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Revision 3

COMMONWEALTH EDISON COMPANY

OFFSITE DOSE CALCULATION SYSTEM

A Meteorological Monitoring, Offsite Dose Calculation Program for Emergency Preparedness at Operating Nuclear Power Plants

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#0291A

Table of Contents

Commonwealth Edison Company
Offsite Dose Calculation System

This report describes the upgraded Commonwealth Edison (CECo) Offsite Dose Calculation System (ODCS), a computer-based method for estimating the environmental impact of unplanned airborne releases of radioactivity from nuclear stations. The ODCS is designed to meet the meteorological criteria of NUREG-0654 and the NRC order for Zion Station dated 02/29/80. It also addresses the intent of the criteria in Regulatory Guide 1.23. The original ODCS submittal was made in July 1980 on all dockets and is referenced in this report. Only pertinent appendices from that submittal are reproduced herein.

NUREG-0654 "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants" and the NRC order for Zion Station dated 2/29/80 describe meteorological criteria for emergency preparedness at operating nuclear power plants and Zion in particular. The position of the NRC is that all operating plants shall have an adequate operational meteorological measurements program to produce real-time and record historical local meteorological data. Highlights of these criteria are:

(1) There shall be a primary meteorological measurements program and a viable backup system and/or procedures to obtain real-time local meteorological data.

(2) There shall be a QA program consistent with applicable provisions of Appendix B to 10 CFR 50; the acceptance criteria of Revision 1, Section 17.2 of NUREG-75/087 apply.

(3) The meteorological tower(s) shall be connected to a power system which is supplied from redundant power sources.

(4) There shall be two classes of atmospheric dispersion models:

Class A: A model which can produce initial transport and diffusion estimates within 15 minutes following classification of an incident.

Class B: A model which can produce refined estimates for the duration of the release. It shall also include forecasts of changing meteorological conditions.

(5) The models shall incorporate these features: weather forecasts (for the Class B model only), local meteorological anomalies (such as lake effects at Zion), routine meteorological data transmission to the NRC, and simultaneous remote interrogation by the licensee, the emergency response organization and the NRC.

II. Objectives of the ODCS

The objectives of the Commonwealth Edison Offsite Dose Calculation System are:

(1) Meet the intent of the meteorological criteria of NUREG-0654 the Zion order,and Regulatory Guide 1.23.

(2) Provide, where possible, redundant independent pathways of data transmission and redundant data processing computers for use in an emergency situation.

(3) Provide quick and reasonably accurate estimates of radiation dose to persons living offsite, including preparation of procedures and training of users required to accomplish this assessment.

(4) Provide off-site access to plant and meteorological information by the licensee, the emergency response organization and the NRC.

(5) Provide a method for the meteorological contractor to secure meteorological data for assessment of routine releases and to detect equipment failure quickly.

III. Description of the O.D.C.S.

1. System Design and Atmospheric Dispersion Models

Design

On a routine basis each nuclear station meteorological tower will be interrogated many times daily by the meteorological contractor to secure the information necessary for preparation of meteorological operating reports and to detect system failures.

Every hour, and more frequently during an accident, a corporate (in Chicago) computer will poll each meteorological facility to prepare the corporate data file and to check the system in order to maintain the ODCS in a readiness posture. The corporate computer will then store the data for an extended period of time and process the data when refined estimates of dose are needed.

At each nuclear station, two computers with different functional requirements will process the meteorological information. The plant process computers produce one minute averages of meteorological data from the analog signals. The plant Prime computer uses the 1-minute averages to create 15 minute running averages of meteorological data. Refined estimates of dose may be generated in the Technical Support Center (TSC) and Emergency Operations Facility (EOF).

During an accident, the described computer systems will provide the various users with timely information required to make decisions. Emergency actions will be performed in the following approximate time frame sequences:

first - initial one-half hour or so post-accident - the control room operator will rely on wind speed and direction and effluent release rate information provided by the plant process computer and these data converted into requisite Emergency Action Levels (EAL) by the Class A computer model.

second - 1/2 hour to few hours - the plant will rely on the station designated ODCS user to analyze the off-site consequences using either the A-model,(demand execution mode) or the C-model.

third - few hours to duration of accident - a corporate environmental group, formed to support all nuclear stations, will provide refined estimates of the offsite consequences for the duration of the emergency period using the B-model and a CECo developed, C-model for analysis of certain environmental dose pathways. A data link between the corporate facility and each EOF will provide these independent analyses to the EOF recovery team. Additionally the EOF ODCS operator will produce refined estamate of dose using the A, B, and C. models.

Figure 1 shows the ODCS data processing centers and the multi-tiered lines of communication for transmitting meteorological information among the centers. The control room operator will be provided ODCS information from the plant process computer which will be linked directly to the meteorological tower. The operator will have immediately available on command meteorological, noble gas effluent, emergency action level, and offsite dose consequence information through the Class A computer model.

Table 1 provides a summary of CECo's planned Offsite Dose Calculation system.

The backup meteorological measurements program, forecasts of changing meteorological conditions and the NRC data link for meteorological information are described in subsequent sections.

Models

The Class A model will activate the necessary EAL alarms for site emergency: 2-minute average noble gas release rate having projected offsite dose rate of 500 mR/hr and 30-minute average noble gas release rate having projected offsite dose rate of 50 mR/hr, using worst case meteorology, and for general emergency: 2-minute average noble gas release rate having projected offsite dose rate of 1000 mR/hr using 15-minute average actual meteorology. For additional information on this model see Appendix A.

The ODCS operator in the TSC has access to the plant computers. As a result, the TSC operator can produce estimates of the offsite consequences with the Class A or Class C-models. Site meteorological data are available to the TSC through a number of paths: directly via the process computer or indirectly via the telephone link to the Microtels. In addition, meteorological information from other similarly equipped CECo meteorological towers (there are a total of six) may be interrogated directly via the prime network or indirectly via telephone link to the Microtels. All data are stored in the corporate computer for 60 days. (Note that dew point temperatures at Dresden, Quad Cities, LaSalle and Zion will be available through Microtel A but not through Microtel B due to limited rack space.)

The Class C-model incorporates techniques for making refined estimates of offsite radiation doses. Through a series of short, quick, calculations based on the Gaussian straight line plume model, the ODCS operator may easily update changing meteorological and plant information, keeping the offsite assessment as current and up-to-date as possible. Inhalation and ingestion doses may be determined using actual field measurements of dose rate. Further, the model allows for dose assessment under lake breeze conditions of plume trapping and fumigation. As a predictive tool, forecasted meteorological data may be input and projected offsite consequences determined.

As an adjunct to the Class C-model, a tracking model has been developed to aid in the depiction of flow regimes, especially under lake breeze conditions. The model is described in detail in Appendix E.

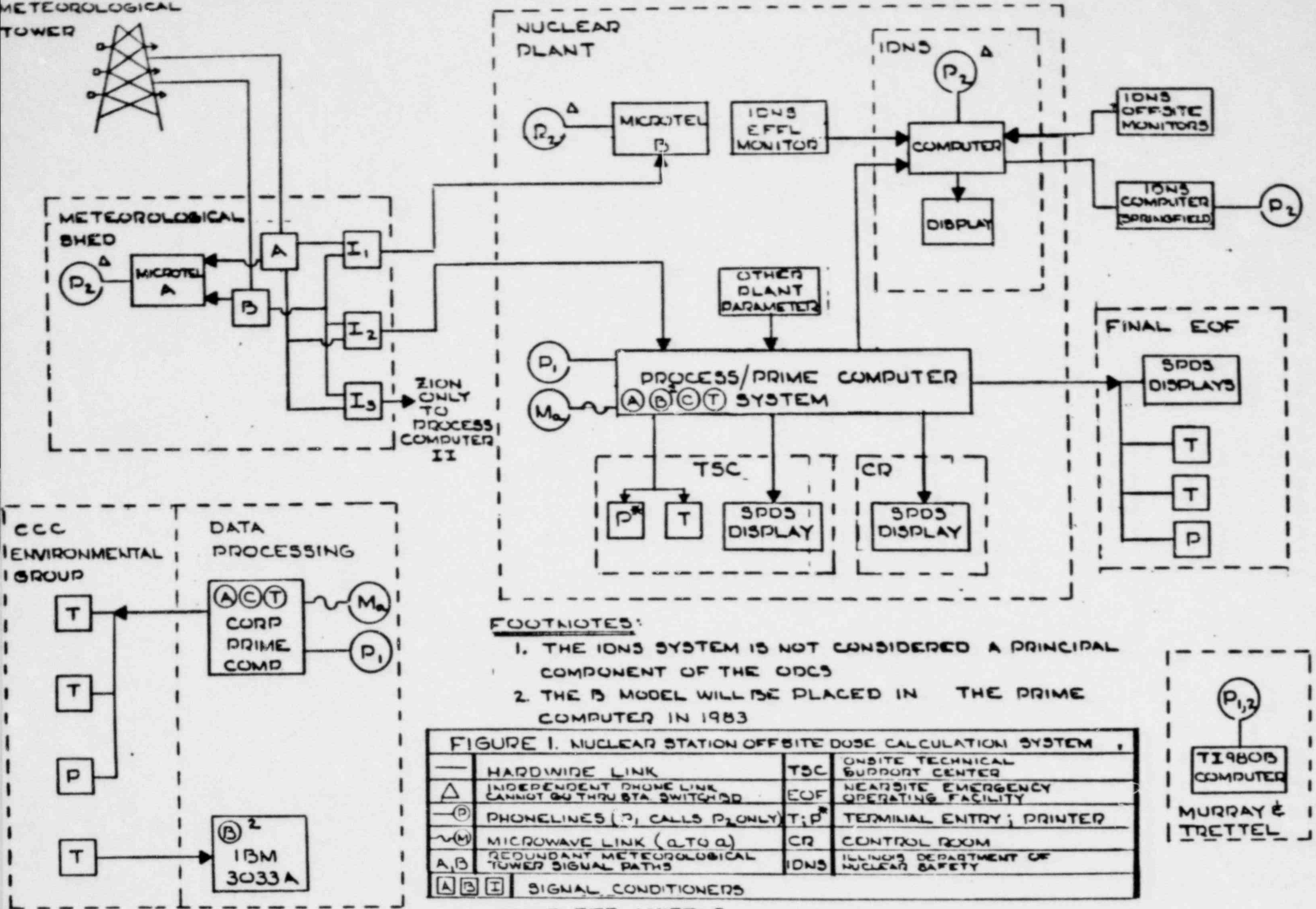
The Class B-model, a historical model, documents all releases (multiple release periods) and changing conditions for the duration of the incident. The offsite individual's whole body dose, the population whole body dose, the individuals skin dose and the inhalation dose to 7 organs of the adult and infant from 73 different non-noble gas nuclides are determined. The B-model is described in Section 9.0 of the Commonwealth Edison Offsite Dose Calculation Manual (ref. 14)

All four computer models used by CECo are based on atmospheric transport models and data processing techniques described in TID-24190 "Meteorology and Atomic Energy 1968", NUREG/CR-0936 "Recommendations for Meteorological Measurement Programs and Atmospheric Diffusion Prediction Methods for Use at Coastal Nuclear Reactor Sites", and Nuclear Regulatory Commission Regulatory Guide 1.109 "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 50, Appendix I".

At Zion Station, the lake breeze effects of plume trapping and fumigation have been incorporated into each of the models, developed from the NUREG/CR-0936 Class. Section I.4 describes the lake effect model in further detail.

Plume meander or absence thereof as estimated from the measurement of sigma-subtheta has been incorporated into the plume centerline dispersion model which heretofore was based only on a measurement of differential temperature on the tower.

Lastly, all calculations have been documented in emergency procedures (ref. 18) such that they may be performed manually, if necessary.



FOOTNOTES:

1. THE IDNS SYSTEM IS NOT CONSIDERED A PRINCIPAL COMPONENT OF THE ODCS
2. THE B MODEL WILL BE PLACED IN THE PRIME COMPUTER IN 1983

FIGURE 1. NUCLEAR STATION OFFSITE DOSE CALCULATION SYSTEM

—	HARDWIRE LINK	TSC	ONSITE TECHNICAL SUPPORT CENTER
△	INDEPENDENT PHONE LINK CANNOT GO THRU STA. SWITCHBD	EOF	NEARSITE EMERGENCY OPERATING FACILITY
—(P)	PHONELINES (P_1 CALLS P_2 ONLY)	T; P*	TERMINAL ENTRY; PRINTER
~(M)	MICROWAVE LINK (a TO a)	CR	CONTROL ROOM
A, B	REDUNDANT METEOROLOGICAL TOWER SIGNAL PATHS	IDNS	ILLINOIS DEPARTMENT OF NUCLEAR SAFETY
[A] [B] [I]	SIGNAL CONDITIONERS		

COMPUTER MODELS

(A) REALTIME MODEL; HARDWIRE SIGNALS
(B) HISTORICAL MODEL; MANUAL ENTRY
(C) CALCULATIONAL MODEL; MANUAL ENTRY
(T) TRACK MODEL; MANUAL ENTRY

Table 1

A Summary of the

Offsite Dose Calculation System

Computer	Source of Meteorological Information: Site	Other Sites	Forecast	Radiation Dose Model	User or Data Link
Plant Process	(1) Direct analog signal from tower	-	(1) Manual entry for lake effect parameters (Zion only)	A	.Control room oper. .TSC ODCS oper.
Plant Prime	(1) Plant Process (2) Phone link to Tower Microtel (3) Phone link to Plant Microtel	(1) Phone link to Tower Microtel (2) Phone link to Plant Microtel (3) Prime Computer Link	(1) Metro-Contractor on command	C,A T	.TSC ODCS oper. .EOF ODCS oper.
Tower Microtel	(1) Direct analog signal	-	-	-	Backup Data Link for: .Plant Computer .Corporate Computer .Metro Contractor
Plant Microtel	(1) Direct analog signal from tower	-	-	-	Data Link for: .Plant Computer .IDNS .Metro Contractor .Corporate Computer

Table 1

A Summary of the

Offsite Dose Calculation System

Computer	Source of Meteorological Information: Site	Other Sites	Forecast	Radiation Dose Model	User or Data Link
Corporate Prime	(1) Phone Link to Tower Microtel	Same as plant Prime	(1) Metro-Contractor polled routinely every 12 hours.	T,C A	.Corporate ODCS oper. .All stations TSC and EOF operators.
	(2) Phone Link to Plant Microtel	computer	(2) Metro-Contractor on command (3) Manual entry		
Corporate IBM	(1) Corporate Prime			B*	.Corporate ODCS operator

* The B model will be placed in the Prime computer in 1983.

2. Backup Measurement Systems

Section 3 of Annex 2 to the Zion 2/29/80 order and NUREG-0654, Appendix 2, both require a backup metro measurements program consisting of either a "viable backup system and/or procedures." Although the order calls for a system and/or procedures, CECo will implement both. The backup systems consist of the already existing multiple measurement tower-mounted equipment that is being specially isolated to provide completely independent signals from one another (Tables 2a - 2f). Therefore, loss of any signal due to component failure will not result in the loss of additional signals. This method of signal isolation is superior to the installation of more instrumented towers in several ways.

First, based on more than 50 station years of operation, instrument failures from whatever cause have occurred in the sensor and/or signal conditioners, thereby preventing other unaffected sensors' signals from being processed. The isolated signal processing with independent power supplies and signal paths is designed to prevent this failure mode from occuring. (For a more detailed description of the independent signal pathways see Appendix C).

Second, a disaster of sufficient magnitude to render all measurements on the tower useless, although extremely remote, would in all probability also inflict similar damage to any backup tower nearby.

Should a disaster of sufficient magnitude occur, a contract is maintained to have a temporary tower erected within 72 hours. For ready placement on this temporary tower the meteorological contractor maintains two levels of sensors (wind speed, wind direction and temperature).

Third, CECo's existing instrumented towers at six (6) nuclear plant sites located in Northern Illinois provide a high-density measurement network with multiple backup opportunities.

Finally, CECo's meteorological consultants provide a 24 hour per day, 7 days per week data source consisting of all routinely available National Weather Service information plus the CECo network data.

The backup system priority is summarized in Tables 3 and 4. For example, if a ground level release occurred (Table 3) at Quad Cities and the primary wind or differential temperature (196 ft. and 196-33 ft.) were lost then the immediate backup measurements would be the second level (296 ft. and 296-33 ft.) at Quad Cities. The backup identified in the table with 'f' represents values provided by the meteorological consultant. Backup systems for accidental elevated releases are shown in Table 4 with similar interpretations.

The backup priority was developed from the following considerations:

(a) As described in Appendix C, the sensors and signal conditioners for each elevation on the tower are isolated from one another to the extent possible into two independent paths (denoted by A and B in Figure 1). Since all the towers have wind instruments at at least two elevations, each is placed in separate paths. Similarly, where multiple measurements of the same parameter are made, they are separated into two paths.

(b) The primary measurements are those located on the tower at the elevation that most appropriately represents the principal release points, i.e. elevated or ground level.

(c) The first backup system for reach release level will come from the signals provided in the alternate path on the same tower.

(d) Data from additional tower systems in the network or from the meteorological consultant comprise the remainder of the backup.

2.1 Meteorological Maintenance Program

The meteorological maintenance program consists of several independent methods to verify quality data transmissions from each meteorological tower.

The corporate computer polls each meteorological tower every hour. The A Microtel is polled first, if the poll fails, the B Microtel is then called. If a transmission is not received from either Microtel, the computer automatically increments its request for the next hour. Should the number of requests be four or more, the console operator notifies the computer system's ODCS staff who begins to isolate the cause. The meteorological contractor is also notified and an independent check of the transmission is made from the contractor's office.

Each day's data are screened by a validation program which flags all missing and/or suspect values. The meteorological contractor is notified of persistent outages and the proper restoration procedure is followed. Additionally, data may be examined in the corporate office, for correctness, on demand.

As an independent method of data retrieval, the meteorological contractor interrogates each meteorological tower three times a day. Data are passed through a validation procedure, and suspect data closely examined. Field teams are then assigned for restoration of the system.

The meteorological contractor maintains a comprehensive field program. Routine visits are made to each tower once a week to retrieve analog data and inspect the equipment. These visits are directed toward ground based equipment, although a visual inspection of the tower sensing equipment is made. Those instruments equipped with internal calibrations are checked on a weekly basis. A log of the week's activities is filled out and kept on file both with the contractor and at the corporate office.

Bi-monthly calibrations are performed at each meteorological tower as part of the maintenance program. An instrument technician and a tower climber verify the operating performance of the system. Using a precision digital multi-meter which is NBS traceable, to monitor signals during the inspection, all systems are checked and calibrated. Worn or damaged wind sensors are replaced with working spares. The complete wind system is checked for proper operation. Anemometers are stopped and signal zero is verified. Vanes are oriented toward targets whose directions from the tower were predetermined and the orientation verified. Sensor tracking is also checked. Reference temperatures are measured on the tower with an independent device. All analog recorders are checked for proper operation. The microprocessing units are checked for proper operation and their outputs verified. These procedures help maintain the highest possible operating levels of all measuring and recording systems and the maximum data integrity.

Emergency field visits to the meteorological sites are made as quickly as possible after a detection of a failure. A two man team consisting of an instrument technician and tower climber are available 7 days per week, 24 hours an day to respond to detected failures. Wherever possible, components are replaced with working spares to minimize data loss. Damaged items are later repaired in-house or replaced.

Table 2a

Braidwood Station

Instrument Locations and Data Record

Measurement	Type	Location	Elevation (Above Grade)	Recording Frequency	Recorder Type	Chart Speed	Chart Period
Wind speed/direction	MRI Model 1074-2	Tower	34 ft.	Continuous	Belfort/ Esterline Angus	3"/Hr.	2 weeks
Wind speed/direction	MRI Model 1074-2	Tower	203 ft.	Continuous	"	3"/Hr.	2 weeks
Ambient Air Temperature	MRI Model 832	Tower	30 ft.	1 minute	Esterline Angus E1124	3"/Hr.	2 weeks
Differential Temperature	MRI Model 832	Tower	199-30 ft.	1 minute	"	3"/Hr.	2 weeks
Dew Point Temperature	EG&G 220	Tower	30', 199'	1 minute	"	3"/Hr.	2 weeks
Precipitation	MRI Model 302 Tipping Bucket	Ground	3 ft.	Continuous	"	3"/Hr.	2 weeks

Table 2b

Byron Station

Instrument Locations and Data Record

Measurement	Type	Location	Elevation (Above Grade)	Recording Frequency	Recorder Type	Chart Speed	Chart Period
Wind speed/direction	MRI Model 1074-2	Tower	30 ft.	Continuous	Belfort/ Esterline Angus	3"/Hr.	2 weeks
Wind speed/direction	MRI Model 1074-2	Tower	250 ft.	Continuous	"	3"/Hr.	2 weeks
Ambient Air Temperature	MRI Model 832	Tower	30 ft.	1 minute	Esterline Angus E1124	3"/Hr.	2 weeks
Differential Temper-ature	MRI Model 832	Tower	250-30 ft.	1 minute	"	3"/Hr.	2 weeks
Dew Point Temperature	EG&G 220	Tower	30', 250'	1 minute	"	3"/Hr.	2 weeks
Precipitation	MRI Model 302 Tipping Bucket	Ground	3 ft.	Continuous	"	3"/Hr.	2 weeks

Table 2c

Dresden Station

Instrument Locations and Data Recorded

Measurement	Type	Location	Elevation (Above Grade)	Recording Frequency	Recorder Type	Chart Speed	Chart Period
Wind speed/direction	Teledyne/Geo. Tech Series 50	Tower	35 ft.	Continuous	Esterline Angus Series	3"/Hr.	[illegible] weeks
Wind speed/direction	Teledyne/Geo. Tech Series 50	Tower	150 ft.	Continuous	"	3"/Hr.	2 weeks
Wind speed/direction	Teledyne/Geo. Tech Series 50	Tower	300 ft.	Continuous	"	3"/Hr.	2 weeks
Ambient Air Temperature	EG&G Model 110S-M	Tower	35 ft.	1 minute	Esterline Angus E1124	2"/Hr.	3 weeks
Differential Temperature	EG&G Model 110S-M	Tower	150-35 ft.	1 minute	"	2"/Hr.	3 weeks
Differential Temperature	EG&G Model 110S-M	Tower	300-35 ft.	1 minute	"	2"/Hr.	3 weeks
Dew Point Temperature	EG&G Model 110S-M	Tower	35', 150', 300'	1 minute	"	2"/Hr.	3 weeks
Precipitation	MRI Model 302	Shelter Roof	10 ft.	Continuous	Esterline Angus MS401	1.5 cm/Hr.	3 weeks

Table 2d

LaSalle County Station

Instrument Locations and Data Recorded

Measurement	Type	Location	Elevation (Above Grade)	Recording Frequency	Recorder Type	Chart Speed	Chart Period
Wind speed/direction	MRI Model 1022 S&D	Tower	33 ft.	Continuous	Esterline Angus Model 1102S	3"/Hr	2 weeks
Wind speed/direction	MRI Model 1022 S&D	Tower	200 ft.	Continuous	Esterline Angus Model 1102S	3"/Hr.	2 weeks
Wind speed/direction	MRI Model 1022 S&D	Tower	375 ft.	Continuous	"	3"/Hr.	2 weeks
Ambient Air Temperature	MRI Model 15021	Tower	33 ft.	1 minute	Esterline Angus Model E1124E (multipoint)	3"/Hr.	2 weeks
Differential Temperature	MRI Model 15021	Tower	200-33 ft.	1 minute	"	3"/Hr.	2 weeks
Differential Temperature	MRI Model 15021	Tower	375-33 ft.	1 minute	"	3"/Hr.	2 weeks
Dew Point Temperature	EG&G 110-SM	Tower	33', 200'	1 minute	"	3"/Hr.	2 weeks
Precipitation	MRI Model 302 Tipping Bucket	Shelter Roof	10 ft.	Continuous	"	3"/Hr.	2 weeks

Table 2e

Quad Cities Station (South)

Instrument Locations and Data Recorded [a]

Measurement	Type	Location	Elevation (Above Grade)	Recording Frequency	Recorder Type	Chart Speed	Chart Period
Wind speed/direction	Climet	Tower	33 ft.	Continuous	Esterline Angus	2"/Hr	2 weeks
Wind speed/direction	Climet	Tower	196 ft.	Continuous	Esterline Angus	2"/Hr.	2 weeks
Wind speed/direction	Climet	Tower	296 ft.	Continuous	"	2"/Hr.	2 weeks
Ambient Air Temperature	Rosemont #78-0065-0041	Tower	33 ft.	2 minutes	Esterline Angus E1124	2"/Hr.	2 weeks
Differential Temperature	Rosemont	Tower	196-33 ft.	2 minutes	"	2"/Hr.	2 weeks
Differential Temperature	Rosemont	Tower	296-33 ft.	2 minutes	"	2"/Hr.	2 weeks
Dew Point Temperature	EG&G	Tower	33 ft.	2 minutes	"	2"/Hr.	2 weeks
Precipitation	MRI Model 302 Tipping Bucket	Shelter Roof	10 ft.	Continuous	"	2"/hr.	2 weeks

(a) In addition there is an MRI Series 10-22 wind speed/direction sensor on a 30 ft. pole located in the switchyard for providing wind information to the control room on an interim basis. This system will be discontinued when the ODCS is fully operational.

