CAROLINA POWER & LIGHT COMPANY
BRUNSWICK STEAM ELECTRIC PLANT, UNIT NOS. 1 AND 2
REVISED PLANT EMERGENCY PROCEDURES

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CAROLINA POWER & LIGHT COMPANY
BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 & 2

INITIAL EMERGENCY ACTIONS

PLANT EMERGENCY PROCEDURE PEP-2.1

VOLUME XIII

Rev. 3

Recommended By: Robert A Indelicato Date: 11/20/81

Approved By: RE Morgan for CR. Dietz Date: 11-20-81
Plant General Manager

PEP-2.1 INITIAL EMERGENCY ACTIONS

1.0 Responsible Individual and Objectives

The Shift Operating Supervisor is responsible for:

1.1 Directing the emergency response activities in the Control Room and elsewhere on the site and ensuring that the proper Emergency Instructions and Procedures are being followed.

1.2 Classifying the emergency in accordance with the Emergency Action Levels (EALs) as either: (a) Unusual Event (PEP-2.2); (b) Alert (PEP-2.3); (c) Site Emergency (PEP-2.4); or (d) General Emergency (PEP-2.5).

Note: Figure 2.1-1 (found at the end of this procedure) provides a Logic Flow Diagram of this procedure.

The alternate persons for implementing this procedure are the Shift Foreman or, in his absence, the Senior Control Operator.

All plant personnel are responsible for reporting to the Control Room any conditions or symptoms, indicated by instrument readings or direct observations, that could lead to an emergency.

2.0 Scope and Applicability

This procedure may be implemented (at the discretion of the Shift Operating Supervisor or his alternate) upon recognition of an off-normal condition as determined by instrument readings or direct observation. This procedure shall be implemented following: 1) implementation of any Emergency Instruction; 2) any report of an unplanned fire or explosion on site; 3) any tech spec violation; 4) receipt of a hurricane or tornado warning; or 5) any report of a security threat. Implementation of this procedure does not constitute an emergency but rather serves as a guideline for evaluation of the plant conditions and comparisons with Emergency Action Levels (EALs). Once implemented, this procedure shall remain in effect until either 1) the emergency is classified and the proper Emergency Control procedure is implemented, or 2) the off-normal condition is resolved. The Shift Operating Supervisor on duty (or his designated alternate) has immediate and unilateral authority to carry out this procedure. He may be relieved by a properly trained individual, as identified in PEP-1.2, "Emergency Organization."

3.0 Actions

("*" denotes decisions or actions which should be entered in the Shift Foreman's Log).

Note: The following actions are to be carried out by the Shift Operating Supervisor (or his designated alternate) in an expeditious manner for personnel and plant protection and emergency classification.

3.1 Ensure appropriate Emergency Instructions and plant procedures are being implemented.

3.2 Determine need to evacuate localized plant areas.

Note: If a Building Evacuation is not required, go to Step 3.3.

*3.2.1 Sound Building Evacuation alarm for 15 seconds and announce over the Plant PA System "(state emergency condition) in the (location). Evacuate the (location)."

Example: "Radiation Alarm in Radwaste Building, Evacuate the Radwaste Building."

3.2.2 Implement Section 3.1 of PEP-3.8.1, "Evacuation" and direct evacuees to report to the designated assembly area for the building being evacuated.

*3.2.3 Implement Section 3.1 of PEP-3.8.2, "Personnel Accountability," and direct work group supervisors to inform the Shift Operating Supervisor of any personnel not accounted for within 30 minutes.

3.2.4 Repeat Step 3.2.1 above.

3.3 Determine whether personnel injuries have occurred.

Note: If no personnel injuries are reported, go to Step 3.4.

*3.3.1 Determine number of persons injured and their location(s).

3.3 2 Implement PEP-3.9.2 "First Aid and Medical Care," and PEP-3.9.6 "Search and Rescue," as appropriate.

3.3.3 Determine whether injuries involve radioactive contamination.

Note: If contamination is involved, ensure appropriate precautions are taken in accordance with PEP Section 3.9, "Aid to Affected Personnel."

-CAUTION-

FRIORITY SHOULD BE PLACED ON LIFESAVING INJURY TREATMENT OVER THE NEED TO DECONTAMINATE. SEE PEP-3.9.2 FOR GUIDANCE.

3.4 Determine whether off-normal conditions include fire.

Note: If no fire is detected or reported, go to Step 3.5.

3.4.1 Determine location of fire, sound fire alarm, and announce location using plant PA if not announced as part of Step 3.2.

*3.4.2 Implement Fire-Fighting Procedures FP-7, "General Fire Plan" (Vol. XIX; Plant Operating Manual).

3.5 Using EXHIBIT 2.1-1 "Emergency Action Levels" compare plant conditions (observed or indicated parameters and conditions) with the EALs and classify the emergency.

Note: If no emergency exists (i.e., no Emergency Action Level is met), go to Step 3.6.

-CAUTION-

DECLARATION OF THE HIGHEST EMERGENCY CLASS FOR WHICH AN EMERGENCY ACTION LEVEL IS MET SHOULD BE MADE.

3.5.1 If an EAL for an Unusual Event is met, implement PEP-2.2, "Emergency Control - Unusual Event."

3.5.2 If an EAL for an Alert is met, implement PEP-2.3, "Emergency Control - Alert."

3.5.3 If an EAL for a Site Emergency is met, implement PEP-2.4, "Emergency Control - Site Emergency."

3.5.4 If an EAL for a General Emergency is met, implement PEP-2.5 "Emergency Control - General Emergency."

3.6 Continue to monitor and evaluate plant conditions in accordance with previous steps until off-normal conditions are returned to normal.

* Note: When operations are within normal operating parameters, and safe in the judgment of the Shift Operating Supervisor, terminate use of this procedure.

EXHIBIT 2.1-1

EMERGENCY ACTION LEVELS

<u>UNUSUAL EVENT</u>

1.0 Effluent Releases

1.1 Liquid Releases

1.1.1 Any unplanned release from the liquid waste system resulting in activity levels greater than those in 10CFR20, Appendix B, Table II to the discharge canal.

1.1.2 A planned release giving activity levels greater than those given in 10CFR20, Appendix B, Table II to the discharge canal as indicated by a <u>failure</u> to isolate or terminate the release upon:

a) exceeding the RMS setpoint, or
b) exceeding 2 times the permitted release flow rate, and loss of circulating water pump.

1.1.3 Any other accidental, unplanned, or uncontrolled off-site liquid release which exceeds or which could have exceeded 10 curies.

1.2 Gaseous Release exceeding 1.0, at the release point, as indicated by the Instantaneous Limit calculated in accordance with OG-6.

2.0 Plant Occurrences Having Direct Consequences

2.1 In-Plant Releases

2.1.1 Failed fuel, as indicated by Reactor Coolant System (RCS) activity:

a) RCS activity >4.0 μCi/ml (Dose Equivalent I-131),
b) RCS activity >0.2 μCi/ml (Dose Equivalent I-131), but less than limit in (a) above, for more than 48 hours,
c) RCS activity >100/E μCi/ml for all isotopes.

EXHIBIT 2.1-1

EMERGENCY ACTION LEVELS (cont.)

UNUSUAL EVENT (continued)

2.1.2 In-plant leak or spill as indicated by:

a) Any Building Evacuation based on confirmed radiological conditions (except precautionary).
b) Reactor Coolant System leakage in excess of 25 gpm for >8 hours.
c) Unidentified Reactor Coolant System leakage in excess of 5 gpm for >8 hours.
d) Any non-isolable RCS pressure boundary leakage.

2.2 Failure of a primary system safety/relief valve (including ADS) to open if challenged OR to close once opened.

2.3 Emergency Core Cooling System automatically initiated and discharging to vessel for a period greater than five (5) minutes other than by operator action.

2.4 Loss of containment integrity requiring shutdown by technical specifications and shutdown is not achieved within required time period.

2.5 Loss of engineered safety feature or fire protection system function requiring shutdown by technical specifications and shutdown is not achieved within required time period.

2.6 Indications or alarms on process or effluent parameters not functional in control room to an extent requiring plant shutdown or other significant loss of assessment or communication capability for greater than sixty (60) minutes.

2.7 Loss of all off-site power or loss of all on-site AC Power capability.

2.8 Transportation of contaminated injured individual from site to off-site hospital.

2.9 Unplanned fire within the Protected Area not brought under control more than 10 minutes after activation of a Fire Suppression System or 10 minutes after manual fire-fighting efforts have begun.

3.0 Occurrences Having Indirect Consequences

3.1 Natural Phenomenon or Man-Made Event Having Potential for Degrading Plant Safety.

a) Any alarm on seismic monitor and confirmation of an earthquake in the region.

EXHIBIT 2.1-1

EMERGENCY ACTION LEVELS (cont.)

UNUSUAL EVENT (Continued)

b) Any tornado crossing the site boundary (by observation or evidence).
c) Any hurricane requiring implementation of EI-37.1, "Operation During Hurricane Warnings and Hurricane Conditions."
d) Any aircraft crash within the site boundaries.
e) Any unplanned explosion within the site boundaries.
f) Any release of toxic or flammable gas that could endanger personnel.

3.2 Exceeding any Technical Specification Safety Limit.

3.3 Plant Situations:

a) Security threat (bomb threat, attack threat, civil disobedience), attempted sabotage, or attempted entry
b) Any incident involving licensed nuclear material (i.e., nuclear fuel or licensed sources), which may have caused or threatens to cause:
   i. A loss of one day or more of the operation of the facility,
   ii. Property damage in excess of $2,000.
c) Strikes of operating employees or security guards, or honoring of picket lines by such employees.

3.4 Any other instance that, in the judgment of the Shift Operating Supervisor/Site Emergency Coordinator warrants declaration of an Unusual Event:

An Unusual Event represents conditions that involve (1) releases to the environment in excess of Technical Specification limits; <u>or</u> (2) failures of fuel cladding that result in concentrations of radioactivity in the primary coolant requiring hot shutdown; <u>or</u> (3) degradation of the plant safety systems.

ALERT

1.0 Effluent Release

1.1 Any liquid release giving >1.0 X 10^{-4} μCi/ml in the discharge canal as indicated by:

a) Whenever the Service Water discharge monitor reads >1000 cps.
b) Field measurement indicating >1.0 x 10^{-4} μCi/ml in the discharge canal.

1.2 Any gaseous release giving >3 X 10^{-4} uCi/cc at the site boundary:

a) Main Stack high range discharge monitor reading >0.1 R/hr.
b) Whenever Steam Jet Air Ejector discharge monitor is off-scale-high.
c) Whenever the Reactor Building Ventilation monitor is off-scale-high.
d) Whenever the Reactor Building Roof Vent monitor is off-scale-high.
e) Whenever the Turbine Building Vent monitor is off-scale-high.

2.0 Plant Occurrences Having Direct Consequences

2.1 In-Plant Releases

2.1.1 Failed fuel, as indicated by:

a) RCS activity >40 μCi/ml (Dose equivalent I-131)

Note: Whenever main steam isolation is indicated due to high radiation in the line, an RCS grab sample should be taken immediately and analyzed for gross activity.

2.1.2 In-Plant Leak or Spill, which may be indicated by:

a) The high range drywell area monitor reading >10R/hr.*
b) Any Area Radiation Monitor or Continuous Air Monitor off-scale-high.
c) Any Site Evacuation based on confirmed radiological conditions.
d) Fuel handling accident involving damage to spent fuel, as indicated by:

*When instrumentation is installed and operable.

ALERT (continued)

i. observation/report, AND an alarm on Reactor Building Ventilation monitor, Reactor Building roof vent monitor, or the refueling floor area monitor.
ii. Any time EI-22, "Spent Fuel Damage" is implemented.

e) Whenever the Reactor Building Closed Cooling Water monitor is off-scale-high.

2.2 Loss of Coolant Accident (primary system leakage >50 gpm) as indicated by:

a) Reactor Vessel water level falling and normal feedwater system unable to restore.
b) Low or falling RCS pressure, with rising drywell pressure and temperature.
c) Any time EI-1.2 is implemented.

2.3 Steam Line Break (i.e., downstream of MSIVs and upstream of feedwater isolation valves), as indicated by:

a) Reactor trip, with:
   i. low RCS pressure, or
   ii. low steam pressure, or
   iii. low reactor vessel water level, or
   iv. high steam flow.
b) Any time EI-1.3 is implemented.

AND either:

c) RCS activity >0.2 uCi/cc Iodine equivalent, or
d) MSIV fails to close

2.4 Loss of all AC Power

a) Loss of off-site power (startup transformer and auxiliary transformer de-energized),

AND

b) Failure of on-site emergency AC power source, as indicated by loss of diesel generators.

2.5 Failure of the Reactor Protection System to initiate and complete a trip which brings the reactor to a subcritical condition.

2.6 Loss of all D.C. power (more than momentary).

2.7 Complete loss of ability to maintain plant in cold shutdown.

ALERT (continued)

2.8 Any unplanned fire not brought under control within 10 minutes after fire suppression efforts have begun AND which could potentially affect vital, safety-related or ESF equipment.

3.0 Occurrences Having Indirect Consequences

3.1 All alarms (annunciators) lost for more than 5 minutes.

3.2 Evacuation of Control Room anticipated or required (i.e., implementation of EI-29), with control of shutdown established from local stations.

3.3 Natural Phenomenon or Man-Made Event Having Potential for Degrading Plant Safety.

a) Earthquake registering >0.08 g on seismic instrumentation.
b) An adverse weather condition that causes a loss of function of 2 or more safety-related trains.
c) Any explosion, aircraft crash, or missiles resulting in major damage to structures housing safety-related systems.
d) Any unplanned and uncontrolled entry of flammable or toxic gases into vital areas in sufficient quantities to endanger personnel or the operability of safety-related equipment.

3.4 Plant Situations

a) Attempted sabotage, with successful entry into a Protected Area.
b) A turbine disk failure resulting in penetration of its outer casing.

3.5 Any other instance that, in the judgment of the Site Emergency Coordinator/Shift Operating Supervisor, warrants declaration of an Alert:

An Alert represents conditions which involve; (1) releases to the environment exceeding 10 times a Technical Specification limit or (2) damage to the core resulting in radioactive levels in the reactor coolant exceeding 40 μCi/ml dose equivalent I-131, 10,000/E μCi/gram, or radiation levels exceeding 10 R/hr as measured by the monitor in the drywell; or (3) occurrence of an event (or events) resulting in a substantial reduction in safety. Corrective action is predicted to be successful in preventing a significant release.

Events in this class reflect a significant degradation in the safety of the reactor. However, releases from such events will be small.

EXHIBIT 2.1-1

EMERGENCY ACTION LEVELS (cont.)

<u>SITE EMERGENCY</u>

1.0 Effluent Releases

Any release to the environment resulting in an off-site dose in excess of 0.1 rem (whole body) or 0.5 rem (thyroid), as indicated by:

a) Dose projections using actual effluent data and actual me[illegible]gical conditions as calculated in accordance with P[illegible]1.
b) Do[illegible] projections using estimated or assumed data (if actual data is unavailable), as calculated in accordance with PEP-3.4.1.
c) Field measurements at or beyond the site boundary.

2.0 Plant Occurrences Having Direct Consequences

2.1 In-plant Releases

2.1.1 Failed Fuel, as indicated by RCS activity >400 μCi/ml (Dose equivalent I-131).

2.1.2 Major In-Plant Leak or Spill, as indicated by:

a) Drywell high range area monitor >100 R/hr.**
b) Major damage to spent fuel, as indicated by:
   i. observation of substantial damage to multiple fuel assemblies,
   ii. observation that the water level has dropped below the top of the fuel.

2.2 Loss of Coolant Accident (primary system leakage >50 gpm) as indicated by:

a) Reactor Vessel water level falling and normal feedwater system unable to restore.
b) Low or falling RCS pressure, with rising drywell pressure and temperature.
c) Any time EI-1.2 is implemented.

<u>AND</u>

Failure of any 2 (or more) ECCS trains to function on demand.

** When instrumentation is installed and operable.

EXHIBIT 2.1-1

EMERGENCY ACTION LEVELS (cont.)

SITE EMERGENCY (continued)

2.3 Steam Line Break (i.e., downstream of MSIVs and upstream of feedwater isolation valves), as indicated by:

a) Reactor trip, with:
   i) Low RCS pressure, or
   ii) Low steam pressure, or
   iii) low reactor vessel water level, or
   iv) high steam flow.

b) Any time EI-1.3 is implemented.

AND

Inability to close MSIVs within 15 minutes.

2.4 Loss of all AC power

a) Loss of off-site power (startup transformer and auxiliary transformer de-energized), AND
b) Failure of on-site emergency AC power source for greater than 15 minutes, as indicated by loss of diesel generators.

2.5 Loss of all DC power for greater than 15 minutes.

2.6 Any fire that:

a) impairs the operability of any safety-related train or vital equipment;
b) causes the inability to shutdown the plant.

2.7 Inability to achieve plant Hot Shutdown.

3.0 Occurrences Having Indirect Consequences

3.1 Loss of all alarms (annunciators) AND occurrence of a plant transient.

3.2 Evacuation of Control Room AND local control of shutdown is not established or is lost.

3.3 Any Natural Phenomenon or Man-Made Event which Degrades Plant Safety concurrent with or causing the loss of more than 2 safety-related trains, i.e.:

a) Earthquake that registers >0.16 g ground acceleration.

SITE EMERGENCY (continued)

b) Hurricane winds - 0-50 ft. above ground level - 130 mph
50-150 ft. above ground level - 150 mph
150-450 ft. above ground level - 180 mph

c) Tornado winds - Maximum tangential of 300 mph with forward velocity of 60 mph.

d) Any explosion, aircraft crash, or missiles resulting in major damage to structures housing safety-related systems.

e) Any unplanned, uncontrolled entry of flammable or toxic gases into vital areas in sufficient quantities to endanger personnel or the operability of safety-related equipment.

3.4 Plant Situations

a) Attempted sabotage with successful attempt(s) at disabling plant equipment or controlling plant operations.

3.5 Any other instance that, in the judgment of the Site Emergency Coordinator/Shift Operating Supervisor, warrants declaration of a Site Emergency:

A Site Emergency represents conditions that involve; (1) releases to the environment resulting in projected doses to members of the public in excess of 0.1 rem whole body or 0.5 rem thyroid; or (2) damage to the core resulting in radiation levels in the reactor coolant exceeding 400 μCi/ml dose equivalent I-131, or radiation levels exceeding 100 R/hr in the primary containment as measured by the monitor in the drywell; or (3) occurrence of an event (or events) that involve major failures of plant equipment and that will lead to core damage unless corrective action is taken. Time is available to implement contingency measures.

The Site Emergency class includes Alert conditions where the plant personnel have been initially unsuccessful in restoring the facility to a safe shutdown condition (e.g., the fire has now continued for more than 10 minutes and has now caused loss of function of safety-related equipment). It also includes Alert conditions where subsequent additional malfunctions have occurred (e.g., a transient occurs during the time when plant alarms are inoperable). The Site Emergency class is more severe than the Alert class because significant radiation releases may occur.

EXHIBIT 2.1-1

EMERGENCY ACTION LEVELS (cont.)

GENERAL EMERGENCY

1.0 Effluent Releases

Any release to the environment resulting in an off-site dose in excess of 1.0 rem (whole body) or 5.0 rem (thyroid), as indicated by:

a) Dose projections using actual effluent data and actual meteorological conditions as calculated in accordance with PEP-3.4.1.
b) Dose projections using estimated or assumed data (if actual data is unavailable) as calculated in accordance with PEP-3.4.1.
c) Field measurements at or beyond the site boundary.

2.0 Plant Occurrences Having Direct Consequences

2.1 In-Plant Releases

2.1.1 Failed Fuel as indicated by RCS activity >4,000 μCi/cc (dose equivalent I-131).

2.1.2 Severe in-containment leak or spill, as indicated by the drywell high range area monitor reading >1000 R/hr.**

2.2 Loss of any two of the three fission product barriers listed below:

a) Failed fuel causing RCS >40 μCi/ml.
b) Loss of primary coolant boundary including:
   i. Loss of Coolant Accident (as defined in "Alert", 2.2);
   ii. Major Steam Line Break (as defined in "Alert", 2.3);
c) Loss of containment integrity including:
   i. Failure to isolate containment.
   ii. Rupture of containment vessel.

3.0 Event Combinations Likely to Lead to Core Melting

3.1 Loss of main condenser decay heat removal capability, (with poor prognosis for recovery), AND either:

a) Failure of all Low Pressure Coolant Injection trains (with poor prognosis for recovery), or
b) Failure of all Service Water trains necessary for removing decay heat (with poor prognosis for recovery).

3.2 Inability to achieve Hot Shutdown for >30 minutes.

**When instrumentation is installed and operable.

GENERAL EMERGENCY (continued)

3.3 Inability to provide makeup water to the RCS (i.e., simultaneous failure of HPCI, LPCI, RCIC, Condensate and Feedwater), as indicated by falling or low Reactor Vessel level with attempts to inject water not successful within 15 minutes.

3.4 Loss of Coolant Accident coincident with failure of both Core Spray System trains AND both Low Pressure Injection System trains.

Shift Operating Supervisor learns of an off normal condition, determined by instrument readings or observation. Shift Operating Supervisor implements PEP-2.1, which flows as shown on this sheet.

