Study Plan for
Study 8.3.1.12.2.1

Meteorological Monitoring Plan (Study Plan for Meteorological Data Collection at the Yucca Mountain Site)

Revision 0

U.S. Department of Energy
Office of Civilian Radioactive Waste Management
Washington, DC 20585

Prepared by
Science Applications International Corporation

T-AD-088
9/90

YUCCA MOUNTAIN PROJECT
STUDY PLAN APPROVAL FORM

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Study Plan Number 8.3.1.12.2.1

Study Plan Title Meteorological Monitoring Plan (Study Plan for Meteorological Data Collection at the Yucca Mountain Site)

Revision Number Rev. 0

Prepared by: SAIC

Date: February 28, 1991

Approved:

[signature] 3/20/91

Director, Regulatory and Site Evaluation Division / Date

Effective Date: April 1, 1991

AP-1.10Q

ABSTRACT

As part of the support requirements for the Yucca Mountain Site Characterization Project (The Project), site-specific meteorological data is being collected in the vicinity of Yucca Mountain. This data will be used to assist the assessment of environmental impacts from potential emission releases, as background information to air quality permits, and as input to the eventual environmental impact statement for the Project. The data will also serve as input to studies dealing with regional meteorology, exteme weather phenomena, and synthesis of meteorological monitoring activities. Five automatic monitoring stations are currently in operation. Details concerning data management, schedule and milestones, and quality assurance are also discussed.

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1. INTRODUCTION

1.1 PURPOSE AND OBJECTIVES

The purpose of the Meteorological Monitoring Plan (MMP) is to describe the meteorological monitoring program being operated for the Department of Energy's (DOE) Yucca Mountain Project (Project). The objectives of the following discussion will be to describe the:

1. Regulatory rationale for the monitoring requirement
2. Physical environment in which monitoring takes place
3. Specific Site Characterization Plan (SCP) studies that this program supports
4. Technical design of the program
5. Management of data generated by the program
6. Schedule and milestones
7. Quality assurance requirements

Note: Contrary to the listing in the SCP (DOE, 1988a), the MMP is not a technical procedure.

1.2 REGULATORY RATIONALE AND JUSTIFICATION

Three regulatory agencies have established rules and regulations governing the repository siting process; these rules and regulations affect meteorological data collection and evaluation activities at Yucca Mountain. The U.S. Environmental Protection Agency (EPA) develops and sets the ambient air quality standards to be used in evaluating environmental impacts. The

EPA also reviews state programs, such as those administered by the Nevada Department of Environmental Protection (NDEP), to ensure that adequate and enforceable steps are being taken to maintain acceptable ambient air quality within a state. Further, the EPA has established the Prevention of Significant Deterioration (PSD) program (40 CFR 52.21, 52 FR 24736, July 1; 1987; 52 FR 27286, July 20, 1987), which is designed to protect those areas of the United States where air quality is better than the national standards. For the State of Nevada, EPA has delegated the authority for administering the PSD program to the NDEP. These programs require that site-specific meteorological data be gathered for use in pollutant dispersion studies and modelling.

The EPA has also proposed standards governing the release of radioactive materials into the environment from high-level radioactive waste repositories (40 CFR Part 191), but sections of the regulations have been remanded. The U.S. Nuclear Regulatory Commission (NRC) has primary responsibility for implementing and enforcing the EPA standards and for ensuring that projects with the potential for radiological impacts are designed properly and operated safely. The NRC has also established standards for worker and public exposure to radiological hazards, and is responsible for granting construction authority and operating or processing licenses for high-level radioactive waste repositories. NDEP grants permits for construction and operation of any facility within the State in accordance with the provisions of the Nevada Administrative Code, Chapter 445. The NDEP is also responsible for ensuring that the nonradiological air quality impacts from any activity do not exceed specified limits.

Each of these agencies has, through its regulations or guidelines, identified the meteorological data required to conduct environmental analyses in the areas of air quality and radiological studies. However, none of these requirements are specific to a deep geologic repository housing high-level nuclear waste. The NRC regulations (10 CFR Part 60), under which a construction authorization and license for the repository would be issued, have been approved,, but do not address the scope and nature of the environmental analyses required to support those decisions. In lieu of specific guidelines concerning meteorological monitoring requirements, the Yucca Mountain Project meteorological monitoring program is based on an understanding of the following: data and analyses required by the NRC for licensing other nuclear facilities (reactors, reprocessing plants, spent fuel storage facilities), and EPA's PSD monitoring requirements (40 CFR 52.21, 52 FR 24714, July 1, 1987). Accordingly, collected meteorological data will be used in addressing the potential for degrading the air quality in the vicinity of the repository and in assessing how effectively routine operational and accidental radiological releases from the repository would be dispersed. Specific agency regulations and how they affect the meteorological monitoring requirements for this program are discussed in later sections of this MMP.

1.3 SOURCE ENVIRONMENT DESCRIPTION

The following two sections describe the topography, vegetation, land use, and climatology of the study area. The third section covers existing emission sources, and the last section describes other sources of meteorological data, specific to Yucca Mountain.

1.3.1 Topography, Vegetation, and Land Use

The proposed repository is located in an area of southwestern Nevada that is approximately 26 km (16 mi) north of the community of Amargosa Valley (formerly Lathrop Wells), Nevada. All existing meteorological monitoring sites are located exclusively within lands controlled by the Federal government. Ownership and control of the proposed site is divided between three entities: the DOE, which controls the eastern portion of the site through land withdrawn for use as the Nevada Test Site (NTS); the U.S. Air Force (USAF), which controls the northwestern portion of the site through land use permits for the Nellis Air Force Range; and the Bureau of Land Management (BLM), which controls the southwestern portion of the study area as public trust lands. Figure 1.3-1 shows the relative location of the Yucca Mountain Project study area.

Yucca Mountain lies in a geographical region of generally linear mountain ranges dissecting alluvial piedmont valleys with rugged, complex

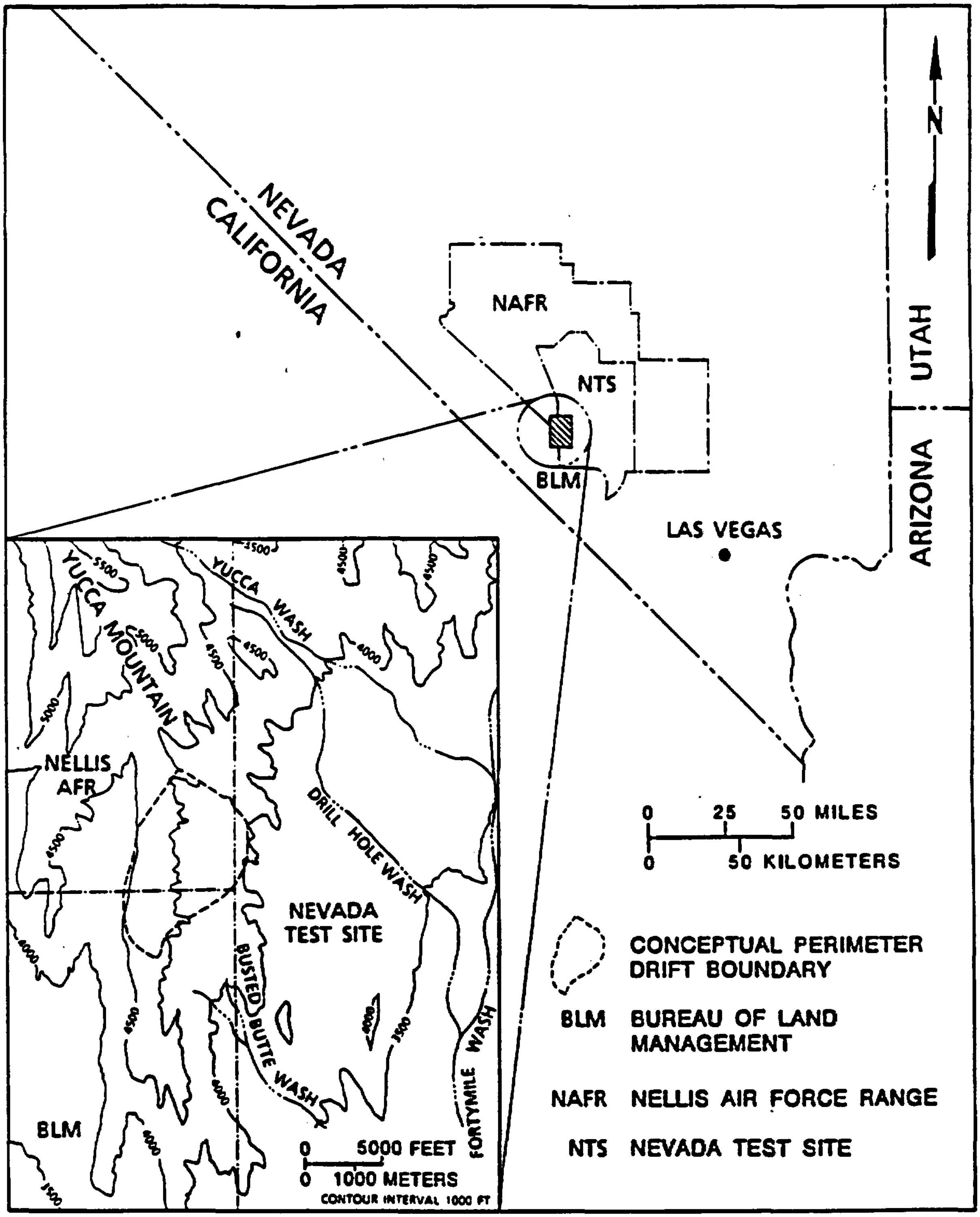

Figure 1.3-1. Relative location of Yucca Mountain Project Study Area

terrain features. Elevations in the area range from 86 m (282 ft) below mean sea level (MSL) in Death Valley (75 km (47 mi) to the southwest), to 3,633 m (11,919 ft) above MSL at Charleston Peak in the Spring Mountains, 100 km (62 mi) to the southeast. Yucca Mountain has an elevation of approximately 1,500 m (4,921 ft) above MSL. It slopes steeply (15° to 30°) to Crater Flat elevation 1,200 m (3,937 ft) on the west, but less steeply (5° to 10°) on the slope leading to Jackass Flats, elevation 1,100 m (3,609 ft), on the east. The major surface drainage for the area is Fortymile Wash, situated east of Yucca Mountain and cut 13 to 26 m (43 to 85 ft) into the surface of Jackass Flats. The area is bounded on the north by the rugged, volcanic terrain of Pinnacles Ridge.

The vegetation cover in the vicinity of Yucca Mountain is sparse, but uniform. The dominant species consist of sagebrush and other shrubs. However, a number of annual species can be found, as well as stands of both Yucca and Joshua trees.

Due to the exclusive nature of the controlled land in the vicinity of the study area, land use is limited. This area of the NTS is not used for testing. Although grazing is possible on the BLM land, the vegetation is so sparse that vast amounts of land would be required to support grazing animals. There are no grazing permits active for the proposed study area. A number of unpaved roads run through this portion of the NTS, but travel on these roads is limited and controlled.

1.3.2 Climatology of Southwest Nevada

Generally, the climate of the Yucca Mountain Project study area is identified with strong solar insolation, limited precipitation, low relative humidity, and large diurnal temperature ranges; however, the climatic variation with altitude is substantial. The lowest elevations are characterized by hot summers and mild winters, which is typical of other Southwest desert areas. As elevation increases, precipitation amounts tend to increase and temperatures tend to decrease. However, minimum temperatures occasionally occur at low elevations in closed geologic basins during calm, cloudless nights. Under these conditions, the ground surface cools quickly, thereby cooling the air near the surface. This cooler, denser air then "drains" down the terrain and pools within the basins. These conditions generally change quickly after sunrise when the ground surface becomes heated by the sun. Aside from these locally induced conditions, the overall weather patterns of the region are influenced primarily by continental air masses, which contain only limited amounts of moisture.

A summary of the meteorological conditions in the study area is shown in Table 1.3-1 for the NTS-60 Repository (Main Site). (Note: winds and temperatures were taken from the 10m level.) This Table is presented in the standard climatological format utilized by the National Weather Service (NWS). The listed values are not necessarily reflective of long-term conditions at the Yucca Mountain area, because of the short period of record (three years), but they do give an indication of monthly and seasonal trends. When contrasted against the climatological summary for the NWS station at Yucca Flat (Table 1.3-2), 32 km (20 mi) east of the Yucca Mountain area, some

Table 1.3-1. Meteorological Summary for the NTS-60 Repository site, December 1985 through November 1988.

