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AmerGen SM
An Exelon/British Energy Company

10 CFR 50.90

September 24, 2001
2130-01-20177

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

Subject: Response To Request For Additional Information – License Amendment Request No. 283 Control Room Habitability (TAC NO. MB0906)

Oyster Creek Generating Station (Oyster Creek)
Facility Operating License No. DPR-16
NRC Docket No. 50-219

This letter provides additional information in response to NRC request for additional information dated July 30, 2001, regarding Oyster Creek License Amendment Request No. 283, submitted to NRC for review on December 19, 2000. The additional information is provided in Enclosure 1.

If any additional information is needed, please contact David J. Distel (610) 765-5517.

I declare under penalty of perjury that the foregoing is true and correct.

Very truly yours,

9/24/01
Executed On

Ron J. DeGregorio
Vice President
Oyster Creek

Enclosures: (1) Response to Request for Additional Information
(2) Calculation No. C-1302-826-E540-017, "Calculation of OC Control Room Air Intake X/Q Using ARCON96"

c: H. J. Miller, USNRC Administrator, Region I
H. N. Pastis, USNRC Senior Project Manager, Oyster Creek
L. A. Dudes, USNRC Senior Resident Inspector, Oyster Creek
File No. 00077

A001

ENCLOSURE 1

OYSTER CREEK

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION – RADIOLOGICAL CONSEQUENCE ANALYSIS FOR CONTROL ROOM OPERATORS

1. **NRC Question**

What is the justification for assuming that the Main Steamline Isolation Valve (MSIV) leakage is a diffuse release from the turbine building?

Response

Postulated MSIV leakage is at a relatively slow rate with no significant driving pressure. The MSIV leakage is assumed to be released from a rupture of the main steam lines at the inlet to the main turbine stop and control valves. The release from the MSIVs is diffuse because the release location is below the operating deck of the turbine building and must migrate upwards to the operating floor of the turbine building in order to be released to the environment. The postulated break location is physically isolated from the operating deck by concrete load bearing walls and floors. These valves are located between column lines "7" and "8" and "E" and "F" as shown on the attached Plant Drawing Nos. 3E-151-02-003, 006, 007, and 008. Column line "F" is approximately 3 ft 5 in. from the postulated break location. The turbine building release to the "B" HVAC air intake is assumed to diffuse and leak from the turbine building East wall at column "F". The vertical dimension of the leakage area is measured from the turbine operating floor 46'6". to the top elevation at 109'4". The horizontal dimension is from column lines 1 through 10. Note that the East wall is blocked by the mechanical equipment room, new cable spreading room, and control room between columns 7 and 10. The release point is conservatively assumed to be at 10m and that the elevation of the "B" air intake is at the same elevation as the release point when calculating the X/Q for that intake. This assumption eliminates any corrections for wind speed at higher elevations. This approach is conservative and provides for the maximum acceptable elevation for determining ground level X/Q. It is recognized that ARCON96 allows modeling at the release height with wind speed corrections resulting in a less conservative X/Q. The X/Q would be smaller with this approach. The release elevation for the turbine building release is based on the NRC Staff recommendations for ARCON96 implementation, April 2000. The release height is set at the point on the surface of the area source that will result in the shortest slant path to the most conservative receptor ("B" intake). The enclosed Calculation No. C-1302-826-E540-017, "Calculation of OC Control Room Air Intake X/Q Using ARCON96" provides the detailed X/Q analysis.

2. **NRC Question**

Where are turbine building penetrations or other potential release locations to the environment?

Response

The potential release path location is from the turbine siding, which is located at approximately elevation 86'6". The operating deck is at elevation 46'6". All of the release within the turbine building is assumed to exit through the East wall of that building, which provides the shortest slant path to the "B" air intake. This assumption provides a conservative estimate since, in reality, the release would be from all sides of the building, including the roof. Attached Drawing No. 3E-151-02-006 shows the East wall construction, which does not include any significant penetrations.

3. **NRC Question**

Provide or reference plant drawings in the Safety Analysis Report or elsewhere that show the relationship between potential release locations from plant systems to the environment and from the environment to the control room intake with respect to distances, structural dimensions, and directions from true north.

Response

Plant drawings referenced in the above responses to NRC Questions 2 and 3 show the relationship between potential release locations from the MSIVs to the environment. Figure 1, in the enclosed Calculation No. C-1302-826-E540-017, provides the distances and directions from true north for the MSIV leakage release and the N_2 line release to the "B" air intake.

4. **NRC Question**

What assurance is there that the effluent will leak out over the surface of the turbine wall or an equivalent area rather than from some other location, such as the turbine building vent closest to the control room intake?

Response

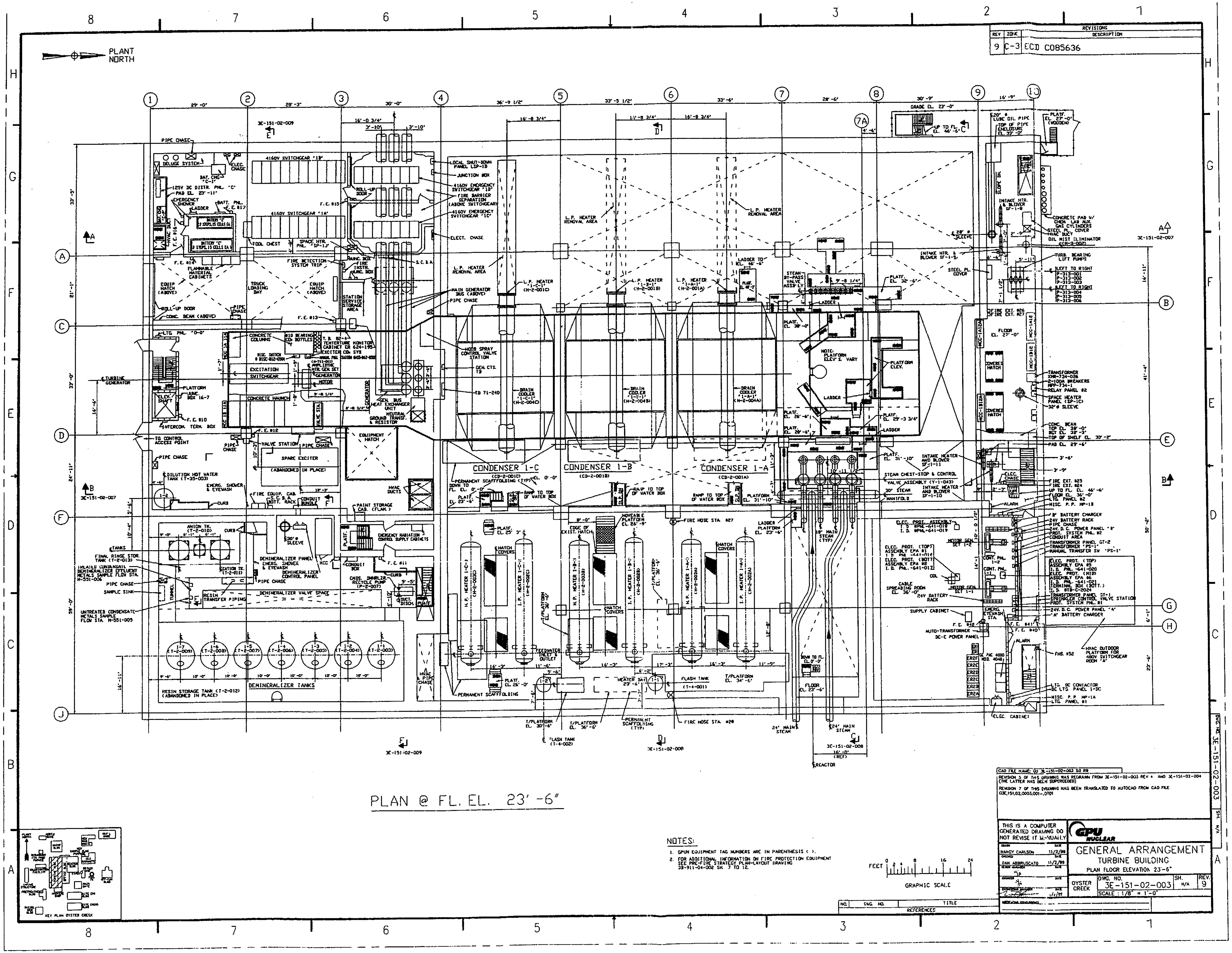
All MSIV leakage release is conservatively assumed to exit the East turbine building wall. This is conservative because this pathway is closer to the air intake for turbine building release.

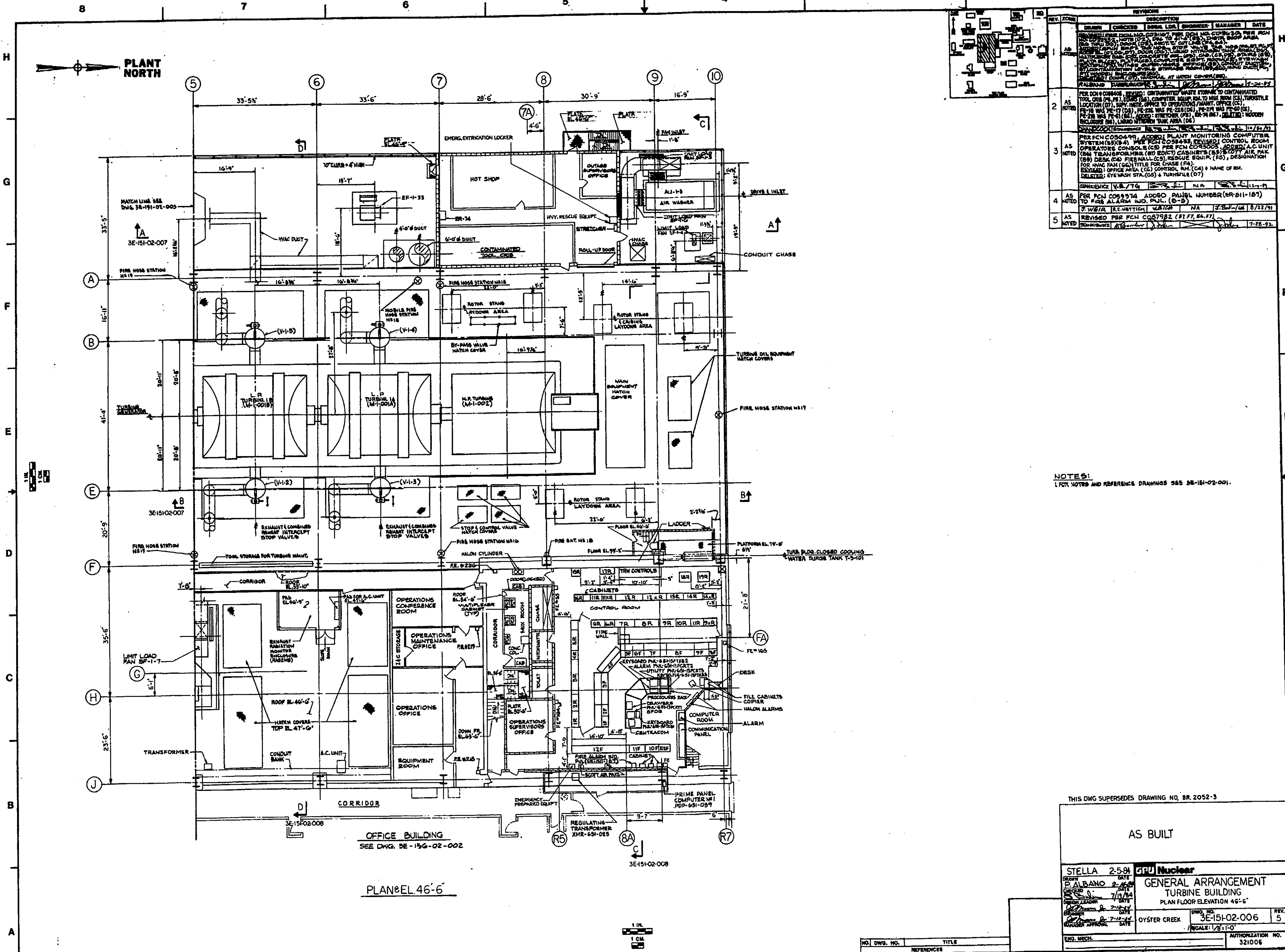
5. **NRC Question**

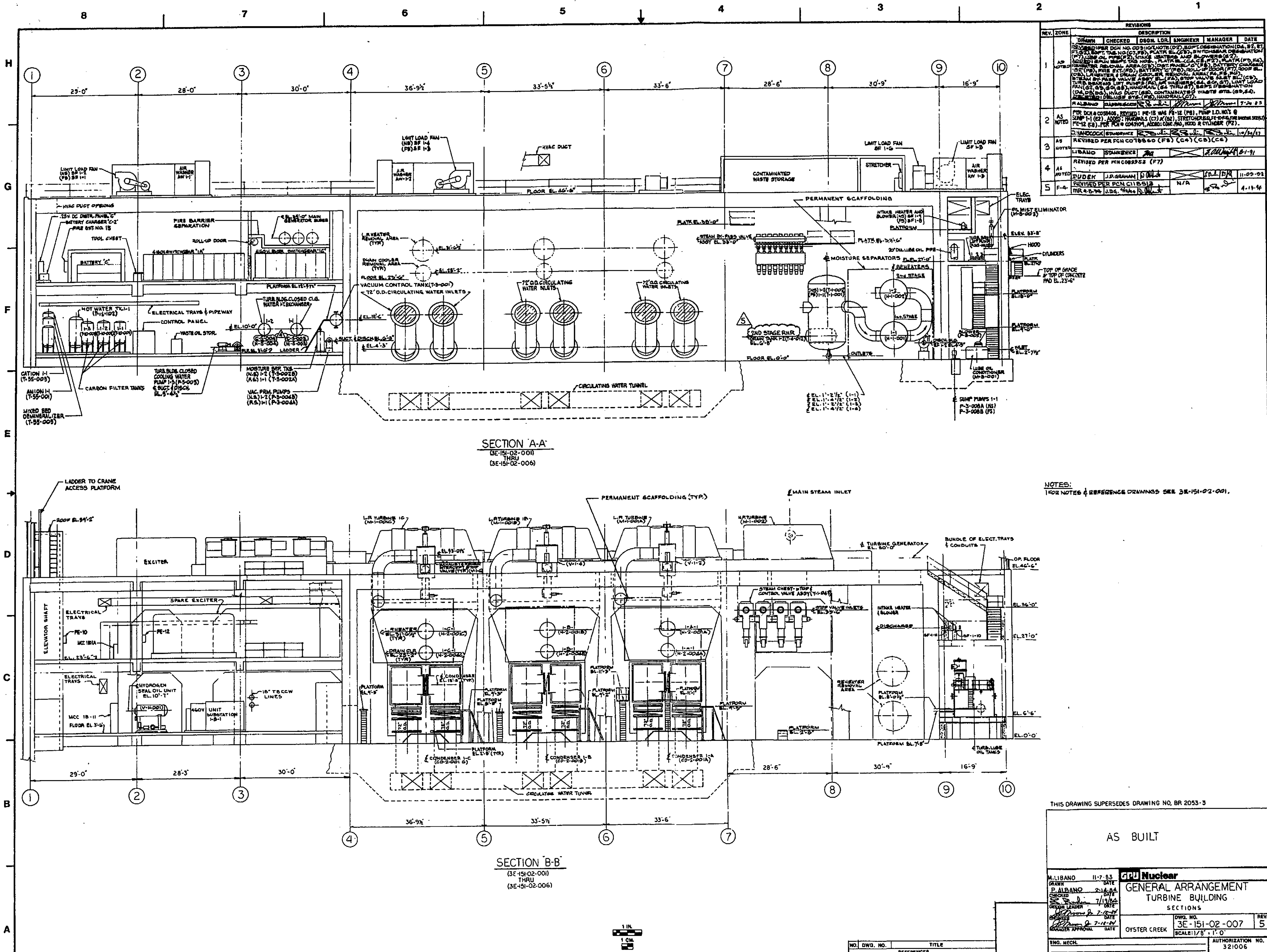
Is flow from turbine building vents forced and, if so, are the fan systems safety grade?

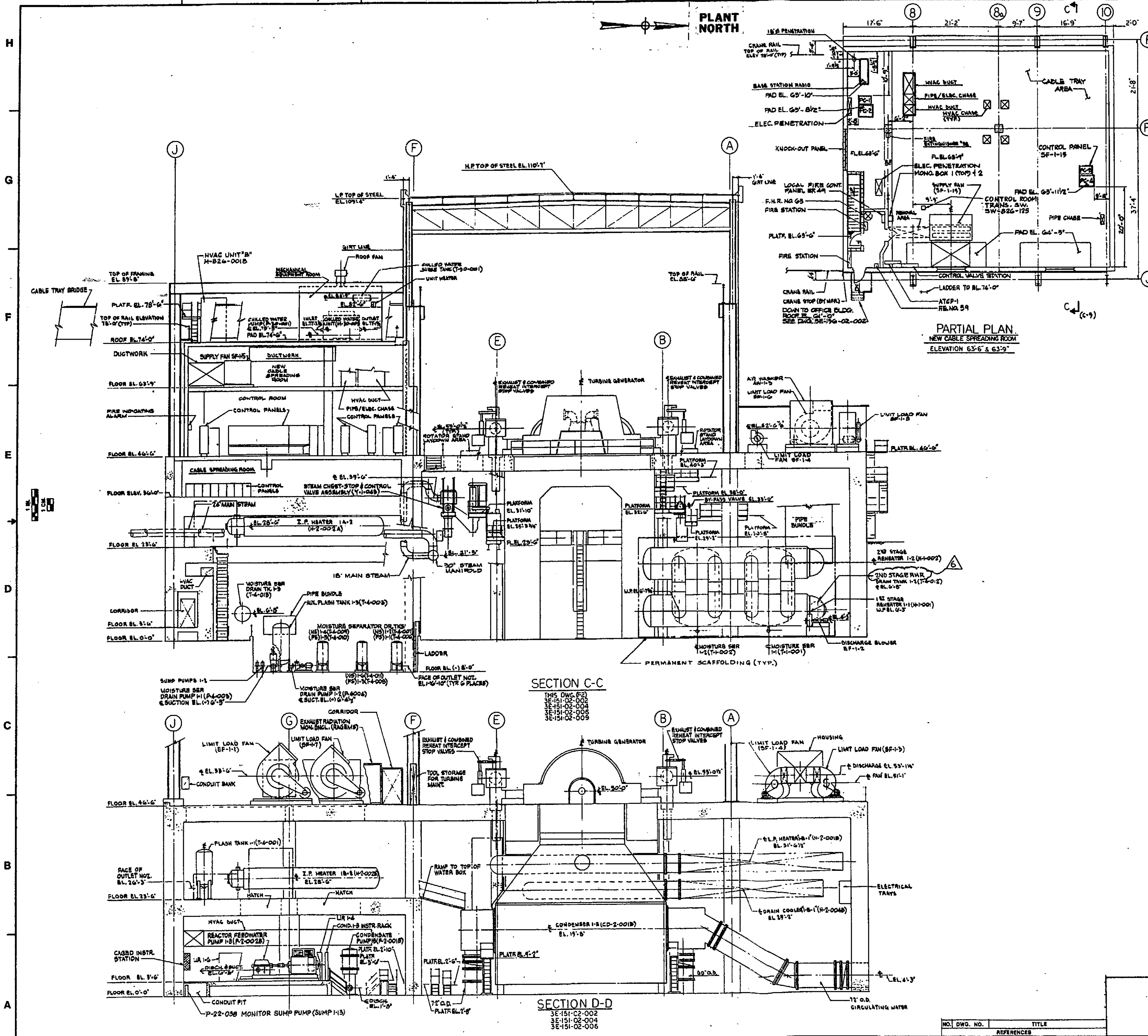
Response

The turbine building operating floor atmosphere is partially exhausted through four roof openings that are connected by a duct that runs on the building roof and down to an exhaust fan located on the west mezzanine roof and exhausted through a separate turbine building stack also located on the west mezzanine roof which is monitored for radiation. The turbine building main exhaust for the operating floor and lower elevations of the turbine building is also exhausted through this turbine building stack. The analysis assumption of a diffuse release from the east wall of the turbine building is conservative since this release is not an elevated release and is closer to the control room air intake. The supply and exhaust fans can be shutdown manually if the radiation level is above a preset level. These supply and exhaust fans are not safety grade.


PLANT NORTH
PLAN @ FL. EL. 23'-6"
CONDENSER 1-C
CONDENSER 1-B
CONDENSER 1-A
4160V SWITCHGEAR '1B'
4160V SWITCHGEAR '1A'
DEMINERALIZER TANKS
RESIN STORAGE TANK (T-2-012) (ABANDONED IN PLACE)
SPARE EXCITER (ABANDONED IN PLACE)
EXCITATION SWITCHGEAR
EQUIPMENT HATCH
L.P. HEATER REMOVAL AREA
H.P. HEATER 1-C-1
L.P. HEATER 1-C-1
H.P. HEATER 1-B-1
L.P. HEATER 1-B-1
H.P. HEATER 1-A-1
L.P. HEATER 1-A-1
FLASH TANK (T-4-001)
24" MAIN STEAM
REACTOR
NOTES:
1. GPUN EQUIPMENT TAG NUMBERS ARE IN PARENTHESIS ( ).
2. FOR ADDITIONAL INFORMATION ON FIRE PROTECTION EQUIPMENT SEE PRE-FIRE STRATEGY PLAN-LAYOUT DRAWING 3B-911-04-002 SH. 7 TO 12.
GRAPHIC SCALE
REVISIONS
9 C-3 ECD C085636
THIS IS A COMPUTER GENERATED DRAWING DO NOT REVISE IT MANUALLY
GPU NUCLEAR
GENERAL ARRANGEMENT
TURBINE BUILDING
PLAN FLOOR ELEVATION 23'-6"
OYSTER CREEK
DWG. NO. 3E-151-02-003
SH. N/A
REV. 9
SCALE: 1/8" = 1'-0"
KEY PLAN OYSTER CREEK


PLANT NORTH
PLAN@EL.46'-6"
OFFICE BUILDING
SEE DWG. 3E-156-02-002
CORRIDOR
HOT SHOP
CONTAMINATED TOOL CRIB
OUTAGE SUPERVISORS OFFICE
AIR WASHER
CONDUIT CHASE
MAIN EQUIPMENT HATCH COVER
H.P. TURBINE (M-1-002)
L.P. TURBINE 1A (M-1-001A)
L.P. TURBINE 1B (M-1-001B)
ROTOR STAND LAYDOWN AREA
TURBINE OIL EQUIPMENT HATCH COVERS
FIRE HOSE STATION N317
LADDER
CONTROL ROOM
CABINETS
COMPUTER ROOM
COMMUNICATION PANEL
OPERATIONS CONFERENCE ROOM
OPERATIONS MAINTENANCE OFFICE
OPERATIONS OFFICE
OPERATIONS SUPERVISORS OFFICE
EQUIPMENT ROOM
MUX ROOM
TOILET
KITCHENETTE
CHASE
TRANSFORMER
LIMIT LOAD FAN EF-1-7
CONDUIT BANK
A.C. UNIT
EXHAUST RADIATION MONITOR ENCLOSURE (RAGEMS)
ROOF EL. 46'-6"
HATCH COVERS TOP EL. 47'-6"
EXHAUST & COMBINED REHEAT INTERCEPT STOP VALVES
STOP & CONTROL VALVE HATCH COVERS
HALON CYLINDER
TOOL STORAGE FOR TURBINE MAINT.
TURB. BLDG. CLOSED COOLING WATER SURGE TANK T-5-101
PRIME PANEL COMPUTER NO. 1 PDP-631-039
REGULATING TRANSFORMER XMR-631-025
EMERGENCY PREPARED EQUIPT.
MATCH LINE SEE DWG. 3E-151-02-005
HVAC DUCT
EMERG. EXTRICATION LOCKER
HVY. RESCUE EQUIPT.
STRETCHER
ROLL-UP DOOR
DESK
FILE CABINETS
COPIER
HALON ALARMS
ALARM
NOTES:
1. FOR NOTES AND REFERENCE DRAWINGS SEE 3E-151-02-001.
REVISIONS
1 AS NOTED
2 AS NOTED PER DCN # C08668, REVISED: CONTAMINATED WASTE STORAGE TO CONTAMINATED TOOL CRIB
3 AS NOTED PER FCN C030499, ADDED: PLANT MONITORING COMPUTER SYSTEM
4 AS NOTED PER FCN C059574 ADDED PANEL NUMBER TO FIRE ALARM IND. PNL. (B-5)
5 AS NOTED REVISED PER FCN C087982
THIS DWG SUPERSEDES DRAWING NO. BR 2052-3
AS BUILT
STELLA 2-5-84
P. ALBANO 2-6-84
GPU Nuclear
GENERAL ARRANGEMENT
TURBINE BUILDING
PLAN FLOOR ELEVATION 46'-6"
OYSTER CREEK
DWG. NO. 3E-151-02-006
REV. 5
SCALE: 1/8"=1'-0"
AUTHORIZATION NO. 321006
NO. DWG. NO. TITLE
REFERENCES


SECTION 'A-A'
(3E-151-02-001)
THRU
(3E-151-02-006)
SECTION 'B-B'
(3E-151-02-001)
THRU
(3E-151-02-006)
REVISIONS
REV. ZONE DESCRIPTION
DRAWN CHECKED DSGN. LDR. ENGINEER MANAGER DATE
1 AS NOTED
2 AS NOTED PER DCN # C055405, REVISED: PE-15 WAS PE-12 (F8), PUMP I.D. NO'S @ SUMP 1-1 (E2).
3 AS NOTED REVISED PER FCN C078860 (F8) (C4) (C8) (C6)
4 AS NOTED REVISED PER FCN C089352 (F7)
5 F-4 REVISED PER FCN C118512
NOTES:
1. FOR NOTES & REFERENCE DRAWINGS SEE 3E-151-02-001.
THIS DRAWING SUPERSEDES DRAWING NO. BR 2053-3
AS BUILT
GPU Nuclear
GENERAL ARRANGEMENT
TURBINE BUILDING
SECTIONS
OYSTER CREEK
DWG. NO. 3E-151-02-007
REV. 5
SCALE: 1/8" = 1'-0"
AUTHORIZATION NO. 321006
PERMANENT SCAFFOLDING
CONTAMINATED WASTE STORAGE
CIRCULATING WATER TUNNEL
MOISTURE SEPARATORS
VACUUM CONTROL TANK (T-3-001)
72" O.D. CIRCULATING WATER INLETS
CARBON FILTER TANKS
MIXED BED DEMINERALIZER (T-55-003)
LADDER TO CRANE ACCESS PLATFORM
ELEVATOR SHAFT
EXCITER
SPARE EXCITER
MAIN STEAM INLET
TURBINE GENERATOR EL. 50'-0"
CONDENSER 1-A
CONDENSER 1-B
CONDENSER 1-C



REVISIONS		
REV.	ZONE	DESCRIPTION
1	AS NOTED	REVISED: PER DCN NO. C091107, C010556; NOTE (D2), WALL (D8, F4), PARTIAL PLAN TITLE (F3), HVAC DUCT (D7), EQPT. DESIGNATION (C7, D8, D7, E7), FLOOR EL. (D8), LADDER SIZE (D5), EL. AT CIRC. WATER (A3), ROOM DESIGNATION (F7); STAIRS (A4). ADDED: OPLN EQPT. TAG NOS., INSTR. PANELS (G2), ALARM CONTROL PANEL (F4), F.H.R. NO. 43 & FIRE STATION (F4), PLATF. EL. (F4), RAMP (B6), LADDER (C6, F3), DOOR (F4), CABLE TRAY BRIDGE (F6 THRU F8), EL. 50'-0" (C5), INSTR. STATION (A7), LIR 1-4, 1-6 (A7), INSTR. RACK (A7), PLATF. (A5, A6), REF. DWGS. (A5, C5), STAIRS (E4), CONDUIT BANK (C7), EXHAUST RADIATION MON. ENCLOSURE (C7), TOOL STOR. (C6), FIRE ALARM (E7). DELETED: PARTIAL PLAN (C3), CLOSED COOLING WATER SURGE TANK (D4, F6). — RALBANO / DABBRUSCATO / 7-26-85
2	AS NOTED	PER DCN # C058405, REVISED: PARTIAL PLAN OF NEW CABLE SPREADING ROOM, FHR-63 WAS FHR-44. ADDED: CONCRETE PADS, ELEVATIONS & CABLE TRAY AREA. — D.HANCOCK / STANKIEWICZ / 10/26/87
3	AS NOTED	PER FCN C093003, ADDED: ELECT. PENETRATIONS (G4) MONO BOX (G3) CONTROL ROOM TRANS. SW. (G3) HVAC UNIT "B" (F7) REVISED: PANEL (G3) FE# 59 WAS #127 (F3) — STANKIEWICZ / V.B./T.G. / N/A
4	AS NOTED	REVISED PER FCN C078860 (D7) (B7) (D4) (B6) — LIBANO / STANKIEWICZ / 8/1/91
5	AS NOTED	REVISED PER FCN C073219 (A7) — STANKIEWICZ / 7-29-92
6	D-3	REVISED PER FCN C118513 — MR4894 / JDG / N/A / 4.15.94

NOTES:
1. FOR NOTES & REFERENCE DRAWINGS SEE 3E-151-02-001.

