SEABROOK UPDATED FSAR

APPENDIX 3A

PIPE BREAK ANALYSIS SUMMARY

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PIPE BREAK ANALYSIS SUMMARY

Introduction

This appendix summarizes the results of the failure mode and effects analyses of breaks in high and moderate energy piping systems.

Summary

Main Steam and Feedwater Pipe Tunnels and Yard

The main steam and feedwater lines are the largest high energy lines located outside Containment, and a rupture in these lines could, therefore, result in more severe environmental conditions locally than any other line outside Containment. The portions of the main steam and feedwater lines in the containment penetration area between the first pipe whip restraint inside Containment and the first pipe whip restraint outside Containment meet all of the requirements of paragraph B.1.b of MEB 3-1, and are excluded from postulation of circumferential ruptures in this area.

In accordance with Branch Technical Position ASB 3-1, paragraph B1.a.(1), longitudinal breaks of the main steam and feedwater lines have been postulated to occur in the penetration areas. A break area of 1.0 square feet has been postulated for this study.

Outside the Containment in the annulus between the containment structure and the containment enclosure, the main steam and feedwater lines are enclosed in guard pipes, composed of the containment penetration sleeves, which prevent pressurization of the Enclosure Building.

The containment penetrations have been designed to withstand without failure the maximum combination of forces and moments that can be transmitted by the attached piping, so that containment boundary integrity would be assured even without the use of pipe rupture restraints. The pipe rupture restraints are designed to prevent pipe rupture forces and moments from being applied to the containment penetrations and the isolation valves and to limit piping stresses to less than the values required by paragraph B.1.b of MEB 3-1, so that pipe ruptures between the inner and outer pipe whip restraints need not be postulated.

In the main steam and feedwater tunnels outside Containment, a maximum temperature of 325°F and pressure of 4.8 psig can be attained as a result of the postulated 1.0 square foot rupture. These P-T effects do not result in failures of any essential structure or component for the following reasons:

a. Electrical cable in the area is qualified to a temperature-time profile which envelopes the 325°F resulting from a main steam line break.

b. The main steam and feedwater valve operators are designed to close the valves in the event of loss of instrument air. In addition, the operators are qualified to the 379°F temperature, and the 4.8 psig overpressure would not affect their operation in any way.

Direct impingement of steam from a one square foot rupture of the adjacent line would result in mechanical forces and torsion which would not cause failure of the valve body or bonnet, or the attached piping. Possible failure of valve operator solenoids, limit or position switches, or instrument, power and control cables would not inactivate the valve because redundant solenoids, switches and instrument, power, and control cables are located on the far side of the valve and are protected by the valve body and operator from direct impingement from the postulated break. A failure of one main steam or feedwater line, would therefore, not result in the loss of function of the other loop.

c. The normally closed valves which control the steam flow to the emergency feedwater turbine-driven pump are qualified to IEEE 383, and would be capable of operating under the above postulated accident conditions. In addition, these valves are designed to fail open in the event of a loss of electrical power and/or instrument air, so that emergency feedwater steam is available regardless of the results of the accident. One emergency feedwater steam supply line is located in each pipe chase, so that a single failure in one chase would not affect the steam supply from the other chase.

d. A series of seven "blow-out" panels have been incorporated in the design of the upper walls near the roof line of each pipe chase. The panels are designed to blow out at a differential pressure of 0.5 psi to relieve internal pressure following a large high energy line break.

e. The seismic Category I structure housing the main steam and feedwater pipe chases was analyzed for the temperature and pressure resulting from the 1.0 square foot rupture of the main steam line. It was concluded that the structure can withstand the 325°F and 4.8 psig conditions, concurrent with SSE, without failure.

A flooding study has been performed to establish the maximum water level in the pipe chases. In accordance with BTP ASB 3-1, a one square foot longitudinal break was postulated in the main feedwater line in the east pipe chase which results in the worst case flood with regard to both flood depth and effect on essential equipment. The resulting flood reaches a level 2'-5" above the pipe chase floor. The instrument room in the east chase has been provided with watertight door and cable tray seals to preclude damage to the MSIV panels within. No other essential equipment is affected by this flood.

Outside Containment and north of the main steam and feedwater pipe chases, pipe whip restraints are located on both the main steam and the feedwater lines. These whip restraints are designed as boundary restraints to prevent any moments or torsion due to a failure in any part of the nonnuclear portions of these lines from being transmitted to the main steam or feedwater isolation valves or to the containment penetrations. The pipe whip restraints are designed to restrain the maximum forces and moments that can be transmitted by the piping without yielding. The load-bearing portions of the piping that pass through these whip restraints consist of heavy-wall forgings with integral lugs to prevent high local stresses and possible pipe wall collapse under pipe rupture loads.

Failure of the main steam lines at elevation 40'-2" could result in the impact of the main steam line on the exterior north wall of its respective pipe chase. Impact loading would cause local failure of the wall, generating missiles (spalled concrete) inside the pipe chase, jeopardizing essential main steam and feedwater isolation valves, cable trays and instrumentation. To provide protection for this essential equipment, pipe whip restraints have been provided to protect the building from damage. The whip restraints are equipped with crush pads and are mounted on a concrete beam to distribute rupture loading into nearby perpendicular walls. Postulated failures in the feedwater lines in this area do not result in unacceptable consequences.

On the east side of the Containment, the nonnuclear portions of the main steam and feedwater lines are run on elevated supports, and no other safety-related equipment is located in the area.

On the west side of the Containment, the nonnuclear portions of the main steam and feedwater lines run on elevated supports adjacent to the east wall of the Control Building. It was determined by analysis, that a split in the main steam line which runs nearest to the control building wall could cause jet impingement which might result in failure of the two-foot thick reinforced concrete wall, with formation of missiles inside the Control Building. These missiles could jeopardize the safety-related electrical trays in the southeast corner of the building, as well as the motor generator sets. To avoid this problem, this line is sleeved from the point at which it leaves the pipe whip restraints north to a point beyond which missiles would cause no problem, a distance of about sixteen feet vertically and twenty-two feet horizontally. Analysis has shown that rupture of the other high energy lines in this area would cause no unacceptable effects.

Failure of the main steam or feedwater lines on the west side of the Containment where they run along the Turbine Building could result in impact of the ruptured lines on the northeast corner of the Control Building, with the possible generation of missiles that could damage safety-related electrical trays in the Control Building. In order to prevent this effect, a pipe whip restraint bumper has been provided to prevent damage to the control building wall. This bumper is equipped with energy absorbing crush pads and beams to distribute pipe rupture loads to nearby perpendicular walls to prevent panel

fracture of the control building wall in this area in the event of a rupture of any of these high energy lines.

Guillotine ruptures inside the Turbine Building would impose blowdown forces on the manifolds in the south direction which would be resisted by the entire piping system inside the Turbine Building and, thus, no impact on the Emergency Feedwater Pumphouse is postulated.

Containment Enclosure and Penetration Area

In the containment enclosure and associated buildings (penetration area), a failure of the chemical and volume control system letdown line, CS-360-9-3" would cause the most severe environmental conditions (see Appendix 3I), but all essential equipment in this area is qualified to operate in a more severe environment, and no failures due to temperature, pressure or humidity are anticipated.

A terminal end rupture of lines CS-328-3-2", CS-329-1-2", CS-330-1-2", CS-331-1-2" or CS-335-1-3" could result in a spray of water at 130°F on nearby essential valve operators 2" CS-V-162, 2" CS-V-166, 3" CSV-142, 3" CS-V-143, 8" RH-V-20, CS-V-167, 2" CS-V-158, or 2" CS-V-154 and on rack MM-1R-12. The impingement force of the water would be insufficient to damage the valve operators or the rack. Wetting due to the water spray would not cause failure of the valve operators, but could cause a short-circuit failure of the rack's electrical connections. Since the rack does not contain any equipment required for safe shutdown of the nuclear reactor, failure of the electrical connections would be acceptable (see Table 3.6(B)-1).

Rupture of the large component cooling water lines would cause flooding of the lower levels, but pressure and flow monitors would alert the operator that a problem existed. The system inventory is limited to the contents of the piping and the head tank, so that flooding to the elevation of the essential equipment in instrument rack MM-1R-13A is not possible, even if no operator action is taken.

Rupture of the small high energy lines in the area can cause flooding, but each system is provided with pressure and flow monitoring instrumentation that would alert the operator in the event of a rupture of a line. The operator would have sufficient time to isolate the leaking line in any case.

Primary Auxiliary Building and Equipment Vaults

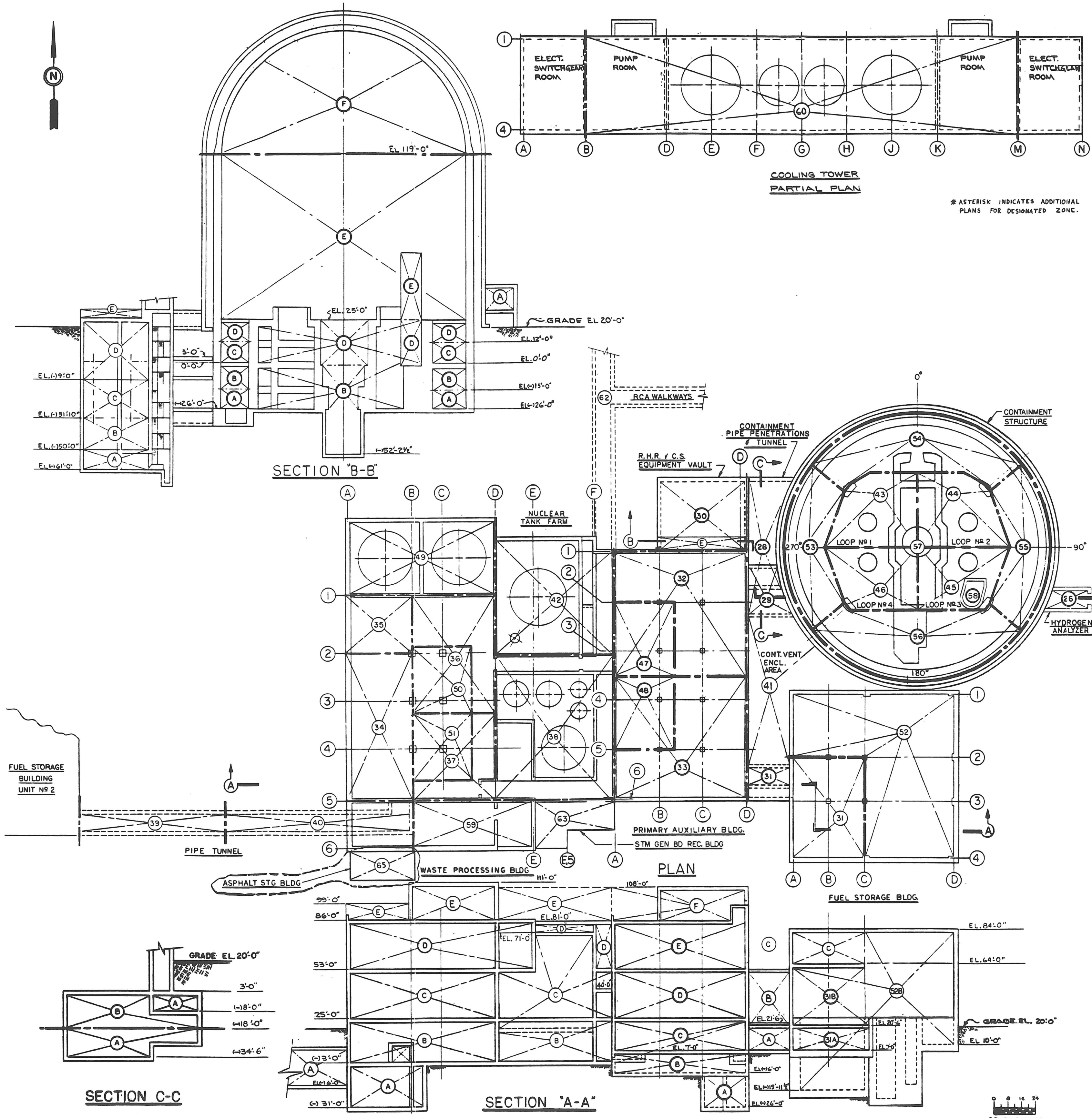
In the Primary Auxiliary Building, the worst environmental conditions would occur from a postulated rupture of the 6" auxiliary steam line break in Zone 33C, which could result in an ambient temperature of 249°F and a pressure of 0.20 psig. All electrical equipment in the PAB which is essential for safe plant shutdown is capable of performing its intended function while exposed to this environment.