MONTH	TEMPERATURE[b] (F°) AVERAGES DAILY MAX	DAILY MIN	MONTHLY	EXTREMES HIGHEST	YEAR	LOWEST	YEAR	DEGREE DAYS (Base 65°) HEATING	COOLING	PRECIPITATION[b,c] (INCHES) AVERAGE	GREATEST MONTHLY	YEAR	LEAST MONTHLY	YEAR	GREATEST DAILY	YEAR	SNOW AVERAGE	GREATEST MONTHLY	YEAR	GREATEST DAILY	YEAR
JAN	51.6	37.8	44.1	67.8	1986	19.4	1987	NR[a]	NR	1.08	1.56	1988	.73	1987	1.38	1988	NR	NR	NR	NR	NR
FEB	56.6	41.2	48.5	79.3	1986	25.0	1987			1.15	2.19	1988	.51	1986	1.38	1988					
MAR	60.8	43.9	52.4	79.2	1986	31.1	1988			.72	1.27	1988	.03	1987	.58	1988					
APR	68.8	50.2	60.6	84.6	1988	37.2	1988			.59	1.56	1987	.05	1986	1.31	1987					
MAY	76.9	57.5	67.9	94.1	1986	33.6	1987			.53	1.11	1988	.15	1986	.44	1988					
JUN	88.9	68.8	79.9	98.1	1988	45.9	1988			.08	.09	1987	.09	1987	.04	1986/7					
JUL	91.5	71.4	82.1	104.9	1988	51.6	1987			.58	1.31	1987	.00	1988	1.21	1987					
AUG	92.1	72.4	82.6	100.0	1986	57.0	1987			.72	1.21	1987	.15	1986	1.17	1987					
SEP	81.7	63.4	73.0	98.4	1988	44.4	1986			.12	.29	1988	.04	1986	.24	1988					
OCT	74.8	57.6	66.4	90.2	1987	43.3	1986			.32	.68	1987	.00	1988	.35	1987					
NOV	59.2	44.3	51.3	79.2	1988	32.7	1988			.18	.50	1986	.00	1988	.50	1986					
DEC	50.6	37.2	43.2	63.7	1985	21.4	1985			.35	.52	1986	.20	1987	.27	1986					
ANN	71.1	53.8	62.7	104.9	1988	19.4	1987	↓	↓	6.42	2.19	1988	.00	1988	1.38	1988	↓	↓	↓	↓	↓

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a Not recorded

Ta[illegible] 1.3-1. Meteorological summary for the NTS-60 R[illegible]sitory site, December 1985 through November 1988 (continued)

MONTH	RELATIVE HUMIDITY (%) HOUR (PACIFIC STANDARD TIME) 04	10	16	22	WIND[b,d] (SPEEDS IN MPH) AVERAGE SPEED	PEAK SPEED	YEAR	RESULTANT (DIR/SP) 23-02 PST	11-14 PST	STATION PRESSURE (INCHES) AVERAGES	HIGHEST	LOWEST	(e) AVERAGE SKY COVER SUNRISE TO SUNSET	AVERAGE NUMBER OF DAYS[1] SUNRISE TO SUNSET CLEAR	PARTLY CLOUDY	CLOUDY	PRECIPITATION .01 INCH OR MORE	.10 INCH OR MORE	.50 INCH OR MORE	1.00 INCH OR MORE	1.0 INCH OR MORE OF SNOW	THUNDERSTORMS	TEMPERATURE MAXIMUM 90°F OR MORE	32°F OR LESS	MINIMUM 32°F OR LESS	0°F OR LESS
JAN	NR	NR	NR	NR	6.0	31.3	1987	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
FEB					7.6	30.2	1988																			
MAR					8.5	40.9	1987																			
APR					8.3	36.5	1987																			
MAY					8.7	32.4	1987																			
JUN					8.9	30.2	1988																			
JUL					8.7	31.1	1987																			
AUG					7.6	22.1	1987																			
SEP					7.4	27.1	1986																			
OCT					6.3	24.6	1986																			
NOV					7.4	36.2	1987																			
DEC					5.8	28.6	1987																			
ANN	↓	↓	↓	↓	7.6	40.9	1987	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓

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Table 1.3-2. Climatological Summary for Yucca Flat 962 through 1971.

MONTH	TEMPERATURE[b] (F°)							DEGREE DAYS (Base 65°)		PRECIPITATION[b,c] (INCHES)											
	AVERAGES			EXTREMES													SNOW				
	DAILY MAX	DAILY MIN	MONTHLY	HIGHEST	YEAR	LOWEST	YEAR	HEATING	COOLING	AVERAGE	GREATEST MONTHLY	YEAR	LEAST MONTHLY	YEAR	GREATEST DAILY	YEAR	AVERAGE	GREATEST MONTHLY	YEAR	GREATEST DAILY	YEAR
JAN	52.1	20.8	36.5	73	1971	- 2	1970	877	0	.53	4.02	1969	T	1971*	1.25	1969	0.9	4.3	1962	4.3	1962
FEB	56.7	25.8	41.3	77	1963	5	1971*	662	0	.84	3.55	1969	T	1967*	1.16	1969	1.9	17.4	1969	6.2	1969
MAR	60.9	27.7	44.3	87	1966	9	1969	634	0	.29	.60	1969	.02	1966	.38	1969	2.0	7.5	1969	4.5	1969
APR	67.8	34.4	51.1	89	1962	13	1966	411	1	.45	2.57	1965	T	1962	1.08	1965	0.7	3.0	1964	3.0	1964
MAY	78.9	43.5	61.2	97	1967	25	1967	147	38	.24	1.62	1971	T	1970*	.86	1971	0	T	1964	T	1964
JUN	87.6	49.9	68.8	107	1970	29	1971*	35	154	.21	1.13	1969	T	1971	.45	1969	0	0		0	
JUL	96.1	57.0	76.6	107	1967	40	1964*	0	366	.52	1.34	1966	0	1963	.77	1969	0	0		0	
AUG	95.0	58.1	76.6	107	1970	39	1968	1	368	.34	1.04	1965	0	1962	.35	1971*	0	0		0	
SEP	86.4	46.7	66.5	105	1971	25	1971	51	103	.68	2.38	1969	0	1968*	2.13	1969	0	0		0	
OCT	76.1	36.9	56.5	94	1964+	12	1971	266	9	.13	.45	1969	0	1967*	.42	1969	0	T	1971	T	1971
NOV	51.8	27.6	44.7	82	1962	13	1966	602	0	.71	3.02	1965	0	1962	1.10	1970	0.5	4.8	1964	2.3	1964
DEC	50.7	19.9	35.3	70	1964	-14	1967	914	0	.79	2.66	1965	T	1969*	1.31	1965	2.3	9.9	1971	7.4	1971
ANN	72.5	37.4	54.9	107	AUG 1970*	-14	DEC 1967	4600	1039	5.73	4.02	JAN 1969	0	SEP 1968*	2.13	SEP 1969	8.3	17.4	FEB 1969	7.4	DEC 1971

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Table 1.3-2. Climatological Summary for Yucca Flat, 1962 through 1971 (continued).

MONTH	RELATIVE HUMIDITY (%) HOUR (PACIFIC STANDARD TIME) 04	10	16	22	WIND[b,d] (SPEEDS IN MPH) AVERAGE SPEED	PEAK SPEED	YEAR	RESULTANT (DIR/SP) 23-02 PST	11-14 PST	STATION PRESSURE (INCHES) AVERAGES	HIGHEST	LOWEST	(e) AVERAGE SKY COVER SUNRISE TO SUNSET	AVERAGE NUMBER OF DAYS[f] SUNRISE TO SUNSET CLEAR	PARTLY CLOUDY	CLOUDY	PRECIPITATION .01 INCH OR MORE	.10 INCH OR MORE	.50 INCH OR MORE	1.00 INCH OR MORE	1.0 INCH OR MORE OF SNOW	THUNDERSTORMS	TEMPERATURE MAXIMUM 90°F OR MORE	32°F OR LESS	MINIMUM 32°F OR LESS	0°F OR LESS
JAN	67	49	35	60	6.6	58	1965	233/0.7	135/2.6	26.10	26.54	25.42	4.9	13	8	10	2	1	*	*	*	*	0	1	29	*
FEB	67	45	32	56	6.9	52	1967	275/1.1	118/2.7	26.05	26.42	25.56	5.0	11	8	9	3	2	*	*	1	0	0	*	23	0
MAR	58	31	23	44	8.4	55	1971	240/1.8	186/4.5	25.99	26.43	25.48	4.8	12	9	10	3	1	0	0	1	1	0	0	24	0
APR	52	27	21	38	9.1	60+	1970*	250/2.2	198/5.1	25.96	26.39	25.50	4.5	13	9	8	3	1	*	*	*	1	0	0	12	0
MAY	46	22	17	31	8.3	60+	1967	260/1.5	179/7.2	25.94	26.39	25.47	4.3	14	11	6	2	1	*	0	0	1	4	0	2	0
JUN	39	19	14	26	7.9	60+	1967	272/1.9	185/8.2	25.92	26.20	25.56	3.0	19	7	4	2	1	0	0	0	2	14	0	*	0
JUL	40	20	15	28	7.5	55	1971	278/0.9	185/12.0	26.00	26.19	25.68	3.0	19	9	3	3	2	*	0	0	4	29	0	0	0
AUG	44	23	16	30	6.7	60+	1968	222/1.5	182/12.0	26.00	26.22	25.71	3.0	20	8	3	3	1	0	0	0	4	27	0	0	0
SEP	43	21	17	32	7.0	52	1970	281/1.3	163/6.4	26.00	26.36	25.56	2.1	22	6	2	2	1	1	*	0	2	11	0	1	0
OCT	46	24	19	36	6.8	60	1971	286/1.3	138/3.7	26.06	26.40	25.52	2.9	20	7	4	1	1	0	0	0	*	2	0	9	0
NOV	61	39	31	52	6.1	51	1970	234/1.2	152/4.1	26.08	26.58	25.64	4.8	13	7	10	3	2	*	*	*	*	0	0	23	0
DEC	68	50	41	64	6.6	53	1970	288/1.9	109/1.0	26.07	26.59	25.49	4.6	14	8	9	3	1	1	*	1	*	0	1	29	1
ANN	53	31	23	41	7.4	60+	APR 1970*	——	——	26.01	26.59	25.42	3.9	190	97	78	30	14	3	1	3	14	87	2	152	1

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[a] Data from Bowen and Egami (1983).
[b] * = most recent of multiple occurrences.
[c] T = trace (amount too small to measure).
[d] Average and peak speeds are for the period starting with December 1964. The directions of the resultant wind are from a summary covering the period December 1964 through May 1969.
[e] Sky cover is expressed in the range from 0 for no clouds to 10 when the sky is completely covered with clouds. Clear, partly cloudy, and cloudy are defined as average daytime cloudiness of 0-3, 4-7, and 8-10 in tenths, respectively.
[f] * = one or more occurrences during the period of record but average less than one-half day.

notable similarities and differences are evident. (Note: Averaging times for hourly observations at NWS stations are not the same as for this program. However, Yucca Flat is the only nearby station which has a published period of record sufficient for comparison purposes.) Like Yucca Flat, the Main Site temperatures are highest in July and August and coldest in December. Average high temperatures for each month are also quite close, usually differing by 1-2 F°, (1/2-1 C°). Monthly average nighttime low temperatures, however, are much lower at Yucca Flat for each month, consistently being around 16F° (9 C°) below those at the Main Site. This may either be the result of less cold air drainage into the basin surrounding the Main Site than at the Yucca Flat site, or that the Yucca Flat station was positioned at the bottom of its basin, so that it experienced the full effect of cold air pooling.

On both a monthly and annual basis, both the Main Site and Yucca Flat site show the sparse precipitation characteristic of the region. About 6.4 in. (163.8 mm) falls at the Main Site and 5.7 in. (145.9 mm) falls at Yucca Flat in the course of a year. Each location also shows two peaks in seasonal precipitation: one in February and another in August or September.

Annual and monthly wind speeds at the two monitoring locations are within 1 mph (1/2 m/s). The significantly higher peak winds at the Yucca Flat site are due to the short averaging time (one minute) used at that location versus the longer averaging time (one hour) used at the Main Site.

