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Conceptual Design of the NRC Headquarters Operations Center

User Needs for Radiological and Meteorological Data

Prepared by J. Hannan, J. Himes*

*Presently with the U.S. Nuclear Regulatory Commission

The MITRE Corporation

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ABSTRACT

The MITRE Corporation is assisting in the design and development of a new Operations Center, to be located at the headquarters of the Nuclear Regulatory Commission (NRC). This report describes the recommended use of meteorological and radiological data by NRC personnel at the center during the course of a nuclear-related incident. Effective display formats are illustrated and data usage procedures are recommended. The report also provides an overview of a hypothetical incident, illustrating the use of meteorological and radiological data at various stages.

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EXECUTIVE SUMMARY

The Nuclear Regulatory Commission (NRC) is currently in the process of improving its capability to respond to incidents that could occur at licensees' plants. This continuing effort includes design and development of a new Headquarters Operations Center to receive, process, and display data transmitted over a variety of different media, including the planned Nuclear Data Link's (NDL) telemetered information.

This report examines two kinds of data, meteorological and radiological, that often assume critical importance during the course of an evolving nuclear incident. During an incident, meteorological and radiological data will originate from a variety of sources; most of the data will probably not be telemetered.

An overall system concept is recommended that will channel the flow of this information so that all sources need not be in direct contact with all users. NRC Headquarters and all other agencies will draw information from the same base of radiological survey data, prepared at a recommended Field Data Correlation Center. In like manner, meteorological data from the site will be provided simultaneously to both the NRC Headquarters Operations Center and a recommended Emergency Operations Facility.

An interactive, "topic-oriented" approach to the use of meteorological and radiological data is suggested. The approach recommends a system that would draw information from the Protective Measures Analysis data base, used to generate lists for health physicists and summaries for the Executive Team. This system would organize all relevant meteorological and radiological information around five key "topics" of interest to headquarters response personnel: Plant Status; Response Personnel Protection; Radiological Survey Operations; Evacuation; and General Support Operations. A headquarters user would enter the system by requesting display information about radiological surveys; within this topic, a sequence of displays would interactively present the viewer with successively more detailed information, ultimately displaying detailed data lists, if desired.

Procedures are identified whereby the proposed topic-oriented approach can be effectively used at NRC Headquarters; data formats are shown in terms of a 24-line by 80-character display (in accordance with tasking); the large variety of transmission media is described and graphically depicted (included are telephone, facsimile, and teletype links); and meteorological and radiological data use is illustrated in terms of distinct phases of an incident.

1.0 INTRODUCTION

The Nuclear Regulatory Commission (NRC) is in the process of improving its capability to respond to incidents which involve licensees. These improvements were prompted largely (but not exclusively) by lessons learned during the response to the Three Mile Island (TMI) incident. One major improvement may be a system for automatically telemetering critical data from operating power reactors to NRC Headquarters in Bethesda, Maryland. This system, the proposed Nuclear Data Link (NDL), is under detailed study by Sandia Laboratories; the work reported here was performed in support of that study.

MITRE previously described initial design considerations for a Headquarters Operations Center,[1] then defined detailed procedures for use within the center of the technical data which is likely to be telemetered from the reactors to Headquarters.[2] A recent MITRE study has also described the spectrum of possible NRC roles during a nuclear incident.[3] Sandia has defined the framework for an NDL, including design alternatives and an implementation plan.[4]

Telemetered data from a reactor site represents only a small part of the total data and information needed by NRC Headquarters during an incident. Other data will be telephoned from the site and a variety of reports will be sent to the NRC from other organizations participating in the response. In Reference 2 MITRE defined six "subsystems" of information flow in terms of differences in the way the data and information will be acquired, processed, and used. One of those subsystems includes all technical data which must be sent to Headquarters by some means other than telemetry, such as data from sensors not yet connected to the NDL or information from locations not included in the NDL system. This report is intended to address headquarters needs and uses of two kinds of data, radiological and meteorological, most of which will not be telemetered.

In this report, however, MITRE does not limit itself strictly to considerations about the use of these two kinds of data during an incident involving a power reactor. A broadened approach was taken in order to help insure that displays and software in the planned center will be sufficiently flexible in design to support an effective response to the full range of NRC emergency actions. This study can provide a basic framework for the development of displays and software specifications. It draws upon MITRE's extensive work in support of the NRC.

MITRE also considered the operational context in which the center must function during an incident. Section 2.0 summarizes the other relevant facilities and participants which have been discussed to date and MITRE recommendations for the primary working relationship among them. Section 3.0 describes the kinds of detailed and summary displays needed within the center; this is done to provide the reader with an understanding of the context in which radiological and meteorological data will be used.

Section 4.0 describes the integrated displays recommended for radiological and meteorological data. Ideally, each user in the center should be provided with information which is organized to suit his task. Some technical specialists, for example, may need only a sample listing of current raw data. Other persons, particularly those with executive functions, require evaluated data and several other kinds of information which should all be displayed in some manner which is less tedious to use than a series of specialized lists would be. MITRE, therefore, reviewed various ways of assembling logically-related information into usable display formats before deciding on the approach described in Section 4.0.

Section 5.0 describes typical uses of the recommended displays in a hypothetical incident.

Section 6.0 contains MITRE recommendations for follow-on actions by the NRC.

2.0 SYSTEM CONCEPT

MITRE suggests that the primary flow of information among major sources and users during an incident be as shown in Figure 1. The proposed system concept will help reduce confusion by clarifying areas of responsibility and by improving the exchange of information. This recommendation is based upon MITRE's past support of the NRC both in exercises, as well as during the TMI.

The Licensee Management Center, the Emergency Operations Facility (EOF), and the Field Data Correlation Center may, of course, be collocated with no adverse effect on the overall response as long as their functions are kept separate and sharply focused.

NRC Headquarters' advice and direction will be transmitted to the plant's control room through licensee management; as indicated, however, the NRC Resident Inspector (RI) will be with licensee personnel in the control room.

Radiological survey data from all field teams, including those from National Laboratories, will be correlated at a single location near the site, i.e., the Field Data Correlation Center, as shown. All interested and participating groups and agencies will draw from the same base of correlated information.

At NRC Headquarters, all non-telemetered radiological and meteorological data will be received by designated members of the Protective Measures Analysis Team (PMT).

This recommended system concept has not been advanced as such by MITRE previously nor has it been adopted by the NRC. It is obvious that many ramifications of the concept will require exploration and resolution, including details of the data/information flow.

