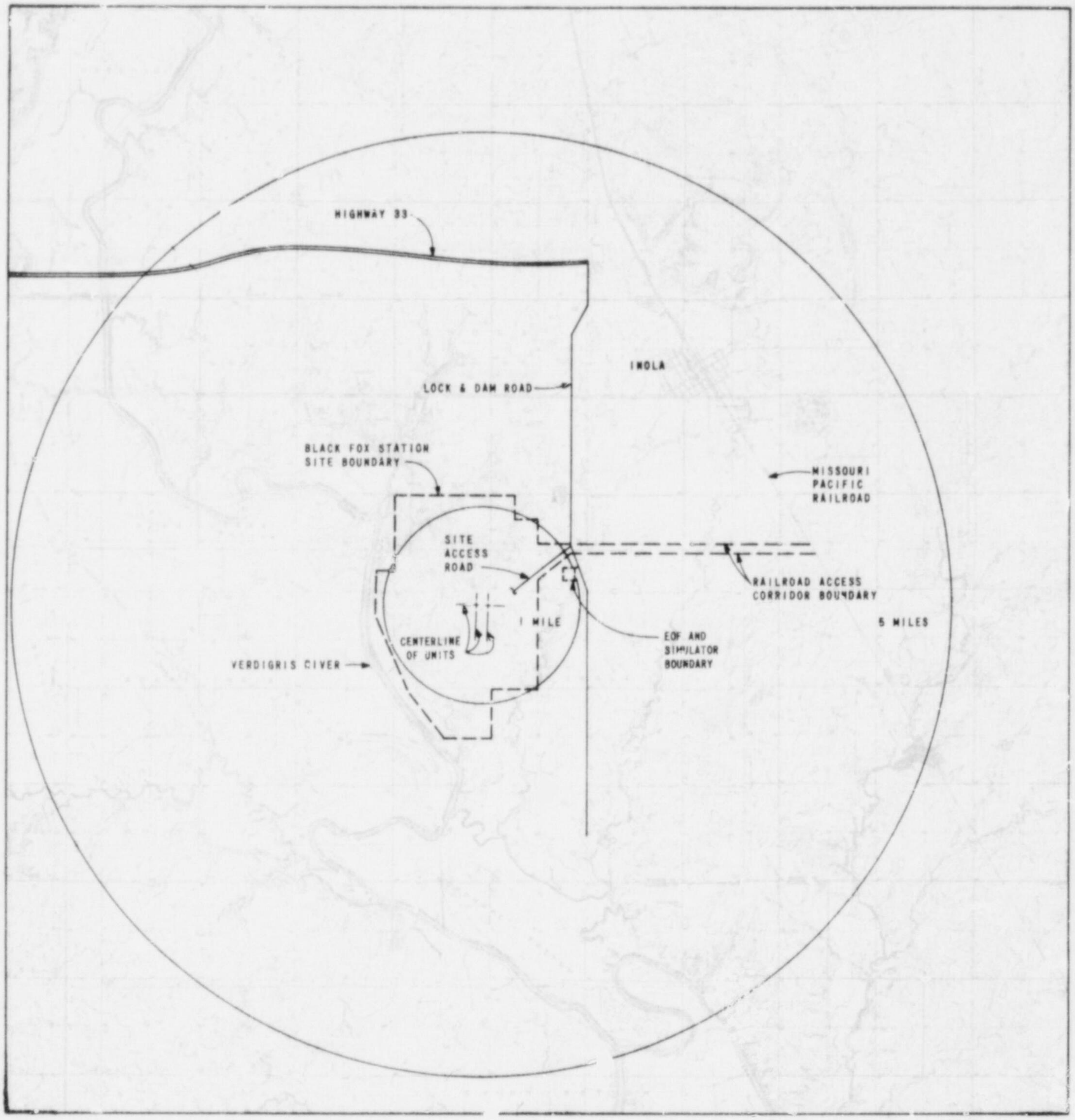
INGESTION EXPOSURE EMERGENCY PLANNING ZONE (50 MILES)

FIGURE 2



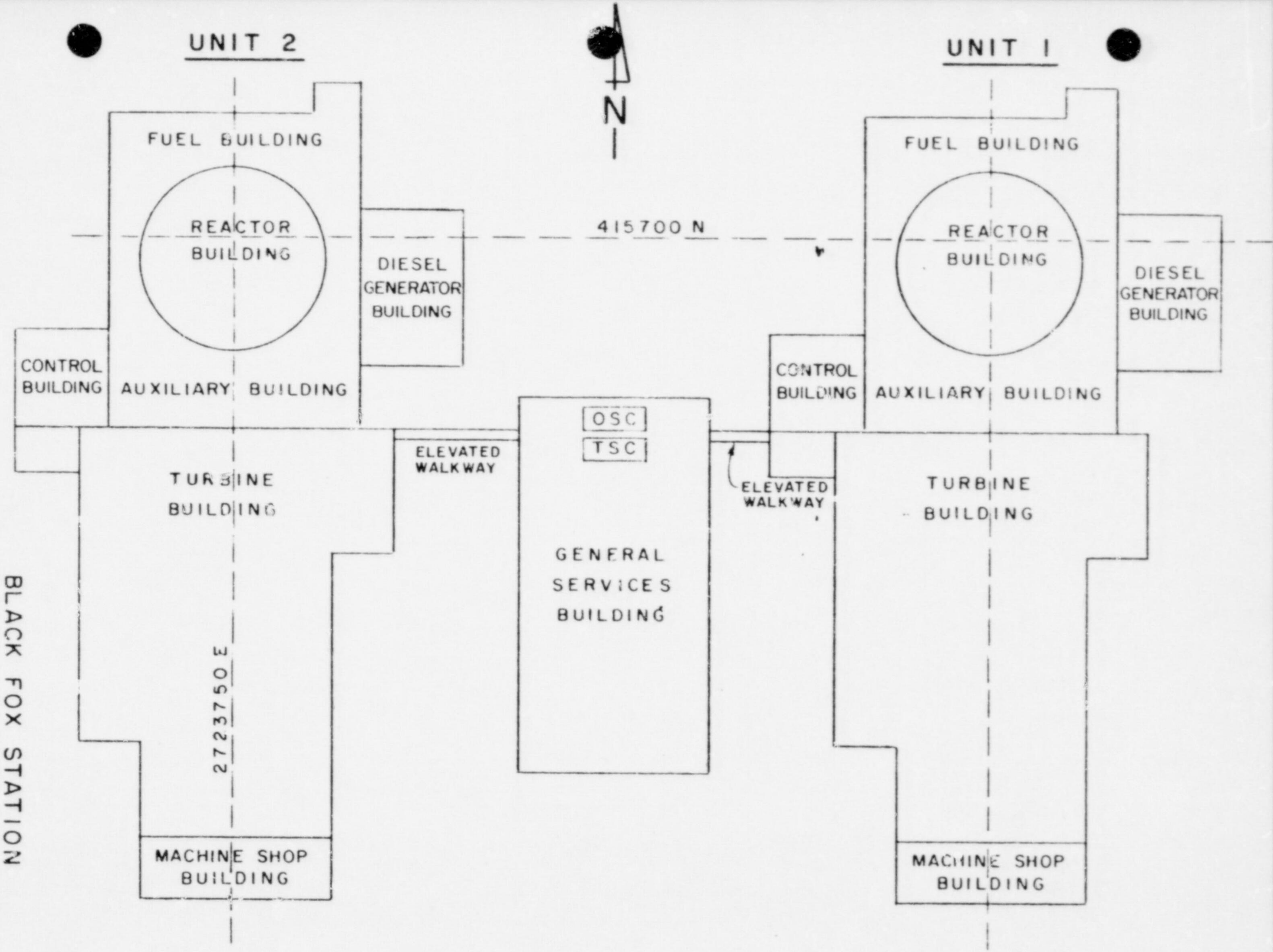
Agreement Letter
Flow Chart

FIGURE 3

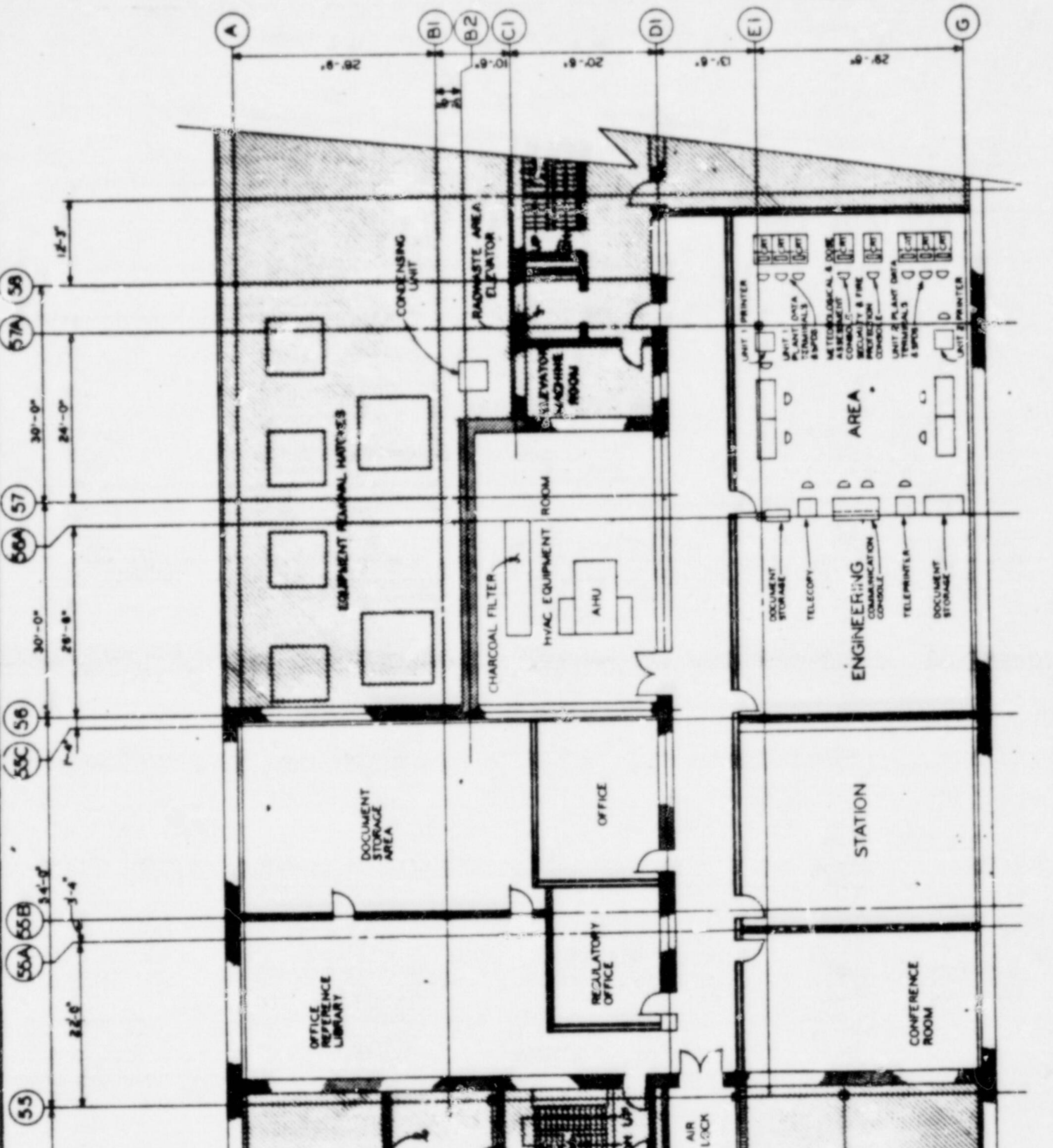


BLACK FOX STATION
SITE ARRANGEMENT

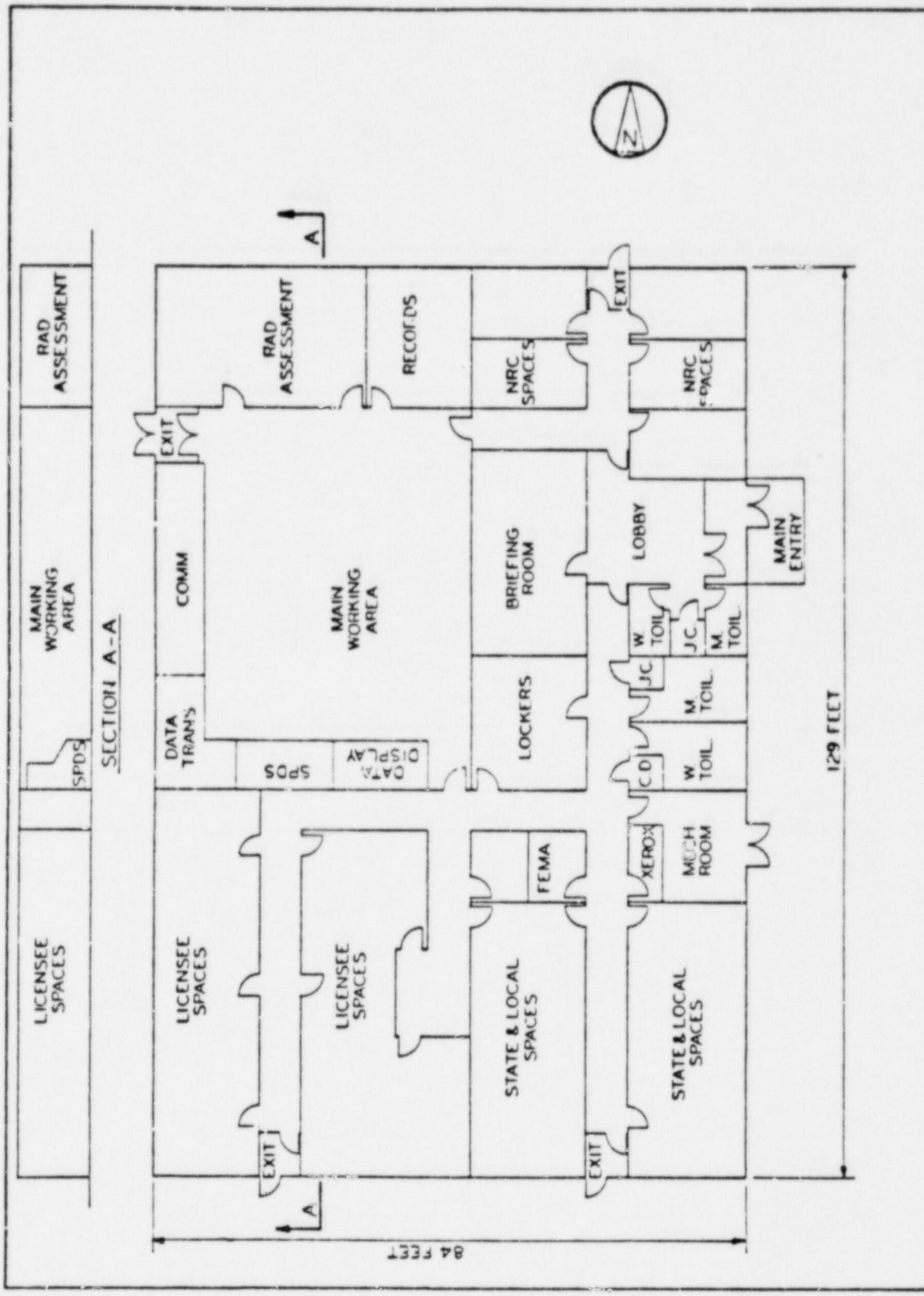
Figure 4



BLACK FOX STATION
MAJOR PLANT BUILDING
ARRANGEMENT FIGURE 5

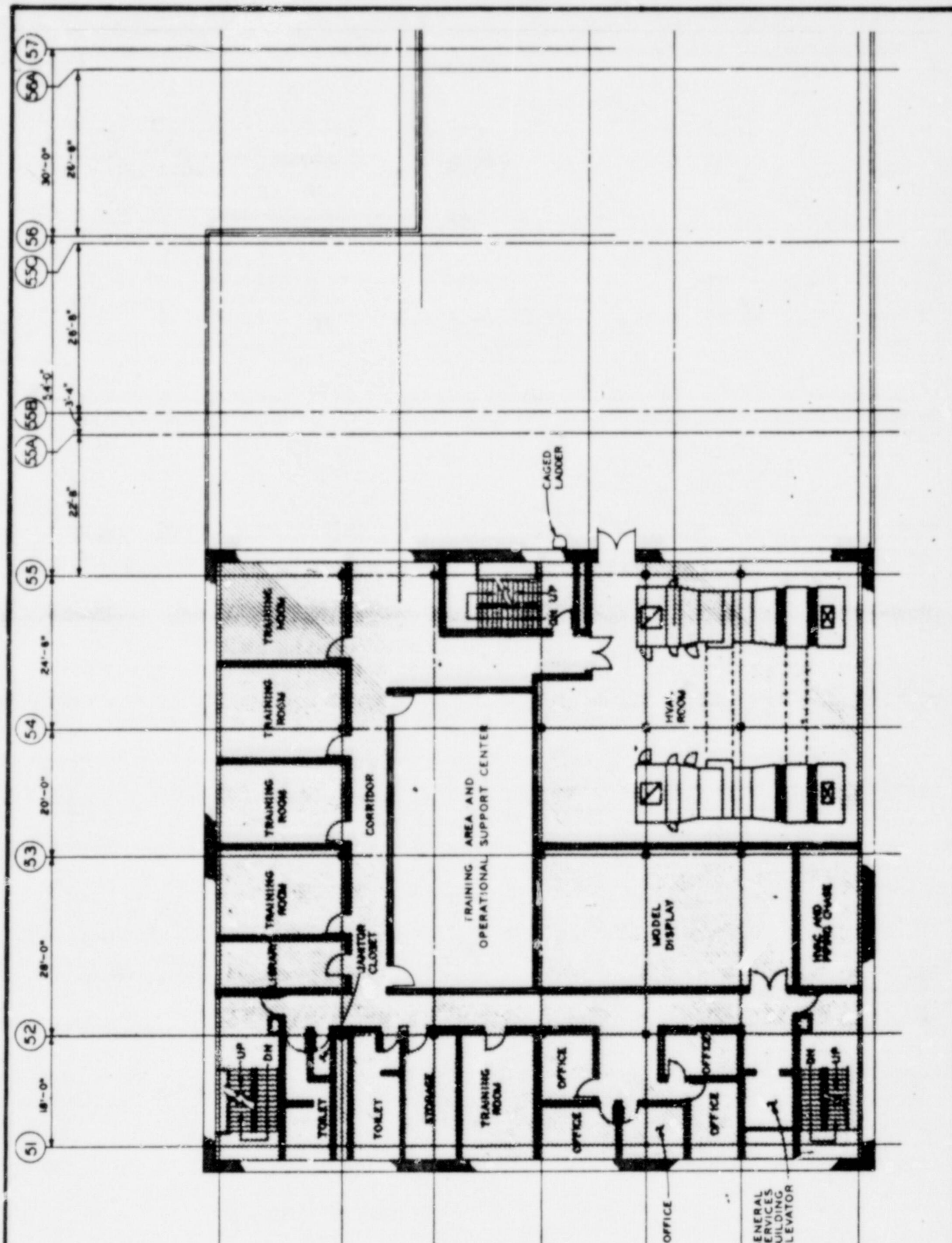


BLACK FOX STATION TECHNICAL SUPPORT CENTER
GENERAL SERVICES BUILDING
EL. 610'-0" FLOOR PLAN FIGURE 6

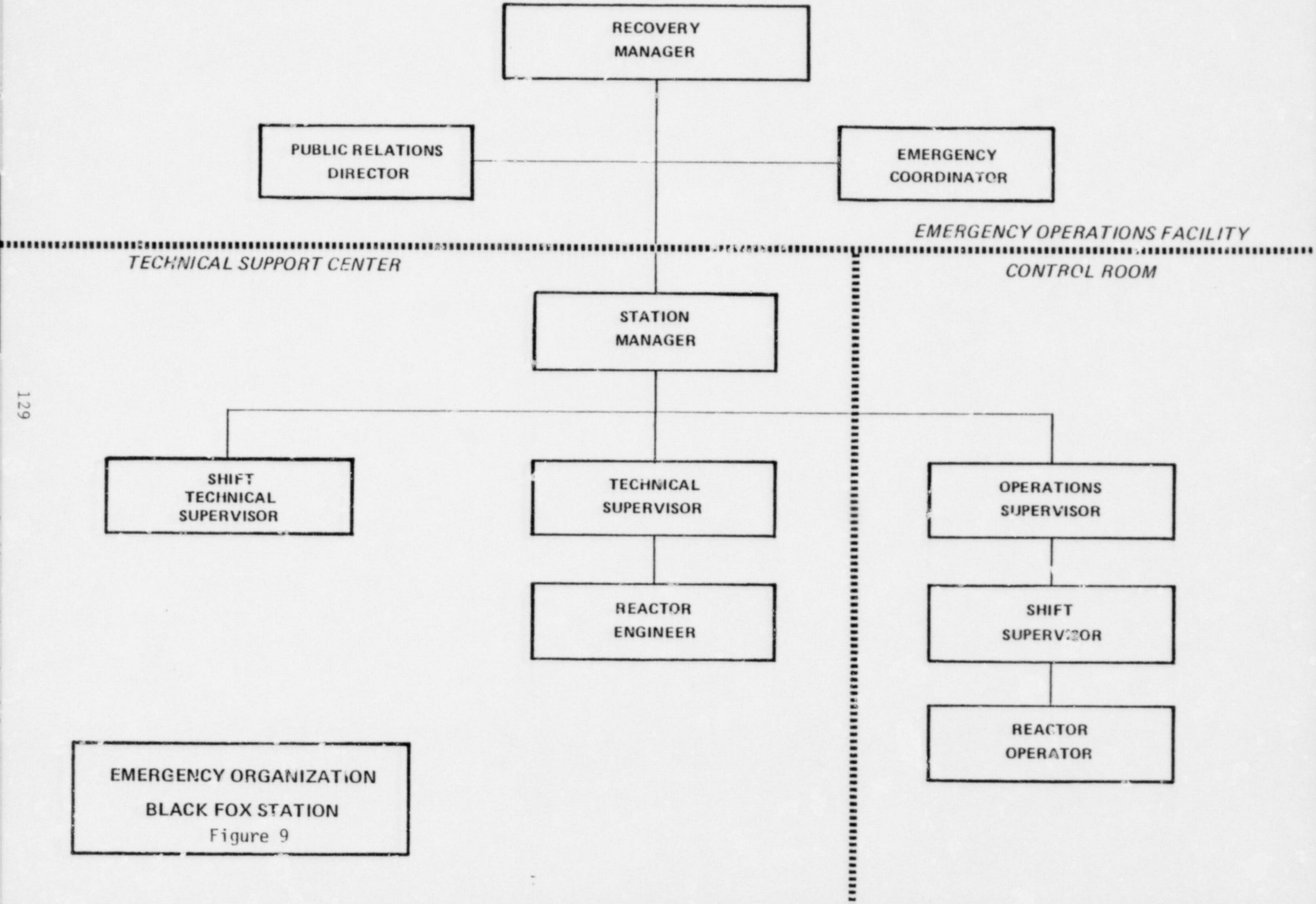


BLACK FOX STATION EMERGENCY OPERATIONS FACILITY
CONCEPTUAL FLOOR PLAN

Figure 7



BLACK FOX STATION OPERATIONAL SUPPORT CENTER
GENERAL SERVICES BUILDING
EL.626'-0" FLOOR PLAN FIGURE 8



EMERGENCY ORGANIZATION
BLACK FOX STATION
Figure 9

APPENDIX A

Agreement Letters With
Emergency Response Authorities

TABLE OF CONTENTS

Commissioner
JOAN K. LEAVITT, M.D.

Oklahoma
State Department of Health

1000 Northeast 10th Street
Post Office Box 53551
Oklahoma City, Oklahoma 73152

February 25, 1980

Vaughn L. Conrad
Manager, Licensing and Compliance
Public Service Company of Oklahoma
P.O. Box 201
Tulsa, Oklahoma 74102

Dear Mr. Conrad:

With reference to your request dated February 7, 1980, and the letter dated October 23, 1979 from the U.S. Nuclear Regulatory Commission (NRC) to Public Service Company (PSO) requesting certain activities and submission of information on an accelerated basis, this letter is to advise you of this department's responsibilities and present and future activities with respect to emergency response planning.

This department has been designated as the official agency of the State of Oklahoma for all activities pertaining to atomic energy and the use of sources of radiation (63 O.S. 1971, Section 1-1503(a)).

In addition, in 1975, then-Governor Boren designated the Occupational and Radiological Health Service of this department as having the primary responsibility and authority for radiological emergency response planning (copy of Boren letter attached).

As you are aware, the radiological emergency response plan for Oklahoma is in draft form at this time; we fully intend and expect the plan to be complete and to have received concurrence prior to the currently-estimated initial operation date of Unit 1 of the Black Fox Station (BFS). We recognize that the plan must undergo review by the Federal Emergency Management Agency (FEMA) and receive concurrence by the NRC in accord with proposed guidelines and regulations of these two federal agencies.

We recognize the need for guidelines within the plan to be used in making decisions necessary to institute certain actions for the mitigation of the effects on the public health and safety of releases of radioactivity to the environment. We are familiar with the contents of the recently-issued "Draft Emergency Action Level Guidelines for Nuclear Power Plants (NUREG-0610)". We agree in principle with the four action levels (notification of unusual event, alert, site emergency, and general emergency) stated in this document, and we intend to incorporate these action levels into our plan. We realize that these guidelines may change, due

to the draft nature of NUREG-0610, and we are prepared to revise our plan to the extent necessary in that regard.

We conceive our responsibility to be to develop and exercise an acceptable plan through a working relationship with the appropriate state and local agencies, the general public, FEMA, NRC, and PSO.

In the event of an emergency at BFS after its operation begins, we conceive our responsibilities to be (1) to dispatch trained and well-equipped radiological response personnel to the vicinity of the BFS site on a timely basis, (2) to monitor and assess the actual or potential releases of radioactivity off-site, (3) to perform necessary analyses of milk, water, food, and other environmental media for radioactivity related to the emergency, (4) to direct off-site emergency response activities and to coordinate such with other state, local, and federal agencies involved in the response, (5) to inform the Governor and recommend to him those protective actions necessary to protect the public health and safety, (6) to provide information to the news media on the status and character of the emergency on a timely basis, (7) to evaluate the situation and provide guidance on the means to cope with the emergency and to bring it to an end, and (8) to take such other actions as may be necessary to mitigate the consequences of a release of radioactivity off-site on the public health and safety.

Finally, please be assured that we intend to develop an emergency response plan in regard to BFS, to receive concurrence from the NRC on such plan, and to have suitable emergency response capability to carry out our responsibilities as briefly summarized in this letter.

Very truly yours,

Dale McHard

Dale McHard, Chief
Occupational and Radiological
Health Service

D.C/kc

Attachment

STATE OF OKLAHOMA
OFFICE OF THE GOVERNOR
OKLAHOMA CITY

DAVID L. BOREN
GOVERNOR

May 27, 1975

JUN 11 1975

Mr. Herbert H. Brown
Director, Office of Government
Liaison-Regulation
Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Brown:

In response to your letter of December 12 concerning emergency radiation response planning, please be advised that the State of Oklahoma does not have written response planning documents which are specific to fixed nuclear facilities at this time.

As requested, the following are the names of the state officials concerned with emergency response planning in regard to fixed nuclear facilities:

Primary responsibility and authority for planning:

Dale McHard
Chief, Occupational & Radiological Health Service
Post Office Box 53551
Oklahoma City, Oklahoma 73105

Principal supportive role in planning:

Hayden Haynes
Director,
Oklahoma Civil Defense
Post Office Box 53365
Oklahoma City, Oklahoma 73105

It is hoped that this information is responsive to your request.

Sincerely,

DAVID L. BOREN

cc: Dr. R. LeRoy Carpenter
Commissioner of Health

Hayden Haynes
Director, Oklahoma Civil Defense

OKLAHOMA CIVIL DEFENSE

SEQUOYAH - WILL ROGERS BUILDINGS
POST OFFICE BOX 53365
OKLAHOMA CITY, OKLAHOMA 73152
405-521-2481

GEORGE NIGH
Governor

HAYDEN HAYNES
State Director

March 13, 1980

R. Robinson

Mr. Vaughn L. Conrad, Manager
Licensing and Compliance
Public Service Company of Oklahoma
P. O. Box 201
Tulsa, Oklahoma 74102

Dear Mr. Conrad:

In reference to your letter of February 28, 1980, we agree in principal to the provisions of NUREG-0610 entitled U. S. Nuclear Regulatory Commission Draft Emergency Action Level Guidelines for Nuclear Power Plants dated September, 1979.

We understand the four classes of emergency action levels and concur with the method of notifying state and local off-sight authorities but reserve the right to require an automatic warning device be installed in a continuously manned state office that would in effect alert that state agency to expect a call from the Black Fox Facility within a reasonable time. Details for this alerting device can be worked out at a later date.

The State Civil Defense Agency pursuant to State Statute 63 O.S. 683 and Governor Boren's letter of May 27, 1975, will make such plans and assist local authorities with the writing of such local plans as are necessary and as are required by NUREG-0610.

Respectfully,

Hayden Haynes

Hayden Haynes

RR/bt

Oklahoma Department of Public Safety

P.O. BOX 11415
OKLAHOMA CITY, OKLA. 73136

PAUL W. REED, JR.
Commissioner

DARRELL WIEMERS
Assistant Commissioner

5 April 1980

Vaughn L. Conrad, Manager
Licensing and Compliance
Public Service Company of Oklahoma
P. O. Box 201
Tulsa, Oklahoma 74102

RE: Letter of Agreement

Dear Mr. Conrad:

In response to your request and the letter dated 4 April 1980 from the U.S. Nuclear Regulatory Commission (NRC) to Public Service Company (PSO) requesting certain activities and submission of information on a preconstruction basis, this letter is to advise you of the Oklahoma Department of Public Safety's responsibilities for future activities in respect to emergency response planning at your Black Fox Station.

This department has the power and responsibility at all times to expedite and direct traffic to ensure the public safety in accordance with the provisions of 47 O.S. §2-117. As part of this provision, we will also have certain policing power inside our jurisdictional boundary for law enforcement as may be needed during an emergency. Our powers of authority would fully apply under an emergency condition at your Black Fox Station.

We are in receipt of and are familiar with the contents of the recently issued "Draft Emergency Action Level Guidelines for Nuclear Power Plants (NUREG-0610)". We agree in principle with the four action levels (notification of unusual event, alert, site emergency, and general emergency) stated in this document. We recognize this document may change, however, we will respond to similar such action levels as will be provided by Oklahoma's radiological emergency response plan being prepared by the Oklahoma State Department of Health's Radiological Health Service (OSDH-RHS).

In the event of an emergency condition at BFS upon it's operation, we conceive our responsibilities to be to aid the OSDH-RHS and the Oklahoma Civil Defense in accordance with the established plan and existing

emergency conditions. This should include such activities as (1) removing persons out of an affected area if an evacuation has been declared, (2) provide access control into and out of affected areas, (3) provide transportational support as deemed necessary, (4) provide any policing action deemed necessary and (5) notify the OSDH-RHS in the event we are first alerted of an accident condition at BFS.

Sincerely,

Paul Clark

PAUL CLARK
Civil Defense Coordinator
Department of Public Safety

PC/bjr

AMOS G. WARD

Sheriff, Rogers County

OFFICE DEPUTY-EMALOYD MULANAX
ASS'T. OFFICE DEPUTY
CAROL PAYNE
TELEPHONE: 341-3535
219 SOUTH MISSOURI
CLAREMORE' OKLA. 74017

DAVE WILLIAMS-OOLOGAH
UNDERSHERIFF
DEPUTY FRITZ FREEMAN-INOLA
DEPUTY MEL MARKHAM-JAILER
DEPUTY HONEY MARKHAM-MATRON
DISPATHCHER
DEPUTY JACK TANNER-OOLOGAH
DEPUTY EDWARD BEARS-CATOOSA
DEPUTY BUCK JOHNSON-CHELSEA

May 1, 1980

Vaughn L. Conrad
Manager, Licensing and Compliance
Public Service Company of Oklahoma
P.O. Box 201,
Tulsa, Ok. 74102

Dear Mr. Conrad:

With reference to your request dated April 7, 1980, referring to Emergency response planning and actions as in regard to the Black Fox Station, Inola, Ok.

We have read and do agree to use NUREG-0610 "Draft Emergency Action Level Guidelines for Nuclear Power Plants." We will incorporate where applicable these guide lines, recognizing the possibility of change due to the draft nature of NUREG0160 and will make revisions as needed.

We see our responsibility to be one of coordination and cooperation with the various agencies involved; Federal, State and Local and Public Service Company of Oklahoma.

In event of an emergency at BFS after its operation begins, we conceive our responsibilities to be the orderly evacuation of the area population (If necessitated by the emergency), the safe guarding of the BFS site, if threatened by outside forces, the preservation and protection of prperty in and about the Inola area in event of an evacuation and or any other course of action necessitated by the circumstances whereas the safety of the general public population of Rogers County is in any way threatened.

Deputy Sheriff F.E. Freeman, Rogers County, will act as liason officer between this department and others involved agencies in the absence of the undersigned.

Sincerely,

Amos G. Ward

AMOS G. WARD, SHERIFF
ROGERS COUNTY, OKLAHOMA

AGW:em

Tommy Gilbert
SHERIFF
WAGONER COUNTY
PHONE 485-3124
WAGONER, OKLAHOMA 74467

Undersheriff
Phil Simpson
Secretary
Phyllis Fulcher
Dispatcher
Dallas Thompson

Deputies
Joe Reynolds
Carl Churchman
Jim Reeves
Steve Schirman

Vaughn L. Conrad; Manager
Licensing and Compliance
Public Service Company of Oklahoma
P.O.Box 201
Tulsa Oklahoma 74102

Dear Mr. Conrad:

In response to your request dated April 7 1980; this letter is to advise you of the Wagoner County Sheriff's Office responsibility for future activities in respect to emergency response planning at your Black Fox Station.

The duties and powers of our office as provided by 19 O.S. 516 is to keep and preserve the peace of the county and to call to aid any persons of the county we deem necessary. This will include any emergency response effort. In conjunction with the overall radiological emergency plan for Oklahoma; we will prepare prior to the scheduled operation of Black Fox; a local plan to assure adequate emergency response for Wagoner County and coordinate with the neighboring counties and the responsible state agencies.

We are in receipt of and are familiar with the contents of the recently issued "Draft Emergency Action Level Guidelines for Nuclear Power Plants (NUREG-0610). We agree in principle with the four action levels (notification of unusual event; alert; site emergency; and general emergency) stated in this document. Our office will use these or similarly adopted guidelines in our future local planning effort as coordinated with the overall state emergency preparedness effort.

Sincerely;

Tommy Gilbert Sheriff

Mr. Tommy Gilbert
Wagoner County Sheriff

AL BOYER
Under Sheriff

Field Deputies
HUGH HORTON
JIM WHITE
A. D. DAVID

— OFFICE OF —

GLEN "Pete" WEAVER

Sheriff of Mayes County

Office Phone 825-3535 — Res. Phone 825-0478

34 North Adair

PRYOR, OKLAHOMA 74361

MAXINE RANDOLPH
Secretary

BETTY KNIGHT
Dispatcher

Jailers
ED BRASSWELL
CLYDE VAUGHN
BOBBY BIAS

Pryor, Oklahoma
May 22, 1980

Vaughn L. Conrad
Licensing and Compliance
Public Service Company of Oklahoma
P.O. Box 201
Tulsa, Oklahoma 74102

Dear Mr. Conrad:

In response to your request dated April 7, 1980, this letter is to advise you of the Mayes County Sheriff's Office responsebility for future activities in respect to emergency response planning at your Black Fox Station.