Other than temperature extremes, severe weather types in the area include: thunderstorms, tornadoes, hail, lightning, and sandstorms/duststorms. Severe thunderstorms create a potential for flash flooding, but such storms generally do not last longer than an hour (Bowen and Egami, 1983). Tornadoes have been observed within 80 km (50 mi) of Yucca Flat, but they are considered rare for this area (DOC, 1981).

1.3.3 Existing Emission Sources

At the present time, there are no stationary sources of air pollutants within the Yucca Mountain area. Elevated levels of some pollutants that are either transported into the area or are due to wind-related sources of particulates may occur occasionally. Ambient concentrations of other criteria pollutants are probably low because there are no significant sources of these pollutants on the NTS. The nearest significant source of gaseous pollutants is the Las Vegas area, which is about 150 km (93 miles) away.

1.3.4 Sources of Monitoring Data

Meteorological data have been collected at various sites on the NTS since the late 1950s, but the data cannot be considered applicable to Yucca Mountain. The sites include, but are not limited to, a National Weather Service (NWS) station at Desert Rock, which is approximately 24 km (15 miles) east-southeast of Yucca Mountain. Sandia National Laboratories (SNL) operated two 10-meter meteorological monitoring stations near the Yucca Mountain area from mid-1982 through late 1984. These stations were established to collect preliminary meteorological data, and were not designed in accordance with PSD or NRC regulatory requirements. Nevertheless, these data may be used as background or corroborating information to establish general site meteorology.

1.4 ORGANIZATION OF DOCUMENT

Chapter 2 of this document describes the rationale for selected studies that are in support of SCP requirements. Chapter 3 presents the technical design of the monitoring program, including the regulatory requirements, descriptions of the sites, and the monitoring equipment. Chapter 4 outlines how the data is managed from initial collection to analysis and report generation. Chapter 5 provides a schedule and associated milestones. Chapter 6 delineates the quality assurance requirements of this program. References are cited in Chapter 7.

2. RATIONALE FOR SELECTED STUDIES IN SUPPORT OF SCP REQUIREMENTS

2.1 CHARACTERIZATION OF REGIONAL METEOROLOGY

The following three sections describe the technical rationale and justification, study constraints, and activities associated with characterization of, the regional meteorology.

2.1.1 Technical Rationale and Justification

One of the major concerns in the siting of a geologic repository is to ensure that its design and performance do not result in airborne radiological releases that exceed established limits. Since this concern must be satisfied before the construction of the facility, predictive tools are used in estimating the impacts of postulated releases from the repository. These predictive tools are typically dispersion models, which require data on the transport mechanism (in this case the atmosphere). Impacts predicted to occur in the immediate vicinity of the release dictate the use of site-specific meteorological data. However, the applicable guidance provided by the Nuclear Regulatory Commission (NRC) Regulatory Guide 4.2 (NRC, 1976); United States Environmental Protection Agency (EPA) (Moore, 1979); and by the DOE (Elder, et al., 1986; Corley, et al., 1981) also require that impact determinations be made at distances up to 80 km (50 miles) from the source. Therefore, site-specific data must be used in conjunction with regional data. In addition, impacts at the nearest major population center must be evaluated. For Yucca Mountain, the nearest major center is Las Vegas, Nevada, 150 km (93 miles) southeast of the study area.

Another aspect of the Yucca Mountain study area that warrants examination of data from various locations is the terrain. Since the topography of the area is complex, data from any single location may reflect unique terrain influences. The transport and deposition of airborne material can therefore be best determined from a collective, or regional, meteorological "picture" developed using data from several stations.

In addition to providing a picture of the overall meteorology of the region, the regional meteorological data will provide corroboration of dispersion model calculations of emission impacts. Lastly, regional data from stations that have operated for long periods of time will help establish a link between present-day meteorological conditions and long-term averages of meteorological parameters.

2.1.2 Constraints on Study

The major constraint of the study will be the availability of meteorological data, particularly from more remote areas surrounding Yucca Mountain. A secondary constraint may be that the data may not be in a readily usable form.

2.1.3 Description of Activities

The following sections describe how regional meteorological data will be obtained, screened, processed, and analyzed for a report on regional conditions.

2.1.3.1 Potential Sources of Meteorological Data

Potential sources of data include the National Weather Service (NWS) at McCarran International Airport, Las Vegas; the Weather Service Nuclear Support Office (WSNSO); the Bureau of Land Management (BLM); the Desert Research Institute (DRI); and other governmental and private entities which collect meteorological data in southern Nevada. Formal requests will be made to these entities for historical meteorological data records.

2.1.3.2 Review of Data

After initiation of contact with the entities described in Section 2.1.3.1, samples of their data records will be obtained. These will be compared to Yucca Mountain Project meteorological data in terms of the period of record, the parameters available, the sampling and averaging frequency, and completeness. In addition, data quality will be checked for random and systematic error utilizing error-checking algorithms. There will also be checks for data incompatibility.

It is anticipated that data from many Southern Nevada stations, such as NWS cooperative stations, will have recorded values for only a few parameters, such as temperature and precipitation. Others will have averaging frequencies that differ from those used in the Project meteorological program, others will have data gaps of weeks or months, and a few may have questionable data documentation. Due to questionable compatibility of the existing regional record with the data collected under the current study, this data will only be used for determination of general seasonal trends.

2.1.3.3 Screening and Processing of Data

All data records secured from outside agencies will be checked to ensure that the data was obtained in accordance with the governing directives of each program. Normally this check will consist of written verification by the Task Manager for the meteorological monitoring program. Data failing this check will be voided.

Data passing the screening check will be sorted by parameter, sampling frequency, location, and date/time. An approved and validated computer-averaging routine will then be applied to generate seasonally-averaged graphic outputs of each parameter integrated over the regional area. This application will smooth out discontinuities caused by data non-uniformity, such as clustering of stations and different data sampling frequencies.

2.1.3.4 Regional Report

A regional meteorological report will be written after collection, processing, and synthesis of the data. It will include an analysis and discussion of general wind flow patterns and their seasonality, differences, and similarities between sites; general trends of any given parameter; terrain influences; and the relationship between site-specific data and regional characteristics.

The analysis will be interpretive in that it will describe the seasonal trends for the meteorological parameters and their relative significance. It is expected that the results of this analyses will help to establish the climatology of the region.

2.2 CHARACTERIZATION OF EXTREME WEATHER PHENOMENA

The following three sections describe the technical rationale and justification, study constraints, and activities associated with the characterization of extreme weather phenomena. [Note: Extreme weather is defined as any weather occurence that could adversely affect surface facilities associated with a repository].

2.2.1 Technical Rationale and Justification

Extreme weather phenomena cannot be resolved from short-term site-specific monitoring programs, such as that conducted for the Yucca Mountain Project. Long-term meteorological and climatological data records must be used to provide a sufficient database upon which to develop statistical predictions of extreme events along with their recurrence intervals.

The identification of extreme conditions is necessary to provide design information for the repository surface facilities. All structures must be designed for the meteorological conditions that may be experienced over the life of the facilities. Examples of how meteorological data will influence design are as follows:

1. Temperature and humidity extremes will affect the design of heating and cooling systems.
2. Precipitation extremes will provide data for the design of containment basins, diversion channels, and culverts.
3. Snow and hail data will provide input to the design of roof loadings and external facilities.
4. Extreme wind speed estimates will provide critical design criteria for surface facility structures.
5. The frequency and intensity of fog, dust storms, and other severe storms will be used to design lighting and emergency facilities and will be factored into the accident analyses relative to the repository.

2.2.2 Constraints on Study

The major constraint on this study is the relative rareness of extreme weather phenomena data relative to a specific location, such as Yucca Mountain. This may make it difficult to obtain sufficient data on such events to develop meaningful statistics.

2.2.3 Description of Activities

Existing data bases and technical publications will be reviewed to characterize the extreme weather phenomena that may be experienced at the site. Where necessary, calculations (e.g. statistical extrapolations) may be made to interpolate existing data to develop site-specific estimates. The data obtained from the site-monitoring program and for the characterization of regional meteorology are expected to be the major sources of existing data. After completion of the extreme weather data-gathering effort, a draft report on such phenomena in the Yucca Mountain area will be prepared.

2.3 SYNTHESIS OF METEOROLOGICAL MONITORING ACTIVITIES

The following three sections describe the technical rationale and justification, study constraints, and activities associated with the synthesis of Yucca Mountain Project meteorological monitoring activities.

2.3.1 Technical Rationale and Justification

Presently no single study integrates all the meteorological monitoring activities needed to characterize the Yucca Mountain area since the meteorological data that are currently collected are required by three separate Project programs to satisfy slightly different purposes. For example, the meteorology program requires data on those parameters that define atmospheric dispersion characteristics, the geohydrology program requires data on precipitation-related parameters, and the climatology program requires data on meteorological characteristics that relate to regional climatology. However, all the data products from these programs need to be coordinated to avoid a duplication of monitoring efforts and to make the most effective use of Project resources and resultant data products.

2.3.2 Constraints on Study

This study is not constrained by any program element.

2.3.3 Integration of Meteorological Data

Science Applications International Corporation (SAIC) and the United States Geological Survey (USGS) currently operate monitoring programs for the Yucca Mountain Project. Although both monitoring programs are similar in several respects, they are not currently coordinated in methodology, instrumentation, data collection, analysis, and application of results. The reasons are primarily due to differing programmatic requirements. The SAIC program was set up to obtain meteorological data in support of radiological dose calculations; air quality permitting for surface disturbance activities; and eventually, the Environmental Impact Statement (EIS). The USGS program collects meteorological data for use in determining precipitation infiltration, surface runoff, and groundwater travel times. Both programs now monitor for several similar parameters, such as winds, temperature, and precipitation.

Integration of the meteorological monitoring data collected by both programs will proceed in four phases: first, a focal "point" for collection and archival of meteorological data records at SAIC will be identified. Second, all "working" data will be transmitted to that focal point or facility. Third, a procedure will be developed for accessing the data by either SAIC or USGS. Finally, the fourth phase of the integration effort will address the preparation of a report synthesizing all available meteorological data.

3. TECHNICAL DESIGN

3.1 METEOROLOGICAL MONITORING REQUIREMENTS

The following sections discuss the specific federal and state regulations and guidelines which apply to the Yucca Mountain Project meteorological monitoring program. Regulatory requirements for meteorological data input to closely related programs, such as air quality, are also discussed.

3.1.1 Department of Energy

The Nuclear Waste Policy Act of 1982 (the NWPA) as amended requires a detailed statement of the basis for nominating a site for development as a deep geologic repository. As directed by Section 112 of the NWPA, the DOE developed general guidelines (10 CFR Part 960) that are to be used in the site selection process for the first repository. These siting guidelines are divided into implementation guidelines, postclosure guidelines, and preclosure guidelines. The implementation guidelines are not directly used in the evaluation of a site; their purpose is to specify how the postclosure and preclosure guidelines are to be applied in site screening and selection. The postclosure guidelines govern the siting considerations that deal with the long-term behavior of a repository; that is, its behavior after waste emplacement and repository closure. The preclosure guidelines govern the siting considerations that deal with the operation of the repository before it is closed. These preclosure guidelines reflect the considerations important in protecting workers and members of the general public from exposure to radiation during repository operations.

An evaluation of site meteorological conditions is required by one of the preclosure technical guidelines (10 CFR 960.5-2-3). The qualifying condition for this guideline is stated as follows:

> "The site shall be located such that expected meteorological conditions during repository operation and closure will not be likely to lead to radionuclide release to an unrestricted area greater than those allowable under the requirements specified in 10 CFR 960.5-1(a)(1)."

While the available historical data were used to make an initial evaluation against this guideline, it is necessary to collect representative onsite meteorological data to fully evaluate whether the qualifying condition is satisfied. Accordingly, the meteorological monitoring program described in this MMP was also structured to provide the data base necessary to characterize the Yucca Mountain site for evaluation against the meteorology guideline.

3.1.2 Nuclear Regulatory Commission

The Nuclear Regulatory Commission (NRC) has established regulations and guidelines concerning facilities that have the potential to release radioactive particles into the environment. These regulations and guidelines establish what permits and licenses are required, the format and content of applications for permits and licenses, and allowable doses of radiation to both workers and members of the general public in the vicinity of NRC-licensed facilities. The primary NRC Regulatory Guideline which deals specifically with meteorological monitoring programs is Regulatory Guide 1.23 (NRC, 1982). The NRC has proposed a revision to Regulatory Guide 1.23 (NRC, 1986), but has not yet issued such a revision. Regulatory Guide 1.23 is not repository-specific but is useful in defining the scope of the meteorological monitoring program being implemented in the Yucca Mountain study area. Sections C.2 (Siting of Meteorological Instruments); C.3 (Data Recorders); C.4 (System Accuracy); C.5 (Instrument Maintenance, Servicing Schedules, and Data Availability); and C.6 (Data Reduction and Compilation) of Regulatory Guide 1.23 were evaluated for guidance in developing the meteorological monitoring network described in this document. Other NRC documents which do not bear directly on the details of a monitoring program, but do specify the required use of the data from such a program, were also reviewed and are discussed below.

