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EVALUATION OF DRYWELL INSULATION DEBRIS EFFECTS ON ECCS PUMP PERFORMANCE

Limerick Generating Station

Units 1 & 2

Philadelphia Electric Company

Bechtel Power Corporation
San Francisco, California

P-274/1(pl)

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1.0 INTRODUCTION

1.1 Purpose:

There is a concern that a high energy pipe break within the primary containment might create insulation debris that would build-up on the Emergency Core Cooling Systems (ECCS) pump suction strainers, impairing operation of these pumps. Such debris considerations are part of Unresolved Safety Issue A-43; "Containment Emergency Sump Performance," Reference 4.1.

In response to this concern, an evaluation was made to estimate the maximum quantity of insulation debris that might be generated by a LOCA, the amount of such debris that might enter the suppression pool and cover the ECCS strainers, the attendant pressure losses and resulting effect on the ECCS pump NPSH margins.

In Section 6.2.2.2 of Reference 4.4, it is concluded that small pieces of fiberglas insulation are the only type of drywell insulation debris that might enter the supression pool and coat the ECCS strainers. Therefore, only shredded fiberglas insulation debris is considered in this evaluation.

1.2 Summary of Results:

It has been determined that fibrous insulation debris generated by a LOCA jet impinging on nearby insulation will not jeopardize ECCS pump operation at Limerick Units 1 & 2. This conclusion is based on the theoretically worst case where 100% of the fibrous insulation debris generated by the LOCA inside the drywell is arbitrarily assumed to migrate onto the ECCS strainers in the suppression pool. The head loss due to maximum theoretical debris blockage concurrent with minimum NPSH conditions, does not cause the available NPSH to drop below that required by the ECCS pumps. Using more realistic considerations, it has been determined that other transport mechanisms will significantly reduce the actual amount of fibrous insulation debris that could migrate to the suppression pool and cover the ECCS pump strainers.

2.0 BACKGROUND

2.1 Limerick Units 1 & 2 are 1,100 MWe, BWR's with Mark II containments.

2.2 The ECCS pumps take suction from the suppression pool water inventory, which is located below the drywell floor. Water released into the drywell from a LOCA first accumulates on the drywell floor. As the level of the drywell floor pool rises, the liquid eventually enters the suppression pool by overflowing into downcomers that extend 18" above the drywell floor. Limerick has 87, 24" nominal diameter downcomers penetrating the drywell floor. Four of the downcomers are capped, so there are actually 83 active downcomers. The configuration of the drywell, downcomers, suppression pool and ECCS suppression pool strainers is shown on Figures 2-1, 2-2, 2-3, and 2-4.

2.3 Insulation Types Employed in the Drywell:

a) Stainless Steel Jacketed Fiberglas Thermal Insulation (Owens-Corning "Nukon"). Fiberglas totally enclosed in woven fiberglas covers is used to insulate high temperature piping and the recirculation pumps. The insulation blankets are protected with 22 gauge, minimum, stainless steel jackets having seismically qualified latches.

b) Metallic Reflective (Diamond Power). This type is used for reactor pressure vessel (RPV) insulation.

c) Jacketed Fiberglas Anti-Sweat (Owens-Corning Fiberglas). This type is used on chilled water lines inside the drywell and constitutes a small percentage, less than 20%, of the insulation used in the drywell.

d) Encapsulated Low Conductivity (Johns-Manville Min-k). This type is used at the whip restraints where the clearance does not allow the use of thicker "Nukon" insulation, and constitutes a small percentage, less than 10%, of the insulation used in the drywell.

3.0 METHOD OF ASSESSING DEBRIS HAZARD

3.1 Assumptions Used to Determine Maximum LOCA Debris Generation:

3.1.1 The criteria for selecting the worst case pipe break with respect to insulation debris generation is in accordance with the assumptions outlined in Appendix C of Reference 4.1. These are:

a) The pipe break is assumed to be circumferential and the downstream pipe section is assumed to be completely displaced so there is no shadowing from it. Although all large high energy lines are restrained at Limerick, this assumption was used because it results in the largest break jet cone.

b) Insulation inside the Region I break jet is assumed to be shredded into small fragments by jet impingement forces. The Region I jet cone is a 7 pipe diameter long cone, expanding 45 degrees on either side of the centerline of the pipe.

c) Insulation inside the Region II break jet is dislodged in the as-fabricated form (i.e., as whole or torn blankets). Region II is the extension of the Region I jet cone starting at L/D = 7 and extending to a plane where the jet thrust divided by the jet area is equal to 0.5 PSIG, with the same 90° expansion angle.

d) Credit was taken for the shadowing effect of pipe whip restraints and larger structural steel members that are inside the jet blast cone. This is in accordance with criteria for modeling jet impingement forces specified in References 4.9, 4.10, and 4.11.

e) Insulation on the displaced pipe downstream of the break between whip restraints is assumed to be shredded.

f) The protective effects of the stainless steel jackets on the "Nukon" insulation were not considered, and the "Nukon" insulation was considered to be unprotected for this evaluation. This is conservative because it is expected that limited protection against shredding would be provided by the insulation jacketing, which would reduce the volume of shredded insulation debris generated by the LOCA.