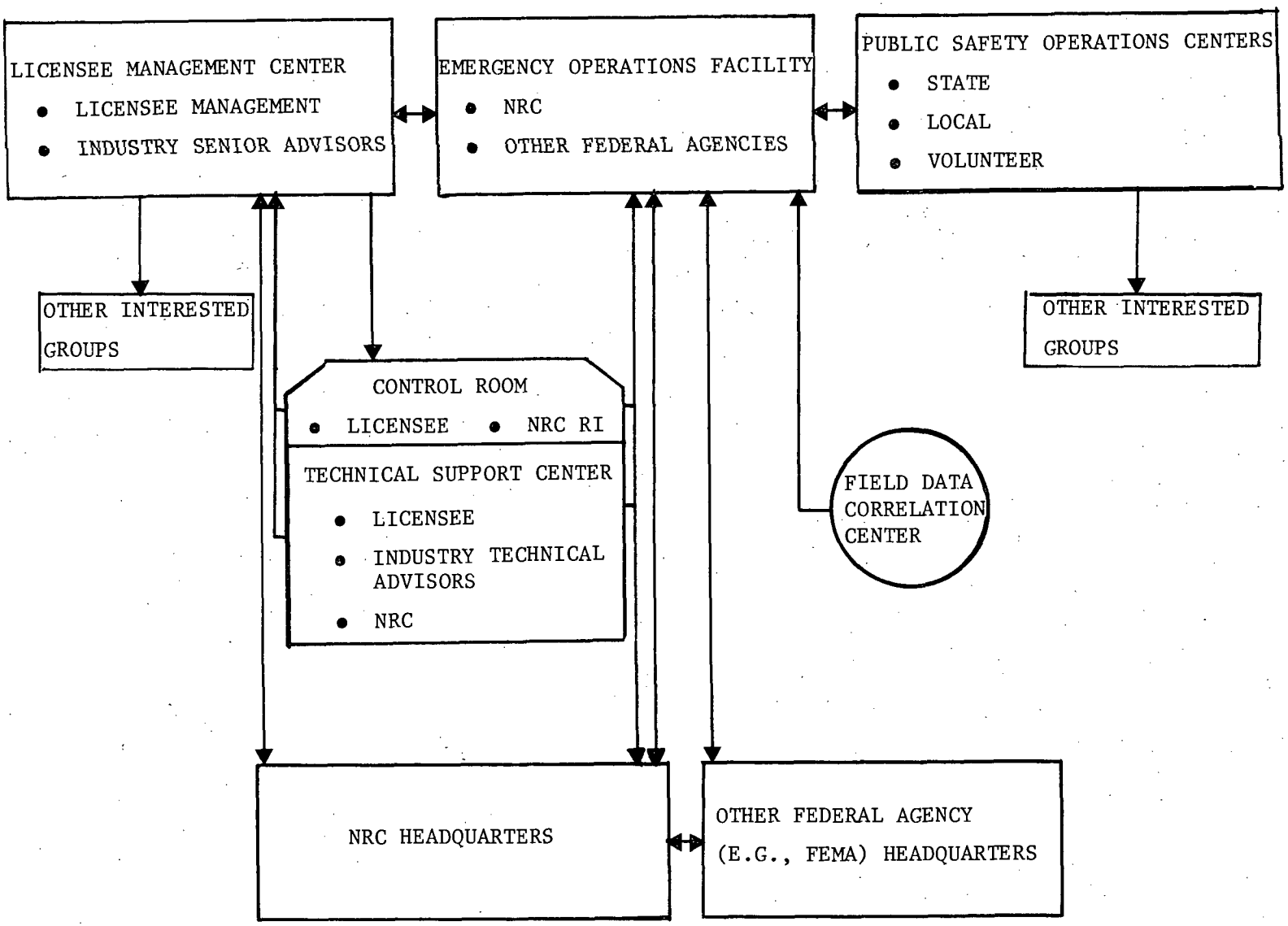


FIGURE 1
PRIMARY INFORMATION FLOW

3.0 OPERATIONS CENTER LIST AND SUMMARY DISPLAYS

The NRC is presently in the process of defining two kinds of data needed in the Operations Center: reactor and radiological. This data, when combined with other information, results in the need for seven displays. Each is described below along with the organizational group best qualified to maintain an accurate, reliable and significant display:

1. Operations Data Display - a detailed list of reactor operational data. Input: The Data Control Team as derived from the NDL and the Operations Analysis Team as obtained from telephone information.

2. Operations Summary Display - a summary of the Operations Data Display. Input: The Operations Analysis Team.

3. Protective Measures Data Display,- a detailed list of radiological and meteorological data. Input: The Data Control Team as derived from the NDL and the Protective Measures Analysis Team obtained from telephone information.

4. Protective Measures Summary Display - a summary of the Protective Measures Data Display. Input: Protective Measures Analysis Team.

5. Incident Summary Display - a listing of all key events related to the incident. The responses to these events are not included in this display, but are part of the Action Summary Display described below. Input: Operations Support and Control.

6. Action Summary Display - a listing of key response events and actions taken by any organization involved in the incident. Input: Operations Support and Control.

7. NRC Task Summary Display - a listing of analysis and tasks pending, underway, or completed by NRC personnel. Input: Operations Support and Control.

These displays described above need not be visible simultaneously; a single console or screen capable of being rapidly switched between the displays would suffice for the purposes intended. The number of

dispersed persons requiring the information will dictate the need for a number of consoles or screens placed at locations throughout the center.

4.0 INTEGRATED DISPLAYS

In addition to the seven detailed and summary displays described in the previous section, it is recommended that displays be developed that integrate and organize all relevant operational, radiological, meteorological, and logistic information around key topics of interest to headquarters response personnel. Radiological and meteorological data are important in five such topics:

- Plant status
- Response personnel protection
- Radiological survey operations
- Evacuation
- General support operations.

Any of the topics may be divided in the future if they prove to be too broad or unwieldy.

Figure 2 illustrates the sequence of displays that might be seen by a viewer interested in any topic listed above. Within each topic, the sequence of displays (see Section 3.0) will present the viewer with successively more detailed information, ultimately displaying relevant portions of the detailed data display. The specific display from which each input is drawn is shown beneath each outline. It should be noted that persons responsible for display inputs will also maintain a log of other details which they may consider inappropriate for any of the display lists. These supplementary logs have been referred to as "backup". Additional detail from this backup could be input as needed to the integrated displays directly from written notes.

The figures are typed in a 24-line by 80-character format. Underlined material will be input during an incident; other material should be retained in the system (and updated as necessary) at all times.