10 CFR Part 20 (Standards for Protection Against Radiation) outlines permissible radiation doses, allowable radiation levels, and precautionary steps to be taken in the event of a release. Disposal procedures, documentation requirements, and enforcement responsibilities associated with nuclear facilities are also outlined in the regulation. However, 10 CFR Part 20 does not specifically address the scope or nature of meteorological monitoring to be performed, or how to use meteorological data in fulfilling the requirements of the regulation.

10 CFR Part 51 (Licensing and Regulatory Policy and Procedures for Environmental Protection) sets forth the policy and procedures to be followed by the NRC in complying with the mandate of the National Environmental Policy

Act of 1969 (NEPA). These requirements include the submittal of an Environmental Report (ER) to accompany the License Application in the event the Yucca Mountain site is approved for repository construction. The ER must include "...a discussion of the status of compliance of the facility with applicable environmental quality standards and requirements which have been imposed by Federal, State, regional, and local agencies having responsibility for environmental protection..." (Section 51.20(c)). The ER and the analysis of existing conditions and potential environmental consequences for an EIS dictate the need for a representative meteorological data base on which to base an air quality assessment. However, neither NEPA nor 10 CFR Part 51 provide any details regarding the implementation of a meteorological program to satisfy these requirements.

10 CFR Part 60 (Disposal of High-Level Radioactive Wastes in Geologic Repositories Licensing Procedures) and NRC Regulatory Guide 4.17, Standard Format and Content of Site Characterization Reports for High-Level Waste Geologic Repositories (NRC, 1982a), both specify that meteorological conditions must be addressed. However, neither document provides specific guidance on what parameters are to be monitored or the period of record needed in addressing meteorological conditions.

Other NRC documents provide guidance on the use of onsite meteorological data to analyze potential radiological and nonradiological air quality impacts from the construction and operation of nuclear facilities. These analyses are to be submitted in a Safety Analysis Report (SAR) and the accompanying ER previously discussed as part of a License Application (LA). In lieu of repository-specific regulations for SARs and ERs, similar NRC regulations for near-surface nuclear waste disposal sites and for nuclear power stations were evaluated for data needs that may be applicable to a geologic repository.

NRC Regulatory Guide 4.18, Standard Format and Content of Environmental Reports for Near-Surface Disposal of Radioactive Waste (NRC, 1983), recommends a minimum of one year of onsite meteorological data for "...determining a water budget for the disposal site, analyzing the airborne pathway, and determining the frequency, probability, and potential consequences of severe meteorological phenomena." The onsite data can then be compared with historical records from nearby recording stations to assess whether the one-year period of record is representative of typical conditions. Longer periods of onsite data may be desirable if representative regional data are not available.

NRC Regulatory Guide 4.2, Preparation of Environmental Reports for Nuclear Power Stations (NRC, 1976), specifies that at least one year of onsite meteorological data be provided for a construction permit application, and preferably three or more whole years of onsite data be provided for an operating license application. The Guide also outlines the parameters to be monitored. The meteorological record must be sufficient to characterize any terrain influences that might affect atmospheric dispersion at the site. These data are used in dispersion models to calculate potential air quality impacts from the project.

NRC Regulatory Guide 1.70, Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (NRC, 1978), provides guidance on the meteorological data needed to support calculation (modeling) of potential radiological impacts. At least one year of onsite data is suggested as appropriate for the submission of the preliminary SAR, and three or more whole years of data are recommended for the final SAR. Again, the intent is to ensure that the meteorological record is sufficient to characterize any terrain influences and limiting conditions that might affect the transport and dispersion of atmospheric releases from the facility.

3.1.3 Environmental Protection Agency (EPA)

The following sections discuss the requirements of the EPA in the area of air quality and radiological monitoring.

3.1.3.1 Air Quality Monitoring

The EPA's PSD program (40 CFR 52.21, 52 FR 24714, July 1, 1987) was established to fulfill the Clean Air Act requirements to protect the ambient air quality in areas of the country where the existing air quality is better than the national standards. As part of the State Implementation Plan (SIP) process (40 CFR Part 51), each state is required to emplace a state-administered PSD program that is at least as stringent as the EPA program. The EPA reviews each SIP individually and, after resolving any outstanding issues, approves the SIP and delegates PSD authority to the state. Several states, including Nevada, have chosen to adopt the EPA PSD program without substantial deviations and have been successful in receiving EPA authority to administer PSD in their respective jurisdictions.

For the Yucca Mountain Project, PSD requirements may apply because the Project is in an area designated as Class II. The Class II designation indicates that the ambient air quality in the area is better than the national standards. The State of Nevada, however, considers the area unclassifiable because there are no monitoring data to support the Class II designation. Although this initial PSD applicability criterion is satisfied, the amount of pollutant emissions from the Project for each pollutant regulated under the Clean Air Act must also be considered. Project emissions must be compared to PSD threshold values to determine if the PSD regulations actually apply. Since the repository is not one of the 28 specific source types that must comply with the PSD regulations, the PSD applicability threshold emission level is 250 tons/year. The repository is also not one of the 30 currently-listed source types that must include fugitive emissions in the threshold comparison. The Project, therefore, only needs to consider nonfugitive air pollutant emissions in determining PSD applicability. The Yucca Mountain Environmental Assessment (DOE, 1986a) indicated that nonfugitive emissions from either site characterization or repository operation would be below the PSD threshold value and that PSD requirements would not apply.

There are many factors that could change prior to the repository permitting stage and possibly affect the determination of PSD applicability for the Yucca Mountain site. For example, a refined repository design may change the operational characteristics, thereby increasing air pollutant discharges. The EPA could undertake further rule-making that includes deep geologic repositories on the list of "major stationary source," which have a PSD applicability threshold of less than 250 tons/year. The EPA could also include deep geologic repositories on the list of source categories that must include fugitive emissions in determining PSD applicability. It was prudent, therefore, to consider PSD monitoring requirements and guidelines in developing this MMP. Considering PSD requirements ensured that the collected meteorological data would be of sufficient quality and duration to support the ambient air quality analyses required for a PSD review.

3.1.3.2 Radiological Monitoring

The EPA also provides guidance and direction to other Federal agencies in developing and setting standards that apply to radiological monitoring activities. Other Federal agencies must then require their facilities to operate in compliance with the EPA standards.

The EPA has promulgated regulations (40 CFR Part 191) addressing radiological exposure standards that were developed specifically for the facilities intended to store high level nuclear waste. A decision on July 17, 1987 by the U.S. Court of Appeals for the First Circuit has vacated and remanded to the EPA for further proceedings, the postclosure standards, Subpart B, of 40 CFR Part 191. However, neither these regulations nor existing regulations (40 CFR Part 190) concerning other nuclear facilities provide specific guidance on the type of meteorological monitoring programs and analyses needed in assessing compliance with the radiological exposure standards.

3.1.4 <u>State of Nevada</u>

The Nevada Air Quality Regulations (NAQRs) (Nevada Administrative Code, Chapter 445) specify that a registration certificate must be obtained prior to construction for each new source of air pollutants within the State, unless the source meets certain exemption criteria. The exemptions are based on "threshold" values of surface disturbance (20 acres per project), process rate (50 pounds per hour), or other factors. The most recent engineering design data for the Project indicate that site characterization (land disturbance, batch process plant, etc.) and the repository (land disturbance, batch process plant, etc.) would not be exempted on the basis of these threshold values. Therefore, the NAQR requirements for registration certificates and subsequent operating permits will apply to these activities. The application for a registration certificate may require an analysis of the potential air quality impacts of the Project. The scope of the meteorological monitoring required to support the impact analysis is determined by the NDEP on a case-by-case basis, but the EPA PSD monitoring guidelines (EPA, 1987) are typically the basis for the monitoring programs.

Any air quality dispersion modeling performed in support of the permit application, which may be required under the NAQRs, must also comply with the EPA Guideline on Air Quality Models (EPA, 1986). This guideline establishes criteria for meteorological data used in dispersion modeling in terms of the proximity of a monitoring site to a project area, the complexity of the terrain, the exposure of the monitoring site, and the duration of monitoring.

At Yucca Mountain, the complex terrain features make the nearest historical regional data from Yucca Flat (discussed in Section 1.3.2) unacceptable for detailed modeling purposes. In such cases, the EPA modeling guideline calls for a period of record of onsite meteorological data that is sufficient to observe worst-case meteorological conditions and that can provide a representative spectrum of site-specified atmospheric dispersion characteristics.

3.2 MONITORING NETWORK DESCRIPTION

The following sections describe the location of each monitoring site, the reason for its selection, and how the individual sites are instrumented. Figure 3.2-1 shows the five site locations in the study area.

3.2.1 Main Site

The main meteorological tower is positioned at an elevation of 1,143 meters (3,751 ft) above MSL near the proposed repository surface facility location. This area is bounded on the west by Yucca Mountain (with a peak elevation of nearly 1,523 m or 4,997 ft. above MSL) and partially blocked from Jackass Flats (to the east) by three intermediate buttes with elevations of up to approximately 1,220 m (4,000 ft) above MSL. Data collected at this location will be used in assessing impacts associated with repository operations. The tower at this site is 60 m (197 ft) high and is referred to as the Main Site. The coordinates of the Main Site tower are given in Table 3.2-1. Figure 3.2-2 represents the view looking towards the southeast at the Main Site and shows the 60-meter tower and instrument shelter. Figure 3.2-3 is a view to the north, also from the Main Site tower location.

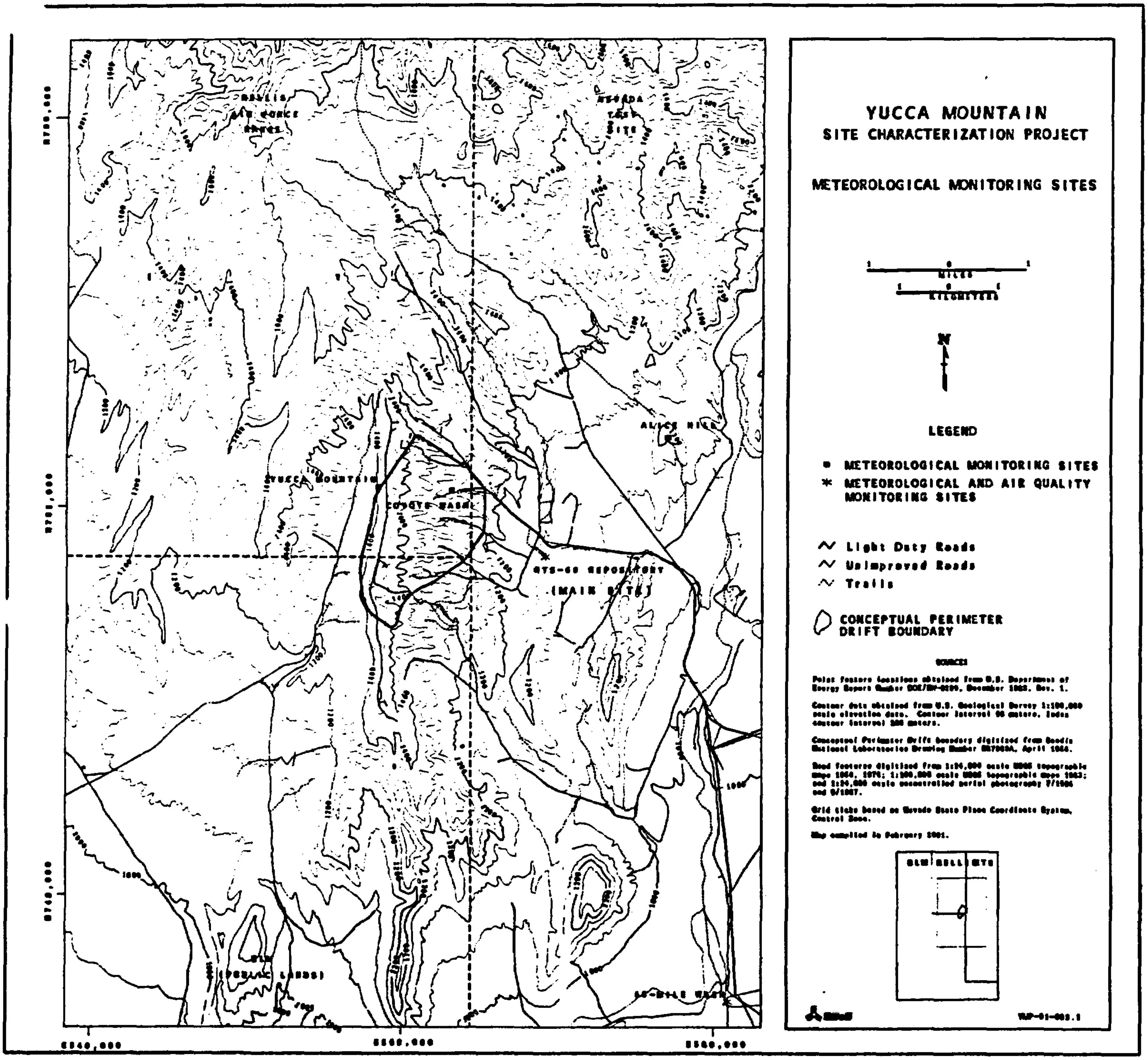

Figure 3.2-1. Meteorological Monitoring Sites

Table 3.2-1. Coordinates of the Yucca Mountain Project Meteorological Monitoring Sites.