Rupture of the large component cooling, reactor makeup water and containment spray lines could result in flooding of the sumps in the equipment vaults. Pressure and flow indicators in each system would alert the operator that a problem existed, so that action to isolate the ruptured line could be taken. The sump high level indicators would also alert the operator that flooding existed.

Uncorrected flooding of one equipment vault might result in loss of function of the equipment in the vault. In this case, the redundant equipment in the other vault would be available for safe plant shutdown.

Other Buildings

Rupture of the hot water heating lines in the Diesel Generator Building, Emergency Feedwater Pumphouse, Service Water Pumphouse and Control Building, would result in short-term elevations of temperature to a maximum of 127°F for 3 minutes. Relative humidity would approach 100 percent, but no flooding would occur because of the limited hot water inventory in the heating system.



- ZONE LOCATION TABLE -

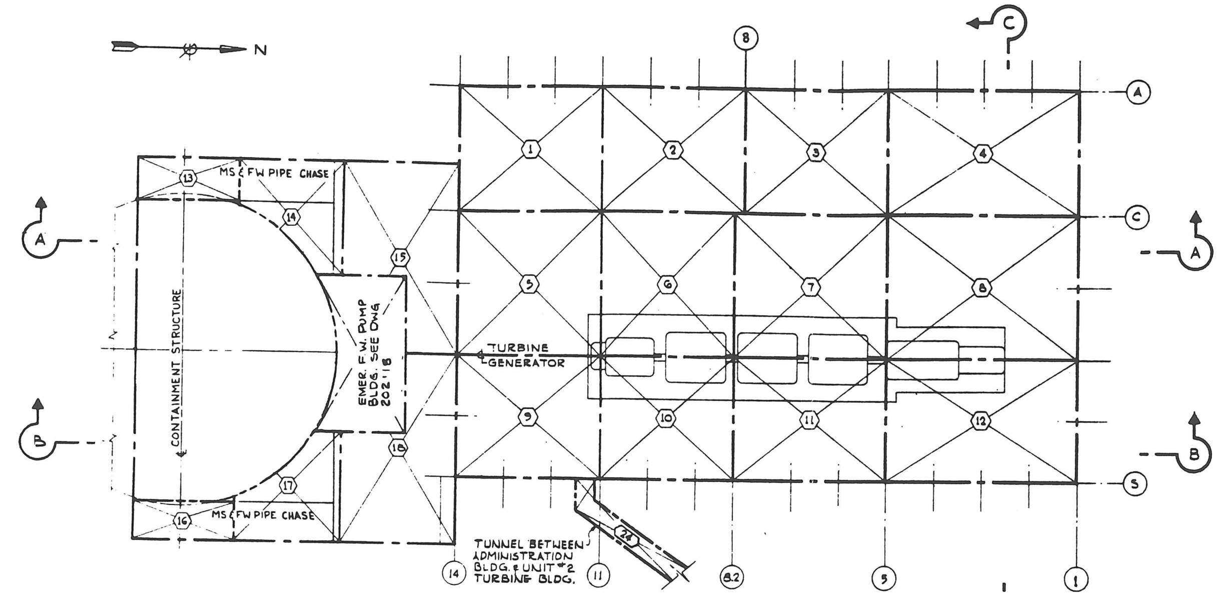
ZONE	ELEV.	DWG. NO.	REMARKS
26A		805175	
28A	(-)34'-6"	805150	805151, 805154
28B	(-)18'-0"	805150	805151, 805154
28B&29A	(-)8'-0"	805152	805154, 805151
30B	(-)50'-0"	805201	805204, 805205, 805206, 805207
30A	(-)61'-0"	805200	805204, 805205, 805206, 805207
31A	7'-0"	815304	UNIT 1 ONLY 815311, 805306
31B	21'-6"	815304	815311
32A	(-)26'-0"	805219	805220
32B	(-)6'-0"	805211	805222
32C	7'-0"	805213	805223, 805224, 80524, 805251 (IA & SA)
32D	25'-0"	805215	805227, 805228, 805252 (IA & SA)
32E	53'-0"	805217	805231, 805210, 805253 (IA & SA)
35E	86-0	805704	
33C	7'-0"	815214	UNIT 1 ONLY 815225, 815226, 805367, *805221, 805251 (IA & SA)
33D	25'-0"	805216	805229, 805230, *805138, 805567, 805249
33E	53'-0"	805218	805232
34A	(-)31'-0"	805674	*805756, 805696, 805697, 805698, 805794
34B	(-)3'-0	805675	*805757, 805699, 805700, 805701, 805795
34C	25'-0"	805676	805702, 805703, 805796,
34D	53'-0"	805716	805738 805742 805745, 805797
35B	(-)3'-0"	805678	805708, 805709, 805710, 805795
35C	25'-0"	805679	805708, 805709, 805796, 805712
35D	53'-0"	805680	805714, 805715, 805797
36B	(-)3'-0"	805681	805717, 805718, 805719, 805709, 805795, 805764
36C	25'-0"	805682	805717, 805720, 805721, 805709, 805713, 805718, 805796
36D	53'-0"	805683	*805761, 805723, 805724, 805725, 805797
37B	(-)3'-0"	805684	805726, 805727, 805729, 805795
37C	25'-0"	805685	805673, 805796
37D	53'-0"	805686	805732, 805733, 805734, 805797
38B	(-)3'-0"	815361	UNIT 1 ONLY 815366, 815364, 815368, 815369, 815359
38C	20'-0"	815361	UNIT 1 ONLY 815364, 815366, 815368, 815359, 815369, 815259
38C	20'-0"	825361	UNIT 2 ONLY
39A	(-)6'-0"	805671	UNIT 2 ONLY 805761
40A	(-)6'-0"	825671	UNIT 2 ONLY 805761
41B	21'-6"	805270	805271, 805255, 805248
30D	25'-6"	805245	
42D	53'-0"	805365	805362, 805363, 805583
42C	20'-0"	805360	805362, 805363, 805583, *805365, 815259
43D	0'	805140	805160
42B	(-)6'-0"	805365	805362, 805363, 805357
44D	0'	805141	805161
37A	(-)31-0"	805728	805731, 805760
45D	0'	805142	805162
38C	25&43'	805673	805688, 805736
46D	0'	805143	805163
42E	86-0"	805707	805722, 805735
47B	(-)6'-0"	805243	,805239, 805241, 805242, *805136
47C	7'-0"	805235	,805239, 805241, 805242, *805136
48B	2'-0"	805244	805240, 805242, 805238 *805136
48C	7'-0"	805236	805240, 805242, 805238 *805136
49B&C	(-)3'-0"	805689	805741, 805744
50B	23'-0"	805691	*805758, 805747, 805748, *805749, 805750, 805795, 805746
51B	23'-0"	805692	*805759, 805747, 805748, 805750, 805749, 805795
49D	53'-0"	805730	
52B	25'-0"	805305	805306
53A	-26	805101	805375
53B	-15'-0"	805097	
53C	-0'-0"	805106	805126, 805119
53D	12'-0"	805093	
52B	2'-0"	825304	825310
54A	-26'-0"	805102	805375
54B	-15'-0"	805098	
54C	0'-0"	805107	
54D	12'-0"	805094	
52C	64'-0"	805307	
55A	-26	805103	805149, 805375
55B	-15	805099	
55C	0'-0"	805108	805126
55D	12'-0"	805095	
56A	-26'	805104	805091, 805375
56B	-15'	805100	
56C	0'-0"	805109	805126
56D	12'	805096	
30C	(-)22'-0" (-)31'-10"	805202	805204, 805205, 805206, 805207
30D	(-)9'-0"	805203	805204, 805205, 805206, 805207
57E	25'-0"	805115	805147, 805169
57F	119'-0"	805146	805147, 805169
58D	0'-0"	805134	
58E	25'-0"	805135	805164
59D	53'-0"	805693	805753, 805754, 805755
60A	+46'-0"	805900	
59D	61&65'-9"	805694	805755
31A	7'-0"	825304	UNIT 2 ONLY 805306, 825311, 825310
59D	75'-4"	805695,	805755
59E	86'-0"	805766	
33C	7'-0"	825214	UNIT 2 ONLY 805367, 825225, 825226, 805221
37A	(-)31'-0"	805760	805731, 805728
43B	-26	805120	805130, 805144, 805133, 805375
44B	-26	805121	805131, 805144, 805133, 805375
45B	-26	805122	805132, 805145, 805148, 805149, 805375
46B	-26	805123	805168, 805145, 805148, 805375
31C	64'-0"	805307	
33F	81'-0"	805212	805248
32F	81'-0"	604118	PIPING BY MECH. SERVICES* 805212, 805248
36E	86'-0"	604502	PIPING BY MECH. SERVICES
62		614125	UNIT 1 PIPING BY MECH. SERVICES
62&64		624254	UNIT 2 PIPING BY MECH. SERVICES
43B	(-)26'-0"	805144	R.C. PUMPS ONLY
44B	(-)26'-0"	805144	R.C. PUMPS ONLY
45B	(-)26'-0"	805145	R.C. PUMPS ONLY
46B	(-)26'-0"	805145	R.C. PUMPS ONLY
31C	64'-0"	604136	PIPING BY MECH. SERVICES
52C	64'-0"	604136	PIPING BY MECH SERVICES
63B	14'-9"	805739	805771
63C	25 & 48'-0"	805740	805773, 805774
36&37E	86'-0"	805799	
59C	25'-0"	805886	805887
30E	25'-6"	805245	(NITROGEN STORAGE AREA)
38D&E	71'-0"	805722	805735
41C	53'-0"	805212	805248
28B&29A	(-)5'-0"	805152	805151, 805154
35&36E	81'-0"	805707	
65C	20'-0"	805742	