THIS DRAWING SUPERSEDES DRAWING NO. BR 2054-3

AS-BUILT

NO.	DWG. NO.	TITLE
REFERENCES		

GPU Nuclear

GENERAL ARRANGEMENT
TURBINE BUILDING
PARTIAL PLANS AND SECTIONS

STELLA 12-12-83
DRAWN: P. ALBANO 2-14-84
CHECKED 7/17/84
DESIGN LEADER 7-17-84
ENGINEER 7-17-84
MANAGER APPROVAL

OYSTER CREEK

DWG. NO. 3E-151-02-008 REV. 6
SCALE: 1/8" = 1'-0"
AUTHORIZATION NO. 321006

ENG. MECH.

DWG. NO. 3E-151-02-008

ENCLOSURE 2

OYSTER CREEK

Calculation No. C-1302-826-E540-017, Rev. 0, " Calculation of OC Control Room Air Intake X/Q Using ARCON96"

GPU NUCLEAR

CALCULATION COVER SHEET
(Ref. EP-006)

Subject: Calculation of OC Control Room Air Intake X/Q's for Ground Level Releases Using ARCON96	Calculation No. C-1302-826-E540-017	Rev. No. 0	System Nos. 826	Sheet 1 of 91

1. Is this calculation within the scope of the GPUN Operational Quality Assurance Plan? (If **YES**, a verification is required unless the calculation is a non-substantive revision.)	X Yes	No
2. Does this calculation contain assumptions / design inputs that require confirmation? (If **YES**, provide CAP or appropriate configuration control number(s)) (e.g., ECD, PFU, MD, PCR, etc.)	Yes	X No
3. Does this calculation require revision to any existing documents? (If yes, provide CAP or appropriate configuration control number(s))	Yes	X No
4. Is this calculation performed as a design basis calculation? (If **YES**, identify design basis parameters.) (See Section 3.3) Parameter: X/Q , meteorological dispersion for control room air intake	X Yes	No

Referenced Calculations and Safety Evaluations (See Section 4.3.1.3)	Rev. No.
Stone & Webster calculation 15050.50 ENV-3. "Control Room Air Intake X/Q Analysis - Murphy and Campe Method. Rev 0.	0
S&W Calc 15050.50 ENV-4. Accident X/Q Values at the Present Control Room Air Intake From the Main Plant Ventilation Stack. Rev 0.	0

Comments:

APPROVALS

Originator	Louis C. Lanese	Louis C. Lanese	Date 7/25/2000
Verification Engineer/Reviewer	Kenneth G. Boughton	K. G. Boughton	Date 7/25/2000
Section Manager	David J. Maisero	D J Maisero	Date 7/27/00
Other Verification Engineer/Reviewer			Date
Other Verification Engineer/Reviewer			Date

N

5870 (10/99)

GPU NUCLEAR

CALCULATION SHEET
(Ref. EP-006)

Subject: Calculation of OC Co..l Room air intake X/Q using .CON96	Calculation No. C-1302-826-E540-017	Rev. No. 0	System Nos. 826	Sheet 2

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1.0 PURPOSE

This calculation determines the X/Q values for ground level releases for control room habitability dose calculations. The ARCON96 computer code is used to recalculate the X/Q values that are currently referenced in Oyster Creek's docketed analyses. (Ref 7.1 & 7.2)

The previous X/Q values were calculated using the Murphy-Campe methodology as described in Reference 7.3 consistent with ARCON code input requirements. ARCON96 input values were modified in accordance with Draft guidance provided by the NRC Staff in April 2000 and attached as Appendix A of this calculation.

Background

CAP No.O2000-0693 was issued on May 26, 2000

> During the recent review of the evaluation of control room habitability submitted to the NRC in 1997, it was identified that the X/Q values for the "A" Control Room HVAC System were less conservative than the X/Q values for the "B" System. This was as a result of the geometric placement of the "B" system intake relative to the "A" system intake location. The "B" CR HVAC System was installed during 12R (end of 1988). The SE for the installation of that system Ref 7.4 indicated that there was no impact on radiological safety. The basis for this was that the flow rates for the new system were the same as for the original "A" system. The SE did not consider that the X/Q for the "B" system was more limiting with respect to turbine building ground level releases. No X/Q values were calculated for the "B" system at that time. The Technical Specification bases (Section 3.17) numbers of 3.14 Rem WB and 29.1 Rem skin dose reflect the analysis that was done for the "A" system. Based upon preliminary evaluations, it is judged that the doses would be increased if analyzed for the "B" system and would likely be greater than the allowable limits reflected in the TS 3.17 and 4.17 bases of 5.0 Rem whole body and 30 Rem skin dose.
>
> The "B" system is considered operable because the X/Q values for both systems have been re-evaluated with the more recent ARCON96 methodology (accepted by the NRC but not specifically for Oyster Creek at this time) and the results are such that the new X/Q for the "B" system is smaller than the original X/Q for the "A" system used to develop the TS values. Consequently, the doses would also be less.

The atmospheric dispersion coefficients (X/Q) were calculated for the "A" ventilation system utilizing the Murphy-Campe methodology for a diffuse ground level release. The Murphy-Campe method conservatively determines a X/Q considering building wake effects upon a release. The methodology does not consider the effects of plume meander during low wind speed conditions and does not depict variations in concentrations near buildings with a high degree of accuracy. The methodology tended to over predict concentrations at low wind speed conditions.

The ARCON96 approach (sponsored by the NRC) provides an alternative to the Murphy-Campe method that provides for a more accurate determination of concentrations in building wakes by considering the effects of meander at low wind speeds. It also provides for a refinement of the effects of building wakes based upon recent studies of field data. This model with the guidance provided by the NRC results in a more accurate prediction of X/Q for control room habitability assessments than previously existed. Utilization of the ARCON96 approach has been recommended as an acceptable replacement model to Murphy-Campe for control room assessments.

2.0 SUMMARY OF RESULTS

The χ/Q for three release point to the closest HVAC intake are summarized below

	Murphy Campe "A" intake	B HVAC χ/Q Turbine building	Murphy Campe	A HVAC χ/Q yard N_2
	Ref 7.1	95-99 met data	Ref 7.2	95-99 met data
0-2 hrs		3.73E-03		2.88E-03
2-8 hrs		2.37E-03		2.49E-03
0-8 hrs	5.18E-3	2.71E-03	1.92E-3	2.59E-03
8-24 hrs	3.94E-3	8.76E-04	1.09E-4	1.15-03
24 -96 hrs	2.75E-3	8.63E-04	5.99E-4	8.44E-04
96-720 hrs	1.66E-3	8.45E-04	1.46E-4	7.18E-04

3.0 ASSUMPTIONS

1. The X/Q to the B HVAC system will not be calculated for the yard release. Rather, the value for the "A HVAC" intake will be used. This is a conservative assumption because:

   a. dose from these sources are small
   b. the A and B air intakes are close to each other, with B closer to the turbine building source and source and "A" closer to the yard release

2. Plant grade is elevation 23 ft 6 in

3. The nominal elevation of the Office Building roof is 63 ft-10 in (location of "A" air intake)

4. The nominal elevation of the New Cable Spreading Room roof is 74 ft-0 in (location of "B" air intake)

5. The release from the main steam lines is diffuse because the release location is below the operating deck of the turbine building. (refer to Figures 10 and 12 which excerpt relevant portions of drawings and 3E-151-009 Ref (7.5) and 3E-151-02-007 (Ref 7.6).

   a. The break location is physically isolated from the operating deck by load bearing walls and floors.

   b. The potential release path location is from the turbine siding, which is located at approximately elevation 82 ft 6in. The operating deck is at el 46 ft 6in.

   c. All of the release within the Turbine Building is assumed to exit through the East wall of that building. This assumption provides a conservative estimate since, in reality, the release would be from all sides of the building, including the roof.

6. The release point for either of the two N_2 system reactor building bypass pathways is assumed to be a point source release and to lie in a direction 75° from the control room air intake. See section 4.2 for additional discussion.

4.0 DESIGN INPUT

Figure 1 is a simplified site plot plan showing the three release points that are considered in control room habitability dose calculations. The first is the release caused by leakage through the main steam isolation valves. The second release point comes from drywell bypass leakage through non-seismic I portion of the N_2 system. The third is the plant stack releases, coming from bypass leakage in the reactor building that is processed by the standby Gas Treatment system. The X/Q for the stack will not be calculated using ARCON96 because it is an elevated release. Atmospheric dispersion from the stack has been previously calculated in Reference 7.7.

4.1 Turbine Building Release

Column Dimensions

		Reference	Variable name
Column 10 to 9	16 ft 9 in	Ref 7.8. 151-02-003	Col10_9
Column 9 to 8	30 ft 9 in		Col9_8
Column 8 to 7	28 ft 6 in		Col8_7
Column 7 to 6	33 ft 6 in		Col7_6
Column 6 to 5	33 ft 5.5 in		Col6_5
Column 5 to 4	36 ft 9.5 in		Col5_4
Column 4 to 3	30 ft 0 in		Col4_3
Column 3 to 2	28 ft 3 in		Col3_2
Column 2 to 1	29 ft 0 in		Col2_1
Column 8 to 7a	4 ft 6 in		Col8_7a
Column 7a to centerline of TS/CV's	10 ft 11.5 in	Ref 7.8 (see grid E-8 of drawing for this dimension and Fig 12)	Col7a_cenTSCV
Column F to postulatedbreak (Turbine stop/control valves)	3 ft 5 in	Ref 7.8 scaled to estimated break location at inlet to steam chest top valves. Also see figures10 and 11.	ColF_TSCV
Column 8 to 7a Roof el 74 ft	6 ft 2 in	Ref 7.5 151-02-009	Col8_7a_el74
Column 9 to 8a	9 ft 7 in		Col9_8a
Column 8 to "B" HVAC intake	13 ft 1-1/8 in	Ref 7.9 15050.68 ES-1A & Fig 6	Col8_B_{intake}
Column 8 to "A" HVAC intake cenetrline	9.5 ft	Ref 10 151-02-008 Partial Plan	
Column F-Fa	21 ft 8 in		ColF_Fa
Column Fa-J	37 ft 4 in		ColFa_J
Column J to "A" HVAC intake	2.5 ft		ColJ_Aintake
Column 8a to 8	21 ft 2in		Col8a_8
Column J to "B" HVAC intake	11 ft 8 in + 4 ft 5-1/8 in	Ref 7.9	ColJ_Bintake
Column F to TB girt line	1 ft 7-3/4 in + 7-7/8in	Ref 7.11 BR 4503	ColF_TBgirt
RxBldg girt line to Column R1	3 ft 3 in	Ref 7.12	ColGirt_R1
RxBldg column R7 to girt	3 ft 3 in		ColR7_girt
RxBldg girt line to Column RA	2 ft 9 in	Ref 7.12 3E-153-02--006	
RxBldg column RA to RB	20 ft 9 in	Ref 7.13 153-02-001	ColRA_RB
RxBldg column RB to RC	21 ft 6 in		ColRB_RC
RxBldg column RC to RD	21 ft 6 in		ColRC_RD
RxBldg column RD to RE	21 ft 6 in		ColRD_RE
RxBldg column RE to RF	20 ft 9 in		ColRE_RF
RxBldg column RF to RG	31 ft 6 in		ColRF_RB
RxBldg column RG to col J	6 ft 1 in		ColRG_J
RxBldg column R1 to R2	22 ft 0 in	Ref 7.13	ColR1_R2
RxBldg column R2 to R3	23 ft 3 in		ColR2_R3
RxBldg column R3 to R4	23 ft 3 in		ColR3_R4
RxBldg column R4 to R5	23 ft 3 in		ColR4_R5
RxBldg column R5 to R6	23 ft 3 in		ColR5_R6
RxBldg column R6 to R7	22 ft 0 in		ColR6_R7

Elevations

A HVAC roof of Office Building	61 ft	3E-153-02-008 (Ref 7.14)	OffBldgrfEl
A HVAC bottom elevation above roof	56 in	Field measurement Ref 7.15	AHVACaboverf
A HVAC height of intake	48 in	Ref 15	AHVACht
A HVAC width of intake	80 in	Field measurement Ref 7.16	A_HVACwf
B HVAC roof cable spreading room	74 ft	Ref 7.10 151-02-008	TbrfEl
B HVAC bottom elevation above roof	69 in	Field measurement Ref 7.15	BHVACaboverf
A HVAC height of intake	59 in	Ref 7.15	BHVACht
Reactor Building top elevation	170 ft 4.5 in	Ref 7.17 153-02-007	Rbtopel
Turbine Building top elevation	109 ft 4in	Ref 7.10 151-02-008	TBEht

The nominal elevation of the Office Building roof is 61 ft (location of "A" air intake)

The nominal elevation of the New Cable Spreading Room roof is 74 ft-0 in (location of "B" air intake)

Meteorological data for the years 1995 through 1999 have been used in this evaluation.

Field Walkdowns for Dimensional Confirmations

On June 2, 2000 a walk-down was performed Ref 7.16 to confirmed the geometric relationship and approximate dimensions on the referenced drawings. The distance from column line "J" to the crane rail and the distance from the crane rail to the southwest edge of the "B" HVAC air intake were measured and showed good agreement with the calculated dimension for Col_J_B.

J_crane := 33 in crane_BHVAC := 13 ft + 3.5 in J_crane + crane_BHVAC = 16.04·ft

The width of the "A" HVAC air intake was measured during a walk-down on June 2, 2000 (Ref 16) as approximately 80 in.

Some additional distances were estimated by field measurements using a 12 ft ruler:

1. The distance from the northern edge of the office building to the center of the "A" HVAC intake
2. The width of the opening for the "A" HVAC air intake

Awidth := 80 in Awidth = 6.67·ft Awidth = 2.03·m

nortW_Acent$_f$:= 36 ft + 40 in nortW_Acent$_f$ = 39.33·ft nortW_Acent$_f$ = 39.33·ft

nortW_Acent$_f$ = 11.99·m

The dimensions from the north wall of the turbine building to the center of the "A" HVAC system were also taken from drawing (Ref 7.10). The estimated distances from the field measurement confirmed that the drawing dimensions were correct. The distance is measured between columns "10" and "8" with the center of the A HVAC system 9.5 feet less than the dimension between columns 8 and 8a. Refer to Figure 2.

There is reasonable agreement between the approximate field measurement and the calculated value using the drawing dimensions.

Release Location

The release from the Oyster Creek turbine building comes from leakage through the main steam lines. The lines are assumed to rupture at the inlet to the main turbine at the turbine stop and control valves. These are located between column lines "7" and "8" and "E" and "F" as shown on drawings 3E-151-02-007 (Ref 7.6) and 3E-151-02-003 (Ref 7.8) and Figure 10.

The turbine building release to the "A" & "B" HVAC air intakes is assumed to diffuse and leak from the turbine building East wall at column "F". The vertical dimension of the leakage area is measured from the turbine operating floor 46-ft 6-in to the top elevation at 109 ' 4" (see drawing 3E-151-02-008, Ref 7.10), and Figures 9 and 10.

The horizontal dimension is from column lines 1 through 10. Note that the East wall is blocked by the mechanical equipment room, new cable spreading room, and control room between columns 7 and 10 (Refs 7.18 and 7.19) to el. 63-ft 9in (drawing 151-02-008 Ref 7.10).

Release Elevation

The release point is conservatively assumed to be at 10m and that the elevation of the "A" or 'B" air intake are at the same elevation as the release point when calculating the X/Q for that air intake. This assumption eliminates any corrections for wind speed at higher elevations. This approach is consistent with the guidance contained in NRC Reg Guide 1.145, Murphy-Campe and Pavan as it provides for the minimum acceptable elevation for determining ground level release X/Q. It is recognized that ARCON96 allows modeling at the release height with wind speed corrections. The X/Q would be smaller with this approach.

The release elevation for the turbine building release is based the draft NRC guidance provided as Appendix A to this document. The release height is set at the point on the surface of the area source that will result in the shortest slant path.

Elevation of Intake

The actual HVAC elevations are calculated for use in sensitivity studies and for reference purposes. Figures 9 and 10 show the elevations of the HVAC air intakes.

The bottom of the "A" HVAC air intake was measured as 56 inches above the office building roof The top of the "A" HVAC air intake was measured as 48 inches high (Ref 7.15) . Roof elevation varies from 60ft 5in to 61 ft) (Ref 7.14). The high point elevation is at the edge where the "A" HVAC intake is located; therefore 61ft is used to calculate the intake height.

OffBldgrfEl = 61.0·ft AHVAC $_{aboverf}$ = 4.67·ft AHVAC $_{ht}$ = 4.0·ft

The elevation of the bottom and top of the A HVAC air intake above grade is:

AIntake $_{bot}$:= OffBldgrfEl + AHVAC $_{aboverf}$ − grade_el AIntake $_{bot}$ = 42.2·ft

$AIntake_{top} := OffBldgrfEl + AHVAC_{aboverf} + AHVAC_{ht} - grade\_el$ $AIntake_{top} = 46.2\,ft$

The elevation of the center-line of the A HVAC air intake above grade is:

$$AIntake_{center} := \frac{(AIntake_{top} + AIntake_{bot})}{2}$$

$AIntake_{center} = 44.2\,ft$ $AIntake_{center} = 13.5\,m$

The bottom of the "B" HVAC air intake was measured as 69 inches above the roof of the mechanical equipment room roof (measurements taken on June 20, 2000 (Ref 7.15). The top of the "B" HVAC air intake was measured as 58 inches high. Roof elevation is taken as 74-ft 0-in (Ref 7.10).

$TBrfEl = 74.0\,ft$ $BHVAC_{aboverf} = 5.7\,ft$ $BHVAC_{ht} = 4.9\,ft$

The elevation of the bottom and top of the "B" HVAC air intake above grade is:

$BIntake_{bot} := TBrfEl + BHVAC_{aboverf} - grade\_el$ $BIntake_{bot} = 56.3\,ft$

$BIntake_{top} := TBrfEl + BHVAC_{aboverf} + BHVAC_{ht} - grade\_el$ $BIntake_{top} = 61.2\,ft$

The elevation of the center-line of the B HVAC air intake above grade is:

$$BIntake_{center} := \frac{(BIntake_{top} + BIntake_{bot})}{2}$$

$BIntake_{center} = 58.7\,ft$ $BIntake_{center} = 17.9\,m$

Source-Receptor Distance/Distances for "A" and "B" HVAC Air intakes

The release distance for the turbine building release) is the shortest horizontal distance from the building surface to the control room intake as recommended in the draft NRC guidance (see Appendix A Section 4.3.4).

The distance to the receptor, in meters, is "the shortest horizontal distance from the building surface to the control room intake" when using ARCON96. The distance from the "A" air intake to column "F" from drawing 151-02-008 Ref 7.10 and Figure 4). The distance from column "F" to column the turbine building girt line is taken from Ref 7.11. Figure 2 shows the general arrangement and dimensions that are used in the following calculations.

$ColF\_TG_{girt} = 2.3 \cdot ft$

$MinHor_A := -ColF\_TG_{girt} + ColF\_Fa + ColFa\_J - ColJ\_A_{intake}$

$MinHor_A = 54.2 \cdot ft$ Min

$MinHor_A = 16.5 \cdot m$

The roof plan arrangement for "B" HVAC is shown on Figure 3 (Ref 7.5) . The distance to the "B" HVAC intake is the distance to "A" HVAC minus the distance from col J to the edge of B HVAC intake (between col "J" & "Fa" (Reference 7.9 and Figure 6).

$Col\_J\_B_{intake} = 16.1 \cdot ft$

$MinHor_B := MinHor_A + ColJ\_A_{intake} - Col\_J\_B_{intake}$ $MinHor_B = 40.6 \cdot ft$ $MinHor_B = 12.4 \cdot m$

Lateral distance between "A" & "B" HVAC

The ARCON96 calculation uses the minimum horizontal distance from the HVAC air intake to the east wall of the turbine building.

The previous meteorological calculation using the Murphy-Campe formulation (Reference 7.1) calculated a source to intake distance from a point on the turbine building roof directly above the location of the stop and control valves. This distance is recalculated here for reference and for use in sensitivity studies of ARCON96 results. Figures 2 and 10 show the distances from the stop and control valves to the air intakes as well as other relevant dimensions and relationships.

The calculation of X/Q using Murphy-Campe used a slant distance of 65 feet from the source to the air intake. This basis for the number was not detailed in the referenced calculation and is being reconstituted here. The line "MS-A" represents the distance from the "A" air intake to the turbine building to the postulated break location of the main steam lines. Refer to Figure 2.

The North-South distance between the centerline of the "A" air intake and the main stop and control valves is calculated from drawing 151-02-003 (Ref 7.8).

Col10_TSCV := Col10_9 + Col9_8 + Col8_7a + Col7a_cenTSCV Col10_TSCV = 63.0·ft

where

Col10_9 = 16.8·ft Col9_8 = 30.8·ft Col8_7a = 4.5·ft

and the distance from column "F" to the turbine stop (F_TSCV)and control valves is scaled from Ref 7.8. The break location is illustrated on Figures 10 and 11. The break location is assumed to be approximately at the outlet of the 90° elbow leading into the stop and control valves.

Col7a_cenTSCV = 10.96·ft

The distance from Column 10 (north end of the roof) to the centerline of the "A" HVAC is calculated from drawing 151-02-008 (Ref 7.10) as illustrated on Figure 4. Also refer to and Figure 2.

$Col10\_A_{cent} := Col10\_9 + Col9\_8a + Col8a\_8 - Col8\_A_{center}$ $Col10\_A_{cent} = 38.0 \cdot ft$

The North-South distance between the centerline of the "A" intake and the stop and control valves is:

$A_{cent\_TSCV} := Col10\_TSCV - Col10\_A_{cent}$ $A_{cent\_TSCV} = 25.0 \cdot ft$

The East-West distance from the turbine stop and control valves to the to the "A" air intake

ColF_TSCV = 3.5·ft

ColF_TSCV = 3.5·ft

$SCV\_A_{intake} := MinHor_A + ColF\_TG_{girt} + ColF\_TSCV$ $SCV\_A_{intake} = 60.0 \cdot ft$

The slant distance is the diagonal of a triangle made up of the North-South and East-West dimensions

$$MS\_A := \sqrt{(A_{cent\_TSCV})^2 + (SCV\_A_{intake})^2} \qquad MS\_A = 19.8 \cdot m \qquad \boxed{MS\_A = 65.0 \cdot ft}$$

This matches the value used in the original calculation of Reference 7.1.

B HVAC Lateral Distance

The distance from column 8 to the southernmost edge of the "B" intake is shown on drawing 15050.68-ES-1A (Ref 7.9 illustrated on Figure 6). The East-West dimension from the "B" intake to the stop and control valves is

$$EW\_B_{intake} := (MinHor_B + ColF\_TG_{girt} + ColF\_TSCV) \qquad EW\_B_{intake} = 49.5 \cdot ft$$

$$NS\_B_{intake} := Col10\_9 + Col9\_8 + Col8\_B_{intake} \qquad NS\_B_{intake} = 60.6 \cdot ft$$

$$MS\_B := \sqrt{(EW\_B_{intake})^2 + (Col10\_TSCV - NS\_B_{intake})^2} \qquad MS\_B = 49.5 \cdot ft$$

Direction of Intake to Source

ARCON96 requires a specification of the "direction to source". The direction is specified as if looking at the source from the intake. If a point source release is assumed then the model below can be used to determine "direction to source" for varying point locations on the Turbine Building east wall. The angles ϕ and θ can be calculated from the dimensions of the figure below, where ϕ is the angle in cartesian coordinates. The x-axis is 0^0 and the y- axis is 90^0, with the angle measured in the counter-clockwise direction.