The duties and powers of our office as provided by 19 O.S. § 516 is to keep and preserve the peace of the county and to cal to aid any persons of the county we deem necessary. This will include any emergency response effort. In conjunction with the overall radiological emergency plan for Oklahoma, we will prepare, prior to the scheduled operation of Black Fox, a local plan to assure adequate emergency response for Mayes County and coordinate with the neighboring counties and the responsible state agencies.

We are in receipt of and are familiar with the contents of the recently issued "Draft Emergency Action Level Guidelines for Nuclear Power Plants (NUREG-0610). We agree in principle with the four action levels (notification of unusual event, alert, site emergency, and general emergency) stated in this

document. Our office will use these or similarly adopted guidelines in our future local planning effort as coorinated with the overall state emergency preparedness effort.

Sincerely,

Pete Weaver
Mayes County Sheriff

CLAREMORE / ROGERS COUNTY
CIVIL DEFENSE
219 SOUTH MISSOURI, CLAREMORE 74017

April 24, 1980

Vaughn L. Conrad, Manager
Licensing and Compliance
Public Service Company of Oklahoma
P.O. Box 201
Tulsa, Oklahoma 74102

Dear Mr. Conrad:

In response to your request dated April 7, 1980, this letter is to advise you of the Rogers County Civil Defense's responsibility for future activities in respect to emergency response planning at your Black Fox Station.

Our authority is provided under 63 O.S. § 683.11 whereby each political subdivision within Oklahoma is directed to establish a local organization for civil defense in accordance with the State Civil Defense plan and program. In conjunction with the overall radiological emergency response plan for Oklahoma, we will prepare, prior to the scheduled operation of Black Fox, a local plan to assure adequate emergency response for Rogers County and coordinate with the neighboring counties and the responsible state agencies.

We are in receipt of and are familiar with the contents of the recently issued "Draft Emergency Action Level Guidelines for Nuclear Power Plants (NUREG-0610). We agree in principle with the four action levels (notification of unusual event, alert, site emergency, and general emergency) stated in this document. Our office will use these or similarly adopted guidelines in our future local planning effort as coordinated with the overall state emergency preparedness effort.

Sincerely,

Mr Erwin Burchette

Mr. Erwin Burchette
Rogers County Civil Defense

blt/EB

COWETA CIVIL DEFENSE
MAX COLE - DIRECTOR
BOX 103
COWETA, OKLAHOMA 74429
918-486-2179

April 25, 1980

Vaughn L. Conrad, Manager
Licensing and Compliance
Public Service Company of Oklahoma
P.O. Box 201
Tulsa, Oklahoma 74102

Dear Mr. Conrad:

In response to your request dated April 7, 1980, this letter is to advise you of the Wagoner County Civil Defense's responsibility for future activities in respect to emergency response planning at your Black Fox Station.

Our authority is provided under 63 O.S. § 683.11 whereby each political subdivision within Oklahoma is directed to establish a local organization for civil defense in accordance with the State Civil Defense plan and program. In conjuntion with the overall radiological emergency response plan for Oklahoma, we will prepare, prior to the scheduled operation of the Black Fox Station, a local plan to assure adequate emergency response for Wagoner County and coordinate with the neighboring counties and the responsible state agencies.

We are in receipt of and are familiar with the contents of the recently issued "Draft Emergency Action Level Guidelines for Nuclear Power Plants (NUREG-0610). We agree in principle with the four action levels (notification of unusual event, alert, site emergency, and general emergency) stated in this document. Our office will use these or similarly adopted guidelines in our future local planning effort as coordinated with the overall state emergency preparedness effort.

Sincerely,

Max Cole

Mr. Max Cole
Wagoner County Civil Defense

Mr. John Baumert, Director
Mayes County Civil Defense
1301 N.E. 4th
Pryor, Oklahoma 74361

May 8, 1980

Vaughn L. Conrad, Manager
Licensing and Compliance
Public Service Company of Okla
P.O. Box 201
Tulsa, Oklahoma 74102

Dear Mr. Conrad:

In response to your request dated April 7, 1980, this letter is to advise you of the Mayes County Civil Defense's responsibility for future activities in respect to emergency response planning at your Black Fox Station.

Our authority is provided under 63 O.S. § 683.11 whereby each political subdivision within Oklahoma is directed to establish a local organization for civil defense in accordance with the State Civil Defense plan and program. In conjunction with the overall radiological emergency response plan for Oklahoma, we will prepare, prior to the scheduled operation of Black Fox, a local plan to assure adequate emergency response for Mayes County and coordinate with the neighboring counties and the responsible state agencies.

We are in receipt of and are familiar with the contents of the recently issued "Draft Emergency Action Level Guidelines for Nuclear Power Plants" (NUREG-0610). We agree in principle with the four action levels (notification of unusual event, alert, site emergency, and general emergency) stated in this document. Our office will use these or similarly adopted guidelines in our future local planning effort as coordinated with the overall state emergency preparedness effort.

Sincerely,

John Baumert
Mayes County Civil Defense

TOWN OF INOLA

INCORPORATED

INOLA, OKLAHOMA
74036

Vaughn L. Conrad, Manager
Licensing and Compliance
Public Service Company of Oklahoma
P.O. Box 201
Tulsa, Oklahoma 74102

Dear Mr. Conrad:

In response to your request dated April 7, 1980, this letter is to advise you of the Inola Police Department's responsibility for future activities in respect to emergency response planning ar your Black Fox Station.

Within the duties and powers of this office under 34 O.S. S 101-103 we will respond as necessary to any emergency conditions at your station in order to protect the public health and safety. In conjunction with the overall radiological emergency response plan for Oklahoma, we will prepare, prior to scheduled operation of Black Fox Station, a local plan to assure adequate emergency preparedness within and around the Town of Inola.

We are in receipt of and are familiar with the contents of the recently issued "Draft Emergency Action Level Guidelines for Nuclear Power Plants (NUREG-0610). We agree in principle with the four action levels (notification of unusual event, alert, site emergency, and general emergency) stated in this document. Our office will use these or similarly adopted guidelines in our future local planning effort as coordintaed with the overall state emergency preparedness effort.

Sincerely,

Charles E. Ormiston

Chuck Ormiston
Inola Police Chief

Saint Francis Hospital

Sister Mary Blandine, Administrator

September 15, 1980

Public Service Company of Oklahoma
P. O. Box 201
Tulsa, Oklahoma 74102

Attention: Mr. V. L. Conrad
Licensing Engineer
Nuclear Division

Gentlemen:

This letter is sent to Public Service Company of Oklahoma to re-confirm our previous letter of June 20, 1975, concerning emergency medical treatment of radiation related injuries for Black Fox station personnel.

We feel that Saint Francis Hospital has the potential in both facilities and professional capability to treat radiation related injuries which would include those postulated for your proposed nuclear station. We recognize that your station will not be operational until at least 1987 and that the terms and conditions of providing medical services can be agreed upon during your detailed emergency response planning. Until such time as details can be mutually agreed upon, this letter will serve to indicate our desire to work with you in providing medical and emergency services which will meet your needs.

We look forward to hearing from you and to working with Public Service Company of Oklahoma.

Sincerely,

Sister Mary Blandine

Sister Mary Blandine
Administrator

SMB:bs

6161 SOUTH YALE AVENUE
TULSA, OKLAHOMA 74177
Founded by The William K. Warren Foundation

OCT 01 1980

HILLCREST MEDICAL CENTER UTICA ON THE PARK TULSA, OKLAHOMA 74104 TELEPHONE: 918 584-1351

Vice President - Administration

September 24, 1980

Mr. Vaughn L. Conrad
Manager - Licensing and Compliance
Public Service Company of Oklahoma
P. O. Box 201
Tulsa, Oklahoma 74102

Dear Mr. Conrad:

This letter is being provided to PSO to reconfirm our previous letter of July 2, 1975 concerning emergency medical treatment of radiation-related injuries for Black Fox Station personnel.

Hillcrest Medical Center has the facilities and professional capability to treat radiation-related injuries which we believe would include potential injuries at your proposed nuclear station. We recognize that your station will not be in operation until at least 1987, whereby the terms and conditions of such treatment services can be agreed upon during your detailed emergency response planning. Until the time that such details can be mutually agreed upon, this letter will serve to indicate our intent to discuss future medical services that will meet your needs.

Our office is willing to further discuss this matter with you at your convenience.

Sincerely,

Phil Goodwin

Phil Goodwin
Vice President-Administration

PG/dka

cc: Bob Suellentrop
Charles Kahlig

OCT 01 1980

APPENDIX B

Population Projections
1980-2020

APPENDIX B

POPULATION PROJECTION, DISTRIBUTION AND LAND USE MAPPING

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APPENDIX B

POPULATION PROJECTION, DISTRIBUTION AND LAND USE MAPPING

1.0 INTRODUCTION

This appendix was prepared by the directors of the Center for System Science and the Center for Applications of Remote Sensing, both research centers at Oklahoma State University (OSU). The appendix contains a description of the population characteristics of the plume exposure Emergency Planning Zone (EPZ), projections of these populations to the year 2020, and an explanation and example of land use mapping by using LANDSAT remote sensing data for the ingestion pathway EPZ.

The analysis of the populations that would be involved in an evacuation was divided into three main parts. First, the several different types of people that would be involved were identified. Six categories were selected for examination-existing residents, growth due to the nearby Tulsa metropolitan area, the construction work force at the BFS, new residents due to the indirect economic impact of the BFS, institutionalized persons, and a miscellaneous category to include such transients as recreational facility users.

Second, time of day and time of year variations were considered. While many choices are possible, those selected as representative in this study were night time conditions, normal working hours, Sunday morning and a summer Saturday.

Third, projections for each of the different population types were developed. Separate growth factors were calculated for each population category reflecting the most recently available trends and local conditions.

Remotely sensed data techniques were used both for the demographic projections and in investigating applications for ingestion pathway EPZ considerations. Aerial photographs, LANDSAT photographs and LANDSAT digital data provided images for identifying metropolitan growth corridors, existing building locations and current land use patterns.

Each of these topics is summarized in the remainder of this introductory section. Detailed descriptions are contained in Sections 2, 3 and 4.

1.1 DATA STRUCTURE

Since the geographic distribution of the population is as important as the gross numbers in estimating evacuation times, a rather fine quantization of locations was developed. A square array was established, 24 miles on a side, with the BFS site at the center. Consequently, all residents within 12 miles of the site were considered, and some higher population density areas more than 12 miles in distance were included in the corners of the square.

Within the square, 2304 individual cells were identified, with each cell totalling one-quarter square mile (one-half mile on a side). Existing section line roads, which are spaced at one mile intervals, were used as convenient cell edges. Thus, each section was divided into four cells, and each cell fronted a section line road.

Each of these cells next was assigned 24 population numbers, corresponding to the six population types and the four possible times of day/year. A total, then, of 55,296 individual numbers describe the area's population for any given year.

This data base is believed to be quite accurate as well as quite comprehensive. Within the 12 mile radius, every cell was viewed in person, with every building and road condition noted on a field survey sheet, and the survey sheets were verified by comparison with aerial photographs. A sample field survey sheet is included as Figure B-1, and illustrates the quality of the initial data set. The less crucial corner areas (some as far as 17 miles from the site) were visited to identify institutions, road conditions, etc.

1.2 POPULATION TYPES

As indicated previously, six population types were identified as being pertinent to the objectives of this study.

The first type, the population currently residing within approximately 12 miles of the plant site, is clearly the major contributory factor to consider in estimating an evacuation time. Consequently, a substantial effort was devoted to establishing an accurate count of the initial 1980 numbers. As was indicated in Section 5.1 of the main report, field survey sheets provided actual house counts per one-quarter square mile cells, with populations found by assuming a residency of 4.2 persons per house. This multiplier was established from a door to door survey of the five mile radius area undertaken in 1976, and is a conservative estimate (would tend to overstate the population) when compared with official statewide counts. In

addition, this same multiplier was used even for apartments and mobile homes, which again would make the population estimates slightly exceed the actual numbers.

Estimates for county population growths through the year 2020, which provided calibration points for the model's total population counts, were taken insofar as possible from the Oklahoma Employment Security Commission (Reference 1), the state agency designated as the official agency for projecting populations. Unfortunately, estimates were available only through the year 2000, so extrapolations were required. In addition, the population estimates were confirmed by a comparison with independent estimates prepared by a research team at Oklahoma State University (Reference 2). That team has developed a computer based model of Oklahoma's economy, and prepares population estimates as a function not only of the present age distribution, but evaluates migration patterns as influenced by salary levels, unemployment rates, regional costs of living, etc. Finally, the population numbers were compared with official national estimates prepared by the Oak Ridge National Laboratory (Reference 3).

The second population type considered was that due to growth of the Tulsa metropolitan area. These numbers clearly depend both on the growth rate for Tulsa and the geographic character of the growth corridors. In addition to considering the topological characteristics that would influence residential development, the history of Tulsa's growth was quantified through an examination of LANDSAT photographs. These photographs provided actual images of the location of Tulsa real estate development from 1972 through 1979. The popular growth corridors were easily identified, and their influence on the EPZ projected.

The third population type is the plant construction work force. These numbers were estimated by PSO for the construction period of BFS with regional resident projections as predicted in Section 4.0 of the BFS Environmental Report. This category also includes the permanent operating crew to be stationed at the plant site.

The fourth population type, new residents attracted by BFS, are additional residents attracted by the economic incentive of the work forces and increased area revenue. These would be primarily in the retail and service industries.

The fifth population type consists of those institutionalized. There are no hospitals, homes for the aged, jails, etc., within the 10 mile radius of the site. Such facilities are located within the 24 by 24 mile square, and have been identified for possible future use as the actual evacuation plans are

developed.

The final population type consists of so-called transient persons. This category is intentionally broad, and would include any persons which neither live, go to school nor work in the plume exposure EPZ. The most obvious example of this type person would be anyone using one of the recreation facilities located along the McClellan-Kerr Arkansas River Navigation System. To again insure an accurate data base, all of these sites were visited by OSU project staff, and estimates prepared for the maximum likely number of users. These numbers were obtained by actually counting parking spaces, picnic tables, etc.

1.3 SEASONAL AND TIME OF DAY VARIATIONS

Both the total number of persons involved and their geographic location within the plume exposure EPZ will certainly vary with time of day and season of the year. While the total number of combinations is almost limitless, four special conditions were considered as representative. Each of these times is termed an "incident-time-of-occurrence" (ITO).

First, a night time ITO was thought to be important to consider, primarily because the populations are so accurately located by residence locations. For this case, all persons are assumed to be at home, with the exception of BFS operating personnel.

The next ITO considered was that of work time, a weekday during work and school hours. This condition consequently is influenced by the location and size of all schools and businesses, with certain percentages of the population assumed to be at home.

Next, a Sunday morning ITO was considered. This case of course included estimating that percentage of the population which attends church, and locating those numbers at the locations of the identified churches.

Finally, a summer Saturday ITO was considered. This case was developed by paying particular attention to the recreational locations, and then summing the transient visitor numbers with the local resident totals.

It is clear that not every combination of time of year and time of day has been considered, for there are simply too many possible combinations. For example, the night time case does not include the possibility of visitors spending the night in campers at a recreation area, nor does the work time case

include the possibility that a ladies club might be meeting at a local church. Nevertheless, the four cases considered do cover the major possible variations, and any special conditions that need to be considered can be evaluated quite easily. For example, if it appears important to study the population densities on a summer Sunday morning, the data sets containing the recreation and Sunday morning numbers can be simply combined.

1.4 POPULATION PROJECTIONS

Projections for the various population types were obtained in a variety of ways. As has been indicated, the resident population projections were established through official growth figures, with checks against other pertinent sources. Growth from the Tulsa metropolitan area was evaluated from LANDSAT photographs. Less critical estimates, church attendance percentages for example, were obtained through various local sources. Construction workers and plant personnel numbers were provided by Public Service Company of Oklahoma.

A final projection for population dispersement was not available from any source. The information needed was how increases in population of the area were going to be located geographically. Certainly, some residential additions will merely become more dense, while others will expand into areas now consisting of only farm land. A very specialized computer simulation was performed to model this activity. Briefly, each of the individual 2304 cells was assigned a maximum population density, in some cases zero to indicate land for some reason not suitable for residential use. Then, as the population growth caused some cell densities to exceed their maximums, the computer program redistributed the excess numbers in adjacent cells.

1.5 LAND USE MAPPING

Previous paragraphs have included a description of the use of aerial photographs and LANDSAT photographs in determining building locations and residential growth corridors. In addition, LANDSAT digital data tapes were obtained for various regions surrounding the plant site, and the data were processed and converted to color image form. This was done to provide an example of the use of such imaging techniques in the monitoring of land use in the ingestion pathway EPZ. A facility for such work is available at Oklahoma State University, currently one of only two such facilities in the United States (Reference 4).

2.0 THE POPULATION DISTRIBUTION MODEL

The population distribution model was developed to provide population estimates from 1980 to 20?0, identified with respect to population type (existing residents, construction workers, etc.) and location of the population at any of the identified incident-times-of-occurrence (night time, at work or school, etc.). To permit an accurate spatial location of the population, a 24 mile by 24 mile square was identified, with the BFS site at the center.

This 576 square mile region includes the incorporated towns of Inola, Catoosa, Chouteau, Coweta and Wagoner, and the unincorporated communities of Tiawah, New Tulsa and Fair Oaks. Of these, Inola (with a 1970 population of 948) is closest to the site, some three miles distant. The larger towns of Broken Arrow and Claremore lie some 14 miles distant, and the center of metropolitan Tulsa is about 23 miles to the west.

This land area was next subdivided into 2304 individual one-quarter square mile cells. The cells were numbered in a grid notation, with the convention that cell (i,j) is i cells to the south and j cells to the east of the northwest corner of the region of interest. This numbering system corresponds to the mathematical notation for matrices, and is convenient for the required numerical processing of the large amounts of data.

Throughout this section, three different land areas will be discussed. The largest is the previously identified 24 mile by 24 mile square. Next, the plume exposure EPZ is defined as a 10 mile radius circle, centered at the BFS site. Finally, a 12 mile radius circle, also centered at the BFS site, has been defined. The use of this larger circle permits consideration of populations, businesses, schools, etc., that may influence the population characteristics lying at the edge of the plume exposure EPZ. For ease of expression, these three areas will be referred to as the 24 mile square, the plume exposure EPZ and the 12 mile radius area.

With any cell's location established, the next task was to assign the 24 required population numbers, one for each of the 6 population types and 4 possible incident-times-of-occurrence. These numbers were organized as indicated in Figure B-2. For each of the 2304 cells, an array was established containing the 24 population numbers. With a vertical column representing one ITO, a computer program was developed to receive as an input the particular ITO desired, then to sum the corresponding column for each of the individual cells. In this manner, each of the population types could be kept separate for the purposes of utilizing different projection techniques, then combined to

provide a spatially and numerically accurate representation of the area's population characteristics.

This section includes descriptions of how each of these numbers was developed for the present (1980) data set. The results and descriptions are divided by ITO, followed by a further division by population type.

2.1 NIGHT TIME INCIDENT-TIME-OF-OCCURRENCE

The term "night time" is used to refer to the ITO of all residents at their homes. This case is important in that it characterizes the actual resident population and the spatial distribution of that population. It applies directly to an actual late night or early morning ITO, and forms the base data set for the generation of several of the other population type numbers.

2.1.1 Existing Residents

The data base describing the existing residents in the 12 mile radius area was developed as follows. First, employees of PSO surveyed each cell within a 12 mile radius of the BFS site. The sample survey sheet of Figure B-1 illustrates the detail of this survey, and indicates the quality of the initial data base. Next, OSU personnel compared each survey sheet with aerial photographs. These photographs were taken in December, 1979, at a scale of 1" to 400'.

This survey and validation served to locate all residences (as well as roads, businesses, schools, churches, etc., for other uses). To convert house counts to population, a residency rate of 4.2 persons per house was assumed. The multiplier is conservative (in an emergency planning context) since other sources (Reference 1) indicate a statewide residency rate of less than 3 persons per house. Also, the same factor was used for apartments and mobile homes, housing units with smaller than average residency rates. Finally, all units were assumed to be occupied, even though an occupancy rate of 90%-95% would probably have been more accurate.

Considering all of these factors, the population figures developed for the EPZ are certainly larger than the actual numbers, perhaps by as much as 25% in those areas with mobile home parks and apartment complexes. More accurate numbers could be developed by using the 1980 census figures as they become available. Nevertheless, these results can still be termed conservative and will envelope any inaccuracies that may be caused due to the inexact science of population prediction.

Outside the 12 mile radius, the corners of the 24 mile square were considered to be less crucial, and the cell populations were estimated by examining the aerial photographs and county road maps (which show house locations in the rural areas), and distributing known town populations over the incorporated areas.

2.1.2 Tulsa Growth

While the BFS site is some 23 miles east of the center of Tulsa, Oklahoma, the site is only about 11 miles from the most eastward of the Tulsa "bedroom" communities, and about 11 miles northeast of the edges of the suburb of Broken Arrow. Since this type of residential development gives rise to rather dense population distributions, it was considered of sufficient importance to be identified as a separate population class. The problem considered was to determine the number of people that were moving into these areas per year, and to specify exactly where the developments were being located.

Information on the raw numbers involved was obtained from population statistics furnished by the Oklahoma Employment Security Commission and the Indian Nation Council of Governments. Discussions with Tulsa planning personnel identified the major growth areas in and around Tulsa, and a reasonable fraction was determined to use for estimating the population growth in the areas of interest.

The more difficult problem was to determine exactly where the growth was taking place. This information was obtained through a study of LANDSAT photographs. While this procedure is completely explained in Section 4, in brief, satellite photographs were obtained for the Tulsa region, one photograph for each 6-month period from 1972 through 1979. Trained photo interpreters then mapped the urban, developed regions, and prepared graphic illustrations of the growth areas. Figures B-3 through B-7 show the urbanized areas for the years 1972, 1974, 1976, 1978 and 1979, and the growth corridors are quite obvious. As would have been expected even without the clear evidence of the satellite images, development is following established transportation routes, with the major developments to the northeast of Tulsa (northwest of the BFS site) along Interstate 44 and US 66, and to the southeast of Tulsa (southwest of the BFS site), along State Highway 51. While there is a good highway route east from Tulsa, passing about 3 miles north of the BFS site, the economic attractions of Broken Arrow and Coweta to the southeast and Claremore to the northeast of Tulsa are apparently causing the major development to remain outside of the plume exposure EPZ.

2.1.3 Black Fox Station Construction Work Force

The construction work force has its greatest impact on the population numbers during the work time ITO. Due to the lack of housing facilities near the site, almost all of the work force will be required to commute from outside the immediate area. For the night time case, then, only 10% of the work force is assumed to be housed in the plume exposure EPZ. Since such construction crews typically have a substantial number of single workers, an average family size of 2.5 was assumed.

2.1.4 Black Fox Station Indirect Impact

The indirect impact of the BFS on the immediate area is defined to be the retail and service jobs that will develop to serve the needs of the construction work force and the plant operating personnel. The impact will be greatest when the construction work force is at a maximum, declining to a much smaller value when only the operating personnel are left. The impact was estimated to be a maximum of 80 jobs created, and counting families, a total of 330 new residents was assumed at the peak of construction. While it is doubtful that these families will all live in the immediate area, the model assumes that they all will find housing in and around Inola.

2.1.5 Institutionalized

For this study, the term "institutionalized" refers to those persons living in group quarters, and without independent means of transportation. Examples would include those in hospitals, nursing homes, orphanages, or jails.

While there are no such facilities in the plume exposure EPZ, there are several located in the 24 mile square area under study. Four nursing homes were located, one in Chouteau, one in Coweta and two in Wagoner; one hospital is located in Wagoner; and a county jail is located in Wagoner. The closest of these facilities to the BFS site is the nursing home in Chouteau, approximately 12.5 miles distant.

While schools and churches are often considered institutions, they were included in this study as part of the existing resident data set for the work time or Sunday morning incident-time-of-occurrence.

2.1.6 Recreation

While there are several recreation facilities in the plume exposure EPZ, attendance at such sites was not included in the night time ITO. The great majority of the recreation sites are

for daytime use only, with very limited overnight camping facilities. The summer Saturday ITO will specifically be devoted to a consideration of the users of these facilities.

2.2 WORK TIME INCIDENT-TIME-OF-OCCURRENCE

The working hours incident-time-of-occurrence was selected to include both normal working conditions and standard school attendances.

2.2.1 Existing Residents

The existing residents were assumed to be either at work, school or home at the work time ITO. Every business or other working location within the 12 mile radius was identified, and an estimate made of the average number of workers employed at each. Each school was also located, and a student population developed for each by assuming a student/teacher ratio of 20 to 1, and determining the number of teachers from the state education handbook (Reference 5).

Census data (Reference 6) was utilized to determine the number of farmers, who were assumed to be at work at their residence location.

In total, 1109 non-farm workers were assigned work locations and 1973 children were assigned school locations within the 12 mile radius area. These numbers are of course quite small considering the total number of residents in this area, and is due to the "bedroom community" character of particularly the western half of the area. In essence, the number of businesses and schools is clearly insufficient to support the population, implying that large percentages work and attend school in nearby Wagoner, Chouteau, Coweta, Broken Arrow, and especially, Tulsa. Consequently, the populations that will be reported in the next section for the work time ITO will be dramatically smaller than the night time numbers.

2.2.2 Tulsa Growth

Those new residents in the region identified as being part of the growth of Tulsa could particularly be assumed to have work and leisure patterns more closely identified with the Tulsa area than the more rural Inola community. Consequently, only 30% of these new residents are assumed to remain in the area during the daytime, at least during the first year of their residency. After the first year, these new residents are assumed to be assimilated into the region's population more completely, and are assigned the same work, school and leisure time characteristics as the existing residents.

2.2.3 Black Fox Station Construction Work Force

The BFS construction work force is assumed to start in 1981 with approximately 550 workers, peak in 1985 with about 2400 workers, and then decline after 1990 to the permanent operating crew. All of these persons are located in the four cells which immediately surround the station site.

2.2.4 Black Fox Station Indirect Impact

Families attracted to the Inola area due to the economic impact of the construction workers and plant operating personnel were not treated exactly like the normal area residents, since their jobs are specifically tied to serving the BFS personnel. Consequently, all of these workers were assumed to remain in the area during work hours.

2.2.5 Institutionalized

The institutionalized persons are assumed, of course, to remain at their institution at all times. While some residents of homes for the aged may leave the institution to shop or for meals, these numbers would be too small to influence the totals. While such persons would deserve special consideration if their evacuation were required, it has been noted that none of these institutions is within the plume exposure EPZ.

2.2.6 Recreation

While the recreation sites near the BFS may contain visitors at any time, the work time ITO assumes that these sites are empty. Since it is assumed that schools are in session for this ITO, it is unlikely that many family vacationers would be in the area. Certainly, the major influence of recreation sites on evacuation times occurs when the sites are crowded, with concomitant heavy loading of rather poor access roads, and these conditions are considered under the summer Saturday ITO.

2.3 SUNDAY MORNING INCIDENT-TIME-OF-OCCURRENCE

A Sunday morning ITO was selected for study to evaluate the influence of localized high density populations at church locations on road loading and, hence, evacuation times.

2.3.1 Existing Residents

For the Sunday morning ITO, the existing residents were assumed to be either at home, at church in the immediate vicinity or completely outside the 24 mile square. While some

businesses are doubtless open even on a Sunday morning (such as serv.ce stations), they were not considered in this case.

All of the churches located within 12 miles of the BFS site were identified during the PSO field survey, and estimates of possible attendance were obtained by examining the building and parking lot sizes. The total of these attendances yielded only about 1800 persons, compared to over a 13,000 1980 population in the plume exposure EPZ. Apparently, many of the residents of this area attend churches in the larger surrounding communities, or do not attend church at all. In order to make sure that the population numbers were not minimized for this case, it was assumed that about 90% of the persons remained within the 12 mile radius, either at home or at the identified church locations.

2.3.2 Tulsa Growth

The residents in the far western edge of the 12 mile radius area are expected to have slightly different church attendance patterns from the existing residents. Having only recently moved into the area, most probably from the Tulsa metropolitan area, they are more likely to attend church in Tulsa. For this reason, 25% of that population are expected to leave the area for church, and the remainder are assumed to remain at home.

2.3.3 Black Fox Station Construction Work Force

Except for the small percentage of the construction work force which are assumed to live in the Inola area, and which are assumed to have church attendance patterns just like the existing residents, the work force is expected to have no effect on this ITO. For the purposes of this study, a normal, single shift, Monday through Friday work schedule will be expected.

2.3.4 Black Fox Station Indirect Impact

The new residents in the Inola area projected to locate there due to the economic attraction of the BFS station are assumed to have the same church attendance patterns as the existing residents.

2.3.5 Institutionalized

While some rest home residents are able to leave the institution to attend church with relatives, friends, etc., these numbers would certainly be quite small. Most attend services in the rest home itself. In any event, all such facilities are outside the plume exposure EPZ, and have been included in this

study only because of their particularly special character and their location in the 24 mile square.

2.3.6 Recreation

As for the night time ITO, even though there may be some users of the recreational facilities on a Sunday morning, their influences on the population distributions, and hence on the evacuation times, is reserved for the summer Saturday analysis.

2.4 SUMMER SATURDAY INCIDENT-TIME-OF-OCCURRENCE

The summer Saturday ITO was selected for study since the population locations are so very different from all other conditions, and the roads to these recreation sites may be of lower quality that the roads around businesses, churches, etc.

2.4.1 Existing Residents

While the recreation sites around the BFS site serve as an attraction for people from outside the area, the local residents are quite likely to leave the area on a summer Saturday for shopping, sports, vacations or other reasons. Consequently, about 70% of the night time residents are assumed to remain in the 12 mile radius for this ITO.

2.4.2 Tulsa Growth

New area residents, even though perhaps with even greater ties to the Tulsa area, are assumed to remain in the area in the same percentages as the existing residents.

2.4.3 Black Fox Station Construction Work Force

As was stated earlier, the construction schedule does not call for Saturday work by the construction work force. Consequently, only that percentage which was assumed to locate housing in the immediate area is present during a summer Saturday. Those which are residents are assumed to remain in the area in the same manner as the existing residents.

2.4.4 Black Fox Station Indirect Impact

The families which were attracted to the Inola area because of the generation of jobs by the BFS are assumed to spend their Saturdays just like the existing residents.

2.4.5 Institutionalized

Those institutionalized are assumed to remain at their institution's location even on a Saturday. While Saturday is a common visiting day at such facilities, the numbers involved are small, and the sites lie outside of the plume exposure EPZ.

2.4.6 Recreation

The recreational facility users play a crucial role in the analysis of the summer Saturday ITO. Fourteen recreation sites were located within the 12 mile radius, providing facilities for an estimated 2491 visitors. These sites ranged from small campsites (spaces for 8 campers), to fairly substantial facilities (spaces for 9[illegible] cars, 49 picnic areas and 2 boat docks). Each of these sites was visited by OSU project staff personnel, and actual counts of maximum occupancies were made.

There are no large bodies of water in the 24 mile square, so there are no possibilities of events such as boat races, water skiing exibitions, etc. The facilities that are available are primarily for picnicking and fishing, with one access point to a public hunting area.

A lock and dam facility, approximately 4 miles southeast of the BFS site, could be considered a sightseeing attraction. While many visitors could be expected in any given day, an examination of parking facilities indicates that no more than 550 persons would be at the site at any one time.

3.0 POPULATION DISTRIBUTION AND PROJECTIONS

The previous section of this appendix described the different population types considered, and the different incident-times-of-occurrence selected for study. The final results of the population modeling are presented in this section. The results are presented for each of the three ITO's, but the different population types have been combined to give total population numbers.

In terms of the spatial location of the population, some difficulty was encountered in organizing the numbers in terms of the geometric sectors as requested by the NRC. The population cells are square, and do not easily conform to an essentially triangular output format. Nevertheless, an effort was made to comply with the desired output form.

Figure B-8 shows just over one 90-degree quadrant of the plume exposure EPZ, and illustrates how the cells were assigned to the sector and radius defining shapes. While the larger radius shapes are fairly close to that desired, some of the interior ones are clearly not a very good approximation to the desired wedge shape. Nevertheless, the shapes as shown were carefully selected to insure that sectors of the same radius contained within one of the same number of cells. Similarly, the total number of cells contained in any one total 10 mile radius sector is within one of that number contained in any other.

3.1 NIGHT TIME INCIDENT-TIME-OF-OCCURRENCE

The populations and their locations that would be expected for a night time ITO are presented in Table B-1. The numbers are shown for the required 16 compass directions and radial dimensions of 0-1, 1-2, 2-3, 3-4, 4-5, and 5-10 miles. The totals for each sector are provided, and all of the numbers are given for 1980, and for 10 year intervals to the year 2020.

The projections of population indicate just over a 2.2% growth rate. This rate is substantially larger than the estimates for Oklahoma's growth as a whole, with these estimates ranging from 1.3% to 1.9% in References 1 and 2. In fact, this growth is more than is expected in all of the plume exposure EPZ except for the far western edge.

This growth, due to the metropolitan Tulsa area, is graphically illustrated by Figures B-9(a) and B-9(b). These figures are computer generated maps of the plume exposure EPZ, showing the densities in persons per square mile, for 1980 and 2020. Growth along the transportaiton corridors is apparent, as is

the relatively much smaller growth closer to the BFS site. The highway routes northeast and southwest out of Tulsa are providing a very useful location for urban growth that is almost outside the plume exposure EPZ.

Of course, the computer model that generated these growth patterns has no way of predicting any particular new real estate development, new highway, or other exogeneous influence. The program was developed to show expansion radially from existing population locations, with the Tulsa growth corridors identified by the LANDSAT images previously discussed.

These figures also show the relatively sparse populations close to the BFS site. Even by the year 2020, there will be few cells with densities exceeding 100 persons per square mile within 5 miles or so of the site.

3.2 WORK TIME INCIDENT-TIME-OF-OCCURRENCE

The same population information for the work time ITO is presented in Table B-2. As would be expected from the discussions of the preceeding section, these numbers are substantially smaller than for the night time ITO.

To summarize these reasons, the plume exposure EPZ simply does not contain work opportunities for the populace, and a large portion of the residents clearly commute to surrounding cities. The same observations are applicable to the school capacities, particularly when considering the cells located close to the Tulsa and Broken Arrow areas. [illegible]teen schools were located within the 24 by 24 mile square area, with a total estimated student population of 6698. Only three of these schools are inside the plume exposure EPZ, with an estimated total capacity of just 425 students. Recalling the resident night time population for the plume exposure EPZ of over 13,000 persons, such a population clearly has more than 425 school age children.

Considerations such as this suppurt the small population numbers as indicated in the table. The 1980 population of under 7000, compared to the night time number of over 13,000, is primarily non-working women, small children and farmers.

3.3 SUNDAY MORNING INCIDENT-TIME-OF-OCCURRENCE

The population projections for the Sunday morning ITO are presented in Table B-3. The numbers are very similar to the night time table, differing only in that the totals are slightly smaller, indicating some residents leaving the area to attend church, and some sectors containing churches show

increases. As an example, the NNE, 2-3 mile sector shows an increase from 15? to 230 persons (for 1980), reflecting a church located in this area. Since relatively few churches were found in the area, this ITO is not now felt to be of sufficient importance for further study. Future evacuation planning procedures would be better devoted to either the night time ITO, with the larger numbers involved, or the recreation influences in the summer Saturday ITO to be discussed next.