Table 2f

Zion Station

Instrument Locations and Data Recorded

Measurement	Sensor Type	Location	Elevation (Above Grade)	Recording Frequency	Recorder Type	Chart Speed	Chart Period
Wind speed/direction	Teledyne 1500 Series	Tower	35 ft.	Continuous	Esterline Angus L1102S	3"/Hr.	2 weeks
Wind speed/direction		Tower	125 ft.	Continuous	"	3"/Hr.	2 weeks
Wind speed/direction	"	Tower	250 ft.	Continuous	"	3"/Hr.	2 weeks
Ambient Air Temperature	Bristol Shielded Resistance Thermometer	Tower	250-35 ft.	1 minute	Westronics multipoint Model M11D2	2"/Hr.	3 weeks
Differential Temperature	Bristol Shielded Resistance Thermometer	Tower	125-35 ft.	1 minute	"	2"/Hr.	3 weeks
Differential Temperature	Bristol Shielded Resistance Thermometer	Tower	250-35 ft.	1 minute	"	2"/Hr.	3 weeks
Dew Point Temperature	Foxboro Dewcell	Instrument Shelter	5 ft.	1 minute	"	2"/Hr.	3 weeks
Precipitation	MRI Model 302 Tipping Bucket	Shelter	10 ft.	Continuous	"	2"/Hr.	3 weeks

Table 3

Backup Metro Measurements Program
Ground Level Release[(a)]

Station	Primary*		Backup		Tertiary		4th		5th	
	Wind	ΔT	W	ΔT	W	ΔT	W	ΔT	W	ΔT
Braidwood (Bd)	1	2	2	f	D1	D2	D2	D3	L1	L2
Byron (By)	1	2	2	f	f	f	Rockford**		-	-
Dresden (D)	1	2	2	3	Bd1	Bd2	L1	L1	3	f
Quad Cities (Q)	1	2	2	3	f	f	Moline**		-	-
Zion (Z)	1	2	2	3	3	f	f	f	-	-
LaSalle County (L)	1	2	2	3	D1	D2	D2	D3	-	-

a the levels are numbered from the lower level up the tower; level 1 is typically at a height of 35'.

* information for any group must come from same source; i.e., one can't mix stations; ex. D1 Bd2. ΔT represents stability class.

f hindcast, nowcast and forecast for station

** National Weather Bureau stations - information that could be provided to a station by the meteorological contractor.

Table 4

Backup Metro Measurements Program
Elevated Release [a]

Station	Primary*		Backup		Tertiary		4th		5th	
	Wind	ΔT	W	ΔT	W	ΔT	W	ΔT	W	ΔT
Dresden	3	3	2	2	Bd2	Bd2	L3	L3	L2	L2
LaSalle	3	3	2	2	D3	D3	Bd2	Bd2	D2	D2
Quad Cities	3	3	2	2	f	f	Moline**			

a the levels are numbered from the lower level up the tower; level 1 is typically at a height of 35'.

* information for any group must come from same source; i.e., one can't mix stations; ex. D1 Bd2. ΔT represents stability class.

f hindcast, nowcast and forecast for station

** National Weather Bureau stations - information that could be provided to a station by the meteorological contractor.

3. Weather Forecasts

Forecasts will be prepared by CECo's meteorological consultant* routinely twice each day. Each forecast is for a 36-hour period beginning at 1200 CST or 2400 CST.

The hourly forecasted parameters include the following:

All Sites: Forecasted Inputs	Output to CECo
1.1 1-Wind Speed	MPS
1.2 1-Wind Direction	Degrees
1.3 1-Stability	DeltaT/DeltaZ
ZION Only:	
1.4 1-Air Temp. over water 1.5 1-Air Temp. over land 1.6 1-Air Mass Stability	0 - for no lake effect** 1 - for Case 1 lake effect 2 - for Case 2 lake effect
	Convergence Zone 0 - No lake breeze 1 - Convergence Zone $\leq$ 2 mi 2 - Convergence Zone $>$ 2 but $\leq$ 5 mi 3 - Convergence Zone $>$ 5 mi

The corporate computer will poll the consultant's computer every 12 hours automatically. Forecasted data are available to station via the computer network. Additionally, the plant computer is able to call the consultant's computer for the forecast should communications with the corporate computer be interrupted.

The corporate ODCS operator, TSC and EOF ODCS operators may use these weather forecasts to estimate radiation doses accruing from postulated future releases of radioactivity.

* Currently Murray and Trettel, Inc., Northfield, Illinois.

** See next section for description of lake effect conditions.

Required Forecast Inputs to Model

The lake effects model requires a variety of inputs. Some are used to determine whether or not a boundary exists. Others are used to select the limited mixing or the fumigation mode. The inputs used to decide whether lake effects will occur are:

Hour of day
Wind Direction
Wind Speed
Temperature contrast between lake and land

The additional input used to select the appropriate dispersion mode is air mass stability.

Signals representing the temperature differential between lake and land and air mass stability are not directly available. Instead they are determined from a variety of meteorological reporting stations and provided by the meteorological consultant. Predicted hourly differential and stability factors are also prepared by the consultant.

The presence or absence of a lake effect condition is reported by the meteorological consultant and appended to the Zion Station forecast. A "zero" (0) indicates that no lake effect condition is forecasted for a particular hour. A "one" (1) indicates that there is a forecasted Case 1 lake effect condition. A "two" (2) indicates that there is a forecasted Case 2 condition.

The predicted inland distance of the lake breeze front is also appended to the forecast. A "zero" (0) indicates no lake breeze. A "one" (1) indicates the convergence zone is less than or equal to 2 miles. A "two" (2) indicates the convergence zone is beyond 2 miles but less than or equal to 5 miles. A "three" (3) indicates the convergence zone is beyond 5 miles. Appendix F describes this further.

Using the lake effect indicator and associated penetration distance of the convergence zone, the computers select the appropriate atmospheric dispersion model for estimating the offsite consequences of a release.

4. Lake Effects at Zion Station

Currently recommended meteorological programs and diffusion methods for nuclear power plants located in coastal zones were recently reviewed for the U.S. Nuclear Regulatory Commission (NUREG/CR-0936 BNL-NUREG-51045, October 1979). Among certain deficiencies in guidelines and procedures noted in this document were "failure to consider the role of coastal internal boundary layers, specifications for tower locations and instrument heights, (and) methods for classifying atmospheric stability...". Included were recommendations for changes to the guidelines.

An atmospheric dispersion model has been developed to account for boundary layer conditions that could occur at the Zion plant. The model development essentially followed the various methods itemized in the reference cited. Conservatively high ground level concentrations result from the model when compared to standard dispersion calculations. (Section 9.4 of Reference 14, the ODCM, provides additional information on the lake breeze model.)

The Boundary Layer

Continuous measurements of the boundary layer in the vicinity of Zion are not available. Indeed, aside from a few intensive short term studies of lake shore dispersion in the vicinity, no boundary layer data exist. Consequently readily available meteorological measurements representing a two year period were used in conjunction with the boundary equation (1) found in NUREG-0936 to infer the existence and location of the boundary.

NUREG-0936 equation (1) was evaluated subject to the following assumptions and conditions:

(1) friction velocity $U^* = 1$ mps
(2) Wind speed less than or = 6 mps
(3) Land-water temperature contrast at least $5^{o}F$
(4) Air mass stability was estimated by the 250-125 ft. differential temperature measured on the Zion tower.
(5) Wind direction onshore

The results are shown in Figure 2. In summary, the boundary was computed to occur roughly 10 percent of the hours annually (876/8760). Of those 876 hours it occurred well above the Zion ventilation stacks 95 percent of the time (832 hours). The remaining 5 percent of the time (44 hours) it was below the stacks leading to potential fumigation downwind (cf. Figure 3).

It should be noted that the existing Zion meteorological tower is located entirely within the calculated boundary. For all practical cases, then, the measurements from the tower can be assumed to represent the boundary layer conditions and not be partially in the boundary layer and partially in the 'lake' air (a caution referred to in NUREG-0936).

Dispersion Model

When a boundary height, variable both in time and inland fetch, is taken into account, four downwind zones with different dispersion characteristics emerge. The dispersion equations differ for the four cases summarized below.

Case 1. The boundary layer is located above the stacks. Consequently vertical dispersion is limited by the boundary and the ground at all ranges downwind to 10 miles (the downwind extent of the model evaluation). Boundary layer dispersion is characterized by meteorological tower measurements.

Case 2. The boundary layer is located below the stacks. This can lead to three distinct cases depending on the downwind range in question.

Case 2.1. At downwind distances from the stacks to the point X_1, beneath which the bottom of the plume intersects the boundary. The plume is embedded in the relatively turbulent-free lake air.

Case 2.2. At downwind distances from point X_1, to the point X_2, beneath which the top of the plume intersects the boundary. In this zone fumigation is assumed to occur. The effluent is uniformly distributed in the vertical.

Case 2.3. At downwind distances beyond the point X_2. Here limited mixing occurs due to the plume being trapped beneath the boundary. Here also the effluent is uniformly distributed in vertical.

Results

The model was evaluated at various downwind distances to ten (10) miles, to yield the 'worst case' values. The highest concentrations were due either to Case 1 or Case 2.2. The remaining cases were therefore eliminated as possible worst cases.

Figure 2

ZION STATION

Estimated Frequencies of Occurence*

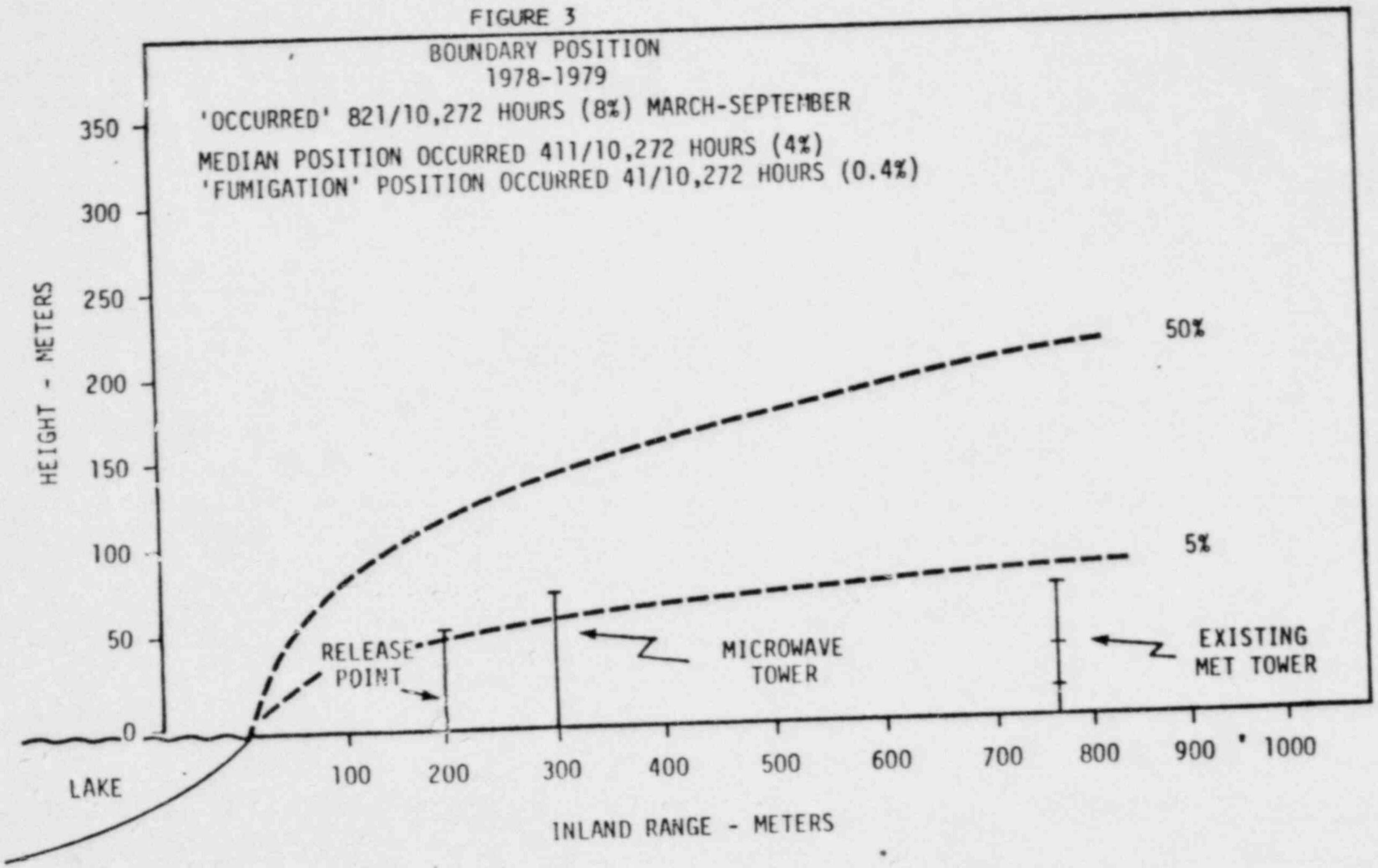
(Hours per year - Percent)

. No Lake Effects	90
. Lake Effects	10
	100
. Lake Effect - Trapping	9
. Lake Effect - Fumigation	1
	10

* Based on 1978 - 1979 Hourly Measurements

(March through November)

FIGURE 3


BOUNDARY POSITION
1978-1979
'OCCURRED' 821/10,272 HOURS (8%) MARCH-SEPTEMBER
MEDIAN POSITION OCCURRED 411/10,272 HOURS (4%)
'FUMIGATION' POSITION OCCURRED 41/10,272 HOURS (0.4%)
HEIGHT - METERS
350
300
250
200
150
100
50
0
50%
5%
RELEASE POINT
MICROWAVE TOWER
EXISTING MET TOWER
LAKE
100
200
300
400
500
600
700
800
900
1000
INLAND RANGE - METERS

5. Nuclear Regulatory Commission Nuclear Data Link (NDL)

The NRC staff is engaged in improving the capabilities of its NRC Operations Center (OC) at Bethesda, Maryland. One aspect of this effort involves the transmission of various plant parameters including meteorological data over the NDL from each nuclear plant to tne OC. In accordance with Reg. Guide 1.23, the 15-minute averaged meteorological data for the previous 12 hour period are available for recall in the OC. When the final scope of the NDL as been determined by the NRC, CECo will review the NRC specifications for the timely application of the NDL at each station.

IV. Model Accuracy and Conservatism

Commonwealth Edison has adopted for use the atmospheric transport and plume gamma dose models recommended by the Nuclear Regulatory Commission in its Regulatory Guide series (e.g., RG 1.23, 1.109 and 1.111) and in the publication "Meteorology and Atomic Energy 1968" (TID-24190, July 1968).

Two very relevant documents to Commonwealth Edison are references 8 and 9 in Appendix G. Reference 8 is a state-of-the-art review of meteorological measurement and atmospheric transport and diffusion prediction models for plants located in coastal zones, such as Zion Station. Whereas this study by Brookhaven National Laboratory was restricted to simple coastlines (such as near Zion) without complex terrain, that only effects within five miles of the plant should be considered, and that models recommended should give conservative predictions for plant design purposes, CECo has adopted the model to the realtime prediction situation.

This modified model should be adequate for the purpose intended: to help the control room operator and the ODCS operator reach a decision concerning the necessity to recommend protective actions in the vicinity of the plant during the initial phase of an accident, i.e., before field personnel are fully capable of tracking the direction of and measuring the radiation intensity from the plume, and to make a reasonably conservative estimate of radiation dose to the public. Once field personnel are dispatched and the plume's behavior is being tracked from the ground and/or air, then the role of a predictive meteorological model is reduced.

Appendix G reference 9 reviews the uncertainty in atmospheric dispersion models to 50 miles. Tables 5 to 8 reproduced herein from reference 9 summarize the uncertainty associated with concentration predictions made by the Gaussian plume atmospheric dispersion model. CECo does not disagree with these findings, in fact our own research supports the accuracy estimates for locations near the plant.

Table 5 An estimate of the uncertainty associated with concentration predictions made by the Gaussian plume atmospheric dispersion model[a]

Conditions	Range of the ratio Predicted/Observed
Highly instrumented flat-field site; ground-level centerline concentration within 10 km of continuous point source	0.8-1.2
Specific hour and receptor point; flat terrain, steady meteorological conditions; within 10 km of release point	0.1-10
Ensemble average for a specific point, flat terrain, within 10 km of release point (such as monthly, seasonal, or annual average)	0.5-2
Monthly and seasonal averages, flat terrain 10-100 km downwind	0.25-4
Complex terrain or meteorology (e.g., sea breeze regimes)	b

[a]T. V. Crawford (Chairperson), Atmospheric Transport of Radionuclides, pp. 5-32 in Proceedings of a Workshop on the evaluation of Models Used for the Environmental Assessment of Radionuclide Releases, ed. by F.O. Hoffman, D. L. Shaeffer, C. W. Miller, and C. T. Garten, Jr., USDOE Report CONF-770901, NTIS, April 1978.

[b]The group which assembled these estimates did not feel there was enough information available to make even a "scientific judgment" estimate under these conditions.

Table 6 Some validation results for ensemble averages predicted by the Gaussian plume model

Conditions	Range of the ratio $\frac{\text{Predicted}}{\text{Observed}}$
Annual average SO_2 concentrations for Roane Co., Tennessee; both point and area source emissions included	0.5-$\leq$ 2
Continuous gamma-ray measurements 0.04-6.8 km downwind of a boiling water reactor	0.33-1.78
Gamma-ray doses downwind of Humboldt Bay Nuclear Power Plant	0.5-$\leq$ 2
Monthly gamma-ray doses for four stations downwind of a nuclear power plant at an inland site	0.30-4.78 individual stations 1.55 mean of all data

Table 7 Validation results for Gaussian plume model predictions out to 140 km

Conditions	Range of the ratio $\frac{\text{Predicted}}{\text{Observed}}$
^{85}Kr measurements 30-140 km downwind of the Savannah River Plant	
Weekly and annual averages	0.25-4
Seasonal averages, Spring	2-4, 69% of samples 2-10, 100% of samples
Summer	0.5-4, 46% of samples 0.5-10,85% of samples
Fall	0.5-4, 31% of samples 0.5-10, 85% of samples
Winter	2-4, 69% of samples 2-10, 92% of samples
Annual Average	1-4, 77% of samples 1-10, 92% of samples
10-hour averages, six variations of the model	0.5-2, 42-65% of samples 0.1-10, 79-95% of samples

Table 8 Some validation results for Gaussian plume model predictions in speed, inversion conditions both complex terrain and also under low wind

Conditions	Range of the ratio Predicted/Observed		
Review of a number of experiments conducted in complex terrain for plume centerline concentrations	0.01-300, individual measurements close to the source		
	0.50-2, 2-15 km downwind of source		
Review of a number of experiments conducted under low wind speed, inversion conditions			
	stability category		
	E	F	G
smooth desertlike terrain[a]	2.3-10	1.3-12	3.6-20
wooded flat terrain[a]	20-25	20-40	20-30
wooded hilly terrain[a]	50-350		300-500

[a]Ratios estimated from curves provided by Van der Hoven.[41]

V. Quality Assurance Program

The NRC Zion Order dated 2/29/80 and NUREG-0654 Appendix 2 requires the establishment of a quality assurance program (Q.A.P.) consistent with applicable provisions of Appendix B to 10 CFR 50. It states further that the acceptance criteria stated in Revision 1, Section 17.2 of NUREG-75/087 apply. CECo agrees that a Q.A.P. can be developed consistent with applicable provisions of 10 CFR 50, Appendix B.

The Commonwealth Edison Company has had a formal quality assurance program (Q.A.P.) for its meteorological monitoring since 1976. The scope of the Q.A.P. is delineated in Standard Quality Assurance Articles which are appended to the contract specifications. The current Articles (Rev. 1) and current Q.A.P. are provided in Appendix C of this report. The Q.A. Articles for meteorological monitoring were adopted specifically for this program from 10 CFR 50 Appendix B. However, since the meteorological facility is not composed of structures, systems and components that prevent or mitigate the consequences of postulated accidents and is thus not "safety related", not all aspects of 10 CFR 50 Appendix B apply. Those aspects of quality assurance germane to supplying good meteorological information for a nuclear power plant were kept in the Articles and incorporated into the contractor's Q.A.P.

VI. Schedule

The ODCS that is available on 04/01/82:

(1) Weather forecasts except for the convergence zone forecast routinely made available to Zion Station and the corporate office.

(2) Routine polling of all six meteorological towers by the corporate office.

(3) Operational B&C models available to all TSCs and EOFs.