SEABROOK STATION UPDATED
FINAL SAFETY ANALYSIS REPORT

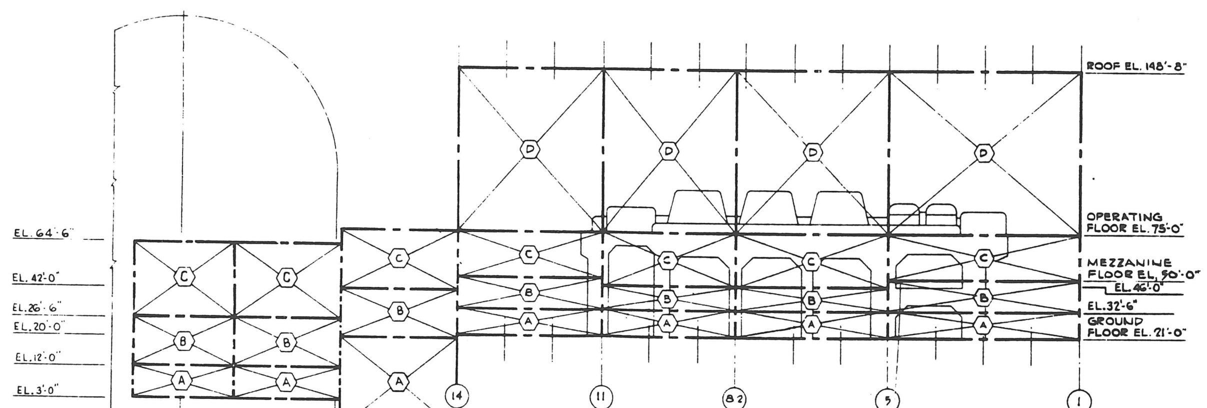
Composite Piping Zones (Nuclear) Key Plan

805067

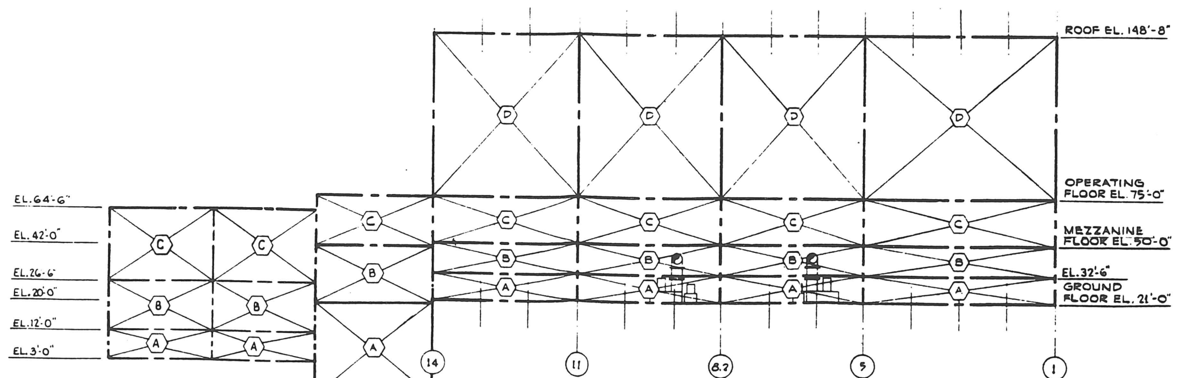
FIGURE 3A-1



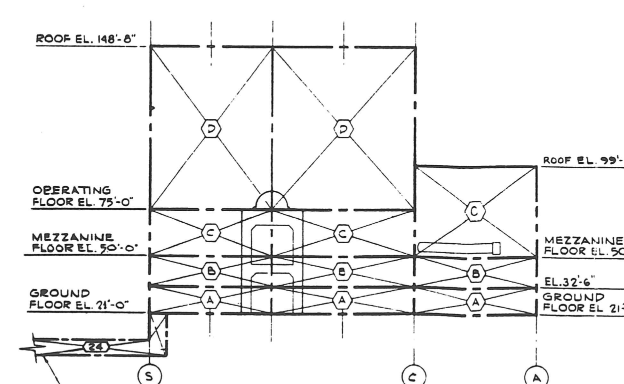
TURBINE BUILDING PLAN



SECTION "B-B"
LOOKING WEST



SECTION "A-A"
LOOKING WEST



SECTION "C-C"
LOOKING SOUTH

ZONE LOCATIONS TURBINE BUILDING

ZONE	ELEVATION	DWG. Nº
1A	EL. 21'-0"	F-202119
1B	EL. 32'-6"	F-202131
1C	EL. 50'-0"	F-202143
—	—	—
2A	EL. 21'-0"	F-202120
2B	EL. 32'-6"	F-202132
2C	EL. 50'-0"	F-202144
—	—	—
3A	EL. 21'-0"	F-202121
3B	EL. 32'-6"	F-202133
3C	EL. 50'-0"	F-202145
—	—	—
4A	EL. 21'-0"	F-202122
4B	EL. 32'-6"	F-202134
4C	EL. 50'-0"	F-202146
—	—	—
5A	EL. 21'-0"	F-202123
5B	EL. 32'-6"	F-202135
5C	EL. 50'-0"	F-202147
5D	EL. 75'-0"	F-202155
6A	EL. 21'-0"	F-202124
6B	EL. 32'-6"	F-202136
6C	EL. 50'-0"	F-202148
6D	EL. 75'-0"	F-202156
7A	EL. 21'-0"	F-202125
7B	EL. 32'-6"	F-202137
7C	EL. 50'-0"	F-202149
7D	EL. 75'-0"	F-202157
8A	EL. 21'-0"	F-202126
8B	EL. 32'-6"	F-202138
8C	EL. 50'-0"	F-202150
8D	EL. 75'-0"	F-202158
9A	EL. 21'-0"	F-202127
9B	EL. 32'-6"	F-202139
9C	EL. 50'-0"	F-202151
9D	EL. 75'-0"	F-202159
10A	EL. 21'-0"	F-202128
10B	EL. 32'-6"	F-202140
10C	EL. 46'-0"	F-202152
10D	EL. 75'-0"	F-202160
11A	EL. 21'-0"	F-202129
11B	EL. 32'-6"	F-202141
11C	EL. 46'-0"	F-202153
11D	EL. 75'-0"	F-202161
12A	EL. 21'-0"	F-202130
12B	EL. 32'-6"	F-202142
12C	EL. 46'-0"	F-202154
12D	EL. 75'-0"	F-202162
24	EL.(-)11'-0"	F-222436

ZONE LOCATIONS MS & FW PIPE CHASE

ZONE	ELEVATION	DWG. Nº
13A	EL. 3'-0"	F-202236
13B	EL. 12'-0"	F-202242
13C	EL. 26'-6"	F-202255
14A	EL. 3'-0"	F-202237
14B	EL 12'-0"	F-202243
14C	EL. 26'-6"	F-202255
15A	EL. -26'-0"	F-604100
15B	EL. 20'-0"	F-202238
15C	EL. 42'-0"	F-202244
16A	EL. 3'-0"	F-202239
16B	EL. 12'-0"	F-202245
16C	EL. 26'-6"	F-202256
17A	EL. 3'-0"	F-202240
17B	EL. 12'-0"	F-202246
17C	EL. 26'-6"	F-202256
18A	EL. -26'-0"	F-604100
18B	EL. 20'-0"	F-202241
18C	EL. 42'-0"	F-202247

MAJOR SYSTEM LOCATIONS TURBINE BUILDING

SYSTEM	ZONE
MAIN STEAM	5B, 6B, 7B, 9B, 5C, 6C, 7C, 10C, 11C, 6D, 7D, 10D 11D
CONDENSATE	6A, 7A, 8A, 2B, 3B, 4B, 6B, 7B, 8B, 10B, 11B, 12B, 2C, 3C, 4C, 6C, 7C, 8C, 10C, 11C, 12C
FEEDWATER	6A, 7A, 2B, 3B, 5B, 6B, 7B, 8B, 9B, 2C, 3C, 6C, 7C, 8C
EXTRACTION STEAM	3B, 4B, 6B, 7B, 8B, 2C, 3C, 4C, 6C, 7C, 8C, 10C, 11C
MOISTURE SEPARATOR -REHEATER DRAINS	6A, 7A, 10A, 11A, 6B, 7B, 10B, 11B, 2C, 3C, 6C, 7C, 8C, 10C, 11C
HEATER DRAINS	1A, 2A, 5A, 6A, 7A, 1B, 2B, 3B, 4B, 5B, 6B, 7B, 8B, 10B, 11B, 12B, 2C, 3C, 4C, 10C, 11C
CONDENSER AIR EVACUATION	2A, 3A, 6A, 7A, 10A, 11A, 2B, 3B, 6B, 7B, 10B, 11B, 2C, 3C, 6C, 7C

SYSTEM DRAWINGS

DWG. Nº	DESCRIPTION
9763-F-202287	TURBINE & H.P. DRAINS
9763-F-202290	MISC. VENTS & DRAINS
9763-F-202293	COMPRESSED AIR - TURB. BLDG.
9763-F-202301	MAIN STEAM ISOMETRIC
9763-F-202302	MAIN STEAM ISOMETRIC
9763-F-202303	MAIN STEAM ISOMETRIC
9763-F-202304	MAIN STEAM ISOMETRIC
9763-F-202328	MAIN STEAM ISOMETRIC
9763-F-202329	MAIN STEAM ISOMETRIC
9763-F-202291	HTR. MISC. VENTS & DRAINS
9763-F-212285	AS & ASC TO C.B. & PAB. UNIT #1 ONLY
9763-F-212300	DEMINERALIZED WATER (UNIT NO.1)
9763-F-222450	DEMINERALIZED WATER (UNIT NO.2)

REFERENCE SPECS:

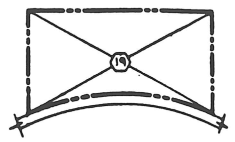
9763-006-248-1 SPECIFICATION FOR THE FABRICATION OF SHOP FABRICATED PIPE
9763-006-248-51 SPECIFICATION FOR THE ASSEMBLY & ERECTION OF PIPING
9763-006-248-8 SPECIFICATION FOR PIPE SUPPORT EQUIPMENT
9763-006-248-43 SPECIFICATION FOR NUCLEAR POWER PLANT SYSTEMS
9763-006-263-2 SPECIFICATION FOR MECH. EQUIPT ERECTION