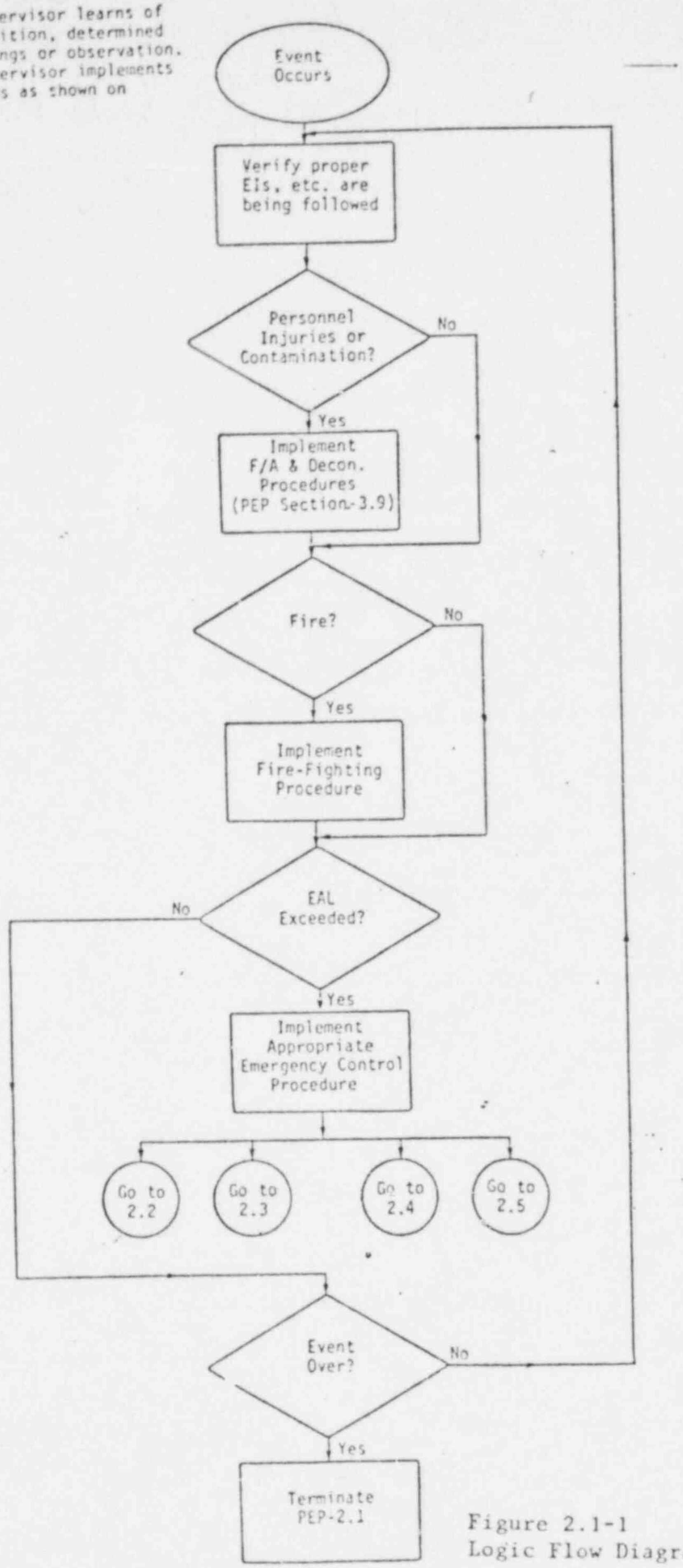


Figure 2.1-1
Logic Flow Diagram for PEP-2.1

File No. ________________
Unit No. ________________
Q+RETcd ________________
App'l ________________

CAROLINA POWER & LIGHT COMPANY
BRUNSWICK STEAM ELECTRIC PLANT

UNIT 0

INITIAL DOSE PROJECTIONS

PLANT EMERGENCY PROCEDURE PEP-3.4.1

VOLUME XIII

Rev 002

Recommended By: Robert A Indelicato Date: 11/6/81

Approved By: [illegible signature] Date: 11/9/81

PEP-3.4.1 INITIAL DOSE PROJECTIONS

1.0 Responsible Individual and Objectives

The Radiological Control Director is responsible to the Site Emergency Coordinator for determining initial dose projections from readily available data. The performance of the calculations may be delegated to the Dose Projections Coordinator. The Radiological Control Manager will assume responsibility for off-site dose projection after the Emergency Operations Facility is activated.

2.0 Scope and Applicability

This procedure is intended to enable a rapid determination of the severity of an emergency. It shall be implemented as the first step subsequent to recognition that an unplanned off-site release has occurred or could have occurred.

The dose projections calculated by use of this procedure are at the approximate site boundary and are to be compared against pre-established criteria (Emergency Action Levels and Protective Action Guidelines) for possible consequences off site, using exposures at or near the property boundary as the benchmark. For more detailed evaluation of off-site consequences, use procedures PEP-3.4.2 through PEP-3.4.6 as appropriate.

A simplified formula for estimating radiological consequences of an accidental release to the atmosphere is:

$$D = Q \frac{\chi}{Q} DCF$$

where D = Dose in rem.

Q = Source Term (Step 3.1), generally as curies or curies per second.

χ/Q = Atmospheric Dispersion Factor (Step 3.3), in units of sec/m^3, and with values determined by atmospheric stability and wind speed.

DCF = Dose Conversion Factor (Step 3.4 or 3.5).

3.0 Actions

List of Exhibits

3.4.1-1 Calculation Sheet for "Projected Dose Near Property Boundary"

3.4.1-2 Source Term Calculation From Plant Stack (High Range)

3.4.1-3 Source Term Calculation From Turbine Building Vent (High Range)

3.4.1-4 Meteorological Dispersion (χ/Q) Values at BSEP Property Boundary (4,000 ft) Elevated Release

3.4.1-5 Meteorological Dispersion (χ/Q) Values at BSEP Property Boundary (4,000 ft) Ground Level Release

3.4.1-6 Extrapolation Ratio for Estimating Doses Beyond BSEP Property Boundary (4,000 ft) Elevated Release

3.4.1-7 Extrapolation Ratio for Estimating Doses Beyond BSEP Property Boundary (4,000 ft) Ground Level Release

NOTE: Exhibit 3.4.1-1 is for calculating and recording dose projections near the site boundary. Steps 3.1 through 3.5 provide the input for the calculations.

3.1 Calculate the source term in accordance with Exhibit 3.4..-2 or Exhibit 3.4.1-3.

3.1.1 Whole Body Dose Projections. Apply the source term directly in terms of curies or curies/sec for whole body dose projections in column 1 of Exhibit 3.4.1-1.

3.1.2 Thyroid Dose Projections. Apply 15 percent of the calculated source term in curies only in column 1 of Exhibit 3.4.1-1.

3.2 Determine the Atmospheric Stability Class. (The following five methods are in order of preferred use.)

3.2.1 If operable, use the plant computer or RC&T computer to obtain the Atmospheric Stability Class, wind speed and wind direction, and record on Exhibit 3.4.1-1.

3.2.2 Call RC&T and request meteorological data in accordance with EI-27.3 Appendix A.

3.2.3 Call Raleigh and request assistance from meteorological Section (PEP Appendix A-4).

3.2.4 Call National Weather Service for area conditions (PEP Appendix A-4).

3.2.5 If there is no meteorological data readily available, a general estimate of the current Atmospheric Stability Class can be made by visual observation, using the following table:

	Sunny Day	Cloudy Day	Cloudy Night	Clear Night
light wind or calm (≤4 m/sec or 8.9 mph)	B	C	E	F
moderately strong wind (>4 m/sec or 8.9 mph)	C	D	D	D

NOTE: Assume Stability Class D whenever it is raining.

3.3 Determine the χ/Q value(s).

3.3.1 Determine whether release was out stack. If so, Exhibit 3.4.1-4 is to used. If not, or if release location is unknown, use Exhibit 3.4.1-5. Ask the Site Emergency Coordinator or Radiological Control Director, as appropriate.

3.3.1.1 If wind speed has been inferred as per 3.2.5 above, use 2 m/sec (4.5 mph) for light wind conditions and 4 m/sec (8.9 mph) for stronger winds.

3.3.2 Read across the appropriate row based on wind speed to the χ/Q value under the Atmospheric Stability Class determined in Section 3.2.

NOTE: The χ/Q values in Exhibit 3.4.1-4 and Exhibit 3.4.1-5 are for distances corresponding generally to the property boundary (approximately 4,000 ft).

3.3.3 Record the selected χ/Q value in column 2 of Exhibit 3.4.1-1.

3.4 Determine the Whole Body Dose Conversion Factor (DCF) from Table 3.4-1 and record in column 3 of Exhibit 3.4.1-1.

NOTE: Select the dose conversion factor that has units of $(R/hr)/(Ci/m^3)$ where the source is given in terms of Ci/sec; otherwise use $R/(Ci\text{-}sec/m^3)$ with the source given in units of total curies released during the time period of interest.

NOTE: If dose projection is for Thyroid (Iodine inhalation), go to Step 3.5.

TABLE 3.4-1

WHOLE BODY DOSE CONVERSION FACTORS

Accident Condition	Dose Conversion Factor $(R/hr)/(Ci/m^3)$	$R/(Ci\text{-}sec/m^3)$
Unknown/unidentified	610	0.170
Major damage to fuel cladding	610	0.170
RCS leaks or steam line leaks but no major cladding failure	290	0.081
Accidental discharge of waste gas	86	0.024
Fuel handling accident	43	0.012

3.5 Determine the Thyroid (Iodine inhalation) Dose Conversion Factor from Table 3.5-1 and record column 3 of Exhibit 3.4.1-1.

NOTE: If Dose Projection is for Whole Body, go to Step 3.4.

TABLE 3.5-1

THYROID DOSE CONVERSION FACTORS

Accident Condition	Dose Conversion Factor Rem/(Ci-sec/m^3)
Unknown/unidentified	63
Major damage to fuel cladding	63
RCS leaks or steam line leaks but no major cladding failure	98
Accidental discharge of waste gas	180
Fuel handling accident	280

3.6 Perform the multiplications and record the projected dose in column 4 of Exhibit 3.4.1-1 and initial and date each calculation in column 5.

NOTE: If the release was via the stack (elevated), maximum radiological exposures could occur beyond the property boundary depending on stability class. Refer to Step 3.8 and Exhibit 3.4.1-6 to project doses at distances beyond the property boundary.

CAUTION: These projections pertain to the radioactive gases at ground level and do not include radiation from an overhead cloud that may contribute to the whole body dose at ground level. Under certain meteorological conditions (elevated release and E, F, or G stability classes), direct radiation from an overhead plume may produce somewhat higher doses than those calculated by this procedure.

3.7 Report the projected dose near the site boundary to the Radiological Control Director (Radiological Control Manager if Emergency Operations Facility is activated) or Site Emergency Coordinator. If an elevated release, determine and report maximum off-site projected doses as per Step 3.8.

CAUTION: The following step provides a quick first cut at determining radiological exposures off site. It is included to aid in developing additional perspective on accident consequences. PEP-3.4.2 and PEP-3.4.3 should be used as the basis for more detailed assessments, particularly those in support of evaluations of possible protective actions.

3.8 The following steps can be used as an initial method to determine the dose at distances in increments out to 10 miles from the plant.

3.8.1 If the release was via the stack, use Exhibit 3.4.1-6; and if not, use Exhibit 3.4.1-7.

<u>NOTE</u>: These exhibits should provide the ratio of χ/Q at the new distance compared to the property boundary χ/Q. Assume the same stability class as found in Step 3.2.

3.8.2 Multiply the dose calculated in Step 3.6 by the ratio found in Exhibit 3.4.1-6 or 3.4.1-7. The result is the projected dose at the distance identified in the left-hand columns.

EXHIBIT 3.4.1-1

PROJECTED DOSE NEAR PROPERTY BOUNDARY

Projected Dose = (Source Term) . (χ/Q) . (Dose Conversion Factor)

Column 1	Column 2	Column 3	Column 4	Column 5
Source Term (1) Ci or Ci/sec for whole body - Ci only for thyroid	χ/Q (2) (sec/m^3)	DCF (3)(4)	Projected Dose (REM or Rem/hr)	Time/ Initial

(1) Obtain from Step 3.1

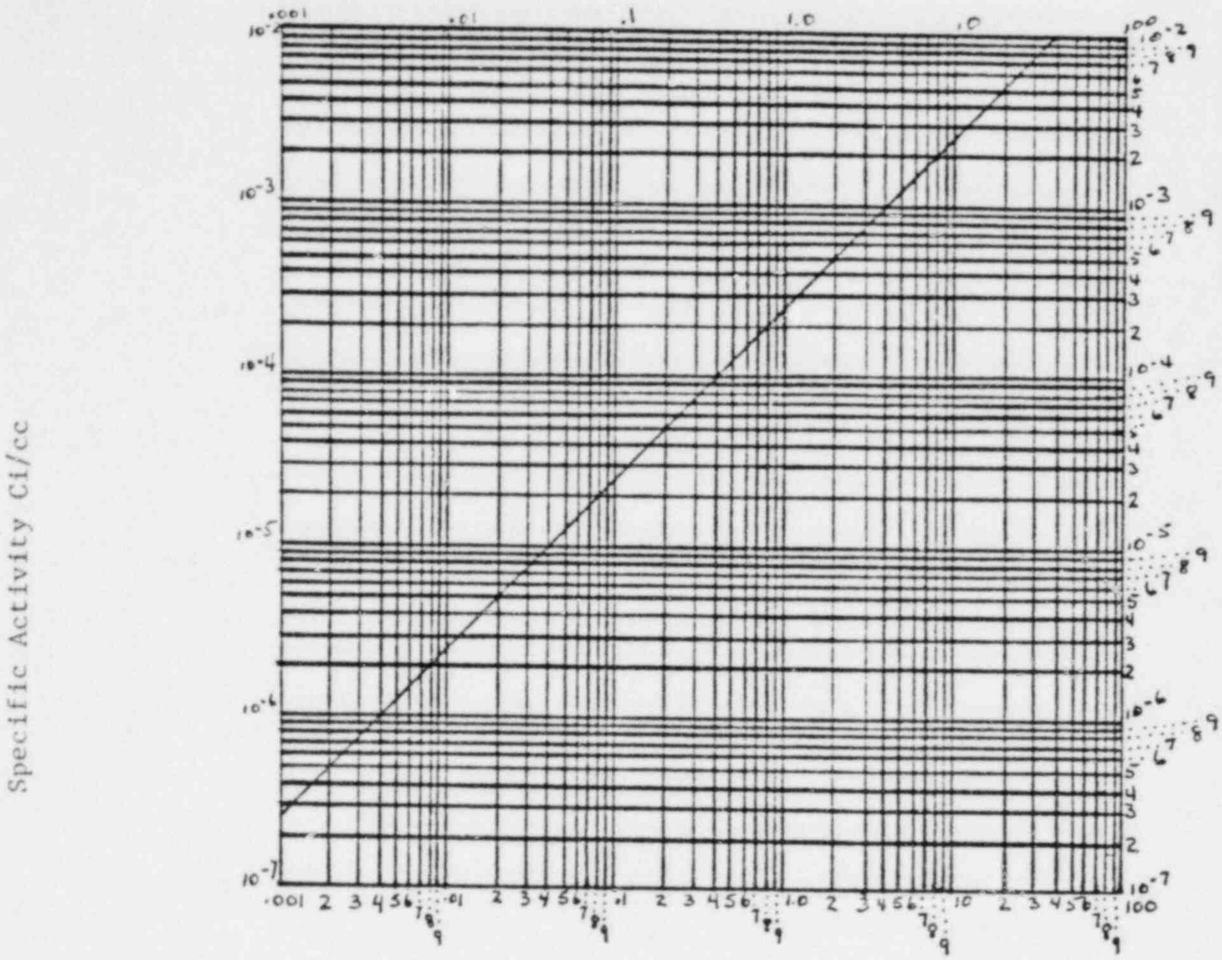
(2) Obtain from Step 3.3

(3) Obtain from Step 3.4 for Whole Body

(4) Obtain from Step 3.5 for Thyroid

EXHIBIT 3.4.1-2

Source Term Calculation From Plant Stack (High Range)



Temporary Gaseous Effluent Monitors

To determine total release activity from the plant stack:

1. Read the actual specific activity (curies/cc) from the graph as a function of the dose rate (R/hr) indicated on the meter.

2. Read flow meter for the specific release point (SCFM).

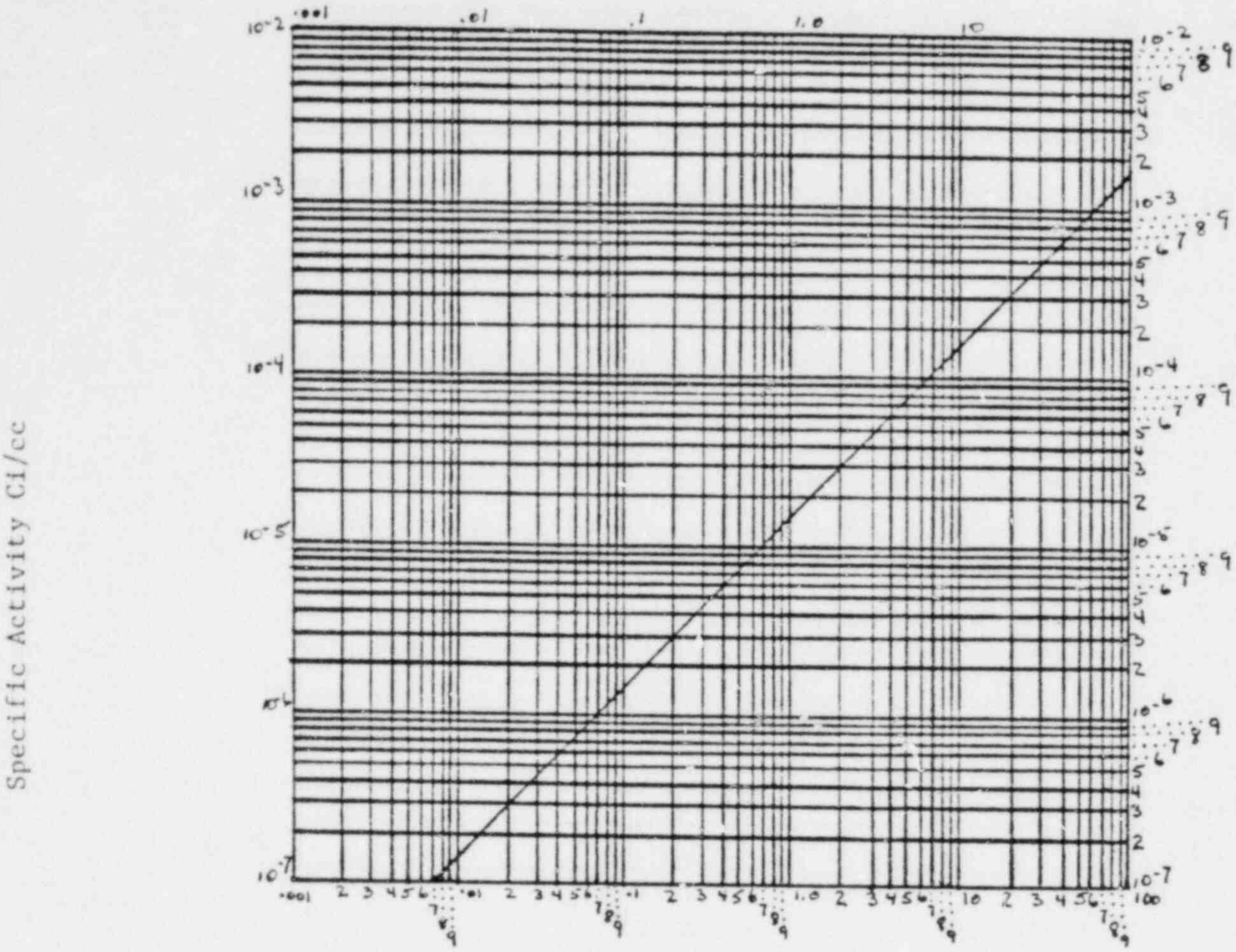
3. Calculate total release in curies/sec = specific activity (Ci/cc) x flow rate (SCFM) x 28300 (cc/SCF) x .0167 (min/sec)

OR

4. Calculate total release in curies = specific activity (Ci/cc) x flow rate (SCFM) x 28300 (cc/SCF) x duration of release in minutes. If release is continuous, recalculate every 30 minutes.

EXHIBIT 3.4.1-3

Source Term Calculation From Unit No. 1 and/or No. 2 Turbine Building Vent (High Range)



Temporary Gaseous Effluent Radiation Monitors

To determine total release activity from a Turbine Building vent:

1. Read the actual specific activity (curies/cc) from the graph as a function of the dose rate (R/hr) indicated on the meter.

2. Read the flow meter for the specific release point.

3. Calculate total release in curies/sec = specific activity (Ci/cc) x flow rate (SCFM) x 28300 (cc/SCF) x .0167 (min/sec)

OR

4. Calculate total release in curies = specific activity (Ci/cc) x flow rate (SCFM) x 28300 (cc/SCF) x duration of release in minutes. If release is continuous, recalculate every 30 minutes.