(4) A functional A-model at LaSalle Station.

The ODCS anticipated to be available on 10/01/82:

(1) A fully operational tracking model installed at Zion Station.

(2) An operational A-model installed at Zion Station.

(3) Covergence zone forecasts appended to the existing transmissions.

The ODCS implementation schedule beyond 10/01/82 includes:

(1) Installation of the full ODCS at Byron and Braidwood before the operating license.

(2) Installation of the Nuclear Data Link as soon as practical after the NRC specifications are finished.

(3) Installation of the A-model at Dresden and Quad Cities as new computers are installed onsite.

(4) Complete the IDNS computer links as soon as practical. Note that the IDNS system is not a critical component of the ODCS as depected in Figure 1, but is included to show how data are transmitted between the licensee and the state.

APPENDIX A
ODCS Class A-Model

APPENDIX A
ODCS Class A-Model

The plant process/Prime computer system houses the A-model, producing initial transport and dispersion estimates within 15-minutes following the classification of an incident. Meteorological signals, along with the final effluent monitors for noble gases and containment activity monitors are hardwired into the system. These data are converted into the requisite Emergency Action Levels (EALs) for use by the control room operator. The A-model may be accessed in the final TSCs and final EOFs.

	Effluent Monitor EAL Criteria (uCi/sec)	
	$\overline{Q}$2min	$\overline{Q}$30min
Ground Level	8.9E6	8.9E5
Elevated	1.3E8	1.3E7

Warning Messages

for $\overline{Q}_{2min}$: The Site Emergency EAL of 500 mR/hr offsite using worst case meteorology has been exceeded.

for $\overline{Q}_{30min}$ The Site Emergency EAL of 50 mR/hr offsite using worst case meteorology has been exceeded.

When the calculated maximum offsite dose rate, using the Q_{2min} and actual meteorology, meets or exceeds the General Emergency EAL of 1000 mR/hr, the following warning is issued:

for $\overline{Q}_{2min}$: The General Emergency EAL of 1000 mR/hr offsite using actual meteorlogy has been exceeded.

Available on demand are dose rates at each of six preselected downwind ranges (400, 800, 1609, 3218, 8045, 16090 m) in the affected centerline sector. The output also includes the affected adjacent sectors, and the wind direction, wind speed and stability class used in the calculations.

Similarly, the drywell radiation monitors are sampled once per minute and compared to the EAL criteria.

2.E2 $\leq$ Activity $<$ 4E2 R/hr; Alert EAL

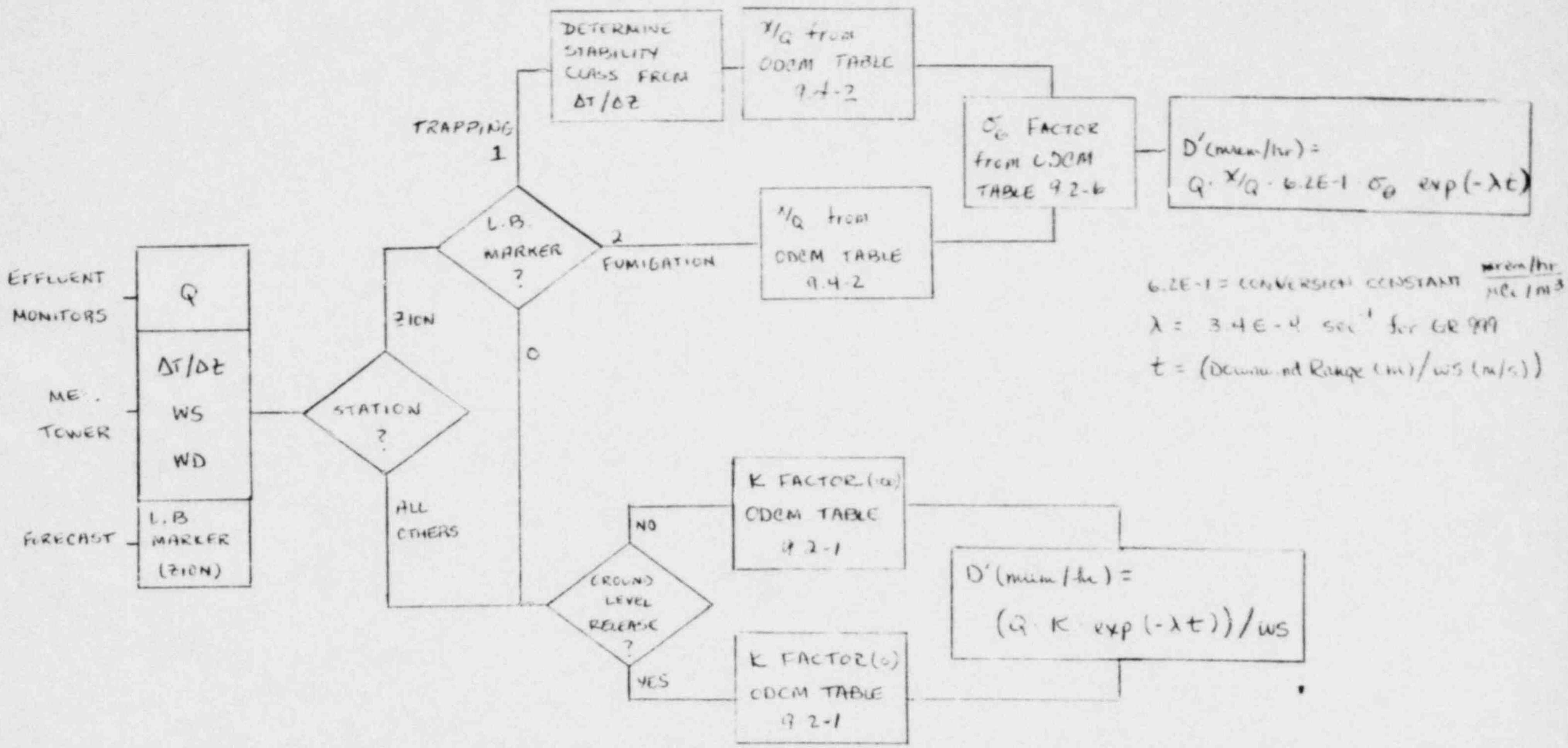
4.E2 $\leq$ Activity $<$ 2E3 R/hr; Site Emergency EAL

2.E3 $\leq$ Activity; General Emergency EAL

When the EAL is met or exceeded, the appropriate warning message is issued. Available on demand are projected dose calculations at each of the six downwind ranges based on the ground level, non-meandering plume model and all activity released to the atmosphere. Similarly, the output includes the affected adjacent sectors and the meteorological data used in the calculations.

CLASS A MODEL

FIGURE 1

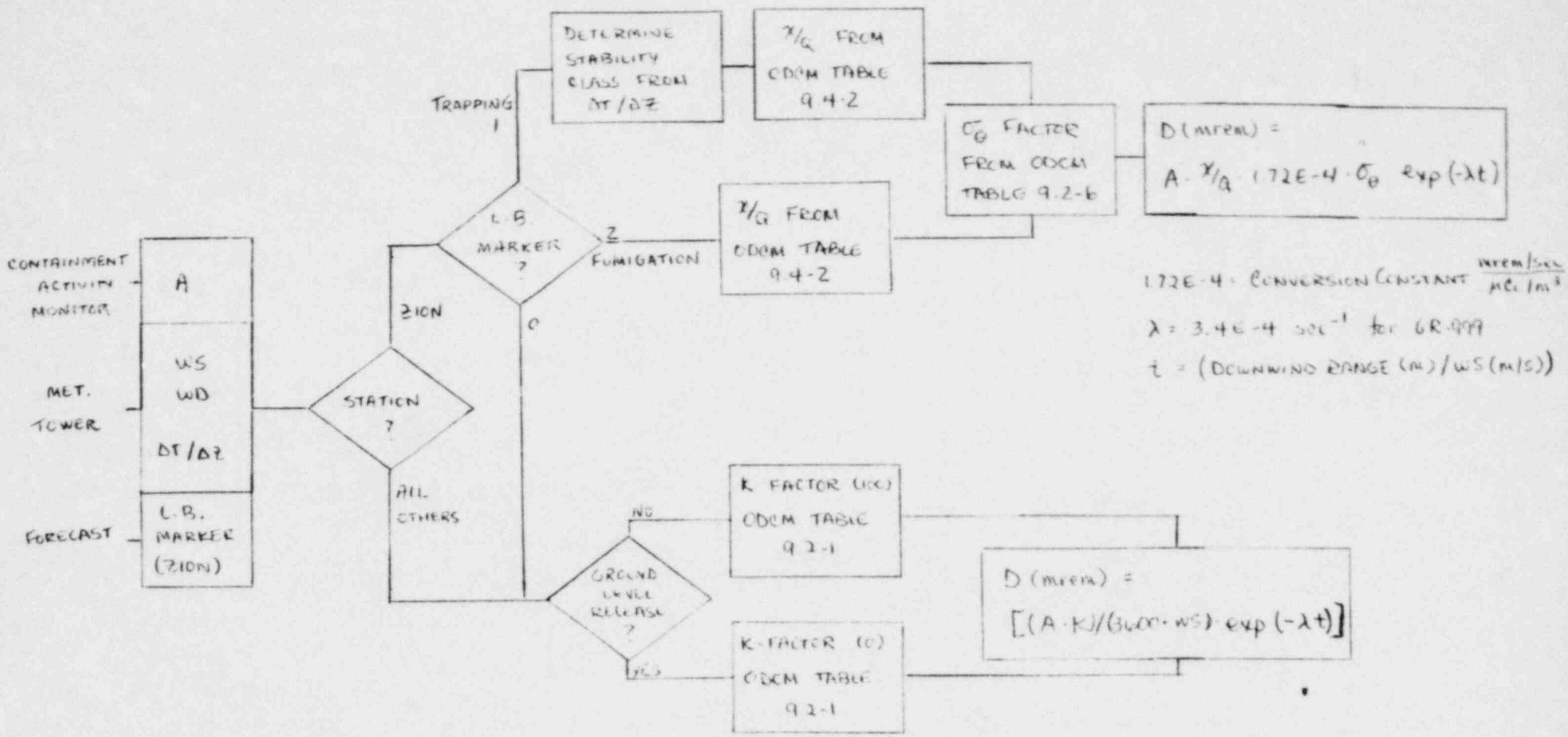


ON COMMAND ANALYSIS OF OFFSITE DOSE RATE (MREM/HR)

USING REAL TIME METEROLOGY

CLASS A MODEL

FIGURE 2



ON COMMAND ANALYSIS OF OFFSITE DOSE (MREM)

USING CONTAINMENT ACTIVITY AND

REALTIME METEOROLOGY

February 1982
Revision 3

TABLE 1

METEOROLOGICAL SIGNALS HARDWIRED INTO THE PROCESS COMPUTER

STATION	WIND SP.	WIND DIR.	TEMP.	DELTA T	PRECIP.*	DEW PT.
Dresden	35'	35'	35'	150-35'	35'	
	150'	150'		300-35'		
	300'	300'				
Quad Cities	33'	33'	33'	196-33'	33'	
	196'	196'		296-33'		
	296'	296'				
Zion	35'	35'	35'	125-35'	35'	
	125'	125'		250-35'		
	250'	250'				
LaSalle	33'	33'	33'	200-33'	33'	
	200'	200'		375-33'		
	375'	375'				
Byron	30'	30'	30'	250-30'	30'	30'
	250'	250'				250'
Braidwood	34'	34'	30'	199-30'	30'	30'
	203'	203'				199'

* Precipitation samplers are at ground level but for purposes of computer listing they are considered to be at the lowest measurement location on the tower.

February 1982
Revision 3

TABLE 2

PLANT MONITORS HARDWIRED INTO THE PROCESS COMPUTER

STATION	CHIMNEY (Effluent)	VENT (Effluent)	CONTAINMENT (Activity)
Dresden	X	X	X
Quad Cities	X	X	X
Zion		X	X
LaSalle	X		X
Byron		X	X
Braidwood		X	X