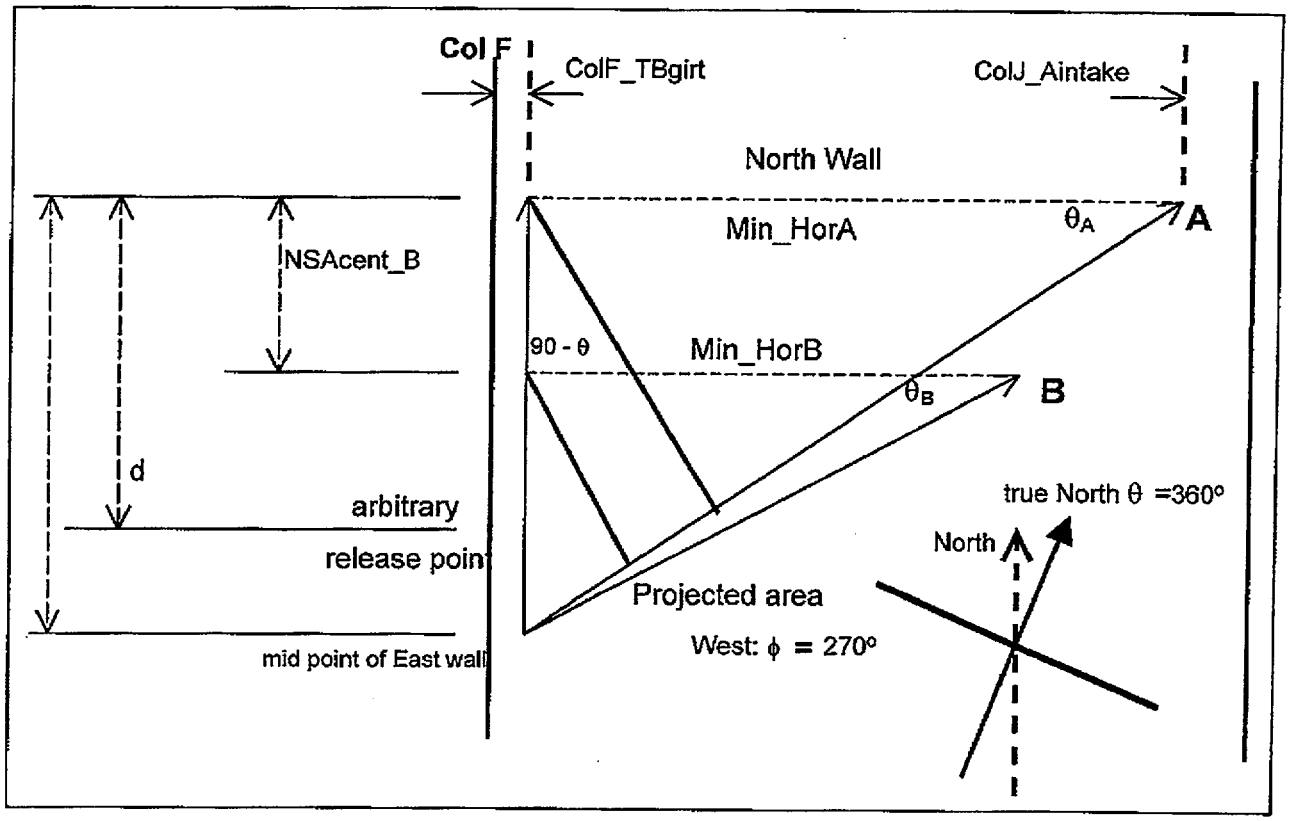
ARCON96 requires that the angle be specified from "true North" to be consistent with wind direction reported in the site meteorological data. θ is measured from "true North" moving clockwise in the clockwise direction. Looking North, θ is 360^0 and looking southwest, θ is 225^0. True North is indicated on the Oyster Creek drawings at bearing N 14^0 40' 46' W as shown on Reference 7.20.

The angles θ_A and θ_B will be calculated for points starting at the mid-point of the East wall of the turbin building to the north wall. (See figure below.

The midpoint of the East wall of the turbine building was calculated from drawing 151-02-007 (Ref 7.6).

$TbW_{East} := Col10\_9 + Col9\_8 + Col8\_7 + Col7\_6 + Col6\_5 + Col5\_4 + Col4\_3 + Col3\_2 + Col2\_1$

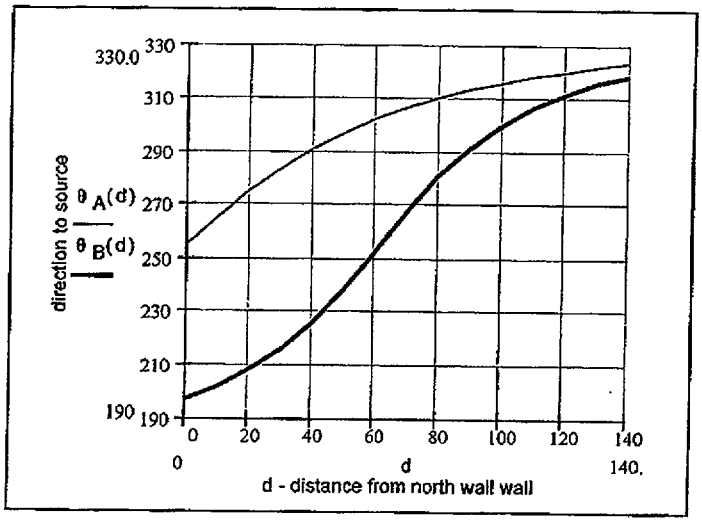
$$\frac{TbW_{East}}{2} = 133.5 \cdot ft$$



$$\phi_A(d) := 180 + \operatorname{atan}\left(\frac{-d}{-54.7}\right) \cdot \text{conv}_{deg} \qquad \phi_B(d) := 180 + \operatorname{atan}\left(\frac{-d+61.33}{-38.6}\right) \cdot \text{conv}_{deg}$$

$$\theta_A(d) := 90 - 15 + \phi_A(d) \qquad \theta_B(d) := 90 - 15 + \phi_B(d)$$

$$\text{conv}_{deg} := \frac{360}{2\pi\,rad}$$



d	θ A(d)	θ B(d)
0	255.0	197.2
10.0	265.4	201.9
20.0	275.1	208.0
30.0	283.7	215.9
40.0	291.2	226.1
50.0	297.4	238.6
60.0	302.6	253.0
70.0	307.0	267.7
80.0	310.6	280.8
90.0	313.7	291.6
100.0	316.3	300.1
110.0	318.6	306.6
120.0	320.5	311.7
130.0	322.2	315.7
140.0	323.7	318.9

For a diffuse release model (as represented by an area release from the East wall of the Turbine Building) it is appropriate to consider the bearing from both the "A" and "B" intakes as that which forms a right angle with a line drawn from "A" or "B" to the East wall of the building. The basis for this approach is that the Turbine Building blockage dominates the dispersion characteristics for an area release anywhere on the East wall. For this model, the bearing to the East wall is 255^0 from True North.

Diffusion Coefficients

The initial diffusion coefficients for the turbine building release are calculated using Section 4.3.3 of the draft NRC guidance provided as Appendix A to this document. The height and width of the area source (e.g., the containment surface) are taken as the maximum vertical and horizontal dimensions of the building cross-sectional area perpendicular to the line of sight to the control room intake.

The width of the area source is the north-south dimension of the turbine building east wall.

$TbW_{East} := Col10\_9 + Col9\_8 + Col8\_7 + Col7\_6 + Col6\_5 + Col5\_4 + Col4\_3 + Col3\_2 + Col2\_1$

$$\sigma_y := \frac{TbW_{East}}{6}$$

$\sigma_y = 13.6 \cdot m$

The vertical diffusion coefficient for this release is based on the distance from grade elevation to the top of the turbine building. As discussed previously, the Turbine Building blockage dominates the dispersion characteristics for an area release anywhere on the East wall and this approach is consistent with Section 4.3.3 of the NRC draft guidance (see Appendix A)

$Height_{areasource} := TBE_{ht}$

$$\sigma_z := \frac{Height_{areasource}}{6}$$

$\sigma_z = 14.3 \cdot ft$

$\sigma_z = 4.4 \cdot m$

Building Wake Area

The building wake area is calculated as the largest area perpendicular to the wind direction (equivalent to the line of sight direction from the receptor to the source).

The wake area has been calculated assuming that the wind direction is perpendicular to the turbine building and that it comes from a diffuse source with it's center at a point perpendicular to the line of sight from the respective air intake .

$WakeArea_{perp.} := TBE_{ht} \cdot (TbW_{East})$

$WakeArea_{perp.} = 22917.5 \cdot ft^2$

$WakeArea_{perp.} = 2129.1 \cdot m^2$

4.2 Nitrogen line/yard releases

The N_2 supply system provides (Ref 7.21) purge for the drywell and torus. This line penetrates the reactor building on the Northeast corner of the Reactor Building as determined by a formal system walkdown. Figure 8 (Ref 7.22) provides a copy of the sketch showing the routing of this line and the penetration at the northeast corner of the building.

Reference 7.2 calculated 45.1m to air intake form the N_2 line penetration at the Reactor Building northeast corner (yard release). The X/Q to the B HVAC system will not be calculated. Rather, the value for the "A HVAC" intake will be used. This a conservative assumption because the two air intakes are close to each other, with A being closer to the source.

The distance from the East wall of the reactor building to the " A" HVAC air intake (column J) is taken from drawing 3E 153-02-001 (Ref 7.13) and 3E 153-02-006 7.12, where the later drawing provides the dimension from column RA to the building girt line.

$$N_{2\_dist} := ColGirt\_RA + ColRA\_RB + ColRB\_RC + ColRC\_RD + ColRD\_RE \ldots + ColRE\_RF + ColRF\_RG + ColRG\_J + ColJ\_A_{intake}$$

$N_{2\_dist} = 148.8\ ft$

$N_{2\_dist} = 45.4\ m$

The release point for either of the two N_2 system reactor building bypass pathways located on the east side of the reactor building is assumed to lie in a direction 75° from the control room air intake. The exact location of the potential release can not be determined since the N_2 line runs along the wall of the RB. However, the shortest distance from any potential release point (see Figure 1) is in a direction normal to the east wall that runs 345° to 165°, or approximately North-South. The normal to the East wall would therefore be at 255°.

Building wake area is area of the east wall projected onto a plane perpendicular to the line of sight to the A HVAC air intake. However, the East wall is perpendicular to the line of sight, so there is no correction required to the area of the wall.

The length of the east wall is taken from drawing 3E-153-02-002 (Ref 7.23) columns R1-R7 + girt dimensions
The height of the Reactor building is taken from drawing 3E-153-02-007 (Ref 7.13)

$$RBEastW_{length} := ColGirt\_R1 + ColR1\_R2 + ColR2\_R3 + ColR3\_R4 \ldots + ColR4\_R5 + ColR5\_R6 + ColR6\_R7 + ColR7\_girt$$

$RBEastW_{length} = 143.5\ ft$

$RB_{topel} := 170\ ft + 4.5\ in$

$RB_{ht} := RB_{topel} - grade\_el$

$RB_{ht} = 146.9\ ft$

The building wake area is, therefore

$WakeArea_{RB} := RBEastW_{length} \cdot RB_{ht}$ $\quad WakeArea_{RB} = 21076.6 \cdot ft^2$ $\quad WakeArea_{RB} = 1958.1 \cdot m^2$

5.0 OVERALL APPROACH AND METHODOLOGY

ARCON96 is controlled under Administrative procedure 1000-ADM-1230.10.

ARCON96 was run on a desktop computer. The executable files in ARCON directory are listed below.

```
Directory of D:\Arcon96
ARCONVB  EXE       251,274  05-09-97   3:00p ARCONVB.EXE
ARCONVB2 EXE       143,612  05-09-97   3:00p ARCONVB2.EXE
ARCON96F EXE       380,928  06-27-97  12:41p ARCON96F.EXE
DOSXMSF  EXE       393,942  01-11-94  12:00a DOSXMSF.EXE
```

Conceptual Model (Ref 7.24)

The basic diffusion model implemented in the ARCON96 code is a straight line Gaussian model that assumes the release rate is constant for the entire period of release. This assumption is made to permit evaluation of potential effects of accidental releases without having to specify a complete release sequence.

ARCON96 permits evaluation of building wake effects in the evaluation of relative concentrations from ground-level releases. Diffusion coefficients used in ARCON96 have three components. The first component is the diffusion coefficient used in other NRC models. The other two components are corrections to account for enhanced dispersion under low wind speed conditions and in building wakes.

Parameter values for the correction factors are based on analysis of diffusion data collected in various building wake diffusion experiments. The diffusion coefficients in ARCON96 account for both low-wind speed meander and wake effects

ARCON96 calculates relative concentrations using hourly meteorological data. It then combines the hourly averages to estimate concentrations for periods ranging in duration from 2 hours to 30 days. Wind direction is considered as the averages are formed. As a result, the averages account for persistence in both diffusion conditions and wind direction. Cumulative frequency distributions are prepared from the average relative concentrations. Relative concentrations that are exceeded no more than five percent of the time (95th percentile relative concentrations) are determined from the cumulative frequency distributions for each averaging period. Finally, the relative concentrations for five standard averaging periods used in control room habitability assessments are calculated from the 95th percentile relative concentrations.

Diffusion Model

The ARCON96 code implements a straight-line Gaussian diffusion model. The basic model for a ground level release is

$$\frac{X}{Q} = \frac{1}{\pi \sigma_z \cdot \sigma_z \cdot U} \cdot \exp\left(-0.5 \frac{y}{\sigma_z}\right)^2 \qquad (A)$$

where X/Q is the relative concentration (concentration divided by release rate) [(ci/m3/(ci/sec)]

σ_y σ_z = diffusion coefficients (m)

U =wind speed (m/sec)

y = distance from the center of the plume (m).

This equation assumes that the release is continuous, constant, and of sufficient duration to establish a representative mean concentration. It also assumes that the material being released is reflected by the ground. Diffusion coefficients are typically determined from atmospheric stability and distance from the release point using empirical relationships. A diffusion coefficient paramaterization from the NRC PAVAN and XOQDOQ codes is used for σ_y and σ_z;.

The diffusion coefficients have the general form

$$\sigma = ax^b + c \qquad (B)$$

where x is the distance from the release point, in meters, and a, b, and C are parameters that are functions of stability. The parameters are defined for 3 ranges: 0 to 100 m, 100 to 1000 m, and greater than 1000 m.

Diffusion Coefficient Adjustments for Wakes and Low Wind Speeds

To estimate diffusion in building wakes, composite wake diffusion coefficients, Σ_y and Σ_z replace σ_y and σ_z. The composite wake diffusion coefficients are defined by

$$\Sigma_y = (\sigma_y + \Delta\sigma_{y1}^2 + \Delta\sigma_{y2}^2)^{1/2}$$

$$\Sigma_z = (\sigma_z + \Delta\sigma_{z1}^2 + \Delta\sigma_{z2}^2)^{1/2} \qquad (C)$$

where

σ_y and σ_z are the normal diffusion coefficients,

σ_{y1} and σ_{z1} are the low wind speed correction, and

σ_{y2} and σ_{z2} are the building wake corrections.

The form of the low wind speed corrections is

$$\Delta\sigma_{y1}^2 = 9.13\text{x}10^5\left[1-\left(\left(1+\frac{x}{1000U}\right)\exp\left(\frac{-x}{1000U}\right)\right)\right]$$

$$\Delta\sigma_{z1}^2 = 6.67\text{x}10^5\left[1-\left(1+\frac{x}{1000U}\right)\exp\left(\frac{-x}{1000U}\right)\right] \qquad (D)$$

where x is the distance from the release point to the receptor, in meters, and U is the wind speed in meters per second. The slant range distance is used for x because these corrections are made only when the release is assumed to be at ground level and the receptor is assumed to be on the axis of the plume.

The diffusion coefficient corrections that account for enhanced diffusion in the wake have a similar form. These corrections are

$$\Delta\sigma_{y1}^2 = 5.24\times10^{-2}\, U^2 A\left[1-\left(1+\frac{x}{10\sqrt{A}}\right)\exp\left(\frac{-x}{10\sqrt{A}}\right)\right] \qquad (E)$$

$$\Delta\sigma_{z1}^2 = 1.17\times10^{-2}\, U^2 A\left[1-\left(1+\frac{x}{10\sqrt{A}}\right)\exp\left(\frac{-x}{10\sqrt{A}}\right)\right]$$

where A is the cross-sectional area of the building.

An upper limit is placed on Σ_y as a conservative measure. This limit is the standard deviation associated with a concentration uniformly distributed across a sector with width equal to the circumference of a circle with radius equal to the distance between the a source and receptor. This value is

$$\Sigma_{ymax} = 2\pi x/\text{sqrt}12 = 1.81x$$

The ARCON96 model described by Equations (A) through (E) is a replacement for the dispersion model in the control room habitability assessment procedure developed by Murphy and Campe (1974) and used in previous calculations of X/Q for Oyster Creek control room habitability calculations. Earlier building wake diffusion model studies conducted for the NRC by Ramsdell showed that the Murphy-Campe model did not account for the variations of the concentrations in the vicinity of buildings particularly well. The studies also showed that one of the primary reasons that the Murphy-Campe model did not predict concentration well was that it overpredicted concentrations during low wind speed conditions. The model described above attempts to overcome the problems associated the Murphy-Campe model.

As reported in Reference 7.24 the tendency for ARCON96 to predict lower concentrations than the Murphy-Campe model is rather uniform across the full range of observed concentrations.

Sector-Average Diffusion Model

Equations (A) through (E) are appropriate for estimating relative concentrations for 1-hour periods. A sector-average relative concentration model is used to estimate concentrations for periods after the initial 0-8 hour period. The sector-average plume model is derived by integrating the concentration across the normal plume model to obtain a crosswind integrated concentration, CIC, which is

$$\frac{CIC}{Q'} = \int_{-\infty}^{\infty} \frac{1}{\pi\cdot\Sigma_y\cdot\Sigma_z\cdot U}\cdot\exp\left[-0.5\left(\frac{y-y_0}{\Sigma_y^2}\right)\right]dy \qquad (F)$$

$$\frac{2}{\sqrt{2\cdot\pi}\ \Sigma_z U}$$

The relative concentration is then calculated by dividing CIC/Q' by the width of the sector, W_s

$$\frac{X_{sa}}{Q} = \frac{2}{\sqrt{2\cdot\pi}\ W_s\cdot\Sigma_z U}$$

$$\frac{X_{sa}}{Q} = \frac{0.80}{W_s \Sigma_z U} \qquad (G)$$

In most cases, the sector width is defined as the width of a 22.5^0 sector, which is a function of the distance downwind. This procedure works well except for small distances in unstable atmospheric conditions. In unstable atmospheric conditions the procedure gives sector average concentrations that are greater than the centerline concentration at small distances. This problem is avoided in ARCON96 by redefining the definition of the sector width. For the ARCON96 code, the sector width is the larger of $\alpha\Sigma_y$ where α is a numerical constant with a value of 4, and $\pi x/8$, where x is the distance between source and receptor. The value of a is entered via the run specification file to permit use of values other than 4. Approximately 95% of the material in a Gaussian plume is within $\pm 2\Sigma_y$ of the plume axis.

To be consistent with the centerline mode1, and to be conservative, the sector width is limited to a maximum value. This maximum value is the circumference of a circle with a radius equal to the distance between the source and receptor, i.e.,

$$W_{max} = 2\pi x$$

The 0-8 hr X/Q is not reported by ARCON. The values is calculated as a time-weighted average from the 0-2 and 2-8 hour values that are reported by ARCON96 using the formula from NUREG/CR-6331, Rev 1 Section 3.7.

$$X/Q_{0\text{-}8hr} = \left[\frac{6 \times X/Q_{2\text{-}8hr} + 2 \times X/Q_{0\text{-}2hr}}{8}\right]$$

Meteorological Data Files

ARCON96 uses information contained in meteorological data files. The meteorological data must have 1 record per hour.
Each record includes the following information in the order and format specified:

Blank	single blank space	1x
alpha-numeric location identifier	5 columns	A5
Blank	3 blank spaces	3x
julian day ranges from 1 to 366	integer, 3 columns wide	I3
hour of the day ranges from 0-23	integer, 2 columns wide	I2
Blank	2 columns wide	2x
lower wind direction	integer 3 columns wide	I3
lower wind speed	integer 4 columns wide	I4
Blank	blank, 1 column wide	1x
stability class	integer 2 columns wide	I2
Blank	blank, 2 columns wide	2x
upper wind direction	integer 3 columns wide	I3
upper wind speed	integer 4 columns wide	I4

Wind directions are entered in degrees, with North being 360^0 and South being 180^0. Wind speeds are reported to the nearest tenth *without the decimal point.*. Atmospheric stability is entered as a number from 1 to 7 with 1 being extremely unstable and 7 representing extremely stable conditions. Missing data in any column is represented by a series of nines that fill the column.

Oyster creek Meteorological data was received in EXCEL spreadsheets in the folowing order.

Julian date
Hour
Wind speed @ 33-feet
Wind speed @ 150-feet
Wind speed @ 380-feet
Wind direction @ 33-feet
Wind direction @ 150-feet
Wind direction @ 380-feet
Delta temperature 150-33 feet
Delta temperature 380-33 feet
Temperature @ 33-feet
Temperature @ 150-feet
Temperature @ 380-feet
Stability class (Pasquill) 150-33 feet
Stability class (Pasquill) 380-33 feet

Wind speed, direction and stability class for elevation 150 feet were not included in the ARCON96 meteorological files. Wind speed was provided in miles/hour and temperature in degrees Fahrenheit.

The Oyster Creek UFSAR, Section 2.3 lists three heights in feet as 33, 150, and 380.

33ft x 0.3048 m/ft = 10.0584
155ft = 35.05m
380ft = 115.824

The following modifications had to be made to the data so that it could be input into ARCON 96 as a meteorological file:

1. Julian date and hour had to be specified
2. data had to be placed in proper sequence and column width and format
3. wind speed had to be multiplied by 10 to eliminate the decimal point
4. blanks or bad data had to be replaced with a string of "9's" equal to the column width.
5. EXCEL spreadsheet was saved as a "Formatted text(space delimited) (.prn) " file.

Quality Assurance Aspects of Meteorological Data

The following regulatory guidance is required for a nuclear meteorological program to provide data needed to estimate potential radiation doses to the public as a result of the routine or accidental release of radioactive materials to the atmosphere and to assess other environmental effects:

a. "USNRC Safety Guide 23" – describes instrument accuracy, maintenance and service scheduling and reduction and compilation. Instrument redundancy is required at potential effluent release height.

b. "Instrumentation For Light-Water-Cooled Nuclear Power Plants To Assess Plant And Environs Conditions During And Following An Accident – USNRC Reg. Guide 1.97" – describes the various instrument ranges acceptable. Ranges for horizontal wind speed, direction and the determination of stability are included.

Quality Assurance

Atmospheric monitoring is a process greatly affected by external influences (weather, mechanic, etc.). When one needs to discover how much variability in a process is due to random variation and how much due to unique events / individual actions in order to determine whether a process is in statistical control, the use of a statistical Control Chart is employed. This analytical statistical method applies when analysis is performed over time. Basically, as time goes on, instrumentation can malfunction.

The Control Chart is simply a run chart with statistically determined upper and lower control limits drawn on either side of the process average. If the process exceeds the control limits (usually 3σ), it could indicate a problem with a particular instrument. Also, if the process is consistently on "one side" of the average, this could indicate that instrument performance is degrading.

The meteorological data from Oyster Creek are not only reviewed on a 15-minute basis (for the previous day), but redundant sensors undergo the aforementioned statistical analysis to ensure proper data are used in offsite (and onsite) air dispersion analysis, both routine and non-routine. As previously mentioned, redundant instrumentation are required at heights of potential radiological release (stacks, vents, etc.).

In addition, when the instrument signal is received from the sensor to the tower PC, all data are passed through software that will flag "bad" data points or if a particular reading is consistent over a long period of time, the software will tag it as "questionable".

6.0 CALCULATOINS

Summary of ARCON96 Input Values

The following values summarize the calculated inputs for ARCON 96. Other default value inputs were modified in accordance with NRC Staff recommendations as described in Appendix A.

RECEPTOR INPUT	Turbine Building	N_2/Yard Release
Distance to Receptor		
A intake	16.5m	45.4m
B intake	12.4m	Not calculated
Intake Height	10m	10m
Elevation Difference	0	0
Direction to source	255^0	255^0
SOURCE TYPE		
Release Height	10m	10m
Building Wake Area	$2129.1m^2$	$1958.1m^2$
METEOROLOGICAL INPUT		
Lower Measurement height	10m	10m
Upper Measurement Height	115.8m	115.8m
DEFAULT VALUES		
Initial Diffusion coefficients		
$\rho_y =$	13.6m	0
$\rho_z =$	4.4m	0

Cases Analyzed

Meteorological dispersion from the turbine building release point was calculated for both the "A" and "B" air intakes using Oyster Creek meteorological data from the years 1995-1999. X/Q was also calculated for each individual year from 1995-99. In addition, a case was run using the 1982-83 met data that had been the basis for the X/Q calculations of Reference 7.1. Finally, a final set of sensitivity cases were for the "B" input in varying the source to receptor wind direction. Appendix B lists the ARCON96 output for each of these cases.

Meteorological dispersion from the yard N_2 release point was calculated for the "A" HVAC air intake since it is closer to the release point then the "B" air intake.

Results

The X/Q's for the turbine building release are calculated for both the "A" and "B" HVAC air intakes.