Exhibit 3.4.1-4

Meteorological Dispersion (χ/Q) Values at
BSEP Property Boundary (4000 Ft.) Elevated Release

Wind Speed		χ/Q Values By Atmospheric Stability Class (Units: sec/m^3)						
mph	m/sec	A	B	C	D	E	F	G
2	0.9	2.0×10^{-6}	1.0×10^{-5}	1.6×10^{-5}	2.5×10^{-6}	7.8×10^{-8}	1.8×10^{-12}	2.6×10^{-25}
3	1.3	1.3×10^{-6}	7.0×10^{-6}	1.0×10^{-5}	1.6×10^{-6}	5.2×10^{-8}	1.2×10^{-12}	1.7×10^{-25}
4	1.8	1.0×10^{-6}	5.2×10^{-6}	7.8×10^{-6}	1.2×10^{-6}	3.9×10^{-8}	9.0×10^{-13}	1.3×10^{-25}
5	2.2	8.1×10^{-7}	4.2×10^{-6}	6.3×10^{-6}	9.8×10^{-7}	3.1×10^{-8}	7.2×10^{-13}	1.0×10^{-25}
6	2.7	6.7×10^{-7}	3.5×10^{-6}	5.2×10^{-6}	8.2×10^{-7}	2.6×10^{-8}	6.0×10^{-13}	8.6×10^{-26}
7	3.1	5.8×10^{-7}	3.0×10^{-6}	4.5×10^{-6}	7.0×10^{-7}	2.2×10^{-8}	5.1×10^{-13}	7.3×10^{-26}
8	3.6	5.0×10^{-7}	2.6×10^{-6}	3.9×10^{-6}	6.2×10^{-7}	2.0×10^{-8}	4.5×10^{-13}	6.4×10^{-26}
9	4.0	4.5×10^{-7}	2.3×10^{-6}	3.5×10^{-6}	5.5×10^{-7}	1.7×10^{-8}	4.0×10^{-13}	5.7×10^{-26}
10	4.5	4.0×10^{-7}	2.1×10^{-6}	3.1×10^{-6}	4.9×10^{-7}	1.6×10^{-8}	3.6×10^{-13}	5.1×10^{-26}
11	4.9	3.7×10^{-7}	1.9×10^{-6}	2.8×10^{-6}	4.5×10^{-7}	1.4×10^{-8}	3.2×10^{-13}	4.7×10^{-26}
12	5.4	3.4×10^{-7}	1.8×10^{-6}	2.6×10^{-6}	4.1×10^{-7}	1.3×10^{-8}	3.0×10^{-13}	4.3×10^{-26}
13	5.8	3.1×10^{-7}	1.6×10^{-6}	2.4×10^{-6}	3.8×10^{-7}	1.2×10^{-8}	2.8×10^{-13}	4.0×10^{-26}
14	6.2	2.9×10^{-7}	1.5×10^{-6}	2.2×10^{-6}	3.5×10^{-7}	1.1×10^{-8}	2.6×10^{-13}	3.7×10^{-26}
15	6.7	2.7×10^{-7}	1.4×10^{-6}	2.1×10^{-6}	3.3×10^{-7}	1.0×10^{-8}	2.4×10^{-13}	3.4×10^{-26}
16	7.2	2.5×10^{-7}	1.3×10^{-6}	2.0×10^{-6}	3.1×10^{-7}	9.8×10^{-9}	2.2×10^{-13}	3.2×10^{-26}
17	7.6	2.4×10^{-7}	1.2×10^{-6}	1.8×10^{-6}	2.9×10^{-7}	9.2×10^{-9}	2.1×10^{-13}	3.0×10^{-26}
18	8.0	2.2×10^{-7}	1.2×10^{-6}	1.7×10^{-6}	2.7×10^{-7}	8.7×10^{-9}	2.0×10^{-13}	2.9×10^{-26}
19	8.5	2.1×10^{-7}	1.1×10^{-6}	1.6×10^{-6}	2.6×10^{-7}	8.2×10^{-9}	1.9×10^{-13}	2.7×10^{-26}
20	8.9	2.0×10^{-7}	1.0×10^{-6}	1.6×10^{-6}	2.5×10^{-7}	7.8×10^{-9}	1.8×10^{-13}	2.6×10^{-26}
21	9.4	1.9×10^{-7}	1.0×10^{-6}	1.5×10^{-6}	2.3×10^{-7}	7.4×10^{-9}	1.7×10^{-13}	2.4×10^{-26}
22	9.8	1.8×10^{-7}	9.5×10^{-7}	1.4×10^{-6}	2.2×10^{-7}	7.1×10^{-9}	1.6×10^{-13}	2.3×10^{-26}
23	10.3	1.8×10^{-7}	9.1×10^{-7}	1.4×10^{-6}	2.1×10^{-7}	6.8×10^{-9}	1.6×10^{-13}	2.2×10^{-26}
24	10.7	1.7×10^{-7}	8.8×10^{-7}	1.3×10^{-6}	2.0×10^{-7}	6.5×10^{-9}	1.5×10^{-13}	2.1×10^{-26}
25	11.2	1.6×10^{-7}	8.4×10^{-7}	1.2×10^{-6}	2.0×10^{-7}	6.2×10^{-9}	1.4×10^{-13}	2.0×10^{-26}
26	11.6	1.6×10^{-7}	8.1×10^{-7}	1.2×10^{-6}	1.9×10^{-7}	6.0×10^{-9}	1.4×10^{-13}	2.0×10^{-26}
27	12.1	1.5×10^{-7}	7.8×10^{-7}	1.2×10^{-6}	1.8×10^{-7}	5.8×10^{-9}	1.3×10^{-13}	1.9×10^{-26}
28	12.5	1.4×10^{-7}	7.5×10^{-7}	1.1×10^{-6}	1.8×10^{-7}	5.6×10^{-9}	1.3×10^{-13}	1.8×10^{-26}
29	13.0	1.4×10^{-7}	7.2×10^{-7}	1.1×10^{-6}	1.7×10^{-7}	5.4×10^{-9}	1.2×10^{-13}	1.8×10^{-26}
30	13.4	1.3×10^{-7}	7.0×10^{-7}	1.0×10^{-6}	1.6×10^{-7}	5.2×10^{-9}	1.2×10^{-13}	1.7×10^{-26}

Note: If wind speed is between adjacent values, use the lower value to find χ/Q.

EXHIBIT 3.4.1-5

METEOROLOGICAL DISPERSION (χ/Q) VALUES AT

BSEP PROPERTY BOUNDARY (4000 Ft.) GROUND LEVEL RELEASE

Wind Speed		χ/Q Values by Atmospheric Stability (Units: sec/m^3)						
mph	m/sec	A	B	C	D	E	F	G
2	0.9	2.1×10^{-6}	1.4×10^{-5}	3.9×10^{-5}	1.2×10^{-4}	2.3×10^{-4}	5.4×10^{-4}	1.3×10^{-3}
3	1.3	1.4×10^{-6}	9.2×10^{-6}	2.6×10^{-5}	7.9×10^{-5}	1.6×10^{-4}	3.6×10^{-4}	8.8×10^{-4}
4	1.8	1.0×10^{-6}	6.9×10^{-6}	2.0×10^{-5}	5.9×10^{-5}	1.2×10^{-4}	2.7×10^{-4}	6.6×10^{-4}
5	2.2	8.2×10^{-7}	5.[illegible]x10^{-6}	1.6×10^{-5}	4.7×10^{-5}	9.3×10^{-5}	2.2×10^{-4}	5.3×10^{-4}
6	2.7	6.9×10^{-7}	4.6×10^{-6}	1.3×10^{-5}	4.0×10^{-5}	7.8×10^{-5}	1.8×10^{-4}	4.4×10^{-4}
7	3.1	5.9×10^{-7}	4.0×10^{-6}	1.1×10^{-5}	3.4×10^{-5}	6.7×10^{-5}	1.5×10^{-4}	3.8×10^{-4}
8	3.6	5.2×10^{-7}	3.5×10^{-6}	9.8×10^{-6}	3.0×10^{-5}	5.8×10^{-5}	1.4×10^{-4}	3.3×10^{-4}
9	4.0	4.6×10^{-7}	3.1×10^{-6}	8.7×10^{-6}	2.6×10^{-5}	5.2×10^{-5}	1.2×10^{-4}	2.9×10^{-4}
10	4.5	4.1×10^{-7}	2.8×10^{-6}	7.8×10^{-6}	2.4×10^{-5}	4.7×10^{-5}	1.1×10^{-4}	2.6×10^{-4}
11	4.9	3.7×10^{-7}	2.5×10^{-6}	7.1×10^{-6}	2.2×10^{-5}	4.2×10^{-5}	9.8×10^{-5}	2.4×10^{-4}
12	5.4	3.4×10^{-7}	2.3×10^{-6}	6.5×10^{-6}	2.0×10^{-5}	3.9×10^{-5}	9.0×10^{-5}	2.2×10^{-4}
13	5.8	3.2×10^{-7}	2.1×10^{-6}	6.0×10^{-6}	1.8×10^{-5}	3.6×10^{-5}	8.3×10^{-5}	2.0×10^{-4}
14	6.2	2.9×10^{-7}	2.0×10^{-6}	5.6×10^{-6}	1.7×10^{-5}	3.3×10^{-5}	7.7×10^{-5}	1.9×10^{-4}
15	6.7	2.7×10^{-7}	1.8×10^{-6}	5.2×10^{-6}	1.6×10^{-5}	3.1×10^{-5}	7.2×10^{-5}	1.8×10^{-4}
16	7.2	2.6×10^{-7}	1.7×10^{-6}	4.9×10^{-6}	1.5×10^{-5}	2.9×10^{-5}	6.8×10^{-5}	1.6×10^{-4}
17	7.6	2.4×10^{-7}	1.6×10^{-6}	4.6×10^{-6}	1.4×10^{-5}	2.7×10^{-5}	6.4×10^{-5}	1.6×10^{-4}
18	8.0	2.3×10^{-7}	1.5×10^{-6}	4.3×10^{-6}	1.3×10^{-5}	2.6×10^{-5}	6.0×10^{-5}	1.5×10^{-4}
19	8.5	2.2×10^{-7}	1.4×10^{-6}	4.1×10^{-6}	1.2×10^{-5}	2.4×10^{-5}	5.7×10^{-5}	1.4×10^{-4}
20	8.9	2.1×10^{-7}	1.4×10^{-6}	3.9×10^{-6}	1.2×10^{-5}	2.3×10^{-5}	5.4×10^{-5}	1.3×10^{-4}
21	9.4	2.0×10^{-7}	1.3×10^{-6}	3.7×10^{-6}	1.1×10^{-5}	2.2×10^{-5}	5.1×10^{-5}	1.3×10^{-4}
22	9.8	1.9×10^{-7}	1.2×10^{-6}	3.6×10^{-6}	1.1×10^{-5}	2.1×10^{-5}	4.9×10^{-5}	1.2×10^{-4}
23	10.3	1.8×10^{-7}	1.2×10^{-6}	3.4×10^{-6}	1.0×10^{-5}	2.0×10^{-5}	4.7×10^{-5}	1.1×10^{-4}
24	10.7	1.7×10^{-7}	1.2×10^{-6}	3.2×10^{-6}	9.9×10^{-6}	1.9×10^{-5}	4.5×10^{-5}	1.1×10^{-4}
25	11.2	1.6×10^{-7}	1.1×10^{-6}	3.1×10^{-6}	9.5×10^{-6}	1.9×10^{-5}	4.3×10^{-5}	1.0×10^{-4}
26	11.6	1.6×10^{-7}	1.1×10^{-6}	3.0×10^{-6}	9.1×10^{-6}	1.8×10^{-5}	4.2×10^{-5}	1.0×10^{-4}
27	12.1	1.5×10^{-7}	1.0×10^{-6}	2.9×10^{-6}	8.8×10^{-6}	1.7×10^{-5}	4.0×10^{-5}	9.8×10^{-5}
28	12.5	1.5×10^{-7}	9.9×10^{-7}	2.8×10^{-6}	8.5×10^{-6}	1.7×10^{-5}	3.8×10^{-5}	9.4×10^{-5}
29	13.0	1.4×10^{-7}	9.6×10^{-7}	2.7×10^{-6}	8.2×10^{-6}	1.6×10^{-5}	3.7×10^{-5}	9.1×10^{-5}
30	13.4	1.4×10^{-7}	9.2×10^{-7}	2.6×10^{-6}	7.9×10^{-6}	1.6×10^{-5}	3.6×10^{-5}	8.8×10^{-5}

Note: If wind speed is between adjacent values, use the lower value to find χ/Q.

EXHIBIT 3.4.1-6

EXTRAPOLATION RATIO FOR ESTIMATING DOSES BEYOND
BSEP PROPERTY BOUNDARY (4000 Ft.) ELEVATED RELEASE

Distance From Plant		Extrapolation Ratios by Atmospheric Stability Class						
Miles	km	A	B	C	D	E	F	G
1	1.6	4.6×10^{-1}	6.8×10^{-1}	8.3×10^{-1}	2.4×10^{0}	6.8×10^{0}	1.9×10^{2}	4.1×10^{3}
2	3.2	6.1×10^{-2}	2.0×10^{-1}	3.6×10^{-1}	3.6×10^{0}	5.4×10^{1}	9.7×10^{4}	4.3×10^{12}
3	4.8	3.6×10^{-2}	1.4×10^{-1}	1.8×10^{-1}	3.0×10^{0}	7.4×10^{1}	4.9×10^{5}	8.7×10^{15}
4	6.4	1.1×10^{-2}	6.5×10^{-2}	1.1×10^{-1}	2.2×10^{0}	7.4×10^{1}	1.0×10^{6}	3.9×10^{16}
5	8.0	3.7×10^{-3}	3.2×10^{-2}	7.8×10^{-2}	1.8×10^{0}	6.8×10^{1}	1.4×10^{6}	1.4×10^{17}
6	9.7	2.2×10^{-3}	2.2×10^{-2}	5.7×10^{-2}	1.5×10^{0}	6.3×10^{1}	1.6×10^{6}	3.9×10^{17}
7	11.3	1.3×10^{-3}	1.7×10^{-2}	4.3×10^{-2}	1.3×10^{0}	5.7×10^{1}	1.6×10^{6}	7.6×10^{17}
8	12.9	8.9×10^{-4}	1.3×10^{-2}	3.4×10^{-2}	1.0×10^{0}	5.3×10^{1}	1.7×10^{6}	1.1×10^{18}
9	14.5	6.1×10^{-4}	1.1×10^{-2}	2.7×10^{-2}	9.5×10^{-1}	4.8×10^{1}	1.7×10^{6}	1.6×10^{18}
10	16.1	4.3×10^{-4}	8.5×10^{-3}	2.3×10^{-2}	8.4×10^{-1}	4.4×10^{1}	1.7×10^{6}	2.0×10^{18}

NOTE: With an Elevated Release maximum radiological exposures may occur beyond the property boundary depending on stability class. The following table indicates the downwind distance where maximum exposures are likely to occur as the result of an elevated release.

Stability Class	Downwind Distance	
A	0.27 Miles (0.43 km)	
B	0.45 Miles (0.72 km)	
C	0.76 Miles (1.22 km)	[Property Boundary]
D	1.8 Miles (2.9 km)	
E	3.5 Miles (5.6 km)	
F	9 Miles (14.5 km)	
G	33 Miles (53 km)	

EXHIBIT 3.4.1-7

EXTRAPOLATION RATIO FOR ESTIMATING DOSES BEYOND BSEP PROPERTY BOUNDARY (4000 Ft.) GROUND LEVEL RELEASE

Distance From Plant		Extrapolation Ratios by Atmospheric Stability Class						
Miles	km	A	B	C	D	E	F	G
1	1.6	$4.6x10^{-1}$	$5.8x10^{-1}$	$5.9x10^{-1}$	$6.3x10^{-1}$	$6.6x10^{-1}$	$6.6x10^{-1}$	$6.6x10^{-1}$
2	3.2	$6.0x10^{-2}$	$1.5x10^{-1}$	$1.7x10^{-1}$	$2.2x10^{-1}$	$2.3x10^{-1}$	$2.4x10^{-1}$	$2.5x10^{-1}$
3	4.8	$1.8x10^{-2}$	$6.8x10^{-2}$	$7.7x10^{-2}$	$1.2x10^{-1}$	$1.2x10^{-1}$	$1.3x10^{-1}$	$1.4x10^{-1}$
4	6.4	$7.1x10^{-3}$	$3.9x10^{-2}$	$4.6x10^{-2}$	$7.5x10^{-2}$	$8.4x10^{-2}$	$8.9x10^{-2}$	$9.8x10^{-2}$
5	8.0	$3.6x10^{-3}$	$2.5x10^{-2}$	$3.2x10^{-2}$	$5.5x10^{-2}$	$6.2x10^{-2}$	$6.7x10^{-2}$	$7.3x10^{-2}$
6	9.7	$2.2x10^{-3}$	$1.7x10^{-2}$	$2.2x10^{-2}$	$4.2x10^{-2}$	$4.7x10^{-2}$	$5.2x10^{-2}$	$5.8x10^{-2}$
7	11.3	$1.2x10^{-3}$	$1.2x10^{-2}$	$1.6x10^{-2}$	$3.2x10^{-2}$	$3.7x10^{-2}$	$4.1x10^{-2}$	$4.7x10^{-2}$
8	12.9	$8.7x10^{-4}$	$9.7x10^{-3}$	$1.3x10^{-2}$	$2.7x10^{-2}$	$3.2x10^{-2}$	$3.6x10^{-2}$	$4.0x10^{-2}$
9	14.5	$6.0x10^{-4}$	$7.7x10^{-3}$	$1.1x10^{-2}$	$2.3x10^{-2}$	$2.7x10^{-2}$	$3.1x10^{-2}$	$3.4x10^{-2}$
10	16.1	$4.2x10^{-4}$	$6.4x10^{-3}$	$8.6x10^{-3}$	$2.0x10^{-2}$	$2.3x10^{-2}$	$2.7x10^{-2}$	$3.0x10^{-2}$

File No. ______
Unit No. ______
Q+RETcd ______
App'l ______

CAROLINA POWER & LIGHT COMPANY
BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 & 2

WHOLE BODY DOSE PROJECTIONS

PLANT EMERGENCY PROCEDURE PEP-3.4.2

VOLUME XIII

Rev. 2

Recommended By: Robert A Schelneato Date: 11/20/81

Approved By: RCMorgan for C.R. Dietz Date: 11-20-81
Plant General Manager

PEP-3.4.2 WHOLE BODY DOSE PROJECTIONS

1.0 Responsible Individuals and Objectives

The Radiological Control Director or the Dose Projection Coordinator is responsible for calculating whole body dose projections to be used by the Radiological Control Director and the Site Emergency Coordinator in determining and evaluating possible off-site consequences from a release of radioactivity. The Radiological Control Manager shall assume responsibility for calculating off-site whole body dose projections (to be used by the Emergency Response Manager) after the Emergency Operations Facility is activated.

2.0 Scope and Applicability

This procedure is intended to be used for all manual calculations of whole body dose subsequent to that in PEP-3.4.1, "Initial Dose Projections." It is intended to provide realistic assessment of doses at any point in the Emergency Planning Zone (EPZ). This procedure shall be performed periodically as directed by the Radiological Control Director, (Radiological Control Manager after the Emergency Operations Facility is activated). These projections pertain to the radioactive gases at ground level and do not include radiations from an overhead cloud that may contribute to the whole body dose at ground level.

Provisions are included for:

1) Determining the Atmospheric Dispersion Factor (χ/Q) at any point downwind in the Plume Exposure Planning Zone based on the Atmospheric Stability Class and the distance to that point from the point of release.
2) Correcting the dose to account for the time after shutdown that the source data is taken.
3) Correcting from a semi-infinite cloud to finite cloud.
4) Correcting for distance away from the centerline of the cloud.

3.0 Actions

List of EXHIBITS:

3.4.2-1	"Whole Body Dose Projections"
3.4.2-2	10 Mile EPZ Map (Example)
3.4.2-3	50 Mile EPZ Map (Example)
3.4.2-4	$\chi\bar{u}/Q$ with Distance for Elevated Releases
3.4.2-5	$\chi\bar{u}/Q$ with Distance for Ground Level Releases
3.4.2-6	Horizontal Dispersion Coefficient as a Function of Downwind Distance From the Source
3.4.2-7	Vertical Dispersion Coefficient as a Function of Downwind Distance From the Source
3.4.2-8	Whole Body Dose Conversion Factors
3.4.2-9	Finite Cloud Correction Factors
3.4.2-10	Doses at Various Distances From Cloud Centerline

Note: EXHIBIT 3.4.2-1, "Whole Body Dose Projections," is for recording and calculating dose projections. Steps 3.1 through 3.7 provide input for the calculations.

3.1 Use the source term calculated in accordance with appropriate PEP-Section 3.6, "Source Term Assessments and Estimates of Core Damage." Enter the Source Term Value in column 1 of EXHIBIT 3.4.2-1.

3.2 Determine the Atmospheric Stability Class

Note: Steps 3.2.1 through 3.2.5 are in order of preferred use.

3.2.1 If operable, use the plant computer or RC&T computer to obtain the Atmospheric Stability Class, wind speed and wind direction, and record on EXHIBIT 3.4.2-1.

Note: The wind speed and wind direction should be that best approximating the effective height of the release. This may be determined by various plant monitors. Where available, results from plume tracking/monitoring should be used to confirm or modify these estimates.

3.2.2 If the computers are not accessible, determine the Atmospheric Stability Class, wind speed, and wind direction in accordance with EI-27.3, Appendix A, "Manual Met Tower Data Aquisition," and record on EXHIBIT 3.4.2-1.

3.2.3 If the on-site meteorological station is completely inoperable, the following can be performed to obtain an estimate of the on-site wind speed and direction, and the appropriate Atmospheric Stability Class.

1) Call the National Weather Service Office at Wilmington, North Carolina, for the current weather observations. Obtain the following information from the meteorological forecaster who is on duty:

a. Station for which data is given ____________

b. Wind speed (knots) ____________

c. Cloud cover (in tenths of total) ____________

d. Cloud ceiling (feet above ground) ____________

e. Wind direction (N, S, E, etc.) ____________

2) Load the programmed cassette (the same cassette used in the Automated Dose Projection Procedure, PEP 3.4.5) into the HP9830A, enter LOAD 3 EXECUTE, and enter RUN EXECUTE.

NOTE: Press the EXECUTE button after each entry into the computer to allow the program to proceed.

3) The display will read "WIND SPEED (knots)." The program is asking for the wind speed in knots for the NWS observation station. Enter the appropriate response (example...1.0, 3.0, or 0.0 for a calm wind).

4) The display will read "CLOUD COVER (TENTHS)." The program is asking for the total cloud cover of the sky in tenths. That is, if the sky is overcast, 10/10ths would be the condition. The proper response to the computer would be to enter 10. If the sky was clear, the appropriate response to the computer would be to enter 0. Enter the appropriate response.

5) The display will read "CLOUD CEILING (FEET)." The program is asking for the height of the most obscure cloud deck above the ground level. Enter the appropriate response (example.....1000.).

6) The display will read "JULIAN DATE." The program is asking for the current JULIAN DATE, that is, the number of calendar days since the first of the calendar year. Enter the appropriate response.

7) The display will read "CURRENT TIME (24-hour clock)." The program is asking for the current time (EASTERN STANDARD TIME) in the common 24-hour clock (that is, NOON=1200 and midnight=0000.; all other times are reported such as 1 p.m. = 1300). Enter the appropriate response.

8) The computer program will now compute the appropriate Atmospheric Stability class, based upon the weather observations entered into the computer. The output will be displayed on the visual screen as follows:

   Wind speed = (number) mph

   Atmospheric Stability Class = (letter)

   NOTE: The letter for the Atmospheric Stability class will be the Pasquill Stability indicator, plant process computer.

9) Obtain and record wind direction and speed on EXHIBIT 3.4.2-1. Use the correct Atmospheric Stability class in the Dose Calculations.

3.2.4 Call the Licensing & Permits Section in Raleigh and request meteorological data (see PEP Appendix A.4).

3.2.5 If there is no meteorological data readily available, estimate the wind speed and direction, and determine and circle appropriate Atmospheric Stability Class.

	Sunny Day	Cloudy Day	Cloudy Night	Clear Night
light wind or calm ($\leq$4m/s) = ($\leq$8.9 mph)	B	C	E	F
moderately strong wind (>4m/s) = (>8.9 mph)	C	D	D	D

Record wind direction and stability class on EXHIBIT 3.4.2-1.

Note: Assume Stability Class D whenever it is raining.

3.3 Locate and mark with an "X" the point of interest on either EXHIBIT 3.4.2-2 (10 Mile EPZ) or EXHIBIT 3.4.2-3 (50 Mile EPZ) and estimate the distance in meters or miles to be used in Step 3.4

Note: EXHIBITS 3.4.2-2 and 3.4.2-3 are examples only. DO NOT USE. Use an appropriately scaled (larger) map provided.

3.4 Determine the Atmospheric Dispersion Factor, χ/Q, by using either Step 3.4.1 or Step 3.4.2. Step 3.4.1 makes use of $\chi\bar{u}/Q$ versus distance curves by stability class. Step 3.4.2 makes use of the original equation from which the curves in Step 3.4.1 were generated.

3.4.1 Determine the Atmospheric Dispersion Factor, χ/Q, using either EXHIBIT 3.4.2-4 if the release is via the stack or EXHIBIT 3.4.2-5 if the release is considered from ground level.