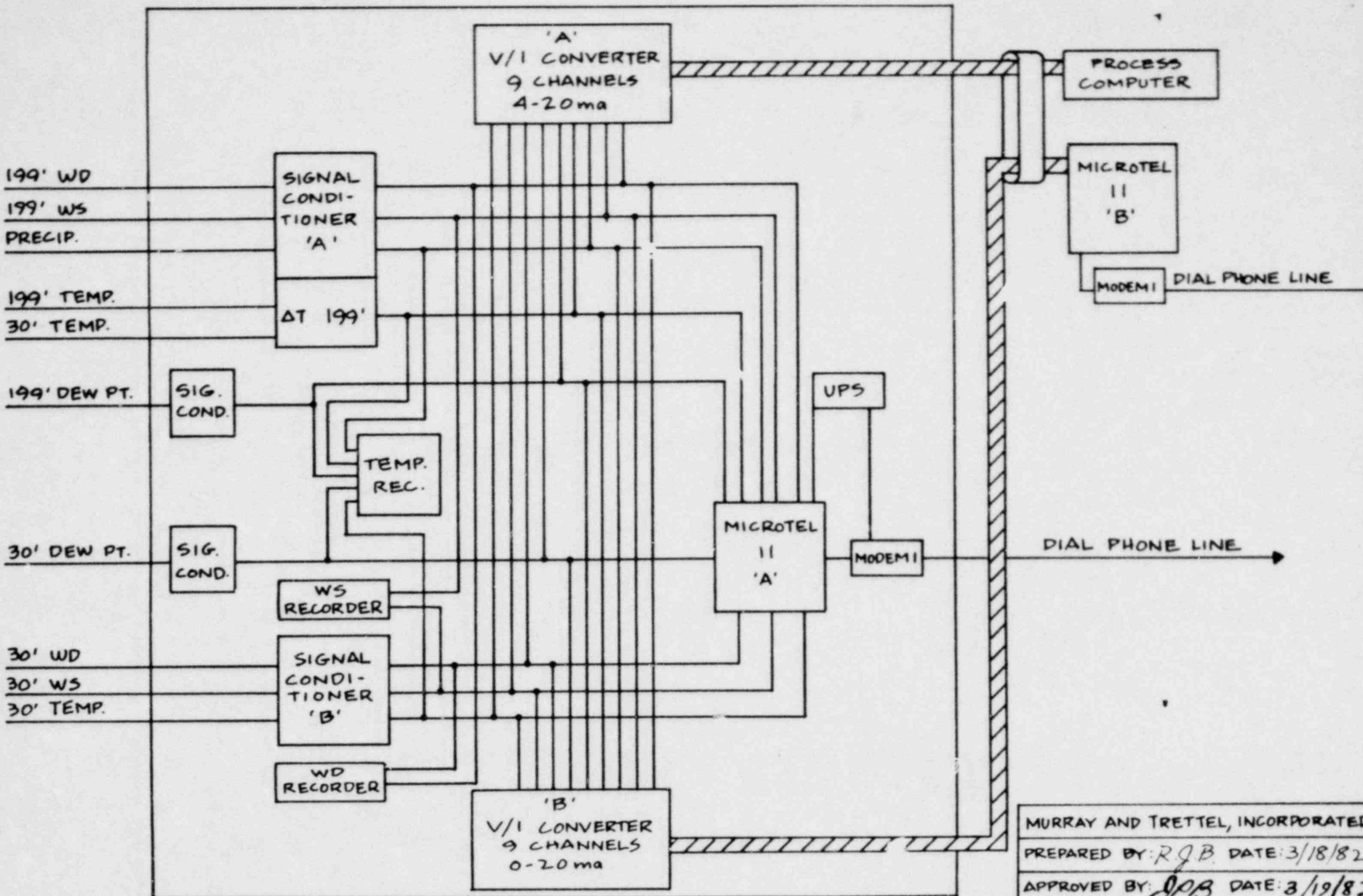
February 1982
Revision 3

APPENDIX B

INDEPENDENT SIGNAL PATHWAYS AT METEOROLOGICAL FACILITIES

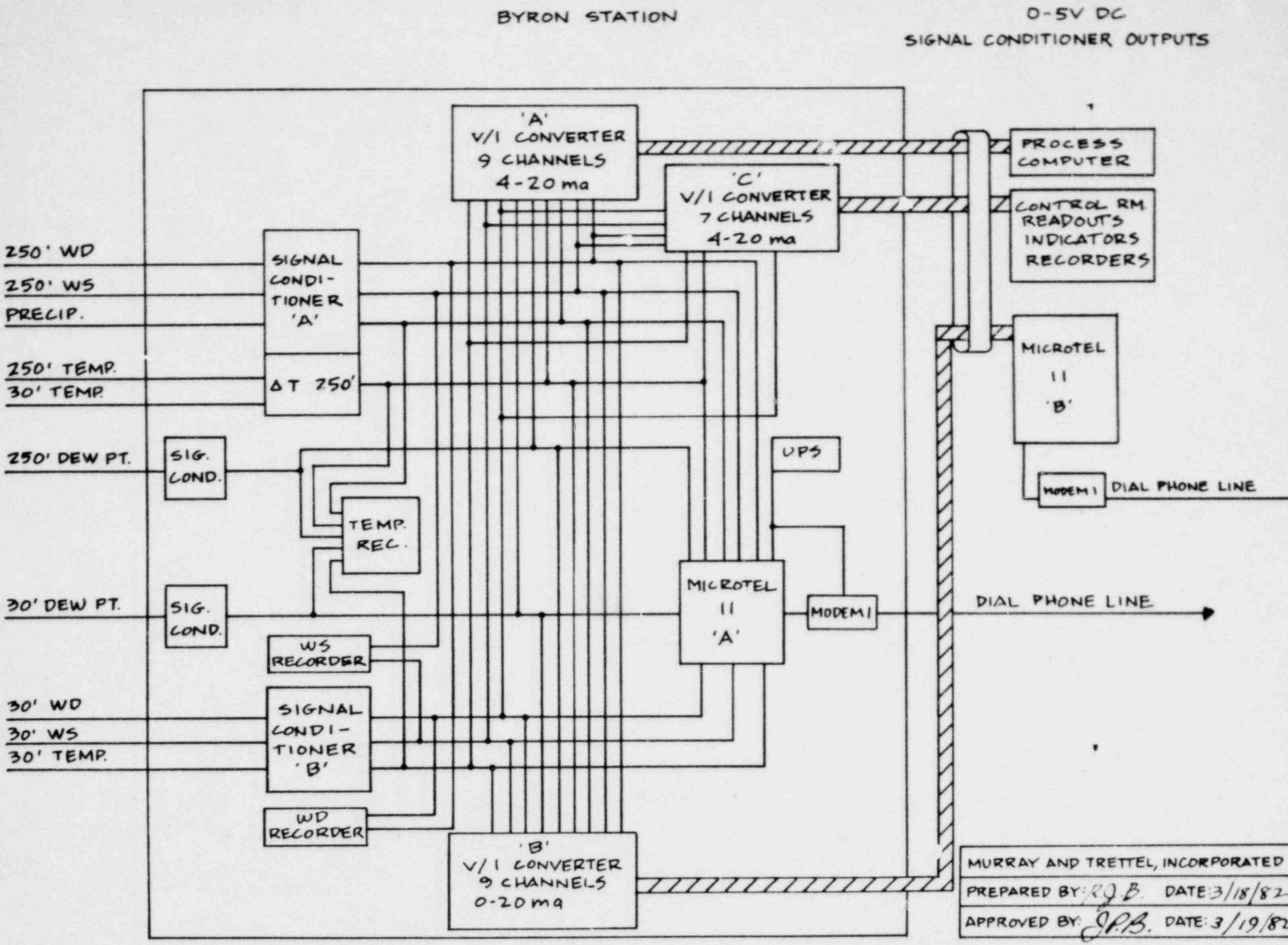
BRAIDWOOD STATION

0-5V DC
SIGNAL CONDITIONER OUTPUTS



MURRAY AND TRETTEL, INCORPORATED
PREPARED BY: R.J.B. DATE: 3/18/82
APPROVED BY: JOB DATE: 3/19/82

BYRON STATION

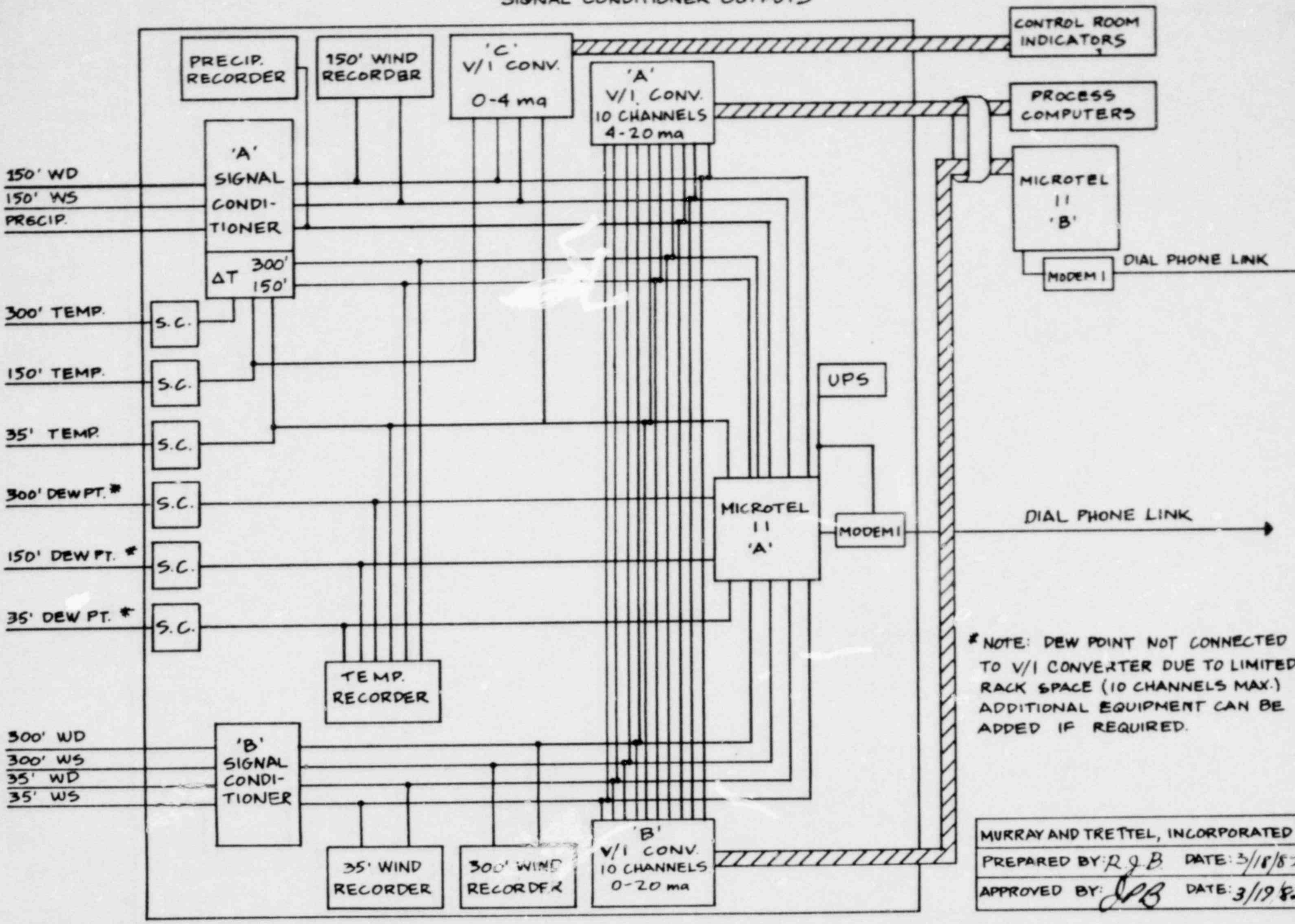


MURRAY AND TRETTEL, INCORPORATED
PREPARED BY: RJB. DATE: 3/18/82
APPROVED BY: JPB. DATE: 3/19/82

DRESDEN STATION

0-5V DC

SIGNAL CONDITIONER OUTPUTS



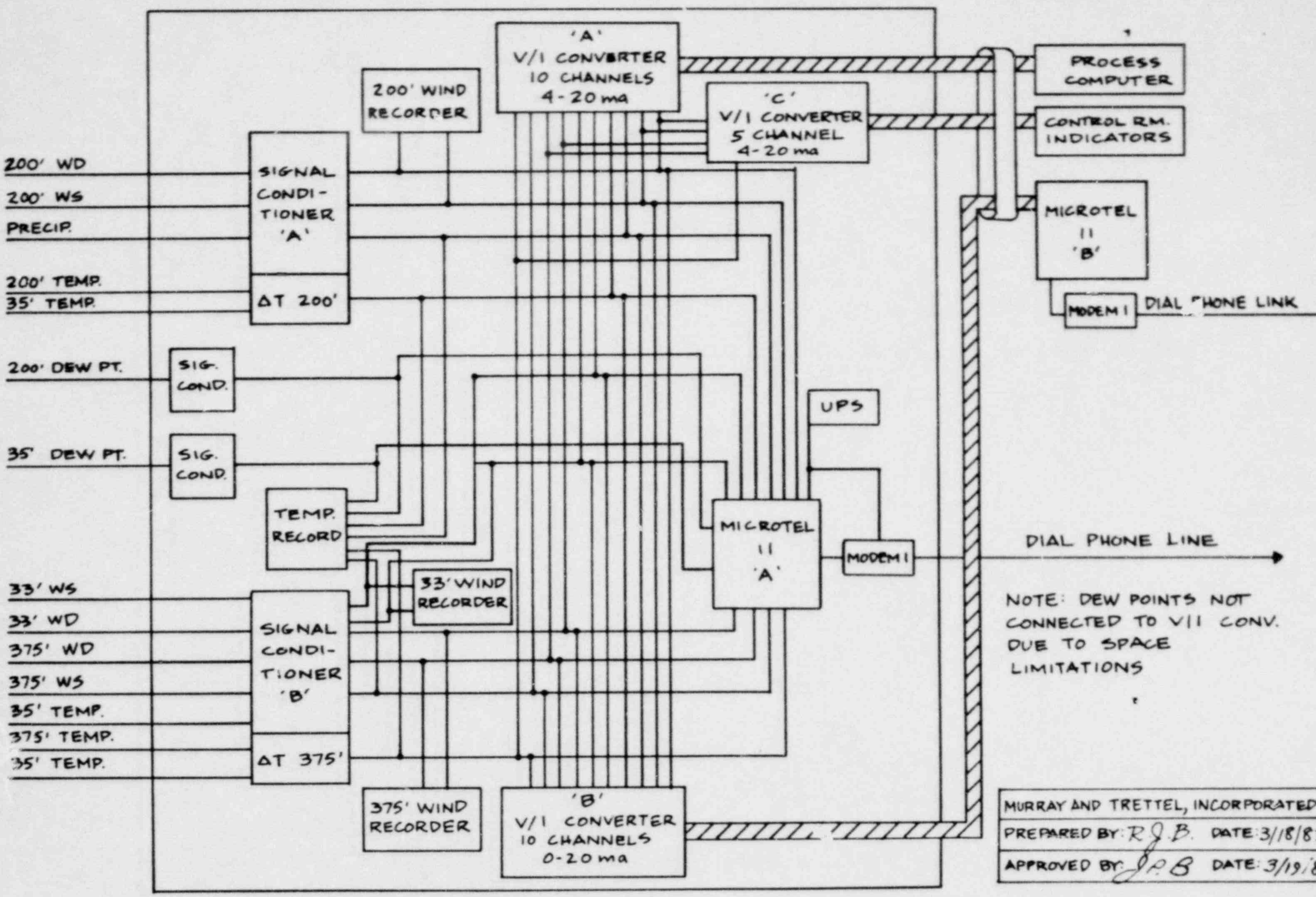
* NOTE: DEW POINT NOT CONNECTED TO V/I CONVERTER DUE TO LIMITED RACK SPACE (10 CHANNELS MAX.) ADDITIONAL EQUIPMENT CAN BE ADDED IF REQUIRED.

MURRAY AND TRETTEL, INCORPORATED	
PREPARED BY: R.J.B.	DATE: 3/18/82
APPROVED BY: JCB	DATE: 3/19/82

LASALLE STATION

0-5V DC

SIGNAL CONDITIONER OUTPUTS

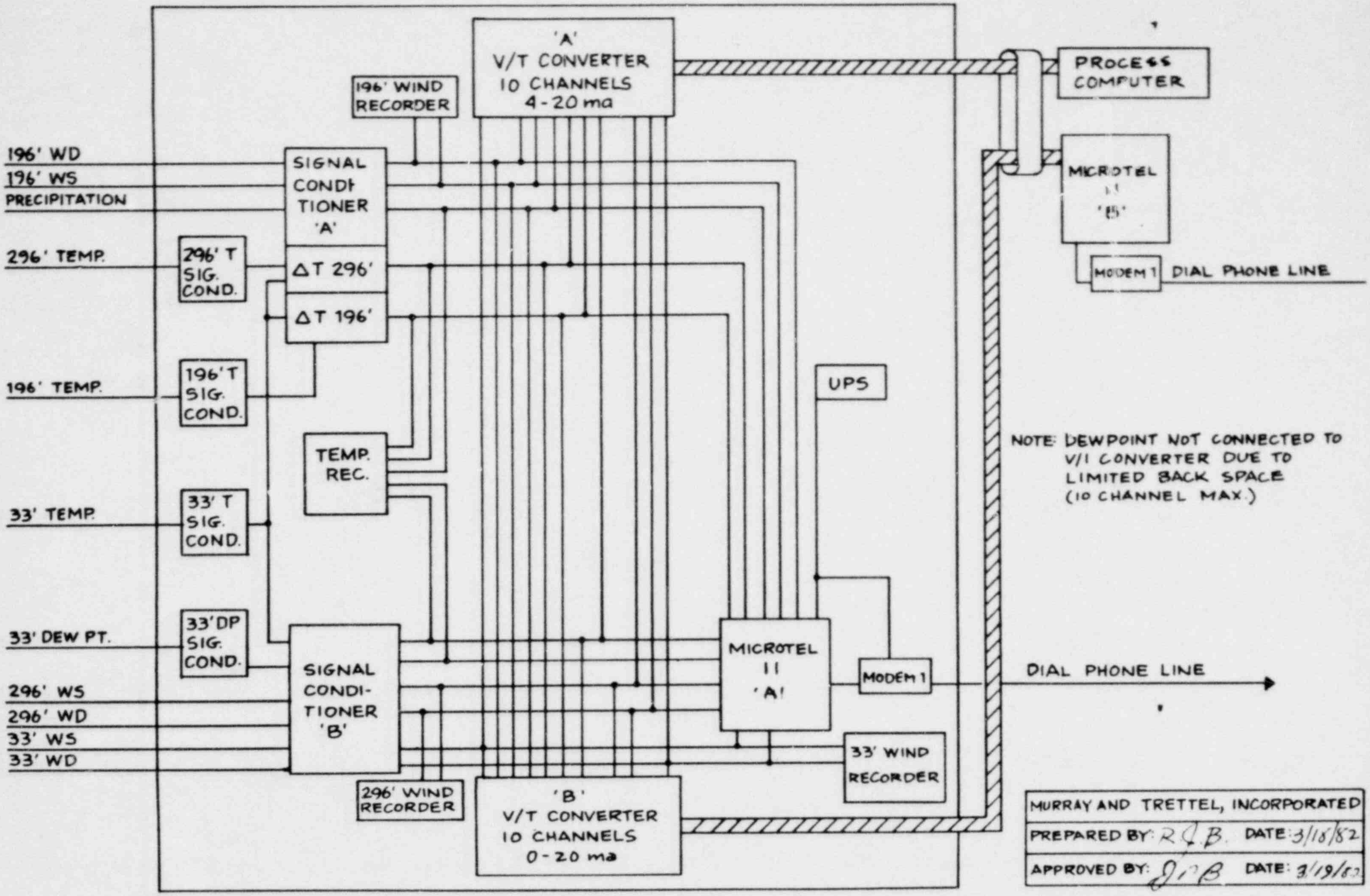


NOTE: DEW POINTS NOT CONNECTED TO V/I CONV. DUE TO SPACE LIMITATIONS

MURRAY AND TRETTEL, INCORPORATED	
PREPARED BY: R.J.B.	DATE: 3/18/82
APPROVED BY: J.P.B	DATE: 3/19/82

SOUTH QUAD STATION

0-1V DC
SIGNAL CONDITIONER OUTPUTS



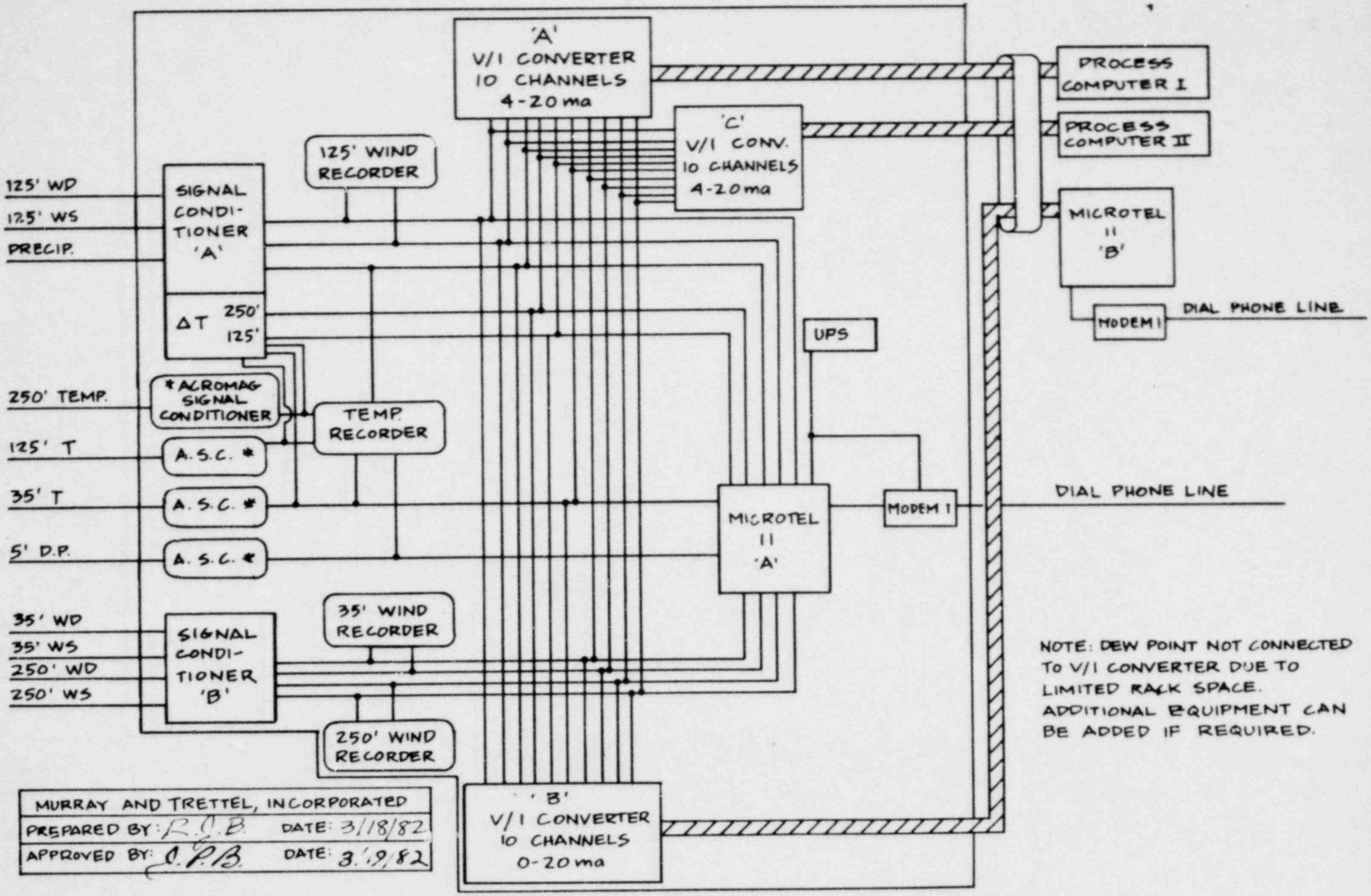
NOTE: DEWPOINT NOT CONNECTED TO V/I CONVERTER DUE TO LIMITED BACK SPACE (10 CHANNEL MAX.)

MURRAY AND TRETTEL, INCORPORATED	
PREPARED BY: R.J.B.	DATE: 3/18/82
APPROVED BY: J.P.B.	DATE: 3/19/82

ZION STATION

0-1V DC

SIGNAL CONDITIONER OUTPUTS



February 1982
Revision 3

APPENDIX C

QUALITY ASSURANCE PROGRAM

(1) Commonwealth Edison Company Quality Articles for Meteorological Monitoring Revision 1, July 1980.

(2) Meteorological Contractor's Quality Assurance Program for Meteorological Monitoring Programs Revision 4, January 1981*

* This is the Q.A. Program of CECo's present contractor. A similar program will be required of any meteorological contractor.

Commonwealth Edison Company

Quality Articles for Meteorological Monitoring

Section I - Qu[illegible] Assurance

1.0 Quality Assurance Program:

1.1 The contractor shall be required to have an acceptable Quality Assurance Program which will be in effect for the duration of the contract. The Quality Assurance Program shall include the quality assurance system, organization, policies, responsibilities, listing of procedures and/or requirements for processes necessary to control quality throughout all phases of the contract. This program shall meet the applicable requirements of 10CFR50, Appendix B and must address the requirements delineated in Article 5.0, "Acceptance Criteria". Acceptable guides for meeting the applicable requirements are ANSI N 45.2, "Quality Assurance Requirements for Nuclear Power Plants", and applicable associated ANSI N 45.2 daughter documents. The program must be accepted by the purchaser prior to award of contract.

2.0 Quality Assurance Program Approval:

2.1 Before any contractor can be considered acceptable for an award of contract, he must have submitted an acceptable Quality Assurance Program. In order to be considered as acceptable, the program must address, as applicable, the requirements delineated in Article 1.0 above.

2.2 If the contractor's program does not cover all of the requirements in detail, he must state when and how the requirements do not apply. This statement of non-applicability must be substantiated.

2.3 Commitments accepted by the purchaser as a condition of award shall be implemented by the contractor immediately upon award of contract. These commitments shall require the contractor to make written changes to the program in the form of revisions or supplements to the program. The supplement shall be controlled in the same manner as the manual, and considered as a auditable part of the program.

2.4 The control of the accepted Quality Assurance Program is the responsibility of the contractor. Contractor shall promptly notify the purchaser of all revisions to the Quality Assurance Program for the duration of the contract. No revisions to the accepted Quality Assurance Program shall be implemented on the purchaser's work by the contractor without the purchaser's written approval of the Program revision.

3.0 Quality Assurance Program Submittal with Proposal:

3.1 A contractor who has written acceptance by the purchaser and a controlled copy of the accepted Quality Assurance Program assigned to the Manager of Quality Assurance, Commonwealth Edison Company, need only submit documented verification that the controlled copy is applicable to the scope of work involved in the bid, and include information with the proposal covering the current effective date of the program manual, including all current revisions and supplements in effect.

3.2 A contractor who does not have an accepted and controlled copy of his Quality Assurance Program as described in Article 3.1 above shall submit to the purchaser with his bid two (2) controlled copies of his Quality Assurance Program for review and acceptance, one assigned to the Manager of Quality Assurance and the other assigned to the Nuclear Stations Division Manager.

4.0 Quality Assurance Program Submittal After Award:

4.1 After award, if the contractor meets the requirements of 3.2 above, he must submit three (3) uncontrolled copies of the accepted Quality Assurance Program to the purchaser.

4.2 After award, if the contractor meets the requirements of 3.1 above, the contractor must submit four (4) copies of the accepted Quality Assurance Program. One (1) copy must be controlled, and will be assigned to a designated individual in the Nuclear Stations Division; the three (3) remaining shall be uncontrolled.

4.3 After award, if contract is for more than one station, the contractor must submit two (2) additional uncontrolled copies for each additional station.

4.4 After award, any revisions to the accepted quality assurance program which the purchaser approves, the contractor must submit copies of the accepted revisions for the uncontrolled and controlled manuals in the purchaser's possession for the duration of the contract.

5.0 Quality Assurance Program Acceptance Criteria:

5.1 Organization:

A. The contractor's Quality Assurance Program shall include an organization chart identifying key positions and the reporting relationship between the Quality personnel and management (including field Q.A. organization, if applicable). All quality related activities which are referenced in the manual must be assigned to specific personnel. The Quality Assurance personnel shall have:

1. Written responsibilities for quality related job positions.
2. Authority and organizational freedom to:
   a. identify and evaluate problems
   b. require and implement approved corrective actions
   c. control further activities where appropriate action such as "stop work" may be required.
3. Independence from groups involved in design and/or operation of the system, computer programming, data processing system design/modification.

5.2 Quality Assurance Program:

A. The contractor's Quality Assurance Program must be formally accepted by Company Management with a written policy statement. This Program shall be implemented through written procedures and/or instructions or they shall be established to ensure that the subject's work is accomplished in compliance with the appropriate code and procurement requirements.

B. Provisions for training Quality Assurance personnel performing activities affecting quality shall be a part of the program. These provisions must include how this training is accomplished and who is responsible for its implementation.

C. Provisions for a review of the status, adequacy, implementation and effectiveness of the total Quality Assurance Program on a specific time schedule shall be a part of the Program.

D. Provisions shall be established in the Program for the controlled issuance of the latest revision to the quality assurance manual, procedures and instructions.

E. Includedin the Program is a commitment that the program complies with applicable portions of 10 CFR 50 Appendix B and/or ANSI N 45.2.

F. The Program shall delegate responsible individual(s) to sign off on Certificates of Conformance and/or

Compliance

5.3 Design Control:

A. Measures to assure that the design basis for the systems and/or components are correctly translated into specifications, drawings, procedures, and instructions as appropriate, shall be described. These measures shall include provisions to insure that appropriate quality standards are specified and included in design documents.

B. The design control measures for independent verification or check of the adequacy of design, such as by the performance of design reviews, by the use of alternate or simplified calculational methods, or by the performance of a suitable testing program shall be described.

C. Means by which the contractor will insure that design changes are subjected to design control measures commensurate with those applied to the original design shall be described.

5.4 Procurement Document Control:

A. Measures to assure that purchase documents for procurement of material, equipment, and services, whether purchased by the contractor or by a subcontractor performing a significant portion of the actual services, are reviewed for inclusion of quality requirements shall be described in the Program.

Subcontractors who perform a significant portion of the service shall be required to provide to the contractor a Quality Assurance Program consistant with the requirements of the contractor's Q.A. program for review and acceptance by the contractor. The contractor will be responsible for determining the Quality Assurance requirements to be applied to any subcontractor who performs a significant portion of the actual services.

5.5 Instructions, Procedures and Drawings:

A. Activities affecting quality shall be prescribed by documented work procedures or instructions, as appropriate, and accomplished in accordance with these documents. Procedures or instructions shall include appropriate acceptance criteria for work performance and quality compliance. The above measures shall be described in the Program.

5.6 Document Control:

A. Measures to control the issuance of the latest applicable documents such as instructions, procedures, drawings, purchase requirements and confirmatory documents such as test reports, including changes thereto, which prescribe activities affecting quality shall be described. These measures shall assure that documents including changes are reviewed for adequacy and approval for release by authorized personnel and are distributed to and used at locations where the prescribed activity is performed; and shall assure that obsolete drawings, specifications and instructions have been destroyed or isolated from use.

5.7 Control of Purchased Material, Equipment and Services:

A. Measures to assure that purchased material, equipment and services, whether purchased directly or through subcontractors, conform to the procurement documents shall be described. These measures shall include provisions, as appropriate, for source evaluation and selection, objective evidence of quality furnished by contractor or subcontractor, inspection at the contractor or subcontractor source, and receiving inspection for compliance with procurement documents upon delivery. The effectiveness of Quality Control by contractor, or by subcontractors who perform a significant portion of the actual services, may be assessed by purchaser or his designee at intervals appropriate to the importance, complexity, and quantity of the activities being performed.

5.8 Inspections:

A. The inspection program for activities affecting quality that is established and executed by or for the contractor and his subcontractors to verify conformance with documented instructions procedures, and drawings shall be described. Such inspection shall be performed by qualified personnel, with certification as required, other than those who perform the activities being inspected. The program shall identify the person responsible for the training, documentation of this training, and maintenance of the training records.

B. There shall be provisions in the Program for establishing, after award of contract, inspection, by the customer or by other as directed by Edison, of any activities or facilities utilized in the performance of these services by the contractor or significant subcontractors.

C. The Program shall have provisions for documenting and retaining all inspection results:

5.9 Test Control:

A. A test program shall be established to insure that any bench or field testing required to demonstrate that the systems and/or components perform satisfactorily in service is performed by qualified personnel, with certification as required, in accordance with written test procedures which incorporate the requirement and acceptance criteria and limits contained in specifications. Test procedures shall include provisions for assuring that all prerequisites for the given test have been met, that adequate and calibrated test instrumentation is available and used, and that the test is performed under appropriate environmental conditions.

B. The Program shall have provisions for documenting, evaluating, and retaining all test results.

5.10 Control of Measuring and Test Equipment:

A. Measures shall be established in the Program to assure that proper tools, gauges, instruments and other measuring and testing devices are used in activities affecting quality. To assure accuracy the equipment shall be calibrated, adjusted and maintained at prescribed intervals or prior to use against certified equipment having known valid relationships to the National Bureau of Standards or other recognized applicable standards.

B. Records shall be maintained and equipment suitably marked (such as tag, sticker, etching, etc.) to verify calibration status.