1. The system is engaged by user:

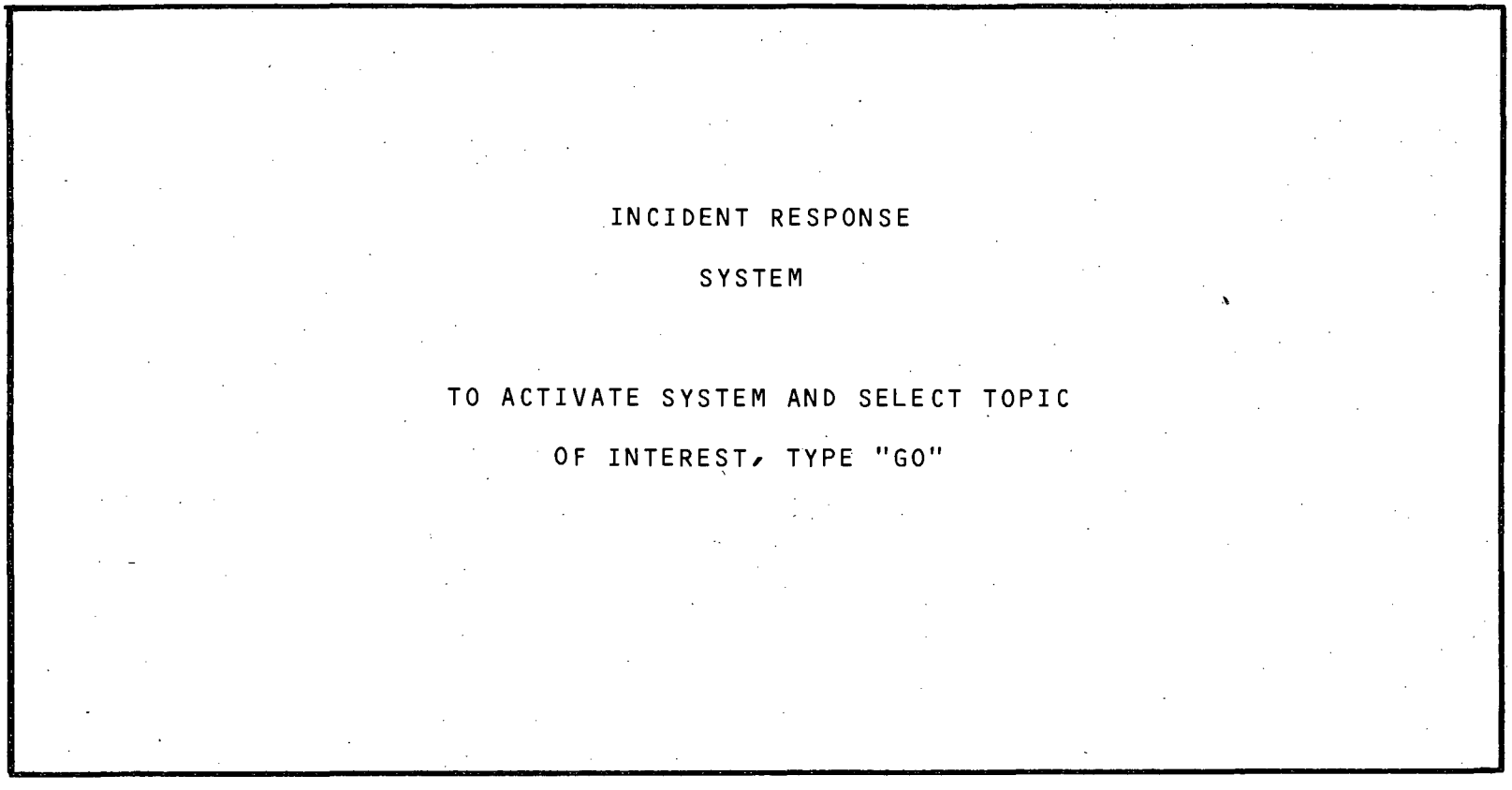


FIGURE 2
EXAMPLES OF SYSTEM DISPLAYS

2. Having typed "GO", user receives list of topics:

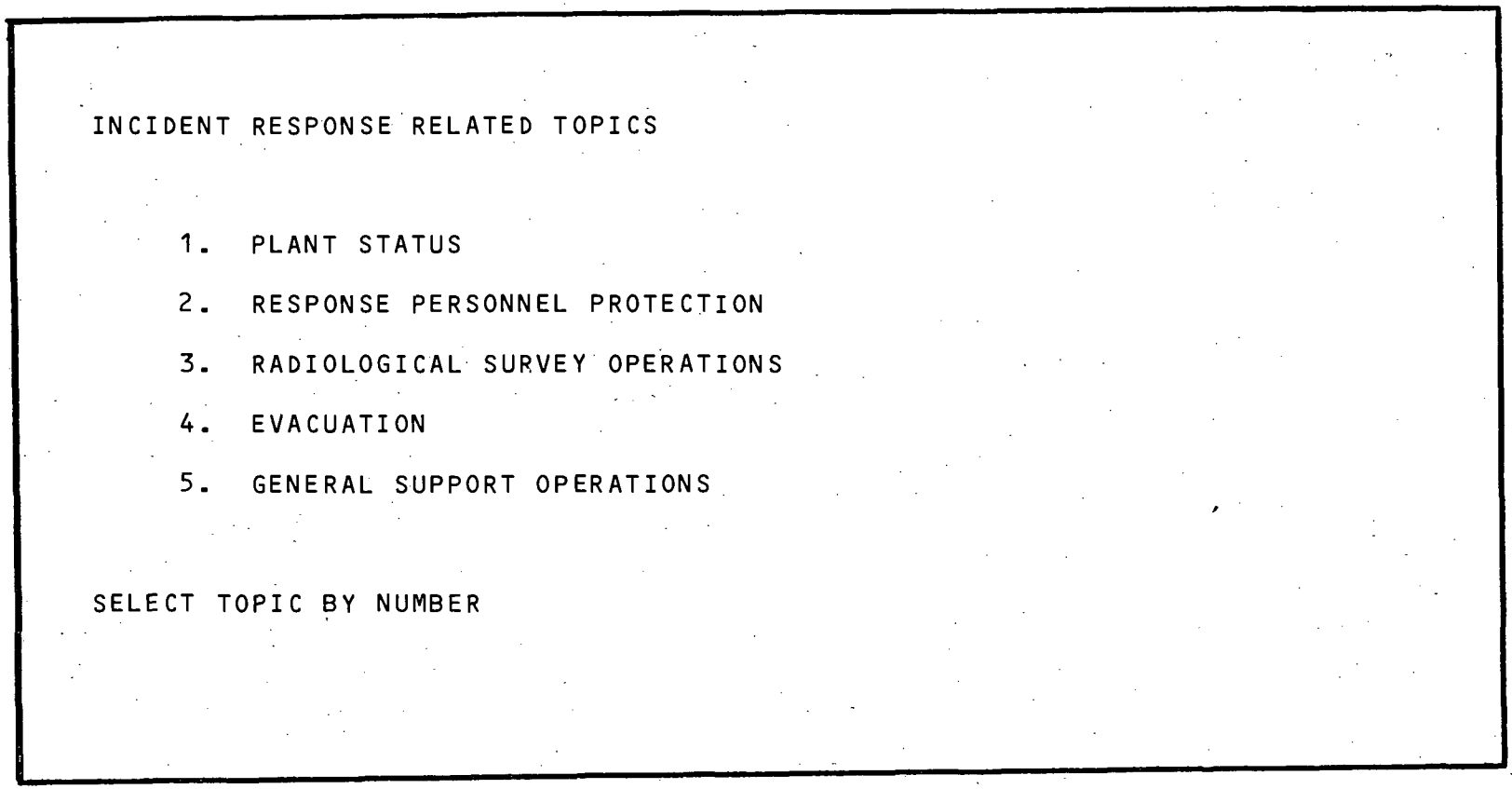


FIGURE 2
EXAMPLES OF SYSTEM DISPLAYS
(CONTINUED)

3. User selects No. "5", thereby selecting "General Support Operations":

THE FOLLOWING SUPPORT OPERATIONS ARE CURRENT AS OF (DATE-TIME)

1. EVACUATION VEHICLES BEING BROUGHT INTO AREA UNDER STATE POLICE GUIDANCE
2. CONTRACTOR AIRCRAFT BEING OBTAINED FOR RADIOLOGICAL SURVEY FLIGHTS
3. TRAILERS COMING IN FOR OFF-SITE HQ USE
4. STATE GOVERNOR/PARTY TO TOUR SITE AREA ON (DATE-TIME)

TO OBTAIN DETAILS ON ANY OPERATIONS SELECT NUMBER

FOR WEATHER DATA SELECT 99

- All inputs from Action Summary display.
- (DATE-TIME) on line 1 is that of latest entry.

FIGURE 2
EXAMPLES OF SYSTEM DISPLAYS
(CONTINUED)

4. User enters No. "1":

INCIDENT SUPPORT OPERATION

EVACUATION VEHICLES BEING BROUGHT INTO AREA UNDER STATE POLICE GUIDANCE

1. TRUCKS REQUESTED FROM NATIONAL GUARD AT (DATE-TIME). CONTACT GENERAL PHONE

2. SCHOOL BUSES PROVIDED BY STATE GOVERNOR WILL BE AVAILABLE FOR USE BY (DATE-TIME)

3. FEMA HAS ASSUMED RESPONSIBILITY FOR EVACUATION MANAGEMENT. CONTACT PHONE

TO OBTAIN DETAILED EVACUATION INFORMATION SELECT 88

FOR WEATHER DATA SELECT 99

- Inputs 1 and 2 may be extra detail solicited by Operation Support and Control as backup to the Action Summary display.
- Input 3 from Action Summary display.

FIGURE 2
EXAMPLES OF SYSTEM DISPLAYS
(CONTINUED)

5. If user selects "88", he will be provided "Evacuation" topic-related information, in accordance with other example. In this example, however, user selects "99" and the following display appears:

NOTICE: THERE ARE NO CURRENT CRITICAL WEATHER CONDITIONS REQUIRING ALERT OR WARNING AS OF (DATE-TIME)

TO RECEIVE DISPLAY OF CURRENT WEATHER REPORT PREPARED BY NRC METEOROLOGISTS FROM NWS AND OTHER INPUTS, SELECT 1

TO RECEIVE INCIDENT-ORIENTED WEATHER REPORT PLUS FORECAST, SELECT 2 FOLLOWED BY LETTER DESGNATING FORECAST DESIRED:

A	2 HOURS
B	6 HOURS
C	12 HOURS
D	36 HOURS
E	72 HOURS

TO RECEIVE DISPLAY OF CURRENT ALPHANUMERIC DATA TRANSMITTED FROM SITE, SELECT 3

METEOROLOGISTS CAN BE CONTACTED ON _____

- Input from Protective Measures Summary display.

FIGURE 2
EXAMPLES OF SYSTEM DISPLAYS
(CONTINUED)

6. User selects "2C", i.e, a current report plus 12 hour forecast:

CURRENT AS OF (DATE-TIME)		FORECAST (12 HOUR)	
WIND SPEED	15 MPH	WIND SPEED	20 MPH
WIND FROM	EAST	WIND FROM	E N E
TEMPERATURES	UP 40s	TEMPERATURES	LOW 50s
PRECIPITATION	RAIN	PRECIPITATION	CLEAR
ENDING	5 HR.	ENDING	
ACCUM	MIN	ACCUM	
STABILITY	PASQUILL F	STABILITY	PASQUILL E

SELECT 1 TO DISPLAY DETAILS OF SITE-PROVIDED METEOROLOGICAL DATA INCLUDING MULTI-LEVEL WIND READINGS, TEMP DIFFERENCES, SIGMA THETA CALCULATIONS

TO CONTINUE, SELECT 2

- Inputs from Protective Measures Data display.

FIGURE 2
EXAMPLES OF SYSTEM DISPLAYS
(CONTINUED)

7. User keys in number "2" and receives following display:

```
THIS CONCLUDES INCIDENT RESPONSE SUPPORT OPERATIONS DISPLAY SERIES

                TO RETURN TO LIST OF INCIDENT RESPONSE TOPICS
                                                    SELECT 1

                TO REVIEW LIST OF MSGS IN SYSTEM FOR INDIVIDUALS
                OR OFFICES OR AGENCIES
                                                    SELECT 2

                TO DISENGAGE SYSTEM
                                                    SELECT 3
```

FIGURE 2
EXAMPLES OF SYSTEM DISPLAYS
(CONTINUED)

8. If the user returns to the list of topics and subsequently selects "4", the following is displayed:

```
                                EVACUATION
                                SUMMARY

SITE- ALPHA, NEVADA                STATE PLAN- OK          LAST EXERCISE:  4/79
STATE CONTACT- HEALTH DEPT            JAMES ONASSY           (998) 062-1515

ACTIONS
   1.  POPULATION WITHIN 5 MILES (ALL SECTORS) ADVISED TO STAY INDOORS UNTIL
       FURTHER NOTICE BY GOV JONES AT 0900 FEB 21
   2.  NRC RECOMMENDED ONLY CHILDREN AND PREGNANT WOMEN WITHIN 5 MILES (SECTORS
       1-2-11-12) NEED TAKE PRECAUTIONS ...0830 FEB 21  DETAILS:  SELECT A2
   3.  EVACUATION VEHICLES BEING BROUGHT INTO AREA UNDER STATE POLICE GUIDANCE
       ...0545 FEB 21


NRC ANALYSES
   1.  TOTAL POPULATION DOSE: xx MAN-REMS ... 1130 FEB 21
   2.  PROJECTED NRC ACTIONS... IN PROGRESS...SELECT B2
   3.  PROJECTED SAFE END TO ACTION 1...IN PROGRESS...SELECT B3




TO RETURN TO TOPIC LIST:  SELECT "GO"
```

- "Actions" inputs from Action Summary display.
- "NRC Analyses" input 1 from Incident Summary display; inputs 2 and 3 from NRC Task Summary.