REFERENCE DWGS:

F-202052 TURBINE BLDG. GEN'L ARRGT. PLAN - EL. 21'-0"
F-202053 PLAN - EL. 46'-0" & 50'-0"
F-202054 PLAN - EL. 75'-0"
F-202055 SECTION "A-A"
F-202056 SECTION "B-B"
F-202057 SECTION "C-C"
F-202058 SECTION "D-D"
F-202059 SECTION "E-E"
F-202060 SECTION "F-F"
F-202065 EMERGENCY FEED PUMP BLDG. GEN'L ARRGT.
S-202400 HTR BAY COMPOSITE EL. 21'-0"
S-202401 WEST BAY EL. 21'-0"
S-202402 EAST BAY EL. 21'-0"
S-202403 HTR BAY EL. 32'-6"
S-202404 WEST BAY EL. 32'-6"
S-202405 EAST BAY EL. 32'-6"
S-202406 HTR BAY EL. 50'-0"
S-202407 WEST BAY EL. 50'-0"
S-202408 EAST BAY EL. 50'-0"
S-202409 WEST BAY EL. 75'-0"
S-202410 EAST BAY EL. 75'-0"
S-202411 FPT ROOM
S-202412 FPT ROOM
F-202118 AUX. BLDGS. ZONE KEY PLAN

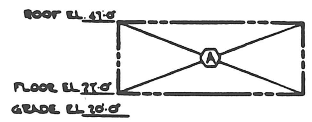
P&I DIAG
F-202074 MAIN STEAM - SH.1
F-202075 MAIN STEAM - SH.2
F-202077 CONDENSATE - SH.1
F-202078 CONDENSATE - SH.2
F-202079 FEEDWATER
F-202080 EXTRACTION STEAM
F-202081 MOIST SEP REH DRAINS & VENTS
F-202082 HEATER DRAINS - SH.1
F-202083 HEATER DRAINS - SH.2
F-202084 HEATER MISC VENTS & DRAINS - SH.1
F-202085 HEATER MISC VENTS & DRAINS - SH.2
F-202086 MAIN TURB & STEAM PIPING
F-202087 FPT & MISC STEAM PIPING
F-202093 CONDENSER AIR EVACUATION
F-202094 SEC COMP COOLING WATER - SH.1
F-202095 SEC COMP COOLING WATER - SH.2
F-202104 LUBE OIL TRANSFER & CONDITIONING
F-202105 COMPRESSED AIR SYS KEY PLAN
F-202106 COMPRESSED AIR
F-202107 TURB BLDG COMPRESSED AIR HEADERS
F-202116 HEAT BALANCE
F-202063 MS & FW PIPE CHASE GEN'L ARRGT. - PLAN
F-202064 MS & FW PIPE CHASE GEN'L ARRGT. - SECTIONS
F-202610 " " " " " COMPOSITE WEST CHASE EL. 3'-0" & 12'-0"
F-202611 " " " " " 27'-6" & 64'-6"
F-202612 " " " " " EAST 12'-0" & 27'-6"
F-202613 " " " " " 3'-0"
F-202614 " " " " " - SECTIONS.
F-202076 EMERGENCY FEEDWATER SYS. P&I DIAG
F-202088 MISC. EQUIP. VENTS & DRAINS P&I DIAG
F-202089 CONDENSATE CLEANING & CHEM. FEED SYS. P&I DIAG

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Turbine Building Zone Key Plan Piping	
	202117	FIGURE 3A-2

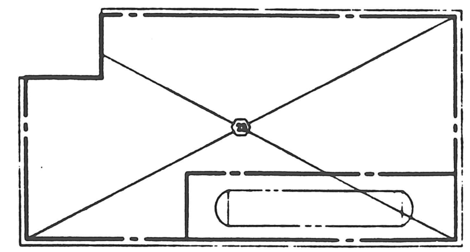


ZONE PLAN
EMERGENCY FEED PUMP BLDG.

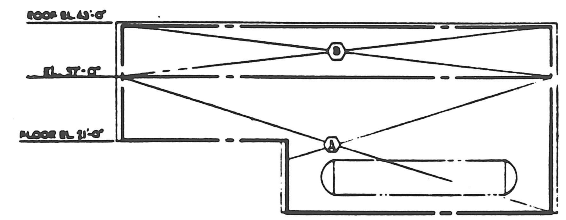
EMERGENCY FEED PUMP BLDG. ZONE LOCATIONS		
ZONE	ELEV.	DWG. NO
19A	27'-0"	F-202296



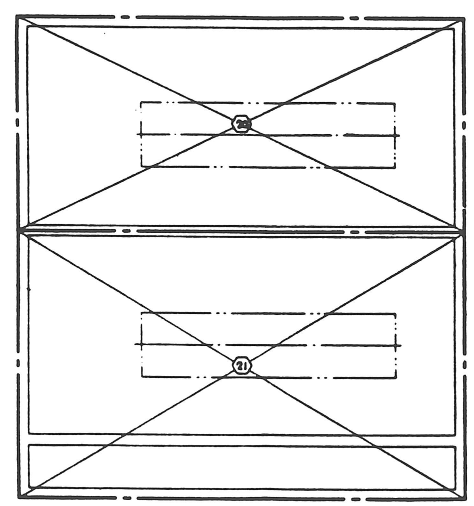
ELEVATION VIEW
EMERGENCY FEED PUMP BLDG.



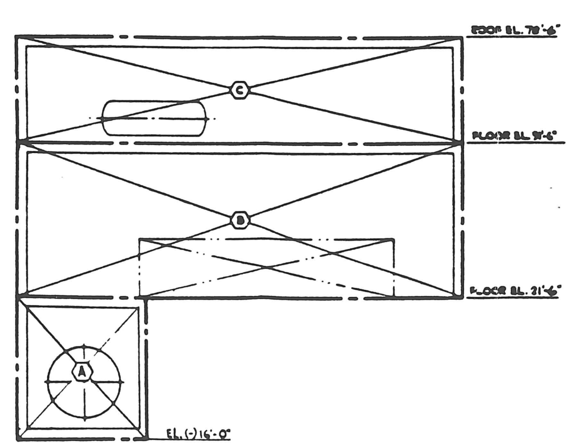
ZONE PLAN
WATER TREATMENT ROOM



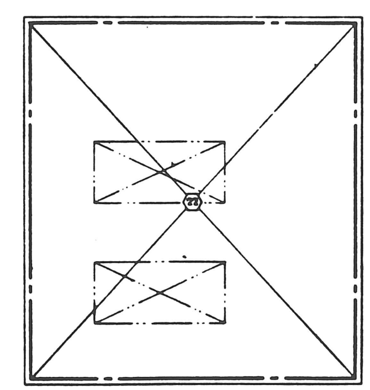
ELEVATION VIEW
WATER TREATMENT ROOM



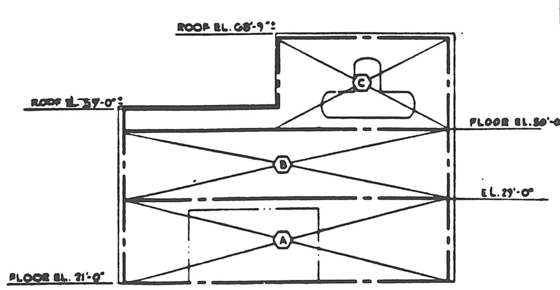
ZONE PLAN
DIESEL GENERATOR BLDG.



ELEVATION VIEW
DIESEL GENERATOR BLDG.



ZONE PLAN
AUX. BOILER ROOM



ELEVATION VIEW
AUX. BOILER ROOM

WATER TREATMENT ROOM ZONE LOCATIONS		
ZONE	ELEVATION	DWG. Nº
23A	EL. 21'-0"	F-212276
23B	EL. 37'-0"	F-212277

DIESEL GENERATOR BLDG. ZONE LOCATIONS		
ZONE	ELEVATION	DWG. Nº
20A	EL.(-)16'-0"	F-202264
20B	EL. 21'-6"	F-202266
20C	EL. 51'-6"	F-202268
21A	EL.(-)16'-0"	F-202265
21B	EL. 21'-6"	F-202267
21C	EL. 51'-6"	F-202269

AUX. BOILER ROOM ZONE LOCATIONS		
ZONE	ELEVATION	DWG. Nº
22A	EL. 21'-0"	F-212258
22B	EL. 29'-0"	F-212259
22C	EL. 50'-0"	F-212263

ADMIN. & SERVICE BUILDING STOREROOM AREA ZONE LOCATIONS		
ZONE	ELEVATION	DWG. Nº
25A	21'-0"	F-212280

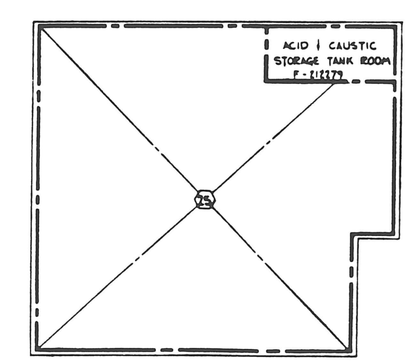
SYSTEM DRAWINGS	
DWG. Nº	DESCRIPTION
9763-F-212282	AUX. BLR. STEAM SAFETY VALVES
9763-F-212285	WATER TREATING SYSTEMS
9763-F-202354	DIESEL GEN. FUEL OIL ISOMETRIC
9763-F-202355	DIESEL GEN. FUEL OIL ISOMETRIC
9763-F-202356	DIESEL GEN. FUEL OIL ISOMETRIC
9763-F-202357	DIESEL GEN. FUEL OIL ISOMETRIC
9763-F-202358	DG STARTING AIR ISOMETRIC
9763-F-202359	DIESEL GEN. EXHAUST ISOMETRIC
9763-F-202420	DG COOLING WATER ISOMETRIC
9763-F-202421	DG COOLING WATER ISOMETRIC
9763-F-202422	DG COOLING WATER ISOMETRIC
9763-F-202423	DG STARTING AIR ISOMETRIC
9763-F-202424	DG STARTING AIR ISOMETRIC
9763-F-202360	EMERGENCY FW ISOMETRIC
9763-F-202361	EMERGENCY FW ISOMETRIC
9763-F-202426	EMERGENCY FW ISOMETRIC
9763-F-202426	EMERGENCY F.W. ISOMETRIC
9763-F-202427	EMERGENCY F.W ISOMETRIC
9763-F-202428	EMERGENCY F.W. ISOMETRIC
9763-F-202429	EMERGENCY F.W. ISOMETRIC
9763-F-212279	ACID & CAUSTIC STORAGE TANK ROOM