3.4 SUMMER SATURDAY INCIDENT-TIME-OF-OCCURRENCE

The population numbers for the summer Saturday ITO are provided in Table B-4. The totals are again smaller than for the night time ITO, reflecting the expected weekend shopping trips of a percentage of the population to the Tulsa and other nearby commercial centers. Some of the sectors, however, show dramatic increases due to recreation sites. Sector S, 4-5 miles contains the lock and dam facility, and a population increase from 16 at night to 559 for a summer Saturday (in 1980) is noted. Such changes are substantial and, particularly since roads to recreation sites may be less developed than in high density residential areas, confirm the decision to include this ITO as one of the four to be considered.

3.5 SPECIAL CONSIDERATIONS

While the preceeding sections have rather completely characterized the population numbers and spatial locations, there are some special considerations which are not reflected by mere numbers.

First, an Amish Mennonite community is located in an area east of the BFS site. This is of importance since many modern technologies are not used by some families. The staunch Mennonite families use neither radios nor televisions, and do not use modern vehicles except for tractors. Their normal transportation needs are filled by horse-drawn buggies. Some of these families are becoming more progressive and are using pickups for transportation, and will be able to support neighboring households for transportation.

The community's church is located three and one-half miles due east of Inola, and one mile south of SH 33. Since these families are exclusively farmers, they are spread over a rather extensive area. While there are only about 40 families, some of them are located over four miles from the church, and hence are included in about a 40 square mile region. If evacuation plans require special consideration be given to this community, their farms can be located exactly. Since there are no telephone or electricity service lines to the farm houses, they can

be identified by the aerial photographs available.

Second, special notice must be given to rest homes. While there are currently no such institutions within the plume exposure EPZ, the rural yet convenient to urban areas character of the region would make it suitable for such facilities in the future. Since the residents of such homes do not have independent means of transportation, and may require trained health care personnel to move in any case, the development of such a facility should be noted and included in the evacuation planning function.

Similarly, future development of businesses and schools could alter particularly the work time ITO population totals and locations. However, since the numbers for this ITO are so much smaller than for the night time ITO, considerable development would have to occur before any special evacuation problems developed.

Finally, the presence of the river navigation system offers the possibilities of considerable future recreational facility development. Such expansions of facilities would be essentially independent of the population in the immediate vicinity, and would result from demands of the nearby Tulsa urban residents.

4.0 LAND USE AND LAND COVER TYPE MAPPING THROUGH REMOTE SENSING

The Oklahoma State University Center for Applications of Remote Sensing (CARS) was contracted by PSO to perform two particular work-tasks for populations projections.

The first was to determine the growth corridors and encroachment of the Tulsa metropolitan area into the plume exposure EPZ around the Black Fox Station. The second was to demonstrate the capability and to appraise the potential of LANDSAT digital satellite data to map land use and land cover types within the 50 mile radius ingestion pathway EPZ.

4.1 INTRODUCTION TO LANDSAT

The LANDSAT series of Earth orbiting satellites have supplied data for most of the planet's land surface continuously since July, 1972. Three satellites have been launched and the fourth in the series is scheduled for launch in the last quarter of 1981.

Two imaging sensor systems operate on the LANDSATS. The first is a television camera system referred to by the acronym RBV, for return beam vidicon. The second is a multispectral scanner (MSS), which produces a continuous image strip built up from successive scan lines extended perpendicular to the forward direction of the satellites orbital motion (Figure B-10), and divided into 115 by 115 mile swaths or LANDSAT scences. Reflected light from the ground is transmitted by an oscillating mirror in the MSS to a recorder system after passing through filters that select different wavelength intervals of this light (Figure B-11). Each of the four wavelength channels of MSS and the three channels of RBV possess a predetermined spectral interval or band.

4.1.1 LANDSAT's Sensitivity

The detectors that sense in the pre-determined bands or slices of the electromagnetic spectrum of LANDSAT are sensitive to different properties or attributes of the same earth surface feature being detected.

Earth surface features can be highlighted or discriminated in one band, while the same feature can be obscured or not easily delineated on another LANDSAT band. Generally, band 4 (500-600nm) is sensitive to urban structures; band 5 (600-700nm) is sensitive to vegetation; band 6 (700-800nm) is sensitive to geologic features, and band 7 (800-1100nm) is sensitive to delineating the land/water interface.

In sensing the earth in discrete wavelengths of the electromagnetic spectrum (multispectral scanning), the opportunity for recognizing the sensed object as distinct from all other background objects because of its unique spectral signature is greatly enhanced. A method of comparing spectral responses in bands is by having the sensed data recorded in the form of digital tapes in order to facilitate comparisons through quantitative techniques.

4.1.2 LANDSAT Orbit and Resolution

Digital data is available from the LANDSAT satellite for a given geographic location every 18 days. Each satellite orbits the Earth 14 times a day actively scanning only during the southward path. The MSS scans an are 185 km wide in a continuous swath (Figure B-11).

The spatial resolution of the MSS aboard LANDSATS 1, 2, and 3 is 1.118 acres or 57 x 79 meters. Over 7.5 million picture elements (pixels) occur in a single 185 x 185 km frame of LANDSAT MSS data. If two or more land-covers with varying spectral reflectance characteristics occupy a single 1.118 acre pixel, then the resulting values for each band are determined by the ratio of the spectral composition and percent reflectance of each land cover (Figure B-12). These border pixels do occur, but generally they are not a significant number in terms of the overall data set.

A full range of image processing software supplies by the NASA/Earth Resources Laboratory is available at CARS for LANDSAT digital data viewing and enhancement, statistical manipulation, automatic landcover classification, and product generation on the CARS minicomputer and image display system (Figure B-13). In addition to the above, LANDSAT digital data can be geographically referenced to a Universal Transverse Mercator (UTM) grid system. A software package is available which resamples the data, removes the distortions and fits the satellite data to a UTM northing and easting coordinate system. Other data sets, such as LANDSAT data from a different date over the same area, soils data from maps, topographic data, rainfall, or slope and aspect can be superimposed onto the original LANDSAT data set. These data are often of assistance in interpretation of land cover types not discernable by spectral reflectance alone.

4.2 LANDSAT IMAGE ANALYSIS

LANDSAT color composite images were used to determine the growth corridors and encroachment of the Tulsa metropolitan area into the plume exposure EPZ around the Black Fox Station.

A LANDSAT color composite image is a color image prepared by projecting individual black and white multispectral images (obtained by the multispectral scanner) in color. The resulting color composite is a falsecolor rendition, similar to color infrared aerial photography.

LANDSAT color composite images at a scale of approximately 1:250,000, covering 115 by 115 miles, and for the years 1972-1979 were used to determine the growth trends, growth corridors, and growth encroachment of Tulsa, Claremore, Pryor, Wagoner, Coweta, and Muskogee into the BFS plume exposure EPZ. Tulsa, by far, is the most significant in terms of metropolitan growth and encroachment into the area.

In addition to the MSS LANDSAT color composite images, RBV black and white images for 1979 were also utilized. The RBV images provide approximately twice the resolution of the MSS images, but are only recently available due to prior satellite sensor failings. The 1979 RBV data was used to provide greater control and accuracy for mapping current urban and metropolitan conditions, in conjunction with 1979 MSS images over the same area. Ground truth data was gathered to provide additional control and accuracy for proper interpretation of urban and suburban areas from the satellite images.

In addition to image interpretation for 1979, the years of 1972 to 1978 were also mapped from MSS color composite images. Images of all years were chosen for minimal cloud cover, availability at the U.S. geological Survey's EROS data Center, Sioux Falls, South Dakota for quick delivery of orders, good image quality, and good discrimination of urban areas.

Since ground truth could not be gathered for years past to complement the satellite MSS image interpretations, larger scale, more detailed color infrared aerial photography was acquired for the Tulsa area for 1974 to provide more control and assistance in satellite image interpretation.

From the interpretation, maps were compiled to show urban growth from year to year. Figures B-3 to B-7 show the growth patterns for the years 1972, 1974, 1976, 1978, 1979, respectively. It should be noted that very small urban units have not been attempted to be mapped due to the resolution limitations and slight scale variations of LANDSAT. These figures indicate that the major growth corridors and major urban encroachment into the plume exposure EPZ is from Tulsa and heading in a northeast and southeast directions. The other cities analyzed and mapped indicate negligible effects.

4.3 DIGITAL PROCESSING OF LANDSAT DATA

A demonstration of the capability of LANDSAT digital data for the classification of land use and land cover types within a 50 mile radius ingestion pathway EPZ was completed by Center for Applications of Remote Sensing personnel.

4.3.1 LANDSAT Digital Classification

A LANDSAT digital classification is the process of assigning each of the pixels of a LANDSAT scene study area to a class based upon the set of input statistics generated by training set selection and cluster formation. The unsupervised classification technique was utilized in this study and a June 14, 1975 digital tape was analyzed. The unsupervised classification technique consists of a 3 x 3 pixel search of the study area by the computer. This search sought to group into a statistical class, those pixels with similar reflectance values as detected and measured by LANDSAT sensors. The search routine produced 45 statistical classes. The computer algorithms provided mean reflectance value statistics for all four LANDSAT bands for all the 45 generated classes. The computer does not indicatee the corresponding land use or land cover type associated with the generated classes. The computer can indicate, however, the areal distribution throughout the study area of each of the generated classes through various data output and display modes. Ground truth information and data secured through photographic interpretation provide the needed information to identify the particular land use or land cover type associated with each computer generated class.

Not all the 45 classes generated by the computer and determined by the unsupervised classification approach were utilized as a totally unique land use or cover type category. Numerous classes, for example, may represent different types of agricultural crops or different conditions of one particular crop type. For demonstration purposes, the general class "cropland" is sufficient. The 45 classes were therefore combined into seven general classes.

The process of displaying a class or group of classes on the Comtal color video display screen, studying its spatial organization and reflectance statistics in order to combine classes into similar surface cover types is very effective and accurate. Each class is displayed on the Comtal screen individually in a bright color to appreciate very small pixel clusters. Classes were combined into the same color to further study spatial similarity of classes within the study area for determing usable computer class combinations.

4.3.2 LANDSAT Derived Land Cover Type Map

Table B-5 shows the seven land use and land cover classes defined in this study. These classes were chosen because they demonstrate the capab·lity of LANDSAT to map major land use and land cover types over large areas. Figures B-14 to B-17 show various portions of the 50 mile ingestion pathway EPZ which has been classified according to the seven major land use and land cover types, representative colors, and class combinations shown in Table B-5. Figures B-14 to B-17 are contact prints taken from the Comtal image processing system screen. Other output products are available, such as, elctrostatic printer/plottermaps where symbols represent land uses and land cover types instead of colors (Figure B-18), and Cromalin color processed maps where the en.·re study area can be shown with summary statistics including nu...er of acres per class and percent area of each class throughout the entire study area. Graphics can also include labeling of geographic areas on the map, and the use of various grid overlays on the colored maps, such as, Township-Range, Latitude-Longitude, and Universal Transverse Mercator.

It can be note· in Table B-5, that the class names may include a combination of major land uses or cover types. This is due to the fa.t that grassland and pasture, for example, have very similar reflectance statistics during various seasons of the year, and if their discrimination or separation is required, a multi-temporal anlalysis may be neede·. A similar situation is seen in the case of urban and bare soil in Table B-5. There are some bare soil pixels that have a spectral signature similar enough to urban to be classed together, and displayed as the same color. This does not mean that the classification is in error, but more data is required, in the form of additional LANDSAT data acquired on different dates than the one employed to adequately differentiate between urban and the isolated pixels which are bare soil. For demonstration purposes, a complex and costly multi-temporal analysis was not attempted, but is capabile of being completed by CARS personnel.

4.4 LANDSAT ADVANTAGES FOR LAND COVER TYPE MAPPING

The application of LANDSAT data to detect and map land cover types and characteristics was employed because of LANDSAT's repetitive coverage over approximately the same geographic area; regional area utility of LANDSAT data; computer compatibility of sensed data for detailed quantitative analysis; and the capability of wavelength detection through the visible and into the near infrared portion of the electromagnetic spectrum. These characteristics of LANDSAT were important to this study

because large geographic areas were analyzed, vegetation and land use discrimination was completed, and statistical summaries for the various land cover types could be extracted to include acres per mapping class, and its percent area within the study area.

4.5 CONCLUSIONS: USE OF LANDSAT DATA FOR MAPPING WITHIN THE EMERGENCY PLANNING ZONE

The Center for Applications of Remote Sensing has specialized equipment and personnel to analyze and process aerial photography and satellite digital data for land cover-type mapping and resource assessment.

The Center has been designated by the National Aeronautics and Space Administration as the state center for remote sensing technology, and has received substantial training and financial support from that administration.

The value and applicability of remote sensing for land cover-type mapping has historically been documented. The use of LANDSAT digital data for land cover-type mapping within the ingestion pathway EPZ has been demonstrated in this report. Because of the demonstration status of remote sensing in this project certain factors were generalized (land cover-types), and other factors were simplified (graphics). Even with these generalizations, the demonstration has shown that remote sensing techniques would be of great value in the event of an incident at the BFS. Land cover-type mapping could immediately identify agricultural production areas, surface water, and any other cover types that would have to be examined or tested.

In a true application of aerial photography and LANDSAT digital data to land cover-type mapping in an emergency planning zone, the following activities could be accomplished:

Greater detail and discrimination in land cover-type mapping to include such cover-types as:
- orchards
- crop-type
- urban
- suburban
- transportation arteries
- grazing land
- water bodies and rivers and creeks

Topographic delineation including:
- elevation
- slope angle
- slope aspect

- drainage basins
- geology
- geomorphology

Acreage and percent area measurements per land cover-type:

Grid overlays on graphics, such as:
- township
- range
- Latitude
- Longitude
- Universal Transverse Mercator
- Counties

Merging of tabular data, map data, aerial photography, and satellite data to provide digital information per sectors as to:
- climate
- populations
- land use
- housing
- topography
- wind patterns
- transportation

Graphics, to include:
- hardcopy color-coded maps at a variety of scales and colors
- color slides and prints
- high resolution electrostatic computer maps
- tabular area summaries

In short, the application of LANDSAT digital data for land cover-type mapping, especially over large areas, has high utility and numerous advantages over conventional methods. The LANDSAT capability of repetitive monitoring over time and area is essential to up-date data and maintain its usefulness. The wavelength of LANDSAT detector also provides for good land use and vegetation discrimination, and when used in conjunction with aerial photography, additional detail over small areas can be obtained to supplement large area inventories.

5.0 REFERENCES

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(2) Second Century Project, Oklahoma's Second Century, Oklahoma State University, 1980.

(3) Oak Ridge National Laboratory, Long-Term Projections of Population and Employment to Regions of the United States, December, 1978.

(4) Center for the Application of Remote Sensing, Oklahoma State University.

(5) Oklahoma Department of Education, Oklahoma Education Directory, 1978-1979.

(6) U.S. Department of Commerce, Bureau of the Census, General Population Characteristics, 1970.

TABLE B-1

BFS AREA RESIDENT POPULATION AND PROJECTIONS
(NIGHT TIME ITO)
RADIAL DISTANCE FROM REACTOR (MILES)

SECTOR	YEAR	0-1	1-2	2-3	3-4	4-5	5-10	10-MILE TOTAL
N	1980	0	8	67	141	137	510	863
	1990	4	8	87	188	176	595	1058
	2000	4	10	102	219	207	749	1291
	2010	4	23	126	247	253	933	1586
	2020	5	29	135	261	292	1174	1896
NNE	1980	0	0	152	235	83	70	540
	1990	0	0	188	286	96	75	645
	2000	0	0	225	344	117	92	778
	2010	0	0	282	394	150	135	961
	2020	4	10	354	494	173	207	1242
NE	1980	4	4	899	1079	220	198	2404
	1990	4	4	1167	1406	273	218	3072
	2000	5	5	1406	1695	327	267	3705
	2010	7	7	1718	2078	376	349	4535
	2020	10	15	2228	2376	414	442	5485
ENE	1980	0	4	4	187	59	309	563
	1990	0	4	4	219	68	344	639
	2000	0	5	5	267	83	419	779
	2010	0	7	8	314	114	546	989
	2020	1	12	23	330	130	674	1170
E	1980	0	8	13	12	34	183	250
	1990	4	9	15	13	39	200	280
	2000	4	11	18	16	47	246	342
	2010	4	14	23	21	61	329	452
	2020	5	21	32	36	82	418	594

TABLE B-1 (Continued)

SECTOR	YEAR	0-1	1-2	2-3	3-4	4-5	5-10	10-MILE TOTAL
ESE	1980	13	12	12	104	4	130	275
	1990	15	13	13	122	4	138	305
	2000	18	16	16	148	5	170	373
	2010	23	21	21	184	7	228	484
	2020	24	27	26	222	9	270	578
SE	1980	25	21	124	163	49	114	496
	1990	29	24	153	208	54	119	587
	2000	36	29	183	246	67	147	708
	2010	42	37	226	304	84	200	893
	2020	42	41	280	376	95	228	1062
SSE	1980	0	54	54	24	13	166	311
	1990	0	71	63	26	15	177	352
	2000	0	83	77	32	18	218	428
	2010	0	103	95	42	23	291	554
	2020	2	132	116	52	27	342	671
S	1980	0	25	13	4	16	89	147
	1990	4	29	15	4	17	96	165
	2000	4	35	18	5	21	119	202
	2010	4	43	23	7	28	154	259
	2020	7	49	28	8	34	216	342
SSW	1980	0	0	0	29	25	259	313
	1990	0	0	0	33	28	294	355
	2000	0	0	0	40	34	399	473
	2010	0	0	0	51	44	577	672
	2020	0	1	0	58	65	785	909

TABLE B-1 (Continued)

SECTOR	YEAR	0-1	1-2	2-3	3-4	4-5	5-10	10-MILE TOTAL
SW	1980	0	0	0	4	24	626	654
	1990	0	0	0	4	25	802	831
	2000	0	0	0	5	31	1040	1076
	2010	0	0	0	7	48	1254	1309
	2020	0	0	0	8	72	1456	1536
WSW	1980	0	0	0	8	33	3031	3072
	1990	0	0	0	9	38	3692	3739
	2000	0	0	0	11	46	4682	4739
	2010	0	0	0	14	57	6178	6249
	2020	0	0	0	18	66	8053	8137
W	1980	0	0	21	0	8	398	427
	1990	4	0	24	0	8	461	497
	2000	4	0	29	0	10	617	660
	2010	4	0	37	0	14	969	1024
	2020	4	1	42	1	42	1386	1476
WNW	1980	0	4	4	8	0	1662	1678
	1990	0	4	4	9	0	1966	1983
	2000	0	5	5	11	0	2411	2432
	2010	0	7	7	14	0	2932	2960
	2020	2	15	22	24	32	3322	3417
NW	1980	0	0	80	121	34	236	471
	1990	0	0	100	143	40	279	562
	2000	0	0	120	175	48	367	710
	2010	0	4	143	202	71	517	937
	2020	5	11	158	214	126	801	1315

TABLE B-1 (Continued)

SECTOR	YEAR	0-1	1-2	2-3	3-4	4-5	5-10	10-MILE TOTAL
NNW	1980	0	21	80	79	146	245	571
	1990	0	25	108	98	173	280	684
	2000	0	30	126	116	211	395	878
	2010	0	39	144	165	244	534	1126
	2020	5	44	154	190	272	695	1360
GRAND TOTALS								
	1980	42	161	1523	2198	885	8226	13035
	1990	64	191	1941	2768	1054	9736	15754
	2000	75	229	2330	3330	1272	12338	19574
	2010	88	305	2853	4044	1574	16126	24990
	2020	116	408	3598	4668	1931	20469	31190

DATE OF RUN: 08/13/80

TABLE B-2

BFS AREA RESIDENT POPULATION AND PROJECTIONS
(WORK TIME ITO)
RADIAL DISTANCE FROM REACTOR (MILES)

SECTOR	YEAR	0-1	1-2	2-3	3-4	4-5	5-10	10-MILF TOTAL
N	1980	0	2	32	102	65	310	511
	1990	186	2	42	139	84	361	814
	2000	9	2	49	159	99	430	748
	2010	9	4	65	191	123	513	905
	2020	9	6	87	228	154	626	1110
NNE	1980	0	0	73	431	37	24	565
	1990	0	0	90	520	42	26	678
	2000	5	0	108	631	51	29	824
	2010	5	1	133	771	63	34	1007
	2020	5	2	163	942	78	48	1238
NE	1980	1	1	435	657	109	75	1278
	1990	1	1	526	841	137	82	1588
	2000	4	1	637	997	163	96	1898
	2010	7	1	778	1225	199	115	2325
	2020	10	3	951	1[illegible]	246	153	2866
ENE	1980	0	1	1	85	27	130	244
	1990	0	1	1	99	31	141	273
	2000	5	1	1	121	37	171	336
	2010	5	2	1	147	46	208	409
	2020	5	3	2	181	56	265	512
E	1980	0	3	6	4	21	77	111
	1990	187	3	7	4	24	101	326
	2000	9	4	8	5	29	138	193
	2010	9	5	10	6	35	188	253
	2020	9	7	12	8	42	251	329

TABLE B-2 (Continued)

SECTOR	YEAR	0-1	1-2	2-3	3-4	4-5	5-10	10-MILE TOTAL
ESE	1980	6	4	4	48	1	42	105
	1990	7	4	4	56	1	44	116
	2000	15	5	5	68	1	50	144
	2010	20	6	6	83	1	58	174
	2020	24	9	8	102	2	86	231
SE	1980	12	9	58	77	19	35	210
	1990	14	10	72	99	21	37	253
	2000	20	12	85	116	25	40	298
	2010	26	15	105	143	30	45	364
	2020	33	19	129	176	39	70	466
SSE	1980	0	26	24	8	6	54	118
	1990	0	34	27	8	7	56	132
	2000	5	40	34	10	8	65	162
	2010	5	50	41	12	10	76	194
	2020	5	62	51	16	12	109	255
S	1980	0	11	6	1	5	31	54
	1990	186	12	7	1	5	33	244
	2000	9	15	8	1	6	39	78
	2010	9	20	10	1	7	45	92
	2020	9	25	12	2	10	64	122
SSW	1980	0	0	0	17	10	104	131
	1990	0	0	0	19	11	114	144
	2000	5	0	0	23	13	138	179
	2010	5	1	0	29	16	167	218
	2020	5	3	0	36	20	213	277

TABLE B-2 (Continued)

SECTOR	YEAR	0-1	1-2	2-3	3-4	4-5	5-10	10-MILE TOTAL
SW	1980	0	0	0	1	7	281	289
	1990	0	0	0	1	7	318	326
	2000	3	0	0	1	8	390	402
	2010	5	0	0	1	9	472	487
	2020	5	0	0	2	14	591	612
WSW	1980	0	0	0	3	14	1455	1472
	1990	0	0	0	3	15	1719	1737
	2000	5	0	0	4	19	2097	2125
	2010	5	0	0	5	23	2561	2594
	2020	5	0	0	6	29	3127	3167
W	1980	0	0	9	0	2	174	185
	1990	187	0	10	0	2	197	396
	2000	9	0	12	0	2	239	262
	2010	9	0	15	0	2	294	320
	2020	9	0	19	0	4	364	396
WNW	1980	0	1	1	3	0	794	799
	1990	0	1	1	3	0	939	944
	2000	5	1	1	4	0	1145	1156
	2010	5	3	1	5	0	1401	1415
	2020	5	5	2	6	0	1714	1732
NW	1980	0	0	37	56	21	115	229
	1990	0	0	48	79	35	124	286
	2000	3	0	57	99	42	149	350
	2010	5	0	72	125	54	182	438
	2020	5	1	94	162	70	225	557

TABLE B-2 (Continued)

SECTOR	YEAR	0-1	1-2	2-3	3-4	4-5	5-10	10-MILE TOTAL
NNW	1980	0	10	37	142	69	134	392
	1990	0	11	58	116	109	139	433
	2000	5	14	66	134	138	168	525
	2010	5	17	88	150	173	205	638
	2020	5	22	123	154	207	254	765
GRAND TOTALS								
	1980	19	68	723	1635	413	3835	6693
	1990	768	79	893	1988	531	4431	8690
	2000	116	95	1071	2373	641	5384	9680
	2010	134	125	1325	2894	791	6564	11833
	2020	148	167	1653	3524	983	8160	14635

DATE OF RUN: 08/13/80

TABLE B-3

BFS AREA RESIDENT POPULATION AND PROJECTIONS
(SUNDAY MORNING ITO)
RADIAL DISTANCE FROM REACTOR (MILES)

SECTOR	YEAR	0-1	1-2	2-3	3-4	4-5	5-10	10-MILE TOTAL
N	1980	0	6	57	119	116	528	826
	1990	4	6	71	151	145	618	995
	2000	4	8	85	180	174	749	1200
	2010	4	10	104	223	213	891	1445
	2020	4	25	126	249	264	1025	1693
NNE	1980	0	0	230	199	68	55	552
	1990	0	0	287	253	99	65	704
	2000	0	0	344	3[illegible]1	122	85	862
	2010	0	0	421	386	146	109	1062
	2020	0	1	524	501	171	166	1363
NE	1980	3	3	771	1384	186	158	2505
	1990	3	3	1014	1554	373	192	3139
	2000	4	4	1227	1883	381	251	3750
	2010	5	5	1502	2343	386	326	4567
	2020	6	6	2058	2555	420	419	5464
ENE	1980	0	3	3	157	49	290	502
	1990	0	3	3	213	73	329	621
	2000	0	4	5	262	96	407	774
	2010	0	5	12	309	117	509	952
	2020	0	10	23	331	134	635	1133
E	1980	0	6	11	9	28	142	196
	1990	4	7	13	10	32	175	241
	2000	4	8	16	12	40	232	312
	2010	4	10	19	15	49	302	399
	2020	4	14	32	33	78	388	549

TABLE B-3 (Continued)

SECTOR	YEAR	0-1	1-2	2-3	3-4	4-5	5-10	10-MILE TOTAL
ESE	1980	11	9	9	88	3	100	220
	1990	13	10	10	103	3	108	247
	2000	16	12	12	127	4	136	307
	2010	19	15	15	155	5	169	378
	2020	24	19	18	188	6	214	469
SE	1980	21	17	104	138	69	88	437
	1990	25	19	127	177	72	96	516
	2000	30	24	153	213	89	124	633
	2010	37	29	188	267	97	155	773
	2020	42	37	229	334	105	192	939
SSE	1980	0	96	45	58	11	127	337
	1990	0	123	53	47	30	141	394
	2000	0	145	64	56	35	177	477
	2010	0	179	78	73	39	221	590
	2020	0	220	97	92	44	281	734
S	1980	0	21	11	3	12	69	116
	1990	4	24	13	3	13	75	132
	2000	4	30	16	4	16	94	164
	2010	4	36	19	5	21	117	202
	2020	4	43	24	6	26	147	250
SSW	1980	0	0	0	23	20	227	270
	1990	0	0	0	26	23	257	306
	2000	0	0	0	32	28	317	377
	2010	0	0	0	39	34	389	462
	2020	0	0	0	49	44	476	569

TABLE B-3 (Continued)

SECTOR	YEAR	0-1	1-2	2-3	3-4	4-5	5-10	10-MILE TOTAL
SW	1980	0	0	0	3	48	523	574
	1990	0	0	0	3	42	617	662
	2000	0	0	0	4	51	760	815
	2010	0	0	0	5	60	923	988
	2020	0	0	0	8	72	1094	1174
WSW	1980	0	0	0	6	27	2580	2613
	1990	0	0	0	7	31	3070	3108
	2000	0	0	0	8	38	3751	3797
	2010	0	0	0	10	47	4570	4627
	2020	0	0	0	12	58	5695	5765
W	1980	0	0	17	0	6	350	373
	1990	4	0	19	0	6	402	431
	2000	4	0	24	0	8	493	529
	2010	4	0	29	0	10	602	645
	2020	4	0	36	0	17	868	925
WNW	1980	0	3	3	6	0	1515	1527
	1990	0	3	3	7	0	1795	1808
	2000	0	4	4	8	0	2198	2214
	2010	0	5	5	10	1	2664	2685
	2020	0	6	9	18	26	3073	3132
NW	1980	0	0	67	102	75	195	439
	1990	0	0	82	133	71	224	510
	2000	0	0	99	163	82	276	620
	2010	0	0	122	194	90	350	756
	2020	0	5	148	207	115	507	982

TABLE B-3 (Continued)

SECTOR	YEAR	0-1	1-2	2-3	3-4	4-5	5-10	10-MILE TOTAL
NNW	1980	0	18	67	65	124	200	474
	1990	0	21	87	79	154	226	567
	2000	0	26	102	96	188	280	692
	2010	0	31	125	123	230	354	863
	2020	0	41	144	173	256	512	1126
GRAND TOTALS								
	1980	35	182	1395	2360	842	7147	11961
	1990	57	219	1782	2766	1167	8390	14381
	2000	66	265	2151	3359	1352	10330	17523
	2010	77	325	2639	4157	1545	12651	21394
	2020	88	427	3468	4756	1836	15692	26267

DATE OF RUN: 08/13/80

TABLE B-4

BFS AREA RESIDENT POPULATION AND PROJECTIONS
(SUMMER SATURDAY ITO)
RADIAL DISTANCE FROM REACTOR (MILES)

SECTOR	YEAR	0-1	1-2	2-3	3-4	4-5	5-10	10-MILE TOTAL
N	1980	4	4	101	96	94	339	638
	1990	4	4	141	135	125	393	802
	2000	4	4	179	153	145	481	966
	2010	4	6	225	192	180	587	1194
	2020	4	8	274	235	220	725	1466
NNE	1980	0	0	106	161	55	41	363
	1990	0	0	133	195	62	43	433
	2000	0	0	159	238	78	51	526
	2010	0	0	194	289	94	65	642
	2020	0	0	239	356	117	84	796
NE	1980	2	2	627	754	150	120	1655
	1990	2	2	841	1017	191	130	2183
	2000	2	2	1008	1222	224	156	2614
	2010	3	3	1233	1492	279	196	3206
	2020	4	4	1506	1822	340	248	3924
ENE	1980	0	2	2	126	39	191	360
	1990	0	2	2	147	45	203	399
	2000	0	2	2	179	55	257	495
	2010	0	3	3	219	67	310	602
	2020	0	4	4	270	82	392	752
E	1980	4	5	9	7	22	110	157
	1990	4	5	10	7	25	115	166
	2000	4	7	13	9	31	143	207
	2010	4	8	15	11	37	177	252
	2020	4	10	19	14	46	225	318

TABLE B-4 (Continued)

SECTOR	YEAR	0-1	1-2	2-3	3-4	4-5	5-10	10-MILE TOTAL
ESE	1980	9	7	7	71	2	74	170
	1990	10	7	7	83	2	76	185
	2000	13	9	9	101	2	90	224
	2010	15	11	11	123	3	116	279
	2020	19	14	14	152	4	150	353
SE	1980	17	13	84	112	30	63	319
	1990	20	15	106	147	33	65	386
	2000	24	18	125	172	39	73	451
	2010	30	22	155	213	50	98	568
	2020	36	27	191	263	62	128	707
SSE	1980	0	37	36	14	49	94	230
	1990	0	51	41	14	68	97	271
	2000	0	59	51	18	92	115	335
	2010	0	73	62	22	114	148	419
	2020	0	90	76	28	139	190	523
S	1980	4	16	9	2	559	52	642
	1990	4	18	10	2	814	55	903
	2000	4	22	13	2	1100	65	1206
	2010	4	27	15	3	1386	84	1519
	2020	4	34	19	4	1674	107	1842
SSW	1980	0	0	64	314	16	163	557
	1990	0	0	93	453	17	177	740
	2000	0	0	126	610	22	220	978
	2010	0	0	159	768	26	270	1223
	2020	0	0	192	928	33	338	1491

TABLE B-4 (Continued)

SECTOR	YEAR	0-1	1-2	2-3	3-4	4-5	5-10	10-MILE TOTAL
SW	1980	0	0	0	2	13	415	430
	1990	0	0	0	2	13	477	492
	2000	0	0	0	2	15	583	600
	2010	0	0	0	3	20	716	739
	2020	0	0	0	4	26	880	910
WSW	1980	0	0	0	5	21	2097	2123
	1990	0	[illegible]	0	5	23	2479	2507
	2000	0	0	0	7	29	3034	3070
	2010	0	0	0	8	35	3697	3740
	2020	0	0	0	10	44	4521	4575
W	1980	4	0	13	0	4	[illegible]	281
	1990	4	0	15	0	4	294	317
	2000	[illegible]	0	18	0	4	364	390
	2010	4	0	22	0	6	442	474
	2020	4	0	27	0	8	547	586
WNW	1980	0	2	2	5	0	1142	[illegible]
	1990	0	2	2	5	0	1347	[illegible]
	2000	0	2	2	7	0	1646	1657
	2010	0	3	3	8	0	2006	2020
	2020	0	4	4	10	0	2455	2473
NW	1980	0	580	54	83	143	204	1064
	1990	0	849	69	96	201	248	1463
	2000	0	1148	82	120	270	313	1933
	2010	0	1447	101	145	338	385	2416
	2020	0	1746	125	178	410	471	2930

TABLE B-4 (Continued)

SECTOR	YEAR	0-1	1-2	2-3	3-4	4-5	5-10	10-MILE TOTAL
NNW	1980	0	14	54	52	100	158	378
	1990	0	16	78	67	117	174	452
	2000	0	20	88	79	144	216	547
	2010	0	24	109	97	176	263	669
	2020	0	31	135	120	214	328	828
GRAND TOTALS								
	1980	44	682	1168	1804	1297	5523	10518
	1990	48	971	1548	2375	1740	6373	13055
	2000	55	1293	1875	2919	2250	7807	16199
	2010	64	1627	2307	3593	2811	9560	19962
	2020	75	1972	2825	4394	3419	11789	24474

DATE OF RUN: 08/24/80

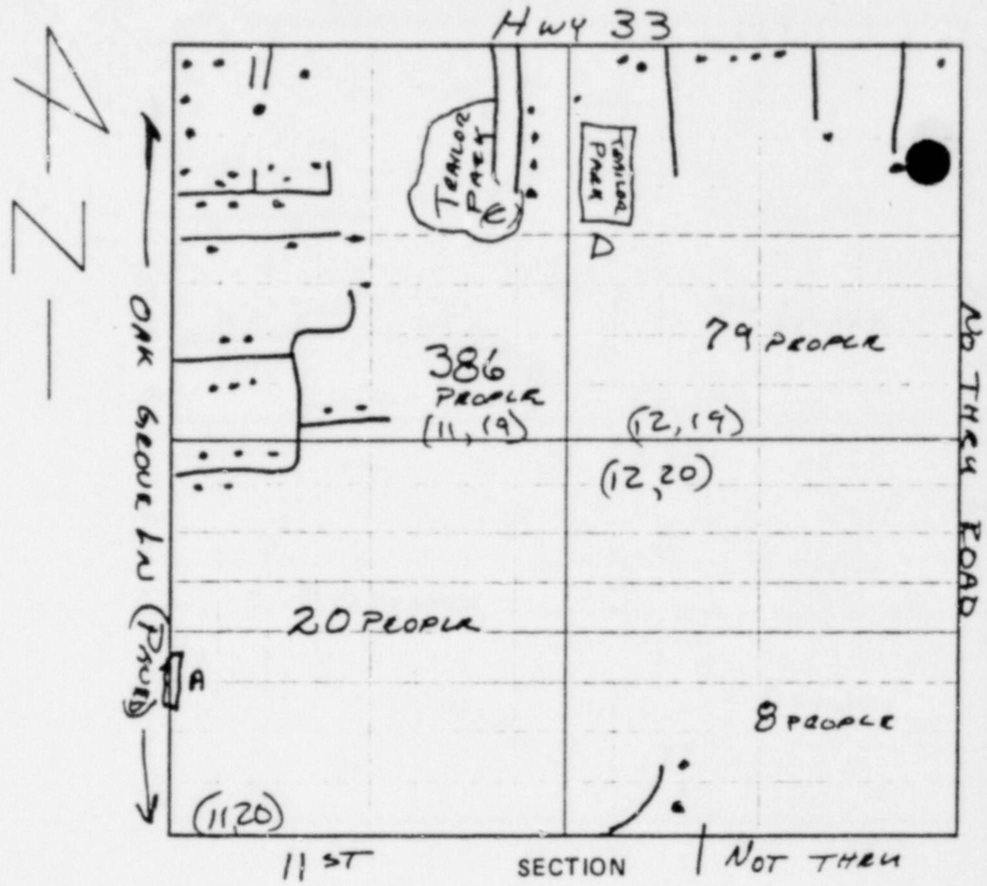
TABLE B-5

LANDSAT DIGITAL CLASSIFICATION:
LAND USE AND LAND COVER

Class Name	Class Cover	Classes Combined
Grassland/Pasture	Light Green	1, 2, 4, 7, 9, 10, 17, 33
Cropland	Medium Green	3, 5, 6, 8, 15, 30, 39
Cropland/Pasture	Yellow	11
Forest	Black	12, 13, 16, 18, 25
Urban/Bare Soil	Purple	14, 19, 20, 22, 24, 26, 27, 41, 43
Bare Soil	Orange	21, 34, 36, 37, 42, 44, 45
Water	Blue	23, 28, 29, 31, 32, 35, 38, 40

Note: "Classes combined" column indicates which classes of the 45 total classes recognized by LANDSAT and clustered by the computer were combined into the same land cover type. Classes 1, 2, 4, 7, for example, are all grouped together representing Grassland/Pasture. Class 1 may actually be sparse grass; class 2 may be dense grass; class 4 may be unimproved pasture, and class 7 may be improved pasture. They all represent, however, the general land cover category, Grassland/Pasture used in this demonstration, and therefore should be grouped together.