The 95% X/Q for standard averaging intervals are summarized below:

B HVAC	ARCON 95-99	ARCON 82-83
0-2 hrs	3.73E-03	3.31E-03
2-8 hrs	2.37E-03	2.17E-03
0-8 hrs	2.71E-03	2.46E-03
8-24 hrs	8.76E-04	7.11E-04
24 -96 hrs	8.63E-04	7.16E-04
96-720 hrs	8.45E-04	5.84E-04

TB-B X/Q HVAC calculated for individual years

95% X/Q for standard averaging intervals	1995	1996	1997	1998	1999
0 to 2 hours	3.49E-03	3.64E-03	3.48E-03	4.42E-03	3.27E-03
2 to 8 hours	2.19E-03	2.39E-03	2.30E-03	2.87E-03	2.15E-03
8 to 24 hours	7.82E-04	8.42E-04	7.67E-04	1.13E-03	8.28E-04
1 to 4 days	7.20E-04	7.93E-04	7.69E-04	1.07E-03	6.44E-04
4 to 30 days	7.09E-04	7.73E-04	6.43E-04	9.39E-04	5.95E-04

TB-B X/Q HVAC calculated for 95-99 Met data

	Angles of approach		
95% X/Q for standard averaging intervals	345°	75°	165°
0 to 2 hours	3.09E-03	2.19E-03	2.64E-03
2 to 8 hours	1.66E-03	1.42E-03	1.57E-03
8 to 24 hours	6.95E-04	6.56E-04	7.41E-04
1 to 4 days	5.93E-04	4.44E-04	5.45E-04
4 to 30 days	5.30E-04	3.72E-04	5.27E-04

Turbine Building - B HVACSummary of Met Data by year							
	1982 & 83	1995	1996	1997	1998	1999	1995-1999
Total number of hours of data processed	17520	8760	8784	8760	8760	8760	43824
Hours of missing data	1246	6	2	14	12	9	43
Hours direction in window	6166	3217	3273	3733	3136	3159	16518
Hours elevated plume w/ dir. In window	0	0	0	0	0	0	0
Hours of calm winds	92	85	125	91	285	120	706
Hours direction not in window or calm	10016	5452	5384	4922	5327	5472	26557

GPU NUCLEAR

CALCULATION SHEET
(Ref. EP-006)

Subject: Calculation of OC Co[illegible] Room air intake X/Q using [illegible].CON96	Calculation No. C-1302-826-E540-017	Rev. No. 0	System Nos. 826	Sheet 25

A HVAC	χ/Q Turbine building		
		ARCON 95-99	ARCON 82-83
0-2 hrs		3.12E-03	2.90E-03
2-8 hrs		2.08E-03	1.94E-03
0-8 hrs	5.18E-3	2.34E-03	2.18E-03
8-24 hrs	3.94E-3	7.52E-04	6.18E-04
24 -96 hrs	2.75E-3	7.15E-04	6.21E-04
96-720 hrs	1.66E-3	6.81E-04	5.11E-04

TB X/Q A HVAC calculated for individual years					
95% X/Q for standard averaging intervals	1995	1996	1997	1998	1999
0 to 2 hours	3.00E-03	3.11E-03	3.01E-03	3.40E-03	2.80E-03
2 to 8 hours	1.98E-03	2.09E-03	2.04E-03	2.46E-03	1.82E-03
8 to 24 hours	6.72E-04	7.42E-04	6.87E-04	9.44E-04	7.20E-04
1 to 4 days	6.44E-04	6.78E-04	6.83E-04	8.52E-04	5.75E-04
4 to 30 days	6.34E-04	6.87E-04	5.70E-04	7.44E-04	5.16E-04

ARCON 96 Summary of Met Data	TB A HVAC	1995-1999
	1995-1999	1995-1999
Total number of hours of data processed	43824	43824
Hours of missing data	43	43
Hours direction in window	16518	16518
Hours elevated plume w/ dir. in window	0	0
Hours of calm winds	706	706
Hours direction not in window or calm	26557	26557

A HVAC	χ/Q yard N_2		
		ARCON	
	Ref 7.2	95-99	82-83
0-2 hrs		2.88E-03	2.86E-3
2-8 hrs		2.49E-03	2.35E-3
0-8 hrs	1.92E-3	2.59E-03	2.48E-3
8-24 hrs	1.09E-4	1.15-03	8.60E-4
24 -96 hrs	5.99E-4	8.44E-04	7.01E-4
96-720 hrs	1.46E-4	7.18E-04	5.54E-4

7.0 REFERENCES

1 Stone & Webster calculation 15050.50 ENV-3. "Control Room Air Intake X/Q Analysis - Murphy and Campe Method. Rev 0.
2 PSAT 05201H.07 X/Qs for N_2 System Reactor Building Bypass Releases for OCNGS Control Room Habitability
3 Murphy, K.G. and K.M. Campe, "Nuclear Power Plant Control Room Ventilation system Design for Meeting General Design Criterion 19." 13th AEC air Cleaning Conference, August, 1974.
4 SE-402854 - 002, "Addition of a New Independent HVAC System to Control Room Envelope HVAC System", Revision 0, ISR dated 11/23/87
5 3E-151-02-009, Rev 3 Turbine Building " Partial Plans and Sections.
6 3E-151-02-007,Rev 5. Turbine Building Sections.
7.S&W Calc 15050.50 ENV-4. Accident X/Q Values at the Present Control Room Air Intake From the Main Plant Ventilation Stack. Rev 0.
8 3E-151-02-003,Rev 7. Turbine Building " Plan-Floor Elevation 23'-6.
9 15050.68-ES-1A ,Rev 1 Ctrl Rm. HVAC Mod Str. & Arc. Plans, Sect. & Details.
10 3E-151-02-008, Rev 6. Turbine Building " Partial Plans and Sections.
11 BR 4503 "Turbine Building Exterior Wall Sections"
12 3E-153-02-006, Rev 6. General Arrangement-Reactor Building-Plan Floor elevation 119'-"
13 3E-153-02-001,Rev 6. Reactor Building Plan-Floor Elevation 19'-6.
14 3E-153-02-008 General Arrangement Reactor Building section B-B Rev 3.
15 Walkdown measurements taken on June 20, 2000 by John Yuen and Ken Boughton.
16 Walkdown by L.C.Lanese on June 2, 2000.
17 3E-153-02-007, Rev 4. General Arrangement- reactor building- Section A-A.
18 3E-151-02-006, Rev 5 Turbine Building Plan Floor Elevation 46'-6.
19 3E-156-02-002, Rev 3. Office Building "Plan Floor Elevation 46'-6 and Roof Elevation.
20 3E-120-01-001, Rev 11 " Site Plan- Planning Board Application
21 SN 13432.19-1 Nitrogen Purge - Drywell and Torus, Rev 27.
22 CMT transmittal No. 163680. Letter No. E550-97-005. [Attached sketch].
23 3E-153-02-002,Rev 9. Reactor Building Plan-Floor Elevation 23'-6.
24 Ramsdell, J.V., Jr., C.A. Simonen. NUREG/CR-6331. PNNL-10521, Rev 1. "Atmospheric Relative Concentration in Building Wakes.

8.0 APPENDICES

Appendix A Comparison to NRC Staff draft recommendations on ARCON96 implementation page 28

Appendix B Base output files for ARCON96 page 36

Turbine Building - A HVAC 1995-1999 Met Data

B HVAC - Turbine Building 1995-199 Met Data
N_2 Yard Release A HVAC

Turbine Building - B HVAC 1982 & 83 Met Data
Turbine Building- B HVAC 1995 Met Data
Turbine Building- B HVAC 1996 Met Data
Turbine Building- B HVAC 1997 Met Data
Turbine Building- B HVAC 1998 Met Data
Turbine Building- B HVAC 1999 Met Data

Turbine Building- B HVAC 1995- 1999 Met Data Direction Intake to Source 75^0
Turbine Building- B HVAC 1995- 1999 Met Data Direction Intake to Source 165^0
Turbine Building- B HVAC 1995- 1999 Met Data Direction Intake to Source 345^0

Turbine Building - A HVAC 1982 & 83 Met Data
Turbine Building- A HVAC 1995 Met Data
Turbine Building- A HVAC 1996 Met Data
Turbine Building- A HVAC 1997 Met Data
Turbine Building- A HVAC 1998 Met Data
Turbine Building- A HVAC 1999 Met Data

Guidance

The May 9,1997, version of the ARCON96 computer code as described in NUREG/CR-6331 R1 is an acceptable methodology for assessing control room X/Q values for use in design basis accident radiological analyses, subject the conditions listed below, unless unusual siting, building arrangement, release characterization, source-receptor configuration, meteorological regimes, or terrain conditions indicate otherwise.

1. The ARCON96 code is obtained and maintained under an appropriate software quality assurance program that complies with the applicable criteria of 10 CFR Part 50 Appendix B and meets other applicable industry consensus standards. Although the software was developed under a software quality assurance program, the licensee is ultimately responsible for the accuracy and appropriateness of use of the ARCON96 results

2. Meteorological observation data input to ARCON96 are obtained from instrumentation that are maintained under the site's meteorological measurements program, as described in the facility's licensing basis The data must be shown to be representative for the control room X/Q assessments. Five years of hourly observations should be used. If less data are used, additional evaluations may be necessary to demonstrate that the lesser data period used is representative of long-term meteorological trends at the site.

3. All potential locations from which the control room may draw air from the environment must be considered as an intake. This includes all ventilation system intakes and infiltration locations, such as doors and penetrations. The potential intakes may change over the course of the accident due to plant systems response or manual operator actions. While ventilation intakes can be located via reviews of FSAR drawings, the location of significant infiltration intakes is more subjective and will require judgement on the part of the dose analyst.

3.1 A X/Q value should be evaluated for each release-intake combination. It may be possible to qualitatively show that the X/Q values for some release-intake combinations would be bounded by values calculated for other combinations and in doing so reduce the number of needed calculations.

3.2 The licensee should use the most restrictive (i.e., resulting in the highest dose) X/Q value for each release-intake combination applicable to the particular radiological analysis.

3.3 For control rooms with dual intake designs, the guidance of Section III.D and Figure 1 of the Murphy-Campe paper applies. Also, the practice of determining the X/Q for the more restrictive intake and dividing by two is acceptable only if it can be shown that the two intakes have equal flow rates and are not simultaneously within the wind direction window for any given wind direction.

4. ARCON96 provides options that allow a user to model three different release types -ground level, stack, and vent. An area source can be modeled as a subtype of a ground level release.

4.1 Ground Level Release. The ground level release type is appropriate for the majority of control room X/Q assessments.

4.2 Stack Release. The stack release type is appropriate for releases from standalone stacks that are two and one-half times the height of adjacent solid structures. Plume rise from buoyancy and mechanical jet effects are not to be used in demonstrating compliance with this criterion. Use of the elevated plume option may lead to unrealistically low concentrations at control room intakes located close to the base of tall stacks. If the X/Q values generated by ARCON96 are all extremely low, other models should be used to estimate the potential control room intake X/Q's during low wind speed conditions.

4.2.1 If addressed in the current licensing basis, fumigation[A] conditions are to be considered using the guidance of Regulatory positions 1.3.2.b, 2.1.2, and 2.2.2 of Regulatory Guide 1.145, *Atmospheric Dispersion Models for _ Potential Accident Consequence Assessments at Nuclear Power Plants.* Ground level X/Q values generated by ARCON96 may be substituted for values generated with equation 5 of RG 1.145.

4.3 Area Source. The diffusion models in ARCON96 are based on point-source formulations. However, some release sources can be better characterized as area sources. Examples might include postulated releases from the surface of a reactor or secondary containment building, or releases from multiple points such as the roof vents on typical turbine buildings. ARCON96 reduces an area source to a virtual point source using two initial diffusion coefficients entered by the code user.

4.3.1 LOCA radiological analyses have typically assumed that the containment structure could leak anywhere on the exposed surface. As such, these analyses typically used the shortest distance between the containment surface and the control room intake and treated the containment as a point source. This approach may be unnecessarily conservative. A more reasonable approach is to model the containment surface as a vertical area source with ARCON96. This treatment is acceptable for design basis calculations provided that it is used in conjunction with the total release rate (e.g., Ci/sec) from the containment.

4.3.2 Since leakage is more likely to occur at a penetration, dose analysts must consider the potential impact of containment penetrations exposed to the environment within this modeled area. It may be necessary to consider several cases to ensure that the X/Q value for the most limiting location is assigned. Penetrations that are enclosed within safety-related structures need not be considered here.

4.3.3 In the absence of site-specific empirical data the initial diffusion coefficients are found by:

$$\sigma_y = \frac{\text{width area source}}{6}$$

$$\sigma_z = \frac{\text{Height area source}}{6}$$

[A] For facilities that are implementing or have implemented an alternative source term, fumigation conditions should be assumed to exist at the onset of the major radioactivity release in lieu of the start of the accident as specified in Regulatory Guide 1.145.

4.3.4 The height and width of the area source (e.g., the containment surface) are taken as the maximum vertical and horizontal dimensions of the building cross-sectional area perpendicular to the line of sight to the control room intake. The shortest horizontal distance from the building surface to the control room intake is used as the source-receptor distance. The release height is set at the point on the surface of the area source that will result in the shortest slant path.

4.3.5 Bypass leakage from secondary containment buildings may be treated in a similar manner.

4.3.6 Multiple roof vents could be modeled as a horizontal circular area source of a sufficient radius to encompass all of the vents. This treatment would be acceptable for those configurations in which (1) the vents are arranged in a pattern that approximates a circular area, (2) if no individual vent is significantly closer to the control room intake than the center of the assumed circular area source, and (3) the release rate from each vent is approximately the same. The distance to the receptor is measured from the closest point on the circumference of the assumed circular area source. In the absence of site-specific empirical data the initial diffusion coefficients are found by:

$$\sigma_y = \frac{\text{Diameter}_{\text{area source}}}{6}$$

$$\sigma_z = 0.0$$

4 The degree of significance will depend on the radius of the assumed circle and the proximity of the vent cluster to the control room intake. As the radius decreases or the distance from the cluster to the control room intake increases the less significance the position of any one vent has.

4.4 Vent Release. The vent release type was intended for use with uncapped upward-directed vents on or slightly above building surfaces. The model used for the vent release type is based on the mixed-mode model used in long-term routine effluent calculations. This model may be inappropriate for the short-term releases associated with accident assessments. Pending further confirmatory study, the vent release type is not acceptable for use in design basis accident applications.

5. Appropriately structured site-specific atmospheric diffusion tests will be considered by the staff as the basis for deviations from this guidance. Such tests must encompass a sufficient range of meteorological conditions applicable to the site so as to ensure that the limiting case(s) have been evaluated. The testing and the results obtained should be verified and validated.

6. With regard to review assignments, the dose analysts are expected to characterize the release point, i.e., location, release height, velocity, duct diameter, type of release (e.g., ground, elevated, area), stack flow, release temperature, source dimensions (if diffuse); and characterize the control room intake, i.e., location, height, position relative to release point, etc.; as applicable. The assigned meteorologist will review the appropriateness of the licensee's data and perform confirming calculations as deemed necessary, using the parameters provided by or confirmed by the dose analyst.

Attached to this memorandum is a table that identifies each ARCON96 input and acceptable values (or range of values) for each.

GPU NUCLEAR	CALCULATION SHEET (Ref. EP-006)			
Subject: Calculation of OC Control Room Air Intake X/Q's for Ground Level Releases Using ARCON96	**Calculation No.** C-1302-826-E540-017	**Rev. No.** 0	**System Nos.** 826	**Sheet** 31

ARCON96 INPUT PARAMETER SUMMARY

Parameter	Discussion	Acceptable Input	OYSTER CREEK
Lower Measurement Height, meters	The value of this parameter is used by ARCON96 to adjust wind speeds for differences between the heights of the instrumentation and the release.	Use the actual instrumentation height when known. Otherwise, assume 10 meters.	Uses actual height of 11m
Upper Measurement Height, meters	The value of this parameter is used by ARCON96 to adjust wind speeds for differences between the heights of the instrumentation and the release;	Use the actual instrumentation height when known. Otherwise, use the height of the containment or the stack height, as appropriate. If wind speed measurements are available at more than two elevations, the instrumentation at the height closest to the release height should be used.	Uses actual height of 11m and 115.15m
Wind Speed Units	ARCON96 requires that wind speed be entered as miles per hour, meters per second ,or knots.	Use the wind speed units that correspond to the units of the wind speeds in the meteorological data file.	Met data file uses miles/hr
Release Height, meters	The value the release height is used for three purposes in ARCON96 (1) to adjust wind speeds for differences between the heights of the instrumentation and the release, (2) to determine slant path for ground level releases, (3) to velocity of the release will be maintained correct off-centerline data for elevated releases.	Use the actual release heights whenever available. Plume rise from buoyancy and mechanical jet effects may be considered in establishing the release height if the licensee can demonstrate with reasonable assurance that the vertical during the course of the accident .If actual release height is not available, set release height equal to intake height.	Ground level releases from turbine building are conservatively taken at 10m. Yard releases are taken at grade elevation.
Building Area, m^2	ARCON96 uses the value of the building area in the high speed wind speed adjustment for ground level and vent release models.	Use the actual building vertical cross sectional area perpendicular to the wind direction. Use default of 2000 m^2 if the area is not readily available. Do not enter zero. Use 0.01 m^2 if a zero entry is desired. *Note: This building area, is for the building(s) that has the largest impact on the building wake within the wind direction window. This is usually, but need not always be, the reactor containment. With regard to the diffuse area source option, the building area entered here may be different from that used to establish the diffuse source.*	Assume minimum horizontal distance from air intake to release point. Use full building cross-sectional area since the TB East wall and RB East wall are perpendicular to the air intake.

ARCON96 INPUT PARAMETER SUMMARY (continued)

Parameter	Discussion	Acceptable Input	
Vertical Velocity, m/s	In ARCON96, the value of the vertical velocity is used only in vent and stack release models. It is used for the downwash calculation. In the vent release model the velocity is used in the mixed-mode calculation. If the vertical velocity is set to zero, the maximum downwash will be calculated and the release height will be reduced by an amount equal to six times the stack radius.	Note: the vent release model should not be used for DBA accident calculations. For stack release calculations only, use the actual vertical velocity if the licensee can demonstrate with reasonable assurance that the value will be maintained during the course of the accident (e.g., addressed by technical specifications), otherwise, enter zero. If the vertical velocity is set to zero, the stack radius should also be set to zero.	No credit for v[illegible]ities in OC model.
Stack Flow, m^3/s	ARCON96 uses the value of the stack flow in X/Q calculations for all 3 release types to ensure that the near field concentrations are no greater than the concentration at the release point. The impact diminishes with increasing distance.	Use actual flow if the licensee can Demonstrate with reasonable assurance that the value will be maintained during the course of the accident (e.g.,addressed by technical specifications). Otherwise, enter zero.	N/A
Stack Radius, Meters	ARCON96 uses the value of the stack radius in downwash calculations in the vent and stack release models.	Use the actual stack internal radius when both stack radius and vertical velocity are available. If the stack flow is zero, the radius should be set to zero.	N/A
Distance to Receptor, meters	The value of horizontal distance to the receptor from the release point is used in ARCON96 for calculating the slant range for ground level releases and the off-centerline correction factors for stack release models.	Use the actual straight line horizontal distance between the release point and the control room intake. For ground level releases, it may be appropriate to consider flow around an intervening building if the building is sufficiently tall that it is unrealistic to expect flow from the release point to go over the building. *Note: if the distance to receptor is less than about 10 meters, ARCON96 should not be used to assess relative concentrations*	OC model conservatively uses the minimum horizontal distance from the the ar intake to the release point because the release point is unknown.

GPU NUCLEAR	CALCULATION SHEET (Ref. EP-006)			
Subject: Calculation of OC Control Room Air Intake X/Q's for Ground Level Releases Using ARCON96	**Calculation No.** C-1302-826-E540-017	**Rev. No.** 0	**System Nos.** 826	**Sheet** 33

ARCON96 INPUT PARAMETER SUMMARY (continued)

Parameter	Discussion	Acceptable Input	
Wind Direction Window, Degrees **Code Default**	ARCON96 uses the value of this parameter and the Direction to Source to establish which range of wind directions should be included in the assessment of the X/Q	Use the default window of 90 degrees (45 degrees on either side of line of sight from the source to the receptor).	Uses default of 90 degrees 98/27/01 10:39:14
Minimum Wind Speed, m/s **Code Default**	ARCON96 uses the value of this parameter to identify calm conditions.	Use the default wind speed of 0.5 m/s (regardless of the wind speed units entered earlier), unless there is some indication that the anemometer threshold is greater than 0.6 m/s.	Uses default of 0.5m/sec
Averaging Sector Width Constant Code Default	ARCON96 uses the value of this parameter to prevent inconsistency between the centerline and sector-average X/Qs for wide plumes. Has largest effect on ground level plumes.	Although the default value is 4, a value of 4.3 is preferred.	Value of 4.3 is used
Initial Diffusion Coefficients, Meters	See Section 3.3 of the memo.	These values will normally be set to zero. If the diffuse source option is being used. See Section 3.3 of the memo.	Oyster Creek model uses diffuse source model. [B]

[B] Comments by the design verifier:

General Diffuse Source Comments

ARCON96 computes X/Q for this release by determining a virtual point location upstream of the release. The location of the virtual point is different for each stability class and based upon the user input of initial diffusion coefficients (σ_{y0} and σ_{z0}). This technique is driven by the wake effect (turbulence) produced by the building and not the actual release location. The perpendicular projected building cross sectional area is used for this determination. It is important to understand that the direction of wind, which is perpendicular to the structure, produces the characteristics of flow response so one can estimate these initial diffusion coefficients. A skewed wind direction to a building will produce different effects for which this virtual point technique becomes invalid.

The dispute that exists between the Gaussian approach and that of Hatlisky and others is that the wake models do not deal with re-circulation flow in what is known as the building cavity. Wind tunnel experiments have indicated that concentrations in the cavity will be higher due the re-circulation flow. The virtual point technique does not consider cavity effects at all.

Angle of Approach (Bearing of release relative to receptor)

Based upon the above, the wind direction that should be used in this model should be that which is perpendicular to the turbine building. This works out to be a bearing of 255° from true north. The window of winds that are used for the analysis consists of 255° +90° and 255°-90°. Using an angle from a point relative to Main Steam Stop Valve location is not appropriate. The building is dominant for any release on the surface of the East wall of the turbine building.

GPU NUCLEAR

CALCULATION SHEET
(Ref. EP-006)

Subject: Calculation of OC Control Room Air Intake X/Q's for Ground Level Releases Using ARCON96	Calculation No. C-1302-826-E540-017	Rev. No. 0	System Nos. 826	Sheet 34

ARCON96 INPUT PARAMETER SUMMARY (continued)			
Parameter	**Discussion**	**Acceptable Input**	
Hours in Averages Code Default	The values of this parameter were selected to provide results for desired periods and to provide a smooth X/Q curve.	Use the default values.	Default value used.
Minimum Number of Hours Code Default	The default values of this parameter will allow processing with up to 10% missing data.	Use the default values.	Default value used.

ARCON96 INPUT PARAMETER SUMMARY (continued)			
Parameter	**Discussion**	**Acceptable Input**	**OYSTER CREEK**
Intake Height, meters	The value of the intake height is used in ARC 0N96 for calculating the slant range for ground level releases and the off-centerline correction factors for stack release models.	Use the actual intake height. If the intake height is not available for ground level releases, assume the intake height is equal to the release height. For elevated releases, assume the height of the tallest site building.	Intake height is known. However, OC model uses a more conservative value of 10m.
Elevation Difference, meters	The value of this parameter is used by ARCON96 to normalize the release heights and the intake heights, in those cases where the two heights are specified as "above grade" with different grades for the release point and intake height, or where one measurement is referenced to "above grade" and the other "above sea level".	Use zero unless it is known that the Release heights are reported relative to different grades or reference datum.	Grade elevation is the same for OC

Direction to Source, degrees	ARCON96 uses the value of this parameter and the Wind Direction Window to establish which range of wind directions should be included in the assessment of the X/~	Use the direction FROM the intake back TO the release point. (Wind directions are reported as the direction from which the wind is blowing. Thus, if the direction from the intake to the release point is north, a north wind will carry the plume from the release point to the intake.) *Note: some facilities have a 'plant north,, shown on site arrangement drawings that is different from "true north." The direction entered must have the same point of reference as the wind directions reported in the meteorological data.* For ground level releases, if the plume is assumed to flow around a building rather than over it, the direction may need to be modified to account for the redirected flow. In this case, the X/Q should be calculated assuming flow around and flow over (through) the building and the higher of the two X/Q's should be used.	Wind direction is specified from intake back to the release. ~~98/27/01 10:39:14~~
Surface Roughness Length	ARCON96 uses the value of this parameter in adjusting wind speeds to account for differences in meteorological instrumentation height and release height.	Use a value of 0.2 in lieu of the default value of 0.1 for most sites. valid values range from 0.1 for sites with low surface Vegetation to 0.5 for forest covered sites.)	Value of 0.2 is used in the OC model

B HVAC - Turbine Building 1995-199 Met Data

Program Title: ARCON96.

Developed For: U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Division of Reactor Program Management

Date: June 25, 1997 11:00 a.m.

NRC Contacts: J. Y. Lee Phone: (301) 415 1080
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L. A Brown Phone: (301) 415 1232
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Code Developer: J. V. Ramsdell Phone: (509) 372 6316
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Code Documentation: NUREG/CR-6331 Rev. 1

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Program Run 7/21/2000 at 13:58:08
******* ARCON INPUT **********
Number of Meteorological Data Files = 5
Meteorological Data File Names
D:\ARCON96\METDATA\OC95MET.MET
D:\ARCON96\METDATA\OC96MET.MET
D:\ARCON96\METDATA\OC97MET.MET
D:\ARCON96\METDATA\OC98MET.MET
D:\ARCON96\METDATA\OC99MET.MET
Height of lower wind instrument (m) = 10.0
Height of upper wind instrument (m) = 115.8

```
Wind speeds entered as miles per hour
Ground-level release
Release height (m)                          =     10.0
Building Area (m^2)                         =   2129.1
Effluent vertical velocity (m/s)            =      .00
Vent or stack flow  (m^3/s)                 =      .00
Vent or stack radius (m)                    =      .00

Direction .. intake to source (deg)         =      255
Wind direction sector width (deg)           =       90
Wind direction window (deg)                 =  210 - 300
Distance to intake (m)                      =     12.4
Intake height  (m)                          =     10.0
Terrain elevation difference (m)            =       .0

Output file names
  TBBBase
  TBBase.cfd

Minimum Wind Speed (m/s)                    =       .5
Surface roughness length (m)                =      .20
Sector averaging constant                   =      4.3

Initial value of sigma y                    =    13.60
Initial value of sigma z                    =     4.40

Expanded output for code testing selected
QA output file = TBBqa
 FIRST_MET:     720
 FIRST_MET:     720
 FIRST_MET:     720
 FIRST_MET:     720
Total number of hours of data processed =  43824
Hours of missing data                   =     43
Hours direction in window               =  16518
Hours elevated plume w/ dir. in window  =      0
Hours of calm winds                     =    706
Hours direction not in window or calm   =  26557
```

Appendix B ARCON96 output

DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL

AVER. PER.	1	2	4	8	12	24	96	168	360	720
UPPER LIM.	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02
LOW LIM.	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
ABOVE RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
IN RANGE	17224.	20179.	23639.	28266.	31758.	37352.	43164.	43604.	43501.	43177.
BELOW RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ZERO	26557.	23577.	20069.	15350.	11927.	6315.	574.	69.	0.	0.
TOTAL X/Qs	43781.	43756.	43708.	43616.	43685.	43667.	43738.	43673.	43501.	43177.
% NON ZERO	39.34	46.12	54.08	64.81	72.70	85.54	98.69	99.84	100.00	100.00

95th PERCENTILE X/Q VALUES

	3.73E-03	3.31E-03	3.03E-03	2.71E-03	2.18E-03	1.49E-03	1.02E-03	9.45E-04	8.89E-04	8.68E-04

95% X/Q for standard averaging intervals

0 to 2 hours	3.73E-03
2 to 8 hours	2.37E-03
8 to 24 hours	8.76E-04
1 to 4 days	8.63E-04
4 to 30 days	8.45E-04

HOURLY VALUE RANGE

	MAX X/Q	MIN X/Q
CENTERLINE	4.79E-03	2.97E-04
SECTOR-AVERAGE	3.34E-03	1.73E-04

NORMAL PROGRAM COMPLETION

N_2 Yard Release A HVAC

Program Title: ARCON96.