REFERENCE SPECS:

9763-006-248-1	SPECIFICATION FOR THE FABRICATION OF SHOP FABRICATED PIPE.
9763-006-248-51	SPECIFICATION FOR THE ASSEMBLY & ERECTION OF PIPING
9763-006-248-8	SPECIFICATION FOR PIPE SUPPORT EQUIPMENT.
9763-006-248-43	SPECIFICATION FOR NUCLEAR POWER PLANT SYSTEMS
9763-006-263-2	SPECIFICATION FOR MECH. EQUIPT. ERECTION
9763-006-248-2	SPECIFICATION FOR FABRICATION OF CEMENT LINED PIPE & NON-FERROUS PIPE

REFERENCE DRAWINGS:

202066	EMERGENCY FEED PUMP BLDG - GEN'L ARRG'T.
202068	DIESEL GEN BLDG. PLANS & SECTIONS BELOW GRADE GENERAL ARRANGEMENT
202069	DIESEL GEN. BLDG. PLANS ABOVE GRADE GENERAL ARRANGEMENT
202070	DIESEL GEN. BLDG. SECTIONS ABOVE GRADE GENERAL ARRANGEMENT
212066	AUXILIARY BOILER ROOM PLANS GENERAL ARRANGEMENT
212067	AUXILIARY BOILER ROOM SECTIONS GENERAL ARRANGEMENT
212071	WATER TREATMENT ROOM PLAN GENERAL ARRANGEMENT
212072	WATER TREATMENT ROOM SECTIONS GENERAL ARRANGEMENT
202098	AUXILIARY BOILER SYSTEMS P&I DIAGRAM
202099	AUXILIARY BOILER SYSTEMS P&I DIAGRAM
202100	AUXILIARY BOILER STEAM, CONDENSATE RETURN KEY PLAN P&I DIAGRAM
202101	DIESEL GEN. AIR SYSTEMS P&I DIAGRAM
202102	DIESEL GEN. FUEL OIL & LUBE OIL P&I DIAGRAM
202103	DIESEL GEN. COOLING WATER P&I DIAGRAM
202105	COMPRESSED AIR SYSTEM KEY PLAN P&I DIAGRAM
202108	COMPRESSED AIR HEADERS MISC. BLDGS P&I DIAGRAM
202109	COMPRESSED AIR HEADERS MISC. BLDGS P&I DIAGRAM
202074	MAIN STEAM SHT 1 OF 2 P&I DIAGRAM
202077	CONDENSATE SYS SHT. 1 OF 2 P&I DIAGRAM
202079	FEEDWATER SYSTEM P&I DIAGRAM
202117	TURBINE BLDG ZONE KEY PLAN
202113	ACID & CAUSTIC HANDLING P&I DIAGRAM



ZONE PLAN
ADMIN. & SERVICE BLDG.
STORAGEROOM AREA

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Auxiliary Building Zone Key Plan Piping	
	202118	FIGURE 3A-3

APPENDIX 3B

(Deleted in Amendment 58)

APPENDIX 3C

PROCEDURE FOR EVALUATING JET IMPINGEMENT LOADS FROM HIGH ENERGY PIPING FAILURES

The information contained in this appendix was not revised, but has been extracted from the original FSAR and is provided for historical information.

CONTENTS

1. INTRODUCTION

The scope of this guide is to establish convenient but conservative methods of computing fluid jet impingement loads on structures, components and systems due to postulated ruptures in high energy piping (i.e., piping systems where the maximum normal operating temperature exceeds 200°F, or where the maximum normal operating pressure exceeds 275 psig) (REF. 4), inside as well as outside the reactor containment building in accordance with REF. 5. Only mechanical impingement loads have been considered, thermal shock loads due to high energy fluid jets have not been covered by this guide. The jet impingement loads given in this guide are equivalent static loads, based on the conservative assumption that a target encountering the jet remains elastic. 56

A list of minimum input data required to assess the consequences of jet impingement on essential components is provided.

Simplified techniques of computing conservative values of jet impingement loads, areas, pressures and envelopes are presented for both circumferential and longitudinal type of pipe failures. For each case, an illustrated example is given.

If the simplicity and, therefore, the inherent conservatism of the jet impingement criteria given in this guide result in

unacceptable and/or uneconomical jet impingement protection designs, it is recommended that rigorous analysis be performed. Such analysis should include elasto-plastic behavior of the target, non-homogeneous nature of jet, interaction between the jet and its environment, and drag effect due to the shape of the target.

2. REQUIRED INPUT INFORMATION

To determine jet impingement loads on essential structures, 56
systems and components or on such structures, systems and
components as may adversely affect essential items, the following
is prerequisite information: 56

(a) Composite drawings of high energy piping and safety related target structure, systems and components.

(b) Locations and types of postulated break points for each high energy piping, and

(c) State of high energy piping fluid, fluid pressure and pipe data. 56

3. JET IMPINGEMENT FORCES

3.1 BLOWDOWN FORCE

For steady state flow, neglecting fluid friction in pipe, the blowdown force F_B (see Fig. 1) acting on the discharging pipe segment is given by (REF. 1),

$$F_B = K(p-p_\infty)A \qquad .....(1)$$

where:

K = thrust factor (1.26 for flashing and partially flashing fluids and 2.0 for sub-cooled fluids)

p = fluid pressure in pipe

p_∞ = ambient pressure around the target

A = area of jet opening

Area of jet opening for longitudinal breaks and also for circumferential breaks on unrestrained pipes (Fig. 8) is assumed to be equal to the internal cross sectional area of the pipe. However, if the pipe is axially restrained, then in case of a circumferential break the broken ends of the pipe will separate by circular width B, effecting a fan jet, and the jet opening area will be given by,

$$A = \pi DB$$

where:

D = inside diameter of pipe

B = distance between broken ends of pipe

Value of B for a given case depends upon the pipe geometry, pipe material and properties, restraint stiffnesses and fluid characteristics; and can be determined by dynamic or static analysis of the system including piping and restraints.

3.2 FULL JET IMPINGEMENT LOAD

Whenever a discharging jet encounters a target object in its path, the momentum of some fluid particles is changed and an impingement force is developed. Impingement load characteristics depend upon target shape, projected area, and orientation relative to the jet, as well as jet cross sectional area and flow properties. However, the simple model shown in Fig. 1 is used to estimate jet loads on target(s) encountered in a nuclear power plant.

The jet discharges from an open pipe with jet opening area A and expands to an area A_∞ at some distance L, where it is assumed to be homogeneous. Forward motion of the jet is stopped

by the target shown and the net rightward jet impingement force on the target is therefore

$$R_j = p_i A_\infty \qquad .....(2)$$

where:

p_i = uniform impingement pressure on the target

A_∞ = area of fully expanded jet at the target

If momentum and shear interactions between the jet and its environment are assumed to be negligible then, forward momentum conservation for the jet at any location throughout its travel leads to an equality of blowdown force F_B and total jet force R_j. Equivalent static jet impingement force on the target is therefore also given by

$$R_j = 2\ K(p-p_\infty)A \qquad .....(3)$$

3.3 JET IMPINGEMENT PRESSURE

When a system or component encounters only a part of the jet, it is useful to know the impingement pressure to compute the total jet load acting on such a target. From equations (2) and (3), the impingement pressure,

$$P_i = \frac{2K(p-p_\infty)A}{A_\infty} \quad .....(4)$$

The jet impingement load on a target with area A_t which does not encounter full jet (i.e. $A_t < A_\infty$) is given by

$$R_t = \frac{2K(p-p_\infty)A_t A}{A_\infty} \quad .....(5)$$

3.4 JET IMPINGEMENT AREA

Full jet impingement area A_∞ can be determined if distance L of the target from the jet opening and the shape and size of the jet opening are known. A conservative value of 10° (REF. 3) can be used for jet expansion half-angle Ø. The shape and size of jet opening are governed by the pipe size and the type of postulated pipe failure. 56

CIRCUMFERENTIAL BREAK

UNRESTRAINED PIPES: Circumferential breaks are perpendicular to the longitudinal axis of the pipe. Total separation of the pipe at the postulated break point is assumed. For unrestrained pipes the break area is therefore equal to internal cross sectional area of the pipe (REF. 2).

The following equation gives full jet impingement area (Fig. 2)

$$A_{\infty} = 0.25\pi(D + 2L \tan\phi)^2 \qquad .....(6)$$

where:

D = inside diameter of the pipe

L = distance of the target from the jet opening

ϕ = expansion half-angle of the jet (=10°)

56

Graph given in Fig. 5 can be used to determine the impingement area A_{∞} for known values of L and D.

RESTRAINED PIPES: Full impingement area of the fan jet due to a postulated circumferential break in a restrained pipe (Fig. 3) is given by

$$A_{\infty} = 2\pi(L + 0.5D)(B + 2L \tan\phi) \qquad .....(7)$$

where:

B = distance between the broken ends of the pipe (see sub-section 3.1)

Graph given in Fig. 6 can be used to determine circular impingement area A_{∞} for known values of L, D and B.

LONGITUDINAL BREAK

Longitudinal breaks are parallel to the axis of the pipe and are oriented at any point around the circumference, (REF. 2). The jet axis is therefore perpendicular to pipe axis. The break area is assumed equal to internal cross sectional area of the pipe and the shape of the break is assumed to be rectangular so that the long side of the rectangle is parallel to pipe axis and is equal to twice the inside diameter of the pipe.

Full jet impingement area on a normal target plane (Fig. 4) is given by

$$A_{\infty} = (2D + \Delta_1)\left(\frac{\pi D}{8} + \Delta_1\right) \qquad \ldots\ldots(8)$$

where $\Delta_1, = 2L \tan \phi$.

Graph given in Fig. 7 can be used to determine full jet impingement area A_{∞} for known values of L and D.

If the jet axis is not normal to the target plane, and makes an angle θ to the normal direction, then the full jet impingement area on the target plane is given by:

$$A = (2D + \Delta_2)\left(\frac{\pi D}{8} + \Delta_2\right)/\cos\theta, \qquad \ldots\ldots(9)$$

where $\Delta_2 + 2L \tan \phi/\cos\theta$

3.5 JET IMPINGEMENT ENVELOPE

An area of the target structure larger than the full impingement area A may be affected due to the motion of the unrestrained

broken pipe following a circumferential break. Such an area is called jet impingement envelope. It is generally not applicable to longitudinal breaks where pipe displacement is limited. 56

CIRCUMFERENTIAL BREAK

In case of a circumferential break due to unrestrained motion of the broken end of the pipe, the impinging jet will traverse a larger area of the target structure. In Fig. 8, first the wall and then the floor will encounter the jet force from point a to point i as the broken pipe swings from position 1 to position n.