FIGURE 2
EXAMPLES OF SYSTEM DISPLAYS
(CONTINUED)

9. User selects A2; the following is displayed:

EVACUATION
NRC ACTIONS

CURRENT ADVISORY:
1. CHILDREN, PREGNANT WOMEN WITHIN 5 MILES IN SECTORS 1-2-11-12 STAY INDOORS; ESPECIALLY AVOID RAIN. CLOSE SCHOOLS. MAX PROJECTED CUMULATIVE EXPOSURE ANY PERSON OUTDOORS x MREM; INDOORS y MREM. ISSUED 0830 FEB 21. CANCEL TIME: ANALYSIS IS IN PROGRESS...SELECT B3.

BASIS:
1. GENERAL EMERGENCY
2. 7 REM/HR THYROID 2 HRS N BOUNDARY
3. POOR WEATHER
4. NO LIVESTOCK IN 20 MILES

ACTION LEVEL WILL INCREASE IF:
1. CONTAINMENT PRESSURE TREND CONT TO 1200 FEB 21.

ACTION LEVEL WILL DECREASE IF:
1. TEMP TREND CONT THRU 2400 FEB 23
2. NO MONITOR >Ƶ MREM/HR THYROID

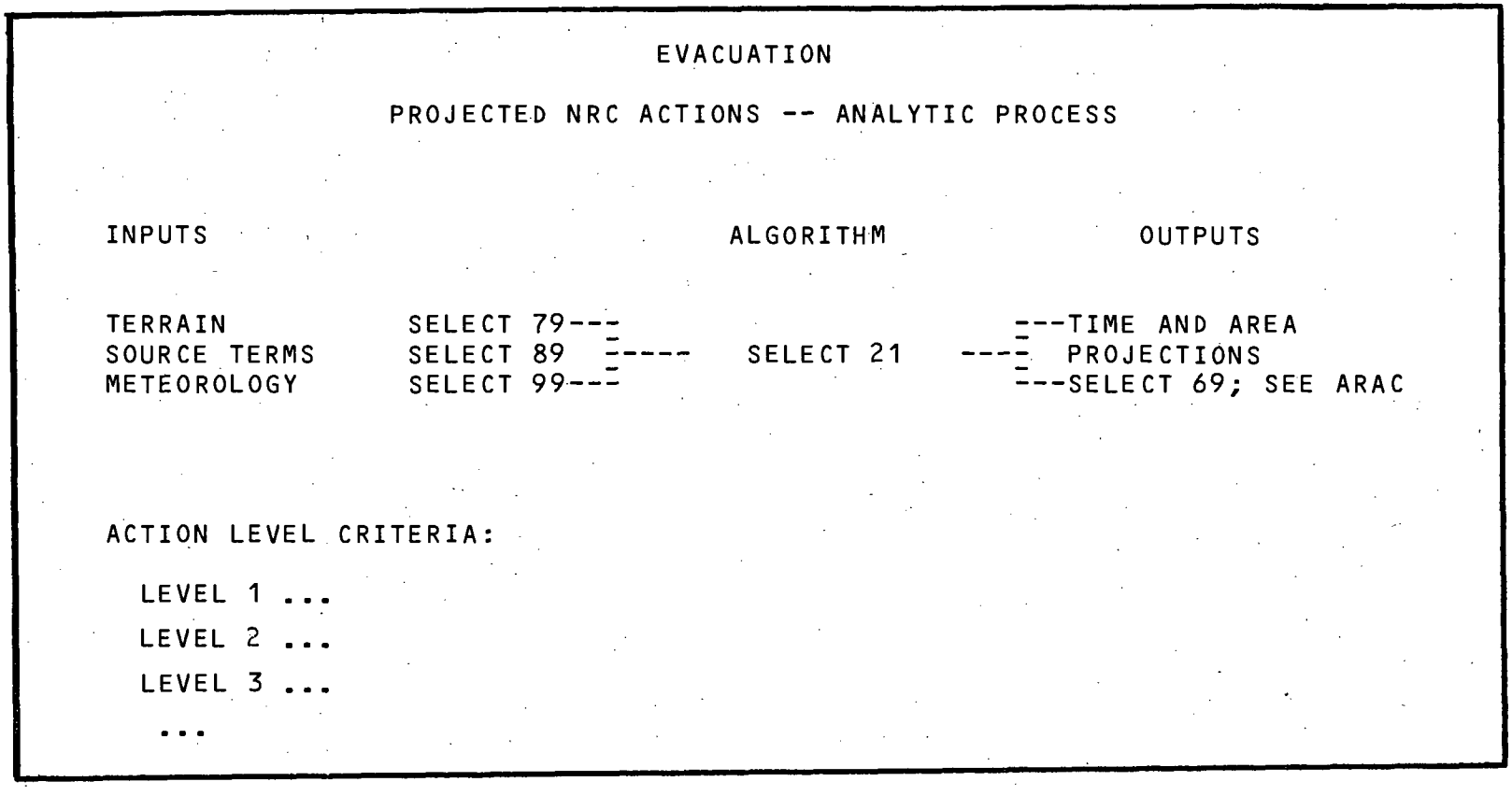
ACTION LEVELS:
1. ANIMALS ON STORED FEED
2. CHILDREN/PREG INDOORS
3. ALL INDOORS
4. CHILDREN/PREG EVACUATE
5. ALL CIVILIANS EVACUATE
6. ALL OTHERS EVACUATE

FOR PROJECTED ACTION ANALYSES
SELECT B2

- All inputs from Projective Measures Summary display or from backup prepared by Protective Measures Analysis Team.
- Action levels and criteria not yet fully defined by NRC.

FIGURE 2
EXAMPLES OF SYSTEM DISPLAYS
(CONTINUED)

10. User selects B2; the following is displayed:



- There are no ad hoc inputs to this display.
- The algorithm has not been fully defined by NRC.
- Action level criteria have not been fully defined by NRC.

FIGURE 2
EXAMPLES OF SYSTEM DISPLAYS
(CONTINUED)

11. If user should return to the list of topics and select "1," the following display might appear:

PLANT STATUS

PLANT IDENTIFICATION

REACTOR XXX
REGION XXX
SYSTEM XXX
LICENSEE XXX
NEAREST CITY XXX

FOR DETAILED INFORMATION ON STATUS/ACTIVITIES IN CONTROL ROOM/TECH SUPPORT CENTER, SELECT 1.

INCIDENT DESRIPTION

GENERAL LOCA

SUMMARY BREAK OCCURRED IN PENETRATION AREA APPROX 1400. NO HELP NEEDED NOW. NO DEATH. NO EXPOSURE. NO SABOTAGE. LOW LEVEL OFFSITE RELEASE LIKELY. UNIT WAS OPERATING FULL POWER.

FOR DETAILED DESRIPTION OF INCIDENT AND ANY ONGOING ACTIONS, SELECT 2.

FOR WEATHER DATA, SELECT 99.

TO RETURN TO LIST OF INCIDENT RESPONSE TOPICS, SELECT 3.

TO DISENGAGE SYSTEM, SELECT 4.

- Displayed information on plant status would be similar to that recommended in incident exercise critiques.
- Response personnel protection information would draw from the same base as survey ops and evacuation.
- The recommended interactive system is both menu-driven and knowledge-based. Many details regarding the topics remain to be worked out.

FIGURE 2
EXAMPLES OF SYSTEM DISPLAYS
(CONCLUDED)

5.0 OVERVIEW OF METEOROLOGICAL AND RADIOLOGICAL DATA USE DURING AN INCIDENT

5.1 Introduction

MITRE has prepared an illustrative application to an applicable hypothetical incident. This task can be accomplished without reference to a "specific" simulated incident. The use of meteorological and radiological data at the Headquarters Operations Center during a nuclear-related event can be illustrated through reference to a generic incident. In this way, basic phases or stages of the incident can be identified, key decision points can be indicated, and the uses of meteorological and radiological data can be described with respect to these stages and decision points.

5.2 General

The flow of meteorological and radiological data to the Operations Center during an incident is graphically depicted in Figure 3. This data comes to the Protective Measures Evaluation Team, either to health physics specialists or to meteorologists. These recipients use the incoming data to prepare the reports and displays discussed in this report. This meteorological and radiological data flow process can be more clearly understood in light of the primary information flow process depicted earlier (Figure 1).

A very simplified overview of meteorological and radiological data use during an incident is shown in Figure 4. This broadbrush look helps to focus on NRC's information needs during the trans-incident process. Information requirements throughout an ongoing incident are analyzed later with reference to key decision points.