3.4.1.1 Using the distance determined in Step 3.3, locate the distance on either of the horizontal axes of the EXHIBIT.

3.4.1.2 Read up or down to the line for the appropriate stability class as determined in Step 3.2.1, 3.2.2, or 3.2.3.

3.4.1.3 Record the appropriate $\chi\bar{u}/Q$ from the vertical scale for use in Step 3.4.1.5.

3.4.1.4 Record the $\bar{u}$ (wind speed) from Step 3.2.1, 3.2.2, or 3.2.3 for use in Step 3.4.1.5.

3.4.1.5 Calculate the χ/Q for the point of interest and enter in Column 2 of EXHIBIT 3.4.2-1.

$$\frac{\chi}{Q} = \frac{\chi\bar{u}}{Q} \div \bar{u}$$

$$\frac{\chi}{Q} = \_\_\_\_\_ \div \_\_\_\_\_ = \_\_\_\_\_$$

Note: Wind speed must be in units of m/sec.

3.4.2 Determine the Atmospheric Dispersion Factor, χ/Q, using the following equation where concentration is to be calculated along the centerline of the plume at ground level.

$$\frac{\chi}{Q} = \frac{1}{\pi \sigma_y \sigma_z \bar{u}} \exp\left[-\frac{1}{2}\left(\frac{H}{\sigma_z}\right)^2\right]$$

where χ/Q = Atmospheric Dispersion Factor, sec/m^3.

π = 3.1415.

$\bar{u}$ = average wind speed, m/sec.

H = release emission height (100 m for stack releases, 0 m for ground level releases).

σ_y = horizontal dispersion coefficient, m; (see EXHIBIT 3.4.2-6).

σ_z = vertical dispersion coefficient, m; (see EXHIBIT 3.4.2-7).

Note: To find σ_y for Stability Class G, multiply the σ_y for Stability Class F by 2/3. To find σ_z for Stability Class G, multiply the σ_z for Stability Class F by 3/5.

3.5 Determine the Dose Conversion Factor corresponding to the time that the cloud is projected to pass by the point of interest.

3.5.1 Estimate the time of cloud passage over the point of interest (x):

$$\text{time after shutdown (in hours)} + \frac{\text{distance to point of interest (in meters)}}{3600\bar{u}}$$

= ___________ hours

3.5.2 Select the Dose Conversion Factor from EXHIBIT 3.4.2-8 corresponding to the cloud passage time of 3.5.1. Use the value in units of $(R/hr)/(Ci/m^3)$ if the source term being used is given in terms of Ci/sec. If the source term is in curies, use $R/(Ci\text{-}sec/m^3)$. Record it in Column 3 of EXHIBIT 3.4.2-1.

Note: Multiplication of columns 1, 2, and 3 of EXHIBIT 3.4.2-1 results in a projected dose for a semi-infinite cloud at the distance and time specified if the point is on the centerline of the cloud.

3.6 The value in Column 3 of EXHIBIT 3.4.2-1 will overestimate doses at distances within 10 miles. EXHIBIT 3.4.2-9 provides correction factors to account for the finite size of the cloud versus that dose assumed in Step 3.5.2. EXHIBIT 3.4.2-9 is only applicable for times less than 3 1/2 hours after reactor shutdown.

3.6.1 Select the appropriate distance (from Step 3.3).

3.6.2 Read across the row to the appropriate Stability Classification Column (from Step 3.2).

3.6.3 Record the Finite Cloud Correction Factor in column 4 of EXHIBIT 3.4.2-1.

3.7 If the point of interest is not on the centerline of the cloud, correct the Dose for lateral distance (y) deviation.

3.7.1 Estimate the lateral distance (y) between the point of interest and the centerline of the cloud using the appropriate maps.

Record: y = _____(m)

Note: If not otherwise known, the lateral distance (y) between the point of interest and the centerline of the cloud is estimated by use of triangulation of the point with respect to the plant and the cloud centerline sector on the appropriately scaled map.

3.7.2 Using EXHIBIT 3.4.2-6, determine σ_y as a function of distance (Step 3.7.1) and Stability Class (Step 3.2) by locating the distance on the horizontal axis, read up to the diagonal line for the stability class and read the σ_y from the left vertical axis.

Note: To find σ_y for stability class G, multiply the σ_y for stability class F by 2/3.

3.7.3 Divide the lateral distance by σ_y to determine the number of σ_y's between the cloud centerline and the point of interest.

3.7.4 Using the number of σ_y's, refer to EXHIBIT 3.4.2-10 and determine the dose conversion factor. Locate the number of σ_y's on the horizontal axis, and read up to the distance of σ_y (meters). Read across to the vertical axis to obtain the appropriate correction factor (CF). Enter this value in Column 5 of EXHIBIT 3.4.2-1.

3.8 Perform the multiplications and record the projected dose in column 6 of EXHIBIT 3.4.2-1 and next to the appropriate mark (X) on the map. Initial and date each calculation in Column 7.

3.9 Report the Whole Body projected dose to the Radiological Control Director or Site Emergency Coordinator. Report to the Radiation Control Manager if the Emergency Operations Facility has been activated.

3.10 To estimate a source term based on measured radiation levels in the environment these procedures need only be performed in reverse order, solving for the unknown value in Column 1 of EXHIBIT 3.4.2-1.

EXHIBIT 3.4.2-1

WHOLE BODY DOSE PROJECTIONS										
				Column (1)	Column (2)	Column (3)	Column (4)	Column (5)	Column (6)	Column (7)
Wind Speed (m/sec)	Wind Direction (FROM)	Stab-ility Class	Point of Interest Downwind Distance	Source Term (Ci or Ci/sec) Step 3.1	X/Q (sec/m^3) Step 3.4	Dose Conver-sion Factor Step 3.5	Finite Cloud Correction Factor Step 3.6	Lateral Deviation Correction Factor Step 3.7	Projected Dose (Rem or Rem/hr)	Time/ Initial

* Column 6 = Column 1 . Column 2 . Column 3 . Column 4 . Column 5

EXHIBIT 3.4.2-1 WHOLE BODY DOSE PROJECTIONS

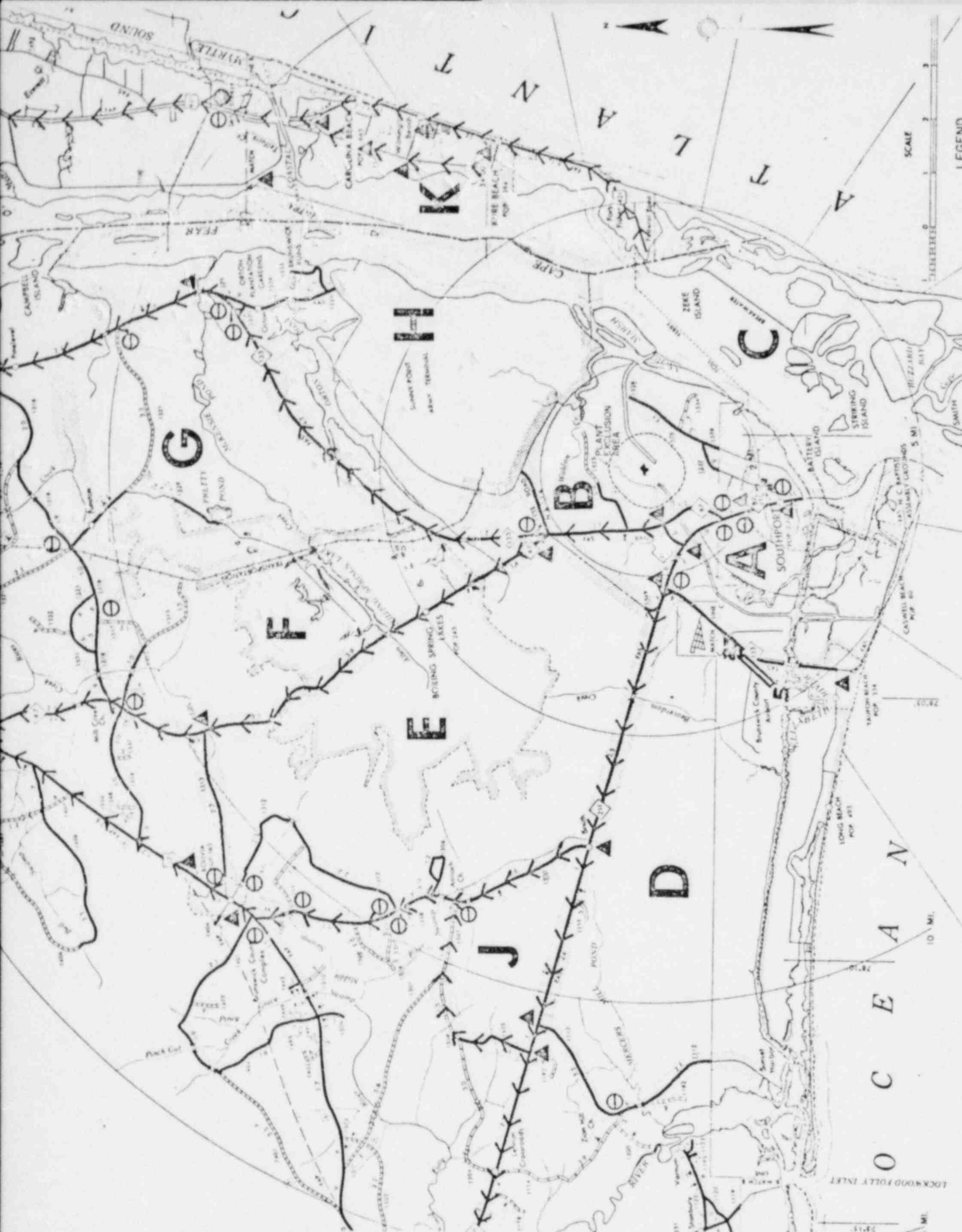


EXHIBIT 3.4.2-2 10 Mile EPZ Map (Example)

EXHIBIT 3.4.2-3 50 Mile EPZ Map (Example)

$\chi\bar{u}/Q$ WITH DISTANCE FOR ELEVATED RELEASES (100 m) BY STABILITY CLASS

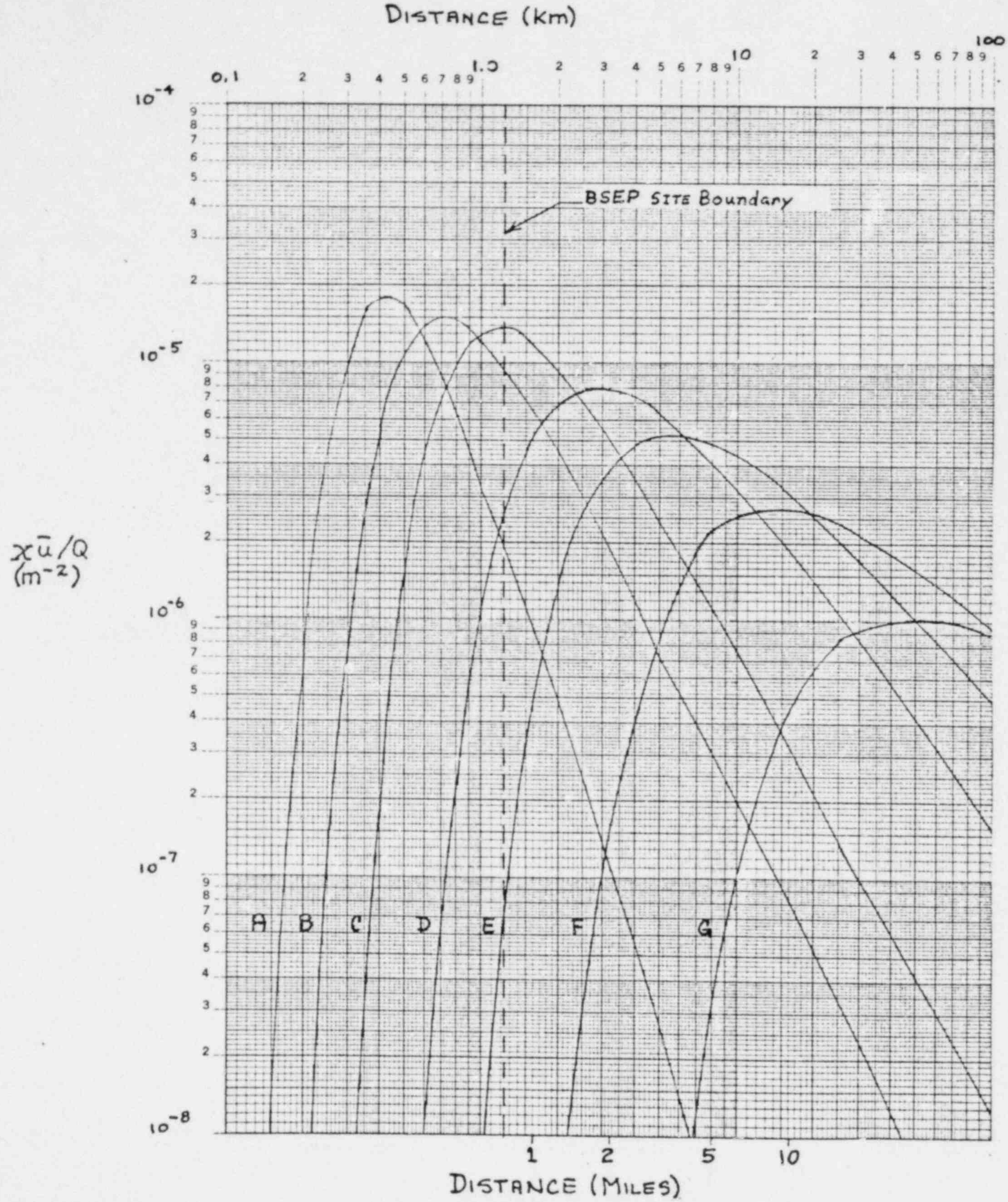


EXHIBIT 3.4.2-5

$\chi\bar{u}/Q$ WITH DISTANCE FOR GROUND LEVEL RELEASES (Øm) BY STABILITY CLASS

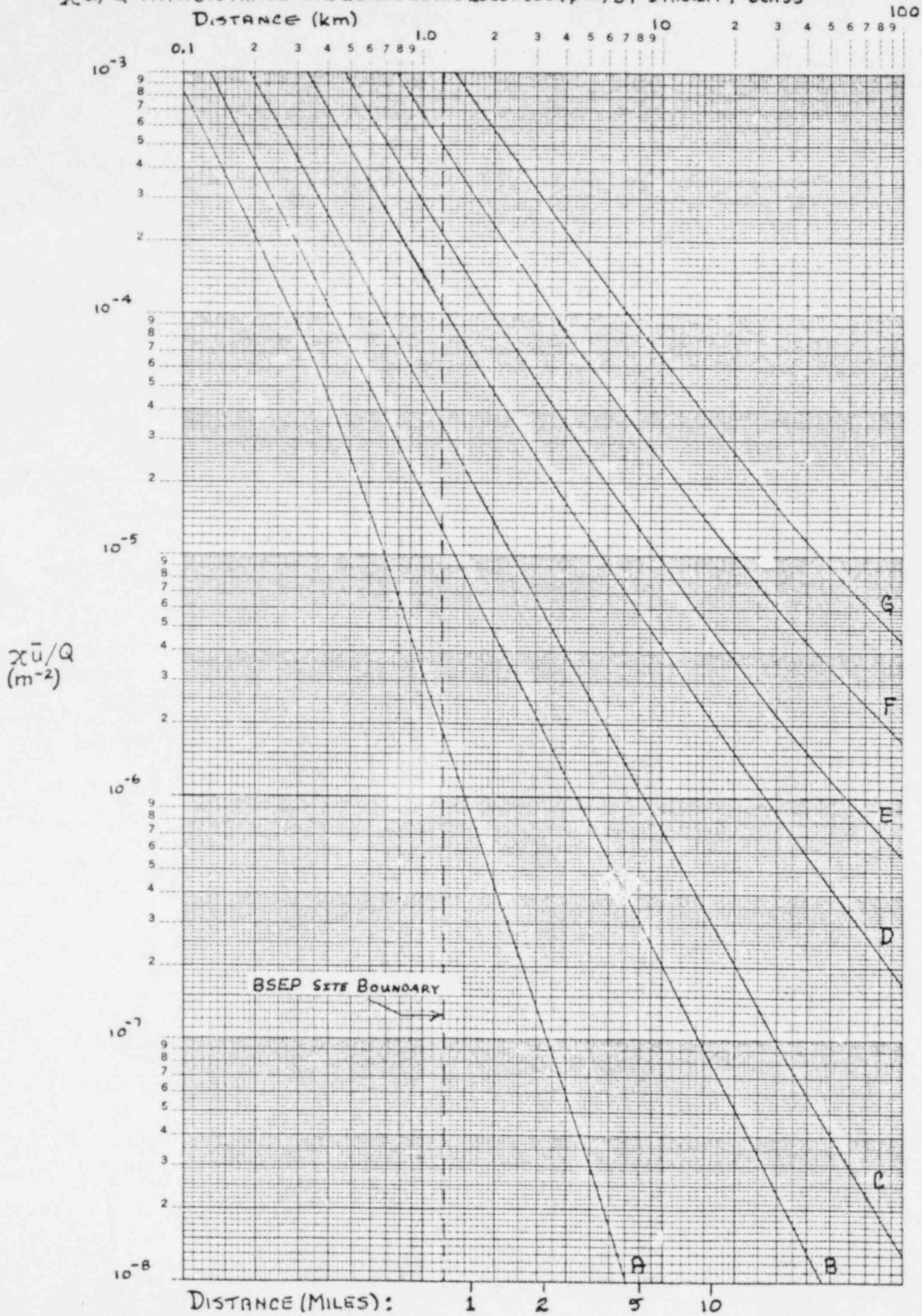
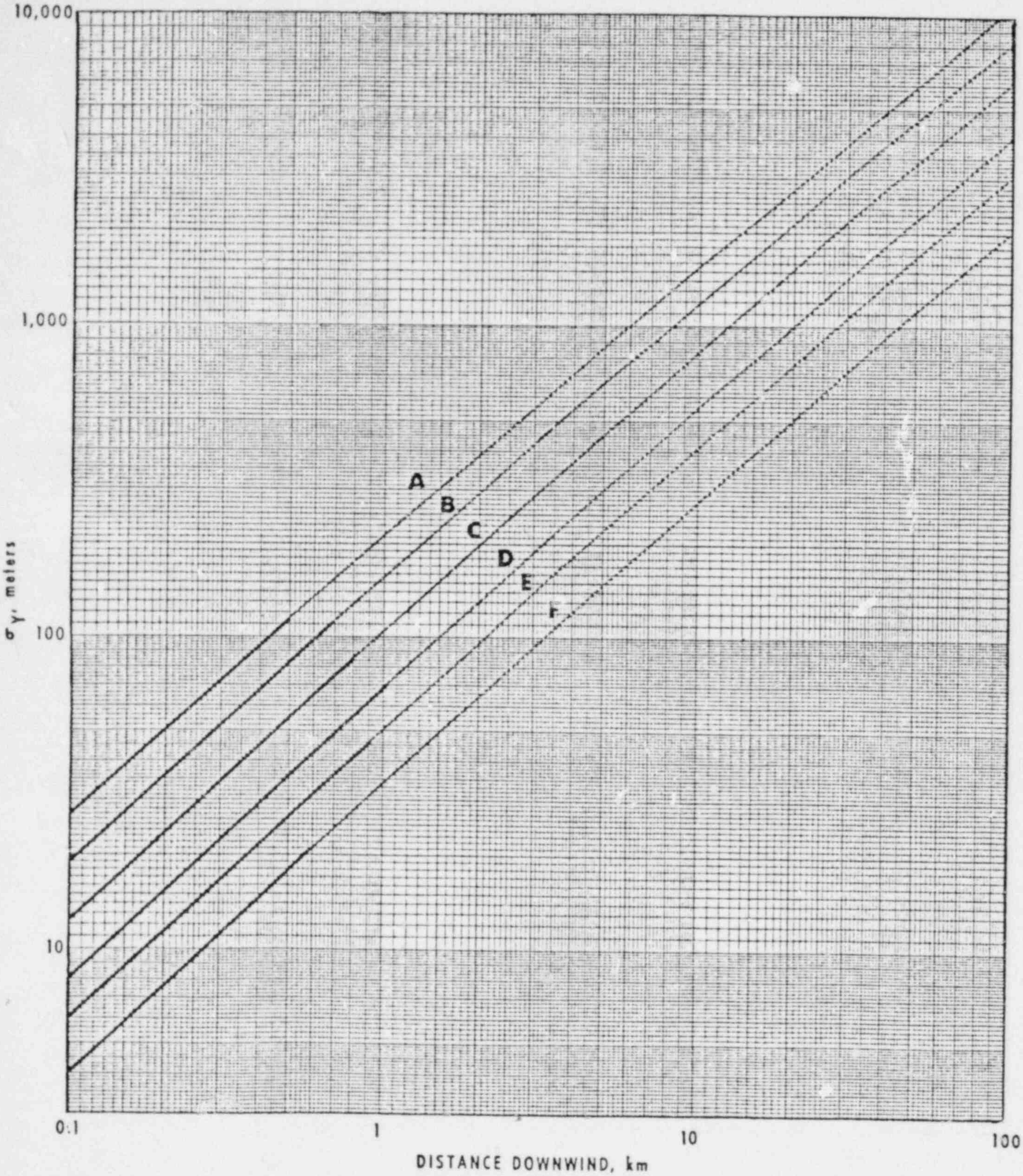
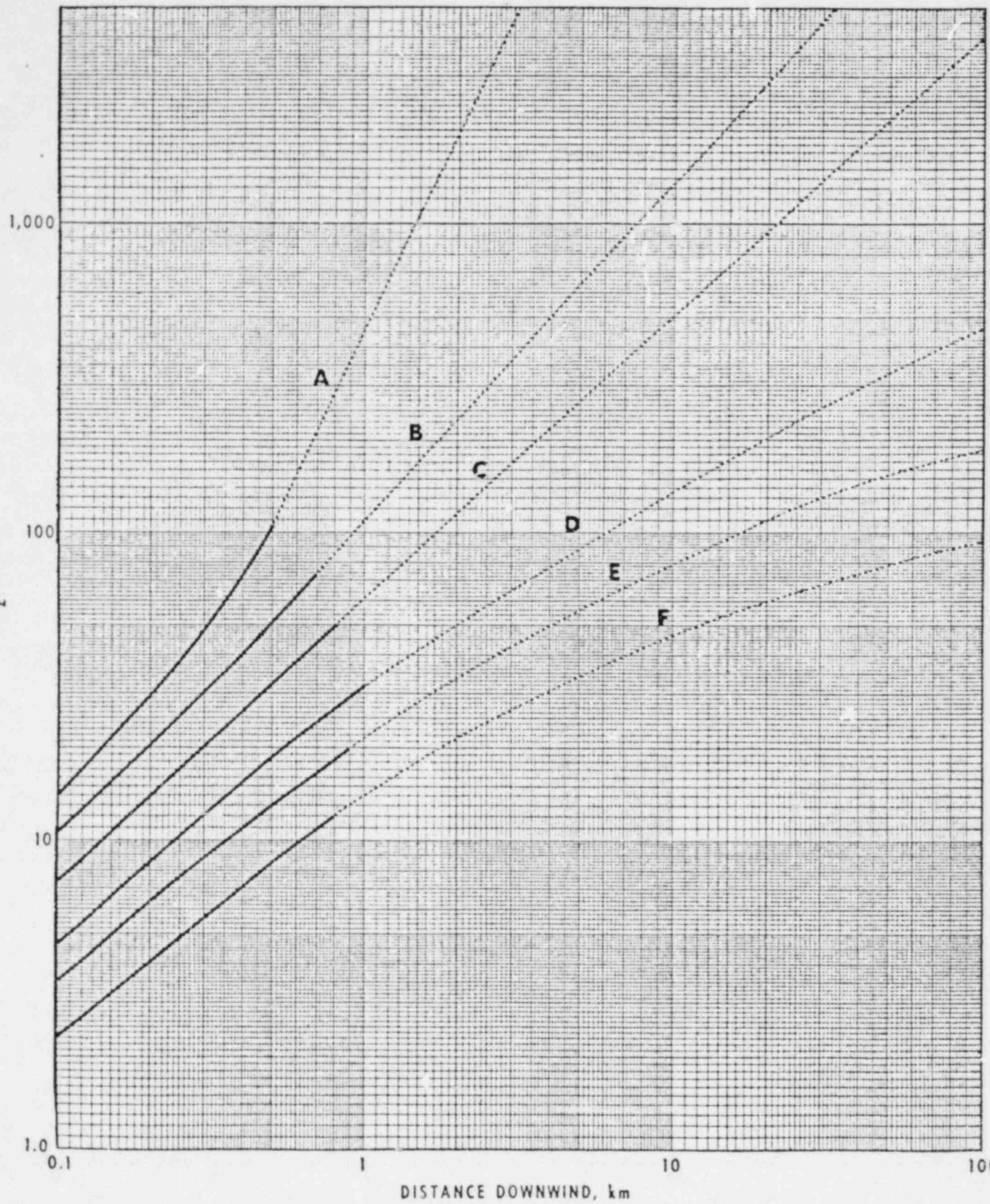


EXHIBIT 3.4.2-6



Horizontal dispersion coefficient as a function of downwind distance from the source.