Developed For: U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Division of Reactor Program Management

Date: June 25, 1997 11:00 a.m.

NRC Contacts: J. Y. Lee Phone: (301) 415 1080
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Code Documentation: NUREG/CR-6331 Rev. 1

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Program Run 7/21/2000 at 14:21:19
******* ARCON INPUT **********
Number of Meteorological Data Files = 5
Meteorological Data File Names
D:\ARCON96\METDATA\OC95MET.MET
D:\ARCON96\METDATA\OC96MET.MET
D:\ARCON96\METDATA\OC97MET.MET
D:\ARCON96\METDATA\OC98MET.MET
D:\ARCON96\METDATA\OC99MET.MET

```
Height of lower wind instrument (m)   =     10.0
Height of upper wind instrument (m)   =    115.8
Wind speeds entered as miles per hour

Ground-level release
Release height (m)                    =     10.0
Building Area (m^2)                   =   1958.1
Effluent vertical velocity (m/s)      =      .00
Vent or stack flow  (m^3/s)           =      .00
Vent or stack radius (m)              =      .00

Direction .. intake to source (deg)   =      255
Wind direction sector width (deg)     =       90
Wind direction window (deg)           =   210 - 300
Distance to intake (m)                =     45.4
Intake height  (m)                    =     10.0
Terrain elevation difference (m)      =       .0

Output file names
  N2.log
  N2.cfd

Minimum Wind Speed (m/s)              =       .5
Surface roughness length (m)          =      .20
Sector averaging constant             =      4.3

Initial value of sigma y              =      .00
Initial value of sigma z              =      .00

Expanded output for code testing not selected
Total number of hours of data processed =  43824
Hours of missing data                 =     43
Hours direction in window             =  16518
Hours elevated plume w/ dir. in window =      0
Hours of calm winds                   =    706
Hours direction not in window or calm =  26557
```

DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL

AVER. PER.	1	2	4	8	12	24	96	168	360	720
UPPER LIM.	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02
LOW LIM.	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
ABOVE RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
IN RANGE	17224.	20179.	23639.	28266.	31758.	37352.	43164.	43604.	43501.	43177.
BELOW RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ZERO	26557.	23577.	20069.	15350.	11927.	6315.	574.	69.	0.	0.
TOTAL X/Qs	43781.	43756.	43708.	43616.	43685.	43667.	43738.	43673.	43501.	43177.
% NON ZERO	39.34	46.12	54.08	64.81	72.70	85.54	98.69	99.84	100.00	100.00

95th PERCENTILE X/Q VALUES

	2.88E-03	2.81E-03	2.72E-03	2.59E-03	2.14E-03	1.63E-03	1.04E-03	9.06E-04	8.07E-04	7.61E-04

95% X/Q for standard averaging intervals

0 to 2 hours	2.88E-03
2 to 8 hours	2.49E-03
8 to 24 hours	1.15E-03
1 to 4 days	8.44E-04
4 to 30 days	7.18E-04

HOURLY VALUE RANGE

	MAX X/Q	MIN X/Q
CENTERLINE	3.83E-03	2.86E-04
SECTOR-AVERAGE	2.23E-03	1.66E-04

NORMAL PROGRAM COMPLETION

Turbine Building - A HVAC 1995-1999 Met Data

Program Title: ARCON96.

Developed For: U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Division of Reactor Program Management

Date: June 25, 1997 11:00 a.m.

NRC Contacts: J. Y. Lee Phone: (301) 415 1080
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Code Developer: J. V. Ramsdell Phone: (509) 372 6316
e-mail: j_ramsdell@pnl.gov

Code Documentation: NUREG/CR-6331 Rev. 1

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Program Run 7/21/2000 at 14:19:57

******* ARCON INPUT **********

Number of Meteorological Data Files = 5
Meteorological Data File Names
D:\ARCON96\METDATA\OC95MET.MET
D:\ARCON96\METDATA\OC96MET.MET
D:\ARCON96\METDATA\OC97MET.MET
D:\ARCON96\METDATA\OC98MET.MET
D:\ARCON96\METDATA\OC99MET.MET

```
Height of lower wind instrument (m)   =     10.0
Height of upper wind instrument (m)   =    115.8
Wind speeds entered as miles per hour

Ground-level release
Release height (m)                    =     10.0
Building Area (m^2)                   =   2129.1
Effluent vertical velocity (m/s)      =      .00
Vent or stack flow  (m^3/s)           =      .00
Vent or stack radius (m)              =      .00

Direction .. intake to source (deg)   =      255
Wind direction sector width (deg)     =       90
Wind direction window (deg)           =   210 - 300
Distance to intake (m)                =     16.5
Intake height  (m)                    =     10.0
Terrain elevation difference (m)      =       .0

Output file names
  TBA.log
  TBA

Minimum Wind Speed (m/s)              =       .5
Surface roughness length (m)          =      .20
Sector averaging constant             =      4.3

Initial value of sigma y              =     13.60
Initial value of sigma z              =      4.40
Expanded output for code testing not selected

Total number of hours of data processed =  43824
Hours of missing data                 =     43
Hours direction in window             =  16518
Hours elevated plume w/ dir. in window =      0
Hours of calm winds                   =    706
Hours direction not in window or calm =  26557
```

DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL

AVER. PER.	1	2	4	8	12	24	96	168	360	720
UPPER LIM.	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02
LOW LIM.	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-0(
ABOVE RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
IN RANGE	17224.	20179.	23639.	28266.	31758.	37352.	43164.	43604.	43501.	43177.
BELOW RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ZERO	26557.	23577.	20069.	15350.	11927.	6315.	574.	69.	0.	0.
TOTAL X/Qs	43781.	43756.	43708.	43616.	43685.	43667.	43738.	43673.	43501.	43177.
% NON ZERO	39.34	46.12	54.08	64.81	72.70	85.54	98.69	99.84	100.00	100.00

95th PERCENTILE X/Q VALUES

	3.12E-03	2.88E-03	2.59E-03	2.34E-03	1.88E-03	1.28E-03	8.56E-04	7.88E-04	7.32E-04	7.04E-04

95% X/Q for standard averaging intervals

0 to 2 hours	3.12E-03
2 to 8 hours	2.08E-03
8 to 24 hours	7.52E-04
1 to 4 days	7.15E-04
4 to 30 days	6.81E-04

HOURLY VALUE RANGE

	MAX X/Q	MIN X/Q
CENTERLINE	3.57E-03	2.55E-04
SECTOR-AVERAGE	2.18E-03	1.49E-04

NORMAL PROGRAM COMPLETION

Turbine Building - B HVAC 1982 & 83 Met Data

Program Title: ARCON96.
Developed For: U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Division of Reactor Program Management
Date: June 25, 1997 11:00 a.m.
Code Documentation: NUREG/CR-6331 Rev. 1

~~10:39:14 10/12/01~~

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Program Run 7/21/2000 at 13:11:25

******* ARCON INPUT **********

Number of Meteorological Data Files = 2
Meteorological Data File Names
D:\ARCON96\METDATA\NUSGS82.MET
D:\ARCON96\METDATA\NUSGS83.MET

Height of lower wind instrument (m)	=	10.0
Height of upper wind instrument (m)	=	115.8
Wind speeds entered as miles per hour		
Ground-level release		
Release height (m)	=	10.0
Building Area (m^2)	=	2129.1
Effluent vertical velocity (m/s)	=	.00
Vent or stack flow (m^3/s)	=	.00
Vent or stack radius (m)	=	.00
Direction .. intake to source (deg)	=	255
Wind direction sector width (deg)	=	90
Wind direction window (deg)	=	210 - 300
Distance to intake (m)	=	12.4
Intake height (m)	=	10.0
Terrain elevation difference (m)	=	.0

Output file names
TBB82831
TBB8283.cfd

```
   Minimum Wind Speed (m/s)                        =       .5
   Surface roughness length (m)                    =       .20
   Sector averaging constant                       =      4.3
   Initial value of sigma y                        =     13.60
   Initial value of sigma z                        =      4.40
   Expanded output for code testing not selected
   Total number of hours of data processed =  17520
   Hours of missing data                           =   1246
   Hours direction in window                       =   6166
   Hours elevated plume w/ dir. in window          =      0
   Hours of calm winds                             =     92
   Hours direction not in window or calm           =  10016
```

DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL

AVER. PER.	1	2	4	8	12	24	96	168	360	720
UPPER LIM.	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02
LOW LIM.	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
ABOVE RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
IN RANGE	6258.	7268.	8430.	9742.	10834.	11897.	14478.	14023.	13850.	14337.
BELOW RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ZERO	10016.	8851.	7392.	5517.	4412.	2356.	88.	0.	0.	0.
TOTAL X/Qs	16274.	16119.	15822.	15259.	15246.	14253.	14566.	14023.	13850.	14337.
% NON ZERO	38.45	45.09	53.28	63.84	71.06	83.47	99.40	100.00	100.00	100.00

95th PERCENTILE X/Q VALUES

3.31E-03	2.95E-03	2.72E-03	2.46E-03	1.95E-03	1.29E-03	8.60E-04	7.39E-04	6.62E-04	6.20E-04

95% X/Q for standard averaging intervals

```
   0 to 2 hours        3.31E-03
   2 to 8 hours        2.17E-03
   8 to 24 hours       7.11E-04
   1 to 4 days         7.16E-04
   4 to 30 days        5.84E-04
```

	HOURLY VALUE RANGE MAX X/Q	MIN X/Q
CENTERLINE	4.79E-03	2.83E-04
SECTOR-AVERAGE	3.34E-03	1.65E-04

NORMAL PROGRAM COMPLETION

Appendix B ARCON96 output

Turbine Building- B HVAC 1995 Met Data

```
Program Title:  ARCON96,

Developed For:  U.S. Nuclear Regulatory Commission
                Office of Nuclear Reactor Regulation
                Division of Reactor Program Management
Date:           June 25, 1997    11:00 a.m.
Code Documentation:  NUREG/CR-6331 Rev. 1
Program Run   7/21/2000  at  13:20:22
 ******* ARCON INPUT **********

    Number of Meteorological Data Files  =  1
    Meteorological Data File Names
      D:\ARCON96\METDATA\OC95MET.MET

    Height of lower wind instrument (m)  =     10.0
    Height of upper wind instrument (m)  =    115.8
    Wind speeds entered as miles per hour
    Ground-level release
    Release height (m)                   =     10.0
    Building Area (m^2)                  =   2129.1
    Effluent vertical velocity (m/s)     =      .00
    Vent or stack flow  (m^3/s)          =      .00
    Vent or stack radius (m)             =      .00
    Direction .. intake to source (deg)  =      255
    Wind direction sector width (deg)    =       90
    Wind direction window (deg)          =   210 - 300
    Distance to intake (m)               =     12.4
    Intake height  (m)                   =     10.0
    Terrain elevation difference (m)     =       .0

    Output file names
      TBB95
      TBB95.cfd

    Minimum Wind Speed (m/s)             =       .5
    Surface roughness length (m)         =      .20
    Sector averaging constant            =      4.3
```

Appendix B ARCON96 output

```
Initial value of sigma y                    =     13.60
Initial value of sigma z                    =      4.40
Expanded output for code testing not selected
Total number of hours of data processed     =      8760
Hours of missing data                       =         6
Hours direction in window                   =      3217
Hours elevated plume w/ dir. in window      =         0
Hours of calm winds                         =        85
Hours direction not in window or calm       =      5452
```

DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL

AVER. PER.	1	2	4	8	12	24	96	168	360	720
UPPER LIM.	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02
LOW LIM.	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
ABOVE RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
IN RANGE	3302.	3879.	4555.	5514.	6259.	7381.	8601.	8609.	8437.	8113.
BELOW RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ZERO	5452.	4870.	4184.	3205.	2479.	1336.	73.	0.	0.	0.
TOTAL X/Qs	8754.	8749.	8739.	8719.	8738.	8717.	8674.	8609.	8437.	8113.
% NON ZERO	37.72	44.34	52.12	63.24	71.63	84.67	99.16	100.00	100.00	100.00

95th PERCENTILE X/Q VALUES

3.49E-03 3.11E-03 2.83E-03 2.51E-03 2.02E-03 1.36E-03 8.80E-04 8.25E-04
7.72E-04 7.32E-04

95% X/Q for standard averaging intervals

0 to 2 hours	3.49E-03
2 to 8 hours	2.19E-03
8 to 24 hours	7.82E-04
1 to 4 days	7.20E-04
4 to 30 days	7.09E-04

HOURLY VALUE RANGE

	MAX X/Q	MIN X/Q
CENTERLINE	4.79E-03	3.75E-04
SECTOR-AVERAGE	3.34E-03	2.19E-04

NORMAL PROGRAM COMPLETION

Appendix B ARCON96 output

Turbine Building- B HVAC 1996 Met Data

Program Title: ARCON96.

Developed For: U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Division of Reactor Program Management

Date: June 25, 1997 11:00 a.m.
Code Documentation: NUREG/CR-6331 Rev. 1

Program Run 7/21/2000 at 13:19:49

******* ARCON INPUT **********

Number of Meteorological Data Files = 1
Meteorological Data File Names
D:\ARCON96\METDATA\OC96MET.MET

Height of lower wind instrument (m) = 10.0
Height of upper wind instrument (m) = 115.8
Wind speeds entered as miles per hour

Ground-level release
Release height (m) = 10.0
Building Area (m^2) = 2129.1
Effluent vertical velocity (m/s) = .00
Vent or stack flow (m^3/s) = .00
Vent or stack radius (m) = .00

Direction .. intake to source (deg) = 255
Wind direction sector width (deg) = 90
Wind direction window (deg) = 210 - 300
Distance to intake (m) = 12.4
Intake height (m) = 10.0
Terrain elevation difference (m) = .0

Output file names
TBB96

TBB96.cfd

```
Minimum Wind Speed (m/s)                        =       .5
Surface roughness length (m)                    =       .20
Sector averaging constant                       =      4.3
Initial value of sigma y                        =    13.60
Initial value of sigma z                        =     4.40
Expanded output for code testing not selected
Total number of hours of data processed =    8784
Hours of missing data                           =       2
Hours direction in window                       =    3273
Hours elevated plume w/ dir. in window          =       0
Hours of calm winds                             =     125
Hours direction not in window or calm           =    5384
```

DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL

AVER. PER.	1	2	4	8	12	24	96	168	360	720
UPPER LIM.	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02
LOW LIM.	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
ABOVE RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
IN RANGE	3398.	4017.	4727.	5649.	6355.	7505.	8580.	8633.	8461.	8137.
BELOW RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ZERO	5384.	4763.	4049.	3119.	2408.	1258.	118.	0.	0.	0.
TOTAL X/Qs	8782.	8780.	8776.	8768.	8763.	8763.	8698.	8633.	8461.	8137.
% NON ZERO	38.69	45.75	53.86	64.43	72.52	85.64	98.64	100.00	100.00	100.00

95th PERCENTILE X/Q VALUES

3.64E-03	3.26E-03	3.01E-03	2.70E-03	2.17E-03	1.46E-03	9.60E-04	8.76E-04	8.39E-04	7.98E-04

95% X/Q for standard averaging intervals

0 to 2 hours	3.64E-03
2 to 8 hours	2.39E-03
8 to 24 hours	8.42E-04
1 to 4 days	7.93E-04
4 to 30 days	7.73E-04

HOURLY VALUE RANGE

	MAX X/Q	MIN X/Q
CENTERLINE	4.79E-03	3.34E-04
SECTOR-AVERAGE	3.34E-03	1.94E-04

NORMAL PROGRAM COMPLETION

Appendix B ARCON96 output

Turbine Building- B HVAC 1997 Met Data

```
 Program Title:  ARCON96.

 Developed For:  U.S. Nuclear Regulatory Commission
                 Office of Nuclear Reactor Regulation
                 Division of Reactor Program Management

 Date:           June 25, 1997    11:00 a.m.
Code Documentation:  NUREG/CR-6331 Rev. 1
Program Run   7/21/2000  at  13:16:29

  ******* ARCON INPUT **********

     Number of Meteorological Data Files  =  1
     Meteorological Data File Names
       D:\ARCON96\METDATA\OC97MET.MET

     Height of lower wind instrument (m)  =    10.0
     Height of upper wind instrument (m)  =   115.8
     Wind speeds entered as miles per hour

     Ground-level release
     Release height (m)                   =    10.0
     Building Area (m^2)                  =  2129.1
     Effluent vertical velocity (m/s)     =     .00
     Vent or stack flow  (m^3/s)          =     .00
     Vent or stack radius (m)             =     .00

     Direction .. intake to source (deg)  =     255
     Wind direction sector width (deg)    =      90
     Wind direction window (deg)          =  210 - 300
     Distance to intake (m)               =    12.4
     Intake height  (m)                   =    10.0
     Terrain elevation difference (m)     =      .0

     Output file names
       TBB97
       TBB97.cfd
```

~~98/27/01 10:39:14~~

Appendix B ARCON96 output

```
Minimum Wind Speed (m/s)                          =      .5
Surface roughness length (m)                      =      .20
Sector averaging constant                         =     4.3
Initial value of sigma y                          =   13.60
Initial value of sigma z                          =    4.40
Expanded output for code testing not selected
Total number of hours of data processed           =    8760
Hours of missing data                             =      14
Hours direction in window                         =    3733
Hours elevated plume w/ dir. in window            =       0
Hours of calm winds                               =      91
Hours direction not in window or calm             =    4922
```

DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL

AVER. PER.	1	2	4	8	12	24	96	168	360	720
UPPER LIM.	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02
LOW LIM.	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
ABOVE RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
IN RANGE	3824.	4423.	5092.	5980.	6647.	7694.	8634.	8609.	8437.	8113.
BELOW RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ZERO	4922.	4314.	3628.	2708.	2056.	1000.	40.	0.	0.	0.
TOTAL X/Qs	8746.	8737.	8720.	8688.	8703.	8694.	8674.	8609.	8437.	8113.
% NON ZERO	43.72	50.62	58.39	68.83	76.38	88.50	99.54	100.00	100.00	100.00

95th PERCENTILE X/Q VALUES

3.48E-03	3.14E-03	2.88E-03	2.60E-03	2.06E-03	1.38E-03	9.21E-04	8.18E-04	7.19E-04	6.80E-04

```
95% X/Q for standard averaging intervals
0 to 2 hours          3.48E-03
2 to 8 hours          2.30E-03
8 to 24 hours         7.67E-04
1 to 4 days           7.69E-04
4 to 30 days          6.43E-04
```

	HOURLY VALUE RANGE MAX X/Q	MIN X/Q
CENTERLINE	4.79E-03	3.59E-04
SECTOR-AVERAGE	3.34E-03	2.09E-04

NORMAL PROGRAM COMPLETION

Appendix B ARCON96 output

Turbine Building- B HVAC 1998 Met Data

```
 Program Title:  ARCON96.

 Developed For:  U.S. Nuclear Regulatory Commission
                 Office of Nuclear Reactor Regulation
                 Division of Reactor Program Management

 Date:           June 25, 1997    11:00 a.m.
 Code Documentation:  NUREG/CR-6331 Rev. 1
Program Run   7/21/2000  at  13:19:10

  ******* ARCON INPUT **********

     Number of Meteorological Data Files  =  1
     Meteorological Data File Names
       D:\ARCON96\METDATA\OC98MET.MET

     Height of lower wind instrument (m)  =    10.0
     Height of upper wind instrument (m)  =   115.8
     Wind speeds entered as miles per hour
     Ground-level release
     Release height (m)                   =    10.0
     Building Area (m^2)                  =  2129.1
     Effluent vertical velocity (m/s)     =     .00
     Vent or stack flow  (m^3/s)          =     .00
     Vent or stack radius (m)             =     .00
     Direction .. intake to source (deg)  =     255
     Wind direction sector width (deg)    =      90
     Wind direction window (deg)          =  210 - 300
     Distance to intake (m)               =    12.4
     Intake height  (m)                   =    10.0
     Terrain elevation difference (m)     =      .0

     Output file names
       TBB98
       TBB98.cfd

     Minimum Wind Speed (m/s)             =      .5
```

Appendix B ARCON96 output

```
Surface roughness length (m)          =      .20
Sector averaging constant             =     4.3

Initial value of sigma y              =    13.60
Initial value of sigma z              =     4.40
Expanded output for code testing not selected

Total number of hours of data processed =   8760
Hours of missing data                 =     12
Hours direction in window             =   3136
Hours elevated plume w/ dir. in window =      0
Hours of calm winds                   =    285
Hours direction not in window or calm =   5327
```

DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL

AVER. PER.	1	2	4	8	12	24	96	168	360	720
UPPER LIM.	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02
LOW LIM.	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
ABOVE RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
IN RANGE	3421.	4039.	4787.	5739.	6447.	7570.	8571.	8598.	8437.	8113.
BELOW RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ZERO	5327.	4700.	3935.	2951.	2270.	1146.	103.	11.	0.	0.
TOTAL X/Qs	8748.	8739.	8722.	8690.	8717.	8716.	8674.	8609.	8437.	8113.
% NON ZERO	39.11	46.22	54.88	66.04	73.96	86.85	98.81	99.87	100.00	100.00

95th PERCENTILE X/Q VALUES

4.42E-03	4.14E-03	3.60E-03	3.26E-03	2.62E-03	1.84E-03	1.27E-03	1.17E-03	1.07E-03	9.83E-04

```
95% X/Q for standard averaging intervals
0 to 2 hours          4.42E-03
2 to 8 hours          2.87E-03
8 to 24 hours         1.13E-03
1 to 4 days           1.07E-03
4 to 30 days          9.39E-04
```

HOURLY VALUE RANGE

	MAX X/Q	MIN X/Q
CENTERLINE	4.79E-03	2.97E-04
SECTOR-AVERAGE	3.34E-03	1.73E-04

NORMAL PROGRAM COMPLETION

Appendix B ARCON96 output

Turbine Building- B HVAC 1999 Met Data

Program Title: ARCON96.
Code Documentation: NUREG/CR-6331 Rev. 1

Program Run 7/21/2000 at 13:50:02

******* ARCON INPUT **********

Number of Meteorological Data Files = 1
Meteorological Data File Names
D:\ARCON96\METDATA\OC99MET.MET

Height of lower wind instrument (m) = 10.0
Height of upper wind instrument (m) = 115.8
Wind speeds entered as miles per hour

Ground-level release
Release height (m) = 10.0
Building Area (m^2) = 2129.1
Effluent vertical velocity (m/s) = .00
Vent or stack flow (m^3/s) = .00
Vent or stack radius (m) = .00
Direction .. intake to source (deg) = 255
Wind direction sector width (deg) = 90
Wind direction window (deg) = 210 - 300
Distance to intake (m) = 12.4
Intake height (m) = 10.0
Terrain elevation difference (m) = .0
Output file names
TBB99
TBB99.cfd

Minimum Wind Speed (m/s) = .5
Surface roughness length (m) = .20
Sector averaging constant = 4.3

Initial value of sigma y = 13.60
Initial value of sigma z = 4.40

Expanded output for code testing not selected

Total number of hours of data processed = 8760
Hours of missing data = 9
Hours direction in window = 3159
Hours elevated plume w/ dir. in window = 0
Hours of calm winds = 120
Hours direction not in window or calm = 5472

DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL

AVER. PER.	1	2	4	8	12	24	96	168	360	720
UPPER LIM.	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02
LOW LIM.	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
ABOVE RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
IN RANGE	3279.	3820.	4475.	5371.	6023.	7140.	8434.	8551.	8437.	8113.
BELOW RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ZERO	5472.	4927.	4264.	3352.	2701.	1553.	240.	58.	0.	0.
TOTAL X/Qs	8751.	8747.	8739.	8723.	8724.	8693.	8674.	8609.	8437.	8113.
% NON ZERO	37.47	43.67	51.21	61.57	69.04	82.14	97.23	99.33	100.00	100.00

95th PERCENTILE X/Q VALUES

3.27E-03	2.95E-03	2.72E-03	2.43E-03	1.94E-03	1.36E-03	8.23E-04	7.35E-04	6.64E-04	6.26E-04

95% X/Q for standard averaging intervals

0 to 2 hours 3.27E-03
2 to 8 hours 2.15E-03
8 to 24 hours 8.28E-04
1 to 4 days 6.44E-04
4 to 30 days 5.95E-04

HOURLY VALUE RANGE

	MAX X/Q	MIN X/Q
CENTERLINE	4.79E-03	4.53E-04
SECTOR-AVERAGE	3.34E-03	2.64E-04

NORMAL PROGRAM COMPLETION

Turbine Building- B HVAC 1995- 1999 Met Data Direction Intake to Source 75°

Program Title: ARCON96.