SITE	UTM COORDINATES ZONE 11 (METERS)	NEVADA SYSTEM (FEET)	LATITUDE-LONGITUDE (DEG. MIN. SEC.)	ELEVATION (MSL)
Nts-60 Repository	550,776E 4,077,427N	569,127E 761,795N	36°50'33" 116°25'49"	3751 ft 1143 m
Yucca Mountain	547,660E 4,078,781N	558,862E 766,434N	36°51'20" 116°28'19"	4849 ft 1478 m
Coyote Wash	548,884E 4,078,689N	562,876E 766,195N	36°51'17" 116°27'05"	4193 ft 1278 m
Alice Hill	553,122E 4,079,787N	576,810E 769,661N	36°51'51" 116°24'14"	4047 ft 1234 m
40-Mile Wash	554,369E 4,068,691N	580,882E 733,230N	36°45'51" 116°23'27"	3124 ft 952 M

Figure 3.2-2 View looking southeast of the NTS-60 Repository site 60-meter tower and instrument shelter

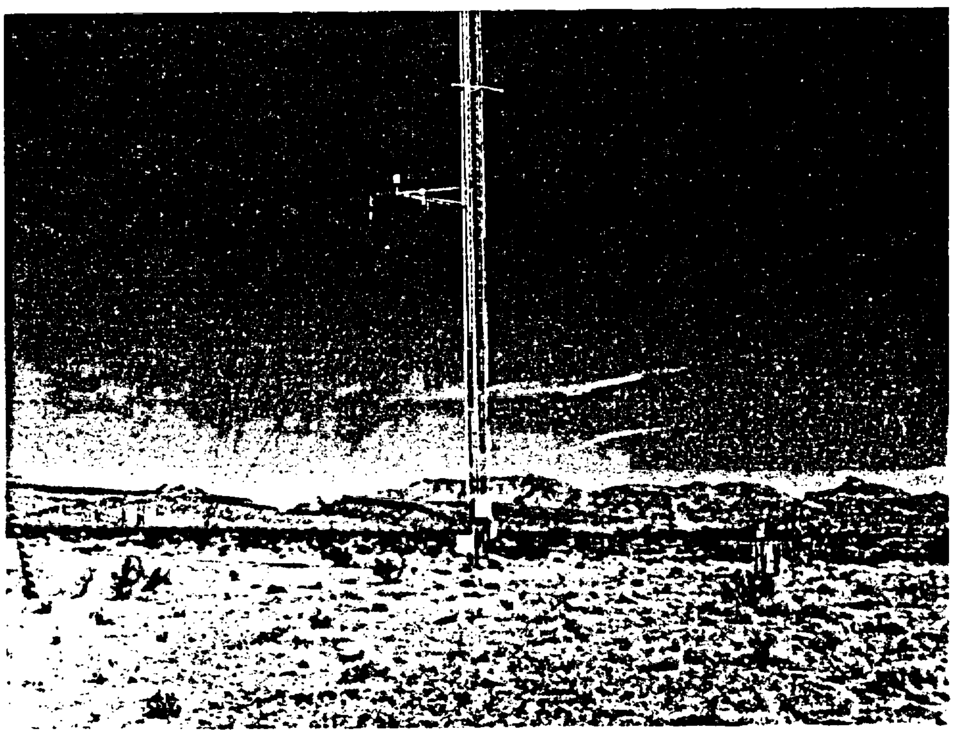

Figure 3.2-3 NTS-60 Repository site tower viewed from the south looking north

3.2.2 Remote Sites

The other four towers are used to collect data on overall meteorological conditions in the area so that a comparison with the data from the main site can be made. Data from these four remote sites is particularly useful in characterizing terrain-induced perturbations that may significantly affect dispersion and transport of pollutant emissions.

The first of these remote locations is along the north-south trending ridge of Yucca Mountain, approximately 3.9 km (2.5 mi) west-northwest of the Main Site at an elevation of 1,478 m (4,849 ft) above MSL. This site is referred to as the Yucca Mountain site. The coordinates of the Yucca Mountain site are given in Table 3.2-1. Data from this site, which has virtually unobstructed exposure in all directions (as seen in Figure 3.2-4), tends to be indicative of synoptic-scale weather conditions. Comparison of these data to data from the Main Site will provide insight into the relationship between synoptic-scale conditions and those conditions that occur at the surface facilities location. Figure 3.2-5 represents the view from the tower location towards the north.

A second 10-m tower is placed at the site of the proposed exploratory shaft, 2.7 km (1.7 mi) west-northwest of the Main Site at an elevation of 1,278 m (4,193 ft) above MSL. This site is referred to as the Coyote Wash site and is located in one of the many drainages along the eastern side of Yucca Mountain. Figure 3.2-6 is a view up the wash towards the west-northwest, and Figure 3.2-7 shows the view down the wash looking towards the southeast. The coordinates of the Coyote Wash site are given in Table

Figure 3.2-4 View from the Yucca Mountain tower location looking east towards Jackass Flats

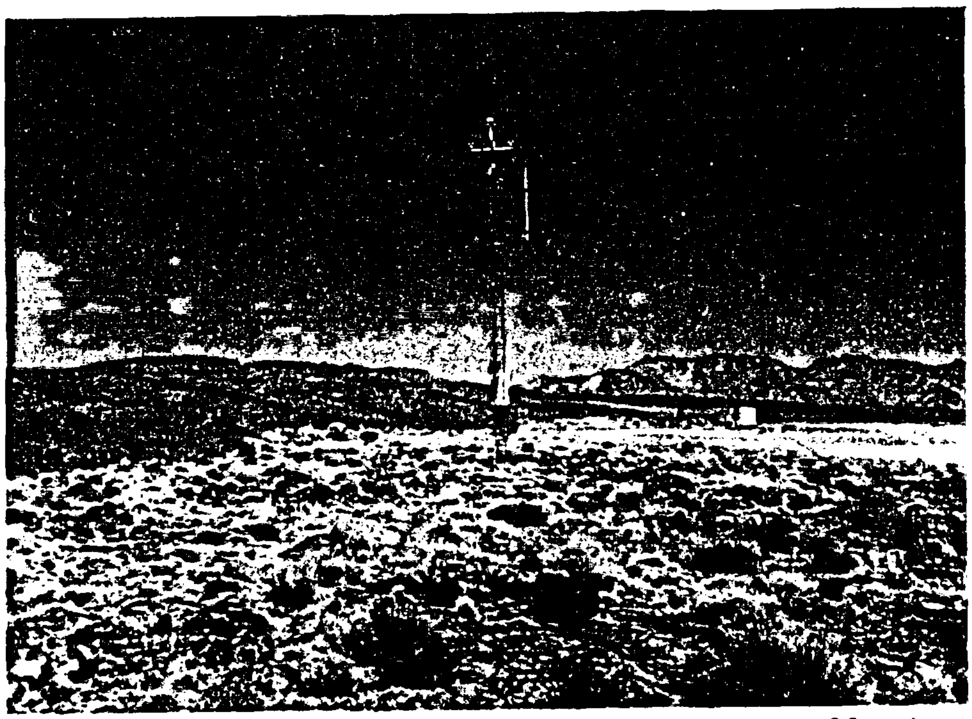

Figure 3.2-5 Perspective of the Yucca Mountain site 10-meter tower looking towards the north

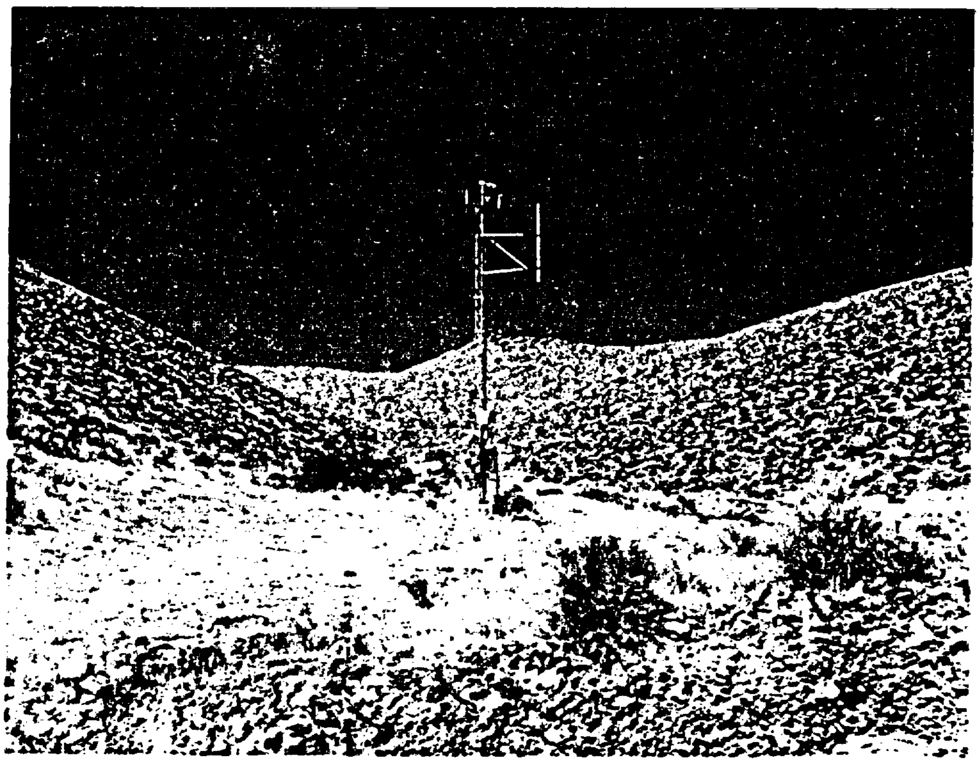

Figure 3.2-6 Coyote Wash 10-meter tower viewed from the south-southeast up the wash towards the west-northwest

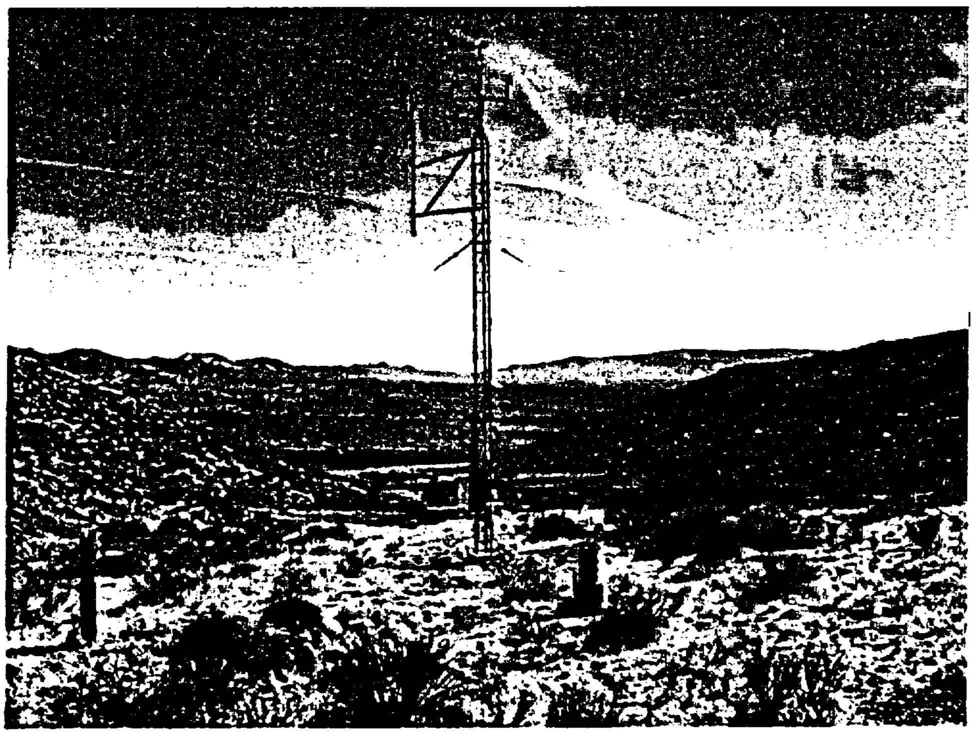

Figure 3.2.7 View looking towards the south-southeast from the Coyote Wash tower

3.2-1. Data from this tower will be used primarily to assess impacts from exploratory shaft operations, but will also be used in the overall repository evaluation.