3.2 Amount of Debris Generated:

3.2.1 A review was made of the postulated pipe rupture locations (PRL) on the high energy lines in the drywell in order to locate those breaks where the jet cone would be oriented towards fibrous insulation. High energy piping systems with small diameter lines are not expected to generate significant amounts of debris because of the small break jet cone size. The review was reduced to the following large diameter high energy piping systems:

- Reactor Recirculation
- Main Steam
- Feedwater
- RHR Shutdown Cooling

Due to separation of high energy lines, the shadowing effect of numerous whip restraints on these lines, surrounding structural steel and other obstacles, none of the actual PRL's listed in Reference 4.4 is a significant insulation debris producer as compared to other non-PRL break locations. Consequently, our review was expanded to include all fitting welds on the above listed piping systems.

Study of the isometric drawings of these systems contained in Section 3.6 of the Limerick FSAR, in conjunction with visual examination of the scale model of the primary containment (1/2" = 1'-0"), was used to locate the break locations that caused the largest insulation debris generation.

3.2.2 Whip restraints and separation of high energy lines would prevent pipe whip and pipe impact, respectively, from being significant mechanisms of debris generation. Further, any debris generated by these mechanisms would be in as fabricated whole blanket form, and this debris form does not jeopardize ECCS pump operation per Section 6.2.2.2 in Reference 4.4. In this review, it was assumed that one length of insulation upstream of the break is blasted off by the LOCA, and shredded in the Region I blast cone.

3.2.3 The two break locations that would generate the largest amounts of insulation debris are:

(1) The 26"Ø main steam line "D" where it crosses over the 26"Ø main steam line "C". The break weld is located inside the whip restraint at approximate elevation 282 ft, and is oriented so the jet cone intercepts main steam line "C". Figure 3-1 shows the specific break location and targets. The same basic geometry exists where main steam line "A" crosses over main steam line "B". However, differences in the main steam relief valve piping makes the main steam line "D" cross-over the largest debris generator.

(2) The second break is at the end cap weld on the 22"Ø recirculation line half ring header, approximate elevation 269 ft. Figure 3-2 shows the specific break location and targets. There are two end caps on each half header. The jet cone from each of the four recirculation line end caps intercepts a similar portion of the vertical 28"Ø recirculation pump suction line. The jet cone from the south-west end cap also intercepts a portion of the 20"Ø RHR shutdown supply line, so this end cap location was selected for analysis.

3.2.4 A geometric analysis was performed to determine the amount of insulation that could be affected by the two selected break jet cones. It was observed that both of these selected break jet cones intercept almost exclusively "Nukon" type fiberglas insulation, with the remainder being a very small amount of encapsulated min-k insulation. Encapsulated insulation is resistant to jet impingement forces and will not be broken-up into small pieces. Since only shredded fibrous insulation is of concern in this evaluation, only the volume of "Nukon" insulation exposed to jet impingement inside the Region I jet cone was quantified. A review of the geometry of the Region II jet cones showed that shadowing from structures, pipe whip restraints and structural steel would provide protection against jet effects in Region II so that only a few whole or torn blankets would be expected to be dislodged. However, the LGS FSAR, (Reference 4.4) Section 6.2.2.2, discusses the physical

barriers that will prevent whole or torn blankets and encapsulated insulation from entering the suppression pool. As a result, these types of insulation were not considered to be a concern, and insulation removed by the Region II portion of the jet cone was not quantified.

3.2.5 Our analysis determined that the main steam line break would produce the largest amount of fibrous insulation debris. The results of our analysis are tabulated below:

	Amount Fibrous Insulation Dislodged
(1) Main steam line break	
* M.S. "D", 26" Ø	16 ft^3
* M.S. "C", 26" Ø	20 ft^3
* MSRV lines, 8"Ø, 12"Ø	18 ft^3
	54 ft^3
(2) Recirc line break	
* Recirc hdr end caps, 2 x 22" Ø	3 ft^3
* Recirc line "B", 28" Ø	24 ft^3
* RHR supply, 20" Ø	7 ft^3
* Recirc hdr, 22" Ø (upstm break)	6 ft^3
	40 ft^3

3.3 Insulation Debris Transport to the Suppression Pool.

3.3.1 Short term transport:

3.3.1.1 Short term transport is caused by the pipe break jet, pipe whip and pipe impact and terminates at the end of blowdown. As indicated in section 3.2.2, pipe whip and pipe impact are not considered to be a significant factors in this review.

3.3.1.2 It was assumed that all shredded debris generated at the selected line break would fall onto the drywell floor. This is considered conservative because some shredded debris (and most dislodged whole blankets) would be trapped or sieved by floor gratings and other horizontal surfaces below the selected break.

3.3.2 Long term transport:

3.3.2.1 Long term transport is caused by operation of ECC systems. For long term operation after a main steam line break, it is probable that the RHR system will be operated in the shutdown cooling mode with no additional ECC systems operating. Therefore, water would not accumulate on the drywell floor to the level of the downcomer, such that there would be no water flow from the drywell to transport the insulation debris to the suppresion pool via the downcomers. However, to be conservative for this analysis, it is assumed that full ECCS flow spills onto the drywell floor from the line break, for the entire accident duration.