Vertical dispersion coefficient as a function of downwind distance from the source.

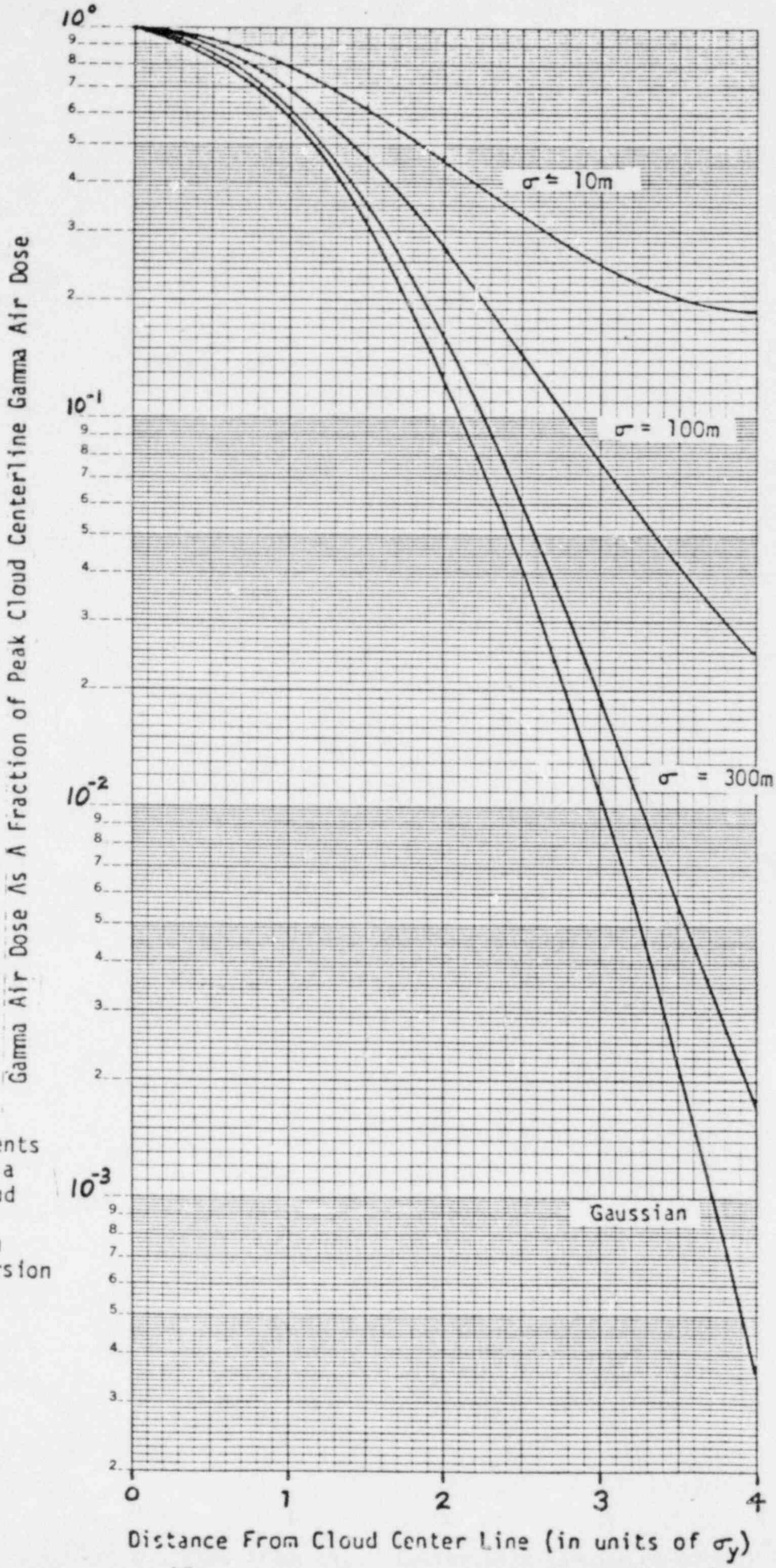
EXHIBIT 3.4.2-8

WHOLE BODY DOSE CONVERSION FACTORS FOR A SEMI-INFINITE CLOUD

Time After Reactor Shutdown (hr)	Dose Conversion Factors $\frac{R/hr}{Ci/m^3}$	$\frac{R}{Ci\text{-}sec/m^3}$
0	650	0.18
0.5	610	0.17
1	470	0.13
1.5	430	0.12
2	330	0.092
2.5	350	0.097
3	340	0.094
3.5	330	0.091
4	290	0.081
4.5	270	0.075
5	260	0.071
6.5	210	0.059
8	180	0.050
10	150	0.042
12.5	120	0.033
15	130	0.035
24	86	0.024
48	36	0.010
72	43	0.012

Source: RG 1.109 Table B-1, ORIGEN Run for inventories

 Dose at Various Distances From Cloud Centerline



[The Gaussian Distribution represents the reduction in concentration as a function of distance from the cloud centerline at any distance. The other curves show the contribution of direct radiation added to immersion - both of which contribute to the gamma dose]

EXHIBIT 3.4.2-9

FINITE CLOUD CORRECTION FACTORS

(Not Valid for times greater than 3-1/2 hours after Rx Shutdown)*

Distance		Ratio of Actual Centerline Cloud Doses to Assumed Semi-Infinite Cloud Dose for Various Stability Classes						
KM	Miles	"A"	"B"	"C"	"D"	"E"	"F"	"G"
1	0.6	0.78	0.71	0.58	0.44	0.35	0.25	0.16
1.22	0.76	0.81	0.75	0.63	0.50	0.40	0.29	0.20
1.5	0.9	0.84	0.80	0.70	0.55	0.46	0.35	0.24
1.6	1.0	0.86	0.80	0.70	0.58	0.48	0.35	0.25
2	1.2	0.91	0.83	0.76	0.64	0.55	0.42	0.31
3	1.9	0.93	0.90	0.83	0.75	0.68	0.54	0.41
3.2	2.0	0.93	0.90	0.85	0.76	0.69	0.56	0.43
4	2.5	0.94	0.91	0.88	0.80	0.74	0.60	0.48
5	3.1	1	0.92	0.90	0.84	0.79	0.70	0.55
7	3.7	1	0.94	0.91	0.89	0.84	0.76	0.65
8	5.0	1	0.95	0.92	0.90	0.88	0.79	0.69
10	6.2	1	1	0.94	0.91	0.89	0.83	0.73
15	9.3	1	1	1	0.93	0.91	0.89	0.81
16.1	10.0	1	1	1	0.94	0.92	0.90	0.83

Note: Based on 0.7MeV $\bar{E}$ (representative of first 30 minutes after shutdown). At longer times (greater than approximately 3-1/2 hr), actual dose will begin to approach semi-infinite cloud dose, and this table should no longer be used. Instead assume that all ratios are 1. (Source: Meteorology & Atomic Energy Figure 7.14)

File No. ______________
Unit No. ______________
Q+RETcd ______________
App'l ______________

CAROLINA POWER & LIGHT COMPANY
BRUNSWICK STEAM ELECTRIC PLANT

UNITS NOS. 1 & 2

THYROID DOSE PROJECTIONS

PLANT EMERGENCY PROCEDURE PEP- 3.4.3

VOLUME XIII

Rev. 2

Recommended By: Robert A. [signature] Date: 11/20/81

Approved By: R E Wagoner for C R Dietz Date: 11-20-81
Plant General Manager

PEP-3.4.3 THYROID DOSE PROJECTIONS

1.0 Responsible Individuals and Objectives

The Radiological Control Director or the Dose Projection Coordinator is responsible for calculating thyroid dose projections to be used by the Radiological Control Director and the Site Emergency Coordinator in determining and evaluating possible off-site consequences from a release of radioactivity. The Radiological Control Manager will assume responsibility for thyroid dose projections after the Emergency Operations Facility is activated.

2.0 Scope and Applicability

This procedure is intended to be used for all manual calculations of thyroid doses subsequent to that in PEP-3.4.1, "Initial Dose Projections." It is intended to provide realistic assessment of doses at any point in the Emergency Planning Zone (EPZ). This procedure shall be performed periodically as directed by the Radiological Control Director (Radiological Control Manager after the Emergency Operations Facility is activated).

Provisions are included for:

1) Determining the Atmospheric Dispersion Factor (χ/Q) based on the Atmospheric Stability Class and distance of the point of the dose projections from the point of release;
2) Correcting the dose to account for the time after shutdown that the source data is taken; and
3) Correcting for distance away from the centerline of the cloud.

3.0 Actions

List of EXHIBITS:

3.4.3-1	"Thyroid Dose Projections"
3.4.3-2	10 Mile EPZ Map (Example)
3.4.3-3	50 Mile EPZ Map (Example)
3.4.3-4	$\chi\bar{u}/Q$ with Distance for Elevated Releases
3.4.3-5	$\chi\bar{u}/Q$ with Distance for Ground Level Releases
3.4.3-6	Horizontal Dispersion Coefficient as a Function of Downwind Distance From the Source
3.4.3-7	Vertical Dispersion Coefficient as a Function of Downwind Distance From the Source
3.4.3-8	Dose Conversion Factors for Iodine (Thyroid) Inhalation Dose
3.4.3-9	Doses at Various Distances From Cloud Centerline

Note: EXHIBIT 3.4.3-1, "Thyroid Dose Projection Calculations," is for recording and calculating dose projections. Steps 3.1 through 3.6 provide input for the calculations.

Note: If the source term, stability class, and χ/Q are known as a result of recently completing a whole body dose projection, transfer information into columns 1 and 2 of EXHIBIT 3.4.3-1 and go to Step 3.5.

3.1 Use the source term calculated in accordance with the appropriate PEP Secton 3.6, "Source Term Assessments." The source term needs to be in terms of total curies of Iodine released. If the source term is based on stack/vent monitor readings, use 15 percent of this monitor-based source term. If the curies of iodine released can be determined from isotopic analysis, use this source term directly. Enter the Source Term Value in column 1 of EXHIBIT 3.4.3-1.

3.2 Determine the Atmospheric Stability Class

Note: Steps 3.2.1 through 3.2.5 are in order of preferred use.

3.2.1 If operable, use the plant computer or RC&T computer to obtain the Atmospheric Stability Class, wind speed, and wind direction.

Record: Stability Class
Wind Speed ________(m/sec)
Wind Direction ________

Note: The wind speed and wind direction should be that best approximating the effective height of the release. This may be determined by various plant monitors. Where available, results from plume tracking/monitoring should be used to confirm or modify these estimates.

3.2.2 If the computer is not accessible, determine the Atmospheric Stability Class, wind speed, and wind direction in accordance with EI-27.3, Appendix A, "Manual Met Tower Data Aquisition," and record on EXHIBIT 3.4.3-1.

3.2.3 If the on-site meteorological station is completely inoperable, the following can be performed to obtain an estimate of the on-site wind speed and direction, and the appropriate Atmospheric Stability Class.

1) Call the National Weather Service Office at Wilmington, North Carolina, for the current weather observations. Obtain the following information from the meteorological forecaster who is on duty:

a. Station for which data is given ____________

b. Wind speed (knots) ____________

c. Cloud cover (in tenths of total) ____________

d. Cloud ceiling (feet above ground) ____________

e. Wind direction (N, S, E, etc.) ____________

2) Load the programmed cassette (the same cassette used in the Automated Dose Projection Procedure, PEP 3.4.5) into the HP9830A, enter LOAD 3 EXECUTE, and enter RUN EXECUTE.

NOTE: Press the EXECUTE button after each entry into the computer to allow the program to proceed.

3) The display will read "WIND SPEED (knots)." The program is asking for the wind speed in knots for the NWS observation station. Enter the appropriate response (example...1.0, 3.0, or 0.0 for a calm wind).

4) The display will read "CLOUD COVER (TENTHS)." The program is asking for the total cloud cover of the sky in tenths. That is, if the sky is overcast, 10/10ths would be the condition. The proper response to the computer would be to enter 10. If the sky was clear, the appropriate response to the computer would be to enter 0. Enter the appropriate response.

5) The display will read "CLOUD CEILING (FEET)." The program is asking for the height of the most obscure cloud deck above the ground level. Enter the appropriate response (example.....1000.).

6) The display will read "JULIAN DATE." The program is asking for the current JULIAN DATE, that is, the number of calendar days since the first of the calendar year. Enter the appropriate response.

7) The display will read "CURRENT TIME (24-hour clock)." The program is asking for the current time (EASTERN STANDARD TIME) in the common 24-hour clock (that is, NOON=1200 and midnight=0000.; all other times are reported such as 1 p.m. = 1300). Enter the appropriate response.

8) The computer program will now compute the appropriate Atmospheric Stability class, based upon the weather observations entered into the computer. The output will be displayed on the visual screen as follows:

Wind speed = (number) mph

Atmospheric Stability Class = (letter)

NOTE: The letter for the Atmospheric Stability class will be the Pasquill Stability indicator, plant process computer.

9) Obtain and record wind direction and speed on EXHIBIT 3.4.3-1. Use the correct Atmospheric Stability class in the Dose Calculations.

3.2.4 Call the CP&L Meteorologist in Raleigh and request meteorological data (see PEP Appendix A.4).

3.2.5 If there is no meteorological data readily available, estimate the wind speed and direction, and determine and circle appropriate Atmospheric Stability Class.

	Sunny Day	Cloudy Day	Cloudy Night	Clear Night
light wind or calm ($\leq$4m/s) = ($\leq$8.9 mph)	B	C	E	F
moderately strong wind (>4m/s) = (>8.9 mph)	C	D	D	D

Record Wind Speed and Direction and Stability Class on EXHIBIT 3.4.3-1. Assume Stability Class D if raining.

3.3 Locate and mark with an "X" the point of interest on either EXHIBIT 3.4.3-2 (10 Mile EPZ) or EXHIBIT 3.4.3-3 (50 Mile EPZ) and estimate the distance in meters or miles to be used in Step 3.4

<u>Note</u>: EXHIBITS 3.4.3-2 and 3.4.3-3 are examples only. DO NOT USE. Use an appropriately scaled (larger) map provided.

3.4 Determine the Atmospheric Dispersion Factor, χ/Q, by using either Step 3.4.1 or Step 3.4.2. Step 3.4.1 makes use of $\chi\bar{u}/Q$ versus distance curves by stability class. Step 3.4.2 makes use of the original equation from which the curves in Step 3.4.1 were generated.

3.4.1 Determine the Atmospheric Dispersion Factor, χ/Q, using either EXHIBIT 3.4.3-4 if the release is via the stack or EXHIBIT 3.4.3-5 if the release is considered from ground level.

3.4.1.1 Using the distance determined in Step 3.3, locate the distance on either of the horizontal axes of the EXHIBIT.

3.4.1.2 Read up or down to the line for the appropriate stability class as determined in Step 3.2.1, 3.2.2, or 3.2.3.

3.4.1.3 Record the appropriate $\chi\bar{u}/Q$ from the vertical scale for use in Step 3.4.1.5.

3.4.1.4 Record the $\bar{u}$ (wind speed) from Step 3.2.1, 3.2.2, or 3.2.3 for use in Step 3.4.1.5.

3.4.1.5 Calculate the χ/Q for the point of interest and enter in Column 2 of EXHIBIT 3.4.3-1.

$$\frac{\chi}{Q} = \frac{\chi\bar{u}}{Q} \div \bar{u}$$

$$\frac{\chi}{Q} = \underline{\qquad} \div \underline{\qquad} = \underline{\qquad}$$

<u>Note</u>: Wind speed must be in units of m/sec.

3.4.2 Determine the Atmospheric Dispersion Factor, χ/Q, using the following equation where concentration is to be calculated along the centerline of the plume at ground level.

$$\frac{\chi}{Q} = \frac{1}{\pi \sigma_y \sigma_z \bar{u}} \exp\left[-\frac{1}{2}\left(\frac{H}{\sigma_z}\right)^2\right]$$

where

χ/Q = Atmospheric Dispersion Factor, sec/m^3.

π = 3.1415.

$\bar{u}$ = average wind speed, m/sec.

H = release emission height (100 m for stack releases, 0 m for ground level releases).

σ_y = horizontal dispersion coefficient, m; (see EXHIBIT 3.4.3-6).

σ_z = vertical dispersion coefficient, m; (see EXHIBIT 3.4.2-7).

<u>Note</u>: To find σ_y for Stability Class G, multiply the σ_y for Stability Class F by 2/3. To find σ_z for Stability Class G, multiply the σ_z for Stability Class F by 3/5.

3.5 Determine the Dose Conversion Factor corresponding to the time that the cloud is projected to pass by the point of interest.

3.5.1 Estimate the time of cloud passage over the point of interest (x):

$$\text{time after shutdown (in hours)} + \frac{\text{distance to point of interest (in meters)}}{3600\bar{u}}$$

= ___________ hours

Select the appropriate time after reactor shutdown from the left column of EXHIBIT 3.4.3-8.

3.5.2 Record the appropriate dose conversion factor in column 3 of EXHIBIT 3.4.3-1.

<u>Note</u>: The values in EXHIBIT 3.4.3-8 apply <u>only</u> to elemental iodine. They are overly conservative by a factor of 100 for organic forms of iodine. The values may be used directly <u>if</u> the sampler

is a charcoal filter which has not been specially treated to trap organic forms (e.g., not doped with Potassium Iodide), or if the sample was taken by a charcoal impregnated paper filter. If there is an indication of a particulate release, use the values in EXHIBIT 3.4.3-8. They will be somewhat conservative but not overly so.

3.6 The dose will be lower at all points not on the centerline of the cloud. To find the dose at any such point follow the steps below:

3.6.1 Estimate the lateral distance (y) between the point of interest and the centerline of the cloud using the appropriately scaled map.

Record: y = ________(m)

Note: The lateral distance (y) between the point of interest and the centerline of the cloud is estimated by use of triangulation of the point with respect to the plant and the cloud centerline vector on the appropriately scaled map.

3.6.2 Using EXHIBIT 3.4.3-6 determine σ_y as a function of distance (Step 3.6.1) and stability class (Step 3.2) by locating the distance on the horizontal axis, read up to the diagonal line for the stability class and read the σ_y from the left vertical axis.

Note: To find σ_y for stability class G, multiply the σ_y for stability class F by 2/3.

3.6.3 Divide the lateral distance by the σ_y to determine the number of σ_y's between the cloud centerline and the point of interest.

3.6.4 Using the number of σ_y's, refer to EXHIBIT 3.4.3-9 and determine the dose conversion factor. Locate the number of σ_y's on the horizontal axis, and read up to the Gausian curve. Read across to the vertical axis for the dose correction factor. Enter the dose conversion factor in column 4 of EXHIBIT 3.4.3-1.

3.7 Perform the multiplication and record the projected dose in column 5 of EXHIBIT 3.4.3-1 next to the appropriate mark (X) on the map. Initial and date each calculation in column 6.

3.8 Report the Thyroid projected dose to the Radiological Control Director (Radiological Control Manager if the Emergency Operations Facility is activated) or Site Emergency Coordinator.