A third 10-m tower sits on Alice Hill, one of the buttes separating the Project area from Jackass Flats. This site is 3.0 km (1.9 mi) northeast of the Main Site at an elevation of 1,234 m (4,047 ft) above MSL, and the tower is referred to as the Alice Hill site. The Alice Hill site coordinates are shown in Table 3.2-1. Figure 3.2-8 is a view of Yucca Mountain from Alice Hill, and Figure 3.2-9 is the view from Alice Hill looking south. This tower is located such that data from Yucca Mountain, Coyote Wash, and Alice Hill will provide a cross-section of the atmosphere in the lee of Yucca Mountain. In addition, because Coyote Wash and Alice Hill are at approximately the same elevation, comparisons with the Main Site can be used to evaluate the characteristics of the drainage flow that may form.

The final 10-m tower is at the edge of Fortymile Wash, 9.2 km (5.7 mi) southeast of the Main Site at an elevation of 952 m (3,124 ft) above MSL, and is referred to as the 40-Mile Wash site. The coordinates of the 40-Mile Wash site are provided in Table 3.2-1. Fortymile Wash, the major water drainage for the area, influences the air drainage during times when rapid nocturnal surface cooling causes air near the surface to subside. Under these drainage conditions, data from the 40-Mile Wash site will indicate how far down-valley repository emissions could be transported. Figure 3.2-10 is the view from the 40-Mile Wash site looking north, and Figure 3.2-11 shows the view towards the south from the site.

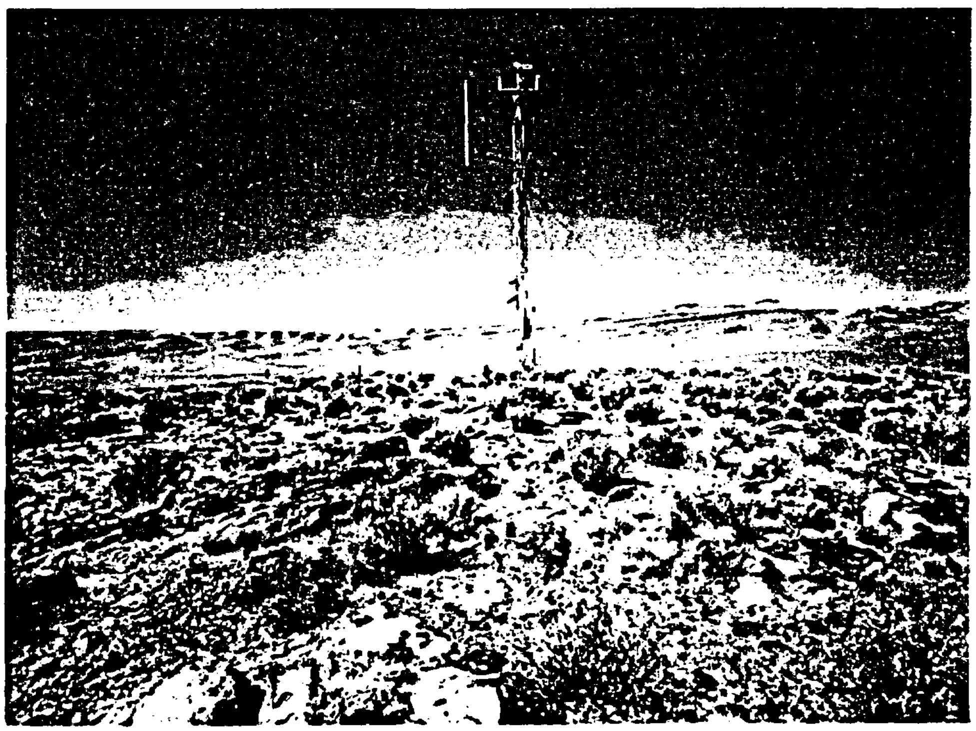

Figure 3.2-8 Yucca Mountain as seen looking west from the Alice Hill site

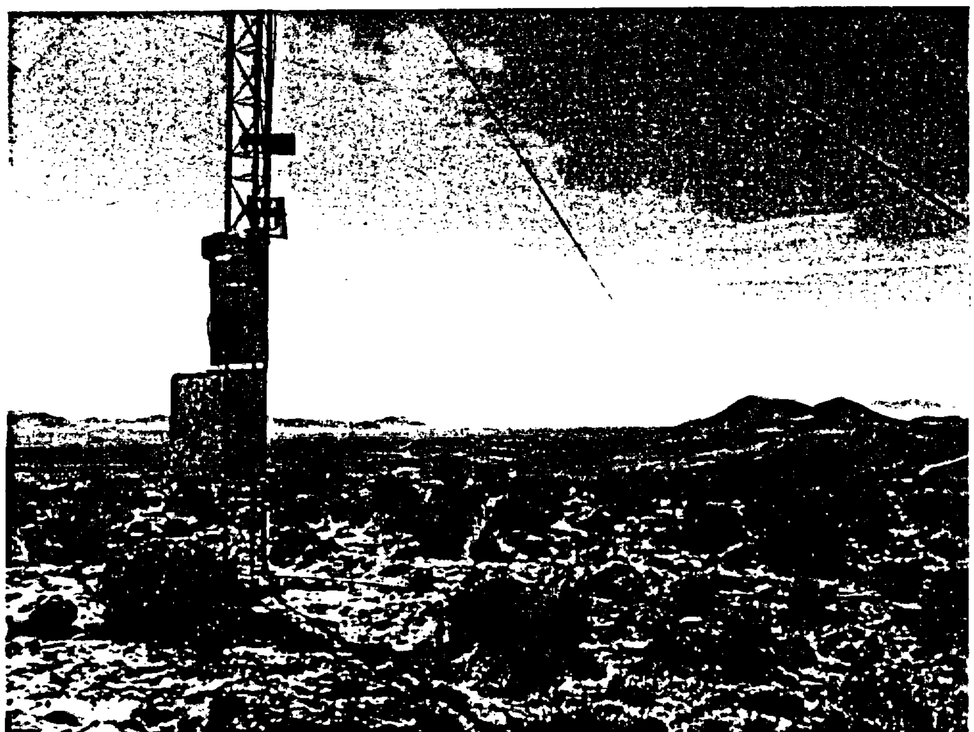

Figure 3.2-9 Vista of Jackass Flats and Fortymile Wash viewed from the Alice Hill site looking south

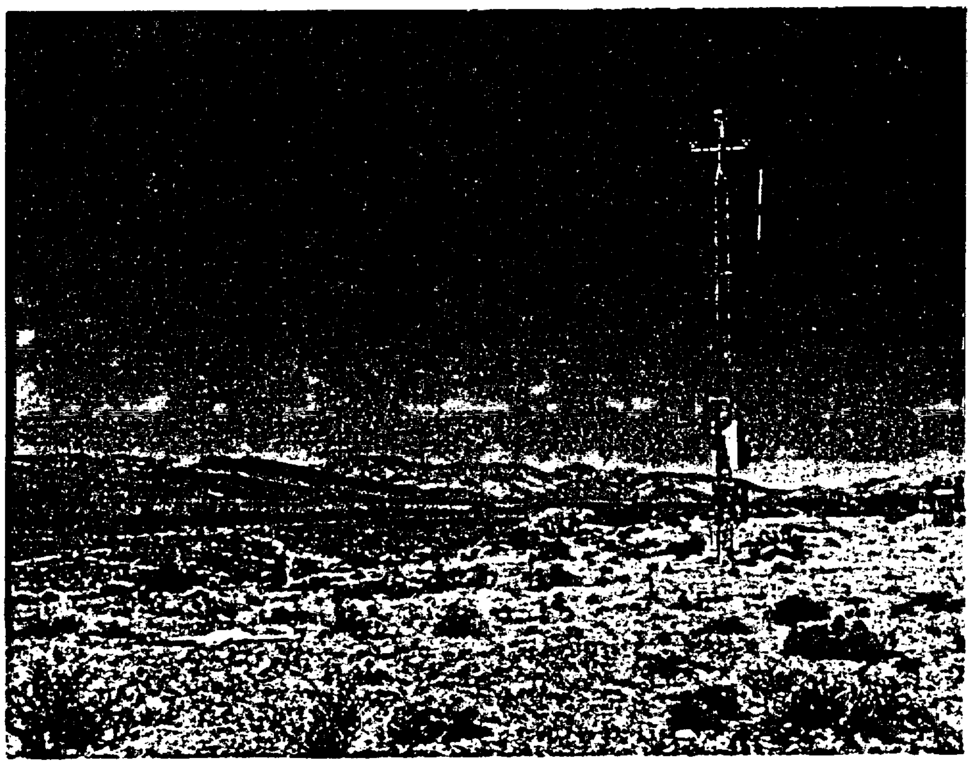

Figure 3.2-10 View from the 40-Mile Wash site looking up the wash to the north

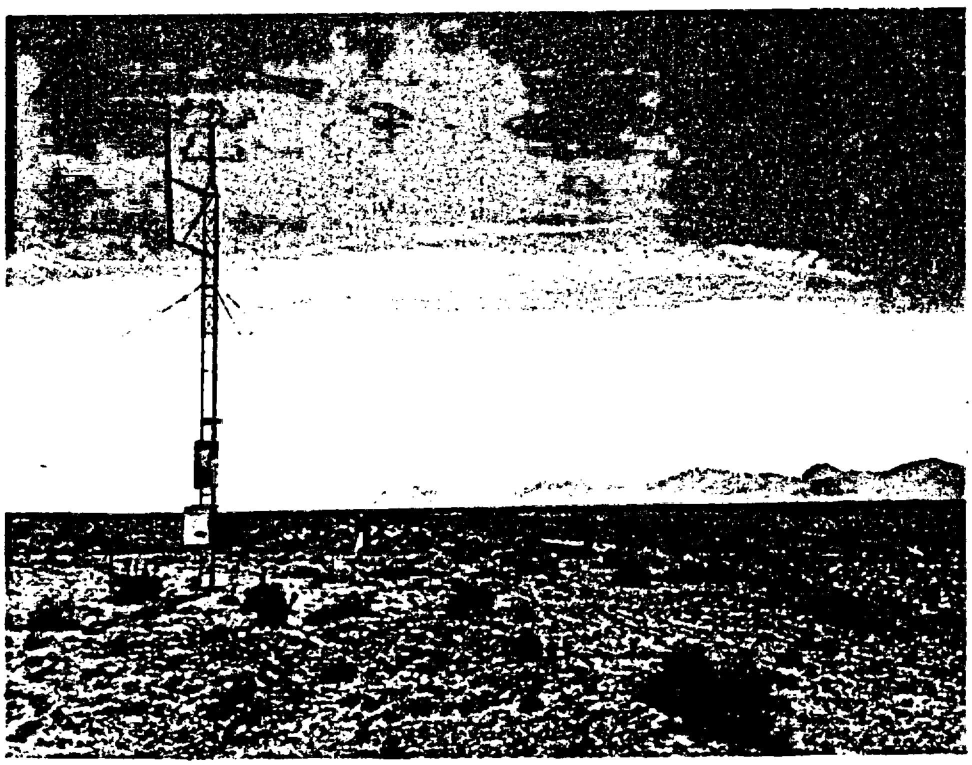

Figure 3.2-11 View looking south towards Amargosa Valley from the 40-Mile Wash site

3.2.3 Meteorological Monitoring Station Design and Probe Siting

Monitoring equipment and stations were designed and sited to ensure that all probes and samplers meet or exceed the requirements given in the PSD rules and regulations (40 CFR 52.21, 52 FR 24714; July 1, 1987) and the PSD probe siting guidelines (EPA, 1987). NRC Regulatory Guide 1.23 (NRC, 1972) also provided guidance in designing the network and stations.