Jet impingement envelope then can be developed by determining full jet impingement areas at the wall and floor according to initial position, some selected intermediate positions, and the final position of the broken end of the pipe in motion, (i.e. positions 1,2,3,......,n). The locations and magnitude of jet impingement loads will vary from points a to i, depending upon the distance between the source of the jet and the target structure, and the inclination of the target structure to the jet axis, at any given instant.

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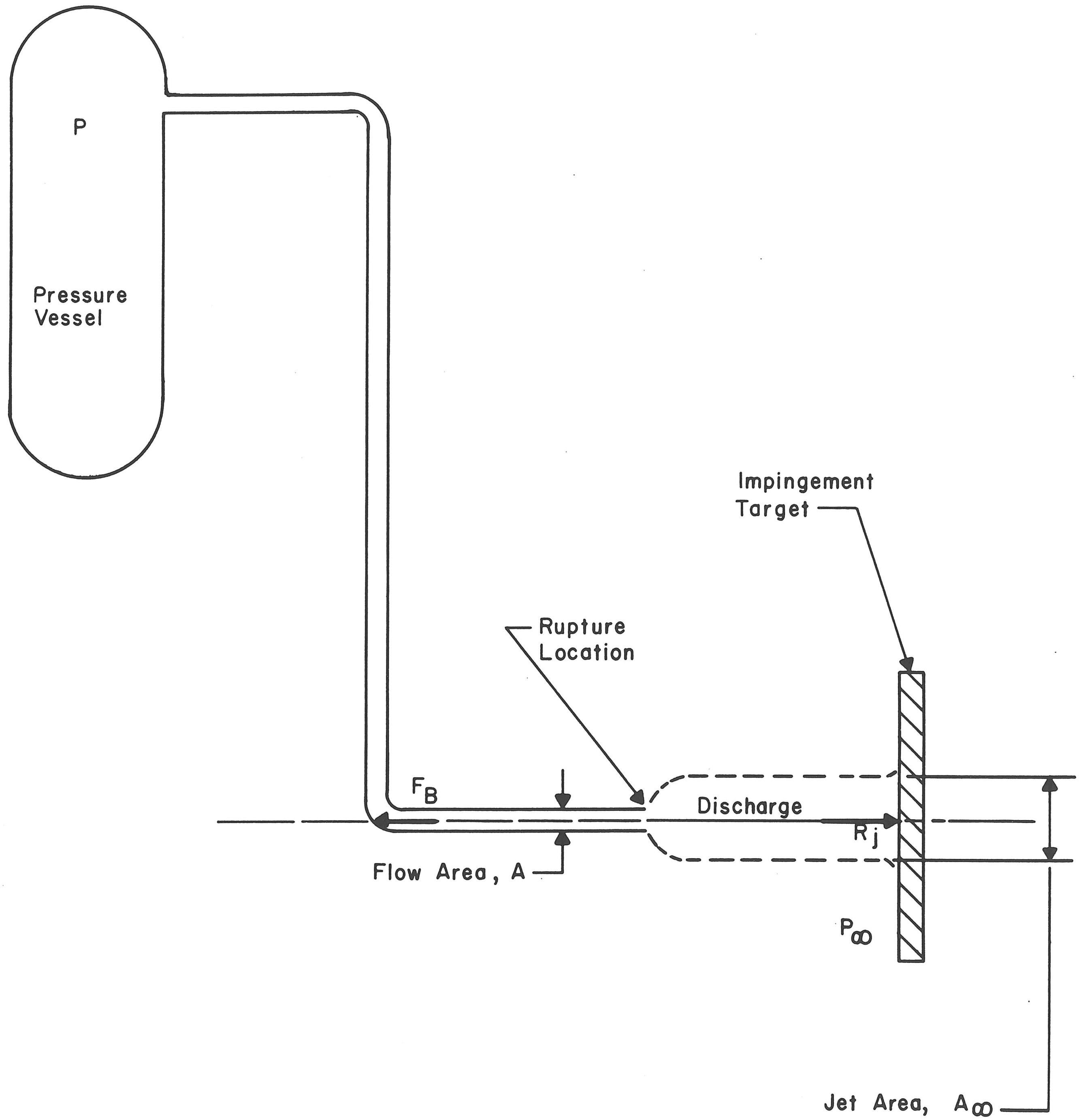