5.11 Handling, Storage and Shipping:

A. Measures established to protect equipment being transported or in storage against damage or deterioration shall be described.

5.12 Nonconforming Materials, Parts or Components:

A. Measures established to control materials, parts or components which do not conform to requirements in order to prevent their inadvertent use or installation shall be described. These measures shall include procedures for identification, documentation, segregation and disposition.

5.13 Corrective Action:

A. Measures shall be established to assure that conditions adverse to quality are promptly identified and corrected. The identification of the adverse conditions, the cause of such condition and the corrective action taken to prevent continuing recurrence of like conditions shall be documented and reported to appropriate levels of management and the customer.

5.14 Quality Assurance Records:

A. Records shall be maintained to furnish evidence of activities affecting Quality. The contractor shall establish measures that will assure prompt and complete delivery to the purchaser of any documents required by the specification. The contractor shall meet the requirements of applicable codes and ANSI Standards concerning record retention regarding identifiability and retrievability, duration of retention, location, and assigned responsibilities.

5.15 Audit:

A. Measures established to provide a comprehensive program of planned and scheduled audits to be carried out to verify compliance with all aspects of the Program, and to determine the effectiveness of that Program, shall be described. This plan shall include both scheduled internal audits and, where appropriate, audits of subcontractors who perform a significant portion of actual services.

B. The Program shall provide for audits to be conducted in accordance with written procedures and/or checklists by trained and certified audit personnel not having direct responsibilities in areas being audited. A description shall be provided in the Program of Auditor training activities, with qualification and certification requirements. This shall include a description of training activities, a delegation of responsibilities for performance of these activities, and documentation of these activities.

C. Audit results shall be documented with objective evidence, distributed, and an archival file shall be maintained. The audit results shall be reviewed by management having responsibilities for the area being audited.

D. Follow-up action, including re-audit of the deficient areas(s) to assure corrective action has been accomplished, shall be described in Program.

Section II - Quality Control

1.0 Quality Control Document Submittal with Proposal

A. The contractor shall include with his proposal an index of Quality Control Procedures to be applied to the work.

B. The contractor shall submit with his proposal for inclusion into the contract awarded, a detailed list of the quality records and documentation regarding system operations and activities, other than those required by the specification, which will be furnished to, or available for inspection by the purchaser.

2.0 Quality Control Document Submittal after Award:

2.1 Quality Control Procedures:

A. Within six weeks after an award of contract, the contractor should submit the detailed procedures to be used or a schedule for submitting these procedures.

NOTE: A contractor shall not start any work covered by these procedures until the appropriate procedures have been accepted in writing by the purchaser and/or the purchaser's consulting engineer as appropriate.

B. The Quality Control Procedures shall contain those administrative procedures necessary to implement each Section (5.1 through 5.15) of the Quality Assurance Program described above. The procedures shall designate who is responsible for the implementation by each of the departments stated in the Quality Assurance Program and define the authorities and duties of all personnel associated with quality control. The procedures shall detail how all elements affecting the product quality will be processed and shall include the specification of the necessary documentation.

C. Quality Control Procedures shall also contain those design, testing, inspection, cleaning, etc., procedures necessary for the accomplishment of the work and to assure its proper quality. Procedures shall be qualified as necessary to Code or Standard requirements. These procedures shall detail what equipment is to be used, limiting conditions, acceptance criteria, techniques, etc., that will be used.

2.2 Inspection Program:

A. An inspection program shall be established by the contractor and shall include pertinent maintenance and inspection operations which will be of concern to the purchaser relative to Quality Control. Contractor's recommend calibration and maintenance program will be applied to the equipment, and documented in monthly reports. Inspection programs shall be submitted to Nuclear Stations Division Manager or his designee.

NOTE: 1. The contractor shall not start any work which requires an inspection program until the purchaser or the purchaser's consulting engineer has reviewed and accepted the program as appropriate.

B. Purchaser and/or his designated representative shall have full access to contractor's and subcontractor's shops and field sites for reviewing progress and determining acceptability of Quality Control activities. Nuclear Stations Division Manager or his designee shall be notified at least two (2) working days, excluding Saturdays and Sundays, prior to starting of specified installation, calibration, or test programs.

C. Purchaser and/or his designated representative shall have full access to contractor's and subcontractor's shops for reviewing and auditing the implementation of its quality assurance program. Any findings resulting from a contractor's/subcontractor's audit shall be addressed and promptly corrected to the purchaser's satisfaction. The audited organization shall provide a scheduled date for completion of corrective action.

2.3 Subcontractor Requirements:

A. Contractor shall be responsible for the review, comment and acceptance of the Quality Assurance Program and Quality Control Procedures of the subcontractor who performs a significant portion of actual services. In addition, contractor shall be responsible for the subcontractor's work.

2.4 Nonconformance Report:

A. Any nonconformance with purchase documents, approved drawings, procedures, or approved material selection shall be promptly reported in writing to the Purchaser.

2.5 Quality Control Records:

A. Copies of all appropriate documentation as herein specified or as required by applicable Codes, Standards, or criteria, shall be submitted in monthly and semi-annual reports.

2.6 Certificate of Compliance/Conformance:

A. Certificate of Compliance

A Certificate of Compliance signed by a qualified party, attesting that the items or services are in accordance with the customer's purchase order and specification, and accompanied by all documentation required by these articles to substantiate that statement, is required upon commencement of the services contemplated by this contract.

2.7 Invoice Submittal:

A. Invoices for equipment purchased for customer shall be sent to Nuclear Stations Division, Commonwealth Edison Company

2.8 Spare Parts:

A. All requirements regarding Quality Control and documentation that applied to the original parts of the specified equipment shall apply equally to the spare parts of the specified equipment. Contractor shall identify those requirements in detail on spare parts quote.

Quality Assurance Program

for

Meteorological Monitoring Programs

Prepared by

MURRAY AND TRETTEL, INCORPORATED
Northfield, IL 60093

26 July 1976

Controlled Distribution No. 9

TABLE OF CONTENTS

Foreword

This is Murray and Trettel's Quality Assurance Program which describes the requirements that must be implemented in connection with the Commonwealth Edison Company meteorological monitoring programs.

The report is divided into fifteen (15) sections conforming in format to fifteen (15) criteria specified in "Quality Articles for Meteorological Monitoring", July 1980, Revision 1.

The contents of this report are to be considered as Murray and Trettel policy and, as such, are to be followed by all employees to the extent of their involvement in the monitoring program.

John R. Murray

John R. Murray, B.S., J.D.
Certified Consulting Meteorologist
President

22 July 1976

Introduction

This report has been prepared to delineate the requirements governing the Murray and Trettel Quality Assurance Program for meteorological monitoring programs. Implementation of the monitoring program with detailed procedures provides the degree of quality assurance commensurate with the requirements of applicable codes and requirements of agencies which govern the installation and operation of meteorological monitoring equipment, and the handling, reduction and processing of data. The scope of this report covers the total Quality Assurance Program for the life of the monitoring program.

1. Organization

Murray and Trettel, Incorporated is responsible for the assurance of quality in all phases of the acquisition, reduction, and analysis of meteorological monitoring data. Murray and Trettel executes this responsibility in accordance with the program described herein and assigns areas of ultimate responsibility to specific individuals.

Lines of authority and responsibility for the Quality Assurance Program are documented in the form of an organization chart. Key quality assurance positions including those providing technical support or audit responsibility are described. The organization chart for the meteorological monitoring program is shown in Figure 1. Solid lines represent responsibility for implementing the procedures and instructions. Dashed lines represent audit responsibility for verifying compliance with the procedures and instructions.

1.A. The specific responsibilities for the Quality Assurance Program are described in the following paragraphs.

1.A.1 Executive Vice President

The Executive Vice President of Murray and Trettel has the overall responsibility for the Quality Assurance (QA) of the meteorological monitoring programs. The development of quality assurance policy for environmental studies, the scheduling of audits, and the training of auditors are under his jurisdiction.

1.A.2. Quality Assurance Officer

Authority and responsibility to conduct periodic audits is assigned by the Executive Vice President to the Quality Assurance Officer. This position reports directly to the Executive Vice President in all matters involving quality assurance, and is independent of the normal operation of the meteorological monitoring programs except for matters involving quality assurance.

The Quality Assurance Officer is responsible for conducting audits and inspections, detecting deficiencies in the procedures, and recommending improvements in the procedures if deficiencies are discovered.

1.A.3. Vice President, Environmental Applications

The Vice President, Environmental Applications is responsible for all environmental projects, including the meteorological monitoring programs. The Vice President, Environmental Applications is also responsible for the training of personnel involved in the program, and for approving all procedures and manuals used in the program.

1.A.4 Project Manager

The Project Manager has the overall direct responsibility for the monitoring program. This position is responsible for providing technical assistance, assigning time tables, setting priorities and the day-to-day decisions required by the project. Also among this position's responsibilities are (1) the preparation of procedures to assure data validity; (2) coordination of data review and remote systems checks to identify possible malfunctions; and (3) the notification of appropriate field personnel when field equipment testing is required.

1.A.5. Environmental Meteorologist

The Environmental Meteorologist is responsible for the day-to-day operation of the project, and for providing technical assistance and training to the technicians. The duties also include inspection of the data for reasonableness, review of the results of computer validation checks to identify problem areas, inspection of charts and records of project documents for completeness, final editing of the data record and preparation of monthly, semi-annual and other miscellaneous related reports.

1.A.6 Data Processing Staff

The Data Processing Staff maintains project records, reviews strip charts, reduces data and performs other tasks related to the day-to-day operation of the program.

1.A.7 Field Operations Staff (Field Staff)

The Field Staff maintains the field equipment, performs in-situ/instrument calibrations, provides documentation of the performance of each system, maintains a spare parts inventory, performs tests of instruments and trouble shooting checks in equipment, and repairs and maintains service instrumentation in proper calibration.

1.B. Quality Assurance personnel have the authority and organizational freedom to identify and evaluate problems, require and implement approved corrective actions, and control further activities where appropriate action may be required.

1.C. The Quality Assurance Officer acts independently of the person or group directly responsible for performing the activities of the meteorological program.

2. Quality Assurance Program

2.A. The Quality Assurance Program at Murray and Trettel is approved by management and assures effective implementation of program procedures. These procedures or instructions assure the monitoring program is conducted in compliance with the appropriate codes and program specifications. In general, the Quality Assurance Program verifies (through audits) that activities have been correctly performed.

2.B. All personnel performing activities with the Quality Assurance program, including personnel performing inspection and testing functions, are trained in the appropriate procedures. Training includes, but is not limited to, review of the QA and Procedures Manuals and all relevant forms. Training is provided to all new personnel, and to all personnel when new procedures are incorporated into the program, and is the responsibility of the Executive Vice President. Training records for personnel trained in Quality functions (including inspecting, testing, and auditing) are maintained by the Project Manager.

2.C. Periodic reviews of the status and adequacy of the monitoring and Quality Assurance programs are provided through a series of unscheduled inspections and semi-annual audits conducted by the QA personnel.

2.D. A controlled distribution list is set up and recipients of controlled documents (including the Quality Assurance Manual, procedures, and instructions) will receive any alterations or revisions.

2.E. The QA program complies with all applicable sections of 10 CFR 50.

2.F. The president of Murray and Trettel, Inc. is responsible for signing off Certificates of Conformance.

3. Design Control

3.A. Detailed specifications, drawings, procedures, and appropriate instructions will be reviewed in order to assure the correct translation of the design bases for systems and components and to assure appropriate quality standards are specified and included in design documents.

3.B. Design reviews are performed for independent verification or check of the adequacy of design.

3.C. Design changes will be reviewed to assure that changes have been subjected to design control measures commensurate with those applied to the original design.

4. Procurement Document Control

4.A. Procurement documents for material, equipment, and/or services are reviewed by QA personnel in order to assure their compliance with applicable QA standards.

4.B. Major subcontractors of Murray and Trettel, Inc. submit for review and acceptance a Quality Assurance program consistent with the requirements of Murray and Trettel, Inc.'s QA program. The applicable QA requirements of the subcontractor are determined by Murray and Trettel, Inc.

5. Instructions, Procedures and Drawings

A set of procedures for meteorological monitoring programs has been prepared for use by all personnel involved with the program (Meteorological Monitoring Program: Equipment Servicing and Data Recovery Procedures. A controlled document No. 1084.), and all work is accomplished in accordance with this document. These procedures contain instructions, specifications, and check lists containing appropriate acceptance criteria covering all phases of the monitoring program from the sensing of the meteorological data to its final verification, analysis and storage.

The procedures manual is maintained by the Project Manager. All persons having registered copies of the manual receive revisions as they are approved and implemented.

All revisions to the procedures manual are approved before being implemented by Murray and Trettel personnel.

6. Document Control

A document control system is used to assure that documents such as procedures, specifications, maintenance forms and data handling forms are reviewed for accuracy and approved by authorized personnel. Such documents are distributed to and used by the personnel responsible for their use. Changes to these documents are handled similarly and are reviewed and approved by the same personnel that performed the original review and approval.

A master controlled distribution list is used to designate the recipients of the documents. Each document recipient is responsible for insuring that only the latest authorized procedures are in use and obsolete documents are marked "VOID" or destroyed.

The Project Manager is responsible for instituting the document control system for the project and the Environmental Meteorologist is responsible for assuring the necessary files, logs, and procedures are instituted and maintained in a neat and proper manner. The Environmental Meteorologist is also responsible for assuring that those documents that are to be sent to the client are prepared and transmitted in a timely manner.

Documents pertaining to the maintenance, calibration, and performance of equipment are retained in a central filing system at Murray and Trettel.

7. Control of Purchased Material, Equipment, and Services

In order to assure that purchased material, equipment, and services conform to procurement documents, the following measures are followed:

7.A. Materials, equipment, and services are obtained from established, reputable suppliers.

7.B. Upon receipt, all purchased materials, equipment, and services are reviewed for conformity to the procurement documents which are then initialed and maintained in the project file.

7.C. Assemblies are installed and tested when placed in service. Documentation is provided on non-routine maintenance forms which are retained in the project file.

7.D. The effectiveness of Quality Control by Murray and Trettel, Inc. or by its subcontractors who perform a significant portion of the actual services, may be assessed by Edison or Edison's designee at intervals appropriate to the importance, complexity, and quantity of the activities being performed.

8. Inspection

8.A. Inspections are carried out at all stages of the data acquisition, processing, and reporting to assure conformance with documented instructions, procedures, and drawings. Equipment inspections are performed by qualified field operations personnel. Quality Assurance inspections are performed by individuals other than those who perform the activities being inspected.

The Field Operations Manager is responsible for the training of field personnel and the Executive Vice President is responsible for the training of QA personnel. Documentation of the training is kept by the Project Manager.

8.B. Inspection, by Edison or by others directed by Edison, of any activities or facilities utilized in the performance of services done by Murray and Trette , Inc. (or their subcontractors) for Edison may be carried out periodically.

8.C. Inspection results will be retained by the Project Manager.

9. Test Control

9.A. A testing program has been established to assure that the meteorological sensors, signal conditioners, and recorders are performing in the required manner. Calibrations are conducted at specified intervals by qualified personnel in accordance with written test procedures (cf. "Meteorological Monitoring Program: Equipment Servicing and Data Recovery Procedures") which incorporate the requirements, acceptance criteria, and limits contained in the specifications. In addition, calibration of the equipment is performed whenever it has been repaired or whenever the quality assurance checks, made on the data, indicate that the system may not be performing up to specifications.

The test equipment used by Murray and Trettel field personnel is calibrated at routine intervals. Electronic test equipment is calibrated and certified by the manufacturer and thermometers are calibrated in house by qualified technicians.

To assure that all of the required tests and calibrations are performed, specific forms have been developed for each site. These forms serve to remind the technician of the required tests, to assure that adequate and calibrated test instrumentation is used, to assure that the test is performed under appropriate environmental conditions, to document the results of the tests, and to indicate any problems encountered in the procedure. The acceptable tolerances for each test are provided on the form to assure all calibrations are within acceptable limits. The calibrated systems are affixed with a sticker indicating the date of calibration, the initials of the technician who performed the work, and the date of the forthcoming calibration.

9.B. All test results will be retained and evaluated.

10. Control of Measuring and Testing Equipment

10.A. The electronic instruments and thermometers used to calibrate the meteorological systems are themselves calibrated at routine intervals. This assures that these items are maintained within acceptable limits of accuracy. Assignment of equipment is recorded in the project inventory.

Electronic testing instrumentation is calibrated once each year by the manufacturer in such a manner that the results can be traced to the National Bureau of Standards. These results are certified by the manufacturer and a calibration label is affixed to the instrument. The label states the date of the calibration and date the next calibration is due.

Thermometers are calibrated at Murray and Trettel by trained personnel. A water bath and a precision thermometer, whose calibration is traceable to the National Bureau of Standards, are used in the calibration procedure. A multi-point calibration is performed quarterly (i.e. within 110 days of the previous calibration) on each thermometer and the results are documented. New thermometers are calibrated before use in the field.

10.B. The status of inspection and tests performed on items furnished as part of the program is indicated by means of labels affixed to the items. All instrumentation used in the calibration of the meteorological system have calibration labels indicating when they were last calibrated, and the date their next calibration is due. Calibration logs are maintained in the project file.

Each time the system is calibrated, a calibration label is affixed to the system by the field service personnel. This label indicates the date of the calibration, the personnel who performed the calibration, and the date the next calibration is due.

11. Handling, Storage, and Shipping

Equipment is stored in a climate controlled area. When being transported, equipment is boxed when appropriate and carried by the technicians in Murray and Trettel vehicles. When equipment is being shipped for repair, padded envelopes and cushioned boxes are used as appropriate.

12. Nonconforming Materials, Parts, or Components

All materials, parts, and components which do not conform to requirements are so labelled and segregated to prevent their inadvertent use or installation. The nonconforming parts are then repaired or destroyed.

13. Corrective Action

A series of on-site visits, checks, and a weekly review of the strip charts provide several means of detecting problems at an early stage.

Procedures have been developed to identify promptly any problems in the data base. When defective equipment is identified as the problem source, field service personnel are notified and a site visit is scheduled to correct the problem. It is not possible to eliminate all data loss from the meteorological systems, but it is possible to minimize the loss through quick detection of the problem. The cause of each problem and the corrective action taken to prevent continuing recurrences are identified and documented in the routine course of the project. When applicable, recommendations of modifications to instrumentation or procedures are made to appropriate levels of management and to Edison in order to eliminate or minimize the loss of data.

14. Quality Assurance Records

Records are maintained to furnish evidence of activities affecting the quality of the data collected by the monitoring programs. All records of site visits, routine maintenance, exceptional maintenance, data review, and progress reports are retained as part of the quality assurance program.

The timely submission of the reports required by the program specification is assured by the routine inspection and processing of the data within one month of the date collected.

All quality assurance records are identifiable and retrievable. Notification will be given to CECO prior to disposing of these records and disposal will not be allowed until permission from CECO is obtained. All quality assurance records are retained in accordance with contract requirements and are maintained in accordance with applicable codes and ANSI standards regarding record retention (ANSI N45.2.9).

Submittal of appropriate Quality Assurance records are also required of major subcontractors. These records are retained as part of the QA files.

15. Audits

15.A. Audits are conducted twice each year by the Quality Assurance Officer. The audits verify the implementation and effectiveness of the monitoring program. Audits cover maintenance and calibration of tower acquisition systems, data handling, and data reduction. Procedures and inspections of records are included in the audit. Audits of major subcontractors are also performed by Murray and Trettel personnel.

15.B. Audits are performed by trained and certified Murray and Trettel personnel who are not directly involved in the day-to-day operation and management of the project. In order to be certified as a Murray and Trettel auditor, an Edison-approved auditor training class must be successfully completed and documented. The Executive Vice President is responsible for the performance of all auditors. The audits are performed using checklists or an agenda approved by the Executive Vice President.

15.C. A report is written after each audit and consists of the following: a Summary Sheet, Checklists or agenda containing objective evidence, and any additional pertinent details recorded on additional sheets necessary. This report is submitted to the Executive Vice President for review. After review, it is signed and is retained as a part of the quality assurance documentation. Audit results are reviewed by management having responsibility for the area being audited.

15.D. A follow-up review, including a re-audit, of deficient areas or adverse conditions and on corrective action commitments is carried out to assure effective implementation.

Deficiencies in the execution or implementation of corrective action are brought to the attention of the person responsible for their rectification. Continued deficiencies or failure to implement corrective action are reported, in writing, to appropriate executives within Murray and Trettel.

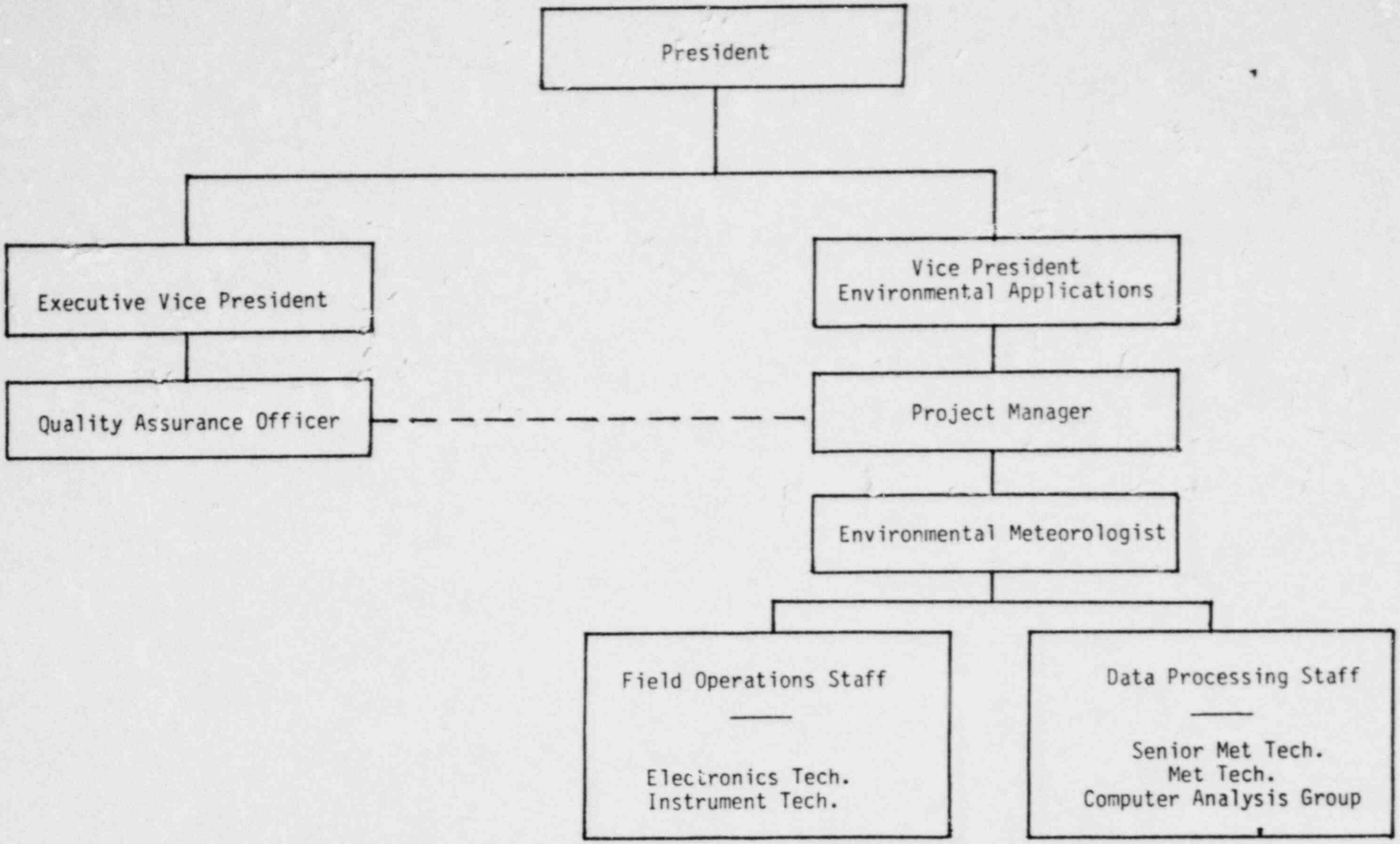


Figure 1: Murray and Trettel, Incorporated Meteorological Monitoring Programs Organization

APPENDIX D

ODCS Class C-Model

February 1982
Revision 3

APPENDIX D

ODCS C-MODEL

The C-model consists of a series of short calculation programs based on the Gaussian straight line plume model, the model enables the ODCS operator to make refined estimates of offsite dose through the manual entry capability. Inhalation and ingestion (via the milk pathway) doses may be determined using field measurements in addition to the whole body dose due to noble gases.