The meteorological sensors on the 10-m towers are mounted at the top of the towers to reduce tower-induced turbulence interference. The towers are instrumented identically to measure wind speed, wind direction, sigma-theta (for determination of atmospheric stability), relative humidity, temperature, atmospheric pressure, and precipitation. (Note: The precipitation gauges are propane-heated for accurate measurement of frozen precipitation.) The sensors at the 10-m level satisfy the requirement for monitoring meteorological parameters at standard exposure heights over level, open terrain according to the PSD monitoring guidelines. It should be noted, however, that the Coyote Wash 10-m tower is located to characterize a specific terrain-induced flow pattern.

For the 60-m tower, wind speed and direction sensors project approximately 1.8 m from the tower, in the direction of the prevailing wind, to minimize tower-induced turbulence effects. The tower is instrumented to measure wind speed, wind direction, and sigma-theta at the 10-m and 60-m levels; sigma-phi, temperature, and humidity at the 10-m level; temperature difference between the 10-m and 60-m levels; net radiation (solar and terrestrial) at the 3-m level (probe placed to avoid shadowing from nearby power pole); atmospheric pressure; and precipitation at essentially ground level a short distance from the base of the tower. (Note: The precipitation gauge is electrically-heated for accurate measurement of frozen precipitation.) The sensors at the 60-m level of the 60-meter tower provide an indication of larger scale wind flow patterns. Other details of the monitoring program such as temperature sensor ventilation and shielding, net radiometer (solar and terrestrial) exposure, and precipitation gauge heating are designed to be in full compliance with acceptable meteorological practice and applicable PSD and NRC regulations and guidelines.

3.3 MONITORING EQUIPMENT AND OPERATION

The following sections describe the considerations that were made for equipment procurement and installation, and the operation of the monitoring equipment.

3.3.1 General Equipment Considerations

The equipment required for implementing this monitoring plan has been identified, purchased, and installed. Procurement of the equipment complied with detailed procedures and instructions for procuring commercial-grade equipment. These procedures are outlined in the Technical and Management Support Services (T&MSS) Quality Assurance Program Description (QAPD). The absence of commercial electrical power at the four remote monitoring sites required selection of equipment with low power consumption and stand-alone operating capabilities. Availability of commercial power at the NTS-60

Repository Site allowed the installation of additional backup recording equipment.

3.3.2 Monitoring Equipment Operation

The instrument specifications for the equipment installed at the monitoring sites are given in Table 3.3-1. This table also includes a brief description of the monitoring methodology and provides the manufacturer and model number of the instruments (where applicable). In addition to the equipment listed in Table 3.3-1. for the Main Site, there is data logging and recording equipment, as well as strip chart recorders that provide back-up data collection. The data logging equipment consists of a digital data logger that scans each of the parameters every 10 seconds, stores and averages these values, writes them to magnetic (cassette) tape through a recorder, and provides a printout of hourly-averaged values. The strip chart recorders proved a continuous record of each of the monitored parameters at the Main Site. The data logging and recording equipment at each of the remote sites is internal to the system package and provides hourly-averaged values on cassette tape.

Table 3.3-1. Instrument Specifications for Meteorological Instruments

Parameter	Methodology	Manufacturer & Model	Range	Detection Limit	Resolution
Main Site					
Wind Speed (10m & 60m)	Optical chopper anemometer	Belfort 1074-12	0-55.8 mph	0.33 m/s	0.1 m/s
Wind Direction (10m & 60m)	Damped vane, 540° potentiometer	Belfort 1074-12	0-540°	0.33 m/s	1°
Sigma-theta (10m & 60m)	Electronic sigma computer		NA	NA	0.1°C
Temperature	Linearized thermistor, aspirated	Belfort 896	-50°C to 50°C	NA	0.1°C
Dewpoint Temperature	Lithium chloride conductivity	Belfort 895	-50°C to 50°C	NA	0.1°C
Temperature Difference	Wheatsone bridge circuitry	Belfort 896	-5°C to 5°C	NA	0.1°C
Net Radiation	Thermopile net radiometer	Qualimetrics 3030	±1369 W/m²	0.1 W/m²	0.1 W/m²
Vertical Wind Speed Sigma	Vertically-mounted propeller	Belfort	±5 m/s	0.2 m/s	0.1 m/s
Atmospheric Pressure	Analog	NA			
Precipitation	Tipping Bucket - electronic, heated	Belfort 302	0-1 in	0.01 in	0.01 in
Remote Sites					
Wind Speed	Magnetic switch-anemometer	Climatronics F460	0-50 m/s	<0.33 m/s	0.1 m/s
Wind Direction	Damped vane, 360° potentiometer	Climatronics F460	0-359°	<0.33 m/s	1°
Sigma-theta	Electronic sigma computer	Climatronics F460	NA	NA	0.1°
Temperature	Linearized thermistor, naturally aspirated	NA	-30°C to 50°C	NA	0.1°C
Relative Humidity	Exposed circuit impedance variation	NA	10% to 95% RH	NA	1% RH
Atmospheric Pressure	Analog	NA			
Precipitation	Tipping Bucket - electronic, heated	Sierra-Misco	0-1 in	0.01 in	0.01 in

3.3.3 Instrument Tolerances

Instrument tolerances are given in Table 3.3-2. Note that these tolerances apply to digital systems; analog back-up systems can deviate by up to one-and-a-half times these values.

Table 3.3-2

Meteorological Instrument Tolerance Limits

Parameter	Tolerance Limits	Notes	Calibration Frequency/ Procedure
Wind Speed: All Sites	± 0.22 m/s, wind speed < 11.1 m/s ± 5% of true speed, wind speed ≥ 11.1 m/s	Not to exceed ± 2.5 for wind speeds > 11.1 m/s	Annual/Wind tunnel testing
Wind Direction	± 3° of true azimuth, < .45 m/s starting threshold	Including sensor orientation error	Annual/Wind tunnel testing
Temperature	± 0.5 C°		Performance Check Only
Temperature Difference	± 0.003 C°/m		Performance Check Only
Humidity/	± 10% RH/± 0.5 C°	Does not apply below values of 30% RH	Performance Check Only
Net Radiation	± 5% of true value	± 10% average difference over 24-hour period	Annual/ Comparison to radiation standard
Precipitation	± 0.01" resolution, ± 10% of total catch		Performance Check Only
Barometric Pressure:			
Main Site	± 1.0 mb		Performance Check Only
Remote Sites	± 2.0 mb		Performance Check Only

Note: Performance checks and performance audits are conducted at six-week intervals for each sensor. A sensor found out of tolerance during a check or audit is recalibrated or replaced, as appropriate.

4. DATA MANAGEMENT

4.1 DATA COLLECTION, TRANSMITTAL, AND SCREENING

To help ensure maximum data recovery, all data is collected onsite on a weekly basis. The data undergoes an initial examination to detect gross errors in transmittal, recording, or documentation. The data tapes are then transcribed onto a computer file. The digital data file is subjected to a screening process that identifies out-of-range conditions, such as extremely high or negative wind speeds, extremely high or low temperatures, or large hourly variations. Data identified through this screening are visually inspected to determine whether the event is real or is the effect of an instrument malfunction. If the out-of-range data are determined to be the result of an instrument malfunction, then that data is voided.

4.2 DATA REDUCTION, VERIFICATION, AND VALIDATION

As a means of verifying the digital data base, a random hour out of each day for each parameter is hand-reduced from the strip chart data at the same time the digital data base is undergoing the screening procedures described in the previous section. These hourly averages are extracted from the strip charts by using a data digitizer. The hand-reduced data are then compared with the corresponding parameter and hour in the digital data base. If random or systematic differences exist between the digital and hand-reduced data, then the data reviewer will recommend corrective action to ensure the integrity of the data base, which is either approved or modified by the task manager. In some cases the corrective action will consist of reducing the corresponding period of strip chart data to fill in gaps caused by voiding out-of-tolerance digital data. In such instances, the hand-reduced data are spot-checked with the original strip chart to ensure agreement. The final listing is visually scanned for any unexplained data gaps before additional data processing is done.

4.3 DATA SUMMARIZATION AND FORMATTING

After the digital data base has been verified and validated using the procedures described in the previous sections, the data are summarized for inclusion in the monthly, quarterly, and annual reports. An example of a page from the monthly reports is shown in Table 4.3.-1, and the quarterly and annual report formats are shown in Tables 4.3-1, 4.3-2, and 4.3-3, respectively.

4.4 APPLICATION OF RESULTS

The meteorological reports serve as input to certain other Project programs, as described in the next sections.

4.4.1 Data Input to Dose Assessments

As described in Section 1.2, 10 CFR Part 20 outlines permissible radiological doses to workers at NRC-licensed facilities and the general public in the vicinity of such facilities. The Yucca Mountain meteorological monitoring program addresses this regulatory requirement for the proposed

NTS-60 REPOSITORY SITE METEOROLOGICAL DATA SUMMARY

DATE: DEC- 1-1985

HR	LWD 1hr deg	LWS 1hr mps	LSIG 1hr deg	UWD 1hr deg	UWS 1hr mps	USIG 1hr deg	TEMP 1hr deg C	DP 1hr deg C	DT 1hr C deg	RAD 1hr W/m2	VSIG 1hr mps	STAB 1hr	PCP 1hr mm	PCP 6hr mm	PCP 24hr mm
0	316.4	2.2	20.5	349.2	1.4	67.5	4.4	-4.9	1.1	-18.8	0.12	D/N	0.00	NR	NR
1	314.6	1.1	30.6	12.4	1.0	100.5	3.9	-4.9	1.1	-24.9	0.01	D/N	0.00	NR	NR
2	326.8	2.4	20.1	347.6	1.5	86.5	4.4	-5.1	0.8	-21.6	0.12	D/N	0.00	NR	NR
3	335.3	2.3	32.7	345.6	1.8	61.4	4.0	-5.0	1.3	-17.9	0.12	D/N	0.00	NR	NR
4	264.0	0.6	32.2	313.9	0.7	41.4	3.9	-4.6	1.0	-11.6	0.01	D/N	0.00	NR	NR
5	320.0	1.0	24.0	350.5	0.5	45.9	4.2	-4.5	0.7	-15.3	0.01	D/N	0.00	0.00	NR
6	334.2	1.7	33.3	341.4	0.9	35.1	4.2	-4.8	0.8	-14.5	0.12	D/N	0.00	0.00	NR
7	307.0	0.7	38.8	36.9	1.0	85.8	4.3	-3.9	0.3	9.8	0.01	D/D	0.00	0.00	NR
8	81.8	0.7	66.1	37.5	0.7	84.1	6.0	-2.8	-0.3	73.9	0.12	D/D	0.00	0.00	NR
9	129.8	1.7	67.1	122.0	2.2	86.8	7.3	-4.2	-0.5	182.0	0.22	C	0.00	0.00	NR
10	163.5	2.6	56.9	154.8	3.0	64.6	7.8	-4.1	-0.8	195.5	0.27	C	0.00	0.00	NR
11	183.1	2.4	66.1	170.9	2.8	75.7	8.0	-3.5	-0.8	251.1	0.27	C	0.00	0.00	NR
12	169.3	3.3	53.3	159.2	3.7	50.8	7.9	-3.2	-0.8	148.3	0.27	C	0.00	0.00	NR
13	169.4	3.2	40.7	161.1	3.8	40.5	7.8	-2.9	-0.6	75.1	0.22	D/D	0.00	0.00	NR
14	177.5	3.0	41.2	165.0	3.6	34.1	7.5	-2.9	-0.5	19.6	0.22	D/D	0.00	0.00	NR
15	155.7	1.7	39.2	147.3	2.2	35.2	7.3	-2.6	-0.5	0.7	0.12	D/D	0.00	0.00	NR
16	154.7	0.6	31.5	137.0	1.0	31.1	7.0	-2.5	-0.3	-18.1	0.01	D/N	0.00	0.00	NR
17	350.0	0.7	23.9	67.1	0.7	51.5	6.6	-2.7	-0.1	-23.4	0.01	D/N	0.00	0.00	NR
18	325.9	1.4	18.4	40.5	0.8	67.2	6.2	-2.9	0.2	-34.0	0.01	E	0.00	0.00	NR
19	325.8	2.1	20.1	8.0	1.0	71.6	5.7	-3.1	0.5	-34.9	0.12	E	0.00	0.00	NR
20	311.6	2.3	13.1	313.3	1.2	33.8	5.7	-2.8	0.7	-17.1	0.01	D/N	0.00	0.00	NR
21	305.6	1.2	35.6	359.9	0.8	59.8	6.0	-2.3	0.6	-9.0	0.01	D/N	0.00	0.00	NR
22	334.1	1.0	41.8	26.2	0.8	66.4	6.3	-2.0	0.3	-9.4	0.01	D/N	0.00	0.00	NR
23	342.3	1.2	31.5	21.7	1.1	47.8	6.2	-2.0	0.3	-7.4	0.01	D/N	0.00	0.00	0.00
DAILY															
MAX:		3.3			3.8		8.0	-2.0					0.00	0.00	0.00
AVG:		1.7			1.6		5.9	-3.5							
MIN:		0.6			0.5		3.9	-5.1				TOTAL:	0.00		

Table 4.3-1. Sample Page of Monthly Data Report from Main Site

Table 4.3-2. Quarterly Report Format

SECTION	SUBJECT MATTER
1.0	Introduction and Summary (brief description of Project and goals)
2.0	Monitoring Program Description (site description, instrumentation, program operation)
3.0	Program Events and Date, Recovery Rates (chronology of events, down times, data recovery rates)
4.0	Meteorological Data Summary (wind roses, stability persistence and frequency, temperature means and extremes, precipitation amounts, etc.)
Appendices	Monthly Wind Roses and Hourly Data Listing for each Site

NOTE: Section 1.0 contents was deleted from succeeding reports after the report for September - November 1988.