3.3.2.2 It is expected that the shredded debris is distributed over a large floor area by blast effects and large concentrations adjacent to a few downcomers do not occur. Consequently, it is assumed the debris is uniformly dispersed over a large floor area and the overall bulk properties of the drywell floor apply to the region where insulation debris is scattered. Refer to section 2.2 of this report for a description of the arrangement of the drywell, suppression pool and downcomers.

3.3.2.3 The maximum possible ECCS flow condition was used in order to maximize the flow velocities into the drywell downcomers and to minimize the residence time available for slow-sinking debris to settle. Specifically, the evaluation is based on simultaneous operation of the following ECCS pumps all operating at their runout flowrates.

4 RHR Pumps	4 x 10,750 GPM = 43,000 gpm
4 Core Spray Pumps	4 x 3,950 GPM = 15,800 gpm
Total ECCS Flow	---------------------58,800 gpm

3.3.2.4 Based on data contained in Reference 4.3, the long term transport evaluation considered the behavior of three types of shredded fibrous debris after it falls onto the drywell floor:

1) Debris that immediately sinks upon contact with hot water.

2) Debris that floats for an indefinite period.

3) Suspended debris that slowly sinks.

3.3.2.5 The shredded fiberglas insulation debris that falls to the drywell floor will initially come into contact with hot water released from the LOCA. Test data contained in Reference 4.2 shows that shredded fiberglas fragments rapidly become wetted and sink in 20 to 30 seconds in 120°F water. Per Reference 4.7, Owens-Corning tests show that the same sinking characteristics apply to fibrous "Nukon" fragments. Reference 4.5 shows that "Nukon" fragments will sink even more rapidly when the insulation is hot, which would be the case for any insulation dislodged from high energy lines. Since the initial water build-up on the drywell floor will be reactor inventory that is hotter than 120°F, and the insulation debris will be hot, it is expected most "Nukon" insulation fragments will rapidly sink.

3.3.2.6 There is sufficient volume below the downcomer overflow level (i.e., 18" above drywell floor) to contain the maximum water release by a design basis LOCA (which would be from a recirculation line break). No liquid overflow into the downcomers occurs until after the ECCS pumps are operating for any high energy line break. Based on accident chronology data for high energy line breaks contained in Reference 4.4, the insulation debris will have substantially more than 30 seconds exposure to hot water before the start of drywell water overflow into the downcomers. It can be assumed there will be sufficient time to permit most debris to sink to the bottom of the drywell floor pool before overflow starts.

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3.3.2.7 Although there is considerable test data supporting the conclusion made in section 3.3.2.6, that most "Nukon" fragments will immediately sink to the bottom of the drywell floor pool, it is acknowledged there is no specific LOCA test data available describing the post-LOCA buoyancy characteristics of "Nukon". In the absence of specific LOCA test data for "Nukon", the conservative approach is to assume less than all the "Nukon" fragments immediately sink. In order to arrive at a credible and conservative factor for the lesser amount of debris that immediately sinks, comparable test data contained in section 4.7.2 of Reference 4.3 describing the post-LOCA buoyancy characteristics of mineral wool insulation was used in the analysis. This data is considered conservative because fragments of as-manufactured fiberglas insulation, and "Nukon" in particular, will become wet and sink faster than mineral wool (i.e., fiberglas has a greater tendency to sink compared to mineral wool). This conclusion is based on data contained in References 4.2, 4.5, and 4.7. There is no reason to believe LOCA effects would change the buoyancy characteristics of "Nukon" debris so that it would be more buoyant than mineral wool. Reference 4.3 states that 40% to 50% of the fibrous insulation (mineral wool) dislodged by a LOCA can be expected to immediately sink. The calculation, therefore, used the conservative factor of 40% to determine the amount of "Nukon" fragments that immediately sink.

3.3.2.8 Obstacles between the main steam line break and drywell floor pool will protect the pool from agitation due to direct break jet impingement. Liquid released from the line break during blowdown and later during ECCS pump operation will tend to fall onto drywell floor pool. In consideration of the plan area of the drywell floor, only comparatively small localized regions of liquid turbulence may exist in the floor pool, where larger streams of falling liquid impact the floor pool. Since

liquid is being displaced at these locations, the flow direction will be away from the disturbed zone. This outward flow pattern will be especially pronounced during the initial build-up of liquid on the drywell floor, and insulation debris that landed in these disturbed zones will be swept into quieter regions where it can settle. Thus, floor turbulence will not interfere with the overall insulation sinking process, but, instead, will assist in wetting the insulation debris which accelerates sinking.

3.3.2.9 Transport test data contained in Reference 4.2 indicates that a flow velocity exceeding 0.3 ft/sec is required to entrain fibrous insulation shreds lying on the bottom of the drywell floor pool. Due to the elevated downcomer pipe ends, the flow velocity profile approaching the downcomers is maximum on the surface and minimum on the bottom. During maximum ECCS flow (58,800 gpm) into the 83 downcomers, the maximum flow velocity at the bottom of the drywell floor pool is less than 0.06 ft/sec. Thus, sunken insulation debris will not be re-entrained by the flow into the downcomers when the ECCS pumps are operating.