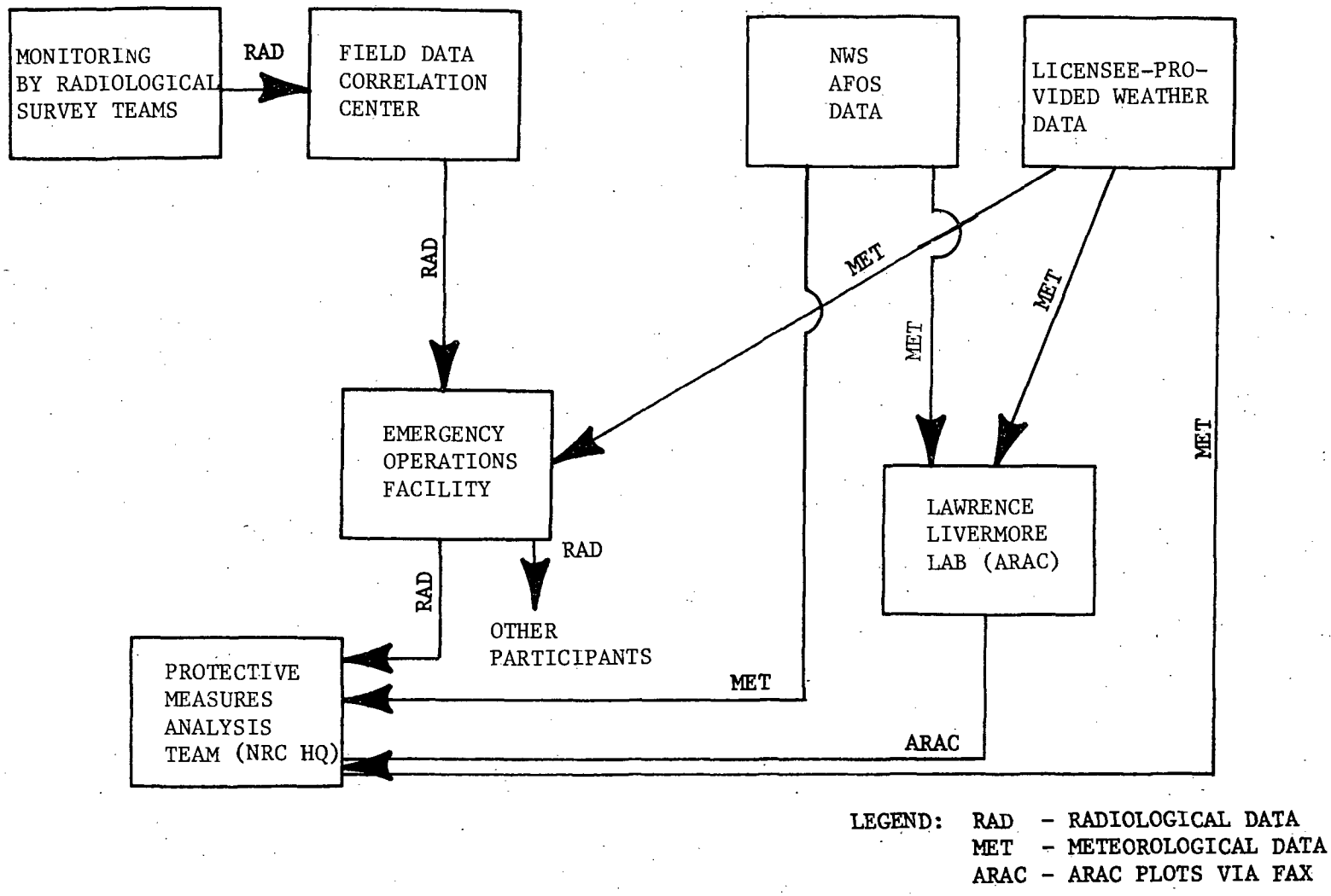


FIGURE 3
METEOROLOGICAL AND RADIOLOGICAL DATA FLOW DURING AN INCIDENT

PHASE	METEOROLOGICAL	RADIOLOGICAL	ARAC
Incident occurs	NWS weather inputs coming to NRC	NONE	NONE
NRC is advised of incident	Meteorologists focus NWS inputs on site area. Meteorologists request site provide weather data.	NRC requests initial on-site radiological data in order to make decision as to nature of incident.	NRC decides to use ARAC services.
Response team is assembled	Meteorologists receiving both NWS and site-provided weather inputs.	NRC begins to deploy air and ground monitoring teams. Field Data Correlation Center is activated.	NRC requests ARAC services be initiated.
Incident progresses	Meteorologists using both NWS and site-provided weather data to prepare reports/forecasts.	Field Data Correlation Center passes radiological survey via emergency OPS facility to HQ Operations Center.	ARAC inputs come to HQ OPS Center.
Incident winds down	Meteorologists gradually stop requiring site-provided weather data.	Site-provided radiological data continues to be needed during clean-up phase.	ARAC services stopped.
Incident ends	Meteorologists continue to receive standard NWS weather services.	NONE	NONE

FIGURE 4
METEOROLOGICAL AND RADIOLOGICAL DATA REQUIREMENTS THROUGHOUT AN INCIDENT: AN OVERVIEW

5.3 Data Descriptions and Sources

5.3.1 Meteorological Data

Meteorological data comes to the NRC from two principal sources: the National Weather Service (NWS) and the licensee. NWS inputs are described in:

- "Operations of the National Weather Service," published by the National Oceanic and Atmospheric Administration (NOAA) (1979)
- "NOAA Products and Services," (including NWS outputs) published by NOAA (1977).

Weather-related data inputs will be received at NRC Headquarters via a terminal connected to the Automation of Field Operations and Services (AFOS) system, which will provide both teletype (TTY) and facsimile (FAX) inputs. During the course of a nuclear-related incident, the terminal in the Operations Center, normally not activated, will receive continuous weather-related inputs, focused insofar as possible around the site.

Weather-related data needed from the site has been recommended in "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants," (NUREG-0654/FEMA-REP-1), January 1980.

Until transmission of this site-provided data can be somehow automated, e.g., via the Nuclear Data Link (NDL), the required information will most likely be passed via telephone.

NRC meteorologists working with PMT members at the Operations Center will receive weather data from the two sources specified above and will use it to prepare the required reports and forecasts. These reports and forecasts will be entered into the topic-oriented system via an interactive, update terminal. These displays will

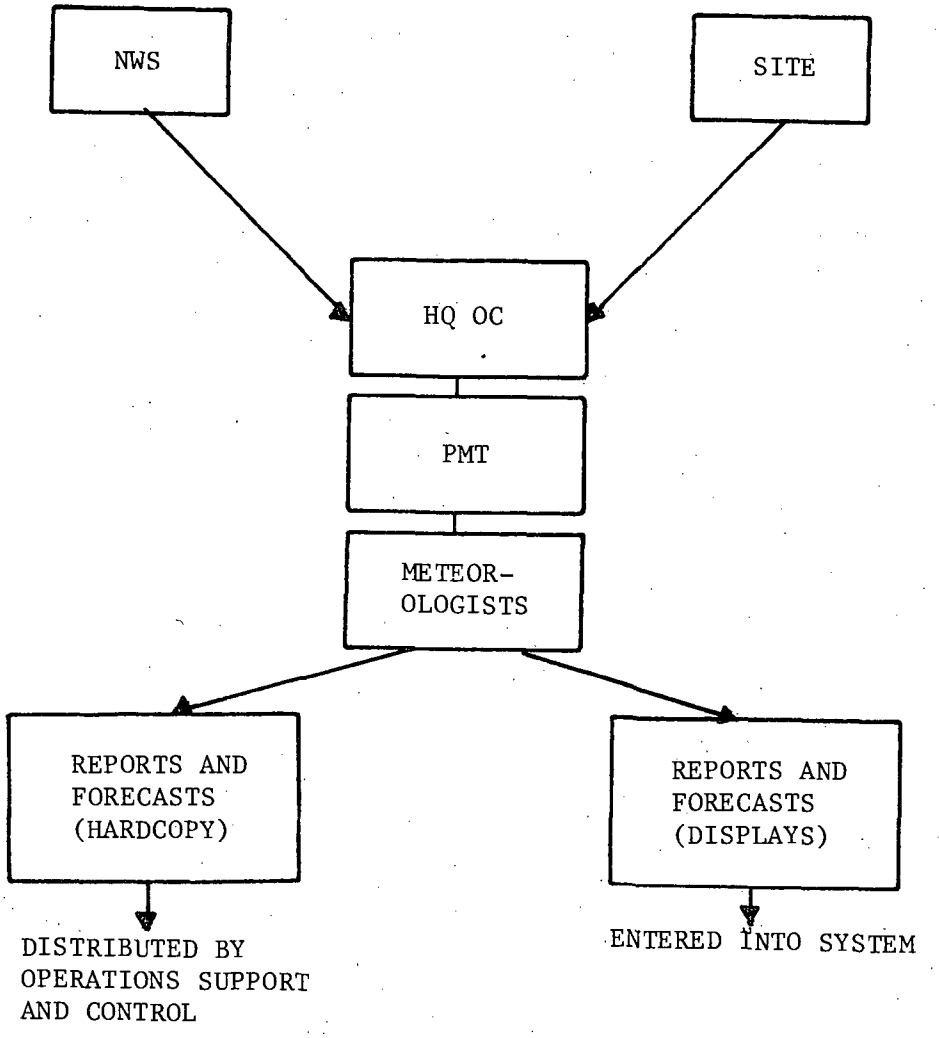
then be available, via a view-only terminal, to persons working with any of the five topics. The use of weather data in NRC decision-making will be described later in this section. This process is summarized in Figure 5.