Table 4.3-3. Annual Report Format

SECTION	SUBJECT MATTER
1.0	Introduction (brief description of program and operation)
2.0	Executive Summary (data summary and dispersion parameters)
Appendix A	Annual Tables
Appendix B	Quality Assurance and Quality Control
Appendix C	Audit Results
Appendix D	NTS-60 Repository Hourly Data Listing
Appendix E	Alice Hill Hourly Data Listing
Appendix F	Coyote Wash Hourly Data Listing
Appendix G	40-Mile Wash Hourly Data Listing
Appendix H	Yucca Mountain Hourly Data Listing
Appendix I	Average Temperatures by Site
Appendix J	Average Wind Speeds by Site

repository by providing data inputs to the radiological monitoring program. Specifically, these inputs are used in calculations of a concentration parameter, χ/Q, for assessing radiological impacts. This parameter is calculated using a dispersion model, and represents the concentration (χ) over the emission rate (Q). χ/Qs are calculated for several locations at various distances from the surface facilities. Calculating χ/Qs as opposed to concentrations allows the source term Q to be varied without rerunning the model. This permits rapid calculation of doses under accident, as well as routine, emission scenarios.

The χ/Q values are calculated at discrete locations, but the receptor grid is arbitrary in that no specific sites have been selected for evaluation. Instead, a radial receptor grid is used and χ/Q values at distances of 2, 4, 8, 16, 24, 32, 40, 48, 56, 64, 72, and 80 km from an assumed source are calculated in directions representing angular sectors of 22.5 degrees each, for a total of 176 receptors. In the future, however, specific locations of interest will be included in the modeling efforts.

To ensure responsiveness to the design and performance issues, χ/Qs representing routine and accident release scenarios are calculated. Routine releases are evaluated by calculating an annual average χ/Q value at each of the receptors. Because the accident scenarios must be evaluated under meteorologically worst-case conditions (in terms of dispersion), one-hour χ/Q values are also required.

Other data needed as input to a dispersion model are the following: one year of hourly sequential meteorological data (wind speed, wind direction, temperature, mixing height, and Pasquill stability class*), receptor terrain heights and their Universal Transverse Mercator (UTM) coordinates, and source characteristics (UTM coordinates, stack height, stack diameter, exit gas velocity, exit gas temperature, and building-stack configuration). When all these data have been put in the format required by the model, the model is run. Although the basic equations used in calculating a χ/Q value are not exceptionally complex, the large number of calculations required for a year of hourly meteorological data dictates the use of a computer.

The dispersion models are capable of simulating the meteorological and topographical influences on material emitted to the atmosphere as the material is transported and dispersed downwind. While many models have been developed for this purpose, most are appropriate only for use in flat or gently rolling terrain. The topography of the Yucca Mountain site warrants the use of a model that can simulate complex terrain effects. Both the EPA and the NRC have issued documents that provide guidance on the selection and use of the various models that have been developed. The NRC has issued at least four regulatory guides (NRC, 1977a; NRC, 1977b; NRC, 1982b; NRC, 1982c) that either reference, provide examples of, or suggest the use of models to determine χ/Q values. One such model that may be applicable to Yucca Mountain is the Particle-in-Cell model. It "uses spatial and temporal variations of wind direction, windspeed, atmospheric stability, and topography as input parameters to define airflow and atmospheric diffusion rates" (NRC, 1977a).

*Stability class is determined using a technique described by Pasquill (1974).

A report presenting the χ/Q values and the information used in calculating those values is prepared at annual intervals.

4.4.2 Data Submittal to Technical Data Bases

In accordance with appropriate adminstrative procedures, meteorological data is prepared and submitted to the Project Technical Data Base (TDB), the Reference Information Base (RIB), and the Site Engineering Property Data Base (SEPDB). As a minimum, the data sets include:

1. Data compiled in the format and scope specified by the administrator of the TDB, RIB, or SEPDB, as appropriate.

2. Documentation that the data was prepared and reviewed in accordance with governing instructions.

3. Signature of the verifying Technical Project Officer (TPO).

4.4.3 Analyses in Support of SCP Requirements

The following sections describe the types and general content of analyses performed in support of the SCP.

4.4.3.1 Site Monitoring

The SCP requirements of site monitoring are:

1. The preparation of annual meteorological monitoring data reports.

2. Summary reports on average and unfavorable χ/Q values.

3. A five-year summary report of meteorological conditions.

4. On-going monitoring of precipitation and other parameters as performance confirmation.

Accordingly, analysis will primarily focus on seasonal patterns of wind direction, wind speed, and stability, with an aim to establishing the dominating flow regimes. Significant deviations from these patterns will be highlighted as they occur. The analysis will also tend to be site-specific.

4.4.3.2 Regional Meteorological Report

Analysis in support of the regional report will describe the seasonal patterns of the standard parameters i.e., wind direction, wind speed, stability, temperature, pressure, and precipitation, for the "region" surrounding Yucca Mountain. The short-term data record of the Project's monitoring will be compared to the longer term record of other Southern Nevada stations to qualitatively identify similarities and differences between regional and site-specific conditions.

4.4.3.3 Extreme Weather Phenomena

Analysis for extreme weather phenomena will, of necessity, be extrapolations from the relatively scarce data of such events in southern Nevada. Severe storms; extreme wind speeds; temperature, humidity, and precipitation extremes; and fog rarely occur in this area (Eglinton and Dreicer, 1984). In, addition, the density of monitoring stations is low. Therefore, the analysis will rely on meteorological summaries of the entire Southwest for extreme weather phenomena. It is anticipated that the bounds of the uncertainty for the frequency and recurrence intervals of extreme weather in the Yucca Mountain area can be established.

4.4.3.4 Synthesis of Meteorological Monitoring

Analysis on integrating the monitoring efforts of the Project will be concentrated on developing a method to exchange data between the monitoring groups i.e., SAIC and USGS. Secondarily, an effort will be made to ensure that the data sets of the two groups are compatible.

5. SCHEDULE AND MILESTONES

Expected completion dates for major events are shown below as months from start date.

EVENT	DATE (number of months from start)
Contact potential sources of regional meteorological data	2
Obtain data from regional meteorological sources	8
Perform regional data screening and processing	14
Draft regional meteorological report (See Note 1)	20
Obtain data on extreme weather phenomena	8
Draft report on extreme weather phenomena (See Note 2)	14
Begin interface discussion for data transfer	3
Develop Memorandum of Understanding	8
Initiate data transfer	15

Note 1: The date for completion of the draft regional meteorological report is a change listed in the master schedule provided in Section 8.5 of the SCP.

Note 2: The date for completion of the draft report on extreme weather phenomena is a change listed in the master schedule provided in Section 8.5 of the SCP.

6. QUALITY ASSURANCE

6.1 CONFORMANCE WITH DOE QUALITY ASSURANCE PLAN

The Yucca Mountain Project has developed and is implementing a Quality Assurance (QA) program in accordance with the "Quality Assurance Requirements Document" (DOE, 1990a) and the "Quality Assurance Program Description" (SAIC, 1990). Each Yucca Mountain Project participant is responsible for developing and maintaining a QA Plan (QAP) and supporting procedures to implement the requirements of the Project QAP and the quality related administrative procedures. All work associated with the implementation of the meteorological monitoring plan was performed in accordance with applicable QA procedures.

The meteorological monitoring program at Yucca Mountain is also subject to the QA requirements of the EPA, which were developed to ensure the accuracy and validity of the collected data (40 CFR Part 58). The monitoring program was broken into discrete activities, and the applicability of the EPA guidance to each activity was determined. Procedures incorporating the requirements of the various Technical and Management Support Services (T&MSS) Standard Practice Procedures (SPs) applicable to a given activity were then prepared. Various audit provisions ensure that the monitoring program is operated in accordance with the procedures developed in response to the EPA's goal of collecting accurate, valid data and the DOE's goal of complying with the Project QAP.

6.2 QUALITY ASSURANCE (QA) SPECIFIC TO METEOROLOGICAL MONITORING

The QA program specific to collecting accurate, valid data is delineated in the meteorological work instructions. The NRC QA criteria that are applicable to the meteorological monitoring program are listed in the Quality Assurance Grading Report (Report No. T12542B). Quality Control (QC) is also performed as part of QA. QC activities are the primary avenue by which the data are kept within prescribed control conditions. The field QC activities are carried out by the site technician, while in-house QC activities are performed by personnel who are involved with the data reduction and analyses. The QA program ensures that each QC function is performed completely and accurately and is documented in accordance with approved procedures. If a QA check indicates that an out-of-control condition has occurred, the related QC activity is modified or restructured to eliminate future occurrences.

6.3 FIELD QUALITY CONTROL ACTIVITIES

The following sections describe the methodology for the control of monitoring equipment.

6.3.1 Equipment Receipt, Inspection, Acceptance Testing, and Installation

The initial quality control tasks include a receiving inspection and acceptance test of the meteorological monitoring equipment prior to installation. The installation of each piece of monitoring equipment is performed after the equipment is inventoried, inspected, and acceptance tested. Installation, onsite tests, and related activities are performed in accordance with approved instructions, information from manufacturers' manuals, and the technician's experience. These activities are fully documented.

6.3.2 Calibration Checks

Calibration checks of the meteorological monitoring equipment are performed on a periodic basis in accordance with approved instructions.

6.3.3 Instrument Maintenance

To provide for continued proper operation of the meteorological monitoring equipment, scheduled maintenance is performed in accordance with approved instructions. Examples of maintenance on the equipment includes:

- o Cleaning of the magnetic tape recording heads
- o Replacement of wind speed and direction sensor bearings, as necessary
- o Checking of all sensor cables, tie-downs, power cords, etc.
- o Inspection of all sensors for proper operation
- o Inspection of all digital and strip chart recorders for data reasonableness and proper timekeeping

6.3.4 Independent System and Performance Audits

Certain QA activities that will be carried out under the meteorologoical monitoring program are defined differently than those for the overall Yucca Mountain Project Office QA program. The following definitions apply to this program:

- o System Audits encompass all aspects of the monitoring program (i.e., probe siting, data handling activities, calibration techniques and schedules, maintenance schedules, etc).
- o Performance Audits involve comparing the meteorological sensors with known standards to determine monitoring accuracy.

Independent system audits of the monitoring installation and operational activities are conducted annually. The system audit, as outlined in EPA guidelines, includes a review of the monitoring stations to determine compliance with the EPA PSD probe siting criteria. This review also includes investigating the onsite data handling and transmittal activities as well as the schedule of calibration check activities and other QA functions in accordance with the T&MSS SPs. All nonconformances identified in any system audit are recorded in an audit report. The resolution of nonconformances is documented in accordance with SPs.

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