3.3.2.10 It is assumed that all floating debris is carried by the flow into the downcomers and enters the suppression pool. Citing post-LOCA data for mineral wool in reference 4.3, 20% to 30% of the mineral wool debris remained afloat during ECCS operation. As noted in section 3.3.2.6 of this report, fiberglas has a greater tendency to sink than mineral wool, so this data is considered conservative when applied to fiberglas debris. For additional conservatism, the highest stated mineral wool floating percentage (30%) was used in the analysis.

3.3.2.11 The remaining 30% of the original shredded insulation volume is considered to be slow-sinking debris dispersed evenly in the water on the drywell floor. A calculation was performed to determine the flow zone around each downcomer that could draw the slow sinking debris into the downcomer before it settles to the bottom of the floor pool. This calculation was based on a settling velocity of 0.012 ft/sec which is the median settling rate between individual fibers and very small clumps of "Nukon" insulation based on data contained in Reference 4.5. Calculation results indicate that a carryover factor of 50% for the slow-sinking debris would be conservative. In terms of the original shredded insulation volume, this results in approximately 15% entering the downcomers due to the slow-sinking phenomena, and coating the ECCS strainers.

3.3.2.12 Based on the forgoing transport analysis, the maximum expected fibrous debris migration into the suppression pool is 24.3 ft^3 (45%) out of the original 54 ft^3 of insulation shredded by the LOCA. A summary of the fibrous insulation transport phenomena is shown on Table 3.1.

3.4 ECCS Suction Strainer Blockage Head Losses Due to Insulation Debris Carryover into the Suppression Pool:

3.4.1 It is assumed that all pieces of fibrous insulation that enter the suppression pool eventually deposit on the 8 sets of active ECCS strainers. No credit was taken for quiet zones in the suppression pool where insulation could settle-out without being drawn onto one of the strainers. Each of the operating pumps identified in section 3.3.2.3, has two conical type suction strainers in a "Tee" configuration in the suppression pool. Figure 2-4 shows details of these conical strainers. The total ECCS strainer surface area is 157.0 ft^2.

3.4.2 Per Reference 4.1, calculation of strainer screen head loss due to fibrous insulation debris blockage is based on the equivalent insulation blockage thickness, t_i, as defined below:

$$t_i = \frac{\text{Transported debris volume}}{\text{Available screen area}}$$

The total transported debris volume is distributed between the RHR and Core Spray strainers based on the ratio of individual pump flowrates to total ECCS flow.

3.4.3 Reference 4.12 contains a head loss formula developed specifically for a bed of shredded "Nukon" insulation. It is noted the maximum debris bed approach velocity tested in Reference 4.12 is 0.5 ft/sec, while the strainer approach velocities at Limerick are closer to 1.0 ft/sec. Review of test data contained in Reference 4.12 indicates it is reasonable to assume the straight line logrithmic relationship between head loss and approach velocity can be extended to approach velocities of 1.0 ft/sec. Thus the "Nukon" fragment bed head loss formula developed in Reference 4.12 is considered valid for the Limerick service conditions. The "Nukon" specific head loss formula was approved for use in this review by the NRC during the Reference 4.6 telecon, and is given below:

$$\Delta H = 68.3\ (t_i)^{1.07}\ (V)^{1.79}$$

where:

ΔH = screen loss, ft of H_2O

t_i = equivalent blockage thickness, ft

V = screen approach velocity, ft/sec

3.4.4 Using the above formula, the strainer head losses due to the deposition of LOCA generated fibrous insulation materials were calculated for two transport conditions:

3.4.4.1 Assume 100% debris migration to ECCS strainers. This condition will establish the maximum theoretical strainer loss due to fibrous debris.

3.4.4.2 Debris migration to ECCS strainers is reduced by transport losses. This condition establishes the maximum expected strainer loss due to fibrous debris.

3.4.5 The calculated ECCS strainer head losses for the two transport conditions are shown in Table 3.2.

3.5 Effect of Suction Strainer Blockage on ECCS Pump NPSH:

3.5.1 Minimum NPSH is available for the ECCS pumps when the suppression pool temperature is 212°F, the drywell pressure is 14.7 psia, and the suppression pool is at minimum level. This minimum NPSH is further reduced by the strainer blockage loss to obtain the actual NPSH available. The calculated actual NPSH available at the pump suction was compared to the NPSH required by the pump to determine if strainer blockage could cause pump cavitation problems.

3.5.2 Table 3.2 shows that the theoretically worst case strainer blockage, (100% migration to stainers), concurrent with the minimum available NPSH operating condition, still leaves more NPSH than required by the ECCS pumps. The NPSH required values used in this evaluation are taken from pump manufacturer certified pump performance data. When certain debris transport losses are taken into consideration, the NPSH margin becomes significantly larger. (The NPSH required values stated by G.E. in the FSAR Process Flow Diagrams contain a large safety margin over the NPSH required values given by the pump manufacturers).

4.0 REFERENCES

4.1 Serkiz, A.W., "Containment Emergency Sump Performance," NUREG-0897 (for comment), NRC, April, 1983.

4.2 Brocard, D.N., "Buoyancy, Transport, and Head Loss of Fibrous Reactor Insulation," NUREG/ CR-2982, SAND 82-7205, Alden Research Laboratory, November, 1982.