EXHIBIT 3.4.3-1

THYROID DOSE PROJECTIONS

Wind		Stability Class	Point of Interest	Column (1) Source Term (Ci) Step 3.1	Column (2) χ/Q (sec/m^3) Step 3.4	Column (3) Time Correction (DCF) Step 3.5	Column (4) Lateral Deviation CF from Step 3.6	Column (5)* Projected Dose (Rem)	Column (6) Initial/ Time/Date
Speed m/sec	From (°)								

* Column 5 = Column 1 · Column 2 · Column 3 · Column 4

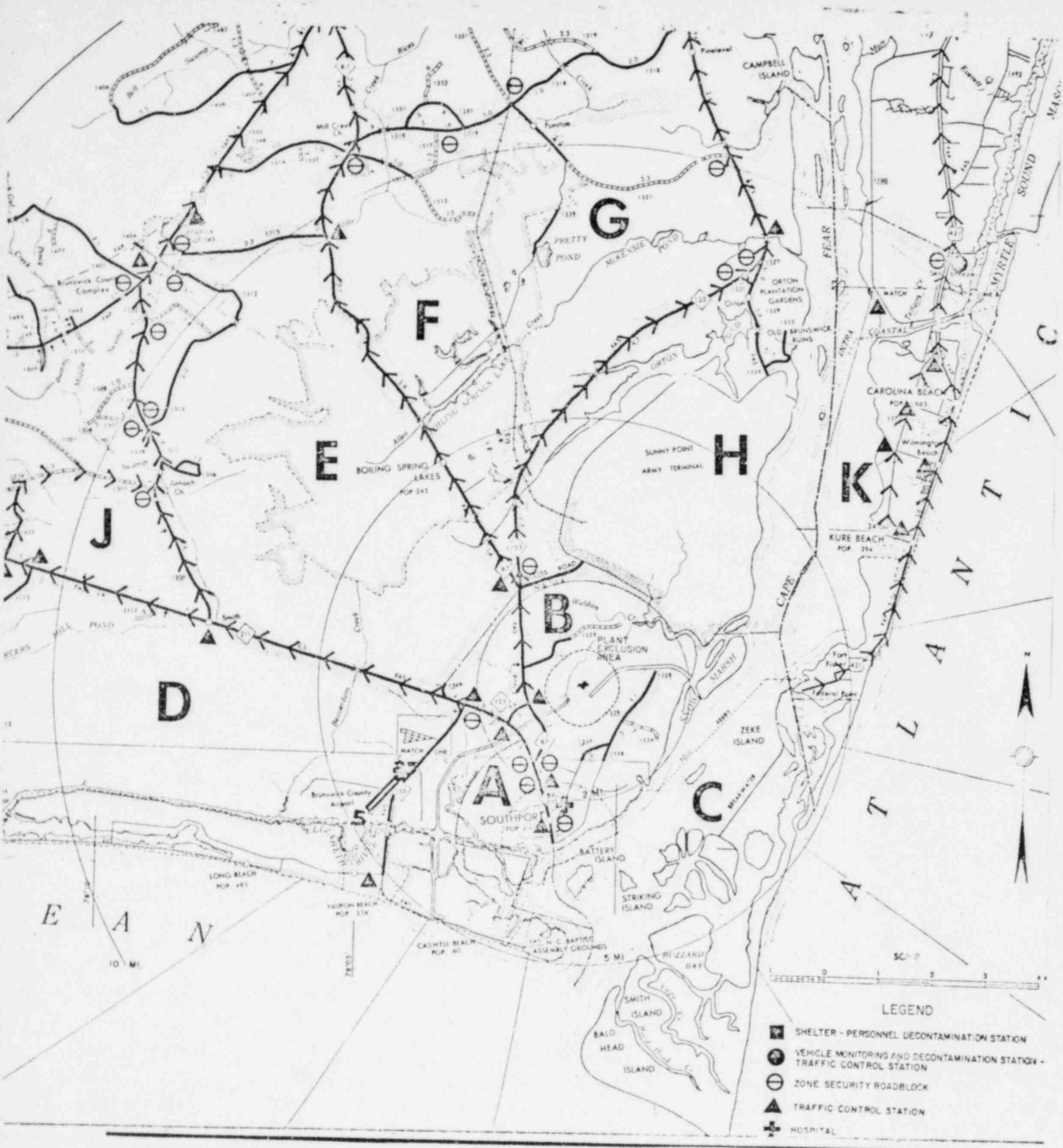


EXHIBIT 3.4.3-2 10 Mile EPZ Map (Example)

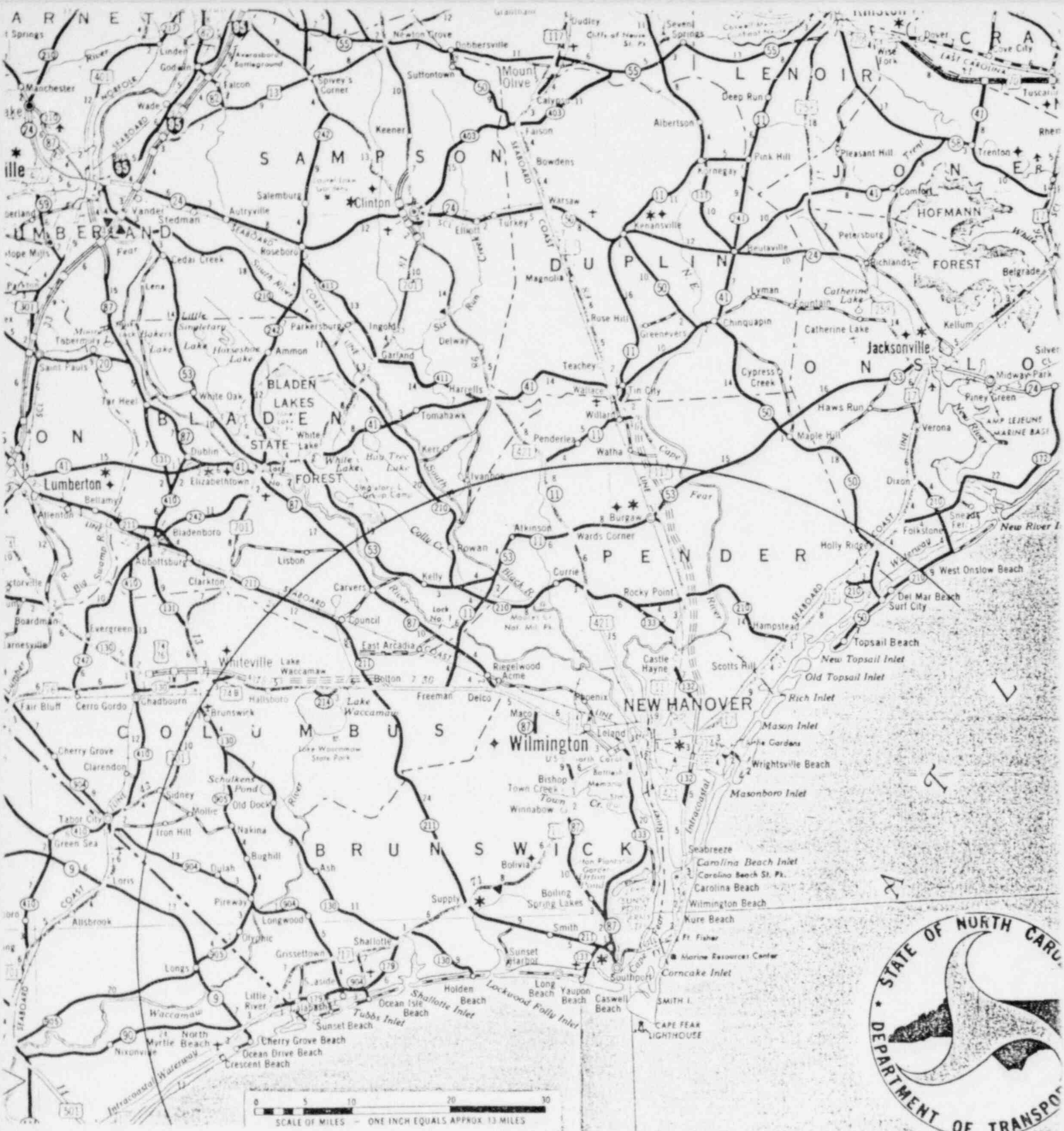


EXHIBIT 3.4.3-3 50 Mile EPZ Map (Example)

EXHIBIT 3.4.3-4

$\chi\bar{u}/Q$ WITH DISTANCE FOR ELEVATED RELEASES (100 m) BY STABILITY CLASS

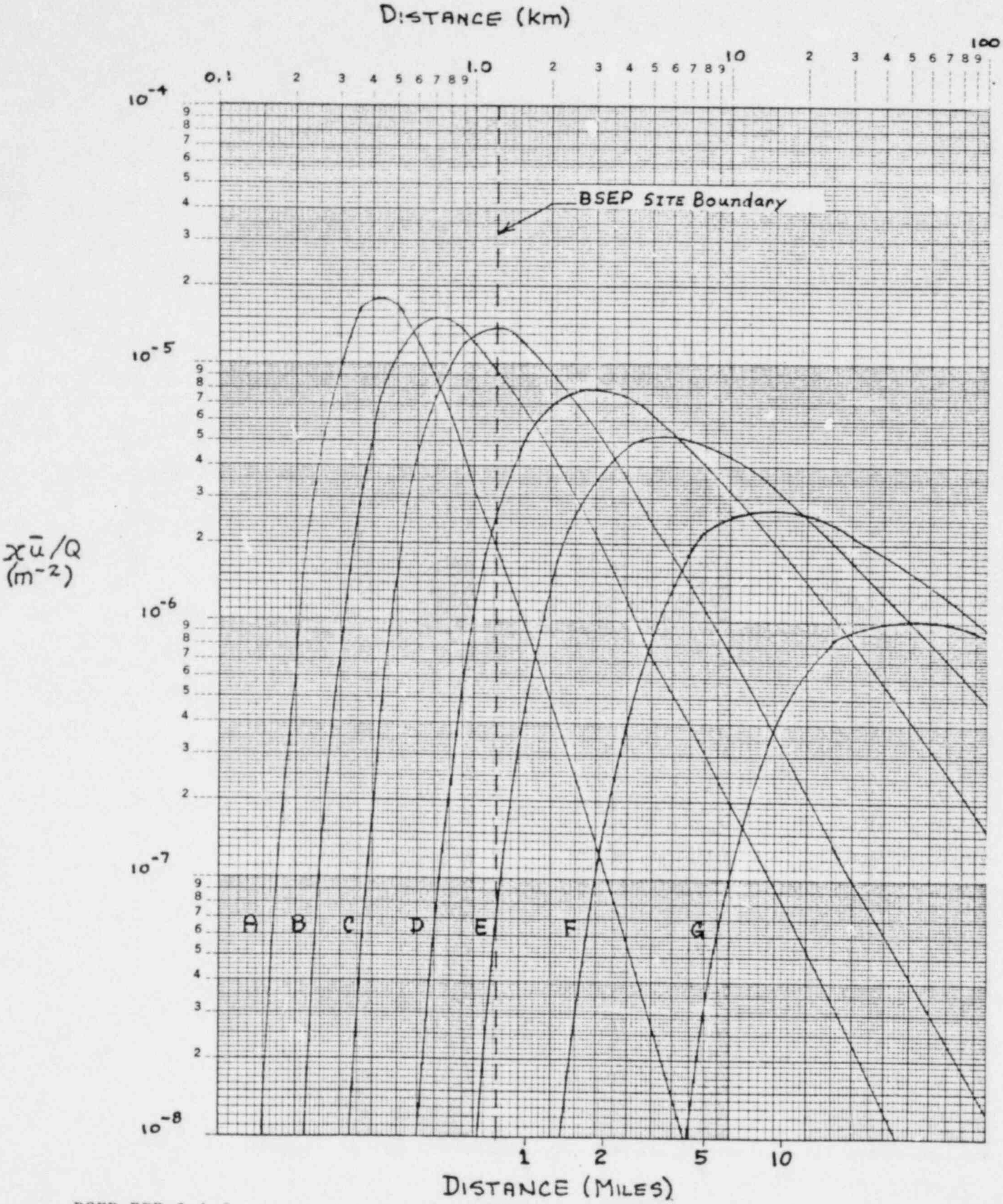
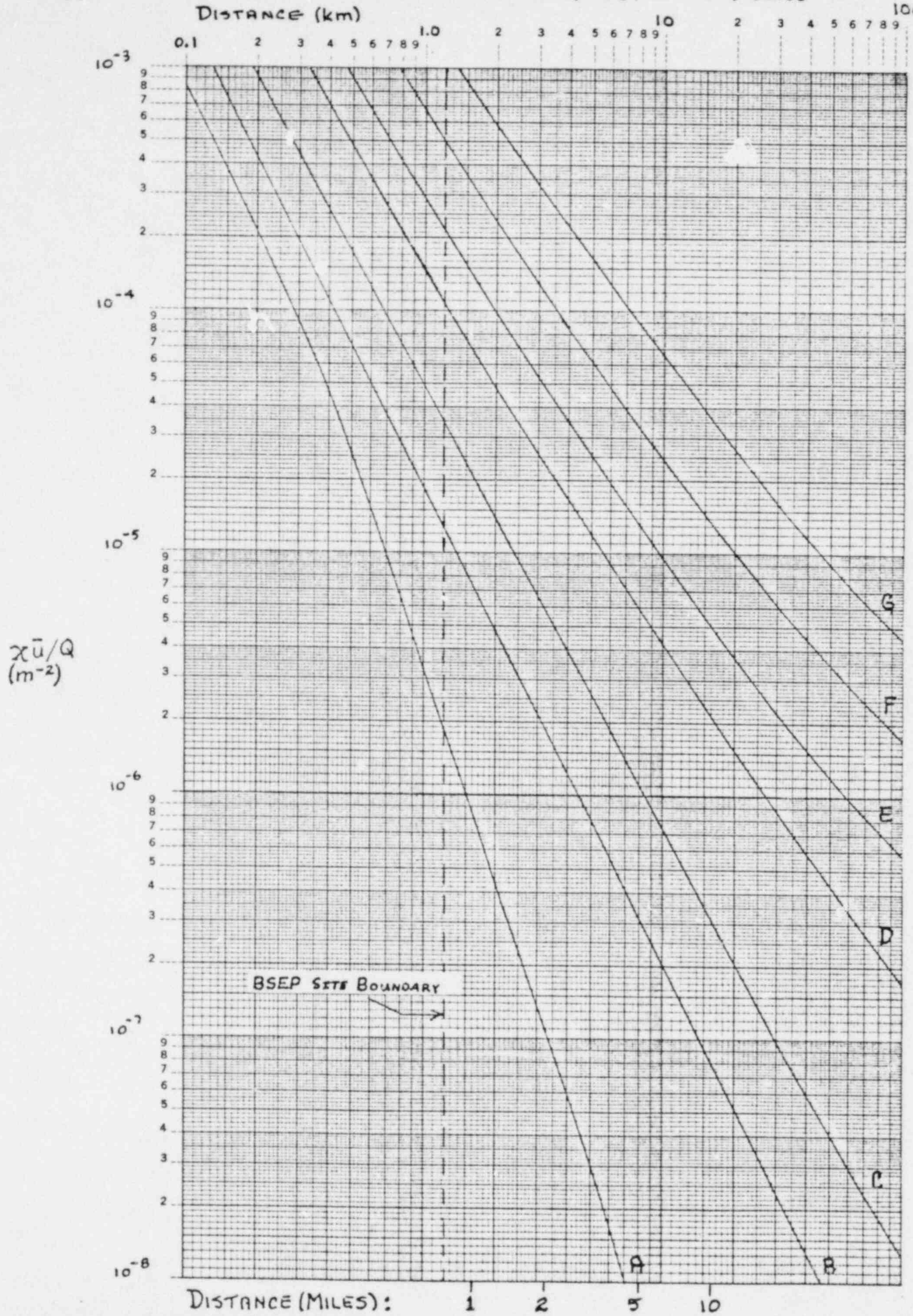
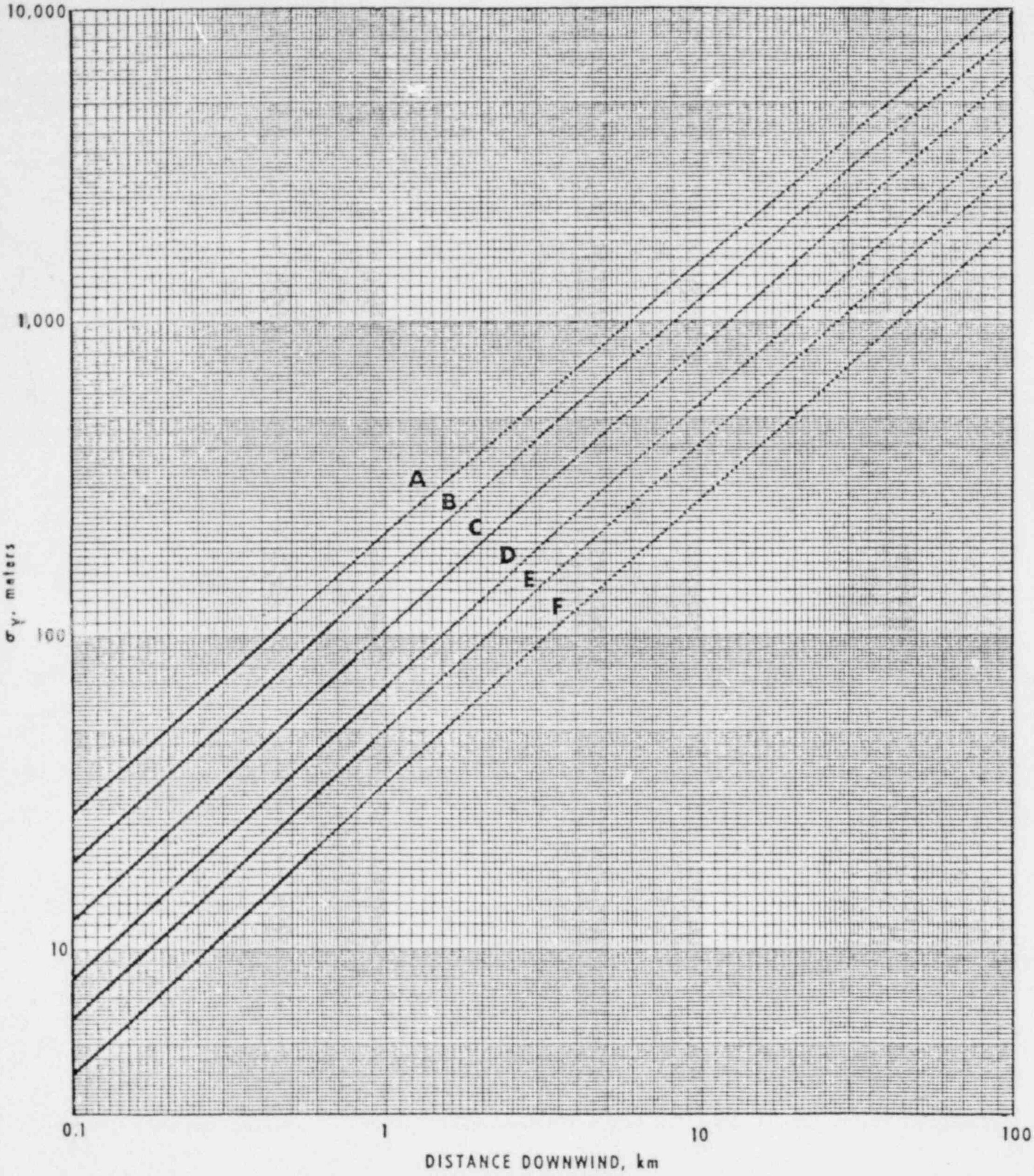