As a predictive tool, forecasted meteorology may be input into any of the programs and the projected offsite consequences determined.

At Zion, lake breeze conditions of fumigation and trapping are calculated. This program utilizes the forecasted parameters of both the lake breeze marker (1=trapping, 2=fumigation) and the forecasted inland penetration of the convergence zone.

These programs have been documented as a part of the Environmental Emergency Procedures (ED series), whose Table of Contents is enclosed. The right-hand column indicates the model to which the procedure applies.

February 1982
Revision 3

GSEP Environmental Director
Emergency Plan Implementing Procedure

TABLE OF CONTENTS

GSEP Environmental Director
TABLE OF CONTENTS
(Continued)

GSEP Environmental Director

TABLE OF CONTENTS

(Continued)

#6205A

February 1982
Revision 3

APPENDIX E

ODCS Tracking Model

APPENDIX E

ODCS TRACKING MODEL

The tracking algorithem is an adjunct to the current ODCS, improving the ability to characterize flow regimes, especially under lake breeze conditions. Its objective is to accurately follow an emission (puff) throughout its lifetime within the 10 mile emergency planning zone (EPZ).

The model, as described herein specifically addresses Zion Station and its coastal regime although the model is available for use at all stations.

Description

The tracking model methodology was developed by the Commonwealth Edison (Attachment E1 is an explanation of the tracking algorithm). The objective of the plume tracking model is to accurately follow an emission (puff) throughout its lifetime within the 10 mile EPZ. If a convergence zone, created by a lake breeze, exists within the 10 mile EPZ, the plume track will be followed within an EPZ subarea which has a convergence zone as one of its boundaries.

The model uses meteorological data from multiple surface towers as well as forecasted meteorology in its analysis of plume location. The forecasted meteorology consists of an approximated location of a convergence zone created during lake breeze conditions.

The model calculates the location of the centroid of each emission (puff). The location of the centroid of a particular puff at time, t1, is determined by algebraically calculating the cumulative effect of the wind speeds and directions, obtained from the nearest two met towers, upon its previous position calculated at time, t0. The calculations are performed at one minute intervals in order to assess the influence of the towers' meteorological data as accurately as possible.

The tracking algorithm necessitates the implementation of supplemental towers to provide additional monitoring points for both wind speed and direction. Towers along with the requisite telemetry to transmit the data to a computer running the dose calculations will be erected at selected sites (Attachment E2 lists the siting criteria which will be followed if suitable land is available). These towers will monitor wind speed, wind direction, dew point temperature and ambient air temperature. A single level tower suffices since delta T will not be necessary for the determination of either the plume location or the convergence zone.

The tracking model will require the determination of the existence of a lake breeze convergence zone. A set of criteria to determine the existence and location of a convergence zone from the data gathered from the meteorological tower network has been developed (Attachment E3 describes the criteria which will be followed in the determination of a convergence zone. Also it lists the references used in the development of the criteria). Additionally, an independent forecast of both the existence and location of a convergence zone will be provided by the meteorological consultants.

The tracking model calculations would be supplemented by field team observations. These observations would verify the algorithm's calculations in most situations. However, there are two situations in which the field measurements would be the primary source of information concerning plume location. In light and variable wind conditions, the tracking model would not be able to accurately determine plume location. Also, the tracking model would produce less than optimum results at the convergence zone because it cannot accurately model flow at a discontinuity. Therefore, the field teams would become the primary source of information in those instances where ambient conditions cause the algorithm to lose accuracy.

The tracking model is an adjunct to a dose calculation algorithm since it cannot calculate doses. There are currently three dose assessment programs used: the A-Program which is run on the process computers; the B-Program which is run on the corporate computer by Corporate Comand Center (CCC) personnel and is historical in outlook; and the C-Program which is run in a real time mode on the corporate computer by EOF, TSC and CCC personnel. The tracking algorithm will be incorporated within the C-Program since this dose assessment program is computationally the fastest of the available codes (Attachment E4 describes the integration of the tracking model with the C-Program). The calculations of the C-Program are based upon a centerline (or straight line) dose assessment algorithm which will produce a "worst case" study. The concentrations are based upon field team measurements, and the dose calculation algorithm can provide projected doses.

Justification

A tracking model enhancement to the current dose assessment programs is being recommended as the response to the NRC's requirements upon nuclear stations having coastal sites for the following reasons:

First, this approach satisfies the NRC's concern that a system be able to track accurately plume trajectory in a non-uniform wind field as it considers lake breeze effects. The algorithm is sufficiently fast - data from the tower network can be obtained and an analysis performed within 10 clock minutes - to provide a "real time" response.

Second, both the modeling and the coding of the tracking model can be performed within the company. This allows company personnel to prototype the criteria which have been developed for both the tracking algorithm and the determination of the convergence zone. Thus, as historical information is compared with computational results, the algorithms can be altered to improve their performance and accuracy.

Third, the tracking model enhances the present system in that it provides an improved method in field team direction. Presently, the movement of field measurement teams is controlled by EOF personnel. They use site specific maps and available meteorology in order to guide field personnel. The tracking model will provide a much improved method in guidance since it can more precisely track plume movement over time given meteorology obtained from the proposed tower network.

Fourth, the tracking model would employ the same computer equipment that is presently required to run the current dose assessment programs (B and C-models). This fact is important for two reasons: First, station personnel are familiar with the existing equipment since they continue to undergo training for execution of the current programs. Thus, the new programming would not necessitate additional training of personnel upon new hardware. Second, less confusion during actual operation of the ODCS would be realized since fewer pieces of computer hardware would be involved in its functioning.

Fifth, the output of the tracking model is easily understood. The algorithm will pictorially display either the plume movement with time or the location of discrete puffs at a particular time. Neither of these displays will be encumbered by a listing of doses. Since the frequency of the reports' use is not high, it is important to create reports which are not elaborate and which can be understood by everyone involved with GSEP.

ATTACHMENT E1

Plume Tacking Algorithm

The objective of the plume tracking model is to follow accurately an emission throughout its lifetime in the 10 mile EPZ. If a convergence zone, created by a lake breeze, exists within the 10 mile EPZ, the plume track will be followed within an EPZ subarea which has the convergence zone as one of its boundaries.

The model uses meteorological data from multiple surface towers as well as forecasted meteorology in its analysis of plume location. The forecasted meteorology consists of an approximated location of a convergence zone created during lake breeze conditions.

The model calculates the location of the centroid of each emission (puff). The location is determined by algebraically calculating the cumulative effect of the wind speeds and directions, obtained at all towers within the Zion network, upon the centroid of a particular puff. The calculations are to be performed at one minute intervals in order to assess the influence of the towers' meteorological data as accurately as possible.

The algorithm is detailed on the following pages:

February 1982
Revision 3

ATTACHMENT E2

Supplemental Tower Siting Considerations

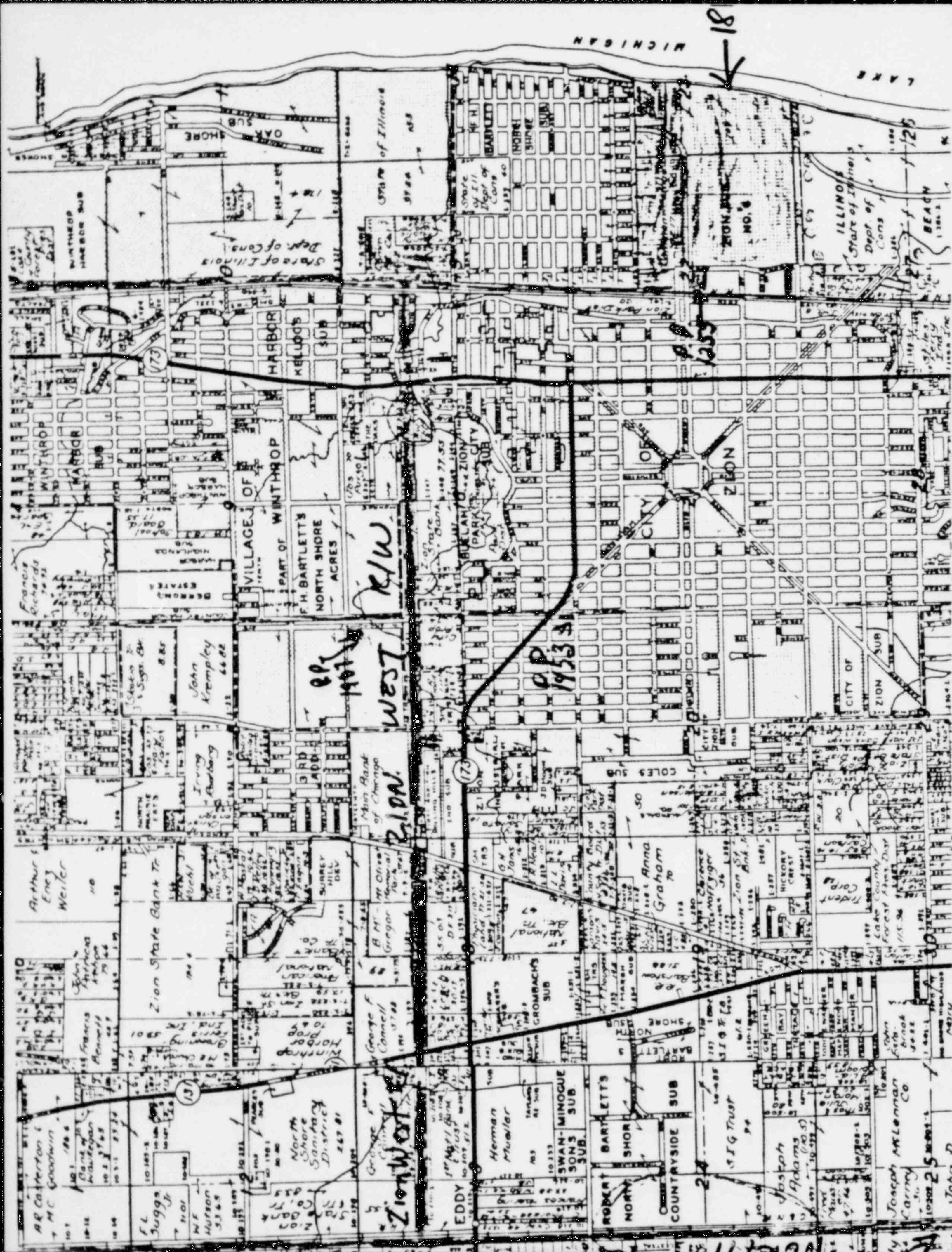
Supplemental towers are proposed to augment the present Zion meteorological data gathering system. These towers will be used both in the determination of a convergence zone as a result of a lake breeze and in the development of the non-uniform wind field, plume tracking model. The following plan concerning the number and position of supplemental towers will be followed if available land to meet the criteria can be secured and if results of tests run to determine tower interaction with existing structures are negative (see: the last paragraph).

Three additional towers are proposed at Zion Station. This number is based both upon GSEP evacuation and sheltering policies and upon convergence zone determination. The first two sites are to be positioned at 2 and 5 miles inland from Zion Station. These distances, coinciding with the State's sheltering and evacuation zone criteria of 2, 5 and 10 miles will position towers at the zone boundaries. This positioning should improve the determination of meteorology in these critical areas. The third tower, located ata site approximately 15 miles inland, will be a control tower in the determination of the existence and location of a convergence zone. It is assumed that this tower will be in the unmodified air mass during the majority of occurances of a lake breeze and subsequent development of a convergence zone.

Using a prototype of the tracking model, it was empirically established that the relative positioning of the towers (line-of-site, random or planning scattering over the EPZ, etc.) did not materially effect the results of the tracking algorithm. Therefore, it is proposed that the towers be positioned along a relatively straight line, due west of the station. This positioning should aid the determination of the location of a convergence zone since it is assumed that a convergence zone would parallel the lake, and a comparison of the towers' meteorclogy would indicate passage of the front at inland distances due west of the station (see: Attachment E3).

It is proposed that two towers be located along the Zion west transmission right-of-way and the Gurnee north transmission right-of-way. This proposal is based both upon the siting criteria (2 and 5 mile distances due west of the station) and the available real estate. Possible locations along these right-of-ways are indicted on the accompanying map.

Assessment of the 10 meter tower interaction with the transmission lines presently existing on the proposed right-of-ways is in progress. This investigation will be concerned with potential problems related to the proposed siting: electrical interference between the transmission system and the data gathering equipment; accessibility of both transmission and meteorological towers for maintenance and repair; and electrical effects of secondary tower siting in close proximity to the EHV transmission.



LAKE MICHIGAN
OAK SHORE SUB
State of Illinois Dept. of Cons
WINTHROP HARBOR SUB
KELLOGG SUB
VILLAGE OF WINTHROP
PART OF WINTHROP
F.H. BARTLETT'S NORTH SHORE ACRES
CITY OF ZION
ZION
State of Illinois Dept of Cons
BEACH
CITY OF ZION SUB
COLES SUB
GROMBACH'S SUB
John Krempley
Irving Paulberg
Main Bank of Chicago
Zion State Bank Tr
Anna Graham
Trident Corp
North Shore Sanitary District
Herman Mueller
MINOGUE SUB
SWAN-SONS SUB
BARTLETT'S NORTH SHORE SUB
COUNTRYSIDE SUB
Joseph Adams
Joseph McLennan Co
EDDY
Zion West R/W
18

ATTACHMENT E3

Criteria for the Determination of A Convergence Zone

The formation and inland penetration of a convergence zone developed as a result of a lake breeze is a function of the temperature difference between land and water, wind speed of the unmodified air mass and the overall synoptic weather pattern. Favorable conditions for the creation of the lake breeze along the shoreline adjoining Zion Station typically occur during the period April through October.

The convergence zone's life cycle begins in the morning as a lake breeze pushes inland. As the land-water temperature differential increases, inland penetration accelerates. The convergence zone begins to recede as evening approaches, and the phenomenon dissipates before nightfall. The convergence zone is characterized by a shift in wind direction, a lowering, or leveling, of the ambient air temperature and measurable changes in the dew point temperature. These three characteristics will be employed in the determination of a convergence zone as described in the following paragraphs.

Three supplemental towers, each 10 meters in height and monitoring wind speed, wind direction, ambient temperature and dew point will be used in addition to the existing Zion Station met tower. When the station's 35' level indicates that the wind direction is within the range of 30-170 degrees (This range is consistent with the meteorological forecast range for lake breeze conditions. See the last paragraph for a discussion of lake breeze forecast.), it is assumed that lake breeze conditions may exist, and a determination of convergence zone is continued. Next, meteorological data are examined at the control tower which is to be located 15 miles inland and is assumed to be characteristic of unmodified air. Results from previous studies indicate that over 60% of all lake breezes travel no farther than 10 miles inland; thus the existence of a convergence zone beyond 15 miles inland is statistically infrequent.

If the wind direction as measured at the control tower lies within the lake breeze range (30-170 degrees, and/+or- 22.5 degrees (1 sector) from the measurement obtained from the Zion tower), both the dew point and the temperature at the control tower are examined to determine whether there is either an easterly flow or a true lake breeze penetration (see the second to the last paragraph).

February 1982
Revision 3

The control tower wind speed is tested when its direction indicates 171 - 29 degrees, a non-lake breeze flow in direct opposition to the measurements at Zion Station. If the wind speed is less than or equal to 6 m/sec. the lake breeze cell is expected to develop and move inland. Research has shown that lake breeze formation is unlikely when the speed of the unmodified air is greater than or equal to 7 m/sec.

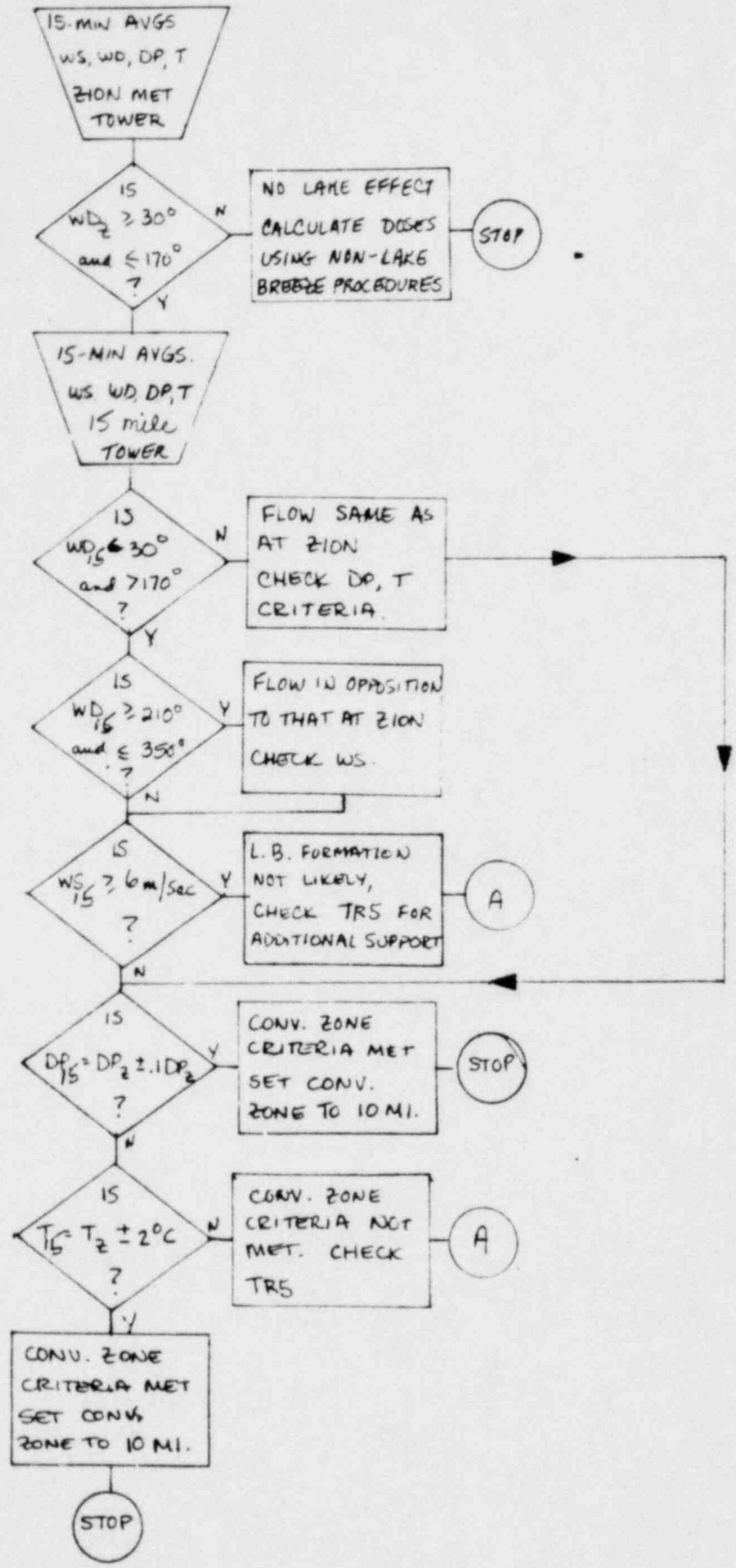
When the speed criteria is satisfied and the control tower indicates a wind direction opposed to the lake breeze, data from the 5 mile supplemental tower is examined. Wind direction is examined first. If it meets the lake breeze criteria, both dew point and ambient temperature are examined to verify the existence or passage of the convergence zone. If the algorithm postulates the passage of the convergence zone at 5 miles, the location of the zone is conservatively placed at 10 miles.