4.3 Wysocki, J.; Kolbe, R., "Methodology for Evaluation of Insulation Debris Effects," NUREG/ CR-2791, SAND 82-7067, Burns & Roe, Inc., September, 1982.

4.4 Bechtel, "Final Safety Analysis Report (FSAR), Limerick Generating Station, Units 1&2, Philadelphia Electric Company," FSAR Vol.4 and Vol.7.

4.5 Owens-Corning Fiberglass Corporation, "Topical Report OCF-1, Nuclear Containment Insulation System, NU'K'ON," January, 1979.

4.6 Telecon between Messrs. Serkiz (NRC); Tutton, Phillabaum (PECo); Schlueter, Lewis, Blakely, Klein, and Bielanowski (Bechtel); July 21, 1983.

4.7 Owens-Corning letter to Bechtel, January 26, 1984, "Sinking Characteristics of Glass Fibers," Limerick Project Document No. 174363.

4.8 Deleted

4.9 U. S. Nuclear Regulatory Commission, Standard Review Plan 3.6.2, "Determination of Rupture Location and Dynamic Effects Associated with the Postulated Rupture of Piping, Rev. 1 - July 1981."

4.10 ANSI/ANS-58.2-1980, "Design Basis for Protection of Light Water Nuclear Power Plants Against Effects of Postulated Pipe Rupture."

4.11 ANSI/ANS-58.3-1977 (N182), "Physical Protection for Systems and Components Important to Safety."

4.12 Brocard, D. N., "Transport and Head Loss Tests of Owens-Corning NUKON Fiberglas Insulation, "Alden Research Laboratory, September, 1983.

TABLE 3.1

SUMMARY OF INSULATION DEBRIS TRANSPORT INTO THE SUPPRESSION POOL

	Original Amount ft^3	Amount Transported to Supp. Pool ft^3
a) <u>Short term transport</u>:		
Shredded insulation debris generated by LOCA	54.0*	N.A.
Shredded insulation debris falling onto drywell floor	54.0*	N.A.
b) <u>Long term transport</u>:		
Breakdown of shredded debris types on drywell floor:		
° Immediate-sinking (40%)	21.6	0.0
° Floating (30%)	16.2	16.2
° Slow-sinking (30%)	16.2	8.1
	54.0	24.3

* Does not include volume of whole, "as-fabricated" blankets of insulation generated by LOCA (Region II blast cone).

TABLE 3.2

SUMMARY OF CALCULATED ECCS STRAINER

HEAD LOSSES DUE TO FIBROUS DEBRIS BLOCKAGE AND

EFFECT ON ECCS PUMP NPSHA

	ECC SYSTEM	FLOW gpm	TOTAL STRAINER SURFACE AREA ft^2	ESTIMATED DEBRIS VOLUME REACHING STRAINERS ft^3	DEBRIS BLOCKAGE ON STRAINERS in	DEBRIS BLOCKAGE HEAD LOSS ft	MIN NPSHA WITH CLEAN STRAINERS ft	ACTUAL NPSHA WITH BLOCKED STRAINERS ft	PUMP NPSHR ft
100% fibrous Debris Migration to ECCS strainer	RHR	43,000	105.7	39.5	4.5	20.0	27.0	7.0	6.0 (2)
	CS	15,800	51.3	14.5	3.4	9.1	28.0	18.9	10.0 (2)
Maximum expected fibrous debris migration to ECCS strainers	RHR	43,000	105.7	17.8	2.0	8.5	27.0	18.5	6.0 (2)
	CS	15,800	51.3	6.5	1.5	4.5	28.0	23.5	10.0 (2)

NOTES

(1) FLUID TEMPERATURE IS 212°F

(2) VALUES FROM SUPPLIER CERTIFIED PUMP PERFORMANCE CURVES.