Developed For: U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Division of Reactor Program Management

Date: June 25, 1997. 11:00 a.m.
Code Documentation: NUREG/CR-6331 Rev. 1
Program Run 7/21/2000 at 14:04:14
******* ARCON INPUT **********
Number of Meteorological Data Files = 5
Meteorological Data File Names
D:\ARCON96\METDATA\OC95MET.MET
D:\ARCON96\METDATA\OC96MET.MET
D:\ARCON96\METDATA\OC97MET.MET
D:\ARCON96\METDATA\OC98MET.MET
D:\ARCON96\METDATA\OC99MET.MET

Height of lower wind instrument (m)	=	10.0
Height of upper wind instrument (m)	=	115.8
Wind speeds entered as miles per hour		
Ground-level release		
Release height (m)	=	10.0
Building Area (m^2)	=	2129.1
Effluent vertical velocity (m/s)	=	.00
Vent or stack flow (m^3/s)	=	.00
Vent or stack radius (m)	=	.00
Direction .. intake to source (deg)	=	075
Wind direction sector width (deg)	=	90
Wind direction window (deg)	=	030 - 120
Distance to intake (m)	=	12.4
Intake height (m)	=	10.0
Terrain elevation difference (m)	=	.0

Output file names
TBB75

TBB75.cfd

```
Minimum Wind Speed (m/s)                        =       .5
Surface roughness length (m)                    =       .20
Sector averaging constant                       =      4.3
Initial value of sigma y                        =    13.60
Initial value of sigma z                        =     4.40
Expanded output for code testing not selected
Total number of hours of data processed =  43824
Hours of missing data                           =     43
Hours direction in window                       =   7014
Hours elevated plume w/ dir. in window          =      0
Hours of calm winds                             =    706
Hours direction not in window or calm           =  36061
```

DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL

AVER. PER.	1	2	4	8	12	24	96	168	360	720
UPPER LIM.	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02
LOW LIM.	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
ABOVE RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
IN RANGE	7720.	9368.	11697.	15180.	17994.	23809.	39505.	42483.	43501.	43177.
BELOW RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ZERO	36061.	34388.	32011.	28436.	25691.	19858.	4233.	1190.	0.	0.
TOTAL X/Qs	43781.	43756.	43708.	43616.	43685.	43667.	43738.	43673.	43501.	43177.
% NON ZERO	17.63	21.41	26.76	34.80	41.19	54.52	90.32	97.28	100.00	100.00

95th PERCENTILE X/Q VALUES

2.19E-03	2.18E-03	1.78E-03	1.61E-03	1.31E-03	9.74E-04	5.76E-04	4.93E-04	4.14E-04	3.99E-04

95% X/Q for standard averaging intervals

0 to 2 hours	2.19E-03
2 to 8 hours	1.42E-03
8 to 24 hours	6.56E-04
1 to 4 days	4.44E-04
4 to 30 days	3.72E-04

HOURLY VALUE RANGE

	MAX X/Q	MIN X/Q
CENTERLINE	4.79E-03	3.94E-04
SECTOR-AVERAGE	3.34E-03	2.30E-04

NORMAL PROGRAM COMPLETION

Appendix B ARCON96 output

Turbine Building- B HVAC 1995- 1999 Met Data Direction Intake to Source 165^0

```
 Program Title:  ARCON96.

 Developed For:  U.S. Nuclear Regulatory Commission
                 Office of Nuclear Reactor Regulation
                 Division of Reactor Program Management

 Date:           June 25, 1997    11:00 a.m.
 Code Documentation:  NUREG/CR-6331 Rev. 1
Program Run   7/21/2000  at  14:04:52

  ******* ARCON INPUT **********
     Number of Meteorological Data Files  =  5
     Meteorological Data File Names
       D:\ARCON96\METDATA\OC95MET.MET
       D:\ARCON96\METDATA\OC96MET.MET
       D:\ARCON96\METDATA\OC97MET.MET
       D:\ARCON96\METDATA\OC98MET.MET
       D:\ARCON96\METDATA\OC99MET.MET

     Height of lower wind instrument (m)  =    10.0
     Height of upper wind instrument (m)  =   115.8
     Wind speeds entered as miles per hour
     Ground-level release
     Release height (m)                   =    10.0
     Building Area (m^2)                  =  2129.1
     Effluent vertical velocity (m/s)     =     .00
     Vent or stack flow  (m^3/s)          =     .00
     Vent or stack radius (m)             =     .00
     Direction .. intake to source (deg)  =     165
     Wind direction sector width (deg)    =      90
     Wind direction window (deg)          =  120 - 210
     Distance to intake (m)               =    12.4
     Intake height  (m)                   =    10.0
     Terrain elevation difference (m)     =      .0
     Output file names
       TBB165
       TBB165.cfd
```

Appendix B ARCON96 output

```
Minimum Wind Speed (m/s)                    =      .5
Surface roughness length (m)                =      .20
Sector averaging constant                   =     4.3
Initial value of sigma y                    =    13.60
Initial value of sigma z                    =     4.40

Expanded output for code testing not selected
Total number of hours of data processed =  43824
Hours of missing data                   =     43
Hours direction in window               =   9584
Hours elevated plume w/ dir. in window  =      0
Hours of calm winds                     =    706
Hours direction not in window or calm   =  33491
```

DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL

AVER. PER.	1	2	4	8	12	24	96	168	360	720
UPPER LIM.	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02
LOW LIM.	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
ABOVE RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
IN RANGE	10290.	12296.	14984.	18737.	21820.	28239.	41241.	42952.	43501.	43177.
BELOW RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ZERO	33491.	31460.	28724.	24879.	21865.	15428.	2497.	721.	0.	0.
TOTAL X/Qs	43781.	43756.	43708.	43616.	43685.	43667.	43738.	43673.	43501.	43177.
% NON ZERO	23.50	28.10	34.28	42.96	49.95	64.67	94.29	98.35	100.00	100.00

95th PERCENTILE X/Q VALUES

2.64E-03	2.34E-03	2.11E-03	1.84E-03	1.50E-03	1.11E-03	6.86E-04	6.14E-04	5.70E-04	5.48E-04

95% X/Q for standard averaging intervals

```
0 to 2 hours        2.64E-03
2 to 8 hours        1.57E-03
8 to 24 hours       7.41E-04
1 to 4 days         5.45E-04
4 to 30 days        5.27E-04
```

	HOURLY VALUE RANGE MAX X/Q	MIN X/Q
CENTERLINE	4.79E-03	3.16E-04
SECTOR-AVERAGE	3.34E-03	1.84E-04

NORMAL PROGRAM COMPLETION

Appendix B ARCON96 output

Turbine Building- B HVAC 1995- 1999 Met Data Direction Intake to Source 345^0

```
 Program Title:  ARCON96.

 Developed For:  U.S. Nuclear Regulatory Commission
                 Office of Nuclear Reactor Regulation
                 Division of Reactor Program Management

 Date:           June 25, 1997    11:00 a.m.
Code Documentation:  NUREG/CR-6331 Rev. 1
Program Run   7/21/2000  at  14:05:42
  ******* ARCON INPUT **********
     Number of Meteorological Data Files  =  5
     Meteorological Data File Names
       D:\ARCON96\METDATA\OC95MET.MET
       D:\ARCON96\METDATA\OC96MET.MET
       D:\ARCON96\METDATA\OC97MET.MET
       D:\ARCON96\METDATA\OC98MET.MET
       D:\ARCON96\METDATA\OC99MET.MET

     Height of lower wind instrument (m)  =     10.0
     Height of upper wind instrument (m)  =    115.8
     Wind speeds entered as miles per hour
     Ground-level release
     Release height (m)                   =     10.0
     Building Area (m^2)                  =   2129.1
     Effluent vertical velocity (m/s)     =      .00
     Vent or stack flow  (m^3/s)          =      .00
     Vent or stack radius (m)             =      .00
     Direction .. intake to source (deg)  =      345
     Wind direction sector width (deg)    =       90
     Wind direction window (deg)          =   300 - 030
     Distance to intake (m)               =     12.4
     Intake height  (m)                   =     10.0
     Terrain elevation difference (m)     =       .0

     Output file names
       TBB345
       TBB345.cfd
```

Appendix B ARCON96 output

```
Minimum Wind Speed (m/s)                    =      .5
Surface roughness length (m)                =      .20
Sector averaging constant                   =     4.3
Initial value of sigma y                    =    13.60
Initial value of sigma z                    =     4.40

Expanded output for code testing not selected
Total number of hours of data processed =  43824
Hours of missing data                   =     43
Hours direction in window               =  10407
Hours elevated plume w/ dir. in window  =      0
Hours of calm winds                     =    706
Hours direction not in window or calm   =  32668
```

DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL

AVER. PER.	1	2	4	8	12	24	96	168	360	720
UPPER LIM.	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02
LOW LIM.	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
ABOVE RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
IN RANGE	11113.	13831.	17448.	22582.	26689.	34133.	43398.	43658.	43501.	43177.
BELOW RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ZERO	32668.	29925.	26260.	21034.	16996.	9534.	340.	15.	0.	0.
TOTAL X/Qs	43781.	43756.	43708.	43616.	43685.	43667.	43738.	43673.	43501.	43177.
% NON ZERO	25.38	31.61	39.92	51.77	61.09	78.17	99.22	99.97	100.00	100.00

95th PERCENTILE X/Q VALUES

3.09E-03	2.46E-03	2.31E-03	2.01E-03	1.61E-03	1.13E-03	7.29E-04	6.53E-04	5.70E-04	5.56E-04

95% X/Q for standard averaging intervals

0 to 2 hours	3.09E-03
2 to 8 hours	1.66E-03
8 to 24 hours	6.95E-04
1 to 4 days	5.93E-04
4 to 30 days	5.30E-04

HOURLY VALUE RANGE

	MAX X/Q	MIN X/Q
CENTERLINE	4.79E-03	2.92E-04
SECTOR-AVERAGE	3.34E-03	1.70E-04

NORMAL PROGRAM COMPLETION

Turbine Building - A HVAC 1982 & 83 Met Data

Program Title: ARCON96.

Developed For: U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Division of Reactor Program Management

Date: June 25, 1997 11:00 a.m.
Code Documentation: NUREG/CR-6331 Rev. 1
Program Run 7/21/2000 at 14:19:30

******* ARCON INPUT **********

Number of Meteorological Data Files = 2
Meteorological Data File Names
D:\ARCON96\METDATA\NUSGS82.MET
D:\ARCON96\METDATA\NUSGS83.MET

Height of lower wind instrument (m) = 10.0
Height of upper wind instrument (m) = 115.8
Wind speeds entered as miles per hour

Ground-level release
Release height (m) = 10.0
Building Area (m^2) = 2129.1
Effluent vertical velocity (m/s) = .00
Vent or stack flow (m^3/s) = .00
Vent or stack radius (m) = .00
Direction .. intake to source (deg) = 255
Wind direction sector width (deg) = 90
Wind direction window (deg) = 210 - 300
Distance to intake (m) = 16.5
Intake height (m) = 10.0
Terrain elevation difference (m) = .0

Output file names
TBA8283.log
TBA8283

Appendix B ARCON96 output

GPU NUCLEAR	CALCULATION SHEET (Ref. EP-006)			
Subject: Calculation of OC Control Room Air Intake X/Q's for Ground Level Releases Using ARCON96	**Calculation No.** C-1302-826-E540-017	**Rev. No.** 0	**System Nos.** 826	**Sheet** 64

Minimum Wind Speed (m/s) = .5
Surface roughness length (m) = .20
Sector averaging constant = 4.3
Initial value of sigma y = 13.60
Initial value of sigma z = 4.40

Expanded output for code testing not selected
Total number of hours of data processed = 17520
Hours of missing data = 1246
Hours direction in window = 6166
Hours elevated plume w/ dir. in window = 0
Hours of calm winds = 92
Hours direction not in window or calm = 10016

DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL

AVER. PER.	1	2	4	8	12	24	96	168	360	720
UPPER LIM.	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02
LOW LIM.	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
ABOVE RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
IN RANGE	6258.	7268.	8430.	9742.	10834.	11897.	14478.	14023.	13850.	14337.
BELOW RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ZERO	10016.	8851.	7392.	5517.	4412.	2356.	88.	0.	0.	0.
TOTAL X/Qs	16274.	16119.	15822.	15259.	15246.	14253.	14566.	14023.	13850.	14337.
% NON ZERO	38.45	45.09	53.28	63.84	71.06	83.47	99.40	100.00	100.00	100.00

95th PERCENTILE X/Q VALUES

	2.90E-03	2.65E-03	2.41E-03	2.18E-03	1.72E-03	1.14E-03	7.50E-04	6.47E-04	5.72E-04	5.43E-04

95% X/Q for standard averaging intervals
0 to 2 hours 2.90E-03
2 to 8 hours 1.94E-03
8 to 24 hours 6.18E-04
1 to 4 days 6.21E-04
4 to 30 days 5.11E-04

HOURLY VALUE RANGE

	MAX X/Q	MIN X/Q
CENTERLINE	3.57E-03	2.43E-04
SECTOR-AVERAGE	2.18E-03	1.41E-04

NORMAL PROGRAM COMPLETION

Appendix B ARCON96 output

GPU NUCLEAR	CALCULATION SHEET (Ref. EP-006)			
Subject: Calculation of OC Control Room Air Intake X/Q's for Ground Level Releases Using ARCON96	**Calculation No.** C-1302-826-E540-017	**Rev. No.** 0	**System Nos.** 826	**Sheet** 65

Turbine Building- A HVAC 1995 Met Data

~~98/27/01 10:39:14~~

```
Program Title:  ARCON96.

Developed For:  U.S. Nuclear Regulatory Commission
                Office of Nuclear Reactor Regulation
                Division of Reactor Program Management

Date:           June 25, 1997    11:00 a.m.
Code Documentation:  NUREG/CR-6331 Rev. 1
Program Run    7/21/2000  at  14:19:09

 ******* ARCON INPUT **********

    Number of Meteorological Data Files  =  1
    Meteorological Data File Names
      D:\ARCON96\METDATA\OC95MET.MET

    Height of lower wind instrument (m)  =     10.0
    Height of upper wind instrument (m)  =    115.8
    Wind speeds entered as miles per hour

    Ground-level release
    Release height (m)                   =     10.0
    Building Area (m^2)                  =   2129.1
    Effluent vertical velocity (m/s)     =      .00
    Vent or stack flow  (m^3/s)          =      .00
    Vent or stack radius (m)             =      .00
    Direction .. intake to source (deg)  =      255
    Wind direction sector width (deg)    =       90
    Wind direction window (deg)          =   210 - 300
    Distance to intake (m)               =     16.5
    Intake height  (m)                   =     10.0
    Terrain elevation difference (m)     =       .0
    Output file names
      TBA95.log
      TBA95
```

GPU NUCLEAR	CALCULATION SHEET (Ref. EP-006)			
Subject: Calculation of OC Control Room Air Intake X/Q's for Ground Level Releases Using ARCON96	**Calculation No.** C-1302-826-E540-017	**Rev. No.** 0	**System Nos.** 826	**Sheet** 66

```
Minimum Wind Speed (m/s)                          =      .5
Surface roughness length (m)                      =      .20
Sector averaging constant                         =     4.3
Initial value of sigma y                          =    13.60
Initial value of sigma z                          =     4.40
Expanded output for code testing not selected
Total number of hours of data processed           =    8760
Hours of missing data                             =       6
Hours direction in window                         =    3217
Hours elevated plume w/ dir. in window            =       0
Hours of calm winds                               =      85
Hours direction not in window or calm             =    5452
```

DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL

AVER. PER.	1	2	4	8	12	24	96	168	360	720
UPPER LIM.	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02
LOW LIM.	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
ABOVE RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
IN RANGE	3302.	3879.	4555.	5514.	6259.	7381.	8601.	8609.	8437.	8113.
BELOW RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ZERO	5452.	4870.	4184.	3205.	2479.	1336.	73.	0.	0.	0.
TOTAL X/Qs	8754.	8749.	8739.	8719.	8738.	8717.	8674.	8609.	8437.	8113.
% NON ZERO	37.72	44.34	52.12	63.24	71.63	84.67	99.16	100.00	100.00	100.00

95th PERCENTILE X/Q VALUES

	3.00E-03	2.75E-03	2.48E-03	2.23E-03	1.77E-03	1.19E-03	7.81E-04	7.32E-04	6.82E-04	6.53E-04

95% X/Q for standard averaging intervals

0 to 2 hours	3.00E-03
2 to 8 hours	1.98E-03
8 to 24 hours	6.72E-04
1 to 4 days	6.44E-04
4 to 30 days	6.34E-04

HOURLY VALUE RANGE

	MAX X/Q	MIN X/Q
CENTERLINE	3.57E-03	3.23E-04
SECTOR-AVERAGE	2.18E-03	1.88E-04

NORMAL PROGRAM COMPLETION

Appendix B ARCON96 output

Turbine Building- A HVAC 1996 Met Data

```
 Program Title:  ARCON96.

 Developed For:  U.S. Nuclear Regulatory Commission
                 Office of Nuclear Reactor Regulation
                 Division of Reactor Program Management
Code Documentation:  NUREG/CR-6331 Rev. 1
 Program Run    7/21/2000   at   14:18:39

  ******* ARCON INPUT **********

     Number of Meteorological Data Files  =  1
     Meteorological Data File Names
       D:\ARCON96\METDATA\OC96MET.MET

     Height of lower wind instrument (m)  =     10.0
     Height of upper wind instrument (m)  =    115.8
     Wind speeds entered as miles per hour
     Ground-level release
     Release height (m)                   =     10.0
     Building Area (m^2)                  =   2129.1
     Effluent vertical velocity (m/s)     =      .00
     Vent or stack flow  (m^3/s)          =      .00
     Vent or stack radius (m)             =      .00
     Direction .. intake to source (deg)  =      255
     Wind direction sector width (deg)    =       90
     Wind direction window (deg)          =   210 - 300
     Distance to intake (m)               =     16.5
     Intake height  (m)                   =     10.0
     Terrain elevation difference (m)     =       .0

     Output file names
       TBA96.log
       TBA96

     Minimum Wind Speed (m/s)             =       .5
     Surface roughness length (m)         =      .20
```

Appendix B ARCON96 output

Sector averaging constant = 4.3

Initial value of sigma y = 13.60
Initial value of sigma z = 4.40

Expanded output for code testing not selected

Total number of hours of data processed = 8784
Hours of missing data = 2
Hours direction in window = 3273
Hours elevated plume w/ dir. in window = 0
Hours of calm winds = 125
Hours direction not in window or calm = 5384

DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL

AVER. PER.	1	2	4	8	12	24	96	168	360	720
UPPER LIM.	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02
LOW LIM.	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
ABOVE RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
IN RANGE	3398.	4017.	4727.	5649.	6355.	7505.	8580.	8633.	8461.	8137.
BELOW RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ZERO	5384.	4763.	4049.	3119.	2408.	1258.	118.	0.	0.	0.
TOTAL X/Qs	8782.	8780.	8776.	8768.	8763.	8763.	8698.	8633.	8461.	8137.
% NON ZERO	38.69	45.75	53.86	64.43	72.52	85.64	98.64	100.00	100.00	100.00

95th PERCENTILE X/Q VALUES

	3.11E-03	2.87E-03	2.57E-03	2.34E-03	1.88E-03	1.28E-03	8.28E-04	7.67E-04	7.18E-04	7.06E-04

95% X/Q for standard averaging intervals

0 to 2 hours	3.11E-03
2 to 8 hours	2.09E-03
8 to 24 hours	7.42E-04
1 to 4 days	6.78E-04
4 to 30 days	6.87E-04

HOURLY VALUE RANGE

	MAX X/Q	MIN X/Q
CENTERLINE	3.57E-03	2.96E-04
SECTOR-AVERAGE	2.18E-03	1.72E-04

NORMAL PROGRAM COMPLETION

Appendix B ARCON96 output

Turbine Building- A HVAC 1997 Met Data

```
 Program Title:  ARCON96.
Code Documentation:  NUREG/CR-6331 Rev. 1
Program Run   7/21/2000  at  14:18:10

 ******* ARCON INPUT **********

    Number of Meteorological Data Files  =  1
    Meteorological Data File Names
      D:\ARCON96\METDATA\OC97MET.MET

    Height of lower wind instrument (m)  =     10.0
    Height of upper wind instrument (m)  =    115.8
    Wind speeds entered as miles per hour
    Ground-level release
    Release height (m)                   =     10.0
    Building Area (m^2)                  =   2129.1
    Effluent vertical velocity (m/s)     =      .00
    Vent or stack flow  (m^3/s)          =      .00
    Vent or stack radius (m)             =      .00
    Direction .. intake to source (deg)  =      255
    Wind direction sector width (deg)    =       90
    Wind direction window (deg)          =   210 - 300
    Distance to intake (m)               =     16.5
    Intake height  (m)                   =     10.0
    Terrain elevation difference (m)     =       .0

    Output file names
      TBA97.log
      TBA97

    Minimum Wind Speed (m/s)             =       .5
    Surface roughness length (m)         =      .20
    Sector averaging constant            =      4.3
    Initial value of sigma y             =    13.60
    Initial value of sigma z             =     4.40
```

Appendix B ARCON96 output

Expanded output for code testing not selected

Total number of hours of data processed = 8760
Hours of missing data = 14
Hours direction in window = 3733
Hours elevated plume w/ dir. in window = 0
Hours of calm winds = 91
Hours direction not in window or calm = 4922

DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL

AVER. PER.	1	2	4	8	12	24	96	168	360	720
UPPER LIM.	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02
LOW LIM.	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
ABOVE RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
IN RANGE	3824.	4423.	5092.	5980.	6647.	7694.	8634.	8609.	8437.	8113.
BELOW RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ZERO	4922.	4314.	3628.	2708.	2056.	1000.	40.	0.	0.	0.
TOTAL X/Qs	8746.	8737.	8720.	8688.	8703.	8694.	8674.	8609.	8437.	8113.
% NON ZERO	43.72	50.62	58.39	68.83	76.38	88.50	99.54	100.00	100.00	100.00

95th PERCENTILE X/Q VALUES

	3.01E-03	2.79E-03	2.51E-03	2.28E-03	1.82E-03	1.22E-03	8.17E-04	7.14E-04	6.26E-04	6.03E-04

95% X/Q for standard averaging intervals

0 to 2 hours	3.01E-03
2 to 8 hours	2.04E-03
8 to 24 hours	6.87E-04
1 to 4 days	6.83E-04
4 to 30 days	5.70E-04

HOURLY VALUE RANGE

	MAX X/Q	MIN X/Q
CENTERLINE	3.57E-03	3.09E-04
SECTOR-AVERAGE	2.18E-03	1.80E-04

NORMAL PROGRAM COMPLETION

GPU NUCLEAR	CALCULATION SHEET (Ref. EP-006)			
Subject: Calculation of OC Control Room Air Intake X/Q's for Ground Level Releases Using ARCON96	**Calculation No.** C-1302-826-E540-017	**Rev. No.** 0	**System Nos.** 826	**Sheet** 71

Turbine Building- A HVAC 1998 Met Data

```
Program Title:  ARCON96.

Developed For:  U.S. Nuclear Regulatory Commission
                Office of Nuclear Reactor Regulation
                Division of Reactor Program Management

Date:           June 25, 1997    11:00 a.m.
Code Documentation:  NUREG/CR-6331 Rev. 1
Program Run   7/21/2000  at  14:17:38

******* ARCON INPUT **********
   Number of Meteorological Data Files  =  1
   Meteorological Data File Names
     D:\ARCON96\METDATA\OC98MET.MET

   Height of lower wind instrument (m)  =     10.0
   Height of upper wind instrument (m)  =    115.8
   Wind speeds entered as miles per hour

   Ground-level release
   Release height (m)                   =     10.0
   Building Area (m^2)                  =   2129.1
   Effluent vertical velocity (m/s)     =      .00
   Vent or stack flow  (m^3/s)          =      .00
   Vent or stack radius (m)             =      .00
   Direction .. intake to source (deg)  =      255
   Wind direction sector width (deg)    =       90
   Wind direction window (deg)          =   210 - 300
   Distance to intake (m)               =     16.5
   Intake height  (m)                   =     10.0
   Terrain elevation difference (m)     =       .0

   Output file names
     TBA98.log
     TBA98
```

Appendix B ARCON96 output

```
Minimum Wind Speed (m/s)                          =       .5
Surface roughness length (m)                      =       .20
Sector averaging constant                         =      4.3
Initial value of sigma y                          =     13.60
Initial value of sigma z                          =      4.40
Expanded output for code testing not selected
Total number of hours of data processed           =     8760
Hours of missing data                             =       12
Hours direction in window                         =     3136
Hours elevated plume w/ dir. in window            =        0
Hours of calm winds                               =      285
Hours direction not in window or calm             =     5327
```

DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL

AVER. PER.	1	2	4	8	12	24	96	168	360	720
UPPER LIM.	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02
LOW LIM.	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
ABOVE RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
IN RANGE	3421.	4039.	4787.	5739.	6447.	7570.	8571.	8598.	8437.	8113.
BELOW RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ZERO	5327.	4700.	3935.	2951.	2270.	1146.	103.	11.	0.	0.
TOTAL X/Qs	8748.	8739.	8722.	8690.	8717.	8716.	8674.	8609.	8437.	8113.
% NON ZERO	39.11	46.22	54.88	66.04	73.96	86.85	98.81	99.87	100.00	100.00

95th PERCENTILE X/Q VALUES

3.40E-03 3.32E-03 3.02E-03 2.69E-03 2.16E-03 1.53E-03 1.02E-03 9.23E-04 8.31E-04 7.81E-04

95% X/Q for standard averaging intervals

0 to 2 hours	3.40E-03
2 to 8 hours	2.46E-03
8 to 24 hours	9.44E-04
1 to 4 days	8.52E-04
4 to 30 days	7.44E-04

HOURLY VALUE RANGE

	MAX X/Q	MIN X/Q
CENTERLINE	3.57E-03	2.55E-04
SECTOR-AVERAGE	2.18E-03	1.49E-04

NORMAL PROGRAM COMPLETION

Appendix B ARCON96 output

Turbine Building- A HVAC 1999 Met Data

```
 Program Title:  ARCON96.

 Developed For:  U.S. Nuclear Regulatory Commission
                 Office of Nuclear Reactor Regulation
                 Division of Reactor Program Management
 Date:           June 25, 1997    11:00 a.m.
Code Documentation:  NUREG/CR-6331 Rev. 1
Program Run   7/21/2000  at  14:16:41

  ******* ARCON INPUT **********

     Number of Meteorological Data Files  =  1
     Meteorological Data File Names
       D:\ARCON96\METDATA\OC99MET.MET
     Height of lower wind instrument (m)  =     10.0
     Height of upper wind instrument (m)  =    115.8
     Wind speeds entered as miles per hour
     Ground-level release
     Release height (m)                   =     10.0
     Building Area (m^2)                  =   2129.1
     Effluent vertical velocity (m/s)     =      .00
     Vent or stack flow  (m^3/s)          =      .00
     Vent or stack radius (m)             =      .00
     Direction .. intake to source (deg)  =      255
     Wind direction sector width (deg)    =       90
     Wind direction window (deg)          =   210 - 300
     Distance to intake (m)               =     16.5
     Intake height  (m)                   =     10.0
     Terrain elevation difference (m)     =       .0

     Output file names
       TBA99.log
       TBA99

     Minimum Wind Speed (m/s)             =       .5
     Surface roughness length (m)         =      .20
```

Appendix B ARCON96 output

```
Sector averaging constant                    =      4.3

Initial value of sigma y                     =     13.60
Initial value of sigma z                     =      4.40

Expanded output for code testing not selected

Total number of hours of data processed =    8760
Hours of missing data                   =       9
Hours direction in window               =    3159
Hours elevated plume w/ dir. in window  =       0
Hours of calm winds                     =     120
Hours direction not in window or calm   =    5472
```

DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL

AVER. PER.	1	2	4	8	12	24	96	168	360	720
UPPER LIM.	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02
LOW LIM.	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
ABOVE RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
IN RANGE	3279.	3820.	4475.	5371.	6023.	7140.	8434.	8551.	8437.	8113.
BELOW RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ZERO	5472.	4927.	4264.	3352.	2701.	1553.	240.	58.	0.	0.
TOTAL X/Qs	8751.	8747.	8739.	8723.	8724.	8693.	8674.	8609.	8437.	8113.
% NON ZERO	37.47	43.67	51.21	61.57	69.04	82.14	97.23	99.33	100.00	100.00

95th PERCENTILE X/Q VALUES

2.80E-03	2.56E-03	2.32E-03	2.06E-03	1.67E-03	1.17E-03	7.23E-04	6.33E-04	5.69E-04	5.44E-04

```
95% X/Q for standard averaging intervals
0 to 2 hours        2.80E-03
2 to 8 hours        1.82E-03
8 to 24 hours       7.20E-04
1 to 4 days         5.75E-04
4 to 30 days        5.16E-04
```

	HOURLY VALUE RANGE MAX X/Q	MIN X/Q
CENTERLINE	3.55E-03	4.11E-04
SECTOR-AVERAGE	2.18E-03	2.40E-04

NORMAL PROGRAM COMPLETION

APPENDIX C

DESIGN VERIFICATION

GPU NUCLEAR

ALCULATION VERIFICATION CHECKLIST

(Ref. EP-006)

Subject: Calculation of OC Control Room Air Intake X/Q's for Ground Level Releases Using ARCON96	Calculation No. C-1302-826-E540-017	Rev. No. 0	System Nos. 826	Sheet: 79

Place an "X" in the applicable box (Yes, No, N/A) for each item.