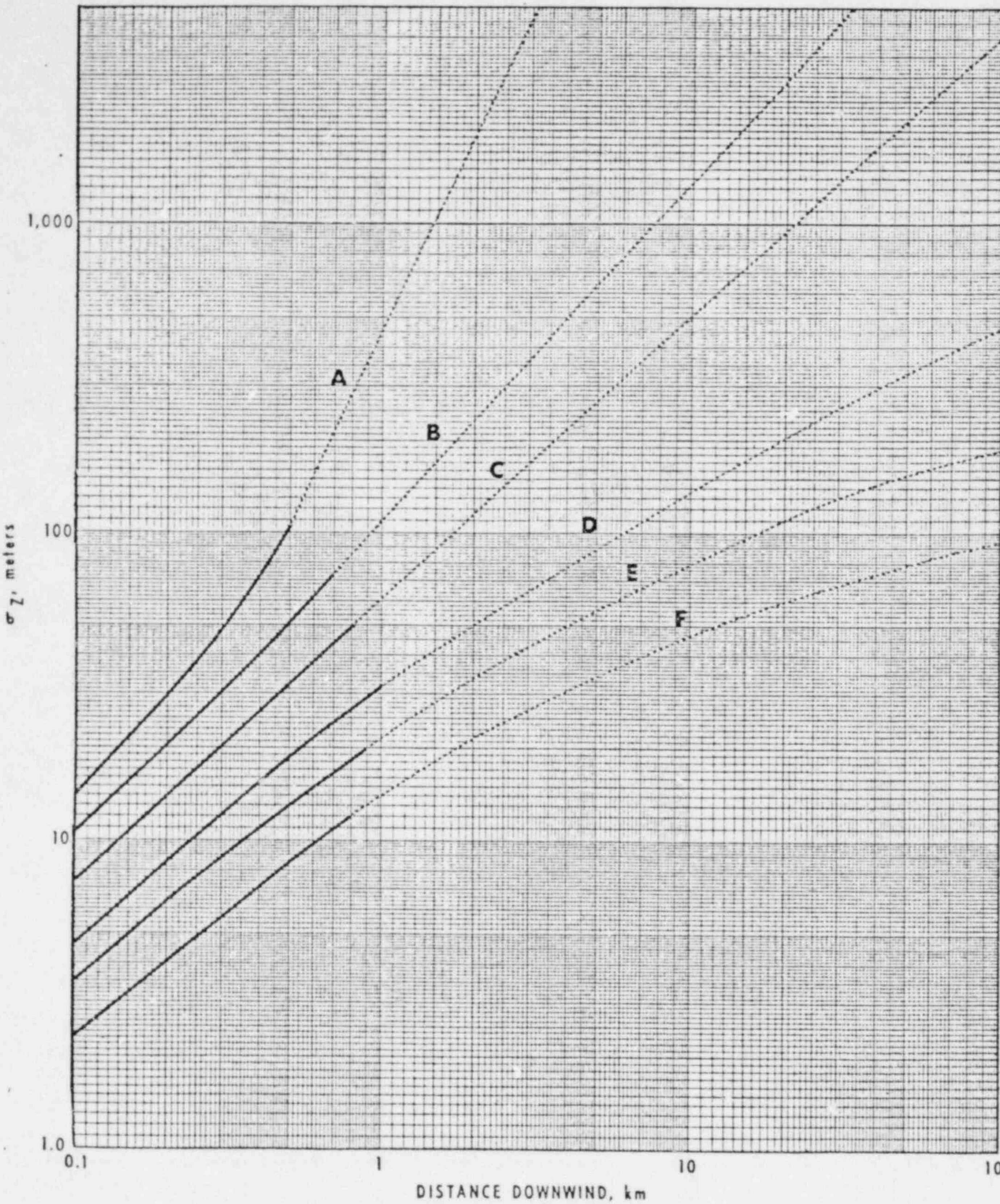
EXHIBIT 3.4.3-5

$\chi\bar{u}/Q$ WITH DISTANCE FOR GROUND LEVEL RELEASES (0m) BY STABILITY CLASS

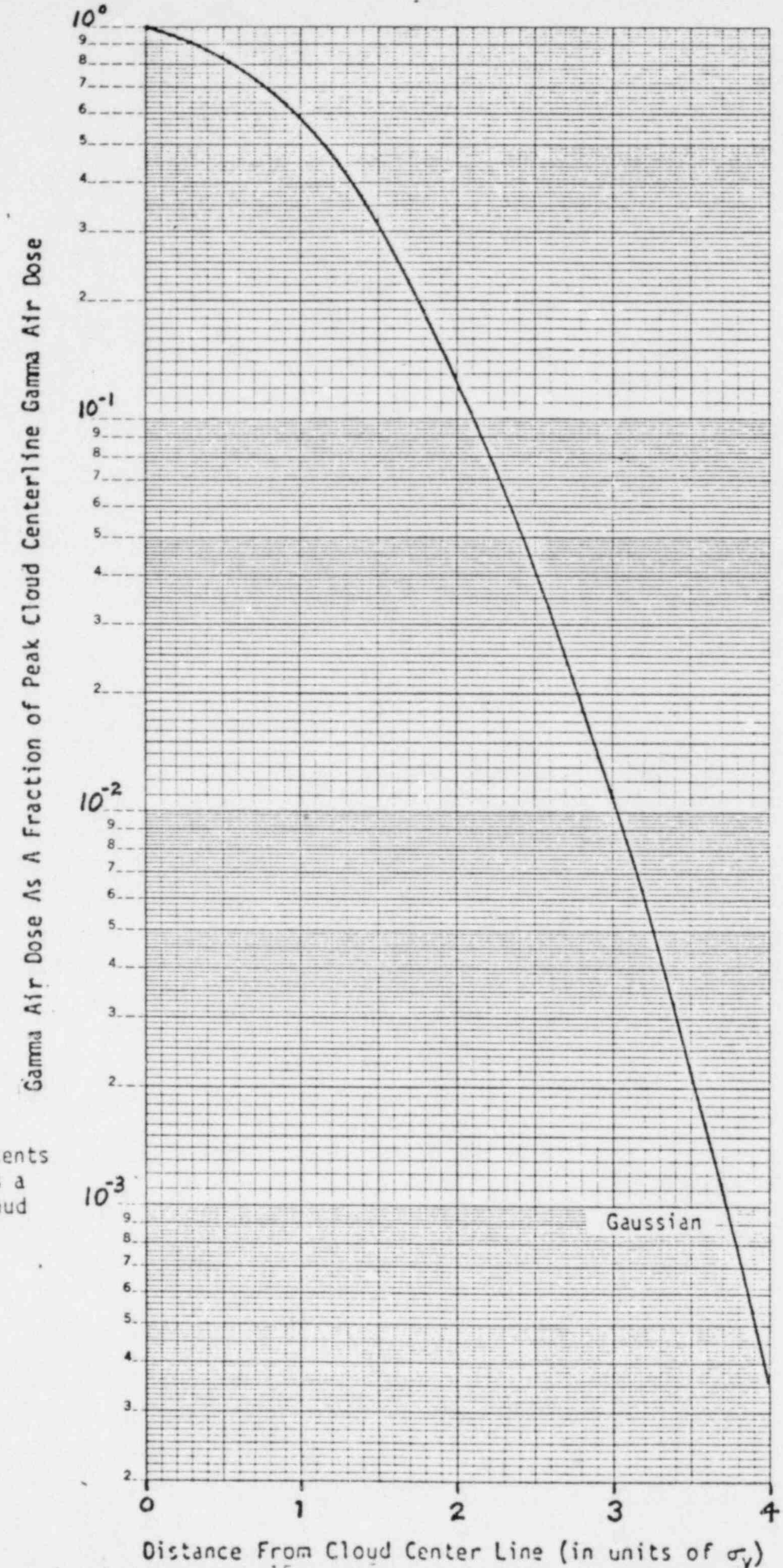




Horizontal dispersion coefficient as a function of downwind distance from the source.



Vertical dispersion coefficient as a function of downwind distance from the source.



[The Gaussian Distribution represents the reduction in concentration as a function of distance from the cloud centerline at any distance.]

EXHIBIT 3.4.3-8

DOSE CONVERSION FACTORS FOR IODINE (THYROID) INHALATION DOSE[1]

Time After Reactor Shutdown (hr)	$\frac{\text{Rem/Ci-sec}}{\text{m}^3}$ (DCF)
0.0	55
0.5	63
1	71
1.5	78
2	85
2.5	87
3	89
3.5	94
4	98
4.5	100
5	110
6.5	120
8	120
10	130
12.5	140
15	140
24	180
48	240
72	280

(1) Based on an average breathing rate, "standard man". Dose to other segments of the population will vary, with the "standard child" inhalation dose generally taken as twice the standard man dose.

File No. ______________
Unit No. ______________
Q+RETcd ______________
App'l ______________

CAROLINA POWER & LIGHT COMPANY
BRUNSWICK STEAM ELFCTRIC PLANT

UNITS NOS. 1 & 2

INITIAL INGESTION DOSE ANALYSIS

PLANT EMERGENCY PROCEDURE PEP-3.4.4

VOLUME XIII

Rev. 2

Recommended By: Robert A Indelicato Date: 11/20/81

Approved By: R.E.Morgan for C.R. Dietz Date: 11-20-81
Plant General Manager

PEP-3.4.4 INITIAL INGESTION DOSE ANALYSIS

1.0 Responsible Individuals and Objectives

The Radiological Control Director or Dose Projection Coordinator is responsible for calculating the possible doses through ingestion for use by the Radiological Control Director and Site Emergency Coordinator in determining and evaluating possible off-site consequences from a gaseous radioactivity release. The Radiological Control Manager will assume responsibility for calculating ingestion doses after the Emergency Operations Facility is activated.

2.0 Scope and Applicability

This procedure is intended only as an initial step in evaluating possible off-site consequences through the ingestion pathway and assumes a pathway based on consumption of milk from cows pastured in an area contaminated as a result of deposition after a release.

3.0 Actions

List of EXHIBITS:

3.4.4-1	"Ingestion Dose Projection Calculations"
3.4.4-2	10 Mile EPZ Map (Example)
3.4.4-3	50 Mile EPZ Map (Example)
3.4.4-4	$\chi\bar{u}/Q$ with Distance for Elevated Releases
3.4.4-5	$\chi\bar{u}/Q$ with Distance for Ground Level Releases
3.4.4-6	Horizontal Dispersion Coefficient
3.4.4-7	Vertical Dispersion Coefficient
3.4.4-8	Doses at Various Distances From Cloud Centerline
3.4.4-9	Ingestion (Milk Consumption) Dose Potential (REM) From 1 Ci-Sec/m^3 of I-131

Note: EXHIBIT 3.4.4-1, "Ingestion Dose Projection Calculations," is for recording and calculating dose projections. Steps 3.1 through 3.8 provide input for the calculations.

3.1 Use the source term calculated in accordance with appropriate PEP Section 3.6, "Source Term Assessments and Core Damage Evaluation." Enter the Source Term Value in column 1 of EXHIBIT 3.4.4-1. The source term needs to be in terms of curies of I-131 released.

Note: If the quantity of Iodine-131 in the mixture of iodine isotopes has not been determined, the following may be used:

$$\text{Curies I-131 Released} = \text{Curies I released at time t} \times \frac{\text{DCF - Iodine @ t}}{330}$$

where the DCF - Iodine is that in EXHIBIT 3.4.3-8 of PEP-3.4.3.

3.2 Determine the Atmospheric Stability Class

Note: Steps 3.2.1 through 3.2.5 are in order of preferred use.

3.2.1 If operable, use the plant or RC&T computer to obtain the Atmospheric Stability Class, wind speed, and wind direction.

Note: The wind speed and wind direction should be that best approximating the effective height of the release. This may be determined by the various plant monitors. Where available, results from plume tracking/monitoring should be used to confirm or modify these estimates.

3.2.2 If the computer is not accessible, determine the Atmospheric Stability Class, wind speed, and wind direction in accordance with EI-27.3 Appendix A "Manual Met Tower Data Acquisition."

Record Stability Class, wind speed, and wind direction on EXHIBIT 3.4.4-1.

3.2.3 If the on-site meteorological station is completely inoperable, the following can be performed to obtain an estimate of the on-site wind speed and direction, and the appropriate Atmospheric Stability Class.

1) Call the National Weather Service Office at Wilmington, North Carolina, for the current weather observations. Obtain the following information from the meteorological forecaster who is on duty:

a. Station for which data is given ____________

b. Wind speed (knots) ____________

c. Cloud cover (in tenths of total) ____________

d. Cloud ceiling (feet above ground) ____________

e. Wind direction (N, S, E, etc.) ____________

2) Load the programmed cassette (the same cassette used in the Automated Dose Projection Procedure, PEP 3.4.5) into the HP9830A, enter LOAD 3 EXECUTE, and enter RUN EXECUTE.

NOTE: Press the EXECUTE button after each entry into the computer to allow the program to proceed.

3) The display will read "WIND SPEED (knots)." The program is asking for the wind speed in knots for the NWS observation station. Enter the appropriate response (example...1.0, 3.0, or 0.0 for a calm wind).

4) The display will read "CLOUD COVER (TENTHS)." The program is asking for the total cloud cover of the sky in tenths. That is, if the sky is overcast, 10/10ths would be the condition. The proper response to the computer would be to enter 10. If the sky was clear, the appropriate response to the computer would be to enter 0. Enter the appropriate response.

5) The display will read "CLOUD CEILING (FEET)." The program is asking for the height of the most obscure cloud deck above the ground level. Enter the appropriate response (example.....1000.).

6) The display will read "JULIAN DATE." The program is asking for the current JULIAN DATE, that is, the number of calendar days since the first of the calendar year. Enter the appropriate response.

7) The display will read "CURRENT TIME (24-hour clock)." The program is asking for the current time (EASTERN STANDARD TIME) in the common 24-hour clock (that is, NOON=1200 and midnight=0000.; all other times are reported such as 1 p.m. = 1300). Enter the appropriate response.

8) The computer program will now compute the appropriate Atmospheric Stability class, based upon the weather observations entered into the computer. The output will be displayed on the visual screen as follows:

   Wind speed = (number) mph

   Atmospheric Stability Class = (letter)

   NOTE: The letter for the Atmospheric Stability class will be the Pasquill Stability indicator, plant process computer.

9) Obtain and record wind direction and speed on EXHIBIT 3.4.4-1. Use the correct Atmospheric Stability class in the Dose Calculations.

3.2.4 Call the CP&L Meteorologist in Raleigh and request meteorological data (see PEP Appendix A.4).

3.2.5 If there is no meteorological data readily available, estimate the wind speed and direction, and determine and circle appropriate Atmospheric Stability Class.

	Sunny Day	Cloudy Day	Cloudy Night	Clear Night
light wind or calm ($\leq$4m/s) = ($\leq$8.9 mph)	B	C	E	F

moderately strong wind (>m/s) = (>8.9 mph)	C	D	D	D

Record wind direction and stability class on EXHIBIT 3.4.4-1.

Note: Assume Stability Class D whenever it is raining.

3.3 Locate and mark with an "X" the point of interest on either EXHIBIT 3.4.4-2 (10 Mile EPZ) or EXHIBIT 3.4.4-3 (50 Mile EPZ) and estimate the distance in meters or miles to be used in Step 3.4.

Note: EXHIBITS 3.4.4-2 and 3.4.4-3 are examples only. DO NOT USE. Use an appropriately scaled (larger) map provided.

3.4 Determine the Atmospheric Dispersion Factor, χ/Q, by using either Step 3.4.1 or Step 3.4.2. Step 3.4.1 makes use of $\chi\bar{u}/Q$ versus distance curves by stability class. Step 3.4.2 makes use of the original equation from which the curves in Step 3.4.1 were generated.

3.4.1 Determine the Atmospheric Dispersion Factor, χ/Q, using either EXHIBIT 3.4.4-4 if the release is via the stack or EXHIBIT 3.4.4-5 if the release is considered from ground level.

3.4.1.1 Using the distance determined in Step 3.3, locate the distance on either of the horizontal axes of the EXHIBIT.

3.4.1.2 Read up or down to the line for the appropriate stability class as determined in Step 3.2.1, 3.2.2, or 3.2.3.

3.4.1.3 Record the appropriate $x\bar{u}/Q$ from the vertical scale for use in Step 3.4.1.5.

3.4.1.4 Record the $\bar{u}$ (wind speed) from Step 3.2.1, 3.2.2, or 3.2.3 for use in Step 3.4.1.5.

3.4.1.5 Calculate the x/Q for the point of interest and enter in Column 2 of EXHIBIT 3.4.2-1.

$$\frac{\chi}{Q} = \frac{\chi\bar{u}}{Q} \div \bar{u}$$

$$\frac{\chi}{Q} = \_\_\_\_ \div \_\_\_\_ = \_\_\_\_$$

Note: Wind speed must be in units of m/sec.

3.4.2 Determine the Atmospheric Dispersion Factor, χ/Q, using the following equation where concentration is to be calculated along the centerline of the plume at ground level.

$$\frac{\chi}{Q} = \frac{1}{\pi\sigma_y \sigma_z \bar{u}} \exp\left[\frac{-1}{2}\left(\frac{H}{\sigma_z}\right)^2\right]$$

where

χ/Q = Atmospheric Dispersion Factor, sec/m^3.

π = 3.1415.

$\bar{u}$ = average wind speed, m/sec.

H = release emission height (100 m for stack releases, 0 m for ground level releases).

σ_y = horizontal dispersion coefficient, m; (see EXHIBIT 3.4.4-6).

σ_z = vertical dispersion coefficient, m; (see EXHIBIT 3.4.2-7).

Note: To find σ_y for Stability Class G, multiply the σ_y for Stability Class F by 2/3. To find σ_z for Stability Class G, multiply the σ_z for Stability Class F by 3/5.

3.5 If the point of interest is not on the centerline of the cloud, correct for the lateral distance (y) deviation.

3.5.1 Estimate the lateral distance (y) between the point of interest and the centerline of the cloud using the appropriate map.

Record y = ________(m)

Note: If not otherwise known, the lateral distance (y) between the point of interest and the centerline of the cloud is estimated by use of triangulation of the point with respect to the plant and the cloud centerline vector on the appropriately scaled map.

3.5.2 Using EXHIBIT 3.4.4-6 determine σ_y as a function of distance (Step 3.5.1) and stability class (Step 3.2) by locating the distance on the horizontal axis, read up to the diagonal line for the stability class and read the σ from the left vertical axis.

Note: To find σ_y for stability class G, multiply the σ_y for stability class F by 2/3.

3.5.3 Divide the lateral (vertical) distance by the σ_y to determine the number of σ's between the cloud centerline and the point of interest.

3.5.4 Using the number of σ's refer to EXHIBIT 3.4.4-8 and determine the dose conversion factor. Locate the number of σ's on the horizontal axis and read up to the Gausian curve. Read across to the vertical axis for the dose concentration correction factor. Enter this value in column 3 of EXHIBIT 3.4.4-1.

3.6 Determine the Ingestion dose potential correction from EXHIBIT 3.4.4-9.

3.6.1 Select the appropriate age category from the left hand column.

<u>Note</u>: If the actual age is not specified, use 0-1 to be conservative in protecting a critical segment of the population.

3.6.2 Read across to the appropriate column for the season and record the conversion factor in column 4 of EXHIBIT 3.4.4-1.

3.7 Perform the multiplication and record the projected dose in column 5 of EXHIBIT 3.4.4-1 and next to the appropriate mark (X) on the map. Initial and date each calculation in column 6.

3.8 Report the projected thyroid ingestion dose to the Radiological Control Director (Radiological Control Manager after the Emergency Operations Facility is activated) or Site Emergency Coordinator.

EXHIBIT 3.4.4.1

INGESTION DOSE PROJECTION CALCULATIONS

Wind Speed m/sec	Wind From (°)	Stability Class	Column (1) Source Term (Ci) Step 3.1	Column (2) X/Q (sec/m^3) Step 3.4	Column (3) Lateral Deviation CF from Step 3.5	Column (4) Dose Correction Factor Step 3.6	Column (5)* Projected Dose (Rem)	(Column (6) Initial/ Time/Date

*Column 5 = Column 1 · Column 2 · Column 3 · Column 4

EXHIBIT 3.4.4-2 10 Mile EPZ Map (Example)

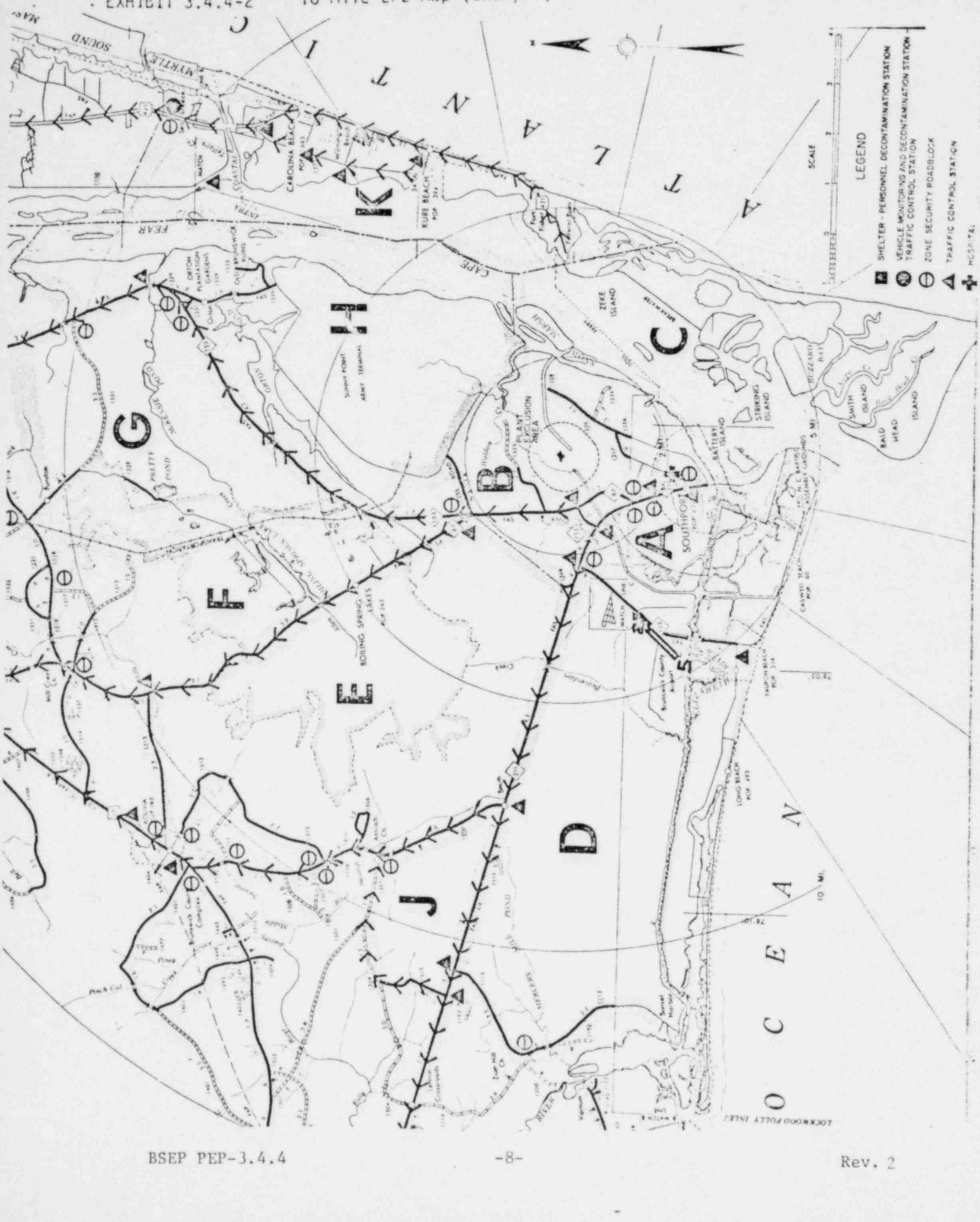


EXHIBIT 3.4.4-3 50 Mile EPZ Map (Example)