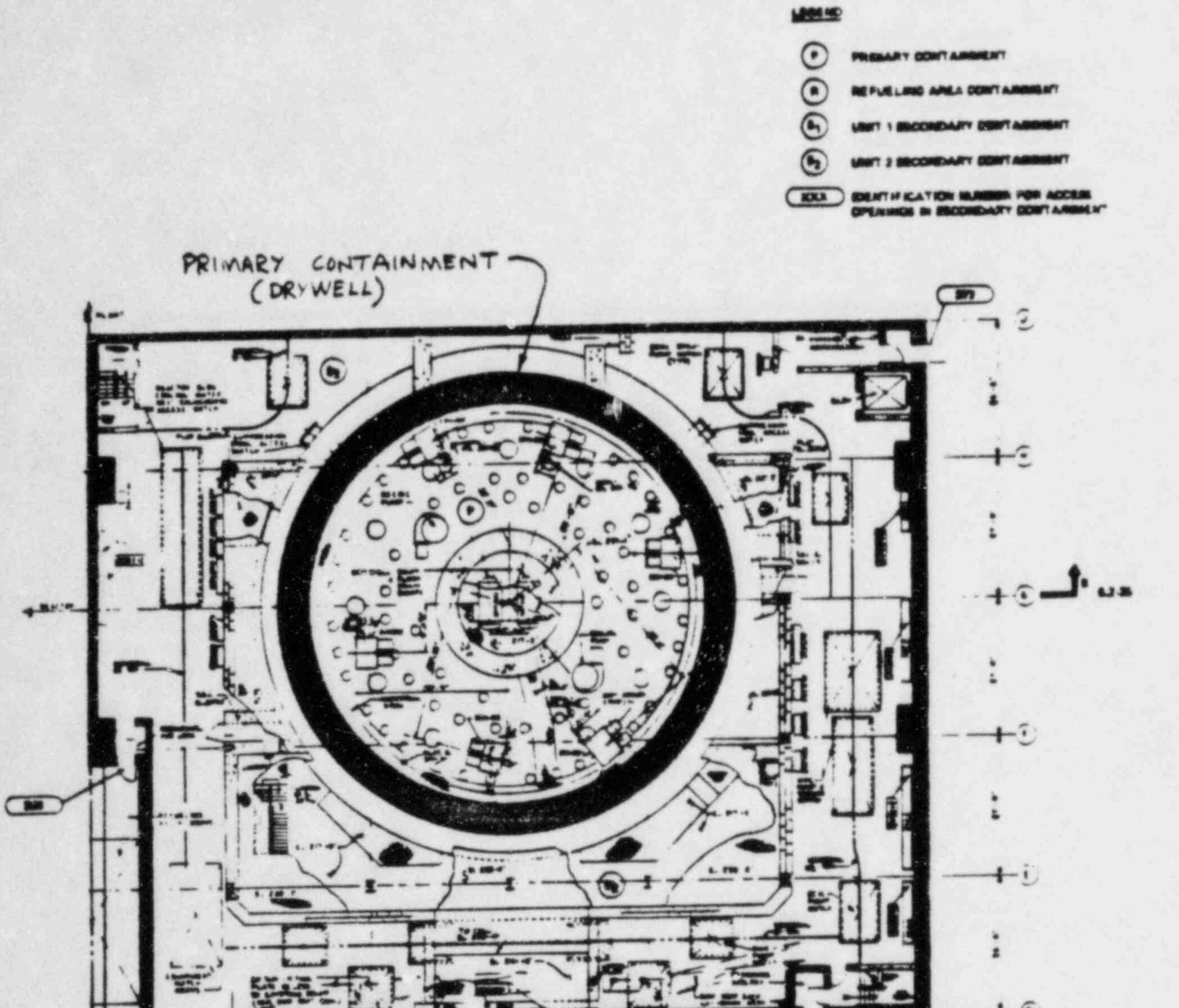


FIG. 2-1 REV. 0

LIMERICK GENERATING STATION
UNITS 1 AND 2
FINAL SAFETY ANALYSIS REPORT

SECONDARY CONTAINMENT
BOUNDARY OUTLINE, PLAN AT
ELEV. 217 FEET

~~FIGURE 6.2-29~~ ~~REV 7, 6/82~~

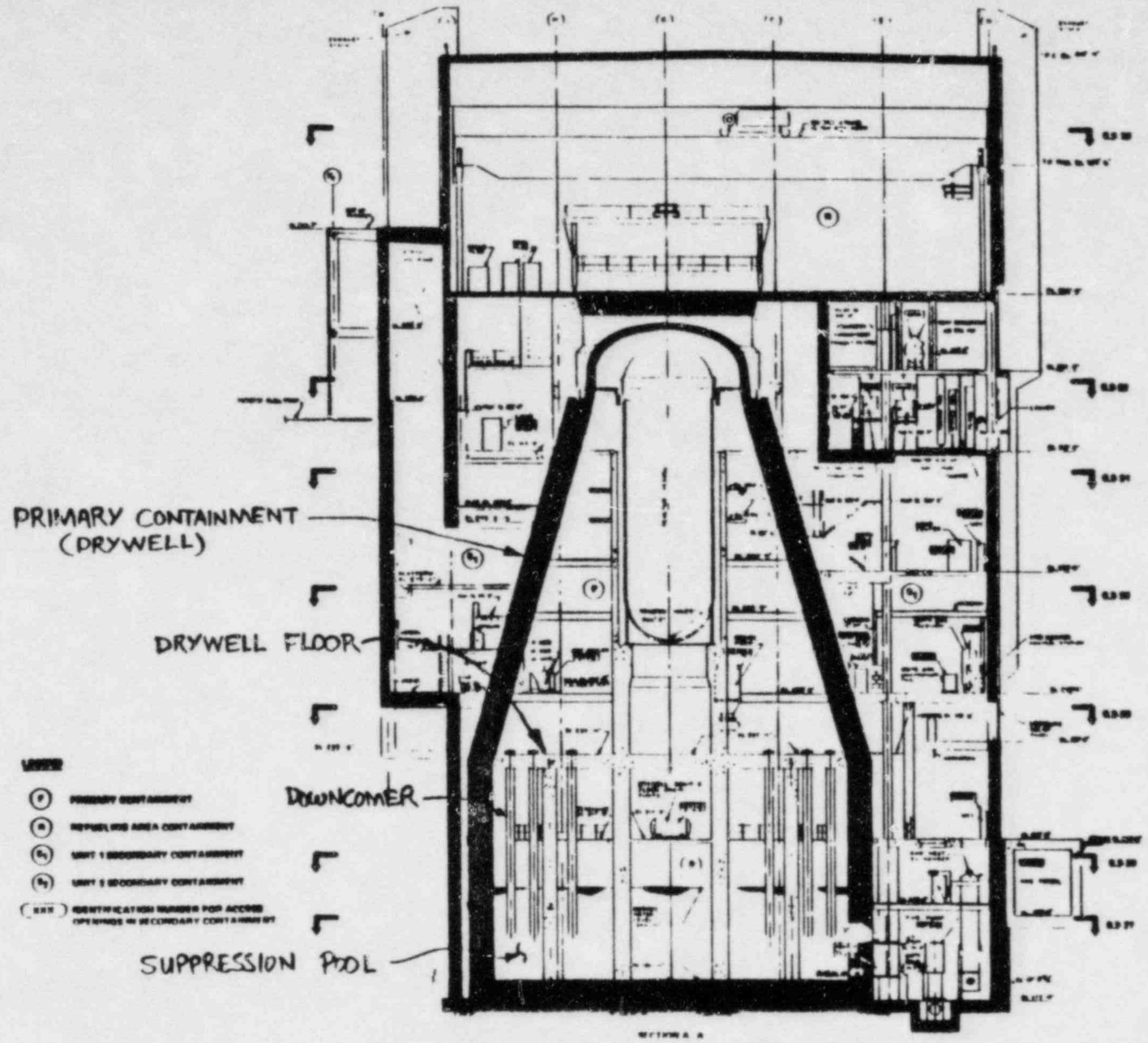
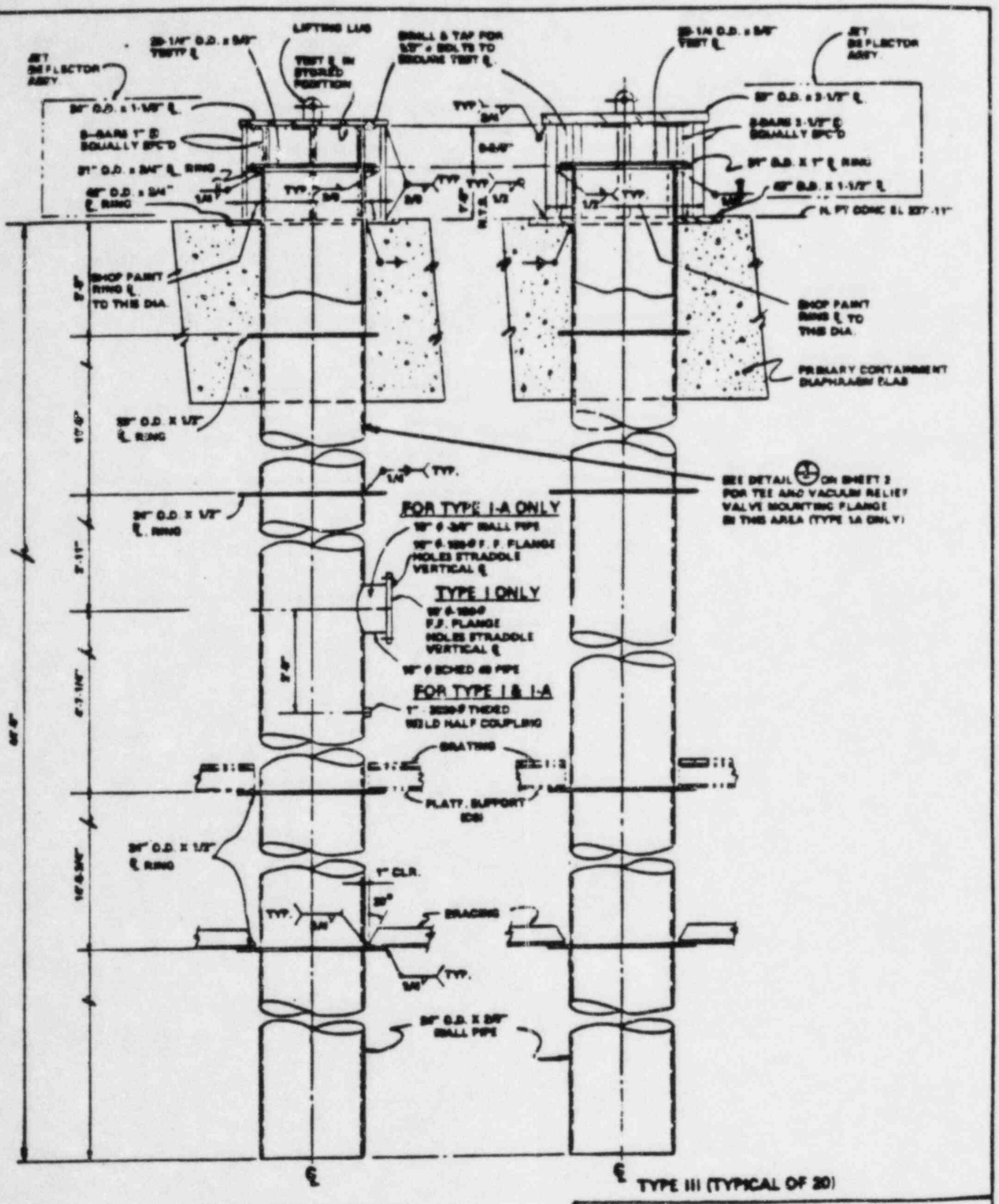


FIG. 2-2 REV. 0

LIMERICK GENERATING STATION
UNITS 1 AND 2
FINAL SAFETY ANALYSIS REPORT

SECONDARY CONTAINMENT
BOUNDARY OUTLINE
NORTH SOUTH SECTION VIEW



TYPE III (TYPICAL OF 20)

TYPE I (TYPICAL OF 8)
TYPE IA (TYPICAL OF 4)
TYPE II (TYPICAL OF 57)

NOTE - DOWNCOMERS WITH END CAPS ARE NOT SHOWN.