A **"NO"** response may indicate that the design or verification is incomplete and may require a CAP to be assigned by the responsible Section Manager. The Section Manager shall review each **"NO"** response to determine if the **"NO"** response requires further investigation.

A "N/A" (Not Applicable) response does not require any further action by the Verification Engineer.

The Verification Summary (Exhibit 7A) may be used to outline the Verification Engineer's work or to document comments that are deemed appropriate by the Verification Engineer.

ITEMS	Review Check Design Compliance		
	Yes	No	N/A
1. Design Input and Data – Were the inputs correctly selected, referenced (latest revision) and incorporated into the calculation?	☒	☐	☐
2. Assumptions – Are assumptions necessary to perform the calculation adequately described and reasonable?	☒	☐	☐
3. Regulatory Requirements – Are the applicable codes and standards and regulatory requirements, including issue and addenda, properly identified and their requirements met?	☐	☐	☒
4. Construction and Operating Experience – Has applicable construction and operating experience been considered?	☐	☐	☒
5. Interfaces – Have the design interface requirements been satisfied?	☐	☐	☒
6. Methods –Is the appropriate calculation method used?	☒	☐	☐
7. Output – Is the output reasonable compared to the inputs?	☒	☐	☐
8. Acceptance Criteria – Are the acceptance criteria incorporated in the calculation sufficient to allow verification that the design requirements have been satisfactorily accomplished?	☐	☐	☒
9. Radiation Exposure – Has the calculation properly considered radiation exposure to the public and plant personnel?	☐	☐	☒

Comments:

GPU NUCLEAR

CALCULATION ERIFICATION PLAN/SUMMARY SHEET

(Ref. EP-006)

Subject: Calculation of OC Con[illegible] Room Air Intake X/Q's for Ground Level Releases Using ARCON96	Calculation No. C-1302-826-E540-017	Rev. No. 0	System Nos. 826	Sheet: 76

PLAN

Scope of Verification:
X/Q @ Control Room Ventilation System Intakes for Turbine Building Release & N_2 Piping Release

Item No.	Method/Depth of Verification Required	Req'd. Comp. Date
1	(Check Applicable Boxes) Design Review ☒ Alternate Calculation ☐ Qualification Test ☐ Other ☐ (Specify below) Verify assumptions, design input, method of analysis, and results for determining the X/Q values for a release from the turbine building to the control room ventilation system "A" and "B" air intakes due to leakage past the main steam isolation valves (MSIV's). a release from the nitrogen supply system to the "A" control room ventilation system air intake	7/31/2000

Assigned Verification Engineer Kenneth G. Boughton

Other Verification Engineer

Section Manager (*Sign*) D. J. Masiero — Date 7/25/00

SUMMARY

Summary of verification scope, methods, results and conclusions:

See attached for summary.

Based on this evaluation, the calculation is verified to be acceptable.

APPROVALS (Sign)

Assigned Verification Engineer K.G. Boughton — Date 7/25/2000

Other Verification Engineer — Date

Use Additional Sheets if Necessary

N5871 (1/99)

VERIFICATION SUMMARY

1.0 SCOPE OF VERIFICATION

This verification documents a review of the assumptions, design input, method of analysis, and results for determining the X/Q values for the following:

- A release from the turbine building to the control room ventilation system air intakes ("A" and "B") due to leakage past the main steam isolation valves (MSIV's) which is emitted to the turbine building through a break in the steam lines at the turbine stop and control valves.
- A release from the nitrogen supply system to the "A" control room ventilation system air intake as a result of a break in the nitrogen supply line at the northeast corner of the reactor building.

This verification does not address releases from the main plant stack and this impact upon the control room system intakes as this was determined by a previous analysis (reference Stone & Webster Calculation No. 15050.50 ENV-4).

2.0 METHODS

A technical review was conducted for this calculation. The review consisted of checking the referenced material for verification of the inputs utilized in the analysis. Numerical accuracy of the geometrical inputs were checked and verified against the referenced documents. The meteorological data was reviewed for completeness by checking that the proper number of hourly records was available for the years of data utilized. In addition the meteorological data was checked utilizing a quality assurance program (QA version 2 dated February 1982 contained in NUREG-0917). The site meteorologist reviewed the quality assurance program results. Independent computer runs were made utilizing the meteorological data and site specific inputs with the ARCON96 code on a separate computer. The ARCON96 model and method were benchmarked through the use of an EXCEL model (Excel File OC_1995_TBXOQ.xls dated 7/19 /00, Size 16346 KB, Time 8.48 AM) for the year 1995 using similar methods. The ARCON96 files used for this comparison consist of OC_TB_95.log (dated 6/29/00, Time 12:39PM, Size 5KB) and OCTB95QA.txt (dated 6/29/00, Time 12.39PM, Size 971 KB).

3.0 RESULTS

The verification determined that the geometrical inputs were correctly transposed and utilized from the referenced documentation. A field walkdown was conducted which confirmed the geometrical inputs. Numerical calculations of the referenced geometry were performed correctly and are accurate. The meteorological data utilized in the calculation was based upon the 33 foot wind speed and direction measurement and stability determinations from the 380 foot and 33 foot measurements. These were determined to be representative for the release elevation of the intakes that were modeled.

Model assumptions for use with ARCON96 were validated against the NRC Draft Guidance. These were determined to be correct. The turbine building release was assumed to be a diffuse area release from the East Side of the building. This assumption was determined to be conservative and appropriate since all the material released to the turbine building was modeled as leaking through the East Side wall. The light sheet metal structure of the turbine building at the area in question supports the diffuse area assumptions. Initial diffusion coefficients utilized in the turbine release were determined to be correct in accordance with the NRC Draft Guidance.
The nitrogen release was assumed to be a point source release. This is a true representation of the release with additional conservatism applied, as it does not credit any enhanced dispersion from building wake effects.

The model conservatively assumes that the release height and receptor heights are at 10 meters. This removes any wind speed corrections that are applied to the 10-meter wind speed data for releases higher than 10 meters. The turbine building release from the East Side of the turbine building can range from 46'-6" to 109'-4". The NRC guidance would require as a minimum that the release height be at the intake height for the "B" unit of 58.7 feet (17.9 meters) above grade elevation of 23'-6"and 44.2 feet (13.5 meters) above grade for releases to the "A" unit. The conservatism applied represents an approach that is consistent with R.G. 1.145, Murph-Campe, and NRC code PAVAN for a ground level release.

The ARCON96 results provided by this calculation represent the 95th percentile X/Q values for the standard intervals used in dose assessment models.

4.0 CONCLUSION

Based upon the review performed for this analysis and the verification of design inputs and assumptions, it is concluded that the results are representative for the releases considered using the ARCON96 methodology. It is therefore concluded that the calculation is acceptable.

GPU NUCLEAR	CALCULATION SHEET (Ref. EP-006)			
Subject: OC Control Room air intake meteorology using ARCON96	**Calculation No.** C-1302-826-E540-017	**Rev. No.** 0	**System Nos.** 826	**Sheet** 80

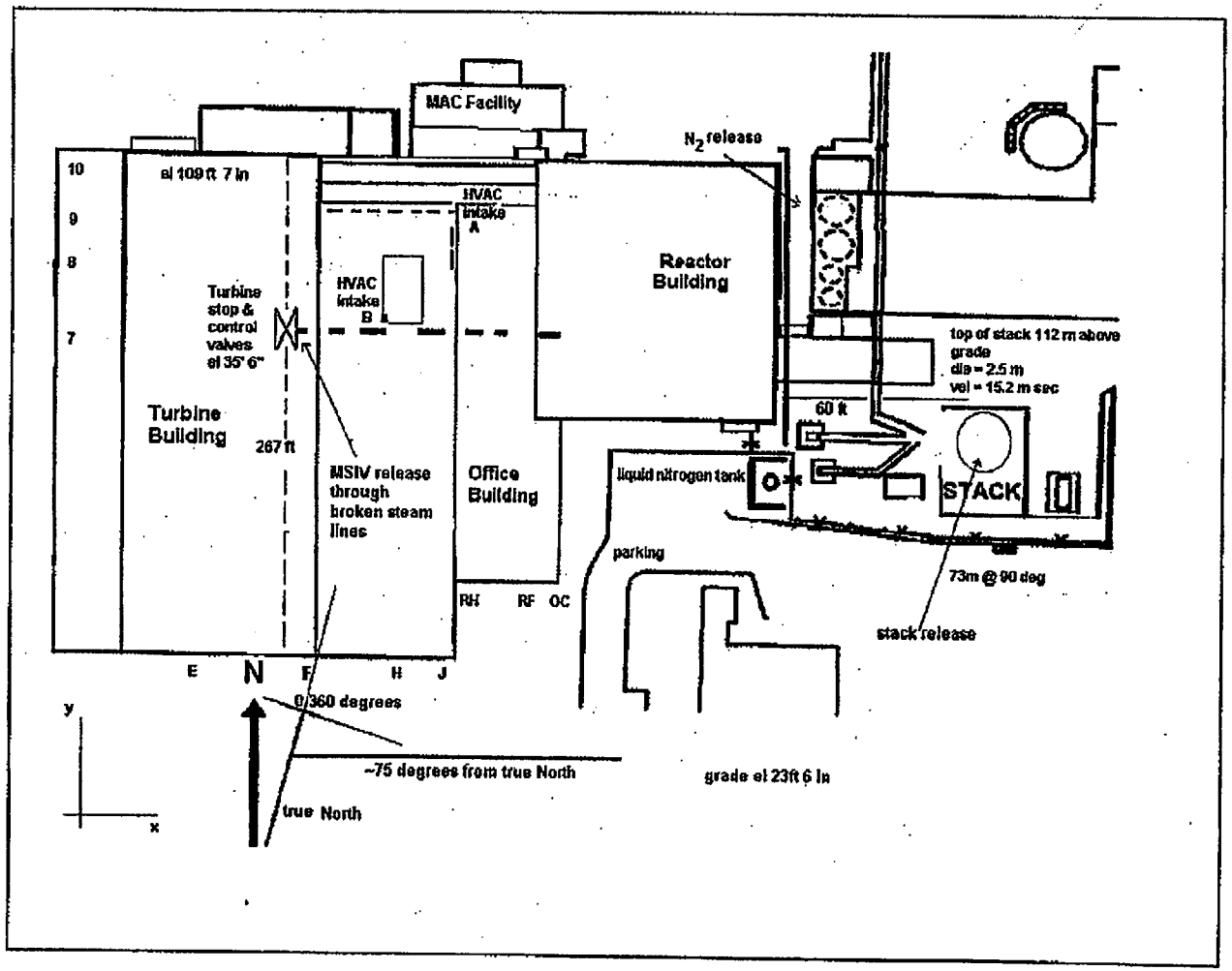

Figure 1 Site Plot Plan showing principal release points

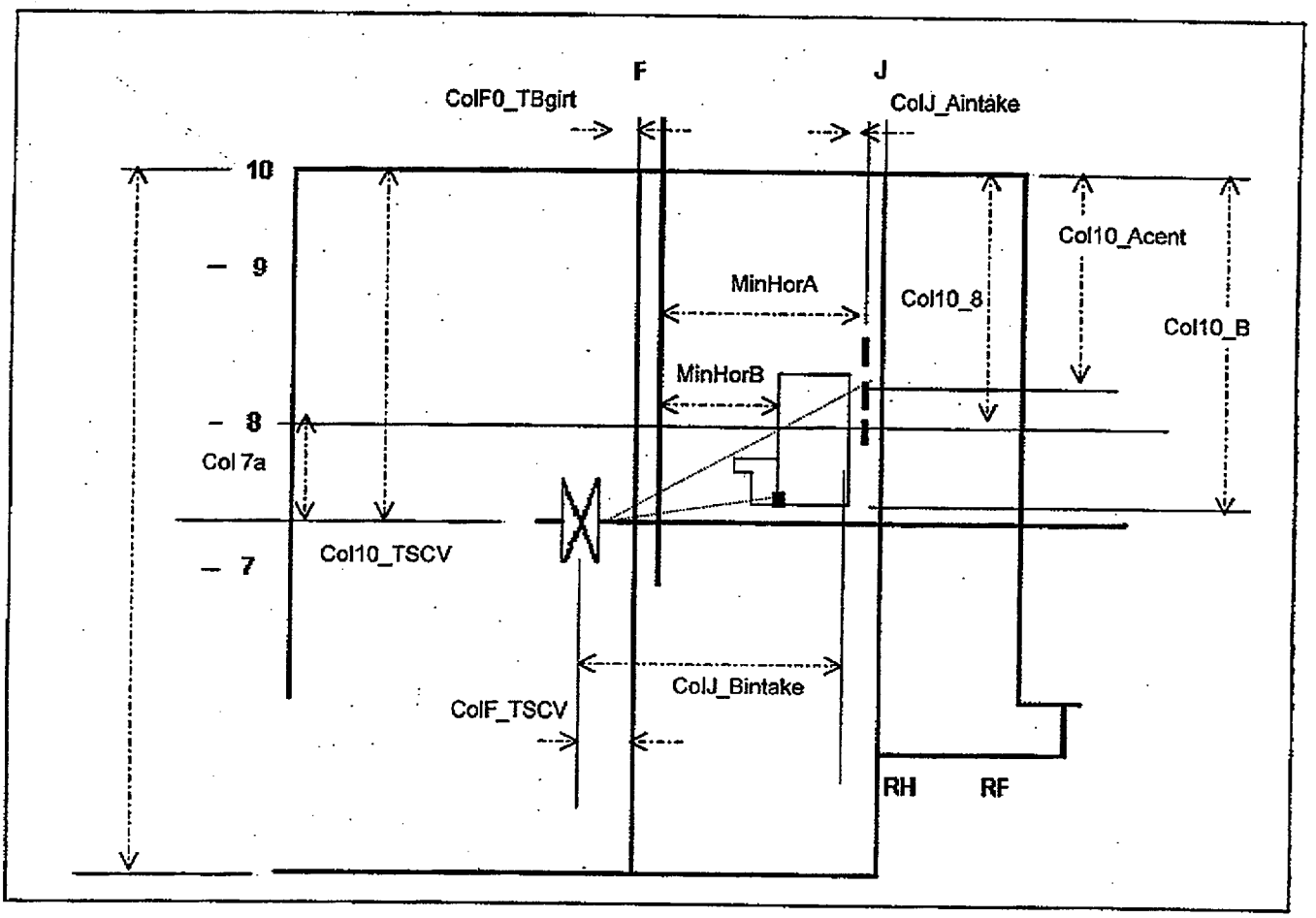

Figure 2 Principal dimensions and orientation of "A" and "B" HVAC air intakes

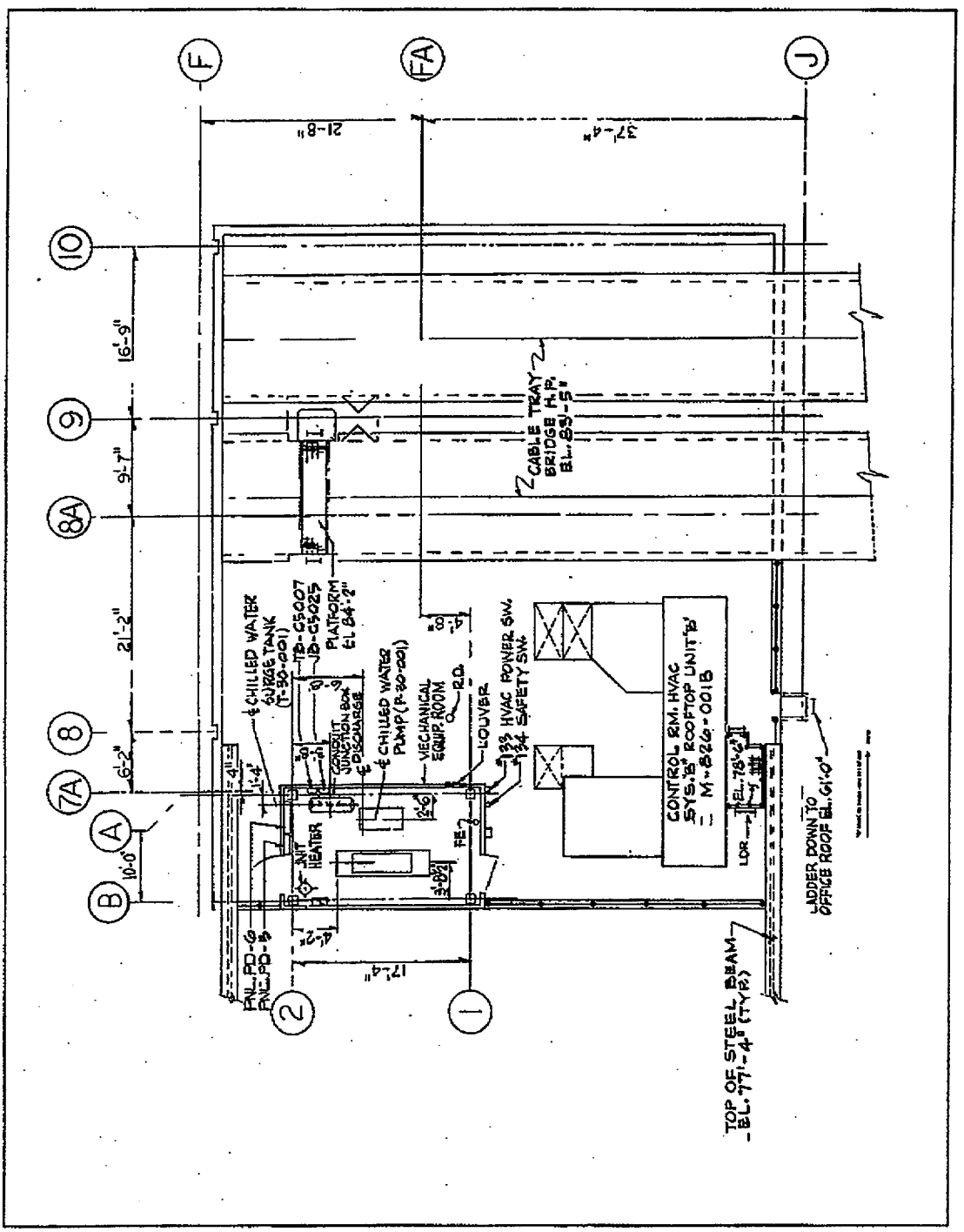

Figure 3 "B" HVAC Plan layout (see dwg 151-02-009)

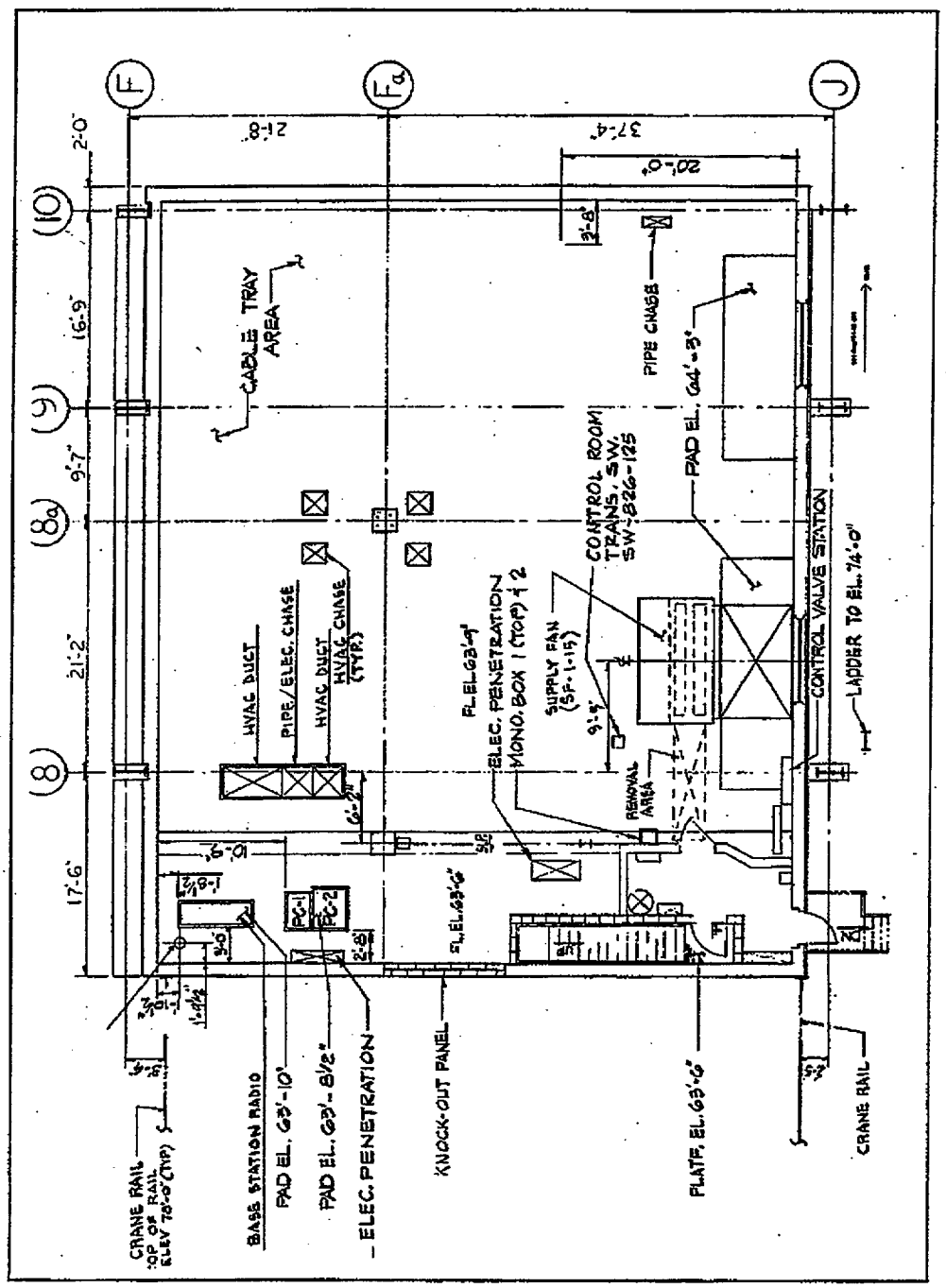

Figure 4 "A" HVAC Air Intake Plan View (see dwg 151-02-008)