FIGURE 1
GENERAL MODEL

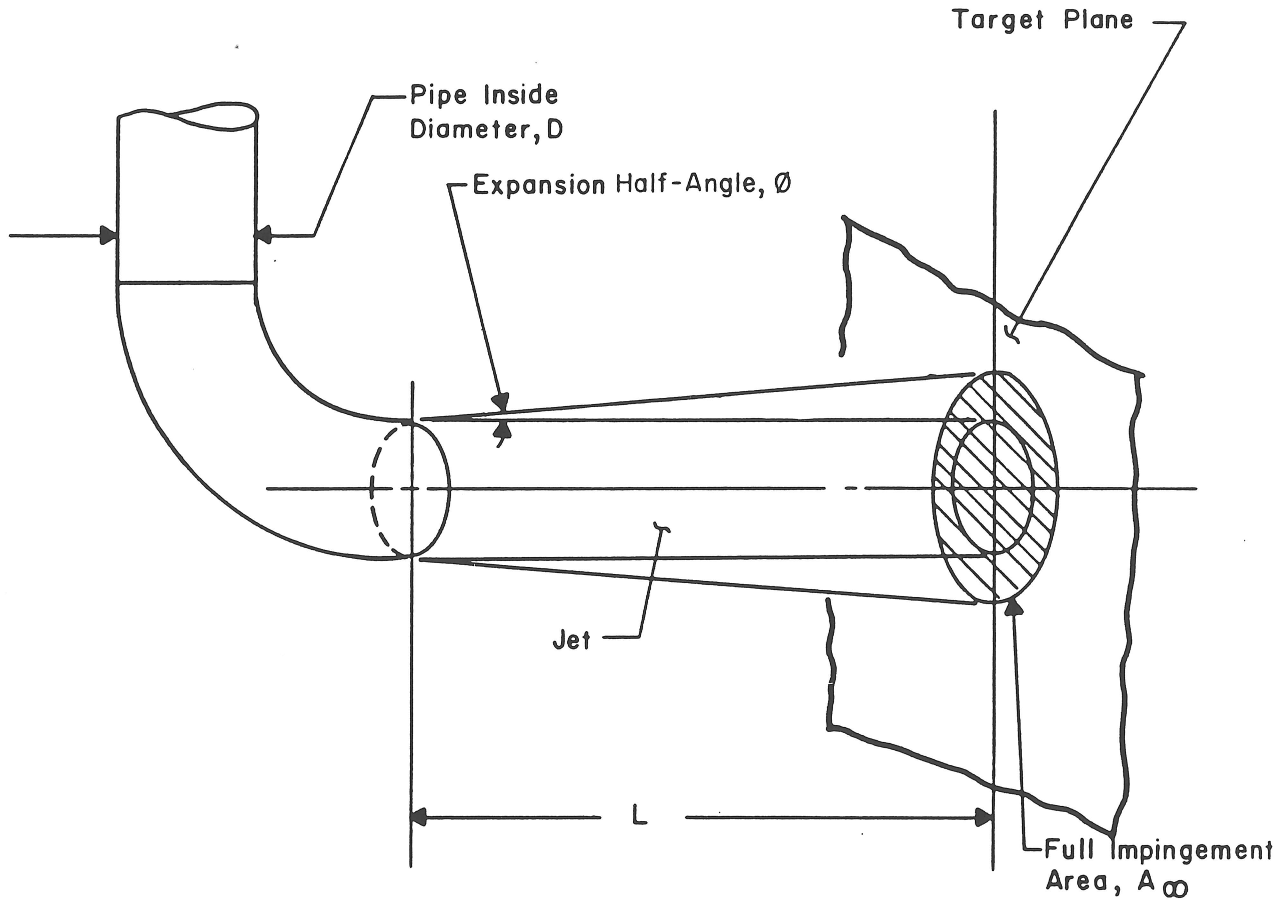

FIGURE 2

FULL IMPINGEMENT AREA - CIRCUMFERENTIAL BREAK

UNRESTRAINED PIPE

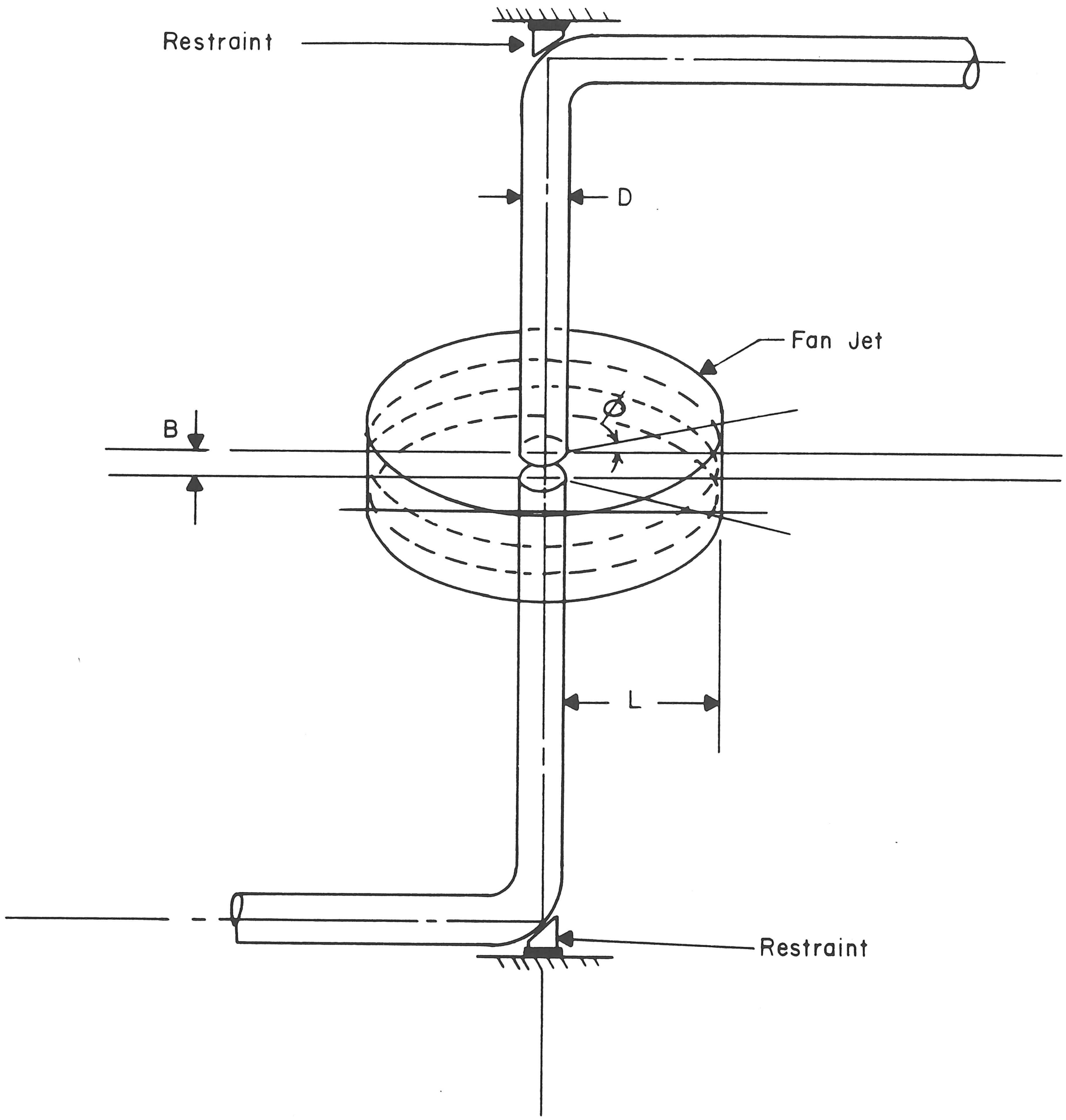

FIGURE 3

FULL IMPINGEMENT AREA - CIRCUMFERENTIAL BREAK

RESTRAINED PIPE

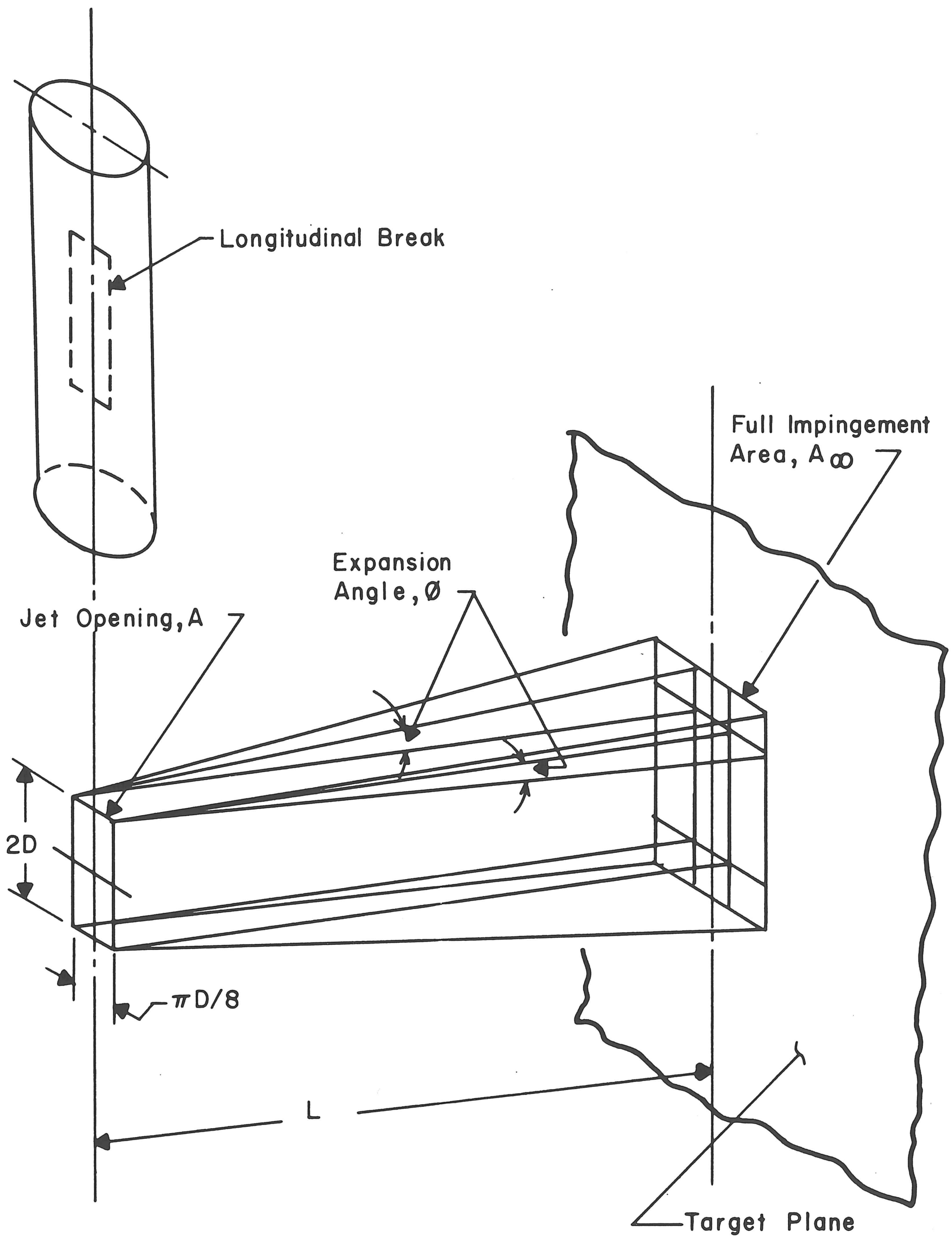

FIGURE 4

JET IMPINGEMENT AREA- LONGITUDINAL BREAK

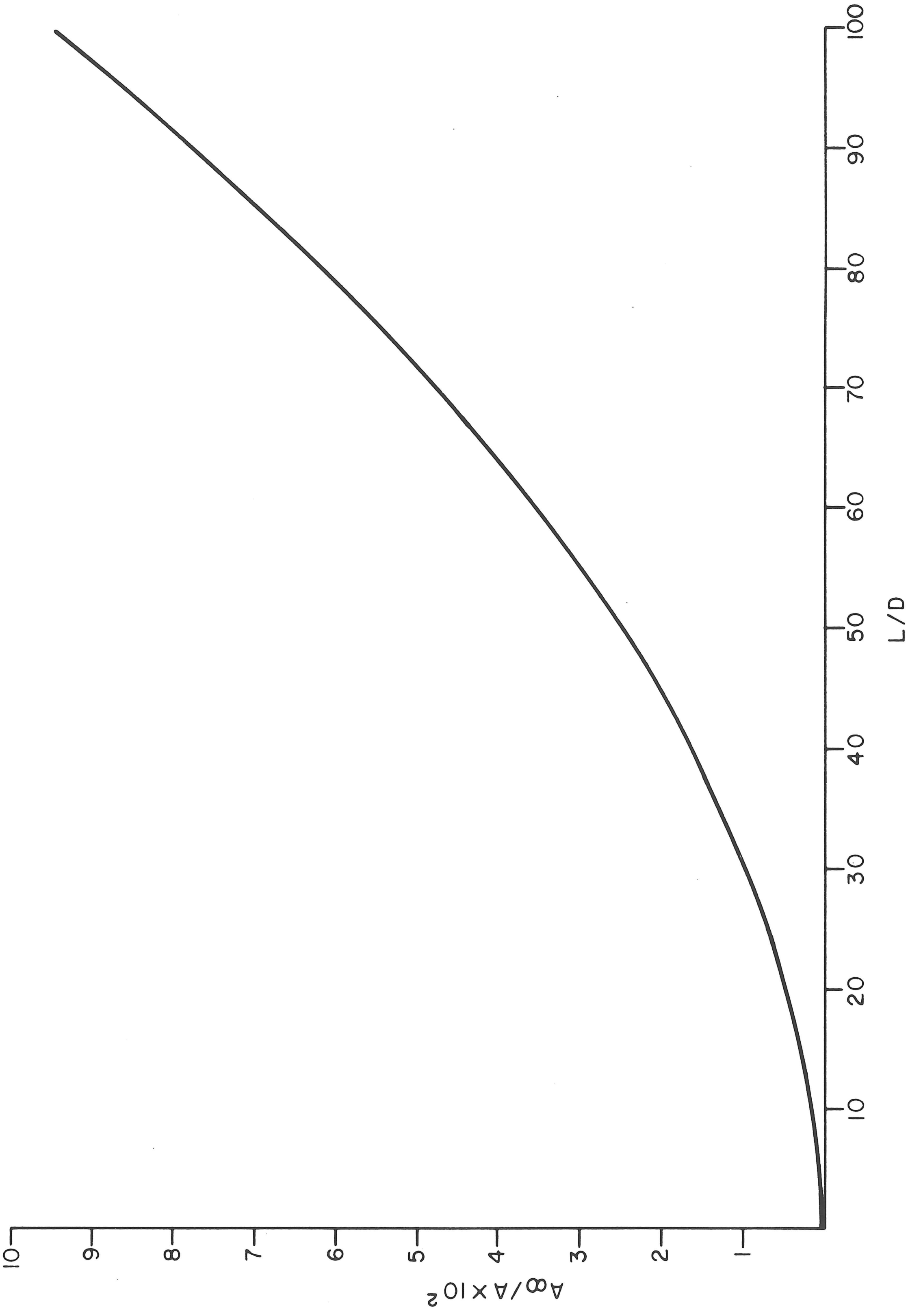

FIGURE 5

JET IMPINGEMENT AREA - CIRCUMFERENTIAL BREAK

UNRESTRAINED PIPE

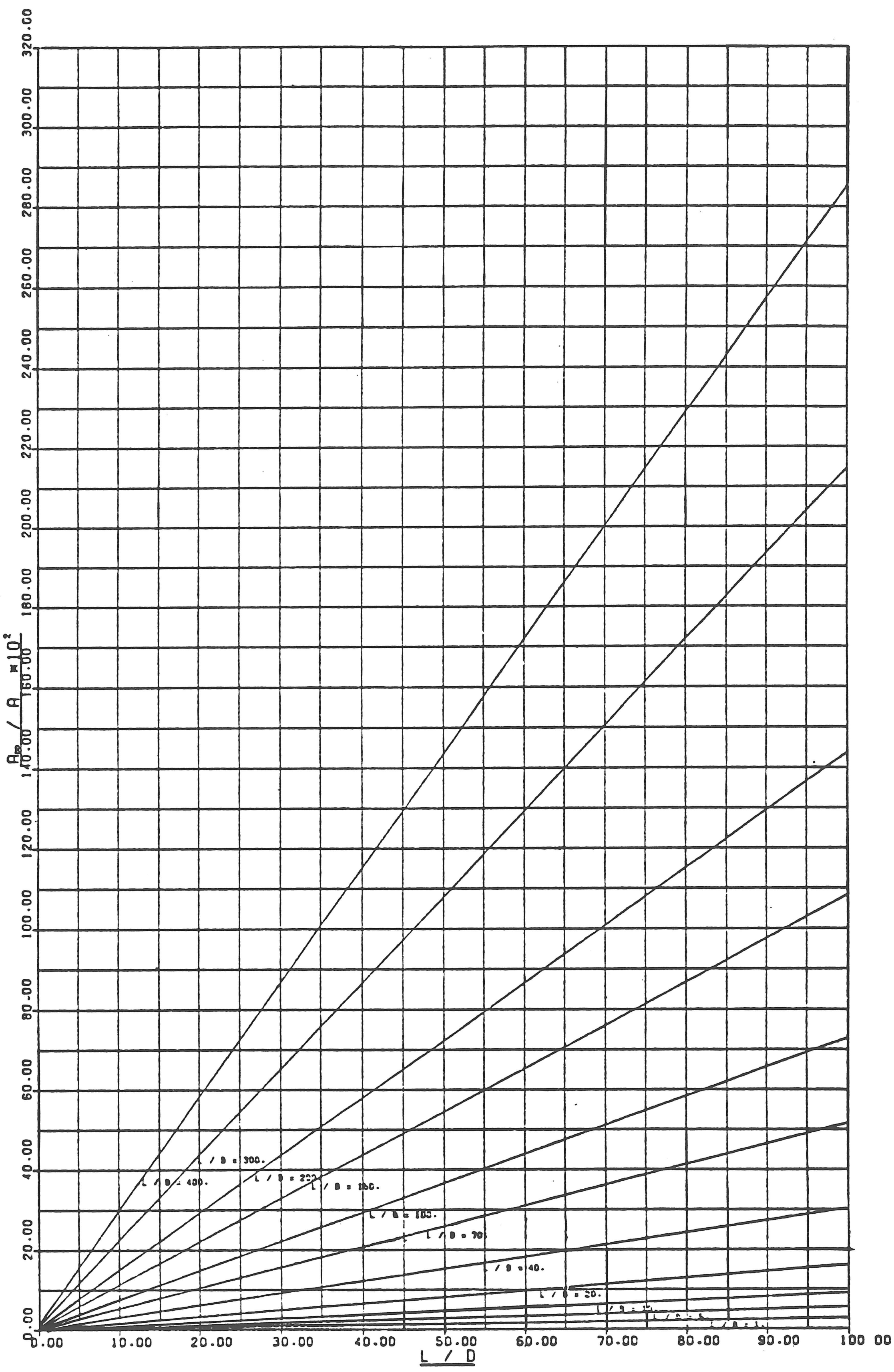

FIGURE 6

JET IMPINGEMENT AREA - CIRCUMFERENTIAL BREAK

RESTRAINED PIPE

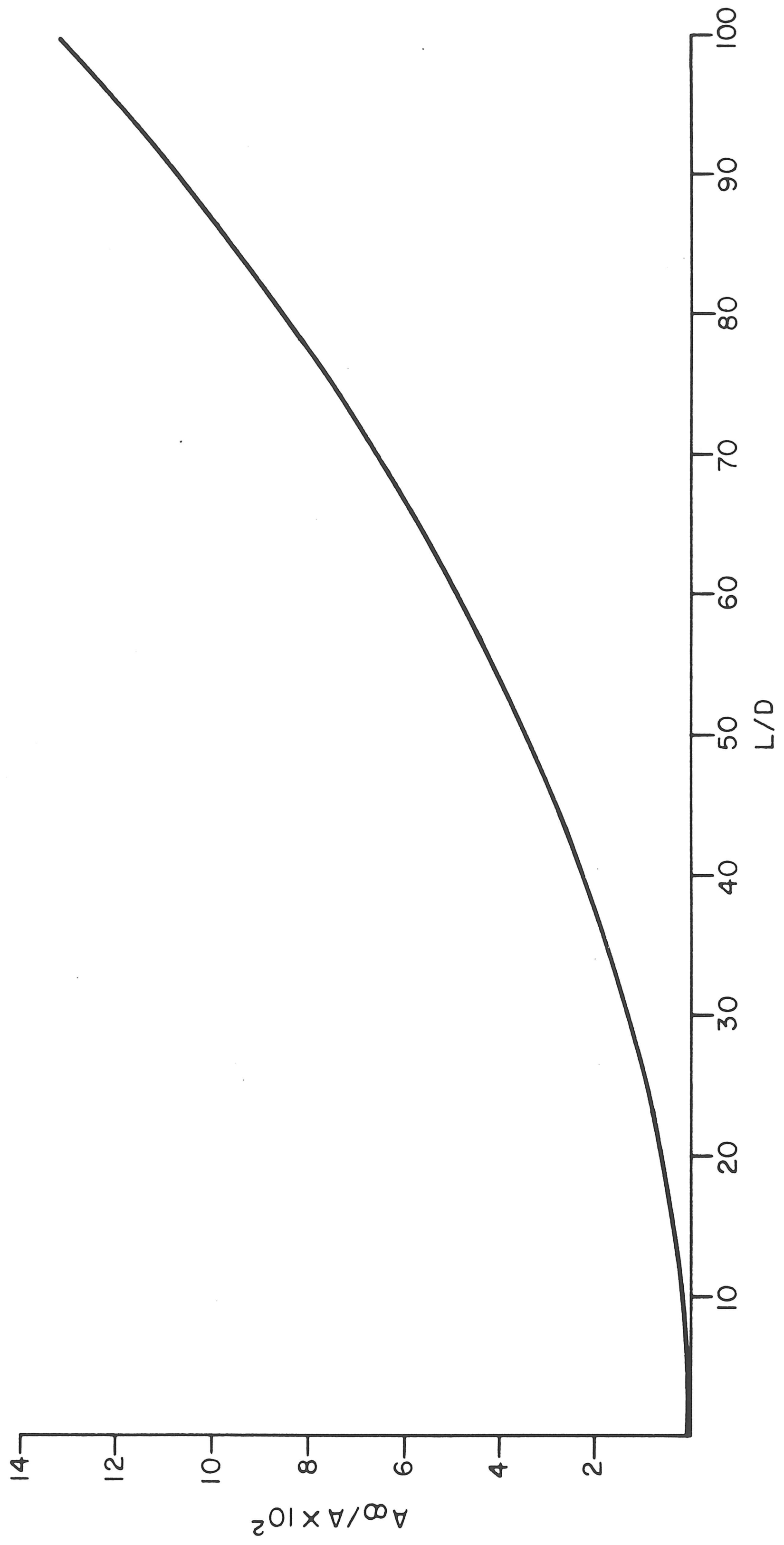

FIGURE 7