The appendix to this report contains material reproduced directly from NUREG-0654/FEMA-REP-1, "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants" (January 1980). This material is included to indicate the nature of the meteorological data sent direct from the licensee's site. More details on meteorological data can be obtained from the aforementioned NOAA documents. Radiological data was described in the NRC's NDL Specification dated 21 February 1980. In lieu of an NDL, this data could be transmitted by other means.

5.3.2 Radiological Data

During the course of a nuclear incident, the NRC and other agencies deploy a variety of radiological survey teams to conduct both air and ground monitoring exercises. Data to be collected and analyzed is described in a large variety of NRC documents including the earlier referenced NUREG-0654/FEMA-REP-1.

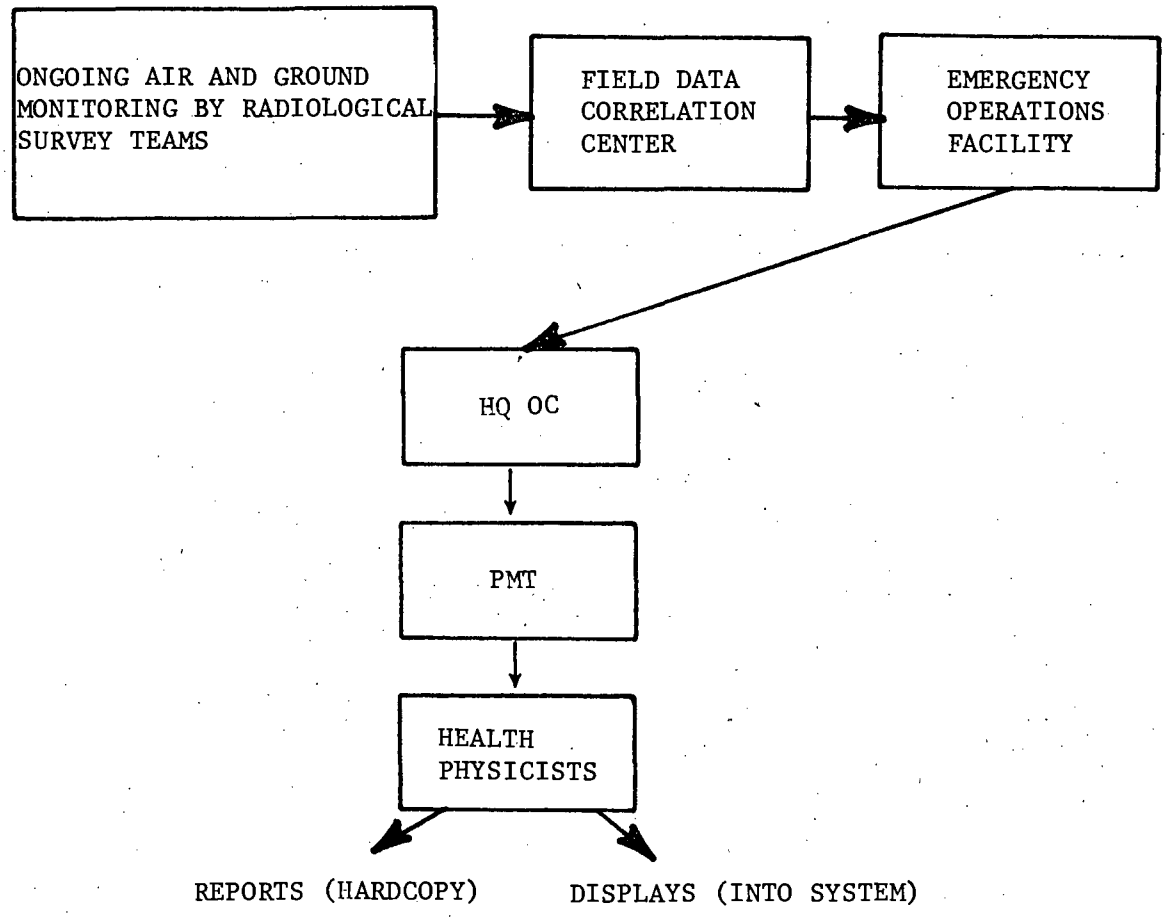
Radiological survey data from field teams will be correlated at an established Field Data Correlation Center and then sent to the EOF from where it will be transmitted to the PMT working at the Headquarters Operations Center. PMT analysis will use the data to prepare its reports and to input the information required for system displays. How this radiological survey information will be used in decision-making during an incident is described below. The process is summarized in Figure 6.



REPORTS AND FORECASTS USED TO HELP:

- DETERMINE HOW/WHERE TO DEPLOY RADIOLOGICAL SURVEY TEAMS;
- PLAN GENERAL SUPPORT OPERATIONS;
- DETERMINE ACTIONS NECESSARY FOR PROTECTION OF PEOPLE NEAR SITE;
- PLAN FOR EVACUATION IF NECESSARY, AND
- CARRY OUT EVACUATION IF REQUIRED.

FIGURE 5
USE OF METEOROLOGICAL DATA



PMT ANALYSES USED:

- TO DETERMINE PLANT STATUS;
- TO INSURE RESPONSE PERSONNEL PROTECTION;
- TO CONTINUE TO PLAN RADIOLOGICAL SURVEY ACTIVITY;
- TO HELP IN EVACUATION PLANNING, AND
- TO PLAN SUPPORT OPERATIONS.

FIGURE 6
USE OF RADIOLOGICAL DATA

5.3.3 ARAC Data

The Atomospheric Release Advisory Capability (ARAC) service is provided by Lawrence Livermore Laboratory under Department of Energy (DOE) sponsorship. This service is fully described in Livermore publications UCRL-52802, ARAC Update - 1979 (July 1979), and UCRL-83489, ARAC Response to TMI (October 1979).

ARAC provides services to DOE facilities; to the Federal Aviation Administration (FAA); and to incidents at facilities not regularly serviced by ARAC. The last situation would apply to NRC-licensed sites today, but plans call for a gradual expansion of ARAC support in conjunction with the development of a new Operations Center quite probably linked to the proposed NDL.

ARAC provides the user with results from numerical models that estimate the rate and temporal distribution of pollutants released into the atmosphere during an incident. Weather inputs are received at Livermore from the site itself, as well as from NES and Air Force Global Weather Control.

Figures 7 and 8 are examples of ARAC "plots" produced by Lawrence Livermore Laboratory during the TMI incident and sent by facsimile service to the Headquarters Operations Center. These "plots" are received by PMT, and reproduced for distribution to the Incident Response Team. They provide invaluable aids to incident response management, particularly in the determination of source term.* In the "example" that follows, use of ARAC inputs at key decision points will be noted.

The generalized ARAC system is diagrammed in Figure 9.

*Source term - Used to indicate a source rate, i.e., (determination of) the rate of release of pollutants and/or hazardous materials.