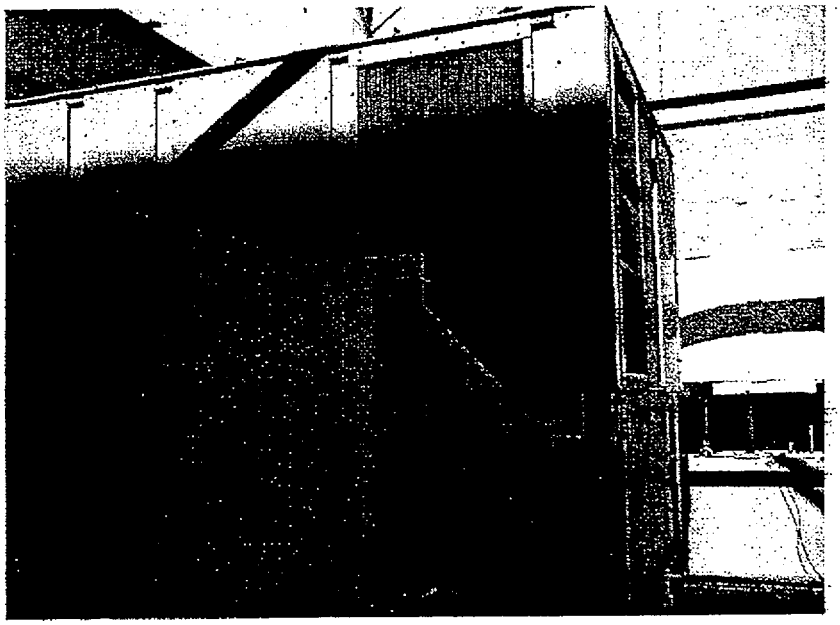

Figure 5 photograph looking east of "B" HVAC Air - southwest corner

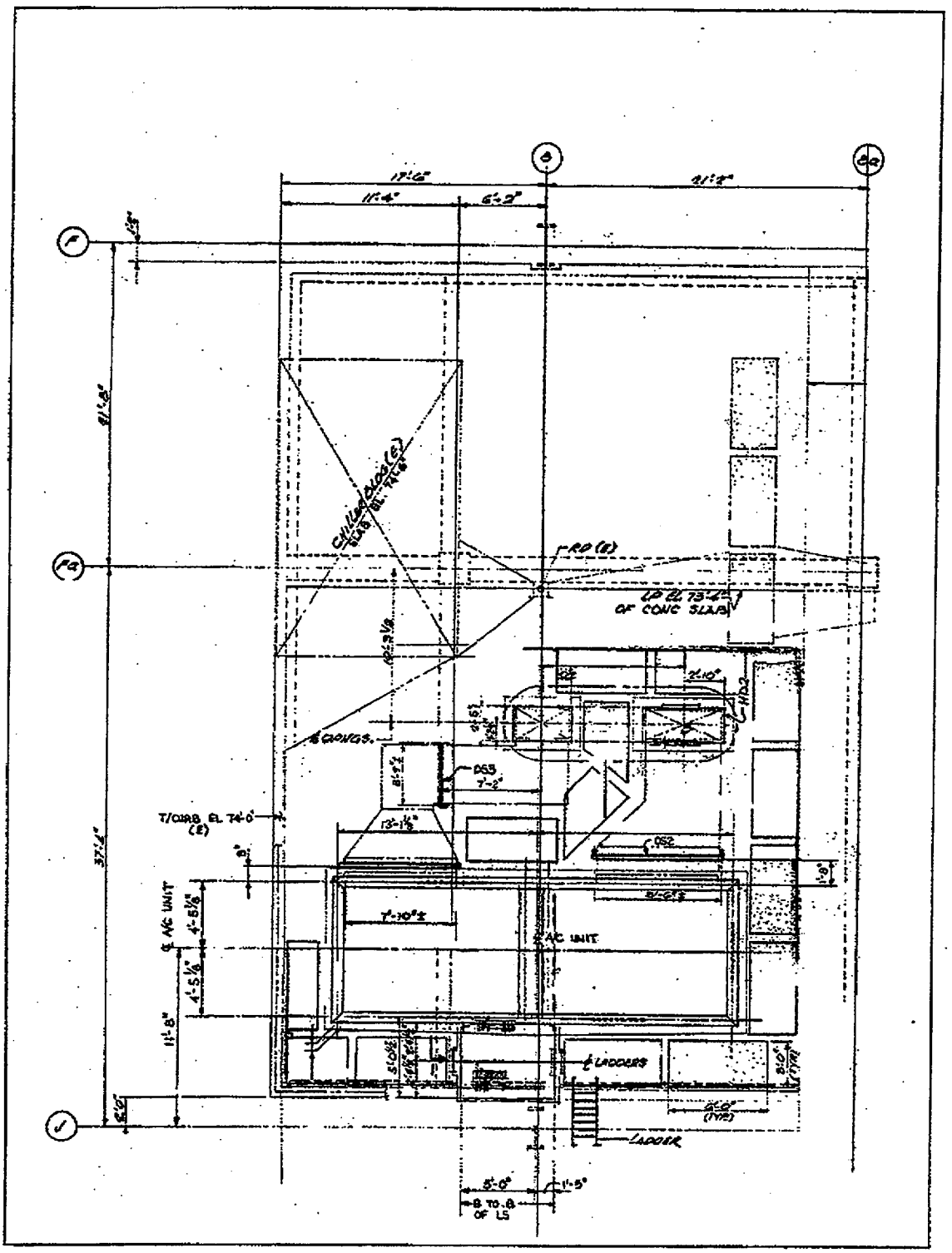

Figure 6 "A" HVAC Air Intake - structural plan view (see dwg 150050.ES-1A)

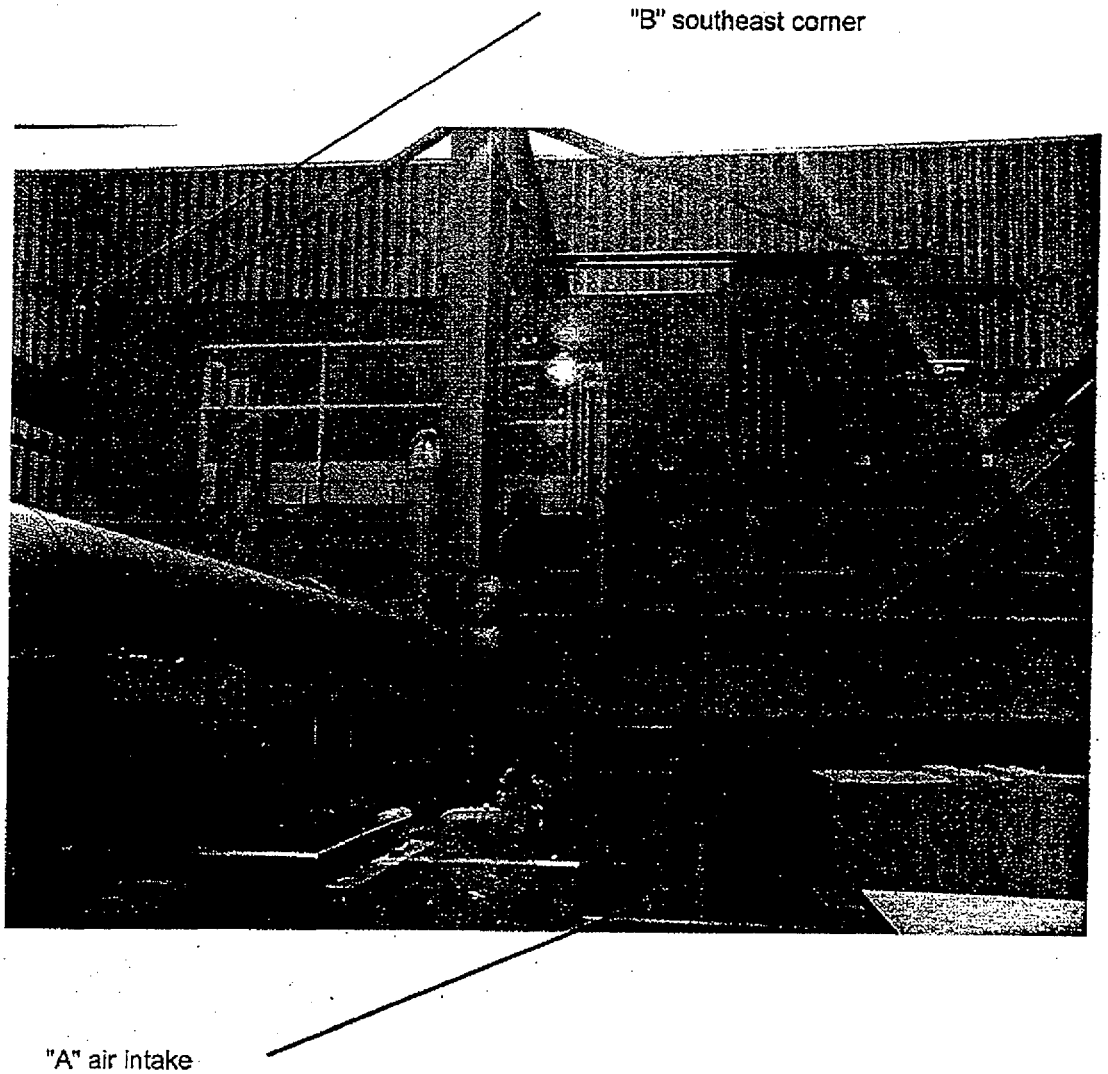

Figure 7 Photograph looking West showing "A" HVAC Air Intake and "B" southeast corner

GPU NUCLEAR	CALCULATION SHEET (Ref. EP-006)			
Subject: OC Cont. Room air intake meteorolog sing ARCON96	**Calculation No.** C-1302-826-E540-017	**Rev. No.** 0	**System Nos.** 826	**Sheet** 87

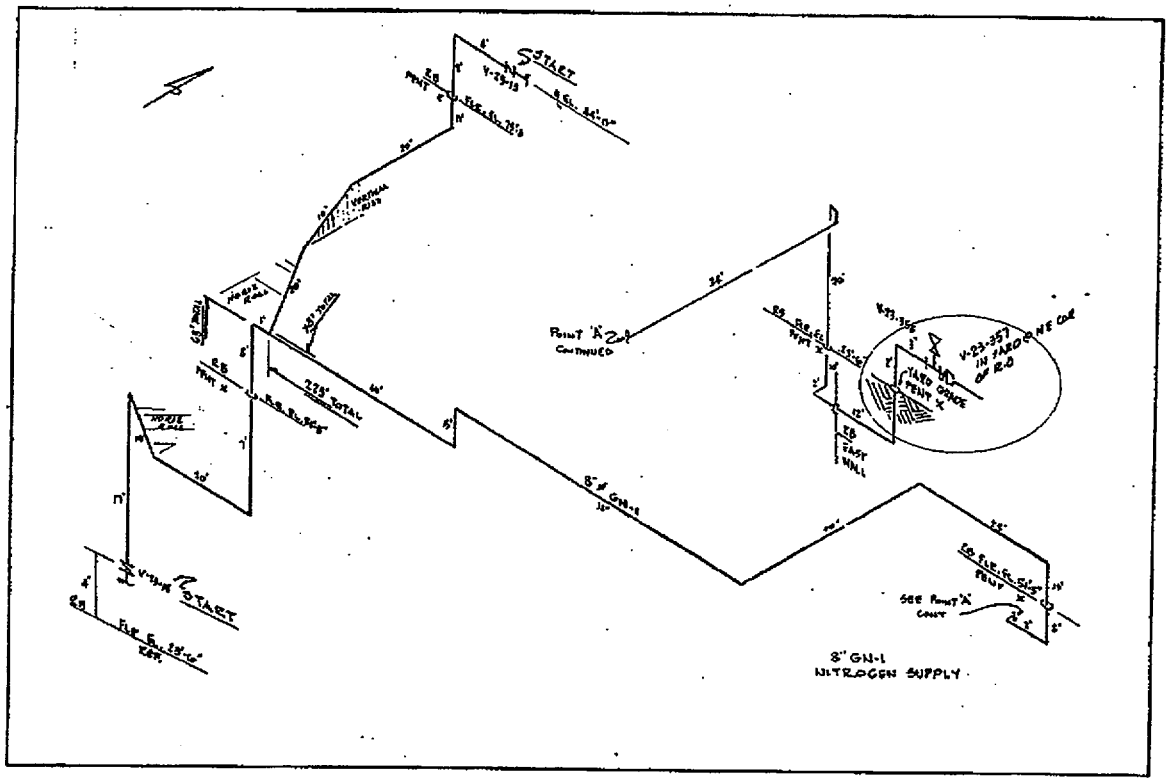

Figure 8 Field sketch of 8 inch Nitrogen supply line routing

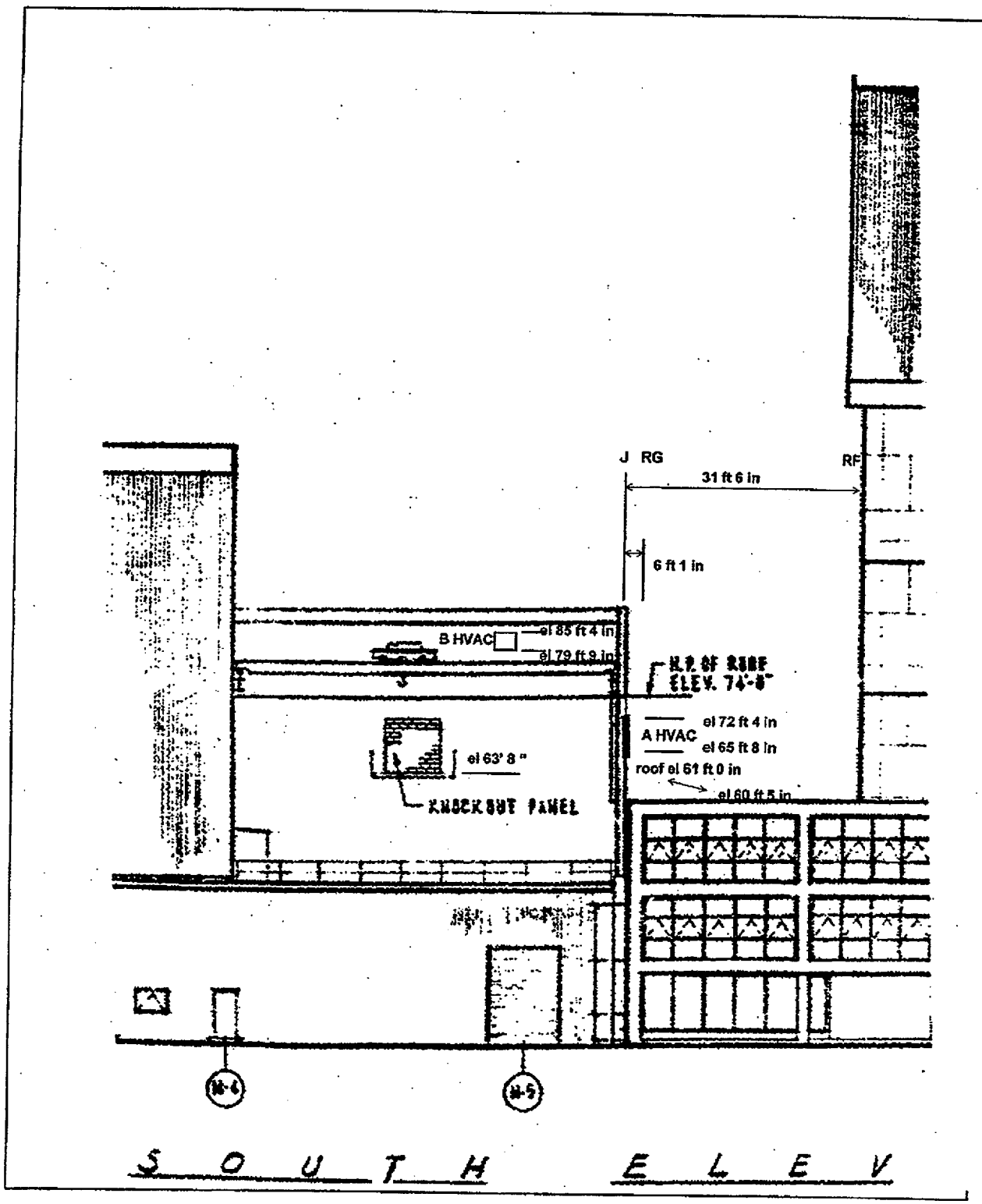

Figure 9 South elevation of site (modified from dwg BR4500-3)

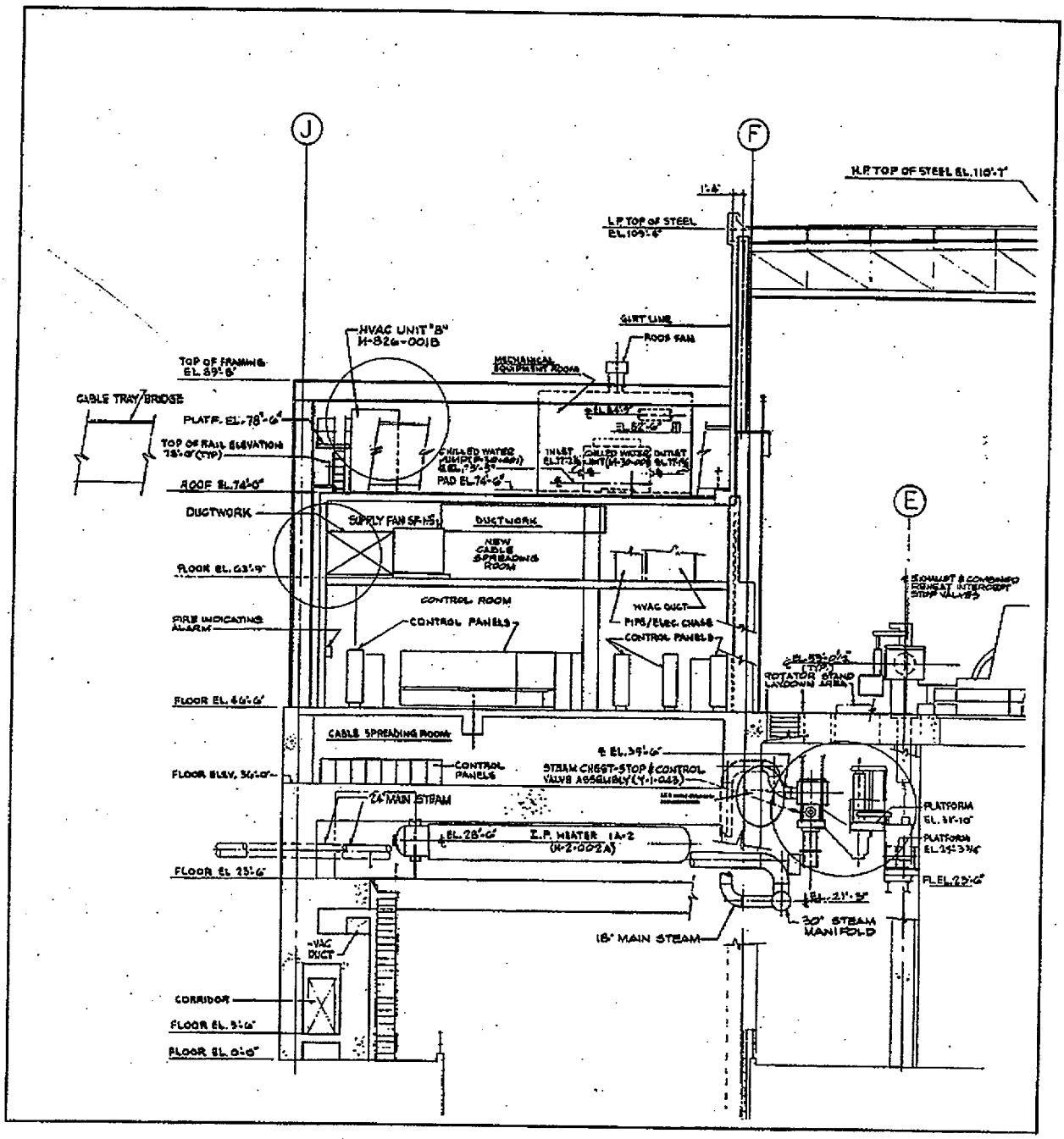

Figure 10 South elevation of site (modified from dwg 151-02-008)

GPU NUCLEAR	CALCULATION SHEET (Ref. EP-006)			
Subject: OC Control Room air intake meteorology using ARCON96	**Calculation No.** C-1302-826-E540-017	**Rev. No.** 0	**System Nos.** 826	**Sheet** 90

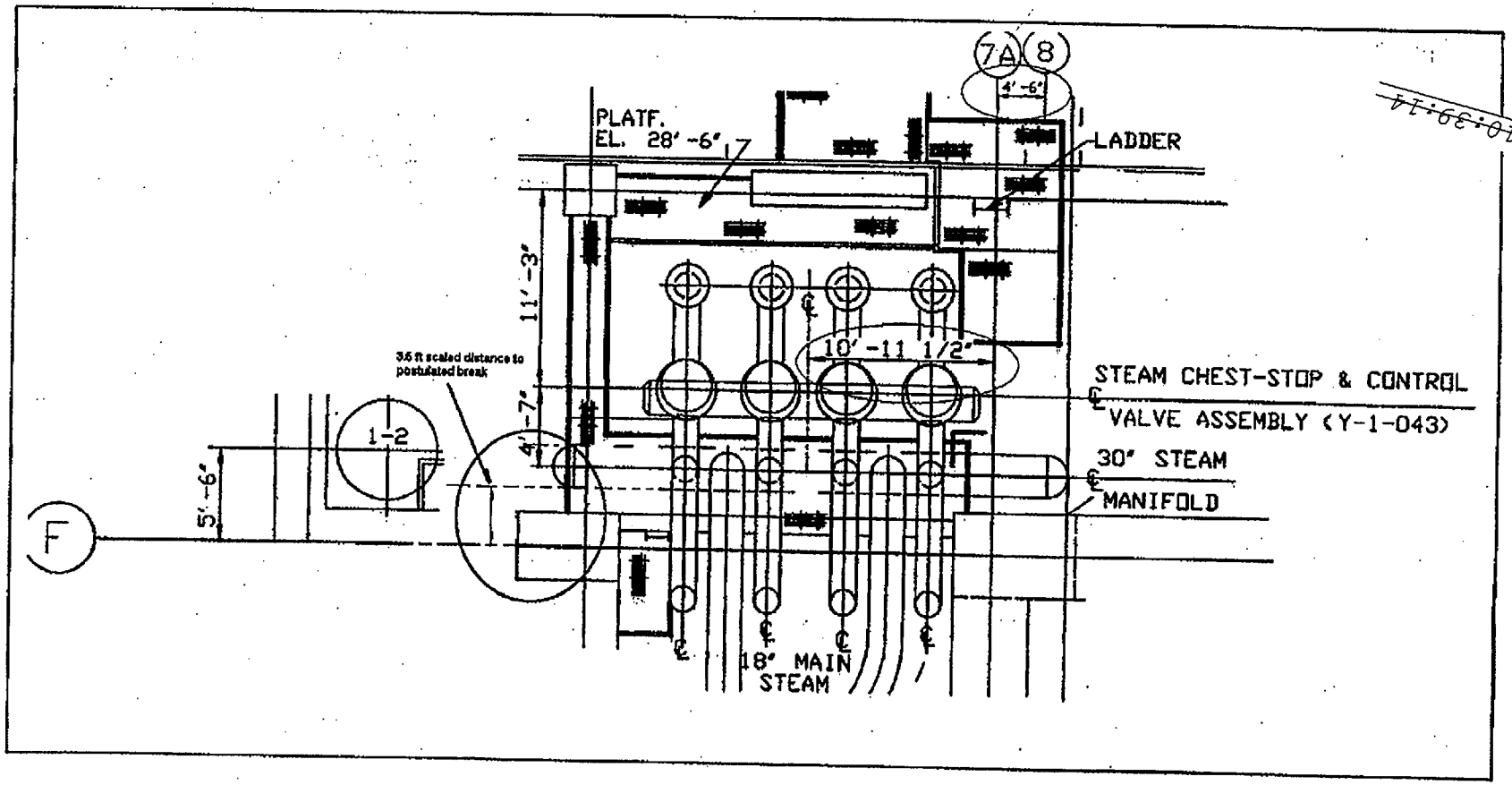

Figure 11 Location of turbine stop & control valves (composed from dwg 151-02-003)

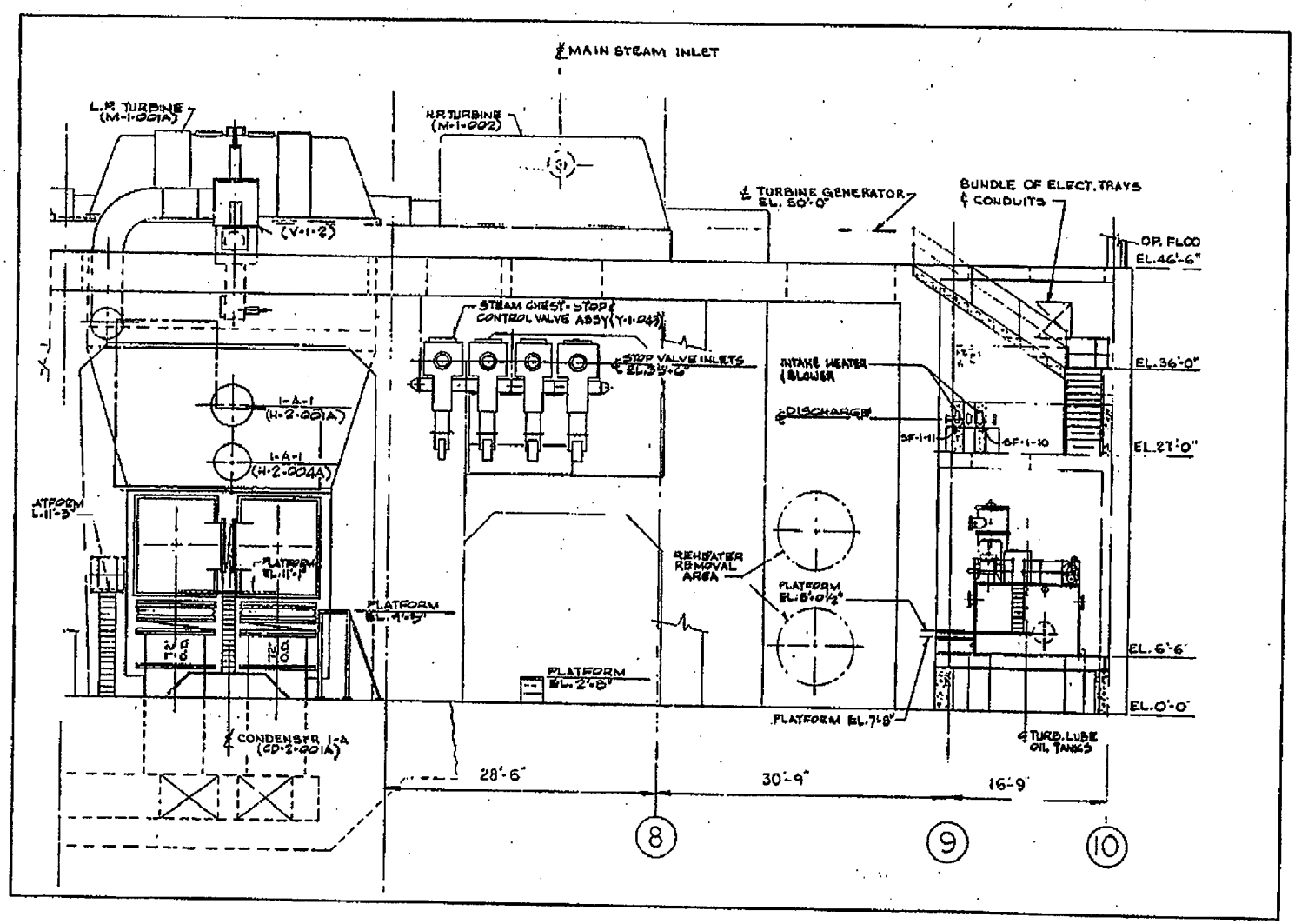

Figure 12 Location of turbine stop & control valves _Section B-B (composed from dwg 151-02-007)