JET IMPINGEMENT AREA- LONGITUDINAL BREAK

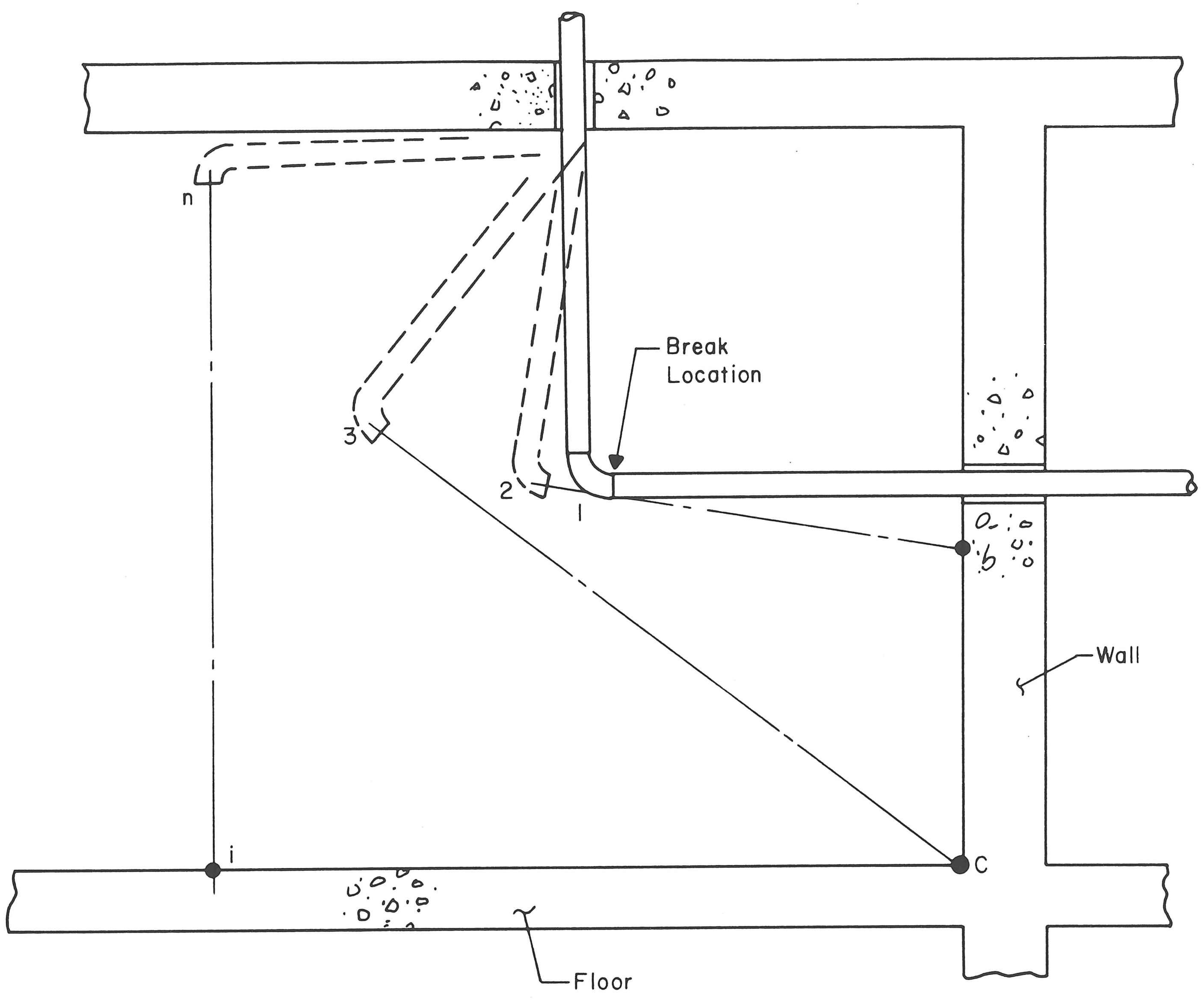

FIGURE 8

JET IMPINGEMENT ENVELOPE - CIRCUMFERENTIAL BREAK

UNRESTRAINED PIPE

PAGE 20 OF APPENDIX 3C

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4. REFERENCES

1. F.J. MOODY, "Prediction of Blowdown Thrust and Jet Forces", ASME Publication No. 69-HT-31, May 1969.

2. Regulatory Guide 1.46, "Protection Against Pipe Whip Inside Containment", Directorate of Regulatory Standards, U.S. Atomic Energy Commission.

3. ANSI N176, "Design Basis for Protection of Nuclear Power Plants against Effects of Postulated Pipe Failures", ANS-58.2, American Nuclear Society, May 1975.