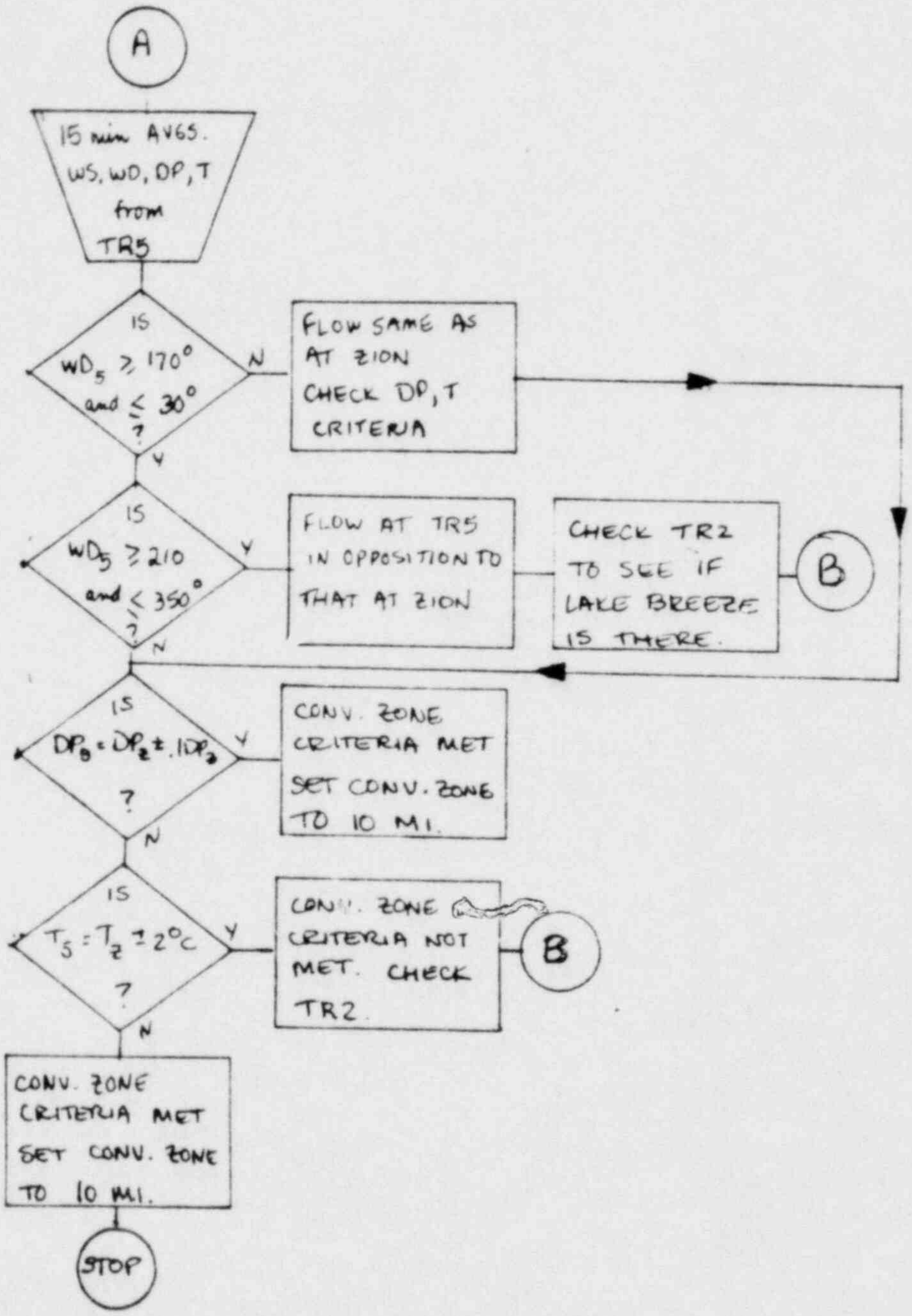
If the supplemental tower at 5 miles indicates flow similar to the control tower and opposed to the tower adjoining the station, the supplemental tower at 2 miles is interrogated. Similar to the logic flow at the 5 mile tower, wind direction is tested first at the 2 mile tower. If the flow indicates lake breeze flow, both dew point and temperature are examined to verify the existence or passage of the convergence zone. If the algorithm postulates the passage of the convergence zone at 2 miles, the location of the zone is conservatively placed at 5 miles.

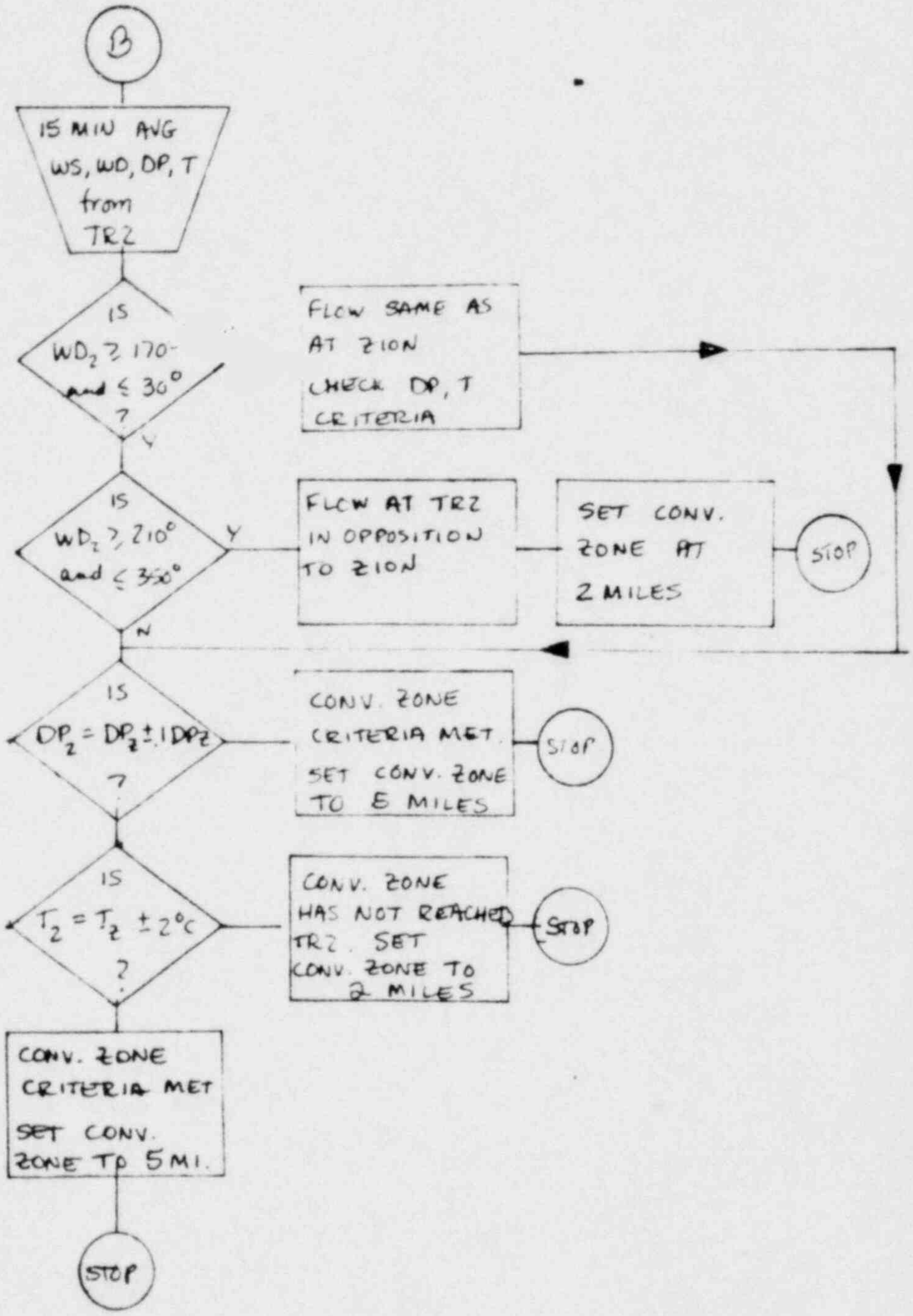
If the criteria are met neither at the control, 5 or 2 mile towers, the convergence zone then lies between the shoreline and 2 miles. For conservatism, the convergence zone will be set to 2 miles in the model.

Temperature and dew point criteria indicating lake breeze flow at any supplemental tower are as follows: dew point as measured at the supplemental tower must be +or - 10% of the dew point temperature measured at the tower adjoining the station and the air temperature measured at the supplemental tower must be +or - 2 degrees centrigrade of the Zion tower measurement.

A forecasted location of the convergence zone will be added to the existing Zion forecast. The forecasted value will be the initial value used in the tracking model to determine plume location. A paper prepared by the meteorological consultant accompanys this report; it outlines the methodology of convergence zone forecasting (Appendix F).


15-MIN AVGS
WS, WD, DP, T
ZION MET TOWER
IS $WD_Z \geq 30°$ and $\leq 170°$?
N
NO LAKE EFFECT CALCULATE DOSES USING NON-LAKE BREEZE PROCEDURES
STOP
Y
15-MIN AVGS.
WS WD, DP, T
15 mile TOWER
IS $WD_{15} \leq 30°$ and $> 170°$?
N
FLOW SAME AS AT ZION CHECK DP, T CRITERIA.
Y
IS $WD_{15} \geq 210°$ and $\leq 350°$?
Y
FLOW IN OPPOSITION TO THAT AT ZION CHECK WS.
N
IS $WS_{15} \geq 6$ m/sec ?
Y
L.B. FORMATION NOT LIKELY, CHECK TRS FOR ADDITIONAL SUPPORT
A
N
IS $DP_{15} = DP_Z \pm .1DP_Z$?
Y
CONV. ZONE CRITERIA MET SET CONV. ZONE TO 10 MI.
STOP
N
IS $T_{15} = T_Z \pm 2°C$?
N
CONV. ZONE CRITERIA NOT MET. CHECK TRS
A
Y
CONV. ZONE CRITERIA MET SET CONV. ZONE TO 10 MI.
STOP


A
15 min AVGS. WS, WD, DP, T from TR5
IS WD5 ≥ 170° and ≤ 30° ?
N
Y
FLOW SAME AS AT ZION CHECK DP, T CRITERIA
IS WD5 ≥ 210 and ≤ 350° ?
Y
N
FLOW AT TR5 IN OPPOSITION TO THAT AT ZION
CHECK TR2 TO SEE IF LAKE BREEZE IS THERE.
B
IS DP5 = DP2 ± .1DP2 ?
Y
N
CONV. ZONE CRITERIA MET SET CONV. ZONE TO 10 MI.
IS T5 = T2 ± 2°C ?
Y
N
CONV. ZONE CRITERIA NOT MET. CHECK TR2.
B
CONV. ZONE CRITERIA MET SET CONV. ZONE TO 10 MI.
STOP


B
15 MIN AVG WS, WD, DP, T from TR2
IS WD2 ≥ 170° and ≤ 30° ?
Y
FLOW SAME AS AT ZION CHECK DP, T CRITERIA
IS WD2 ≥ 210° and ≤ 350° ?
Y
N
FLOW AT TR2 IN OPPOSITION TO ZION
SET CONV. ZONE AT 2 MILES
STOP
IS DP2 = DP2 ± 1 DP2 ?
CONV. ZONE CRITERIA MET. SET CONV. ZONE TO 5 MILES
STOP
IS T2 = T2 ± 2°C ?
CONV. ZONE HAS NOT REACHED TR2. SET CONV. ZONE TO 2 MILES
STOP
CONV. ZONE CRITERIA MET SET CONV. ZONE TO 5 MI.
STOP

ATTACHMENT E3a

Reference

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February 1982
Revision 3

ATTACHMENT E4

Use of the Forecasted Convergence Zone and Plume Tracking Model within the C-Program

This addendum summarizes the use of both the forecasted convergence zone and the tracking model within the C-Program. It assumes that the tracking model has been incorporated into the C-Program, computationally the fastest code available to Company personnel. Also, it is assumed that certain modifications, which will be highlighted in the text, have been made to the C-Program.

Initial dose projections at Zion Station under lake breeze conditions will be made using ED-26 of the C-Program. This program requires both meteorology and effluent data as input. The model also requires that a forecasted inland distance of the convergence zone be provided. Forecasted convergence zone data are required by the enhanced model. Meteorological data can consist of either forecasted or actual values. The forecasted data provide projected results concerning effluent releases; the actual data will provide real time documentation of the release. The effluent data may take the form of either containment activity information or actual release rate data.

The model also requires that a forecasted, inland distance of the convergence zone be provided. This parameter, added as part of the C-program enhancements, will prevent the algorithm from calculating doses beyond the convergence zone. Thus, ED-26 computes worst case dose estimates (modified, Gaussian straight line model) to the lesser of the forecasted convergence zone or the 10 mile limit. This outer limit is in effect for both trapping and fumigation conditions.

Section III.4 of this report describes the rationale used in the determination of the worst case dose estimates. It should be noted that under emergency conditions, all vent stack releases are treated as ground level for conservatism, thus being trapped under the thermal internal boundary layer. Actual 1978-1979 meteorological data indicate the height of the internal boundary layer to be above the Zion release point 95% of the time, further supporting the ground level, plume trapping approach.

A tracking model is employed to more accurately determine plume location. This enhancement uses both meteorological information and the forecasted convergence zone in its processing. In addition to the existing Zion meteorological tower, supplemental towers are required by the tracking algorithm. The towers will be used to refine the forecasted location of the convergence zone and to define the associated turning of the plume. The distances have been so chosen in order to provide accurate meteorology at two of the three evacuation distances of GSEP.

Field teams will be dispatched to those pre-defined locations on the EG-2 (ref. 19) onsite maps which are in close proximity to the plume track. Dose rate readings taken at these sampling locations are used to verify the doses projected with ED-26. Release rates and either a projected or an actual release period are then entered into ED-26 in order to obtain a better estimate of actual dose. Field teams are necessary at the convergence zone where dose rate readings will indicate plume movement up or down the coast along the convergence zone. During light and variable wind conditions, field teams are necessary to verify the plume location since the tracking algorithm fails to give accurate results in such conditions.

As realtime data from Zion become available, the tracking model may be fine-tuned to reflect the actual lake breeze conditions.

February 1982
Revision 3

APPENDIX F

Lake Breeze Forecast Consideration

LAKE BREEZE FORECAST CONSIDERATION

Murray and Trettel, Incorporated (M/T)

Introduction

The wind is air in motion. Air moves in response to forces acting upon it. The dominant forces that affect the wind near the earth's surface are (1) the horizontal deflecting force (HDF) that is caused by the earth's rotation; (2) the pressure gradient force (PGF); and, (3) friction. Both the wind speed and direction in the general circulation and in the wind flow around high and low pressure systems are governed by these forces.

The HDF and friction forces vary slowly and over small ranges compared to the PGF. The PGF varies over a wide range and can change rapidly as weather systems develop, move and decay. At times the PGF can be weak, such as in the middle of a stagnant or slowly moving high pressure area during the summer. When this happens, other weak forces that otherwise are overcome or masked, can exert a noticeable influence on the wind. This is the case with the lake breeze.

In the absence of stronger forces a lake breeze can develop in response to a temperature differential that can exist at a land/water interface. The lake breeze is enhanced when the PGF is weak, the general wind flow is light and the land is substantially warmer than the water. It is inhibited when the PGF is strong or misaligned relative to the shoreline, or the temperature differential is too weak. Thus, lake breeze conditions are optimum in the Chicago area during daylight hours in the late spring and summer when favorable conditions often exist.

The lake breeze goes through a life cycle that begins around mid-morning along the shore. It strengthens and moves inland before retreating and/or collapsing later in the day. The lake breeze phenomenon can occur on a daily basis under described weather conditions.

The lake breeze can have dramatic economic effects. As an example, consider air conditioning loads in Chicago's loop in summertime. In the absence of the lake breeze, temperatures can climb into the nineties driving the demand for electricity to record highs. With the lake breeze, temperatures in the loop can be kept in or near the seventies and the air conditioning load is correspondingly lower.

Knowledge of lake breeze dynamics has obvious value to the load dispatcher at CECO who must plan ahead to assure adequate generation while also scheduling outages for maintenance and/or repair during peak demand periods.

Murray and Trettel, Incorporated (M/T) has provided specialized lake breeze forecasts to the load dispatchers of CECO for more than 25 years. The experience that has been accumulated and the expertise that has followed from it have been translated into certain (proprietary) predictive weights, values and related prognostic techniques. Forecast methods continue to be refined as more data become available and as interest in and concern for the lake breeze and its effects continues to grow in importance.

Forecast Methodology

Those meteorological factors considered important in lake breeze predictions can be divided into primary and secondary groups, and are listed below.

Primary -

- Pressure gradient strength and orientation
- Land/water temperature contrast
- Surface wind speed and direction

Secondary -

- Sky cover
- Haze, smoke, fog
- Diurnal temperature variation

The predicted occurrence of a lake breeze is already being provided to CECO in the Zion forecast. This forecast is routinely transmitted, computer-to-computer. Each hour of the forecast is given a code ("0", "1" or "2") indicating: (1) no lake effect; (2) lake effect with plume trapping; and, (3) lake effect with fumigation.

A new factor will be added to this forecast: the predicted inland distance of the lake breeze front. This will be entered in coded form. The codes and their interpretation are as follows.

Code	Meaning
0	No lake breeze
1	Convergence zone (CZ) less than/equal to 2 miles
2	2 less than CZ less than/equal to 5 miles
3	5 (miles) less than CZ

Refinements will continue to be made both in forecast technique and its verification as additional micro-scale weather measurements are made. At present, there are plans to measure wind speed, direction and humidity at two sites. One site is to be located approximately two (2) miles inland and the other will be five (5) miles inland. Measurements will be telemetered in real-time over telephone lines using Microtels in response to demand polls.

Sample Analysis

Two examples follow. Example One: July 8, 1981 - a case of no lake breeze. Example Two: July 10, 1981 - a lake breeze case. The synoptic patterns are shown in the Surface Weather Maps. They show, graphically, the surface pressure gradients (the solid lines are isobars). Differences in the pressure gradient orientation and strength between the two cases is evident, as is the general surface wind flow, sky cover, etc.

Hourly surface observations are also incorporated. These observations were from O'Hare Airport (ORD), DuPage County Airport (DPA), Midway Airport (MDW) and Meigs Field (CGX). Tabulations are temperature/dew point (T), wind direction/speed (W) and sky cover (S). Units are standard.

The progress of the lake breeze front (convergence zone) is evident in the data for July 10. It formed at the lakeshore and moved inland between 0900 and 1000 CDT (CGX). It passed MDW by 1200 CDT and ORD by 1600 CDT. By 2100 CDT it reached DPA where it apparently dissipated. The average speed of the front was 3 mph (statute), since MDW is approximately 8 miles inland, ORD is 12 and DPA is 30 miles.

CGX - MDW: 8 miles/2 hr = 4 mph

LK - ORD: 12 miles/6 hr = 2 mph

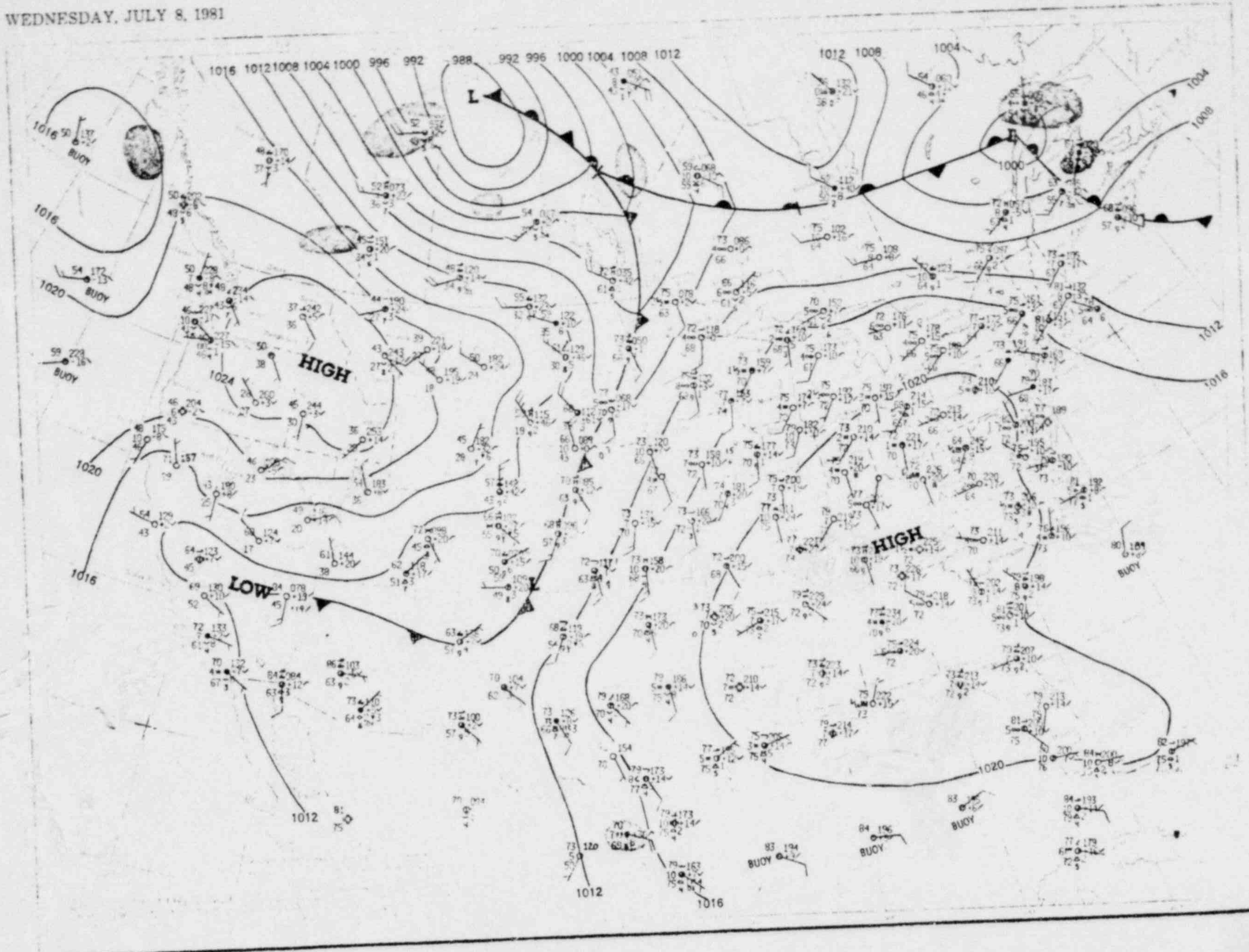
LK - DPA: 30 miles/11 hr = 3 mph

Avg. = 3 mph

Summary

The ability to predict effectively, lake breeze and the resultant convergence zone, is highly dependent on an ability to evaluate the impact of a given air/water temperature difference working within an existing pressure gradient force. The intensity of the convergence zone is related to these factors. They also control the inland penetration of the convergence zone. An effective forecast requires a realistic determination of the dynamics of the temperature differential and gradient flow. In its 35 years' experience in dealing with this phenomenon M/T has developed the necessary dynamic values and weights needed to make this type of prediction with optimum success.