SECTION SURVEY DATA RECORD



SECTION

SECTION 1

TOWNSHIP T19N

RANGE R15E

SECTION PARTICULARS: (RESIDENCES, CHURCHES, SCHOOLS, HOUSING-MOTELS, RECREATION AREAS, HOSPITALS, REST HOMES, DAY CARE CENTERS, TRAILER PARKS, PARKING LOTS, STORES, SHOPPING CENTERS, ETC.)

(C) TRAILS END MOBILE HOME PARK - 50 TRAILORS

(D) NINE TRAILORS

ROADS & ACCESS: TYPE OF ROAD, BRIDGES - DEAD ENDS, CLOSED SECTION LINES, LOW WATER CROSSINGS, TRAFFIC CONTROL (STOP SIGNS & LIGHTS), ETC.

(A) ONE LANE WOODEN PLANK BRIDGE

(B) ROADS ARE PAVED IN EDITION

OTHER SPECIAL CONDITIONS:

FIELD SURVEY DATA SHEET

FIGURE B-1

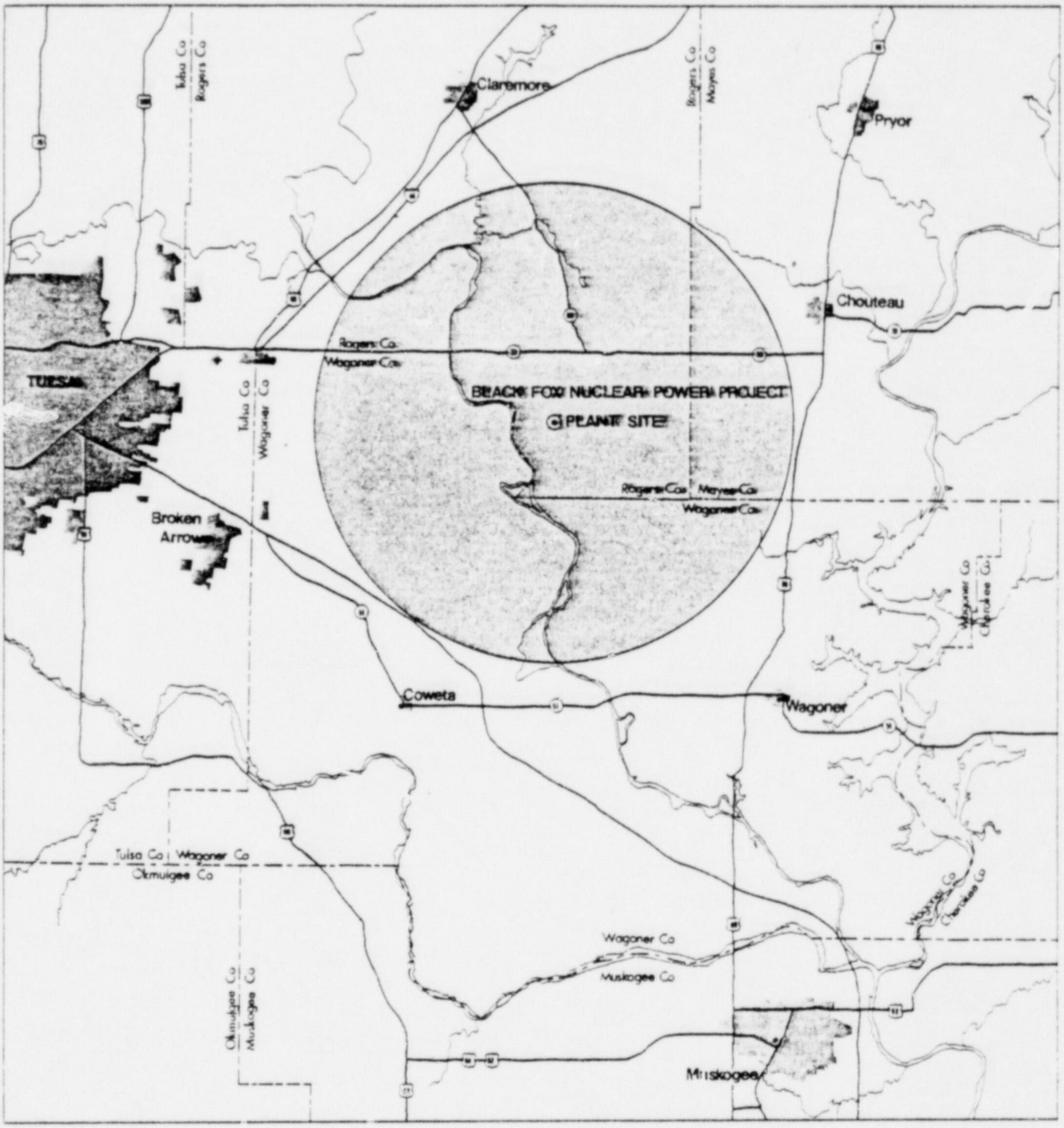
SECTION SURVEY DATA RECORD
FORM B-3353 (1-80)

Population Type	Incident Time of Occurrence: Night Time	Work Time	Sunday Morning	Summer Saturday
Existing Residents	•	•	•	•
Tulsa Growth	•	•	•	•
Construction Force	•	•	•	•
BFS Economic Impact	•	•	•	•
Institutionalized	•	•	•	•
Miscellaneous	•	•	•	•

Each • is one number, representing a population type at a particular ITO. The total data set consists of 24 numbers for each of 2304 cells, and by year, 1980-2020.

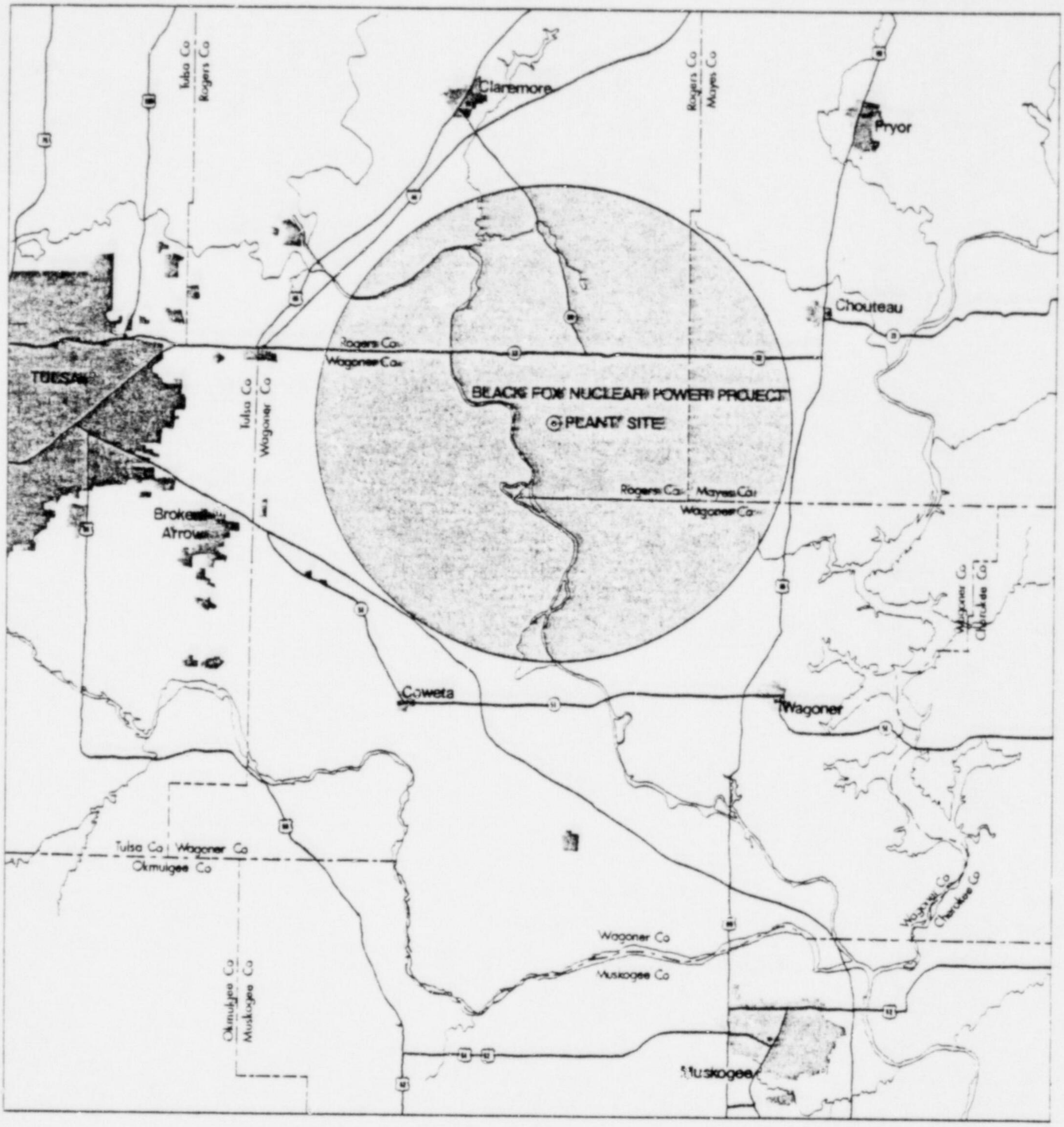
POPULATION NUMBERS PER CELL

FIGURE B-2



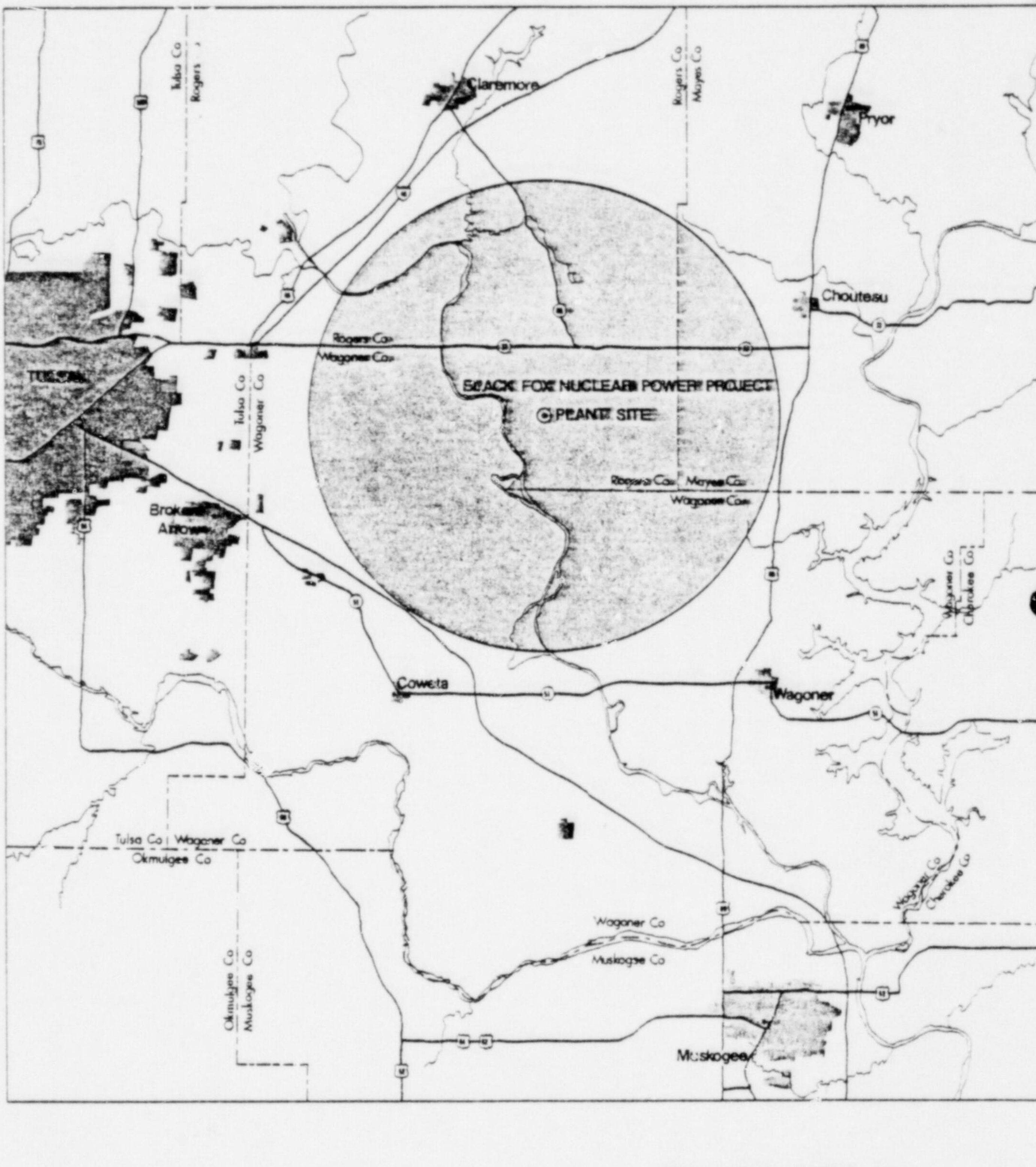
URBAN DEVELOPMENT: 1972

FIGURE B-3



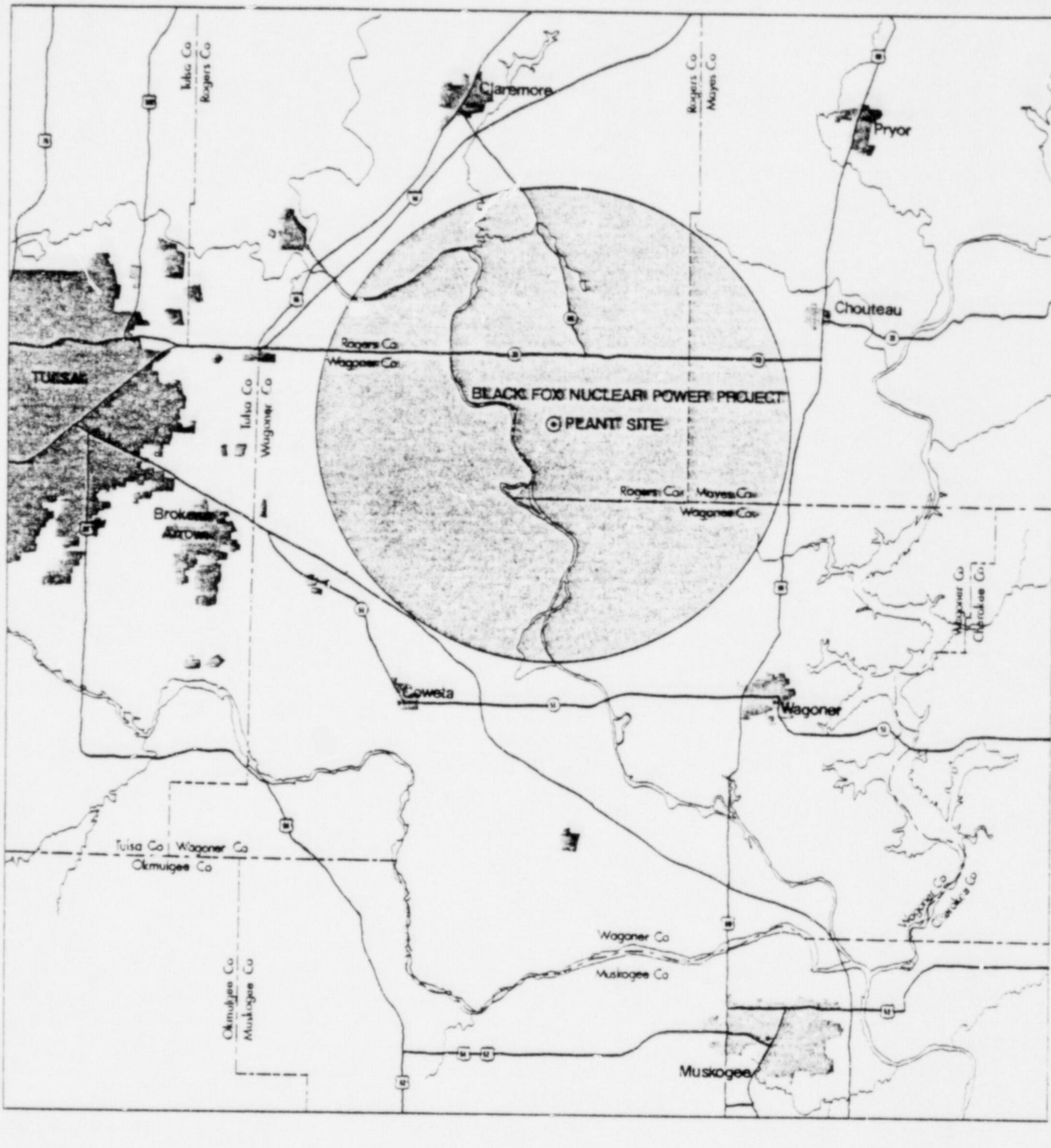
URBAN DEVELOPMENT: 1974

FIGURE B-4



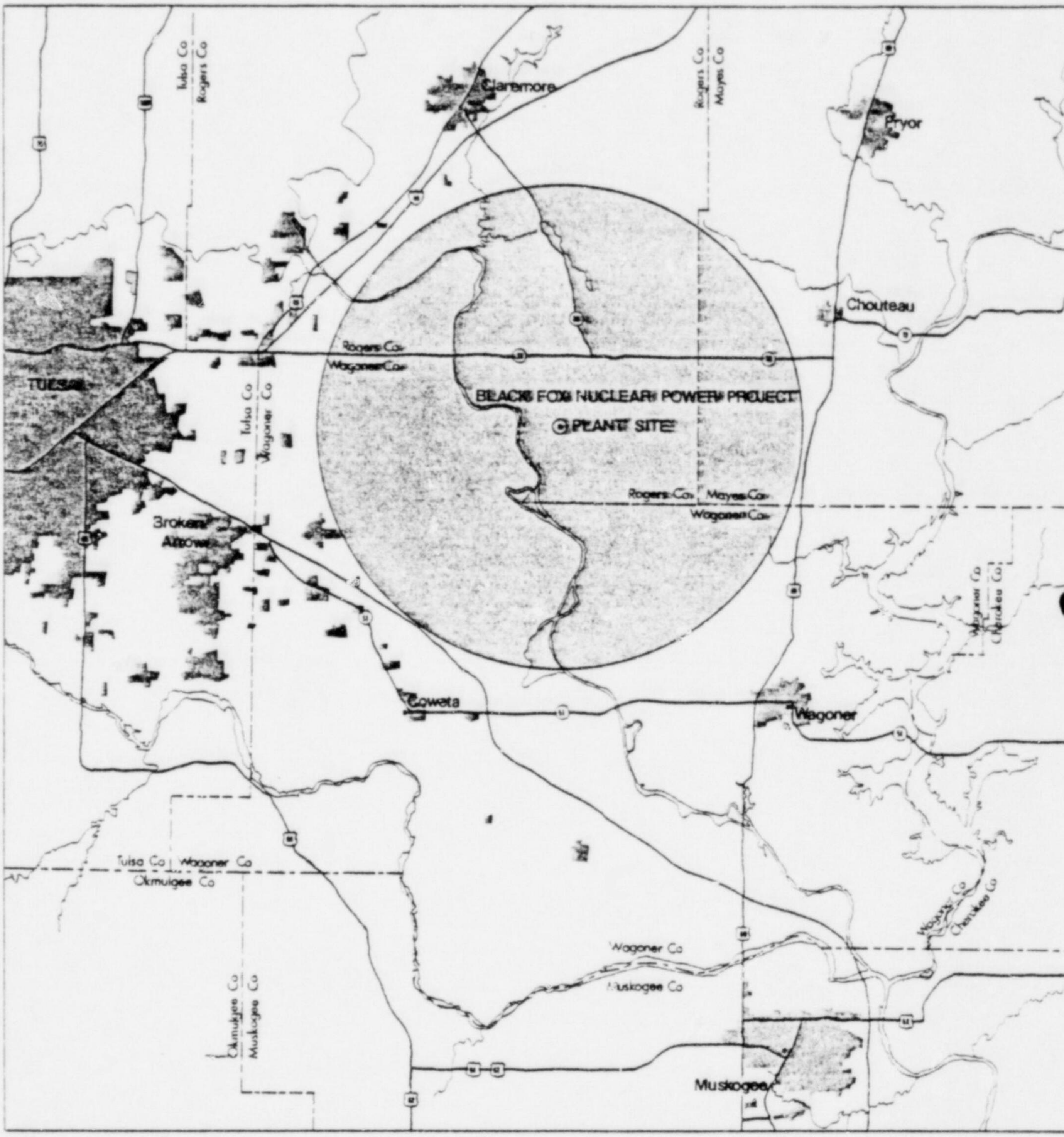
URBAN DEVELOPMENT: 1976

FIGURE B-5



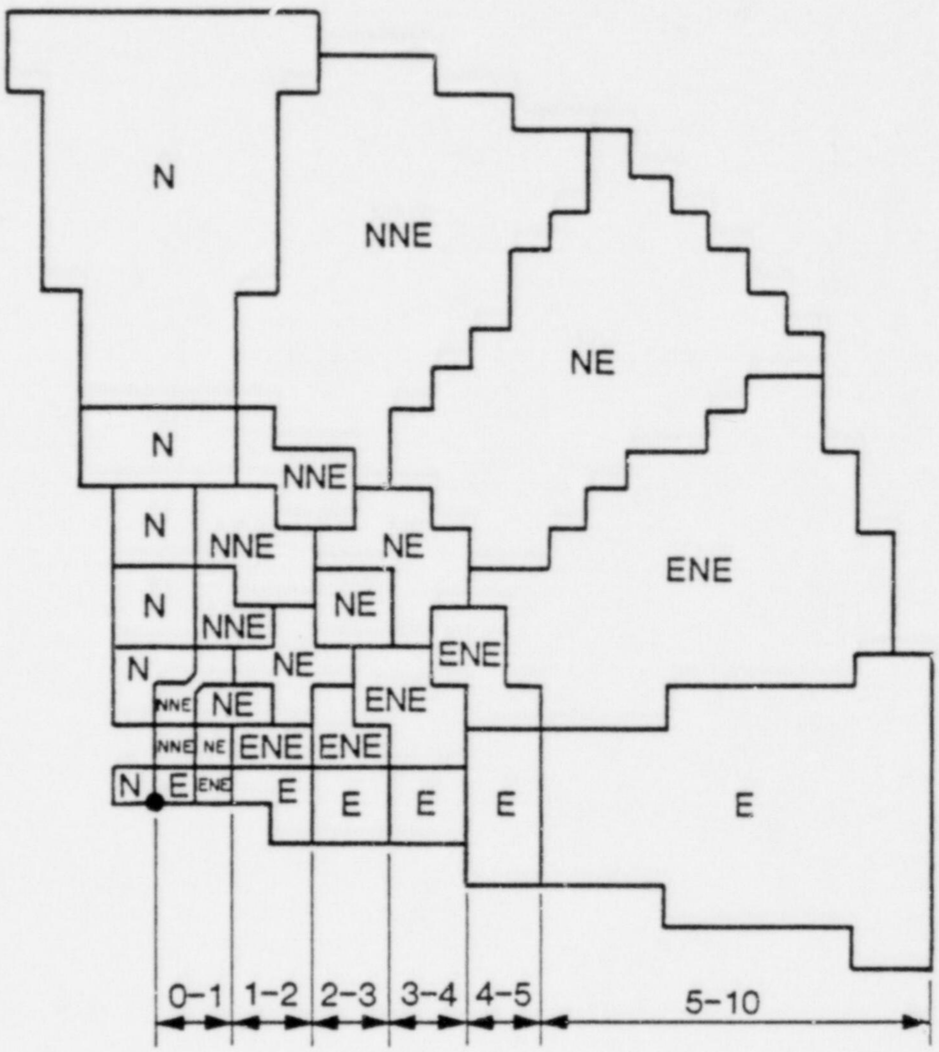
URBAN DEVELOPMENT: 1978

FIGURE B-6



URBAN DEVELOPMENT: 1979

FIGURE B-7



SECTOR DEFINITIONS

FIGURE B-8

```
                      1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 3 3 3 3 3 3 3 3 3 3 4 4 4 4 4 4 4 4 4
    1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8
 1
 2
 3                          11  11
 4                              22
 5                      44                  11
 6                      11
 7                        1122
 8            1122  11
 9                  11
10
11
12
13
14      22
15  331111                                                                                  11  22
16  22          11
174411                                              11
1822                11
194444            11  33                                  11  11
20                                                    114444
21                                                      44
22
23
24                                              □BFS
25    44
26    11                                                                                  11
2722
28
2911          11
30
3111    44      33    22
3244    441122  44
33        334444                    11
34        2222    33
35          11
36
37        3311
38        443311
39          44  11
40
41            1111
42                11
43                      11
44                    2211
45                    11                                                                2233
46                      4444  11                                                    44223322
47                      2244                                                        44442233
48                      224411                                                      11111144
```

Legend

1=100 to 199 persons/square mile
2=200 to 299 persons/square mile
3=300 to 399 persons/square mile
4=400 and over persons/square mile

POPULATION DENSITY: 1980

FIGURE B-9 (a)

```
                       1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 3 3 3 3 3 3 3 3 3 3 4 4 4 4 4 4 4 4
   1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8
 1                                    11  11
 2                              44  11          11
 3                          44114422    11
 4                      1111114444
 5                    334411  11            2211
 6                  1111441144
 7                33  44224444
 8            224433442233
 9            44332244
10
11
12
13      22
14    4444                                                                                    11
15  44444411              11                                                                33  44
16  44221111    11  11                            11                                            11
174444                  11                        22
18444444          1122                                                                          11
19444444          33  4411              11                33  11
20444411                                              334444
21                                                      4411
22                                                              11
23
24                                               □BFS
25    4411
26    22                                                                                  11
2744          11
28    11      22                                    11      11
2911          33      11                                1122
30            22  11  11                                  11
3122    44    2244  1144  11
3244    4422334444
33444444  444444    1111            11
3444  33334444441144  11
3544222233  33      11
36  3322222244
37    3333444444
38      4444444444
39          44444411
40            444444
41            224444  11
42              1144334411
43                4411334411
44                  44444422
45                  22443333                                                          114444
46                    3344444422                                                    44444444
47                    22444444                                                    1144444444
48                      444444                                                    22333344
```

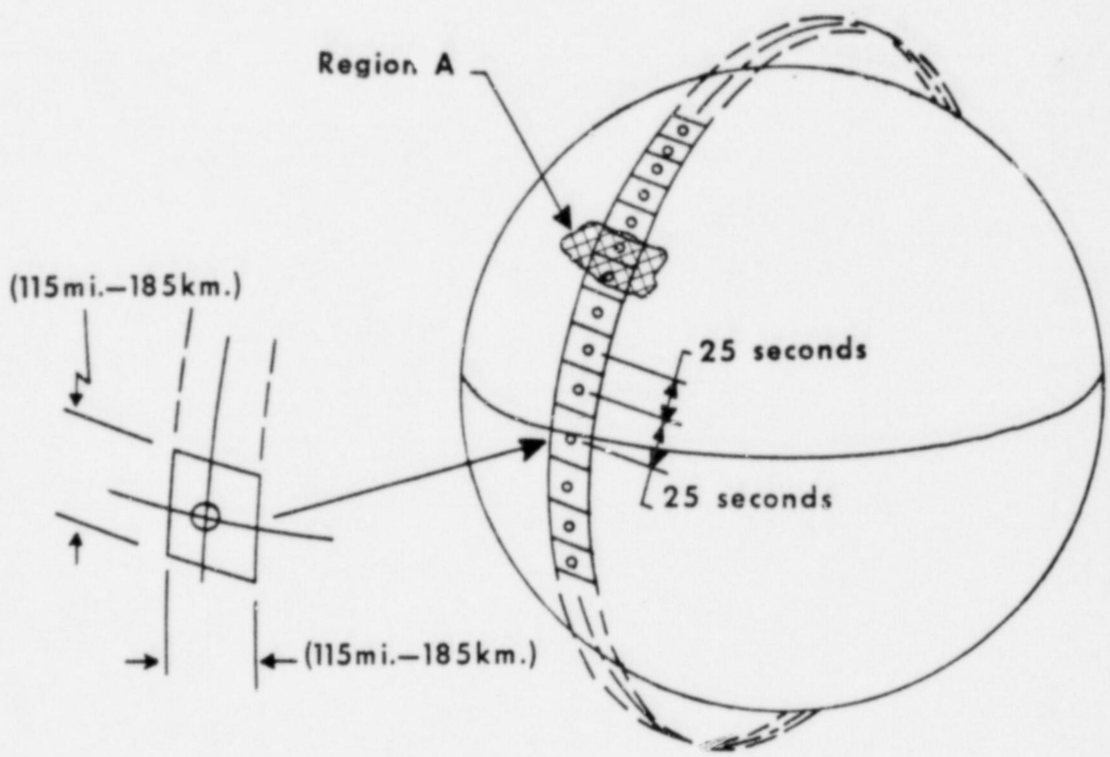
Legend

1=100 to 199 persons/square mile
2=200 to 299 persons/square mile
3=300 to 399 persons/square mile
4=400 and over persons/square mile

POPULATION DENSITY: 2020

FIGURE B-9 (b)

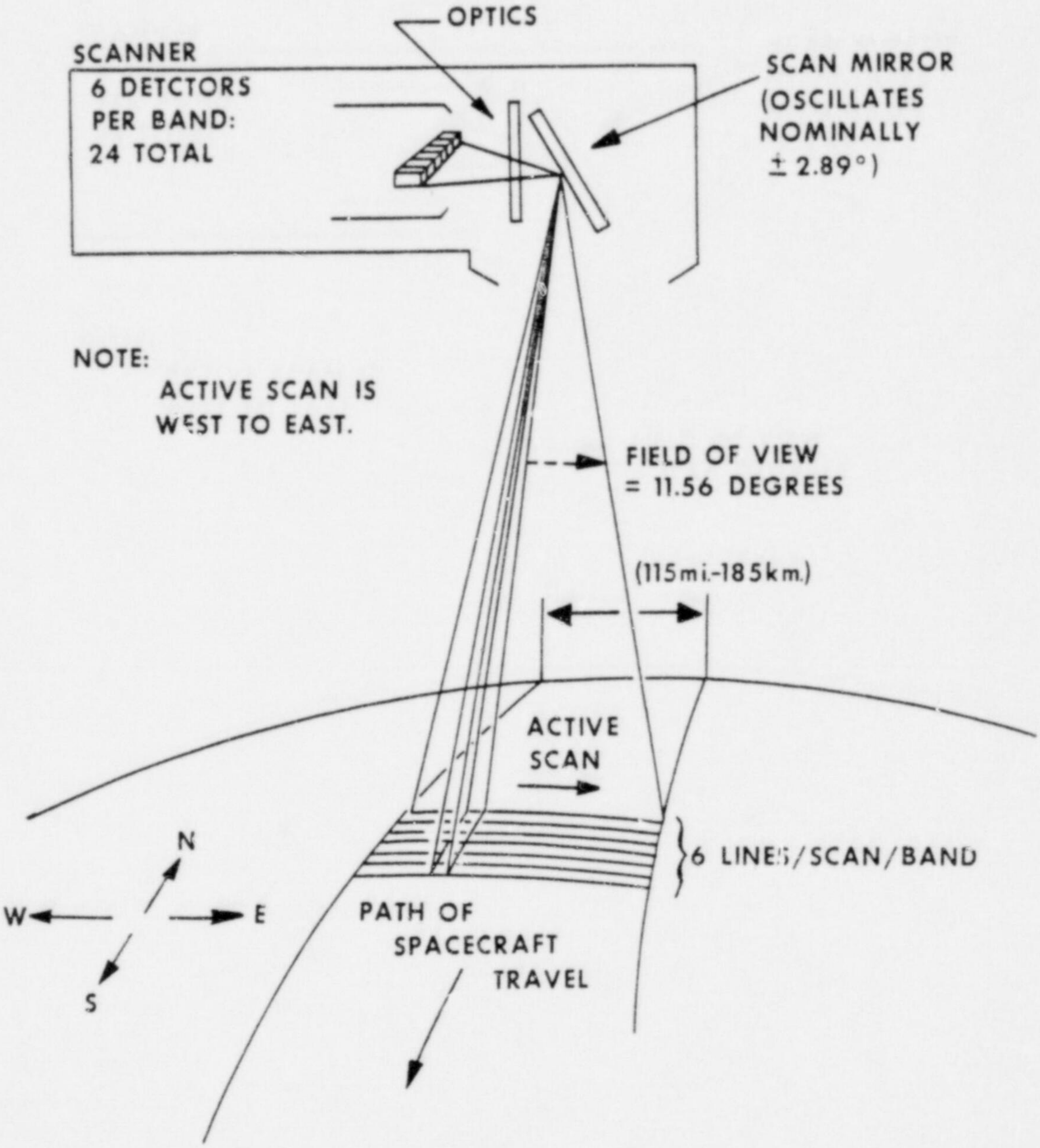
Frame shot within±2 seconds on equator,
other frames spaced at 25 seconds



In-Track Picture Scheduling.