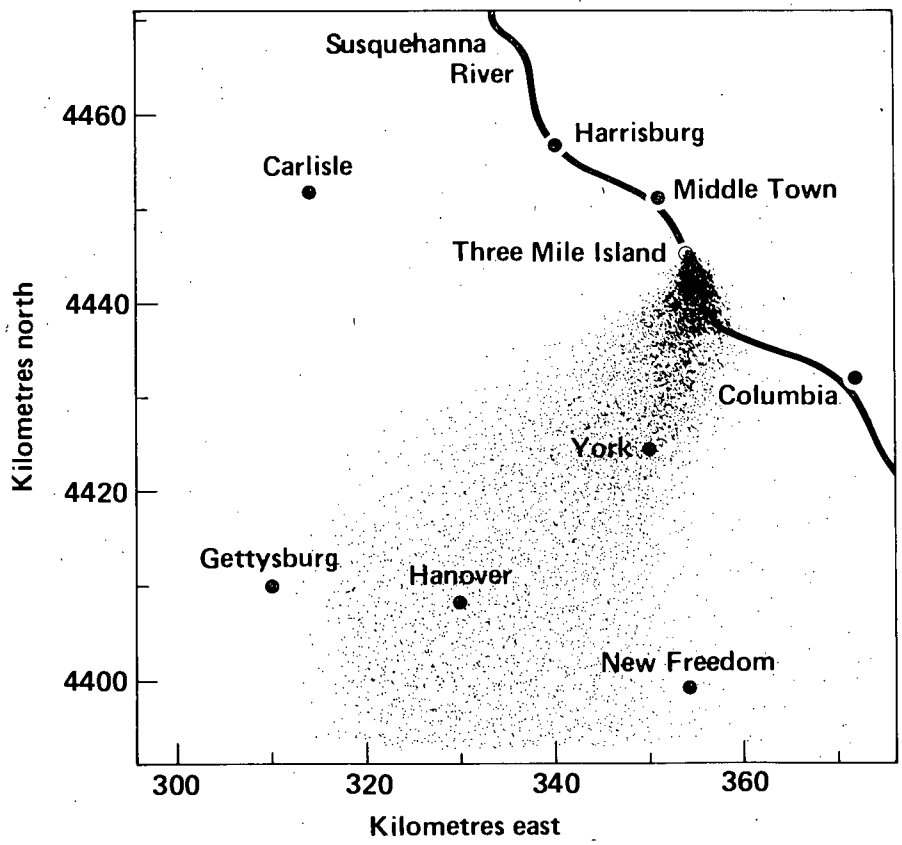


FIGURE 7
TYPICAL ARAC PROJECTION OF THE MOVEMENT OF A POTENTIAL CONTINUOUS RELEASE OF ONE UNIT OF RADIOACTIVITY PER SECOND FROM TMI REACTOR

(Figure provided by Lawrence Livermore Laboratory)

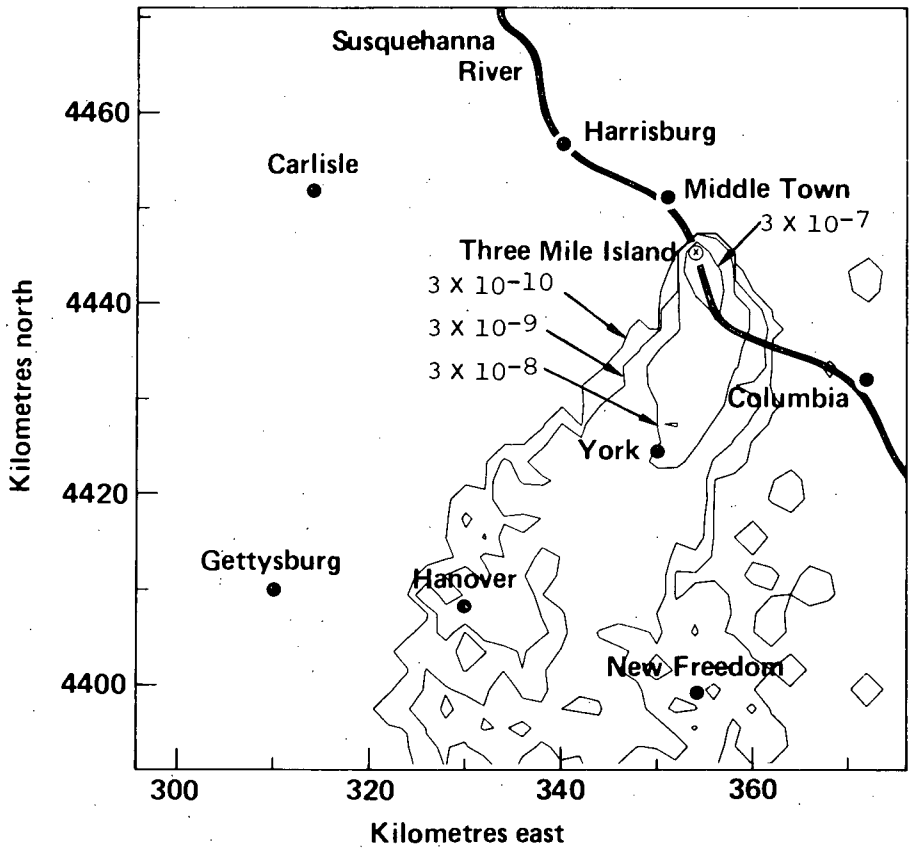


FIGURE 8
INSTANTANEOUS AIR CONCENTRATION CONTOURS CALCULATED FROM PARTICLE LOCATIONS FOR CONTINUOUS UNIT RATE RELEASE SHOWN IN FIGURE 7

(Figure provided by Lawrence Livermore Laboratory)

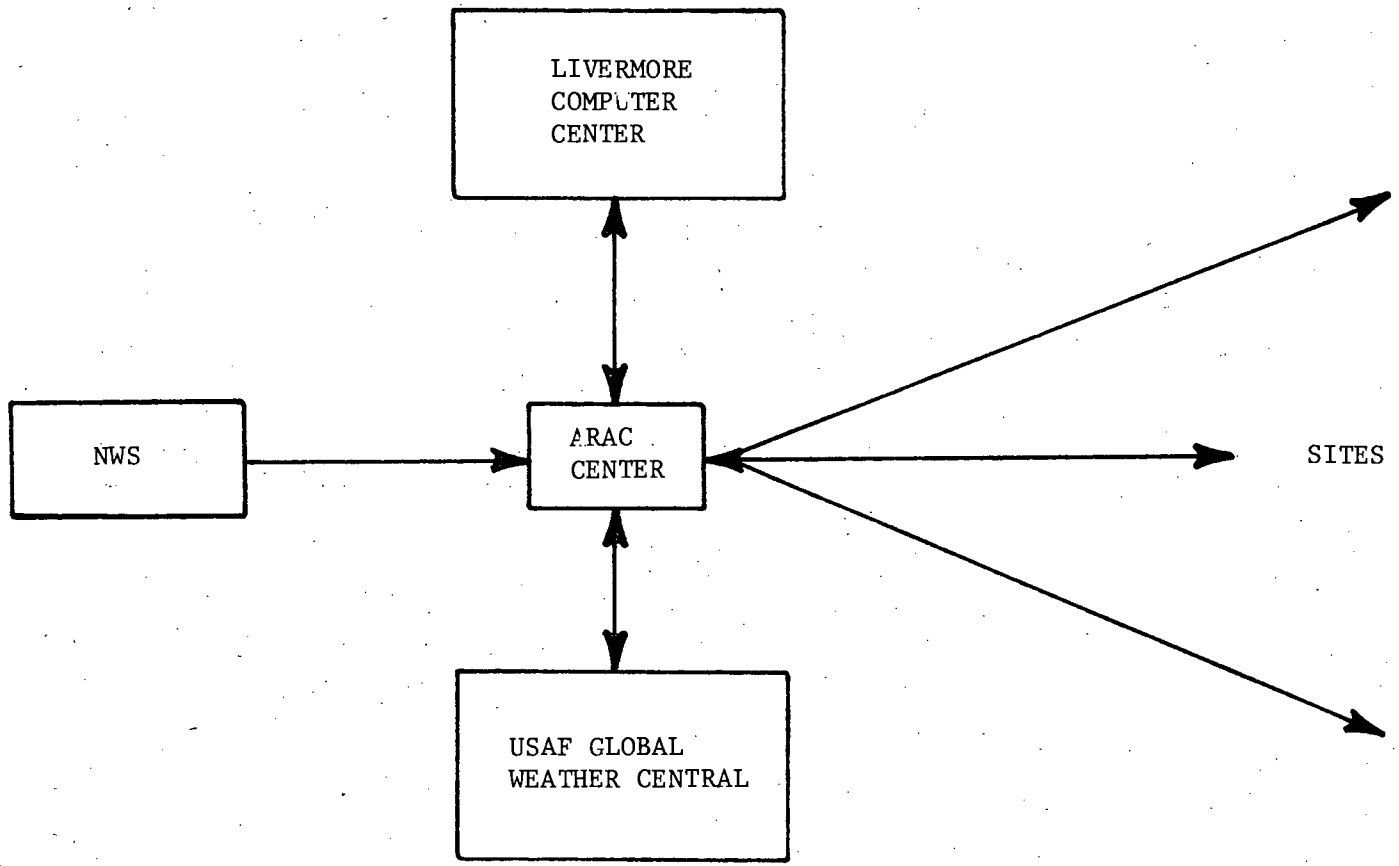


FIGURE 9
DIAGRAMMATIC REPRESENTATION OF THE ARAC SERVICE

(Figure provided by Lawrence Livermore Laboratory)

5.4 Incident-Related Decision-Making Using Meteorological and Radiological Data

The uses of meteorological and radiological data during an incident can be illustrated by reference to critical decision points, as shown in Table I.

TABLE I

USE OF METEOROLOGICAL AND RADIOLOGICAL DATA DURING A HYPOTHETICAL INCIDENT

DECISION POINT/INCIDENT PHASE	USE OF DATA
• Incident occurs at a licensed site	• NRC is advised of incident • Radiological data is requested from the reactor site. This data is used to determine how the NRC will respond. • NRC decides to respond to the initiating condition by establishing an Emergency Action Level, which might be* - Notification of unusual event - Alert - Site emergency or - General emergency.
• An emergency action level is notified	• The Incident Response Team is assembled at HQ Operations Center. • PMT assembles in the Operations Center with health physicists (for radiological data) and meteorologists (for weather data). • Meteorologists activate the NWS AFOS terminal. • Meteorologists request site provide weather data. • ARAC terminal is activated.