WEDNESDAY, JULY 8, 1981

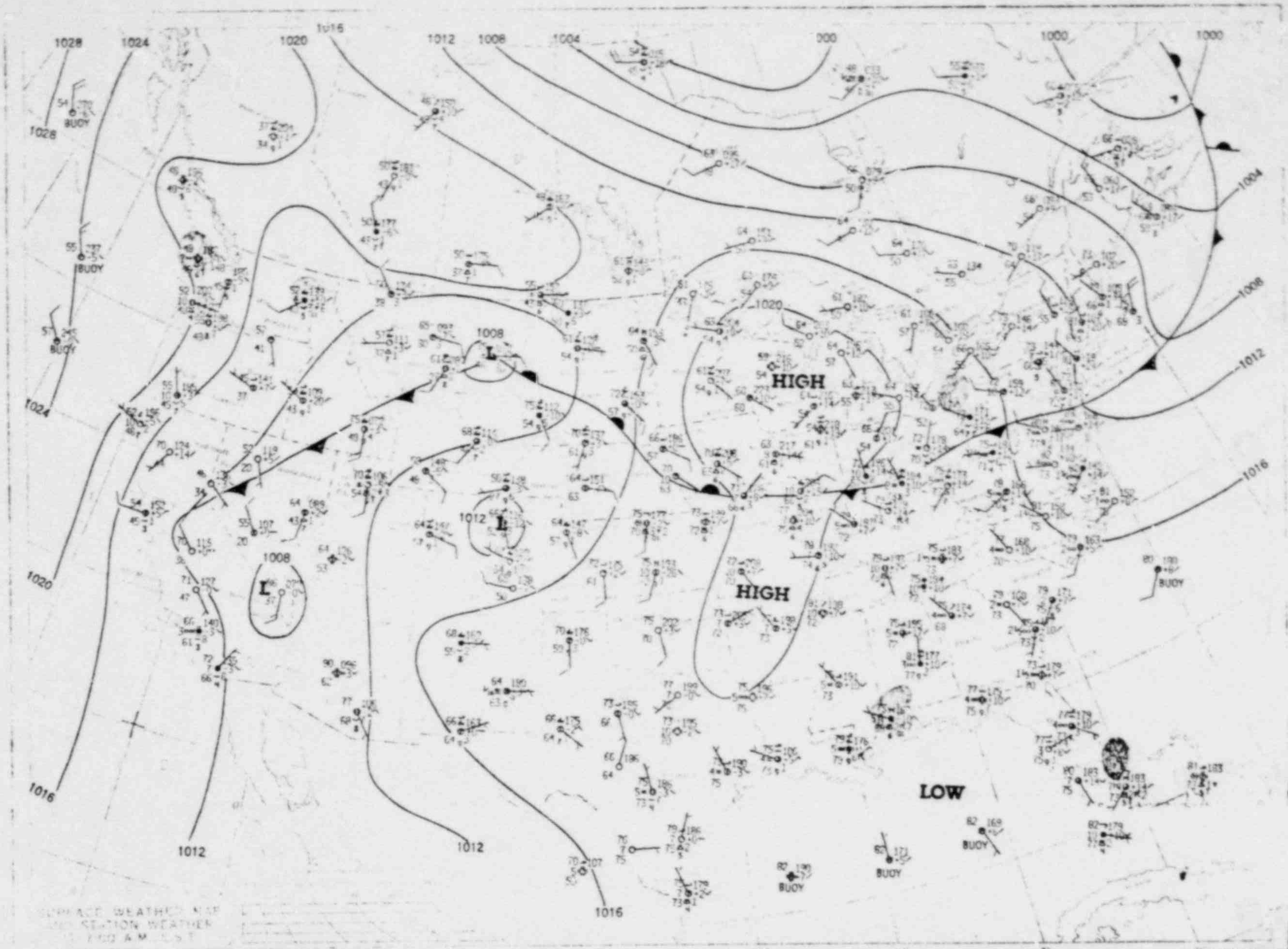


MURRAY AND TRETTEL WORK SHEET

Date: July 8, 1981

	ORD			DPA			MDW			CGX		
00	T	W	S	T	W	S	T	W	S	T	W	S
01	79 73	2107	CLR	MSG	1905	CLR	79 71	2006	CLR			
02	78 73	MSG	CLR	MSG	MSG	CLR	77 --	2106	CLR			
03	78 73	2108	CLR	MSG	2006	CLR	76 71	2106	CLR			
04	78 72	2207	CLR	MSG	MSG	CLR	75 --	2106	CLR			
05	77 72	2107	CLR	MSG	2006	CLR	75 71	2107	CLR			
06	79 73	2207	CLR	MSG	2106	CLR	77 71	2206	CLR	79	2210	CLR
07	82 74	2108	CLR	MSG	2006	SCTRD	81 74	2008	CLR	80	2210	CLR
08	83 74	2306	CLR	MSG	2108	SCTRD	82 73	2208	CLR	81	2212	CLR
09	85 75	2312	BRKN	MSG	2212	OVCST	83 73	2312	BRKN	82	2310	BRKN
10	87 76	2411	BRKN	MSG	2510	BRKN	83 73	MSG	MSG	83	2415	BRKN
11	90 75	2410	BRKN	MSG	2310	BRKN	85 72	2415	BRKN	84	2415	SCTRD/BRKN
12	91 75	2214	BRKN		2410	SCTRD	90 74	2207	BRKN	84	2612	SCTRD
13	92	2112	SCTRD				89 --	2210	SCTRD	87	2315	BRKN
14	91 73	MSG	BRKN	MSG			90 --	MSG	MSG	MSG		
15	93 73	2314	BRKN	91	2315	BRKN	92 71	2216	BRKN	88	2515	BRKN
16	93 73	2114	BRKN	92	2415	BRKN	90 71	2414	BRKN	88	2515	BRKN
17	91 73	2114	BRKN	92	2310	BRKN	90 71	2413	BRKN	91	2515	BRKN
18	90 73	2114	BRKN	90	2615	BRKN	88 70	2412	BRKN	91	2515	BRKN
19	87 71	MSG	BRKN	88	2412	SCTRD	86 70	2410	SCTRD	91	2415	BRKN
20	84 71	2210	SCTRD	86	2408	CLR	84 70	2411	SCTRD	88	2615	SCTRD
21	82 73	2206	CLR	85	2306	CLR	82 72	2407	CLR	87	2615	SCTRD
22	81 72	2106	CLR	83	2106	CLR	81 72	2205	CLR	86	2612	CLR
23	81 72	2206	CLR	82	2206	CLR	80 72	2206	CLR	86	2612	CLR
24	80 72	2205	CLR	82	2307	CLR	79 73	2406	CLR			

FRIDAY, JULY 10, 1981



MURRAY AND TRETTEL WORK SHEET

Date: July 10, 1981

	ORD			DPA			MDW			CGX		
00	T	W	S	T	W	S	T	W	S	T	W	S
01	60 54	2303	CLR	64	CALM	CLR	64 54	3201	CLR			
02	58 54	3304	CLR	62	CALM	CLR	63 54	3003	CLR			
03	59 55	2602	CLR	61	0704	CLR	62 55	2801	CLR			
04	56 54	CALM	CLR	61	CALM	CLR	61 56	2801	CLR			
05	57 54	CALM	SCTRD	59	CALM	CLR	61 53	CALM	CLR			
06	64 60	2803	SCTRD	58	CALM	CLR	67 57	CALM	SCTRD	70	2805	SCTRD
07	75 60	CALM	CLR	66	CALM	CLR	68 56	3005	CLR	72	CALM	SCTRD
08	80 60	2803	CLR	74	3104	CLR	75 52	3208	CLR	74	3104	CLR
09	82 60	3303	CLR	80	2703	CLR	79 54	0701	CLR	78	CALM	CLR
10	84 58	CALM	CLR	83	3406	CLR	82 53	0302	CLR	80	0905	CLR
11	85 58	0903	SCTRD	84	2004	CLR	83 MSG	2002	CLR	80	0906	CLR
12	88 58	2104	CLR	86	CALM	CLR	84 52	1007	CLR	81	0908	CLR
13	88 57	2203	CLR	87	2805	CLR	86 52	1003	CLR	80	1210	CLR
14	91 58	0403	CLR	88	2304	CLR	85 53	1607	CLR	79	1410	CLR
15	91 58	CALM	CLR	88	2405	CLR	85 54	0806	CLR	79	1210	CLR
16	89 57	0609	CLR	MSG	MSG	MSG	85 52	0808	CLR	78	1308	CLR
17	87 56	1208	CLR	88	MSG	CLR	82 50	0807	CLR	79	1208	CLR
18	83 54	1108	CLR	88	3505	CLR	81 50	0708	CLR	79	1408	CLR
19	80 52	1208	CLR	86	3104	CLR	78 50	0708	CLR	79	1307	CLR
20	75 53	1008	CLR	84	3404	CLR	77 50	0806	CLR	79	1307	CLR
21	74 53	1506	CLR	76	1304	CLR	75 52	CALM	CLR	79	CALM	CLR
22	67 54	1406	CLR	75	1304	CLR	75 53	CALM	CLR	79	1305	CLR
23	65 55	1803	SCTRD	71	CALM	CLR	74 53	CALM	CLR	79	1305	CLR
24	63 56	1904	BRKN	69	CALM	CLR	72 55	CALM	CLR			

"_" indicates the passage of lake breeze convergence zone

Murray and Trettel Inc. Certified Consulting Meteorologists

APPENDIX G

References

APPENDIX G

References

1. I. Vanderhoven et al. "Recent Analytical and Experimental Efforts on Single Source Effluent Dispersion to Distances of 100 km", IAWA/SM-181/8, circa 1973.

2. AIF/NESP-007b "Gas tracer Study of Roof Vent Effluent Diffusion at Millstone Nuclear Power Station", Atomic Industrial Forum, October 1975.

3. NUREG-0373 "Dispersion in the Wake of a Model Industrial Complex", February 1978.

4. CONF-770901 "Proceedings of a Workshop on the Evaluation of Models Used for the Environmental Assessment of Radionuclide Release", Oak Ridge National Laboratory, April 1978.

5. ORNL-5382 "The Evaluation of Models Used for the Assessment of Radionuclide Releases to the Environment, Progress Report for the Period April 1976 through December 1977", Oak Ridge National Laboratory, June 1978.

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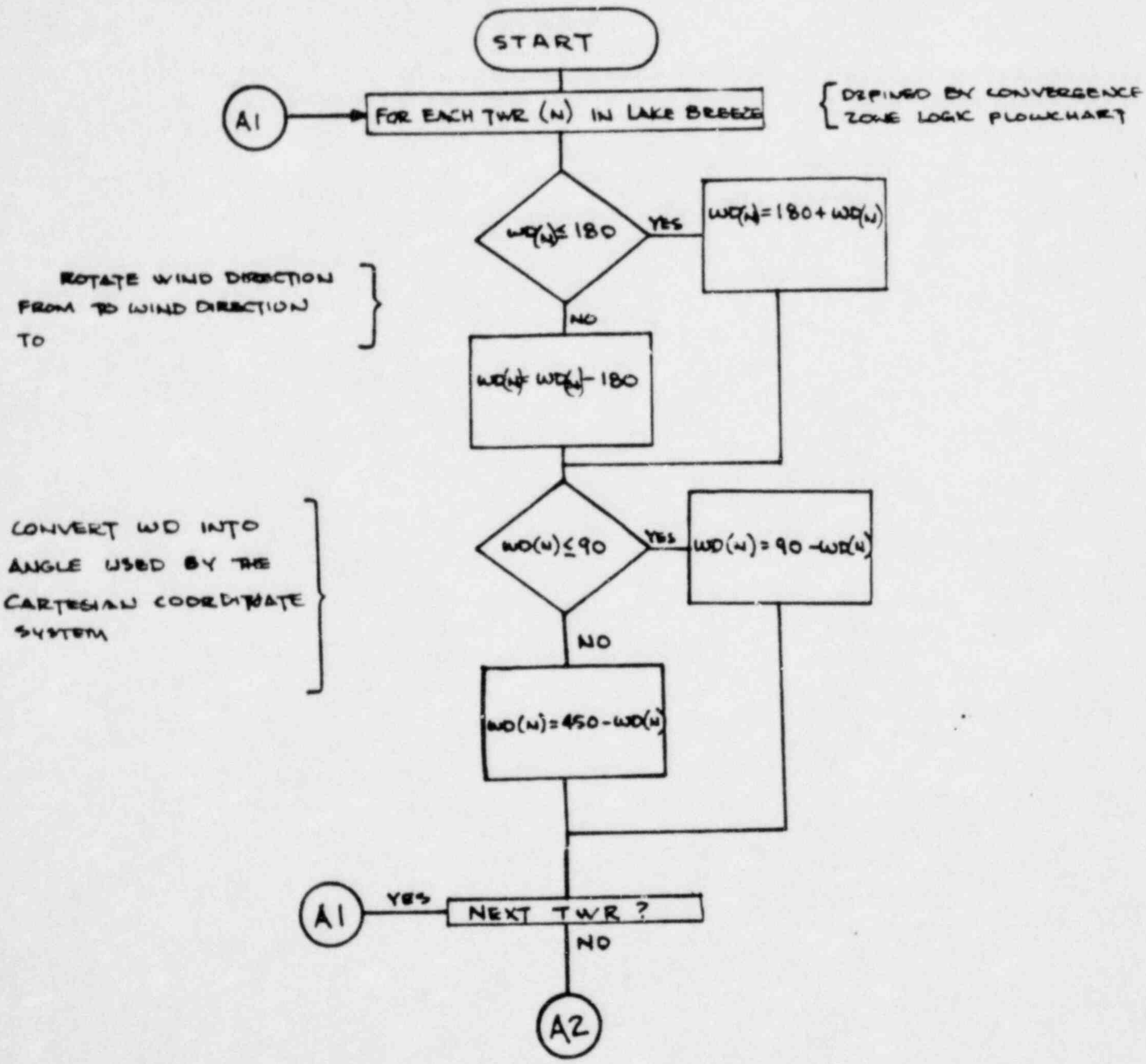
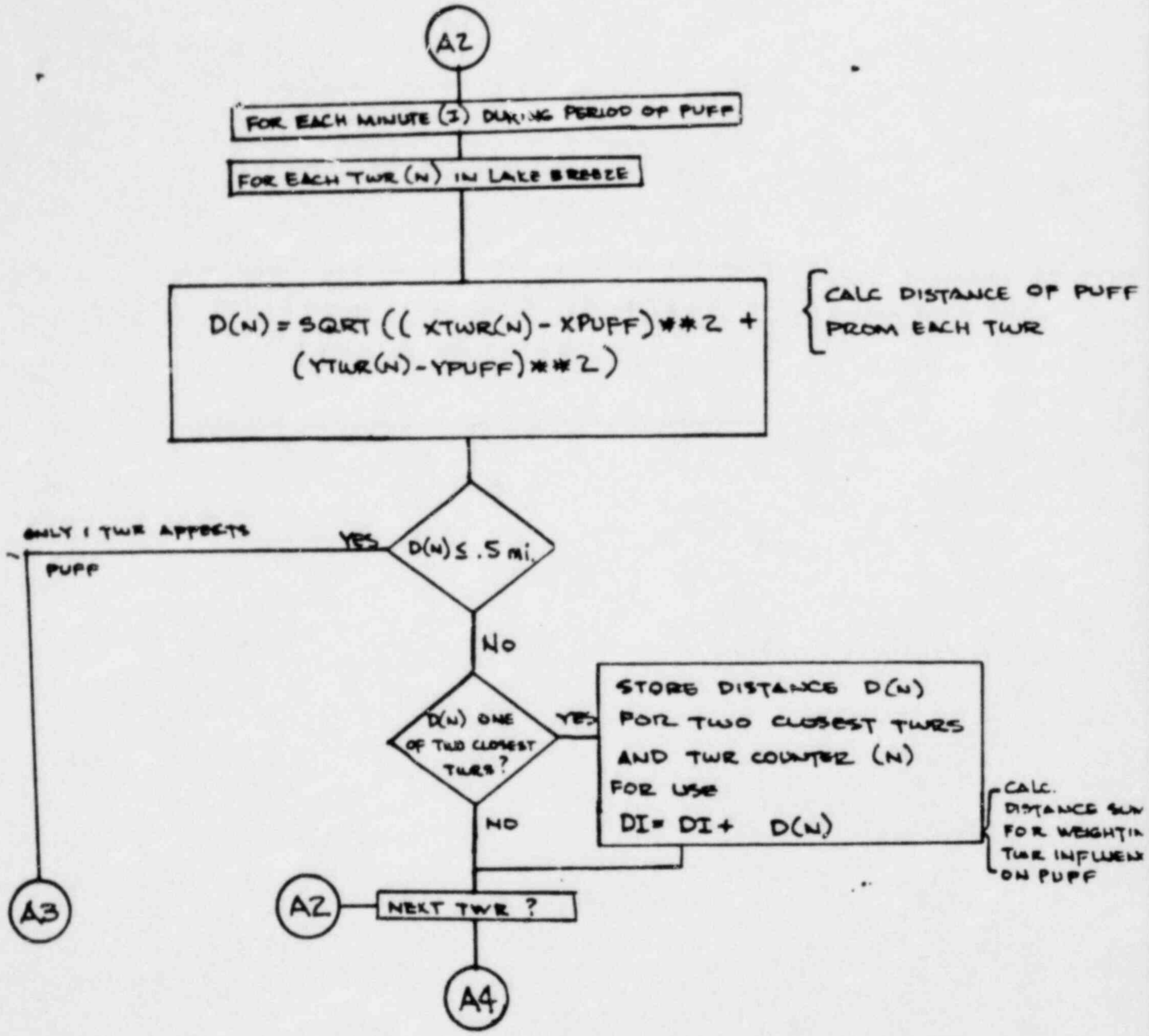
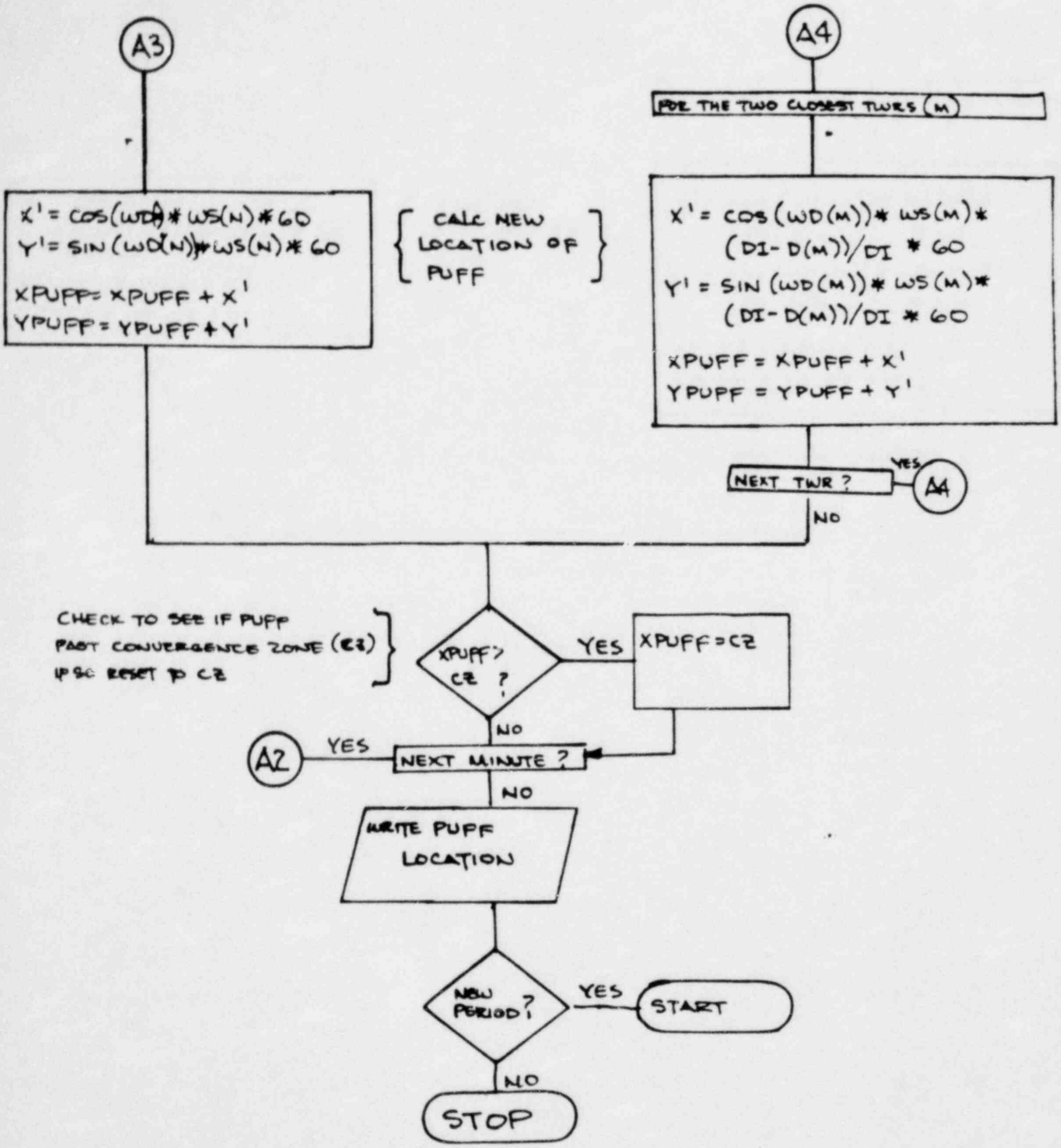

START
A1
FOR EACH TWR (N) IN LAKE BREEZE
DEFINED BY CONVERGENCE ZONE LOGIC FLOWCHART
WD(N) ≤ 180
YES
WD(N) = 180 + WD(N)
ROTATE WIND DIRECTION FROM TO WIND DIRECTION TO
NO
WD(N) = WD(N) - 180
WD(N) ≤ 90
YES
WD(N) = 90 - WD(N)
CONVERT WD INTO ANGLE USED BY THE CARTESIAN COORDINATE SYSTEM
NO
WD(N) = 450 - WD(N)
A1
YES
NEXT TWR ?
NO
A2


A2
FOR EACH MINUTE (I) DURING PERIOD OF PUFF
FOR EACH TWR (N) IN LAKE BREEZE
D(N) = SQRT ((XTWR(N) - XPUFF)**2 +
(YTWR(N) - YPUFF)**2)
CALC DISTANCE OF PUFF
FROM EACH TWR
ONLY 1 TWR AFFECTS
PUFF
YES
D(N) ≤ .5 mi.
NO
D(N) ONE
OF TWO CLOSEST
TWRS?
YES
STORE DISTANCE D(N)
FOR TWO CLOSEST TWRS
AND TWR COUNTER (N)
FOR USE
DI = DI + D(N)
CALC.
DISTANCE SUM
FOR WEIGHTIN
TWR INFLUEN
ON PUFF
NO
A3
A2
NEXT TWR ?
A4


A3
A4
FOR THE TWO CLOSEST TWRS (M)
X' = COS(WD(N)) * WS(N) * 60
Y' = SIN(WD(N)) * WS(N) * 60
XPUFF = XPUFF + X'
YPUFF = YPUFF + Y'
CALC NEW LOCATION OF PUFF
X' = COS(WD(M)) * WS(M) * (DI - D(M))/DI * 60
Y' = SIN(WD(M)) * WS(M) * (DI - D(M))/DI * 60
XPUFF = XPUFF + X'
YPUFF = YPUFF + Y'
NEXT TWR ?
YES
A4
NO
CHECK TO SEE IF PUFF PAST CONVERGENCE ZONE (CZ) IF SO RESET TO CZ
XPUFF > CZ ?
YES
XPUFF = CZ
NO
A2
YES
NEXT MINUTE ?
NO
WRITE PUFF LOCATION
NEW PERIOD ?
YES
START
NO
STOP

14. Commonwealth Edison Offsite Dose Calculation Manual.

15. TID-24190 "Meteorology and Atomic Energy" July 1968.

16. Reg. Guide 1.109 "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating compliance with 10CFR Part 50, Appendix I", Revision 1, October 1977.

17. NUREG 75/087 "Standard Review Plan of Safety Analysis Report for Nuclear Power Station LWR Addition", September 1975.

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19. GSEP Environmental Emergency Plan Implementing Procedures.