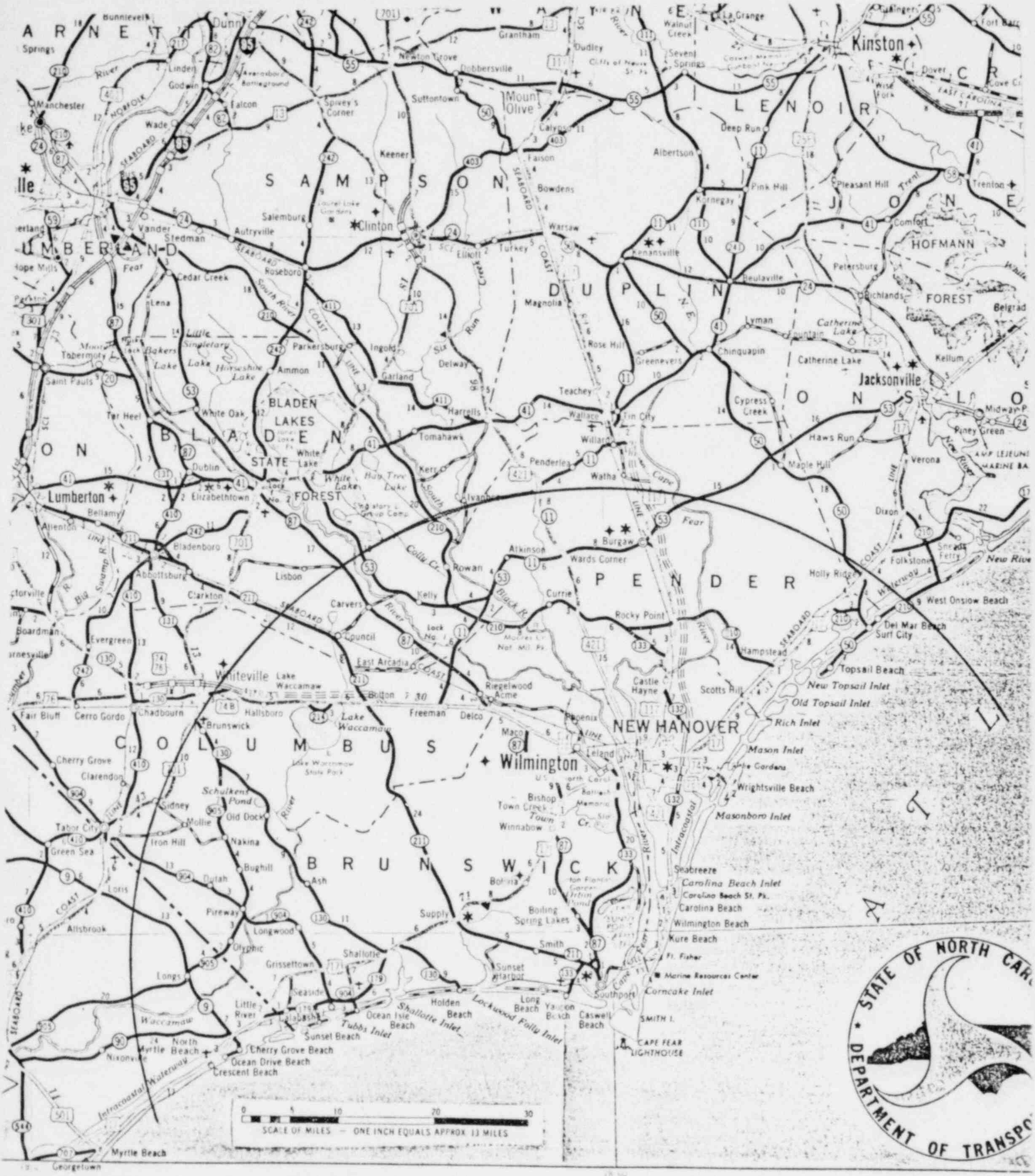


EXHIBIT 3.4.4-4

$\chi\bar{u}/Q$ WITH DISTANCE FOR ELEVATED RELEASES (100 m) BY STABILITY CLASS

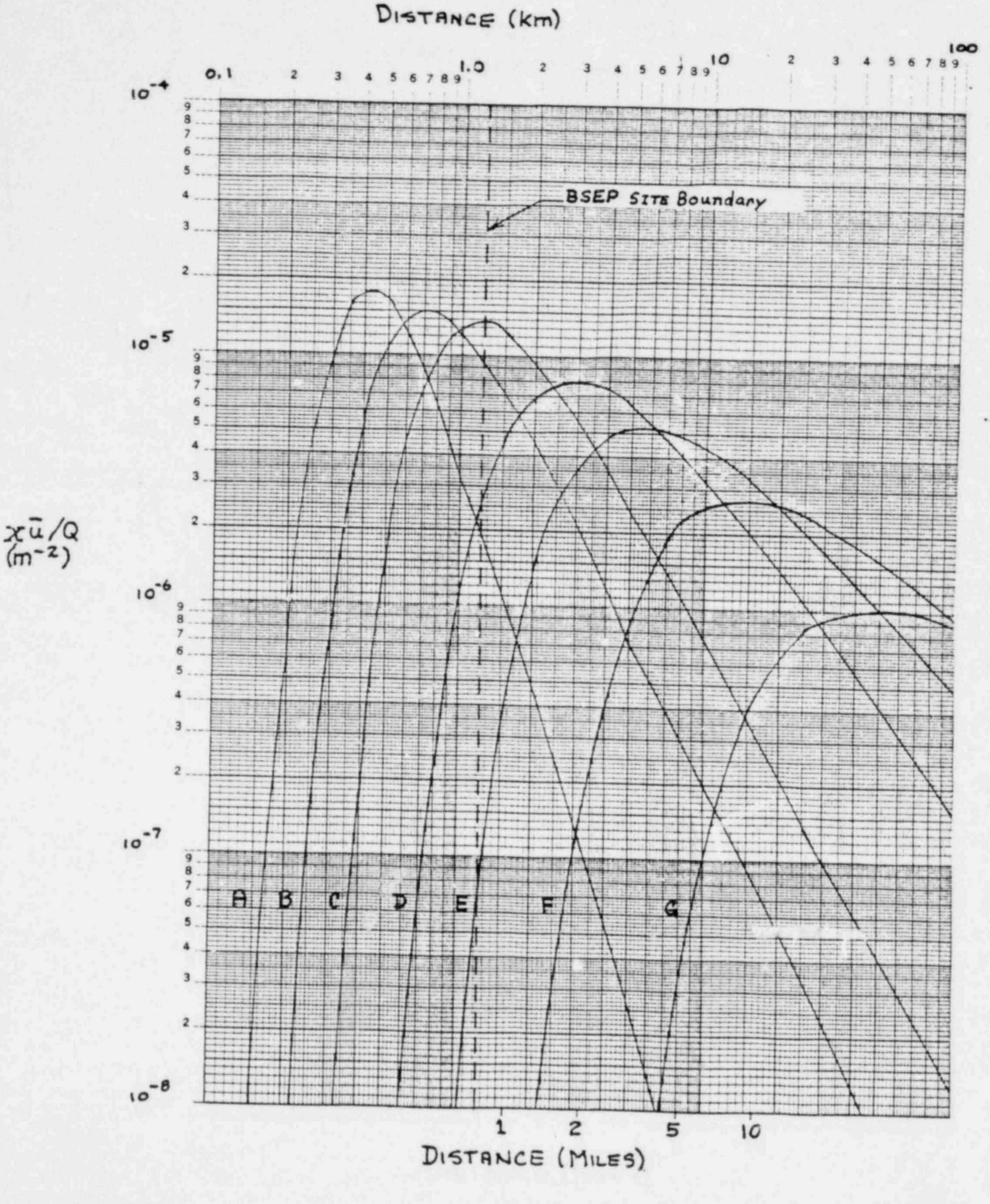
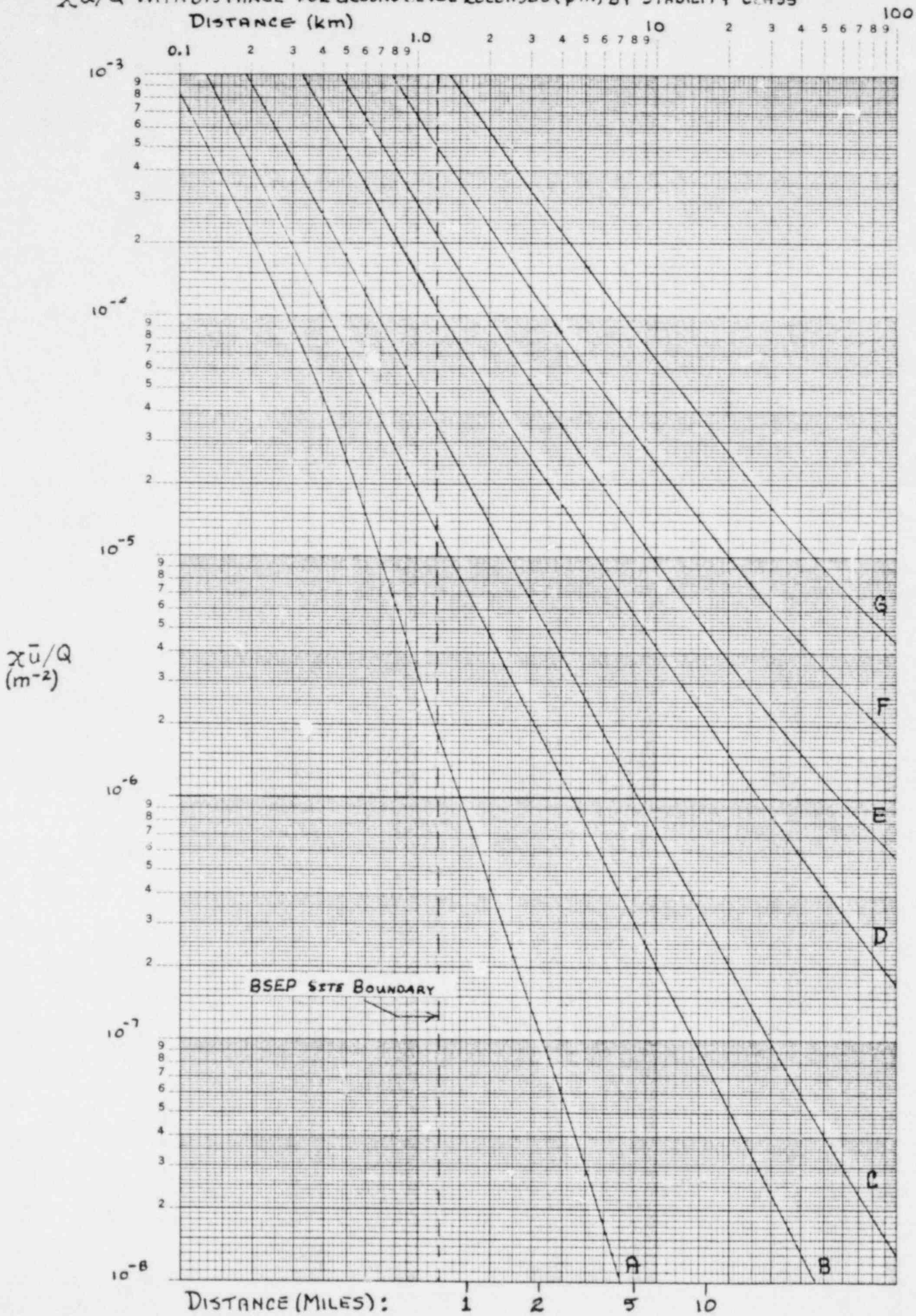
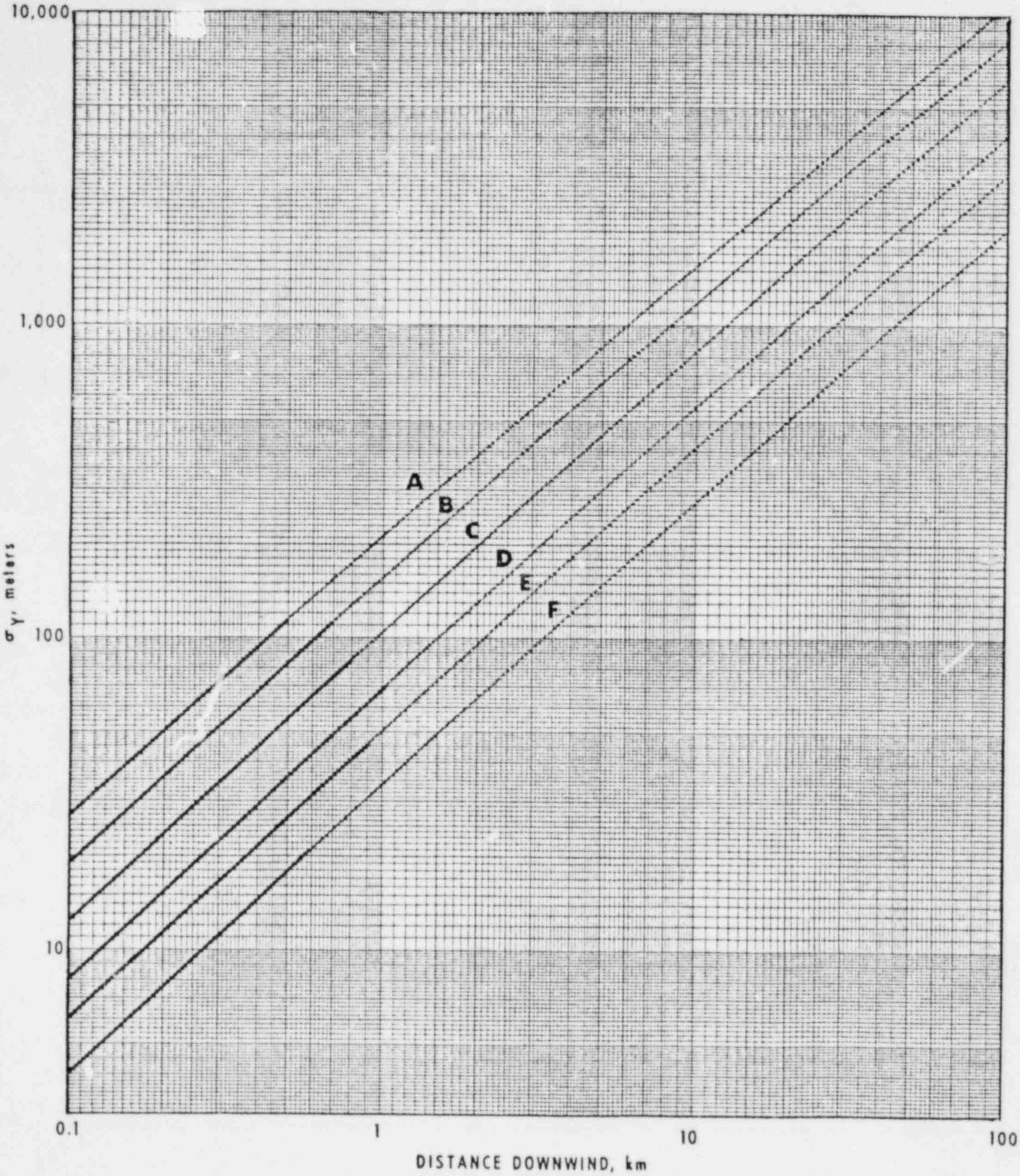


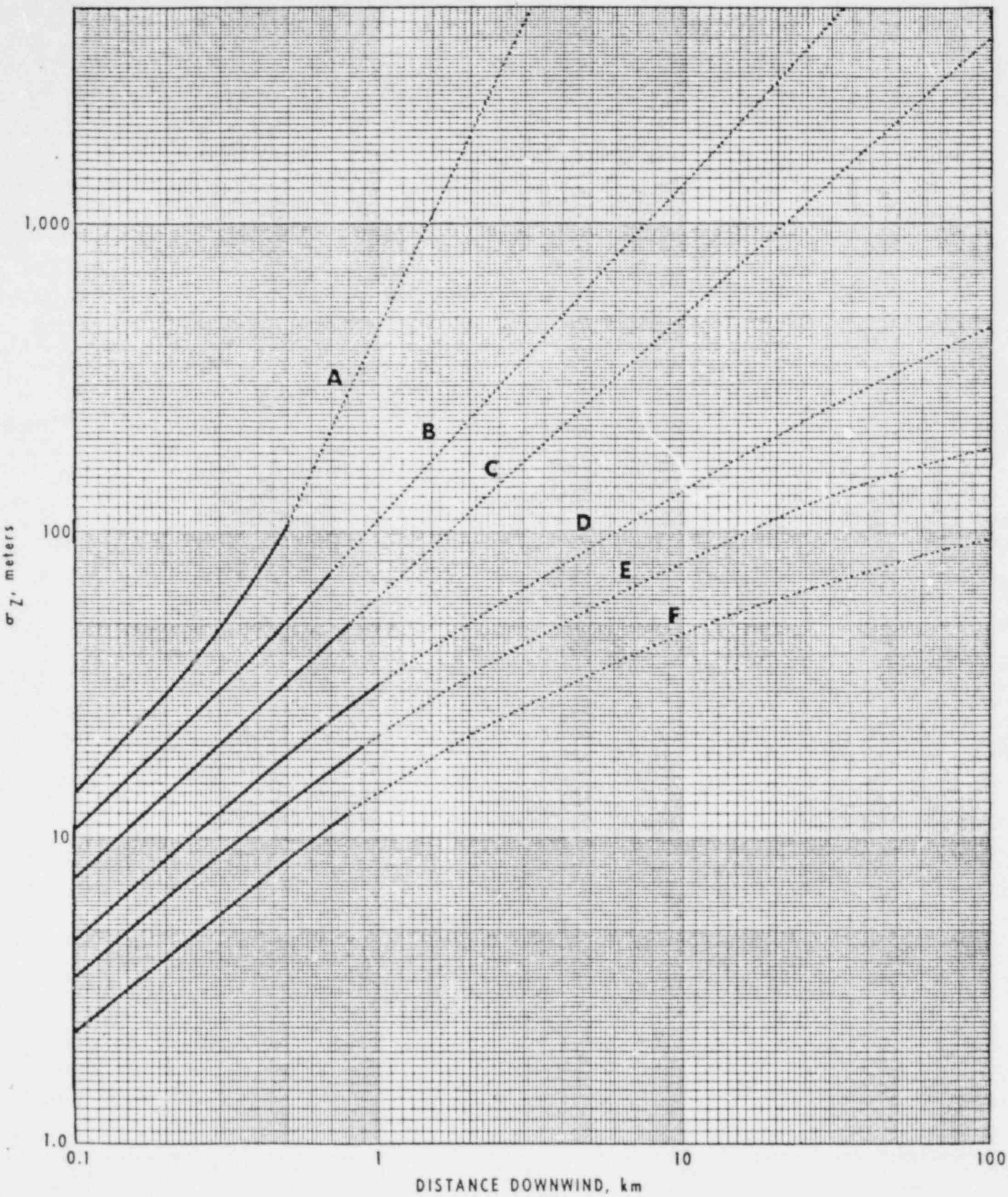
EXHIBIT 3.4.4-5

$\chi\bar{u}/Q$ WITH DISTANCE FOR GROUND LEVEL RELEASES (Øm) BY STABILITY CLASS



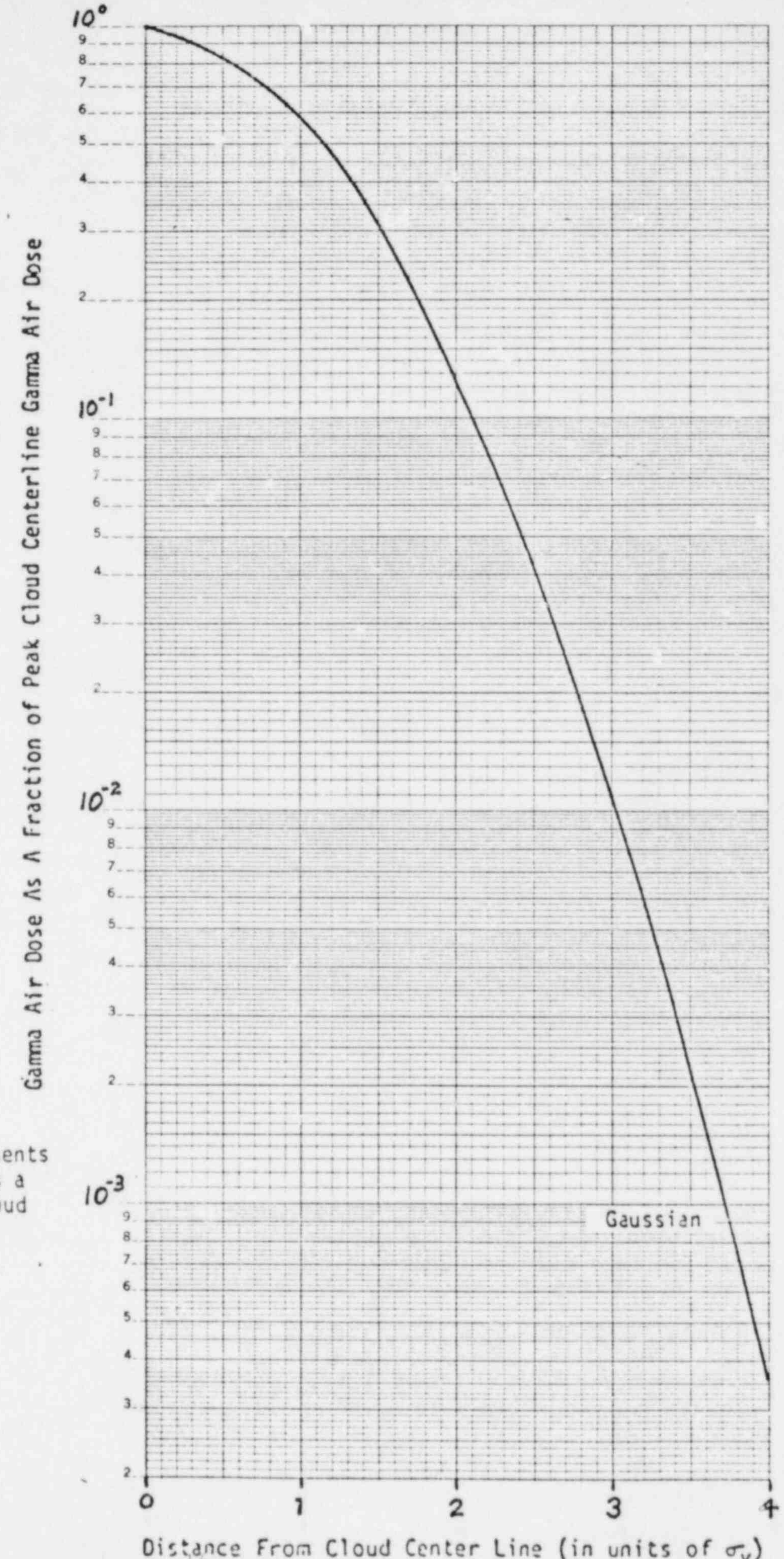


Horizontal dispersion coefficient as a function of downwind distance from the source.



Vertical dispersion coefficient as a function of downwind distance from the source.

EXHIBIT 3.4.4-8 Dose at Various Distances from Cloud Centerline



[The Gaussian Distribution represents the reduction in concentration as a function of distance from the cloud centerline at any distance.]

EXHIBIT 3.4.4-9

INGESTION (MILK CONSUMPTION) DOSE POTENTIAL (REM)

FROM 1 Ci-sec/m^3 of I-131(a)

Age	Winter	Spring	Summer	Fall
0-1	1000	3600	34,000	32,000
2-3	900	3200	31,000	29,000
4-6	900	3200	31,000	29,000
7-12	900	3200	31,000	29,000
13-19	450	1600	15,000	14,000
≥ 20	290	1000	10,000	9,400

(a) All values must be multiplied by the mean wind speed. Thus a 1 Ci release and a dilution factor of 10^{-4} sec/m^3 and a wind speed of 2m/sec will result in a 6.8 rem thryoid dose to a 0-1 year old child in the summer months.

(Source IDO-12053)

PEP APPENDIX A.4, OTHER EMERGENCY RESPONSE CONTACTS

CP&L CORPORATE HEADQUARTERS

	Office	Home
Vice President - Nuclear Operations: B.J. Furr Alternate: H. R. Banks, Manager, Corporate Quality Assurance		
Senior Vice President - Power Supply Lynn W. Eury Alternate: E. E. Utley		
Meteorological Center		
Corporate Meteorologists Brian D. McFeaters Meteorological Supervisor Tim D. Drum Meteorologist		

NATIONAL WEATHER SERVICE

Wilmington, NC
Raleigh, NC

AMERICAN NUCLEAR INSURERS (ANI)

Farmington, Connecticut

INSTITUTE OF NUCLEAR POWER OPERATIONS (INPO)

Atlanta, Georgia
Telecopier:

GENERAL ELECTRIC

San Jose, California

UNITED ENGINEERS AND CONSTRUCTORS

Philadelphia, Pennsylvania

RADIATION EMERGENCY ASSISTANCE CENTER/TRAINING SITE (REAC/TS)

Dr. Karl Hubner