*These levels are proposed in NUREG-0654/FEMA-REP-1, referenced earlier

TABLE I (Continued)

DECISION POINT/INCIDENT PHASE	USE OF DATA
• Initial phases of the incident	• NRC/PMT begins to deploy radiological survey teams.
	• The Field Data Correlation Center is established.
	• Weather data coming to NRC from NWS and site.
• As the incident progresses:	
- Plant Status	• Incoming radiological information (including ARAC) is used to determine plant status, including calculation of source term.
- Response Personnel Protection	• Radiological survey operations are used to help determine action in this status area.
- Radiological Survey Operations	• Incoming weather data, radiological data, and ARAC plots are used to manage the conducting of survey operations.
- Evacuation	• Radiological data will be coupled with incoming weather data to determine the necessity of declaring an evacuation (or not), and once determined, to effectively execute it.
- General Support Operations	• The planning of these operations is heavily dependent upon continuing input streams of radiological and meteorological data.

TABLE I (Concluded)

DECISION POINT/INCIDENT PHASE	USE OF DATA
• Winding down (of the incident)	• Radiological data will be the key determinant in the decision to wind down incident response activities. As this occurs, meteorological data will assume less importance. • For a considerable period of time after the "end" of a nuclear-related incident, there will be a continuing need for NRC Headquarters to monitor site-related radiological data.
• End	• Site-related weather data available as needed. • ARAC services available as needed.

6.0 RECOMMENDATIONS

There are six actions that should be taken, under NRC direction, in order to insure that the conceptual results of this study are translated into a realistic and useful framework:

1. The five recommended topics must be verified by means of exercises, as well as through further study.

2. To complete design of the displays, the NRC must move to insure formalization of:

   - Decision criteria for preevacuation and evacuation situations
   - The algorithm for determining source term
   - Safety state vectors for plant status.

3. All meteorological and radiological data lists, such as those advanced in NUREG-0654/FEMA-REP-1, must be critically evaluated and, if necessary, refined or revised.

4. Candidate display units will require a formal and thorough evaluation using established guidelines.

5. Transmission media must continue to be investigated in depth; preliminary study indicates that a graphics transmission capability for such things as radiological survey maps (as well as schematics, diagrams, etc.) would be extremely useful.

6. The primary information flow (diagrammed in Figure 1 of this report) is recommended by MITRE, based on its continuing support of incident response actions. However, it requires confirmation by the NRC; in particular, the role of the Technical Support Center (on-site) must be clarified as soon as possible. MITRE's assumption in this study has been that the Technical Support Center (on-site) sends the same data, and at the same time, to both the Operations Center (Headquarters) and the Emergency Operations Facility (near-site).

GLOSSARY

AFOS	Automation of Field Operations and Services
ARAC	Atmospheric Release Advisory Capability
DOE	Department of Energy
EOF	Emergency Operations Facility
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
NDL	Nuclear Data Link
NOAA	National Oceanic and Atmospheric Administration
NRC	Nuclear Regulatory Commission
NWS	National Weather Service
OC	Operations Center
PMT	Protective Measures Analysis Team
RI	Resident Inspector
TMI	Three Mile Island

APPENDIX

METEOROLOGICAL

DATA

CHARACTERISTICS*

*Taken from NUREG-0654/FEMA-REP-1

SITE DESCRIPTOR DATA FORMAT
(8 Mandatory Records)

Record	Format	Content
1	80A1	Organization/Utility Name
2	80A1	Plant Name/Tower Identification
3	80A1	See Coding Form (Figure A-1)
4	F10.5	Latitude of Containment (degrees North)
	F10.5	Longitude of Containment (degrees West)
	F10.0	Elevation of Base of Met Tower (feet above MSL)
5	80A1	See Coding Form (Figure A-1)
6	F5.1	Height of Wind Sensor Upper Level (meters)
	F5.1	Height of Wind Sensor Intermediate Level (meters)
	F5.1	Height of Wind Sensor Lower Level (meters)
	5X	Blank
	F5.1	Heights of Temperature Difference (Upper to Lower) Upper Level (meters)
	F5.1	Heights of Temperature Difference (Upper to Lower) Lower Level (meters)
	5X	Blank
	F5.1	Heights of Temperature Difference (Upper to Intermediate) Upper Level (meters)
	F5.1	Heights of Temperature Difference (Upper to Intermediate) Intermediate Level (meters)
	5X	Blank
	F5.1	Heights of Temperature Difference (Intermediate to Lower) Intermediate Level (meters)

SITE DESCRIPTOR DATA FORMAT (CONCLUDED)
(8 Mandatory Records)

Record	Format	Content
	F5.1	Heights of Temperature Difference (Intermediate to Lower) Lower Level (meters)
	5X	Blank
	F5.1	Height of Ambient Temperature Lower Level (meters)
	F5.1	Height of Dew Point Temperature Lower Level (meters)
	F5.1	Precipitation Gauge Height (meters)
7-10	80A1	Comment Section

METEOROLOGICAL DATA FIELD DESCRIPTOR
(3 Records for Every 6 Hours of Data)

Record	Format	Context
1	80X	Blank
2	80A1	See Coding Form (Figure A2)
3	80X	Blank

METEOROLOGICAL DATA FORMAT
(1 Record per 15 Minute Averaged Data Set)

Format	Content
I2	Year
I3	Julian Date
I2	Hour (on 24 hour clock)
I2	Minute (ending observation)
F4.0	Wind Direction (degrees)* Upper Level
F4.0	Wind Direction (degrees)* Intermediate Level
F4.0	Wind Direction (degrees)* Lower Level
1X	Blank Column
F4.1	Wind Speed (meters/sec) Upper Level
F4.1	Wind Speed (meters/sec) Intermediate Level
F4.1	Wind Speed (meters/sec) Lower Level
1X	Blank Column
F3.0	Sigma Theta (degrees) Upper Level
F3.0	Sigma Theta (degrees) Intermediate Level
F3.0	Sigma Theta (degrees) Lower Level
1X	Blank Column
F5.1	Temperature Difference (^{o}C/100m) Upper-Lower
F5.1	Temperature Difference (^{o}C/100m) Upper-Intermediate
F5.1	Temperature Difference (^{o}C/100m) Intermediate-Lower

*Wind direction indicates the direction from which the wind is coming.

METEOROLOGICAL DATA FORMAT (Concluded)
(1 Record per 15 Minute Averaged Data Set)

Format	Content
1X	Blank Column
F5.1	Ambient Temperature (^{o}C) Lower Level
1X	Blank Column
F5.1	Dew Point Temperature (^{o}C) Lower Level
1X	Blank Column
F5.1	Precipitation Total (mm) Ground Level
1X	Blank Column
I1	Pasquill Stability Class or Equivalent to be assumed for Diffusion Estimates (1=A, 2=B, 3=C, . . . , 7=G)

DILUTION FACTOR FORMAT FOR MODEL CLASS A

Record	Format	Content
1	80A1	Model Characteristics/Assumptions
2	80A1	Release Point/Source Characteristics
3	80A1	See Coding Form Attached (Figure A-3)
4	80A1	See Coding Form Attached (Figure A-3)
5	I2	Year
	I3	Julian
	I2	Hour (On 24 Hour Clock)
	I2	Minute (Ending Observation)
	4X	Blank
	F4.)	Affected Direction (Degrees)*
	4X	Blank
	F6.0	Distance to Peak X/Q (Meters)
	2X	Blank
	1PE10.3	Peak X/Q (sec/m^3)
	1X	Blank
	F5.0	Plume Width to 1/10 of Peak (Meters)
	1X	Blank
	1PE10.3	X/Q (sec/m^3) at 3218 meters (2 miles)
	1X	Blank

*Affected direction indicates the direction to which the wind is going.

DILUTION FACTOR FORMAT FOR MODEL CLASS A

(Continued)

Record	Format	Content
	1PE10.3	X/Q (sec/m^3) at 8047 meters (5 miles)
	1X	Blank
	1PE10.3	X/Q (sec/m^3) at 16093 meters (10 miles)

Note: Dilution factor format for model class B to be developed.

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4. "Conceptual and Programmatic Framework for the Proposed Nuclear Data Link," SAND80-1032, Sandia National Laboratories, System Safety Information Division, April 1980.

*Available at the NRC Public Document Room for inspection and copying for a fee.

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This volume describes the recommended use of meteorological and radiological data by NRC personnel at the center during the course of a nuclear-related incident. Effective display formats are illustrated and data usage procedures are recommended. This volume also provides an overview of a hypothetical incident, illustrating the use of meteorological and radiological data at various stages.

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