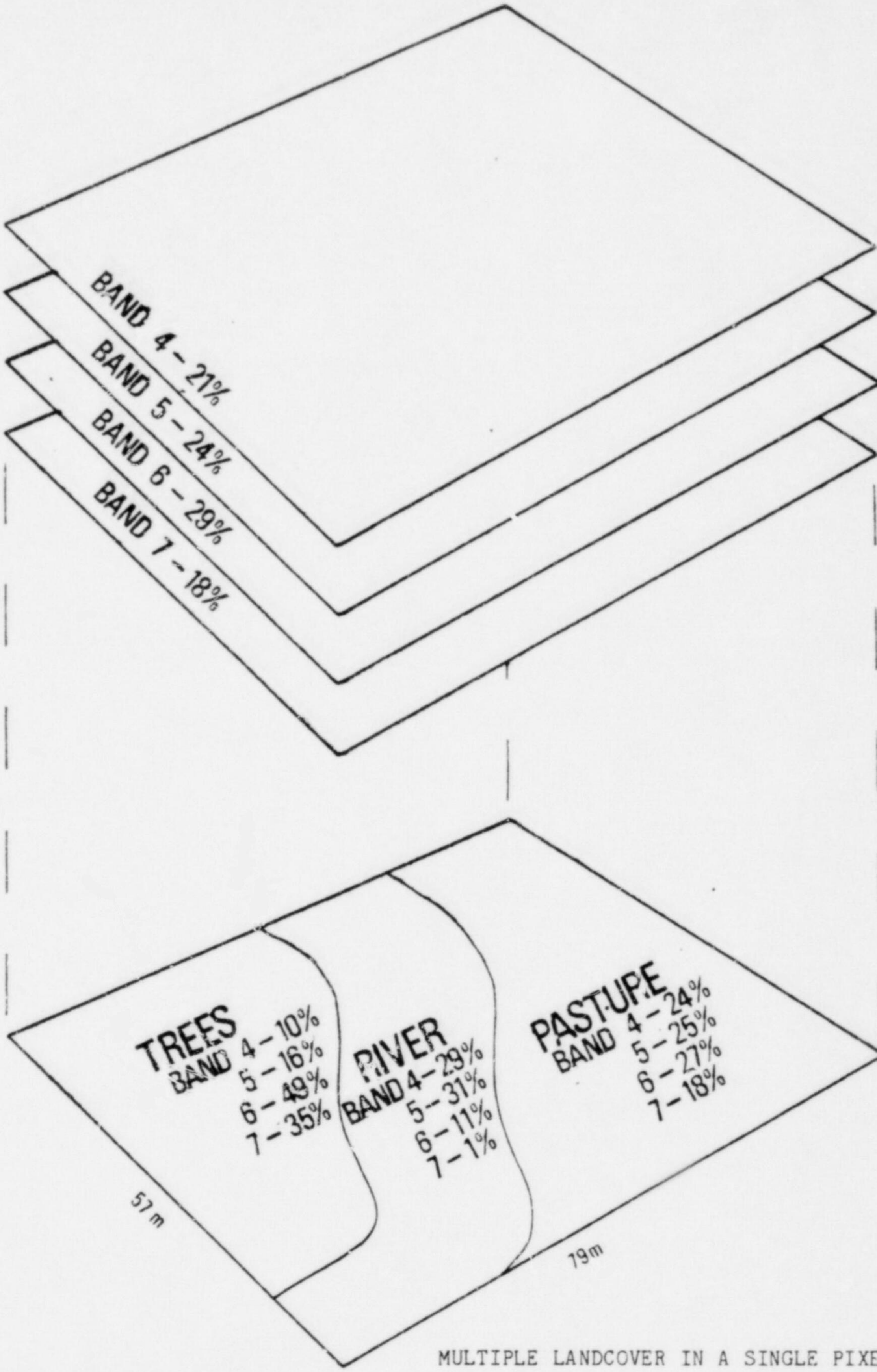
LANDSAT TRACKING SCHEME

FIGURE B-10



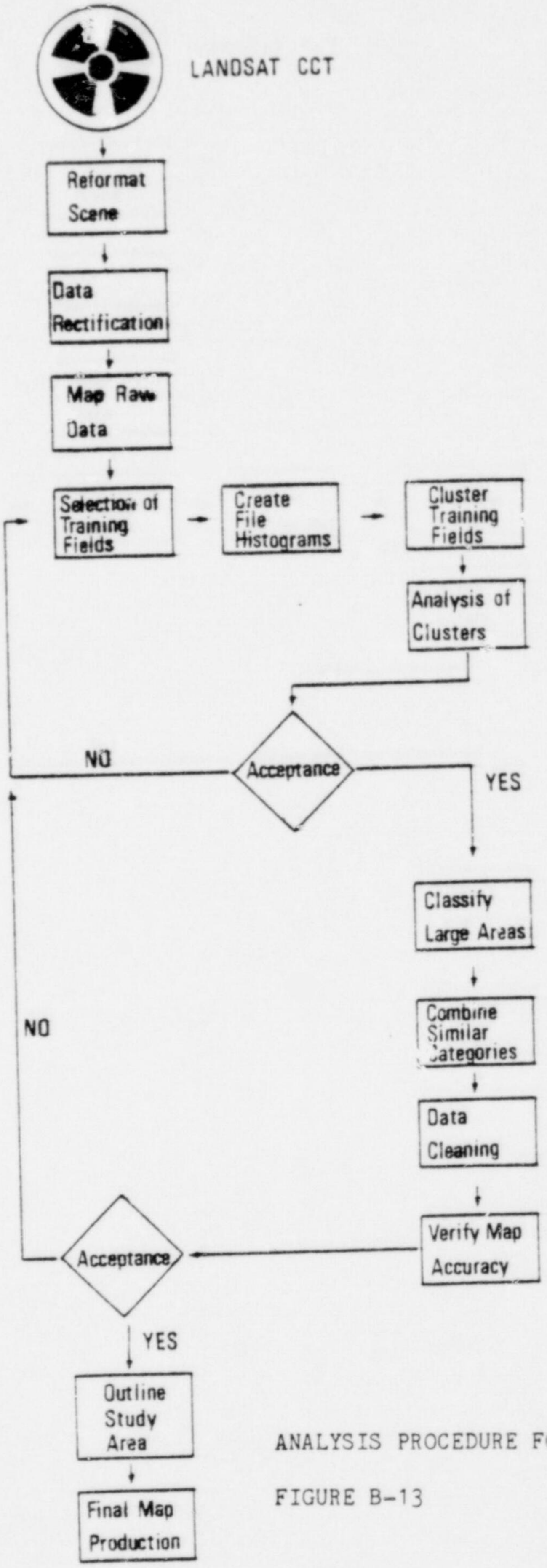
LANDSAT MSS SCANNING

FIGURE B-11



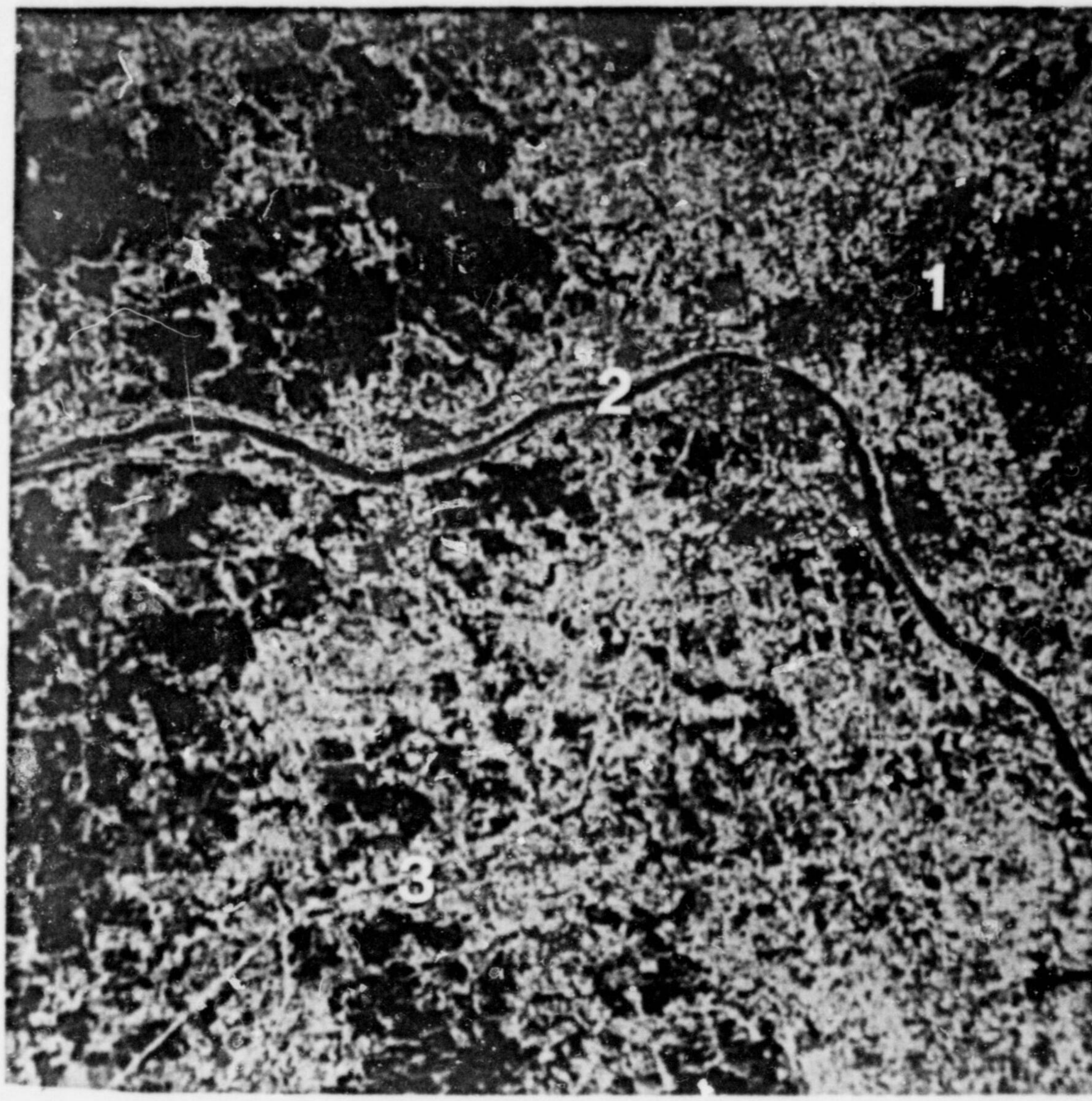
MULTIPLE LANDCOVER IN A SINGLE PIXEL

FIGURE B-12



ANALYSIS PROCEDURE FOR DIGITAL MAPPING

FIGURE B-13

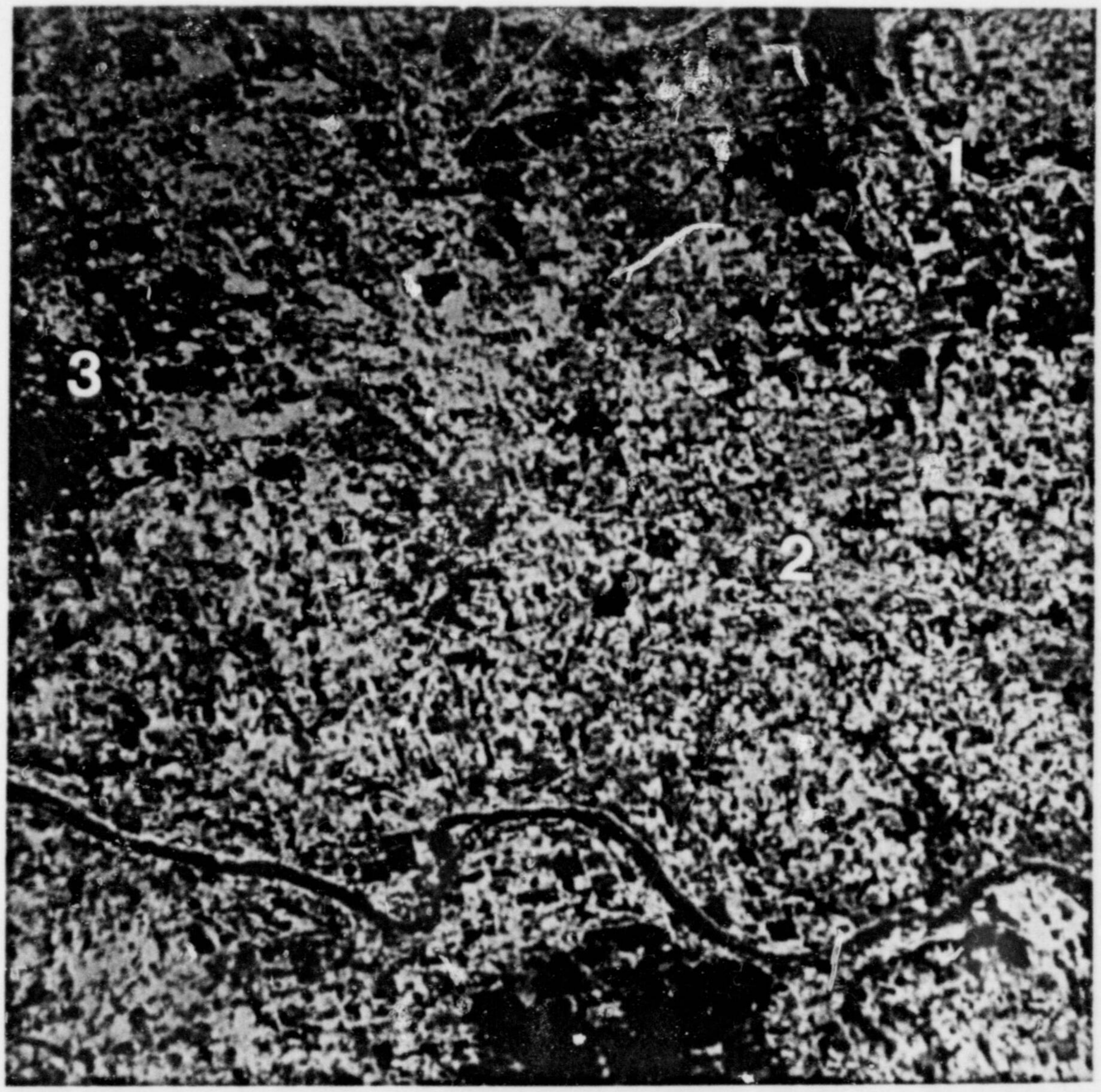


KEY

(1) TULSA
(2) ARKANSAS RIVER
(3) ROUTE I-44

LANDSAT DIGITAL CLASSIFICATION

FIGURE B-14

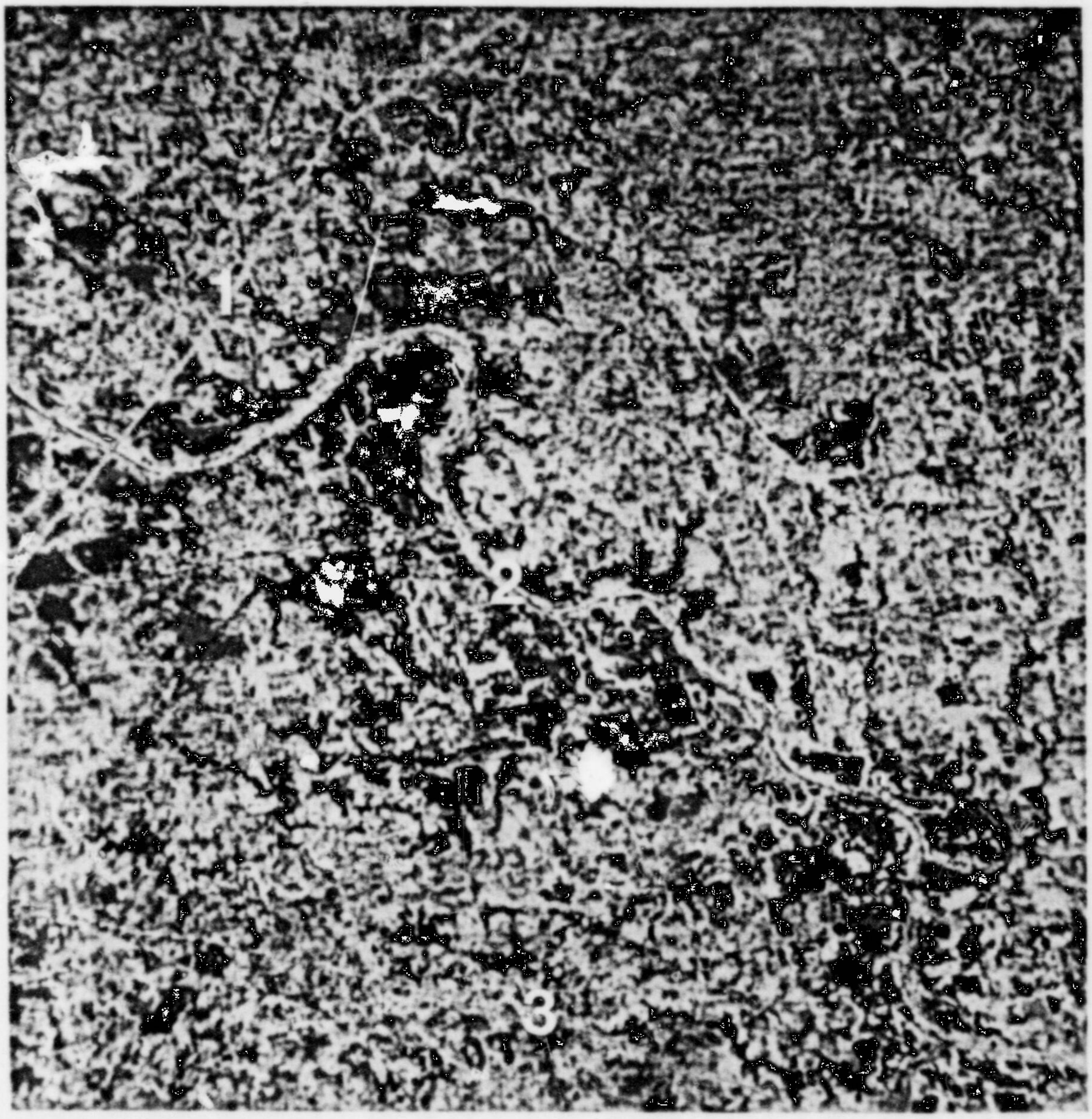


KEY

(1) VERDIGRIS RIVER
(2) MUSKOGEE TURNPIKE
(3) TULSA

LANDSAT DIGITAL CLASSIFICATION

FIGURE B-15



KEY

(1) ROUTE I-44
(2) VERDIGRIS RIVER
(3) MUSKOGEE TURNPIKE

LANDSAT DIGITAL CLASSIFICATION

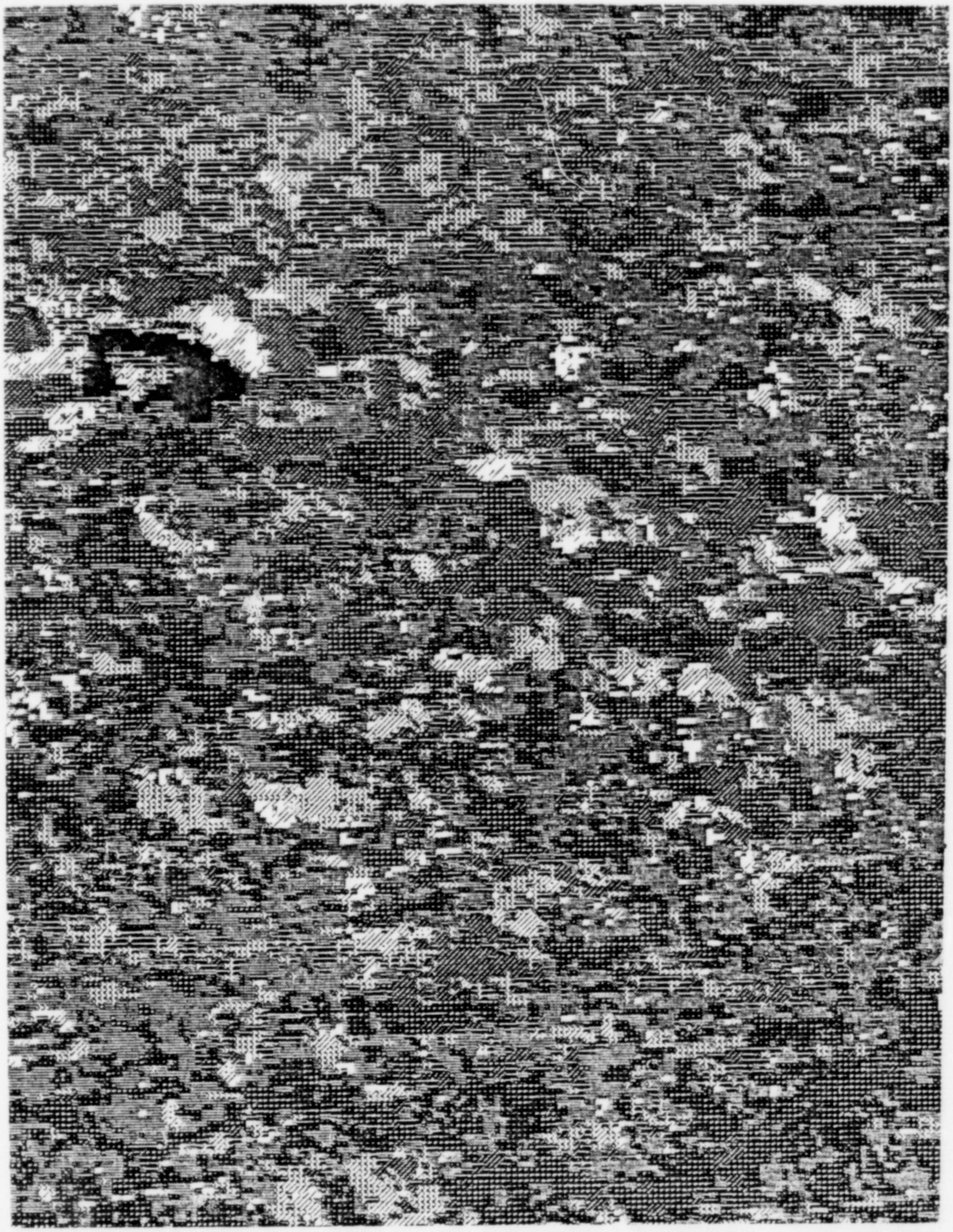
FIGURE B-16

KEY

(1) VERDIGRIS RIVER
(2) MUSKOGEE TURNPIKE
(3) ARKANSAS RIVER

LANDSAT DIGITAL CLASSIFICATION

FIGURE B-17



ELECTROSTATIC PRINTER/PLOTTER MAP

FIGURE B-18

APPENDIX C

Evacuation Time Estimates

APPENDIX C

EMERGENCY EVACUATION TIME ESTIMATES STUDY

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EMERGENCY EVACUATION TIME ESTIMATES STUDY

1.0 INTRODUCTION AND GENERAL CONSIDERATIONS

The central purpose of this study is to provide carefully developed estimates for the time required to evacuate population from the plume exposure Emergency Planning Zone (EPZ) of the proposed Black Fox Station (BFS) nuclear facility in northeastern Oklahoma. This research report was prepared by a project research team of Oklahoma State University (OSU).

1.1 OBJECTIVES OF THE STUDY

The objective of this study is to develop a series of evacuation time estimates which at a minimum will satisfy the requirements of a Nuclear Regulatory Commission (NRC) letter dated December 26, 1979 (see Appendix E), which provides guidelines for evacuation time estimates to be developed for nuclear power generating stations (Reference 1). Based on the requirements of the NRC letter, the OSU team has developed evacuation time estimates using 1980 population data which consider:

a. Partial evacuation of the plume exposure EPZ as follows:
   - --Two 180-degree sectors for areas within 2 miles of the facility.
   - --Four 90-degree sectors for areas within 5 miles of the BFS site.
   - --Four 90-degree sectors for areas within 10 miles of the facility.
   - --Evacuation of the entire plume exposure EPZ.

b. Evacuation time estimates for both normal and adverse weather.

c. Evacuation time estimates for each of four "incident-time- of-occurrence" cases (night time, work time, Sunday morning, and summer Saturday).

d. Total number of evacuation time estimates equals 11 x 2 x 4 = 88. This is based on: 11 areal coverage conditions, 2 weather conditions, and 4 incident-time-of-occurrence conditions.

e. Unique or special conditions which may affect any evacuation time estimate will be included in the estimate or considered separately.

f. Evacuation time estimates based on projections of 1990, 2000, 2010 and 2020 population numbers, densities and other pertinent characteristics.

1.2 CONDITIONS WHICH MAY IMPACT ON EMERGENCY EVACUATION PLANNING

The Black Fox Station and plume exposure EPZ is located in a region of river plain (Verdigris River) and rolling plains land of northeastern Oklahoma. The BFS site is located about 23 miles east of the central business district of Tulsa. The land surface character poses no major, special problems for evacuation planning. The Verdigris River presents a minor topographic barrier to movement east-west as it is bridged at only one point within the plume exposure EPZ (on State Highway 33). Figure C-1 is a general map of the area.

Population density of the region is relatively low. It has one incorporated town, Inola (1970 population 948), and a few other areas of closely settled rural subdivisions. However, the western portion shows evidence of spreading suburban subdivision development associated with the Tulsa metropolitan region. The eastern half of the area is a rather prosperous farming zone with scattered farmsteads.

No major facilities for institutionalized population exist within the plume exposure EPZ (e.g., group quarters for the elderly, room and board schools, hospitals, penal facilities), although some smaller centers of group quarters occur plus several public schools. Mobility of the population is dependent almost entirely upon private automotive vehicles, with school buses the only significant public transportation.

The only special population in the region is a small number of Amish Mennonites centered about 3 miles east of Inola. Because of their reluctance to accept many modern conveniences, their notification and evacuation will require special attention. Their case has been discussed in Section 4.3.3 of this report, and will not be considered further in this Appendix.

A general statement on the Black Fox Station area is that it occurs in a gently rolling plains region with a sparsely populated rural landscape also containing some sections devoid of population and a few areas of low density urban development. Thus the general character of the area presents no major obstacles to the movement of an evacuating population, so long as appropriate consideration is given to notification of the sparse population that an emergency condition exists.

1.3 PREVIEW OF PROCEDURES AND METHODS OF THIS STUDY

Attempting to develop a realistic model of a complex process, such as time estimates for evacuating a dispersed, independent population under emergency conditions, requires acceptance of some limiting assumptions about expected behavior, conditions, rates of change, etc. Those things we have accepted as "given" were either established initially or things which we identified, examined, and found necessary to limit within the scope of the study. These assumptions are clearly defined so that they may be evaluated as more relevant information becomes available in the future. Minor assumptions are indicated in appropriate places in this report. Some of the more broadly-based assumptions are:

a. All relevant persons have been given notification to evacuate such that the entire population may be evacuated. The procedures and process of notification of official evacuation order are considered in Section 3.3 of this report. This study is concerned only with the evacuation process after notification to evacuate has been given.

b. All households and institutionalized population will be evacuated. This is a strong assumption--studies of various other threatening events (including the Three Mile Island incident) have found that some persons are highly resistant to emergency evacuation orders and may remain unless forcibly removed (Reference 2). However, time estimates for a total evacuation depend upon the time at which the last person leaves the emergency evacuation zone. Thus it is necessary to make an estimate (or assumption) of time of departure of the last evacuees. However, some alternative assumptions could be considered. The computer model will be able to provide estimates of the cumulative percentage of the population which has completed evacuation by time intervals after notification (for example, percent evacuated after one hour, after two hours, etc).

c. All persons will be evacuated by motor vehicle (automobile, truck, and, under some scenarios, by bus).

d. All persons will be evacuated from their place of location at the time of notification. This is a "strong" assumption if behavior of evacuees depends upon individual decisions (See Reference 3, Pages 48-52). However, this assumption can be replaced only by much more detailed additional information allowing incorporation of other variables in the analysis or by a set of

weaker assumptions.

Identification of problem variables and conditions was accomplished by examination of prior studies of emergency evacuation planning; from consultations with various federal, state, and local officials; from information supplied by the Public Service Company of Oklahoma; and from field observations. In progressing toward the objective of developing evacuation time estimates, the following procedure was followed:

a. The population was identified and data were supplied by another OSU study team, whose results were reported in Appendix B (BFS population projections). In order to completely encompass the official 10 mile evacuation planning zone, the total area defined was a square measuring 12 miles from the BFS site in each of the four cardinal directions, resulting in a study area with dimensions of 24 x 24 miles. This area was subsequently divided in square cells with 1/2 mile sides, creating a 48 x 48 cell grid or 2304 basic areal data cells. The population estimates and projections made to the year 2020 are discussed in Appendix B.

b. All data on population used in the evacuation time estimates are obtained from the study of Appendix B. All of the cells within 10 miles of the plant site were included in the area to be evacuated.

c. An emergency evacuation roadway network was identified and access of all households to the network was defined.

d. The evacuation network was subjected to analysis and evaluation with respect to traffic carrying capacity, potential obstacles to movement, and traffic flow rate potential.

e. The geographic pattern of population and the evacuation network (with appropriate capacity and flow constraints) serve as input data to a computerized model of the evacuation process.

f. After notification to evacuate has been given, the departure time of vehicles leaving vacuating households is determined by a random "decision" process. The amount of time between notification and departure is recorded for each household as mobilization time.

g. Evacuating vehicles are "moved" along the evacuation network with the total amount of elapsed movement time

depending upon the traffic volumes encountered and the capacity of the routes.

h. The time required for total evacuation depends upon assumptions about the time of departure and movement of the last vehicle to "clear" the plume exposure EPZ boundary. However, the evacuation model can provide estimates of the number (or percentage of the total number) of vehicles which have "cleared" at any of a varied selection of time intervals after the evacuation order has been given--30 minutes after, 45 minutes, an hour, 80 minutes, three hours, or other period of elapsed time.

i. Finally, the evacuation time estimates are evaluated and problems of evacuation can be identified and examined.

2.0 DESCRIPTION OF THE EVACUATION NETWORK AND EVACUATION POPULATION

In developing a model of evacuation time estimates, essential input data must be identified and specification of model variables must be made in a compatible form. This section reports on the input variables which serve as data inputs to the model of the evacuation process.

2.1 IDENTIFICATION OF THE EVACUATION NETWORK

The basic pattern of highways, streets, and roads in the Black Fox Station area is shown on Figure C-1. Information on conditions and characteristics of these roadways was obtained from three sources:

--Survey conducted by Public Service Company employees during February, 1980 (types and locations of all structures and roads were mapped for every quarter mile grid cell).

--Publications and maps from the Oklahoma Department of Transportation.

--Aerial photographs at an approximate scale of 1"=400' were available for the entire study area (date of photography was December, 1979).

--Field checks by project team members.

Exit routes for every one-quarter square mile cell within the plume exposure EPZ were determined. Estimated number of people and households for each cell was obtained from the PSO survey and the study of Appendix B. Roads were classified as being either paved, gravel, or dirt. Figure C-2 identifies major routes and nodes of the network.

2.2 ASSIGNMENT OF EVACUATING VEHICLES TO THE NETWORK

Exit routes for evacuating households (vehicles) were assigned using the following assumptions:

a. People will travel in a direction away from the Black Fox site, given that this choice is possible.

b. Given a choice, people will exit via the best quality roads available, and thus would choose paved over gravel over dirt.

c. People will exit via the shortest route available to them. Most exit route assignment decisions were relatively straightforward, but occasionally arbitrary decisions were necessary. For example, a cell's evacuation route might involve a choice between seven miles of dirt or gravel road heading directly away from the Black Fox site, or twelve miles of paved road of which

the first two miles require travel toward the site.

d. For the case of population projected to the year 2020 it was necessary to assume that roads would be constructed to cells which are presently inaccessible. Our method assumes that gravel roads would link into existing paved roads and that dirt roads would connect with existing gravel roads.

e. All persons will be evacuated by private motor vehicle with an average passenger occupancy of three persons per vehicle assumed. While schools will almost certainly evacuate the students by school bus, the evacuation model does not treat such buses as a different type vehicle. This analysis assumes that the numbers and capacities of buses are sufficient to evacuate all students in a single trip.

f. As the number of persons residing in group quarters is rather small in this area, we have assumed that those persons can be evacuated in a manner similar to the rest of the population.

g. For the town of Inola and environs it was assumed that people would exit in three directions--west, north, and east--and that heaviest movement would be westward toward Tulsa. Thus 70% of Inola's population was assigned evacuation via State Highway 33 westward, 20% by S.H. 88 north, and 10% via S.H. 33 eastward. Because of varied rates of mobilization and departure times, only minor traffic congestion was anticipated for the town of Inola, and it was assumed that local traffic control personnel would be available.

2.3 EVACUATION NETWORK ORGANIZATION: FUNCTIONING OF NODES AND ROUTES

Each cell of the gridded plume exposure EPZ may be viewed as a point or node of origin for evacuating population. Other nodes on the evacuation network represent other points having special functions in the evacuation process. Three types of evacuation route nodes are recognized in terms of function. However, some nodes may have more than one functional role.

a. Collector nodes. Each individual cell was assigned an exit route linking it with an intersection where individual vehicles would be able to enter the traffic flow of a major evacuation route. Collector nodes outside the plume exposure EPZ are identified as nodes 1 - 26; those inside are identified as nodes 27 - 56. Areas

assigned to each of these nodes are shown on Figure C-3. The number of vehicles assigned to these nodes under the 1980 night time population distribution is listed in Table C-1.

Individual vehicles are assumed to travel from their starting locations to these collector nodes at an average rate of 30 miles per hour under normal weather conditions and 15 miles per hour under adverse conditions. The model assumes that there will be no traffic congestion problems in this portion of the evacuation trip.

b. Exit nodes. On any given evacuation route, the first recognized node that is outside the plume exposure EPZ is called an exit node, identified as nodes 1 - 26 on Figure C-2. Each exit node is located at an intersection on a major evacuation route. All exit nodes also serve as collection nodes for their own localized area as some vehicles will travel directly to them and enter a major highway at that point. Some exit nodes, such as node 1 on S.H. 33 west, also serve as important traffic nodes since vehicles from other collector nodes must travel through them.

The calculation of evacuation time includes the time required to leave the ten mile circle en route to an exit node. For example, the evacuation time recorded for vehicles heading toward node 6 on S.H. 20 (east of Claremore) would not include the three miles of gravel road between the edge of the ten mile circle and Highway 20.

The number of vehicles collecting at each of these nodes is given in Table C-1. The total number of vehicles exiting through each of these nodes is also recorded in Table C-1.

c. Traffic nodes. Exit nodes and collector nodes are located at intersections on major evacuation routes to enable the model to simulate traffic flow conditions and predict possible points of congestion associated with those key intersections. Thus both exit nodes and collector nodes also serve as traffic nodes and the program monitors traffic flow conditions through those nodes.

Beyond the exit nodes ten additional exterior intersection nodes (nodes 57 -66 on Figure C-2) were identified as potential traffic bottlenecks, possible affecting exiting vehicles. These are included in the model

to determine if traffic congestion at these nodes could cause traffic to backup into the plume exposure EPZ, thus increasing evacuation time. These nodes are identified in Table C-2.

2.4 EVACUATION ROUTE CAPACITIES AND TRAFFIC FLOW

Rates of movement in a highway network are dependent both on characteristics of users and the nature of routes making up the network. Capacity of routes and individual route segments depend importantly on assorted design characteristics: number of lanes, width of lanes, alignment and grades, type of roadway surface, traffic control devices, shoulders, etc. In turn, capacity is constrained by traffic conditions (user characteristics): volume of demand for travel, average operating speeds of users, and traffic interruptions (intersections, accidents, vehicle breakdowns, and variable behavior of drivers). Thus highway capacity is commonly viewed as a rather complex interaction between design characteristics and traffic flow conditions.

2.4.1 Analysis of Route Capacity in the BFS Evacuation Network

Most studies of highway capacity are based on the only comprehensive and definitive reference, the Highway Capacity Manual, 1965, published as Special Report 87 by the Highway Research Board. Our analysis is based on the concepts and principles of that report (References 4-8).

The Highway Capacity Manual suggests that the capacity for a multilane (4 or more lanes) highway under ideal, uninterrputed flow conditions is 2,000 vehicles per hour (vph) per lane. Under these conditions on a four lane divided highway, an average of 4,000 vehicles in either direction would pass a given point each hour. This ideal capacity assumes an average operating speed of about 30 miles per hour and a lane density of approximately 66 vehicles per mile (vpm).

On a two lane highway with traffic in both directions the ideal capacity rate of flow is 2,000 vph total for both directions. If drivers in a given direction (for example, outward from the plant site) know that they will encounter no opposing traffic, then the ideal flow rate of 2,000 vph per lane could be realized. Under two way traffic flow, gaps in the traffic stream occur, resulting in the lower capacity due to the reduced traffic density. If traffic were about evenly divided between opposing flows, the ideal capacity at 30 mph would yield a density of about 33 vehicles per mile per lane with flows of 1,000 vph in each direction.

Based on the preceding considerations, various segments of the emergency evacuation network were analyzed to estimate capacity flow and density, which in turn are used in the computer model along with average operating speed as factors which determine the nature and rate of movement in the evacuation --and thus, evacuation time estimates. The procedures used in developing flow and density are:

a. Multilane highways. State Highway 33 from a point about two miles northwest of the town of Inola is a modern four lane divided highway without access control. It is a highly important route in the network. Also, SH 51 beyond the plume exposure EPZ toward the west (between nodes 64 and 66) is similar to SH 33 westward. US 66 between nodes 57 and 59 is also four lane divided but of lower quality flow characteristics. To obtain capacity flow, the following equation was used (See Reference 4, page 294):

$$C = 2{,}000\ N\ W\ TC$$

where C is the capacity flow (vehicles/hour in one direction); N is the number of lanes in one direction; W is the adjustment weighting for lane width and lateral clearance (shoulder, etc.), from Table 10.2 of Reference 4; and TC is the truck factor at capacity. Actually this factor was not used because it was assumed that trucks would be excluded from emergency evacuation flows.

The high quality characteristics of the segments of SH 33 west and SH 51 resulted in a W of 1.0 for both but in the case of SH 66 segments W = 0.75. The resulting capacity flow data are shown in Table C-3.

Although something of a "chicken-egg" relationship exists, it seems logical to view capacity as a function of density, but because of the nature of our data and assumptions it became more effective to derive density from our capacity flow calculations. This was accomplished by deriving the following equations from relationships discussed in Reference 4 on Page 51 and related pages:

$$\text{Headway} = 3600 / \text{Volume}$$

where Headway is in seconds between vehicles, 3600 is the number of seconds in one hour, and Volume is in vehicles per hour. Next, we can use our assumed average operating speed to derive a density estimate:

$$\text{Density} = 1 / (\text{Speed} \times \text{Headway})$$

where Density is in vehicles per mile, Speed is in miles per second and Headway is seconds between vehicles. The resulting density estimates are also listed in Table C-3.

b. Two lane highways. All other highways in the Black Fox area are two lane, two directional roads. However, these vary considerably in roadway characteristics. Using examples from the Highway Capacity Manual (Reference 4) plus some judgemental factors, an attempt was made to realistically adjust capacity estimates. Flow capacities were calculated as:

$$C = 2{,}000 \; W \; D$$

where 2,000 is the total number of vehicles per hour for both lanes, W represents weighting factors found in Table 10.8 of Reference 4, and D is a special judgemental factor.

The weighting factor D may be called a directional flow factor and is based on the following argument. It is assumed that under emergency evacuation order all normal traffic on routes approaching the plume exposure EPZ would be halted by traffic control before entering the area. Therefore evacuating traffic would encounter less opposing traffic, allowing for greater ease of passing, and thus higher densities and larger capacity flows. Thus the capacities calculated with the above equation are estimates of the outward flow capacity of each route. The factor weightings used ranged from 0.75 for high quality (wide lanes, wide shoulders, good roadway surface) highways such as SH 33 eastward to 0.55 for low quality, dirt-surfaced section line roads.

Data used in developing both the W and D weighting factors were obtained from the Oklahoma Department of Transportation, aerial photography, and field surveys. Table C-3 shows the capacity flow rates and traffic densities for all node segments of all evacuation routes in the network.

2.4.2 Adverse Weather and Emergency Evacuation

As bad weather conditions can hamper any kind of movement of people, such occurrences could be disruptive of emergency evacuation where time may be critical. Meteorological records for

weather stations in the Black Fox area indicate thunderstorms to be the most common type of adverse weather, occurring an average of 53 days per year in Tulsa. Heavy fog is the second most likely type of adverse weather, occurring 10 days per year on the average. Snow and/or ice pellet storms may also cause temporary paralyzing conditions, but have a probability of occurring only 4 days a year in amounts of one inch or more. In view of the low probability of occurrence of snow/ice storms and heavy fogs, our consideration of the impact of adverse weather on emergency evacuation concentrates on potential effects of rainstorms.

Severe thunderstorms with heavy rainfall are rather common during the summer six months of the year (April through September) and have occurred in all months in the BFS area. Heavy rainfall often accompanied by high winds and some hail causes a needed reduction in operating speeds of vehicles and increases the likelihood of traffic incidents (accidents, vehicle breakdowns, etc.) which may slow traffic flow. Also the possibility of flash flooding exists.

The technical literature on highway capacity exhibits a noticeable deficiency of studies investigating the effects of rain and other natural environmental hazards on roadway capacity (Reference 9). With little evidence to support our efforts, we found it necessary to proceed under some intuitive logic and assumptions about the impact of adverse weather.

First, it seems likely that the spacing between vehicles in traffic flow would increase as drivers become more wary of others --so we adjusted the spacing (headway). Second, slower average operating speeds seem reasonably predictable--so average operating speed was reduced to 15 mph.

Following these adjustments to headway (spacing) and average operating speed, the capacity flow rates and segment densities were recomputed using the adjusted data. The results of these calculations are shown under the adverse weather case in Table C-3.

2.5 HIGHWAY CAPACITY AND EVACUATION FLOW INTERRELATIONSHIPS

The model assumes that traffic will flow at an average speed of 30 mph under normal weather conditions and at 15 mph under adverse conditions. Along with other assumptions about traffic conditions, the node segment capacities and densities are developed as shown in Table C-3 and these in turn become data inputs to the evacuation time estimates model. The number of vehicles expected to use most of the evacuation routes is far below these maximum capacities. With lower traffic volumes,

speeds greater than 30 mph would be expected under normal conditions. For example, vehicles at node 40 moving east on SH 33 would travel the six miles to exit node 9 in 12 minutes at 30 mph, but would require only 6 minutes at a speed of 60 mph. Our model errs on the conservative side in such cases by predicting a larger evacuation time.

The model assumes that all roads within the evacuation-impacted area will remain two-way (two-directional). This allows for inward access of emergency vehicles. However, we also assume that local authorities will close the road network to inward flow of non-evacuation related traffic. For that reason we introduced a direction bias (weighting) in calculating the at-capacity flow rates for two lane highways.

The intricate interrelationships between capacity, traffic density, and operating speed are viewed as the critical behavior which when combined with the geographic distribution of the population at risk enable the model to simulate the evacuation process. The result is a set of evacuation time estimates derived from clearly defined process rules and limiting assumptions.

3.0 METHODOLOGY OF THE EVACUATION TIME ESTIMATES MODEL

Under NRC policy guidelines, total time required for evacuation of an emergency planning zone (EPZ) has four main components:

--Notification time (time needed to notify all population to be evacuated after an emergency evacuation decision has been made).

--Mobilization time (time span between notification of the population and their departure; this is sometimes called preparation time).

--Travel time (following departure from their location when notified, the time actually expended in moving out of the EPZ).

--Confirmation time (time required to confirm that the population at risk has been evacuated).

As stated previously, this study was required to consider only mobilization time, travel time, and confirmation time in developing evacuation time estimates. Therefore, the model described below does not incorporate any element of notification time.

3.1 STRUCTURE OF THE EVACUATION TIME ESTIMATES PROBLEM

As identified for model development, the components of evacuation time are estimates of mobilization time (TM), travel time over local access roads (TLT), and travel time on primary network roads (TPT). The distinction made between local and primary evacuation network roads was discussed in Section 2.0 of this Appendix.

It is assumed that mobilization time is random and TLT and TPT are variable depending on distance, types of highways traveled, and traffic congestion.

Each vehicle within the EPZ leaves its starting location at some random time TM and proceeds along a local access road until it reaches one of the primary routes at a collector node. These nodes where vehicles must enter a primary route represent points where queues may form if the primary road is congested. A vehicle arrives at the collector node, waits in a queue (if necessary) before entering, and then moves onto and along the primary evacuation route. Subject to traffic congestion, the vehicle reaches the boundary of the evacuation zone and continues onward to some designated area.

The total evacuation time for a given vehicle is

$$TTOT = TM + TLT + TPT.$$

The time TLT is assumed to be non-random and strictly a function of distance and speed. Because of traffic congestion, TPT will exhibit random variations because of the randomness in TM.

The calculation of TTOT is performed for all vehicles within the evacuation zone. After most of the vehicles have left a given area within the zone, an evacuation confirmation team would move into the area to assess the status of the evacuation.

3.2 MODEL CHARACTERISTICS AND GENERAL ASSUMPTIONS

Based on the preceding conceptual structure, a computer model was developed to determine evacuation time estimates. Use of a computer model not only provides estimates of TTOT for specific vehicles and areas but also pinpoints potential bottlenecks to evacuation movements and indicates those areas likely to be evacuated last

A flow chart of the computer model developed to determine evacuation time estimates is shown as Figure C-4. The six modules of the model perform the following functions:

--Model inputs and initialization
--Determine mobilization time (TM)
--Calculate travel time over local access roads (TLT)
--Determine movement time over primary network routes (TPT)
--Perform statistical analysis.
--Determine confirmation cime.

Each of these modules is described in detail later in this section.

One general assumption is that mobilization time of individual household units can be adequately described by a given probability density function (Reference 10). Based on data from Section 2.0, traffic capacities (vehicles per hour) and node segment densities (vehicles per mile) are used as model inputs to predict traffic movement. Another assumption is that the use of repeated computer runs (Monte Carlo trials) provides a statistical base which can be analyzed in order to assess expected model accuracy.

3.3 MODEL INPUTS AND INITIALIZATION

Module 1 of the computer model performs the initialization of the program, including the insertion of all physical data describing the EPZ boundaries, the population in each cell, the primary roadway network segment in terms of lengths (miles), capacities (vehicles per hour), and densities (vehicles per mile), and all local access roads with their lengths,

capacities, densities, and conditions (paved, gravel, or dirt). In addition, Module 1 indicates the incident-time-of-occurrence (ITO) and whether normal or adverse weather conditions are in effect.

3.4 PROCEDURE FOR DETERMINING MOBILIZATION TIME

In Module 2, mobilization time is generated randomly for each vehicle in all cells within the plume exposure EPZ boundary. Reports on the Three Mile Island incident were investigated, but these were of little aid because the evacuation was both partial and highly tentative (References 2 and 11). Lacking a clear precedent, estimates of mobilization times become an arbitrary decision. It appears reasonable to assume that the maximum number of vehicles are being mobilized approximately a half hour after the population is warned to evacuate. Moreover, we expect that only a few vehicles remain to be mobilized after an hour following notification and that all are mobilized within two and a half hours.

The evacuation model assumes a curve (Figure C-5) which results in the distribution of mobilization times presented in Table C-4. The random variable TM is generated to obey the Rayleigh probability density function given by

$$f(TM) = (4) \times (TM) \times e^{(-2 \times (TM) \times (TM))},$$

which has a peak when TM is equal to 0.5 hours (shown as 30 minutes in Figure C-5). Values of TM above 2.5 hours are disregarded and new values generated.

3.5 MODELING MOVEMENT AND MOVEMENT TIMES

In Module 3, assumed capacities, speed of travel over local access roads, and their lengths are used to calculate the response time over local access roads (TLT). The sum of TM and TLT is formed and arranged in ascending order for all vehicles assigned to a particular node for entrance onto the primary roadway network. A vehicle which has arrived at a node on the primary roadway network is either allowed to enter upon the primary road immediately or wait until the congested traffic has cleared enough to provide a space for another vehicle. Time is incremented while the vehicle waits in the queue, thus adding to the time of travel along the primary road (TPT). When a space is available, the vehicle enters the primary road and travels amid congested traffic along this road toward the exit node at the zone boundary. The two alternating steps in

the process of load and flow occur during each time interval to produce an effective "pulsating" operation in terms of calculations performed for this potential "stop-and-go" traffic pattern. The travel time TPT for a given vehicle is determined when the vehicle leaves the evacuation zone. These operations in Modules 2, 3, and 4 are repeated for all primary roadways.

3.6 STATISTICAL ANALYSIS

Repeated Monte Carlo trials are performed as indicated in Figure C-4 to form a sufficient statistical base for estimating evacuation time. The computer model simulates evacuation by using 25 different sets of random mobilization times in order to estimate an average expected result and expected variations (standard deviations). Module 5 performs these statistical analysis calculations.

3.7 CONFIRMATION TIME ESTIMATES

Confirmation time estimates in Module 6 are based both on the results of the statistical analysis of Module 5 and the particular assignments of evacuation confirmation teams to given areas within the plume exposure EPZ boundary. While precise estimates of confirmation time depend largely upon the planning of local emergency management decisions, we can provide an estimate based on a reasonable assignment of confirmation personnel.

Using those results from Module 5 identifying the last areas of total evacuation within the plume exposure EPZ, we assign confirmation teams to verify that designated areas have been completely evacuated. The number of confirmation team personnel to be assigned to each area depends upon the relative estimated evacuation time, the population density, and the total number of miles of local access roads within that area. These teams would begin their confirmation tasks even before the last evacuees have left the area, requiring some back-tracking to account for these special cases. For example, confirmation within an area might begin when 99% of the population has been evacuated; the remaining 1% can be identified by the confirmation team and their evacuation can be verified when they arrive at a particular collector node for entry onto a primary road. If the confirmation team within an area begins its work too early, the number of such special cases becomes too large. On the other hand, postponing the start of confirmation until an area is completely evacuated unnecessarily increases the total time for evacuation and confirmation.

Ideally, the assignment of confirmation personnel to specific areas within the plume exposure EPZ should be aimed at

completing the confirmation tasks within all areas at approximately the same time after notification for the evacuation.

4.0 EVACUATION TIME ESTIMATES: FINDINGS AND EVALUATION

Coupling of the study structure and data of section 2.0 with the process model of section 3.0 yields the required evacuation time estimates. These estimates are reported, analyzed, and evaluated in this section. Examination of the time estimates is preceded by a definition and discussion of the geographic sectors of the Black Fox plume exposure EPZ used for consideration of partial evacuation as per NRC requirements.

4.1 SELECTION OF PLUME EXPOSURE EPZ SECTORS FOR PARTIAL EVACUATION

Using the 1980 night time population distribution (See Appendix B) as the base, sectors were geographically oriented in order to place as large a population as possible in a given sector (this might be called a "maximum risk sector") without dividing major concentrations of population. Stated another way, in defining the sectors we attempted to place sector boundaries through zones of low population density. In the plume exposure EPZ, the major population concentrations of concern are the Inola area (NE population sector, 2 to 5 mile band) and suburban Broken Arrow (WSW population sector, 5 to 10 mile band). The term population sector refers to the area subdivisions identified in Appendix B for developing population estimates and projections (See Figure C-6).

An orientation 33.75 degrees west of north (33.75 degrees east of south) was selected as the most appropriate trend for the 90-degree sectors. This resulted in the following association between these sectors (which will be called evacuation quadrants) and the population sectors:

Evacuation Quadrant	Associated Population Sectors
North	NNW, N, NNE, NE
East	ENE, E, ESE, SE
South	SSE, S, SSW, SW
West	WSW, W, WNW, NW

The Inola area falls within the North evacuation quadrant, and the Broken Arrow suburban area is contained within the West quadrant.

Within the two mile radius, portions of the North and East evacuation quadrants were combined to form one 180-degree sector (identified as NE2), with the South and West portions of the two mile radius band forming the other (termed SW2). As the two mile circle around the BFS contains only 3% of the 1980 population, and since it seemed unlikely that only one half of the two mile band would be evacuated during an emergency, the evacuation time estimates for the five and ten mile quadrants

include the entire two mile circle. See Figure C-7 and Figure C-8.

The discussion of partial evacuation uses the terminology N10 to refer to evacuation of the North quadrant out to the 10 mile boundary of the plume exposure EPZ; N5 refers to the North quadrant being evacuated only out to the boundary of the five mile distance band. Thus N10 includes N5, and both include NE2 and SW2.

For analysis purposes, if any part of a cell fell within an evacuation quadrant, the entire cell's population was included within the evacuation of that quadrant. Thus cells intersected by an evacuation quadrant boundary, such as on the line between the NW and NNW population sectors, would be included in evacuation time estimates of both quadrants (in this example in both N10 and W10). It was decided that in a partial evacuation it is better to err on the cautious side and evacuate too many rather than too few. Because of this double-counting, the sum of the partial evacuation populations exceeds the total population by about 24%.

The total population for each of the partial evacuation quadrants is given in Table C-5 for each of the four 1980 incident-time-of-occurrence population distributions.

Prevailing wind direction is another possible criterion for selection of evacuation quadrant orientation, but was considered to be less critical than population distribution. It should be noted, however, that the predominant winds (and especially strong winds) are from the south, making the North quadrant the most likely to be evacuated under a partial evacuation order. As cold fronts pass through the area, the prevailing wind shifts to northerly, making the South quadrant the next most likely to be evacuated. East and west winds are much less frequent and less violent, thus reducing the probability of a partial evacuation of those quadrants.

4.2 EVACUATION TIME ESTIMATE ANALYSIS

This section summarizes the results of 88 separate evacuation simulations resulting from analysis of:

--four different ITO population distributions for 1980 representing where the population is located should an emergency incident occur at night time, work time, Sunday morning, or summer Saturday.

--for each population base, a total evacuation and 10 partial evacuations by area as noted earlier (and outlined in NRC guidelines).

--consideration of both normal and adverse weather cases for

each of the 44 combinations of ITO population bases and evacuation area types.

This results in a total of 88 separate evacuation simulations: 4 ITO population bases times 11 types of evacuation areas times 2 types of weather conditions.

Four other evacuations are also included in order to investigate the relationship between evacuation time and projected population growth in the area. These four simulations are based on only the cases of total evacuation under normal weather conditions using the night time population distribution for 1990, 2000, 2010, and 2020. As Appendix B contains population projections for all ITO geographic distributions for each decade 1990 - 2020 it would be possible for us to make 88 simulations for each projection year. But as this is expensive, largely redundant, and involves some strong assumptions about future transportation conditions, we have elected to run only the four simulations described above.

One of these 92 separate cases of evacuation time estimation will be given a detailed discussion below, in order to demonstrate the capabilities of the model and the level of detail available as output. The remaining 91 cases will then be summarized in tabular form for easy comparison.

4.2.1 Total Evacuation of 1980 Night Time Population Under Normal Weather

Output from the computer model includes the following information:

a. A table showing the number of vehicles entering an evacuation route at each collector node, and number of vehicles leaving the plume exposure EPZ at each exit node (Table C-1).

b. A table showing the average evacuation time for the 25 Monte Carlo runs, as well as the standard deviation and range (Table C-6). Note that each of the 25 Monte Carlo runs represents a different simulation of the evacuation based on a different random distribution of mobilization times. Since in reality there is no way to predict who will be on the road in fifteen minutes and who will take two hours, this approach allows for the possibility that those who are slow to pack up could be located anywhere within the plume exposure EPZ. By using 25 separate and different simulations, the probability of being misled by a single unusually rapid, or unusually slow, evacuation is greatly reduced.

c. Tables which show the detailed progress of the evacuation every five minutes by major exit routes and nodes. Tables C-7, C-8 and C-9 show the details for the fastest, slowest, and average evacuations of the total 1980 night time population under normal weather conditions.

d. When traffic congestion occurs, the program reports the node involved and the number of vehicles delayed. Two types of traffic problems are monitored: (i) a node may become a bottleneck causing traffic to back up along a major exit route. Nodes 24 and 52 on 71st Street near Broken Arrow are examples of this problem. (ii) a major route may be operating at or near capacity resulting in a delay for vehicles attempting to enter the evacuation network at nodes along that portion of the route (i.e., an entry queue forms). Nodes 52 and 53 on 71st Street encounter this problem.

9.2.2 Evaluation: Total 1980 Night Time Population Evacuation, Normal Weather

This evacuation situation has been selected for detailed evaluation.

a. The average evacuation time for the 25 simulations was 143 minutes with a standard deviation of 8 minutes. Statistically this means that for a large number of similar evacuations, two-thirds of outcomes would report an evacuation time between 135 and 151 minutes (plus or minus one standard deviation) and that 95% of the results would be in the 127 to 159 minute range. The actual simulations made ranged from a low of 127 to a high of 160 minutes.

b. In the model, mobilization time is the major component of total evacuation time. While 99% of the population are ready to move in one hour and 24 minutes, achievement of 99% evacuation occurs about 21 minutes later (one hour and 45 minute mark). For most vehicles travel time is relatively small.

c. Traffic problems were encountered only along the 71st Street exit route heading into Broken Arrow. This is a fairly highly suburbanized part of Broken Arrow, with over 3,000 population in the 5 to 10 mile portion of the WSW population sector. Most of these residents probably use 71st Street, a narrow two lane paved road, as their normal access route and it would be their

natural exit under emergency conditions. In an emergency, traffic congestion along this route should be anticipated and traffic control personnel should be made available. In the long run, if population in this area continues to grow, improvement of 71st Street and provision of alternative access routes would be advisable.

The model predicted traffic delays on 71st Street as early as 15 minutes after time of notification. The problem became serious (involving over 50 vehicles) after 25 minutes and reached a peak (involving 280 vehicles) after one hour and five minutes. Congestion then declined gradually such that after one hour and 35 minutes it was no longer serious, and cleared completely by the one hour and 45 minute mark.

None of the other exit routes experienced enough traffic congestion to seriously impede the flow of traffic along the route or to prevent vehicles from entering an evacuation route at their access node.

d. In spite of the predicted traffic congestion on 71st Street, in only three of the 25 simulations was that area the last to be evacuated. Most often (17 of 25 trials) SH 33 heading toward Tulsa was the last route to be cleared.

   This evacuation route includes most of the Inola population and is the largest exit route in terms of number of vehicles. The larger number of vehicles assigned to that route increases the probability that one of those vehicles will be the last to mobilize and start on the road. In addition, vehicles from Inola have farther to travel before they leave the plume exposure EPZ than those from suburban Broken Arrow. It is reasonable that SH 33W would be the last exit node to complete its evacuation.

   Node 18, to the south, was the last node to evacuate on three of the 25 simulations.

e. Attention shoud be drawn to the time differences between a 99% completed evacuation and 100% (Tables C-7 to C-9). On the average, 99% of the population was evacuated within 105 minutes after first notification, compared with 144 minutes for the entire population. This indicates that it required an additional 39 minutes for the stragglers, those with the longest mobilization times, to be evacuated. This is probably quite

realistic. It also suggests that in this example confirmation could begin at the 105 minute mark instead of waiting until 144 minutes have passed; that is, confirmation could begin approximately 40 minutes before the projected 100% evacuation time. In any of the low population sectors, confirmation could reasonably be started still earlier.

f. It is assumed that at a minimum the available manpower for confirmation teams consists of two deputies each from the three County Sheriff Departments and ten guards from the National Guard. Their activity would be to survey by automobiles and one helicopter to verify that evacuation had occurred.

Forming eight two-man teams from these deputies and guards, we could then assign two teams to the Broken Arrow area (71st Street exit route), three teams to the Inola area (33rd West exit route), and one team each to the areas with 33 East and 88 North exit routes. Each of these teams would be in an automobile. The remaining team would be placed in a helicopter to survey the entire southeast area of the plume exposure EPZ.

Based on about 50 miles of local access roads in scattered areas at 25 miles per hour and about 15 miles in densely settled areas at 15 miles per hour, we estimate that the Broken Arrow area can be covered by the two confirmation teams in approximately an hour and a half. Starting at 105 minutes after notification of evacuation, these confirmation teams complete their assignment with a total time for evacuation and confirmation of 195 minutes, or 41 minutes after total evacuation has occurred.

In the Inola area, we estimate that the three teams can cover approximately 65 miles of local access roads in scattered areas (at 25 miles per hour) and about 25 miles in densely settled areas (at 15 miles per hour) in approximately an hour and 25 minutes. Beginning this confirmation at 115 minutes after notification for evacuation gives a total time for evacuation and confirmation of 200 minutes, or 46 minutes after total evacuation has occurred.

The Broken Arrow area and the Inola area are the two "worst case" areas, having the largest populations and most likely to be the last to complete evacuation. Since the other areas can begin verification sooner, we estimate that the other teams, including the helicopter

team, can complete verifications within the total time of approximately 200 minutes (i.e., 3 hours and 20 minutes) for the evacuation and confirmation of the entire plume exposure EPZ.

4.2.3 Partial Evacuations of the 1980 Night Time Population; Normal Weather

The left side of Table C-10 summarizes the number of vehicles involved and the average, minimum, and maximum evacuation time estimates for the ten partial evacuations. Of these, the North 10 mile and North 5 mile quadrants required the largest amount of time. This was expected as the Inola population is included in both of these evacuations, and the Inola population was usually the last evacuated in the total area evacuation discussed above. The time difference for these two partial evacuations is not significantly different than that for total evacuation. And, as noted before, most of the time is accountable to mobilization rather than travel. Table C-11 provides an evacuation summary for the N5 quadrant.

Considering the other partial evacuations, only the West 10 mile quadrant involves a large population--the Broken Arrow suburban area. Nearly 50% of the total population resides in that quadrant, with 90% of that living in the five-to-ten mile portion of the quadrant. Simulation of this quadrant's evacuation reveals the same traffic congestions problems along 71st Street which were discussed earlier in total evacuation. The evacuation summary for this quadrant appears in Table C-12.

None of the remaining partial evacuations involve more than 15% of the total population. Average evacuation times ranged from one hour and 57 minutes to two hours and 13 minutes, with the largest amount of elapsed time attributable to mobilization delays. No traffic problems were observed for any of these partial evacuations.

4.3 EVACUATION OF THE 1980 NIGHT TIME POPULATION UNDER ADVERSE WEATHER

As indicated in prior discussion above, under adverse weather conditions the model assumes that the average travel speed of vehicles would be reduced to 15 mph. This should increase evacuation times for two reasons. First, it would double the driving time required to traverse the exit route for each vehicle, since the speed is cut in half. Second, for most routes both traffic capacities and densities would be reduced because of the slower speeds (See Table C-3). This in turn should increase traffic congestion and result in more and longer delays in both entering and moving along evacuation routes.

Results of the adverse weather evacuations are summarized in the right side of Table C-10.

4.3.1 The Total Evacuation Case Under Adverse Weather Conditions

As expected, the total evacuation time increased considerably to an average of three hours and 39 minutes compared with two hours and 23 minutes under normal weather conditions. Most of the additional time resulted from increased traffic congestion being predicted along the 71st Street evacuation route in the West quadrant.

Except for the SH 33 west exit node, involving the Inola traffic, the model predicted that all other quadrants would be totally evacuated within two and one-half hours. The SH 33 west exit node (node 1) was the next to the last (after 71st Street) to clear in 24 of 25 simulations. It cleared in an average of two hours and 45 minutes for the 25 trials, and required less than three hours in all but one run.

The model predicted the beginning of traffic problems on 71st Street as early as 15 minutes after notification, with serious delays starting after about 25 minutes. Congestion peaked at about one and one-half hours after notification, involving approximately 700 vehicles, after which it gradually declined until the evacuation was complete.

Other than brief and slight intermittent slowups on SH 88 and SH 33 west, the model did not predict serious traffic problems on any other evacuation routes during adverse weather conditions.

4.3.2 Partial Evacuations During Adverse Weather

While all of the partial evacuations took slightly longer under adverse weather conditions, as expected, the predicted evacuation time for most increased by only 20 to 25 minutes (See Table C-10). This increase is mainly due to the reduced speed of 15 mph which doubled the time needed to travel a fixed distance. Bottleneck effects (stoppages, etc.) did not increase significantly on most routes. The fact that total evacuation time was increased only by a relatively small and constant factor under adverse weather reflects that mobiliztion time, rather than travel time, is the major contributing factor.

Only the West 10 mile quadrant shows a greatly increased evacuation time (77 minutes longer than under normal conditions). This increase is similar to that obtained for total evacuation and is caused by the same traffic problems along the

71st Street evacuation route, as discussed in the preceding section.

4.? SUMMARY OF EVACUATIONS FOR OTHER 1980 POPULATION BASES

Total and partial evacuations for other incident-time-of-occurrence (ITO) population distributions (work time, Sunday morning, and summer Saturday) under both normal and adverse weather conditions were also simulated.

Tables C-13, C-14, and C-15 list the number of vehicles assigned to each collector and exit node for a total evacuation based on each of these three ITO population distributions.

Compared to the night time population base, the total number of vehicles evacuating is smaller for each of the other ITO population distributions. This suggests that, although various problems of evacuation planning might be encountered with a more dispersed population such as during the middle of a work day, a Sunday morning, or a summer Saturday, the largest number of vehicles to be evacuated would be associated with the resident population when most household members are at home during a weekday night.

Although a few individual collector and exit nodes show an increase in number of vehicles, most do not, and more importantly the number of vehicles using the two major evacuation routes, SH 33 west from Inola (exit node 1) and 71st Street near Broken Arrow (exit node 24), is decreased in all cases. For exit node 1 the decrease ranges from about 5% for Sunday morning, to about 10% for summer Saturday, to as high as 47% on a work day. Comparable figures for exit node 24 are 14% on Sunday morning, 10% summer Saturday, and 59% on Sunday morning.

The reduction in number of vehicles is largely due to varying proportions of the resident population that are in Tulsa at a given time for purposes of work, shopping, or leisure. The assumptions and methodology used in estimating the different ITO population distributions are fully discussed in Appendix B.

Average evacuation times and standard deviations for these 66 runs are summarized in Table C-16. Summary statistics for the night time ITO simulations are also included in the table for purposes of easy comparison.

The effect of the reduced number of vehicles for the three other population bases can be seen by comparing the total evacuation time for the 88 different evacuations. As expected, the average evacuation time for the other ITO population distributions was generally less than the night time ITO evacuations.

Except for 71st Street, no serious traffic problems were encountered on any of the other 66 simulations. Because of the reduced traffic, congestion along the 71st Street evacuation route was never as bad as for the night time ITO cases. In the case of a work day ITO, there was no traffic flow problem under normal weather conditions and even under the assumption of adverse conditions, the traffic problem lasted less than forty minutes and involved fewer than 100 vehicles at its peak period.

A few of the results presented in Table C-16 appear unusual and require some explanation. For example, on a stormy Sunday morning, why did it take longer to evacuate 217 vehicles for the S5 quadrant than it took to move 659 vehicles from the South 10 mile quadrant, which in fact includes the other 217 vehicles?

The nature of the Monte Carlo randomization process acounts for these apparent anomalies. The details of the simulation output reveal that the S5 evacuation times ranged from a low of 129 minutes to a high of 186 minutes, while the 25 simulations of the S10 evacuation ranged between 135 and 171 minutes. Comparing the 25 simulations for these two partial evacuations reveals that the S5 quadrant emptied more quickly eleven times, compared with thirteen more rapid evacuations for the S10 quadrant. In other words, the two evacuations essentially take the same amount of time. In fact, the difference between the average evacuation times is only a matter of a few minutes, and, given the size of the standard deviations, would not be considered statistically significant.

Thus such apparent inconsistencies are easily within the range of statistical probability and are most likely the result of the random variations in the assignment of mobilization times. As noted earlier, mobilization time accounts for the major portion of all of the evacuation time estimates predicted by the computer model.

It is also reasonable to expect that evacuation times for the five mile quadrants would differ little from those for the corresponding ten mile quadrants. It is likely that the last vehicles to exit in a ten mile partial evacuation come from within the five mile portion of the quadrant anyway. The random process usually assigns a long mobilization time to at least some of the households within the five mile radius (probably quite realistically), at which point their longer exit trip would frequently make them the last to exit. Consequently, the average time required to complete the two partial evacuations would be about the same since the average in both cases is heavily dependent upon the same people, those within

the five mile radius.

If evidence would support it, an alternative to this problem would be to assume that people nearer the nuclear power site would perceive danger as more imminent and mobilize more rapidly. Therefore for populations within the five mile radius, the probability density function generating mobilization times could be designed to have a lower mean departure time and truncated at a lower upper limit for departure. In reality, there is not much to support this contention as there always seems to be laggards or resisters no matter how threatening the incident (for example, Harry Truman and Mt. St. Helen).

Finally, for the summer Saturday simulations some of the evacuation times for small population sectors can be quite high, simply because most of the recreation areas within the plume exposure EPZ have relatively poor access resulting in longer travel times. Examples are some of the areas for outdoor recreation found in the Black Fox Station area.

4.5 EVACUATION TIME ESTIMATES FOR 1990 THROUGH 2020

In order to anticipate future problems steming from population growth in the area, computer simulations for total evacuations were run using the projected 1990, 2000, 2010, and 2020 night time populations. The night time evacuation was selected since it generally involved more people and longer evacuation times than evacuations of the three other population distributions. Partial evacuations were considered unnecessary since any problem that occurred for a partial evacuation for the 1980 population also occurred in the simulation of the total evacuation.

The results of these simulations are summarized in Table C-17. The 1990 simulation revealed no significant change in the total evacuation time. Although the 20% increase in population caused additional congestion along 71st Street, that evacuation route was seldom the last to be cleared in either 1980 or 1990.

For both years, the Inola population exiting to the west on SH 33 was usually the last to be evacuated. The projected increase in population was not sufficient to cause a traffic problem along that route. Since the range of mobilization times was unchanged, evacuation time estimates for the Inola population remained approximately the same for the two years.

The simulation for the year 2000 indicates that the situation has changed. Severe traffic congestion along 71st Street,

due to the projected population increase in the Broken Arrow area, caused that area always to be the last to complete evacuation. The 71st Street traffic problem should become progressively worse in 2010 and 2020. None of the other exit routes should encounter serious traffic congestion.

For all three years (2000, 2010, and 2020), the model predicted that the evacuation of the remainder of the plume exposure EPZ would be completed in approximately two and one-half hours. For the year 2000, the last 4% of the total population was stalled on 71st Street for an additional twenty-two minutes. By 2010 the last 10% of the total population was delayed on 71st Street for an extra hour and twenty-three minutes. By 2020 the model predicts an additional two hours and forty minutes would be required to evacuate the last 15% of the population held up by the 71st Street traffic.

It is important to note that these simulations use the existing 1980 transportation network. It is inconceivable that the population using the 71st Street evacuation route could more than triple (from 1272 vehicles in 1980 to 3892 vehicles in 2020) without significant improvement in the highway network. In this sense the estimates of total evacuation times for 2000, 2010, and 2020 are unrealistic. On the other hand, these simulations indicate that the existing highway network should be sufficient to accommodate evacuation of projected increases in population throughout the rest of the plume exposure EPZ.

5.0 REFERENCES

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TABLE C-1

INFORMATION FOR COLLECTOR AND
EXIT NODES: NIGHT TIME

NODE NUMBER	VEHICLES ENTERING EVACUATION ROUTE	VEHICLES LEAVING EPZ
1	0	1537
2	41	41
3	6	6
4	104	104
5	115	416
6	9	9
7	27	27
8	15	15
9	9	358
10	14	14
11	16	16
12	31	31
13	7	7
14	18	18
15	11	11
16	19	19
17	8	8
18	43	256
19	142	142
20	1	1
21	40	40
22	22	22
23	36	36
24	4	1272
25	95	95
26	9	9
27	484	
28	119	
29	69	
30	31	
31	108	
32	60	
33	55	
34	87	
35	206	
36	318	
37	61	
38	25	
39	19	
40	139	
41	25	
42	29	
43	13	
44	14	
45	24	
46	145	
47	54	
48	9	
49	72	
50	7	
51	14	
52	424	
53	428	
54	363	
55	53	
56	213	

TABLE C-2

EXTERIOR INTERSECTION TRAFFIC NODES

Node #	Intersection
57	US 66 and SH 33
58	SH 266 and access road
59	US 66 and SH 88
60	US 69 and SH 33
61	US 69 and SH 33
62	US 69 and SH 51
63	SH 51 and SH 72
64	SH 51 and 71st Street
65	SH 51 and 51st Street
66	US 66 and SH 51

TABLE C-3

IDEAL FLOW CAPACITIES AND ASSOCIATED TRAFFIC DENSITIES
FOR ALL NODE SEGMENTS OF THE EMERGENCY EVACUATION NETWORK
OF THE BLACK FOX STATION EMERGENCY PLANNING ZONE

Routes	Normal Weather Conditions Capacity (veh./hr.)	Normal Weather Conditions Density (veh./mile)	Adverse Weather Conditions Capacity (veh./hr.)	Adverse Weather Conditions Density (veh./mile)
SH33 (node 34 and west)	4000	133	1800	120
SH 33 (node 35 and east)	1500	50	643	43
SH 88 (nodes 5 and 59)	1330	44	600	40
SH 88 (nodes 46-51)	1079	36	571	38
71st St., Tulsa (node 55)	781	26	450	30
71st. St. (nodes 24, 52-54)	949	32	514	34
51st St. (node 25)	949	32	514	34
31st St. (node 26)	949	32	514	34
US 66 (nodes 2-4, 57, 59)	3000	100	1440	96
US 69 (nodes 7-8, 10-15,62)	1500	50	643	43
SH 51 (node 21 and east)	1079	36	571	38
SH 51 (nodes 22, 23, 63)	1500	50	643	43
SH 51 (nodes 64, 65, 66)	4000	133	1800	120
County Road (node 56)	792	27	461	31
SH 266 (node 58)	1500	50	643	43
SH 20 (node 6)	1500	50	643	43
Other Paved	923	31	500	33
Other Gravel	792	27	461	31
Other Dirt	726	24	434	29

Normal weather estimates are based on an assumed average operating speed of about 30 mph; adverse weather estimates, 15 mph.

TABLE C-4

DISTRIBUTION OF MOBILIZATION TIMES FOR THE BFS/EPZ EMERGENCY EVACUATION MODEL

Time After Notification (minutes)	Percent Leaving During Interval	Cumulative Percent Departed
6	2.0	2.0
12	6.0	8.0
18	8.0	16.0
24	11.0	27.0
30	12.2	39.2
36	11.8	51.0
42	11.0	62.0
48	10.0	72.0
54	8.0	80.0
60	6.0	86.0
66	5.0	91.0
72	3.5	94.5
78	2.6	97.1
84	1.9	99.0
90	0.5	99.5
96	0.2	99.7
102	0.12	99.82
108	0.08	99.90
114	0.05	99.95
120	0.03	99.98
150	0.02	100.00

The above are discrete, rounded estimates of mobilization times derived from the continuous Rayleigh probability distribution function. It has been "forced" to peak at approximately 30 minutes and to curtail estimates at 150 minutes (assuming, therefore, that all persons have begun evacuation by the end of two hours and 30 minutes.

TABLE C-5

1980 POPULATION OF PARTIAL EVACUATION QUADRANTS
BY INCIDENT-TIME-OF-OCCURRENCE (ITO)

Quadrant	ITO Population Distribution			
	Night Time	Work Time	Sunday Morning	Summer Saturday
NE2	237	104	246	166
SW2	188	88	209	718
N5	3689	2350	3743	3186
E5	1181	533	1103	1378
S5	633	275	667	1954
W5	648	386	630	1138
N10	5000	3028	4925	4042
E10	1971	836	1766	1848
S10	2254	968	2020	3007
W10	6871	3099	6071	5464
Total EPZ	13035	6693	11961	11356

TABLE C-6

STATISTICAL SUMMARY: 25 MONTE CARLO TRIALS USING DATA FOR EVACUATION OF TOTAL 1980 NIGHT TIME POPULATION (NORMAL WEATHER)

	Mean	S.D.	Minimum	Maximum
Time Required for Evacuation (minutes after notification)	143	8	127	160

Percent Evacuated	Minutes After Notification
10	24
20	32
30	39
40	45
50	51
60	57
70	64
80	73
90	104
100	143

TABLE C-7

MINIMUM EXITING TIME FOR ALL
SECTORS: NIGHT TIME

TIME ELAPSED (MINUTES)	NUMBER OF CARS EXITED BY ROUTE OR NODE 18	21	4	25	88N	33E	71ST	33W	OTHER	TOTAL CARS EXITED	PERCENT OF CARS EXITED
5	0	1	1	2	0	0	4	0	2	10	0.22
10	0	1	5	6	6	1	33	5	7	64	1.42
15	2	1	8	17	14	6	99	25	20	192	4.26
20	4	6	19	25	27	12	169	66	36	364	8.07
25	12	10	28	36	55	27	242	126	69	605	13.41
30	20	11	40	48	91	54	315	214	110	903	20.02
35	41	19	54	56	121	88	384	321	145	1229	27.25
40	70	21	57	63	162	122	461	482	182	1620	35.92
45	96	29	68	72	201	159	532	610	222	1989	44.10
50	119	33	75	80	240	192	607	740	269	2355	52.22
55	146	35	82	85	274	235	677	898	305	2737	60.69
60	161	36	87	87	301	263	752	1024	338	3049	67.61
65	181	36	93	87	329	284	823	1135	356	3324	73.70
70	196	36	98	90	353	300	887	1221	377	3558	78.89
75	214	37	99	92	375	317	958	1299	393	3784	83.90
80	222	40	100	93	390	332	1024	1361	407	3969	88.00
85	230	40	103	95	397	340	1077	1416	413	4111	91.15
90	237	40	103	95	405	350	1137	1453	417	4237	93.95
95	243	40	103	95	408	351	1191	1482	420	4333	96.08
100	249	40	103	95	411	352	1243	1497	426	4416	97.92
105	251	40	104	95	411	355	1267	1510	428	4461	98.91
110	254	40	104	95	414	356	1269	1521	429	4482	99.38
115	255	40	104	95	414	357	1271	1527	432	4495	99.67
120	256	40	104	95	415	358	1272	1535	432	4507	99.93
125	256	40	104	95	416	358	1272	1536	432	4509	99.98
127	256	40	104	95	416	358	1272	1537	432	4510	100.00

TABLE C-8

MAXIMUM EXITING TIME FOR ALL SECTORS: NIGHT TIME

TIME ELAPSED (MINUTES)	NUMBER OF CARS EXITED BY ROUTE OR NODE									TOTAL CARS EXITED	PERCENT OF CARS EXITED
	18	21	4	25	88N	33E	71ST	33W	OTHER		
5	0	1	0	3	1	0	4	0	1	10	0.22
10	1	2	5	7	6	2	33	1	12	69	1.53
15	2	3	11	13	13	7	94	20	30	193	4.28
20	4	6	17	20	30	15	162	57	56	367	8.14
25	9	9	31	32	67	37	236	133	83	637	14.12
30	21	16	40	39	93	62	310	226	114	921	20.42
35	37	19	49	46	129	92	384	341	150	1247	27.65
40	53	23	59	58	176	127	451	480	196	1623	35.99
45	78	28	70	66	213	168	526	617	241	2007	44.50
50	110	31	81	74	251	202	600	743	284	2376	52.68
55	130	34	91	77	281	234	673	883	316	2719	60.29
60	159	34	95	80	305	263	740	1023	344	3043	67.47
65	186	38	98	84	334	288	815	114[illegible]	381	3367	74.66
70	199	38	100	87	361	305	886	1236	399	3611	80.07
75	211	38	101	89	373	321	951	1313	410	3807	84.41
80	217	39	103	92	387	332	1018	1377	414	3979	88.23
85	229	40	104	93	394	343	1071	1424	423	4121	91.37
90	239	40	104	93	401	348	1128	1464	426	4243	94.08
95	244	40	104	94	406	355	1186	1491	430	4350	96.45
100	248	40	104	94	407	356	1240	1512	431	4432	98.27
105	250	40	104	95	410	356	1266	1519	431	4471	99.14
110	251	40	104	95	416	356	1268	1526	431	4487	99.49
115	254	40	104	95	416	356	1270	1529	432	4496	99.69
120	255	40	104	95	416	358	1270	1530	432	4500	99.78
125	255	40	104	95	406	358	1270	1532	432	4502	99.82
130	256	40	104	95	416	358	1271	1533	432	4505	99.89
135	256	40	104	95	416	358	1271	1534	432	4506	99.91
140	256	40	104	95	416	358	1271	1536	432	4508	99.96
145	256	40	104	95	416	358	1271	1536	432	4508	99.96
150	256	40	104	95	416	358	1271	1536	432	4508	99.96
155	256	40	104	95	416	358	1272	1536	432	4509	99.98
160	256	40	104	95	416	358	1272	1537	432	4510	100.00

TABLE C-9

AVERAGE EXITING TIME FOR ALL SECTORS: NIGHT TIME

TIME ELAPSED (MINUTES)	NUMBER OF CARS EXITED BY ROUTE OR NODE 18	21	4	25	88N	33E	71ST	33W	OTHER	TOTAL CARS EXITED	PERCENT OF CARS EXITED
5	0	2	1	2	3	0	0	0	2	10	0.22
10	0	3	5	6	7	2	21	4	13	61	1.35
15	0	5	7	10	14	2	76	30	27	171	3.79
20	3	11	14	20	34	8	145	69	49	353	7.83
25	9	13	20	26	64	18	216	127	69	562	12.46
30	18	20	29	31	89	39	286	230	103	845	18.74
35	33	23	39	41	122	77	358	338	145	1176	26.08
40	53	26	51	45	159	117	433	485	183	1552	34.41
45	82	26	61	55	196	150	506	633	232	1941	43.04
50	101	28	66	59	255	192	580	767	278	2326	51.57
55	118	31	80	68	295	225	651	904	316	2688	59.60
60	142	31	84	76	332	225	719	1033	339	3011	66.76
65	167	32	89	82	358	275	792	1139	364	3298	73.13
70	180	34	93	87	372	299	867	1227	384	3543	78.56
75	197	34	100	90	384	315	936	1294	393	3743	82.99
80	206	37	102	90	392	328	1001	1356	408	3930	87.14
85	216	38	102	93	401	337	1056	1411	417	4071	90.27
90	229	39	102	95	408	345	1108	1459	422	4207	93.28
95	240	39	103	95	411	351	1171	1485	424	4319	95.76
100	246	39	103	95	411	356	1219	1503	427	4399	97.54
105	248	39	103	95	412	357	1266	1514	431	4465	99.00
110	251	40	103	95	413	357	1269	1520	431	4479	99.31
115	253	40	103	95	414	357	1270	1527	431	4490	99.56
120	254	40	103	95	415	357	1270	1531	431	4496	99.69
125	255	40	104	95	415	357	1270	1533	431	4500	99.78
130	255	40	104	95	416	357	1271	1536	431	4505	99.89
135	256	40	104	95	416	357	1272	1536	431	4507	99.93
140	256	40	104	95	416	358	1272	1537	431	4509	99.98
144	256	40	104	95	416	358	1272	1537	432	4510	100.00

TABLE C-10

PARTIAL EVACUATION STATISTICS - 1980
NIGHT TIME POPULATION

EVACUATION QUADRANTS	Vehicles	NORMAL WEATHER AVERAGE Time (SD)	NORMAL WEATHER RANGE Min.	NORMAL WEATHER RANGE Max.	ADVERSE WEATHER AVERAGE Time (SD)	ADVERSE WEATHER RANGE Min.	ADVERSE WEATHER RANGE Max.
2 Mile Band							
NE2	73	121 (9)	103	137	146 (9)	131	164
SW2	61	117 (9)	116	129	142 (9)	121	154
5 Mile Quadrant							
N5	1201	140 (8)	123	156	163 (9)	148	179
E5	369	130 (12)	114	153	154 (12)	134	206
S5	190	126 (11)	107	159	151 (11)	133	186
W5	198	124 (11)	112	158	148 (12)	133	184
10 Mile Quadrant							
N10	1601	140 (8)	126	152	162 (8)	148	175
E10	582	133 (10)	114	154	155 (11)	136	176
S10	684	129 (11)	113	148	151 (11)	135	175
W10	2219	134 (8)	120	149	211 (1)	217	220
Total EPZ	4510	143 (8)	127	160	219 (1)	217	220

EVACUATION TIMES (MINUTES)

TABLE C-11

AVERAGE EXITING TIME FOR
SECTOR N5: NIGHT TIME

TIME ELAPSED (MINUTES)	NUMBER OF CARS EXITED BY ROUTE OR NODE 18	21	4	25	88N	33E	71ST	33W	OTHER	TOTAL CARS EXITED	PERCENT OF CARS EXITED
5	0	0	0	0	0	0	0	0	0	0	0.0
10	0	0	0	0	0	0	0	0	0	0	0.0
15	0	0	0	0	1	0	0	0	0	0	0.08
20	0	0	0	0	5	2	0	3	0	10	0.83
25	0	0	0	0	13	7	0	9	0	29	2.41
30	0	0	0	0	25	18	0	35	0	78	6.49
35	0	0	0	0	45	28	0	91	0	164	13.66
40	4	0	0	0	53	47	0	153	0	257	21.40
45	11	0	0	0	78	59	0	230	0	378	31.47
50	17	0	0	0	94	74	0	313	0	498	41.47
55	22	0	0	0	111	80	0	392	0	605	50.37
60	27	0	0	0	130	94	0	457	0	708	58.95
65	28	0	0	0	143	108	0	532	0	811	67.53
70	36	0	0	0	156	122	0	585	0	899	74.85
75	40	0	0	0	170	131	0	639	0	980	81.60
80	40	0	0	0	177	136	1	682	0	1036	86.26
85	42	0	0	0	185	145	1	714	0	1087	90.51
90	43	0	0	0	187	148	1	734	0	1113	92.67
95	44	0	0	0	188	152	1	757	0	1142	95.09
100	45	0	0	0	189	155	1	769	0	1159	96.50
105	45	0	0	0	190	160	1	777	0	1173	97.67
110	45	0	0	0	190	160	1	785	0	1181	98.33
115	47	0	0	0	190	161	1	788	0	1187	93.83
120	48	0	0	0	191	161	1	790	0	1191	99.17
125	49	0	0	0	192	161	1	792	0	1195	99.50
130	49	0	0	0	192	161	1	794	0	1197	99.67
135	49	0	0	0	192	161	1	796	0	1199	99.83
140	49	0	0	0	192	161	1	798	0	1201	100.00

TABLE C-12

AVERAGE EXITING TIME FOR SECTOR W10: NIGHT TIME

TIME ELAPSED (MINUTES)	NUMBER OF CARS EXITED BY ROUTE OR NODE 18	21	4	25	88N	33E	71ST	33W	OTHER	TOTAL CARS EXITED	PERCENT OF CARS EXITED
5	0	0	0	1	0	0	4	0	0	5	0.23
10	0	0	1	6	0	0	27	3	3	40	1.80
15	0	0	1	15	0	0	77	21	8	122	5.50
20	0	0	1	22	0	0	139	57	13	232	10.46
25	0	0	2	36	0	0	215	100	21	374	16.85
30	1	0	2	45	0	0	287	180	24	539	24.29
35	4	0	2	59	0	0	356	277	31	729	32.85
40	6	0	6	68	0	0	428	358	39	905	40.78
45	9	0	7	75	0	0	503	428	42	1064	47.95
50	13	0	8	82	0	0	575	496	48	1222	55.07
55	20	0	9	86	0	0	651	549	49	1364	61.47
60	24	0	9	87	0	0	719	602	52	1493	67.28
65	31	0	9	89	0	0	787	656	52	1624	73.19
70	34	0	9	89	0	0	860	693	56	1741	78.46
75	37	0	9	93	0	0	932	720	56	1847	83.24
80	41	0	9	94	0	0	984	742	58	1928	86.89
85	43	0	9	95	0	0	1042	757	58	2004	90.31
90	45	0	9	95	0	0	1100	770	58	2077	93.60
95	46	0	9	95	0	0	1150	784	59	2143	96.58
100	47	0	9	95	0	0	1206	790	59	2206	99.41
105	47	0	9	95	0	0	1210	791	59	2211	99.64
110	49	0	9	95	0	0	1210	792	59	2214	99.77
115	49	0	9	95	0	0	1211	792	59	2215	99.82
120	49	0	9	95	0	0	1211	793	60	2217	99.91
125	49	0	9	95	0	0	1211	794	60	2218	99.95
130	49	0	9	95	0	0	1211	794	60	2218	99.95
133	49	0	9	95	0	0	1212	794	60	2219	100.00

TABLE C-13

INFORMATION FOR COLLECTOR AND
EXIT NODES: WORK TIME

NODE NUMBER	VEHICLES ENTERING EVACUATION ROUTE	VEHICLES LEAVING EPZ
1	0	818
2	19	19
3	0	0
4	49	49
5	82	222
6	3	3
7	8	8
8	4	4
9	4	261
10	5	5
11	8	8
12	10	10
13	1	1
14	1	1
15	3	3
16	5	5
17	2	2
18	12	104
19	60	60
20	0	0
21	13	13
22	9	9
23	9	9
24	2	517
25	41	41
26	3	3
27	226	
28	56	
29	35	
30	15	
31	83	
32	26	
33	36	
34	43	
35	97	
36	201	
37	133	
38	11	
39	8	
40	62	
41	10	
42	13	
43	4	
44	6	
45	10	
46	70	
47	25	
48	2	
49	27	
50	0	
51	16	
52	120	
53	206	
54	169	
55	20	
[illegible]	92	

TABLE C-14

INFORMATION FOR COLLECTOR AND EXIT NODES: SUNDAY MORNING

NODE NUMBER	VEHICLES ENTERING EVACUATION ROUTE	VEHICLES LEAVING EPZ
1	0	1454
2	47	47
3	6	6
4	89	89
5	111	393
6	8	8
7	24	24
8	14	14
9	8	427
10	14	14
11	15	15
12	27	27
13	7	7
14	18	18
15	10	10
16	17	17
17	8	8
18	51	265
19	133	133
20	1	1
21	37	37
22	19	19
23	32	32
24	4	1100
25	90	90
26	9	9
27	424	
28	126	
29	60	
30	42	
31	93	
32	51	
33	47	
34	74	
35	211	
36	326	
37	52	
38	21	
39	117	
40	120	
41	22	
42	40	
43	11	
44	14	
45	22	
46	125	
47	46	
48	8	
49	84	
50	7	
51	12	
52	363	
53	368	
54	207	
55	58	
56	214	

TABLE C-15

INFORMATION FOR COLLECTOR AND EXIT NODES: SUMMER SATURDAY

NODE NUMBER	VEHICLES ENTERING EVACUATION ROUTE	VEHICLES LEAVING EPZ
1	0	1314
2	27	27
3	19	19
4	72	72
5	78	288
6	7	7
7	21	21
8	12	12
9	6	245
10	9	9
11	12	12
12	25	25
13	6	6
14	17	17
15	9	9
16	16	16
17	6	6
18	45	192
19	281	281
20	1	1
21	28	28
22	14	14
23	24	24
24	2	879
25	66	66
26	6	6
27	334	
28	83	
29	48	
30	60	
31	70	
32	232	
33	56	
34	59	
35	15[illegible]	
36	222	
37	41	
38	16	
39	13	
40	96	
41	18	
42	21	
43	11	
44	8	
45	15	
46	101	
47	37	
48	8	
49	49	
50	7	
51	8	
52	294	
53	299	
54	247	
55	37	
56	147	

TABLE C-16

EVACUATION OF THE 1980 POPULATION

BY INCIDENT-TIME-OF-OCCURRENCE, BY SECTORS, AND BY WEATHER CONDITIONS

(Number of Vehicles, Mean Evacuation Time, and Standard Deviation)

EVACUATION TIME (MINUTES)

AREA EVACUATED	NIGHT TIME			WORK TIME		
	VEHICLES	NORMAL	ADVERSE	VEHICLES	NORMAL	ADVERSE
NE2	73	121 (9)	146 (9)	30	109 (11)	134 (11)
SW2	61	117 (9)	142 (9)	27	109 (12)	133 (12)
N5	1201	140 (3)	163 (9)	761	134 (9)	156 (7)
E5	369	130 (12)	154 (12)	158	124 (12)	146 (12)
S5	190	126 (11)	151 (11)	78	118 (9)	143 (9)
W5	198	124 (11)	148 (12)	116	117 (12)	139 (13)
N10	1601	140 (8)	162 (8)	964	135 (8)	157 (8)
E10	582	133 (10)	155 (11)	229	125 (13)	148 (14)
S10	684	129 (11)	151 (11)	277	123 (15)	146 (16)
TOTAL	4510	143 (8)	220 (1)	2175	139 (8)	159 (9)

EVACUATION TIME (MINUTES)

AREA EVACUATED	SUNDAY MORNING			SUMMER SATURDAY		
	VEHICLES	NORMAL	ADVERSE	VEHICLES	NORMAL	ADVERSE
NE2	80	119 (10)	145 (11)	52	114 (11)	140 (11)
SW2	69	119 (9)	143 (10)	235	130 (13)	154 (13)
N5	1235	141 (9)	164 (9)	1040	140 (8)	163 (8)
E5	358	129 (11)	152 (11)	450	134 (11)	158 (12)
S5	217	131 (12)	155 (12)	521	136 (10)	161 (11)
W5	205	126 (13)	149 (14)	369	130 (11)	154 (11)
N10	1617	140 (8)	162 (7)	1320	141 (8)	164 (7)
E10	568	132 (11)	153 (11)	613	134 (12)	159 (11)
S10	659	129 (10)	152 (11)	865	137 (9)	159 (10)
W10	1992	133 (9)	183 (1)	1779	132 (7)	154 (6)
TOTAL	4264	141 (8)	192 (1)	3596	144 (9)	166 (9)

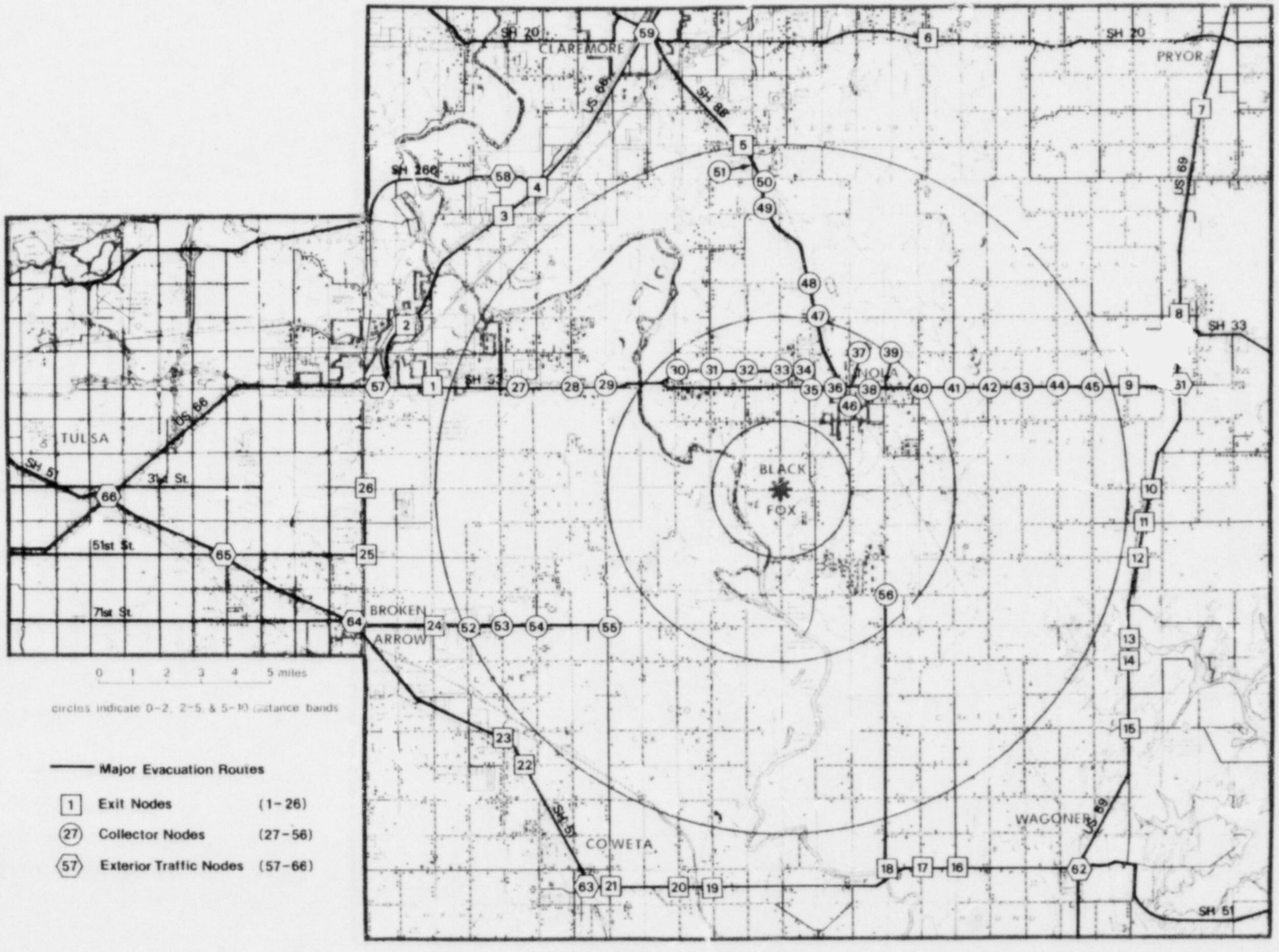
TABLE C-17

EVACUATION TIMES FOR PROJECTED
NIGHT TIME POPULATIONS

Date	Vehicles	Average Evacuation Time (SD)
1980	4510	143 (8)
1990	5695	144 (7)
2000	7119	172 (1)
2010	9273	233 (1)
2020	11733	310 (1)

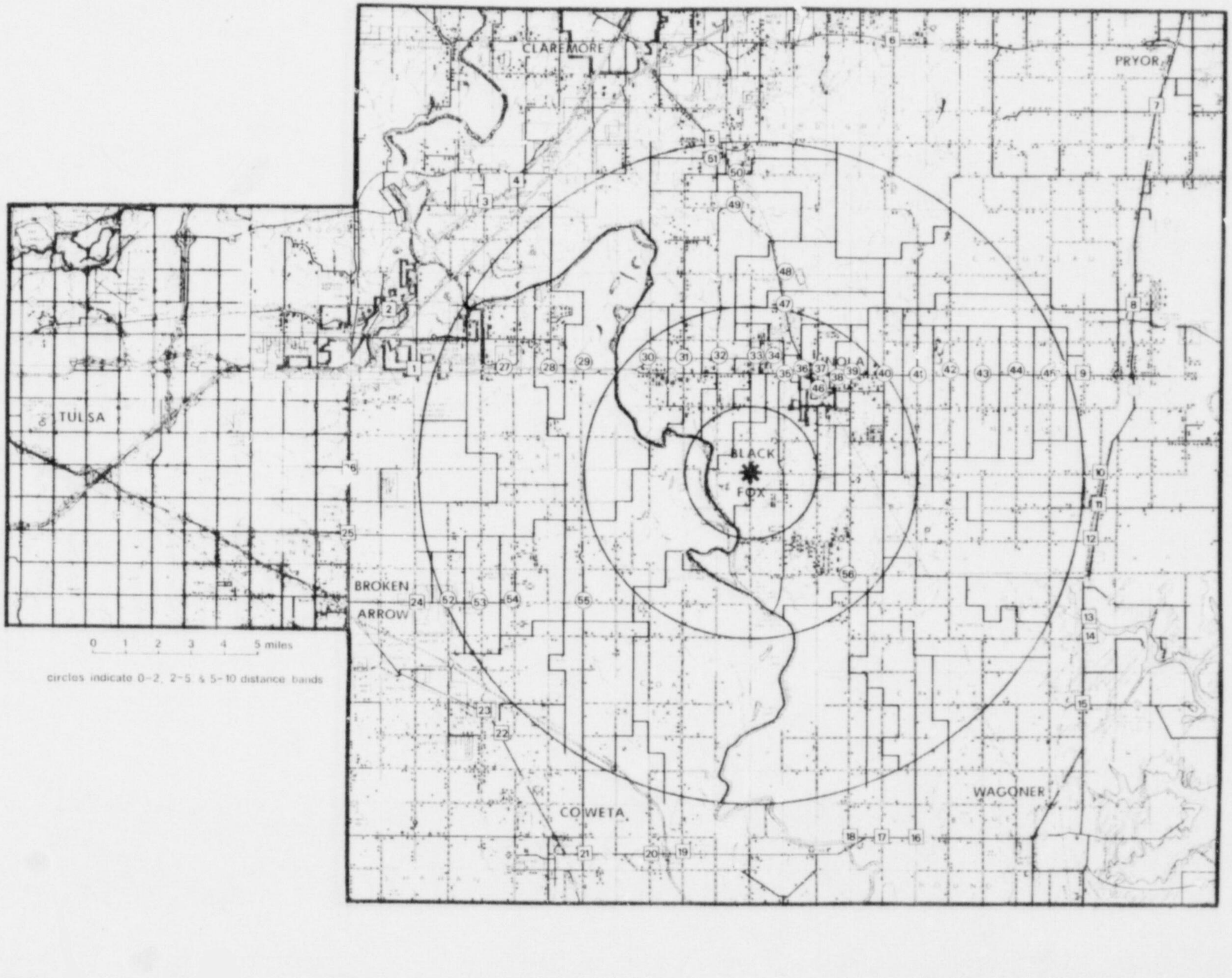
REGIONAL SETTING AND HIGHWAYS

FIGURE C-1



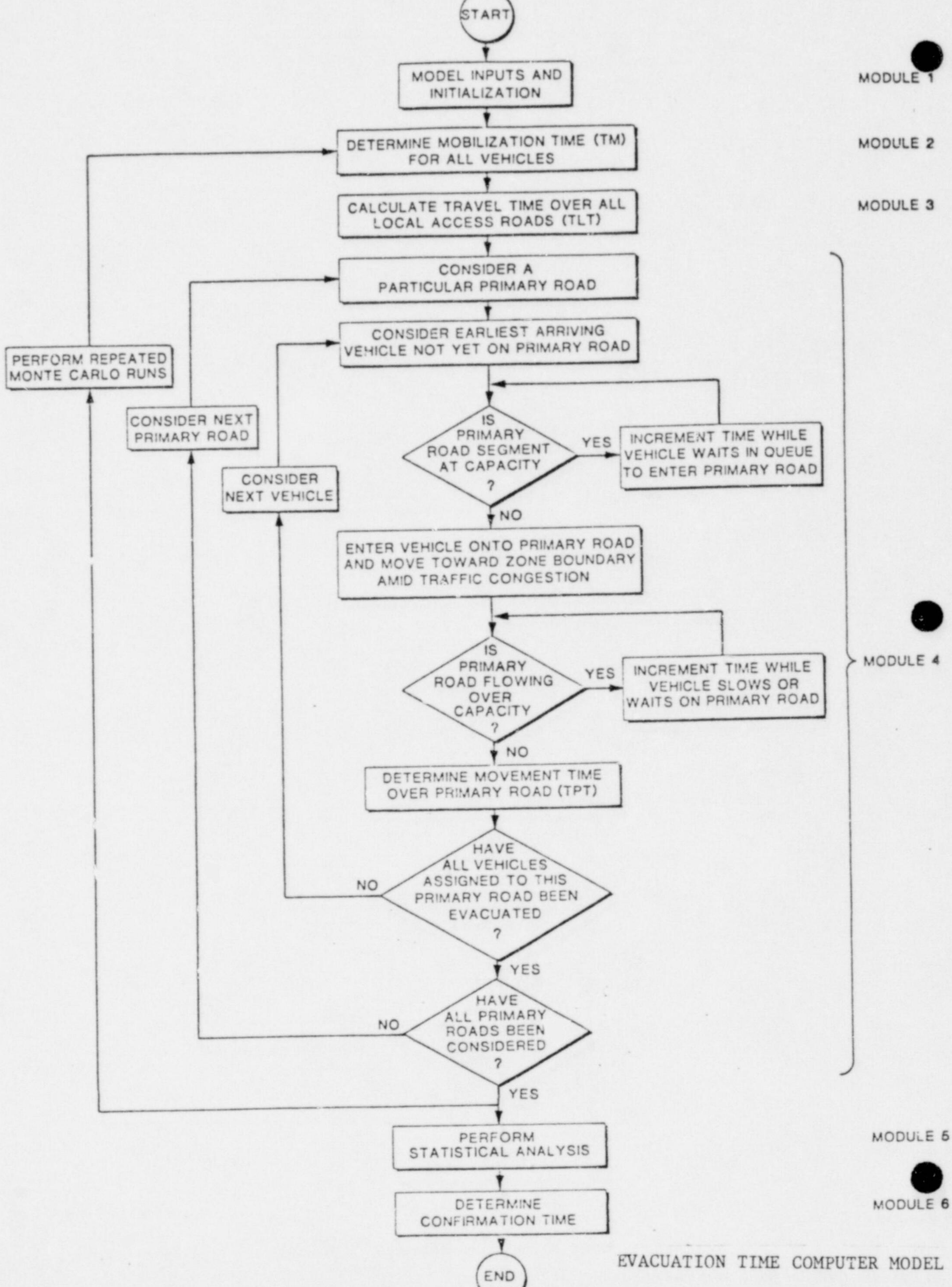
HIGHWAY EVACUATION NETWORK

FIGURE C-2



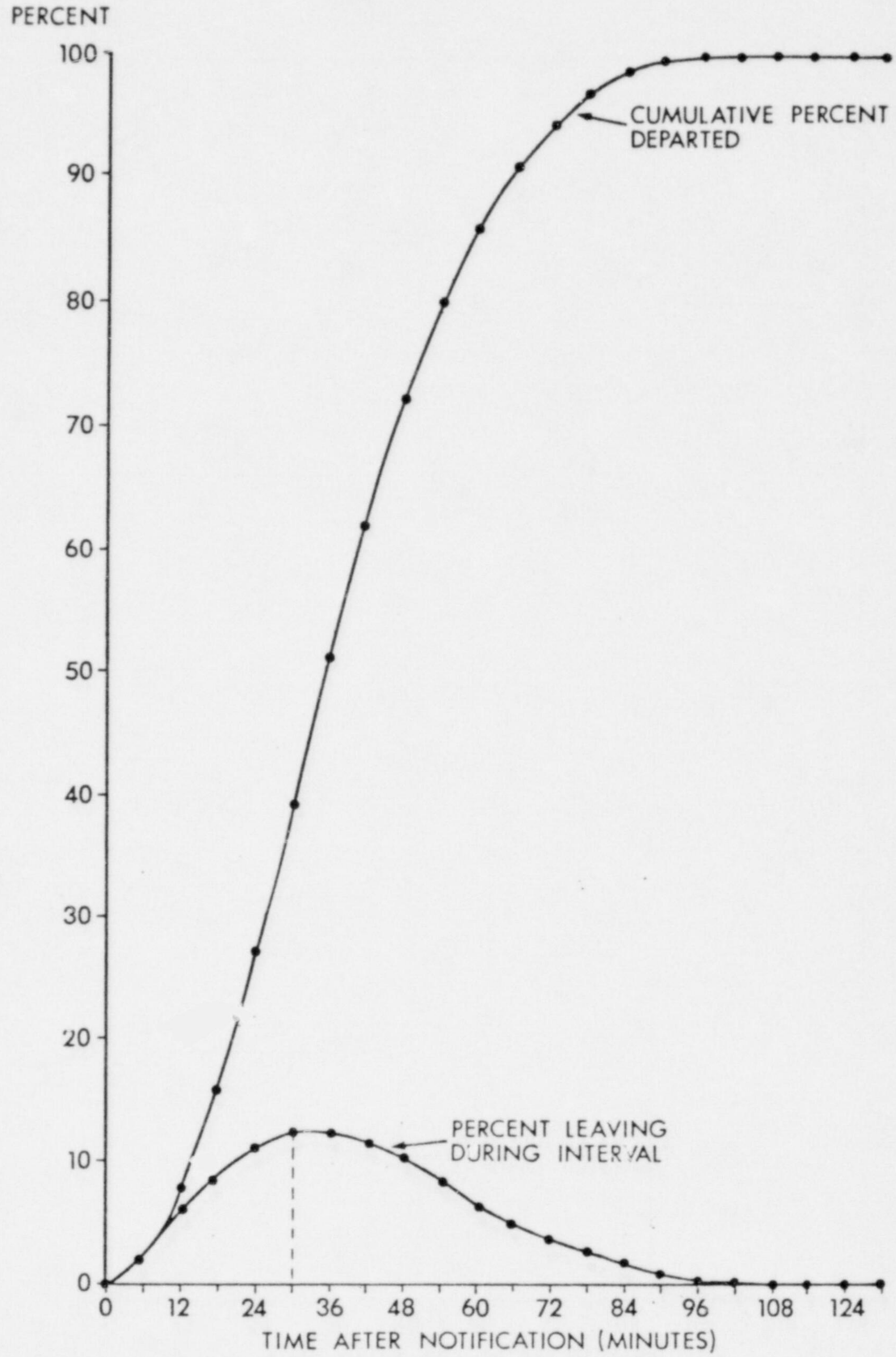
EVACUATION ASSIGNMENT ZONES

FIGURE C-3



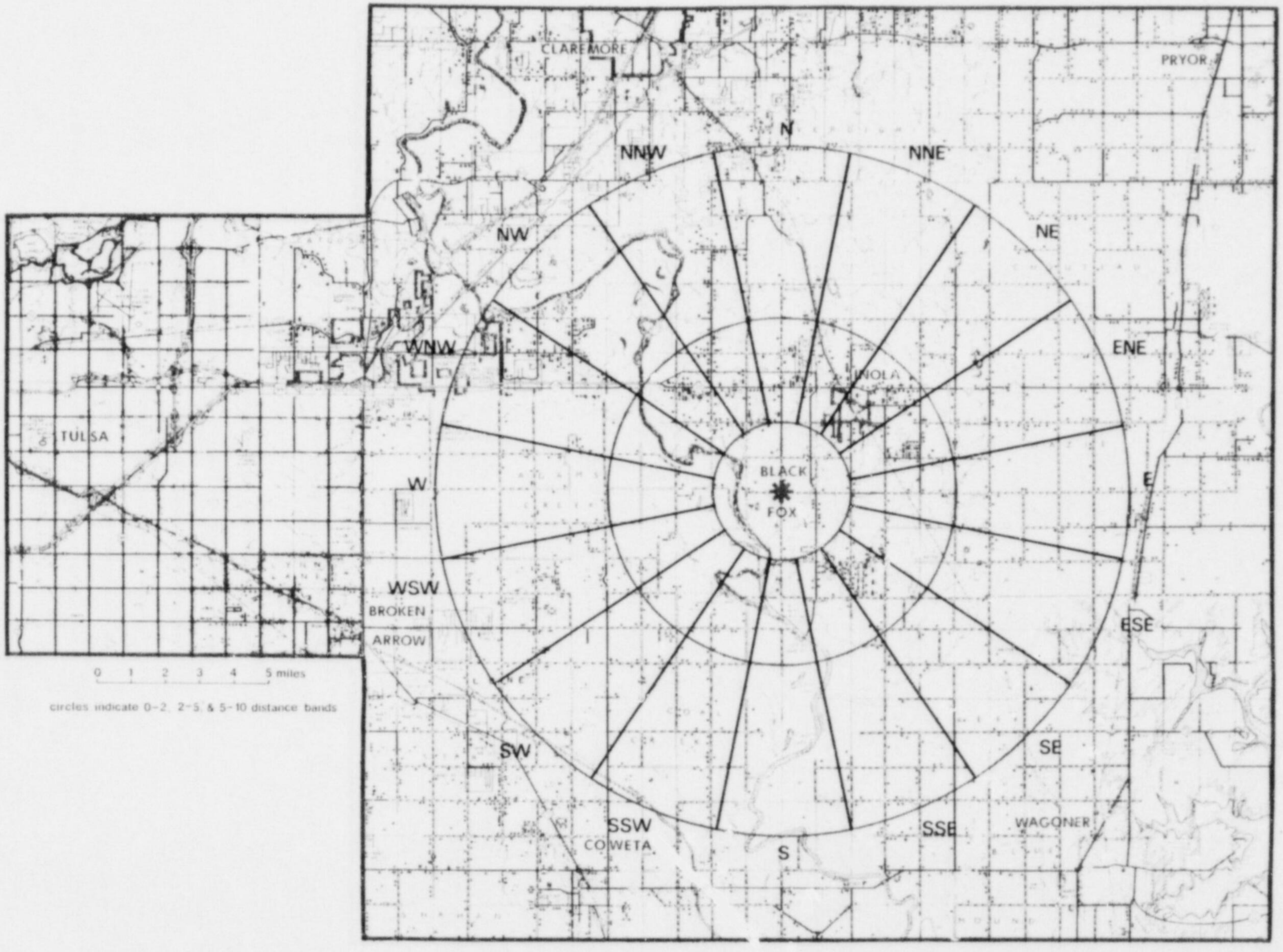
EVACUATION TIME COMPUTER MODEL

FIGURE C-4



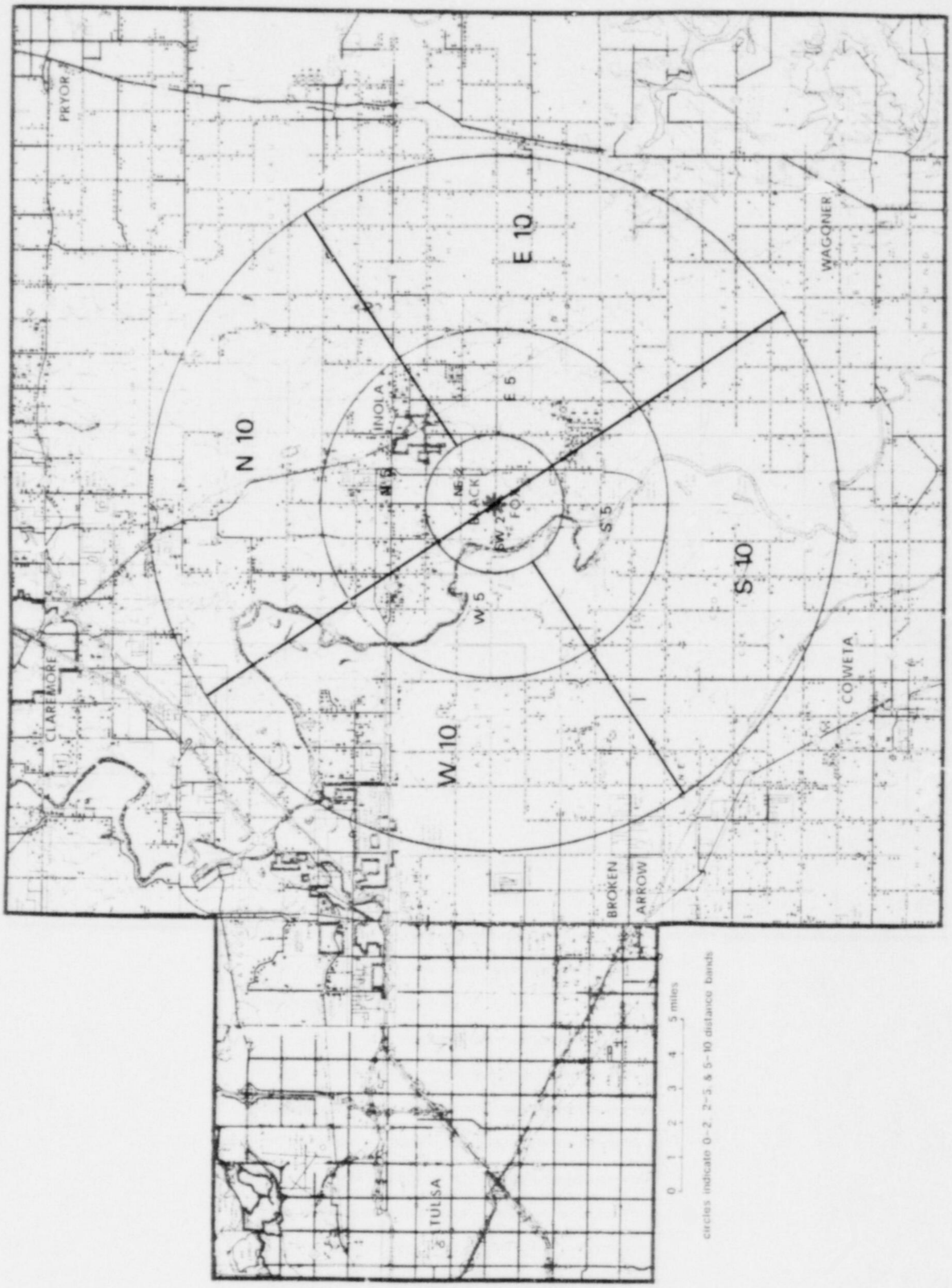
MOBILIZATION TIME CURVES

FIGURE C-5



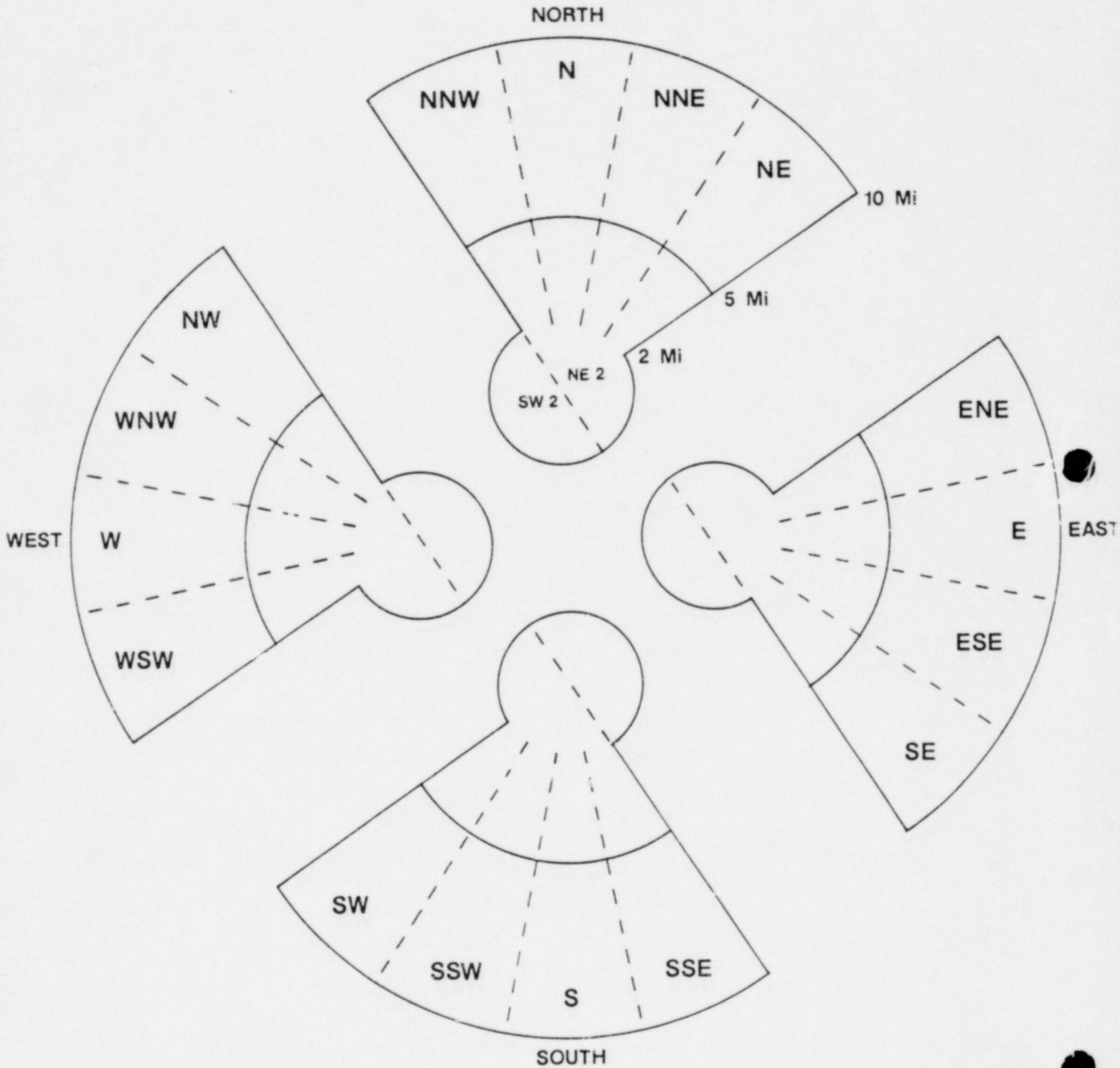
POPULATION SECTORS

FIGURE C-6



EVACUATION QUADRANTS AND POPULATION SECTORS

FIGURE C-7



EVACUATION QUADRANTS

FIGURE C-8

APPENDIX D

EARLY WARNING SYSTEM

EARLY WARNING SYSTEM

1.0 A preliminary early warning system, using USGS topographical maps of the 10 mile area around BFS has been prepared by a reputable warning system manufacturer. The purpose of this initial warning system layout is to allow PSO the preliminary knowledge of the general siren system coverage that would be required for BFS.

The topographical maps used were updated from between the mid-1960's and the mid-1970's. The topographical information accurately represents the land contours within the area; however, the residential information does not represent the most recent demographical data for the 10 mile radius. Even though new residential structures have been added during the resulting time period, the siren systems provided will represent a close approximation of requirements for the area. A step up in a siren system capacity would merely be required. The area within a 10 mile radius of this plant has terrain variances and a population distribution sufficiently dispersed so that a combination of various-sized sirens and a number of Local Coverage Sirens (LCS's) are required to give effective coverage. The estimated total number of sirens required for that area is 92. This includes:

54 - 128 dB full coverage sirens
19 - 115 dB single tone sirens
19 - 102 dB single tone sirens

The general procedure followed in the application of the outdoor warning system and the many environmental effects related to outdoor warning are covered in the FEMA-Document No. CPG 117, entitled "Outdoor Warning Systems Guide," dated March, 1980. The applied criteria corresponds to NUREG-0654.

In addition to the outdoor area warning siren equipment proposed, equipment for alerting public institutions, such as hospitals, schools, nursing homes and large business operations is also included. This will consist of 58 tone activated emergency radio alert units or small local coverage sirens. Depending on the individual application, these units can be interchanged.

The specific choice of sirens and means of control must be based on a detailed site survey and evaluation of availability of power, surrounding buildings, terrain and population distribution. This will be conducted prior to selection of the actual hardware during actual emergency response plan preparation.

APPENDIX E

Correspondence

Appendix E
Table of Contents

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

OCT 23 1979

Docket Nos. 50-556
and 50-557

Mr. T. N. Ewing, Manager
Black Fox Station Nuclear Project
Public Service Company of Oklahoma
P. O. Box 201
Tulsa, Oklahoma 74102

RECEIVED
LICENSING
OCT 29 1979

Dear Mr. Ewing:

SUBJECT: EMERGENCY PREPAREDNESS REQUIREMENTS
(Black Fox Station Nuclear Project)

In a recent letter dated October 10, 1979 on the "Followup Actions Resulting from the NRC Staff Reviews Regarding the Three Mile Island Unit 2 Accident", we outlined the staff's requirements resulting from its Emergency Preparedness Studies. In that letter we stated that the Commission was considering what changes to current regulations and policy would be appropriate as a result of the Siting Policy Task Force Report (NUREG-0625), and it was likely that they would endorse the 10- and 50-mile emergency planning zones recommended by the EPA/NRC study.

On October 18, 1979, the Commission concurred in and endorsed the guidance on emergency planning zones recommended in the NRC/EPA report. In a policy statement on that date (Enclosure 1), the Commission directed the NRC staff to incorporate the planning basis guidance into existing documents used in the evaluation of State and local emergency preparedness plans to the extent practicable.

Thus, in addition to the requirements now set forth explicitly in Appendix E to 10 CFR Part 50, and the requirements of Enclosure 7 of our October 10, 1979 letter, it is the staff position that for near term CPs, preliminary plans for coping with the potential consequences of emergencies beyond the site boundary must include provisions for a plume exposure pathway Emergency Planning Zone (EPZ) and an ingestion pathway Emergency Planning Zone. The EPZ for the plume exposure pathway must encompass an area of about 10 miles in radius, and the EPZ for the ingestion pathway an area of about 50 miles in radius.

The following information must be provided and evaluated in order to implement this staff position.

1. Contacts and agreements with local, State and Federal governmental agencies with responsibility for coping with emergencies for development of final plans must be documented for the areas within the plume exposure Emergency Planning Zone. This shall include agreement in principle between these agencies on a framework for emergency notification and protective action criteria acceptable to the NRC. For a description of the draft Emergency Action Level Guidelines see Enclosure 2. The principal government office or agency in each local political jurisdiction (county and municipality) within the plume exposure pathway EPZ, which would have the responsibility for prompt implementation of protective action warnings and instructions to the public, must be clearly identified.

2. A preliminary analysis which describes the means to be employed in the notification of State and local governments, Federal agencies and the public in the event of an emergency must be submitted for the plume exposure EPZ and for notification of the agricultural agencies and other governmental bodies having jurisdiction within the ingestion pathway EPZ. A commitment must be made to provide prompt notification to offsite authorities and to assure that offsite authorities have the resources to provide a general early warning and clear instructions to the public, acceptable to the NRC, in the plume exposure EPZ within 15 minutes following notification from the facility.

3. Preliminary planning must reflect the need to include facilities, systems, and methods for identifying the degree of seriousness and potential scope of radiological consequences of emergency situations within and outside the site boundary, including capabilities for dose projection using real-time meteorological information and for dispatch of radiological monitoring teams within the EPZ's. The anticipated role and capabilities of offsite agencies in radiological monitoring and dose assessment in the environs must be described for both plume and ingestion exposure pathways. Preliminary planning must reflect the role of the on-site technical support center and of the near-site emergency operations center in assessing information, recommending protective action and disseminating information to the public.

4. Preliminary planning must reflect provisions for initiating protective actions for all exposure pathways, onsite and offsite, including:

   (a) Direct radiation exposure from a confined source in-plant, an airborne plume, and ground deposition,

   (b) Inhalation exposure from an airborne plume, and

   (c) Ingestion exposure from contaminated water, milk, and other agricultural products.

A preliminary analysis which describes various available protective action options must be submitted for the areas within the Emergency Planning Zones. This must include estimates of evacuation times for various sectors and distances within the plume exposure EPZ. Preliminary plans for protective action recommendations within the plume exposure EPZ must include evacuation, sheltering, and area access control. Preliminary plans for protective action recommendations within the ingestion exposure EPZ must include taking cows off pasture when required and controlling the use of milk, drinking water, and agricultural products whose source is within the ingestion EPZ.

If you have any questions concerning this matter, please contact the NRC Project Manager for your facility.

Sincerely,

D. B. Vassallo

D. B. Vassallo, Acting Director
Division of Project Management
Office of Nuclear Reactor Regulation

Enclosures:
1. Commission Policy Statement
2. NRR Staff Draft Guidelines

cc w/enclosures:
See next page

STATE OF OKLAHOMA

OFFICE OF THE GOVERNOR

212 STATE CAPITOL BUILDING

OKLAHOMA CITY, OKLAHOMA 73105

GEORGE NIGH
Governor

405 / 521-2345

June 20, 1979

Mr. Joseph M. Hendrie, Chairman
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Hendrie:

I share your concern with regard to states having adequate radiological emergency response plans in operation which support fixed nuclear facilities. I appreciate your kind offer to assist in preparing such a plan through the mechanism of the Federal Interagency Regional Advisory Committee and your agency.

The Occupational and Radiological Health Service of the Oklahoma Department of Health, in cooperation with the Oklahoma Office of Civil Defense, has recently completed a preliminary draft of Oklahoma's radiological plan. Copies of this draft have been circulated to my office, several State executive agencies, the NRC Office of State Programs, and Public Service Company of Oklahoma for comments. Following revision in accord with these comments, the plan will be circulated for comment to these State agencies, local officials, the public, and the NRC. Our current schedule calls for a final version of the plan to be ready by early 1980. We fully intend and expect to receive NRC concurrence to the final plan several years prior to the now anticipated operational status of the Black Fox Station in 1985.

Sincerely yours,

George Nigh

George Nigh

PUBLIC SERVICE COMPANY OF OKLAHOMA
A CENTRAL AND SOUTH WEST COMPANY

P.O. BOX 201 / TULSA, OKLAHOMA 74102 / (918) 583-3611

PSO

January 15, 1980

R. O. Newman
President

SAMPLE

Governor George Nigh
212 State Capitol Building
Oklahoma City, Oklahoma 73105

Dear Governor Nigh:

Public Service Company of Oklahoma is presently in the process of obtaining a full construction permit for our Black Fox Station (BFS), a nuclear powered electric generating facility. During this phase, the facility is thoroughly reviewed by various government agencies to assure that the public health and safety is protected. Since the accident at Three Mile Island (TMI) on March 28, 1979, many aspects of safety design and public protection are being re-reviewed and changes incorporated into all nuclear power facilities around the country.

One of these aspects is reevaluation of emergency response planning in the area around nuclear facilities to better assure the complete protection of the public in the event of an accident. Even though it is expected that a comprehensive evacuation will never be required, we recognize that complete emergency response preparedness must be available throughout operations of the facility.

Public Service Company of Oklahoma has previously considered the basic aspect of emergency response planning for BFS and presented them to the NRC for review and approval. Included in our early planning were discussions of our organization for coping with emergencies, means for notification, identification of local, State and Federal agencies which will be responsible, and other onsite training and evacuation features at the plant. This description was previously considered adequate at this early stage to show the feasibility to conduct future emergency response actions (prior to the operation of the plant, detailed emergency response programs will be provided by the facility and the State). However, it has now been determined that more comprehensive descriptions and agency contacts should be provided prior to onset of full construction, even realizing our station is still at least six years away from operation.

PSO recently received a request from the Nuclear Regulatory Commission to expand our preliminary emergency response planning for construction to include many areas that were previously to have been covered during the advanced planning stages for operation. This includes documented agreements with local, State and Federal agencies which will be involved with emergency response around BFS. We also must determine protective action response times which will require PSO to perform population surveys within about ten miles of the site.

SAMPLE

PSO will be directly contacting certain State and local authorities to discuss their responsibilities for responding under an emergency condition. Basically, these responsibilities will not differ substantially from the duties already provided for emergency response to other types of emergencies as rail accidents and tornado alerts. To satisfy the NRC request, we will be needing documented agreements from the agencies listed on the Attachment I.

PSO has at this time already contacted the Oklahoma State Department of Health and the Oklahoma Civil Defense who are the primary responsible state agencies for Emergency Response Planning. Recognizing their responsibility and knowledge for such planning, they will be assisting us in our upcoming activities with the local authorities.

Our study profiles in the area will involve performing population density checks out to ten miles. (The BFS site is located approximately three miles southwest of Inola). As part of the activity, we will be obtaining information on many institutions and residences. PSO also desires any assistance available on determining the local population distribution and special conditions in your area.

Inola and Tiawah are the only townships within ten miles of our Black Fox Station which we will need direct agreement from. Several other towns and cities lying between ten and fifteen miles which include Tulsa, Broken Arrow, Catoosa, Claremore, Coweta, Chouteau, and Wagoner are also being notified to allow these communities the opportunity to take part in our activities. These specific parties are listed on Attachment II.

PSO greatly appreciates your assistance on our acquisition of the documented preliminary emergency response agreements for BFS and any input you can provide on population distribution. Your cooperation on this matter is important to the future of the Black Fox Station.

Sincerely,

R. O. Newman

R. O. Newman

Attachments

ATTACHMENT I

PRIMARY AGENCIES

(Parties Which PSO Will Need Agreement Letters)

Mr. Dale McHard
Oklahoma State Health Department
1000 N.E. 10th St.
P.O. Box 53551
Oklahoma City, Oklahoma 73152

Mr. Hayden Haynes, Director
Sequoyah - Will Rogers' Buildings Tunnel
Oklahoma City, Oklahoma 73152

Colonel Paul Clark
Oklahoma Department of Public Safety
3600 N. Eastern
Oklahoma City, Oklahoma 73111

Mr. Chuck Ormiston, Chief of Polic
Broadway & Commercial
Inola, Oklahoma 74036

Mr. Erwin Burchette
Rogers County Civil Defense
219 S. Missouri
Claremore, Oklahoma 74017

Mr. John Baumert
Mayes County Civil Defense
1301 N.E. 4th
Pryor, Oklahoma 74361

Mr. Max Cole
Wagoner County Civil Defense
Box 103
Coweta, Oklahoma 74429

Mr. Amos Ward
Rogers County Sheriff
219 S. Missouri
Claremore, Oklahoma 74017

Mr. Tommy Gilbert
Wagoner County Sheriff
307 E. Cherokee
Wagoner, Oklahoma 74467

Mr. Pete Weaver
Mayes County Sheriff
34 N. Adair
Pryor, Oklahoma 74361

ATTACHMENT II

SECONDARY AGENCIES

(Parties for Information Only)

Dr. E.L. Leonard
Wagoner County Health Department
203 W. Cherokee
Wagoner, Oklahoma 74467

Mr. Elmer McGuire
Rogers County Commissioners
219 S. Missouri
Claremore, Oklahoma 74017

Mr. Averd L. Dye
Rogers County Commissioners
219 S. Missouri
Claremore, Oklahoma 74017

Mr. Glenn Sweet
Rogers County Commissioners
219 S. Missouri
Claremore, Oklahoma 74017

Mr. Bob Mahan
Wagoner County Commissioners
307 E. Cherokee
Wagoner, Oklahoma 74467

Mr. Rufus Young
Wagoner County Commissioners
307 E. Cherokee
Wagoner, Oklahoma 74467

Mr. Lee Roy Denton
Wagoner County Commissioners
307 E. Cherokee
Wagoner, Oklahoma 74467

Mr. V.E. West
Mayes County Commissioners
Box 95
Pryor, Oklahoma

Mr. Lee Mitchell
Mayes County Commissioners
Box 95
Pryor, Oklahoma

Mr. Henry Campbell
Mayes County Commissioners
Box 95
Pryor, Oklahoma 74361

Mr. Richard Brimmer, Administrator
Rogers County Health Department
1415 N. Florence
Claremore, Oklahoma 74017

Mr. Richard Brimmer, Administrator
Mayes County Health Department
111 N.E. 1st
Pryor, Oklahoma 74361

Dr. Edgar Cleaver
Tulsa City/County Health Department
4616 E. 15th
Tulsa, Oklahoma 74112

Francis Krause
Inola Civil Defense
P.O. Box 123
Inola, Oklahoma 74036

Mr. John Wilson
Tulsa County Civil Defense
200 Civic Center, E24
Tulsa, Oklahoma 74103

Mr. Paul Rhodes, Director
Broken Arrow Civil Defense
115 E. Commercial
Broken Arrow, Oklahoma 74012

Mr. Dale Lynch
City of Catoosa Civil Defense
108 Muskogee
Catoosa, Oklahoma 74015

Mr. E.E. Pratt, Jr.
Wagoner Civil Defense
1115 S.E. 15th
Wagoner, Oklahoma 74467

Mr. J.W. Rampey
Broken Arrow Police Department
115 E. Commercial
Broken Arrow, Oklahoma 74012

Governor George Nigh
212 State Capitol Building
Oklahoma City, Oklahoma 73105

Mr. T.L. Riggs, Mayor
Broadway & Commercial Streets
Inola, Oklahoma 74036

Mr. James Inhofe, Mayor
200 Civic Center
Tulsa, Oklahoma 74103

Mr. Clyde Wright, Mayor
115 E. Commercial
Broken Arrow, Oklahoma 74012

Mr Jim Whitlock, City Manager
115 E. Commercial
Broken Arrow, Oklahoma 74012

Ms. Elizabeth Gordon, Mayor
P.O. Box 249
Claremore, Oklahoma 74017

Mr. Curtis Conley, Mayor
P.O. Drawer 190
Catoosa, Oklahoma 74015

Mr. M.I. Dunn, Mayor
City Hall
Coweta, Oklahoma 74429

My Lyman Carter, Jr., Mayor
Drawer C
Chouteau, Oklahoma 74337

Mr. Kenneth Peters, Mayor
P.O. Box 406
Wagoner, Oklahoma 74467

Mr. Ed Caldwell, City Superintendent
P.O. Box 407
Wagoner, Oklahoma 74467

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

December 26, 1979

APPLICANTS FOR CONSTRUCTION PERMITS AND
LICENSEES OF PLANTS UNDER CONSTRUCTION

Gentlemen:

SUBJECT: REQUEST FOR INFORMATION REGARDING EVACUATION TIMES

This letter is being sent to all applicants for construction permits, and licensees of plants under construction. The purpose of the letter is a request for information regarding estimates for evacuation of various areas around future nuclear power plants. The requested information is in addition to that requested by the November 21, 1979, letter to all applicants for an operating license and licensees of plants under construction from Domenic B. Vassallo, Acting Director, Division of Project Management, Office of Nuclear Reactor Regulation.

Although evacuation time estimates are expected to be prepared in the course of the upgrading of the state of emergency preparedness as previously specified submission of these estimates to the NRC is being requested on an accelerated time scale so that the NRC can identify those instances in which unusual evacuation constraints exist and special planning measures should be considered. In some cases of extreme difficulty where a large population is at risk, special facility modifications may also be appropriate. The information requested in the enclosure should be submitted no later than March 31, 1980.

Previous correspondence indicated that efforts to develop a model plan were continuing. It now appears that the model plan will not be completed on a schedule which will be of use in developing upgraded plans in the near term. The upgraded plan development should therefore proceed on a site-specific basis.

Sincerely,

Brian Grimes

Brian K. Grimes, Director
Emergency Preparedness Task Group
Office of Nuclear Reactor Regulation

Enclosure:
Request for Evacuation Time
Estimates

cc w/enclosure:
Service Lists

REQUEST FOR

EVACUATION TIME ESTIMATES (AFTER NOTIFICATION)

FOR AREAS NEAR NUCLEAR POWER PLANTS

Background

Prior to recent NRC requests that means for prompt notification to the public be installed around each nuclear power plant site, a significant component of evacuation time estimates was the time required to notify the public of a need for evacuation. Studies of actual evacuations that have taken place generally do not distinguish between the time required for notification, the time required to implement the evacuation, and the time required to confirm that an evacuation has taken place.[1/] The estimates of time required for evacuations now requested relate primarily to the time to implement an evacuation as opposed to the time required for notification. These estimates may be based on previous local experiences (e.g., chemical spills or floods) or may be based on studies related to population density, local geography and road capacities. No standard method for making such estimates is identified for use at this time. The basis for the method chosen should be described in the response. As a check on the evacuation time estimates, comments on the time estimates made should be obtained from the principal local officials responsible for carrying out such evacuations. Such comments should be included in the submittal.

The format given below is appropriate for reporting to the NRC estimates of the time required to implement evacuation of areas near nuclear power plants. These estimates, are to be made for the primary purpose of making available, to those officials who would make evacuation decisions in an emergency situation, knowledge of the time required to complete one of the protective action options (evacuation) available for a particular potentially affected segment of the population. A second purpose of these estimates is to identify to all concerned those instances in which unusual evacuation constraints exist and that special planning measures should be considered. In some cases of extreme difficulty where a large population is at risk, special facility modifications may also be considered.

Given a decision to evacuate rather than shelter in an actual event, fewer or more sectors or different distances than given in the reporting format might be evacuated should this be the chosen protective action. For example, three 22-1/2° sectors might be initially evacuated in a downwind direction (the sector containing the plume and an adjacent sector on each side), followed by the evacuation of other sectors as a precautionary measure.

1/ Hans, J. M., Jr., and T. C. Sell, 1974 Evacuation Risks - An Evaluation, U. S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, EPA-520/6-74-002.

Format for Reporting Information

The areas for which evacuation estimates are required must encompass the entire area within a circle of about 10 miles radius, and have outer boundaries corresponding to the plume exposure EPZ. These areas are as follows:

Distance	Area
2 miles	two 180° sectors
5 miles	four 90° sectors
about 10 miles	four 90° sectors

Estimates for the outer sectors should assume that the inner adjacent sectors are being evacuated simultaneously. To the exent practical, the sector boundaries should not divide densely populated areas. Where a direction corresponding to the edges of areas for which estimates have been made is thought not to be adequately represented by the time estimates for adjacent areas, an additional area should be defined and a separate estimate made for this case. The format for submittal should include both a table and a figure (overlaid on a map) which each give the information requested in items 1 and 2 below. Additional material may be provided in associated text.

Required Information

1. Two estimates are requested in each of the areas defined in item 1 for a general evacuation of the population (not including special facilities). A best estimate is required and an adverse weather estimate is required for movement of the population.

2. The total time required to evacuate special facilities (e.g., hospitals) within each area must be specified (best estimate and adverse weather).

3. The time required for confirmation of evacuation should be indicated. Confirmation times may consider special instructions to the public (e.g., tying a hankerchief to a door or gate to indicate the occupant has left the premises).

4. Where plans and prompt notification systems have not been put in place for areas out to about 10 miles, estimates of the times required to evacuate until such measures are in place for the plume exposure emergency planning zone (EPZ) should also be given. Notification times greater than 15 minutes should be included in the evacuation times and footnoted to indicate the notification time.

5. Where special evacuation problems are identified (e.g., in high population density areas), specify alternative protective actions, such as sheltering, which would reduce exposures and the effectiveness of these measures.

6. A short background document should be submitted giving the methods used to make the estimates and the assumptions made including the routes and methods of transportation used. This document should also note the comments of principal local officials regarding these estimates.

OKLAHOMA CIVIL DEFENSE
SEQUOYAH-WILL ROGERS BUILDINGS
POST OFFICE BOX 53365
OKLAHOMA CITY, OKLAHOMA 73152
405/521-2481

GEORGE NIGH
Governor

NORRIS PRICE
State Director

October 1, 1980

Mr. Vaughn L. Conrad, Manager
Licensing and Compliance
Public Service Company of Oklahoma
P. O. Box 201
Tulsa, OK 74102

Dear Mr. Conrad:

Our office has reviewed the evacuation time estimates for the ten-mile radius around your Black Fox Station as provided by Oklahoma State University. We believe the methodology and data base used to prepare the estimates has been adequately considered for reasonably estimating evacuation times. Given the use of an early warning system for the public and the relatively low population density around BFS, the over-all evacuation time estimate of 143 minutes is considered by our office to be sufficient time to evacuate the public. The time estimate of 219 minutes for adverse weather conditions of the same population sufficiently represents the increased travel time required.

The complete program developed for the BFS evacuation time estimates is adequate for the detail used at this stage. We will reserve the right to again review similar estimates for Black Fox Station prior to operation.

Sincerely,

Norris Price, Director
Oklahoma Civil Defense Agency

vw