LIMERICK GENERATING STATION
UNITS 1 AND 2
FINAL SAFETY ANALYSIS REPORT

DOWNCOMER DESIGN DETAILS

FIG. 2-3 REV. 0

~~FIGURE 6.2-1~~ ~~SHEET 1 OF 2~~

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STRAINER	NPS *	A LENGTH	FLANGE O.D. I.D. THK.	C DIA.
CS	16	30 3/4	23 1/2"–15 1/4"–1/2"	4"
RHR	24	35 3/4	32"–23 1/4"–1/2"	10 1/4"

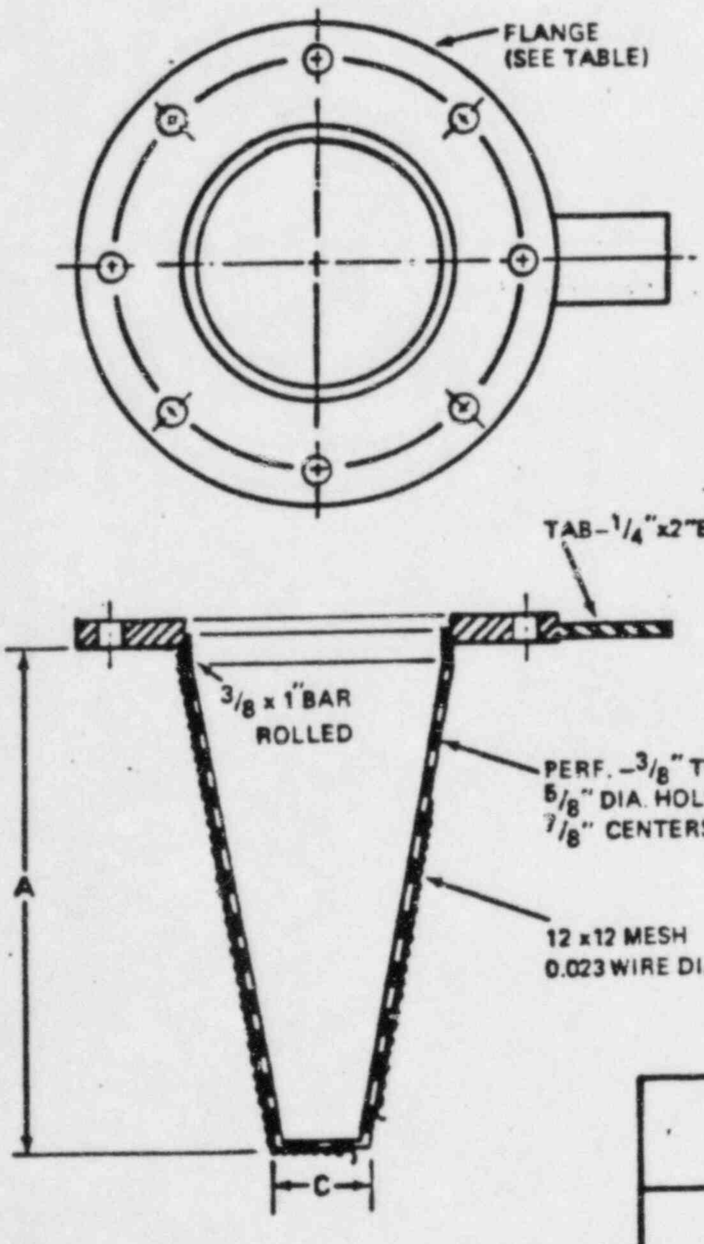
* NOMINAL PIPE SIZE

NOTES:

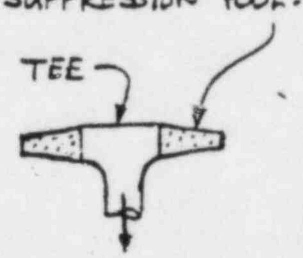
(1) THERE ARE TWO LONGITUDINAL ARC WELDS ON THE PERFORATED PLATE

(2) THERE IS ONE LONGITUDINAL RESISTANCE WELD ON THE 12 MESH CLOTH.

(3) MATERIAL OF CONSTRUCTION IS STAINLESS STEEL; 304L FOR THE BODY AND 316L FOR THE MESH.



STRAINERS ARE INSTALLED IN "TEE" CONFIGURATION IN THE SUPPRESSION POOL.



PLAN VIEW

LIMERICK GENERATING STATION
UNITS 1 AND 2
FINAL SAFETY ANALYSIS REPORT

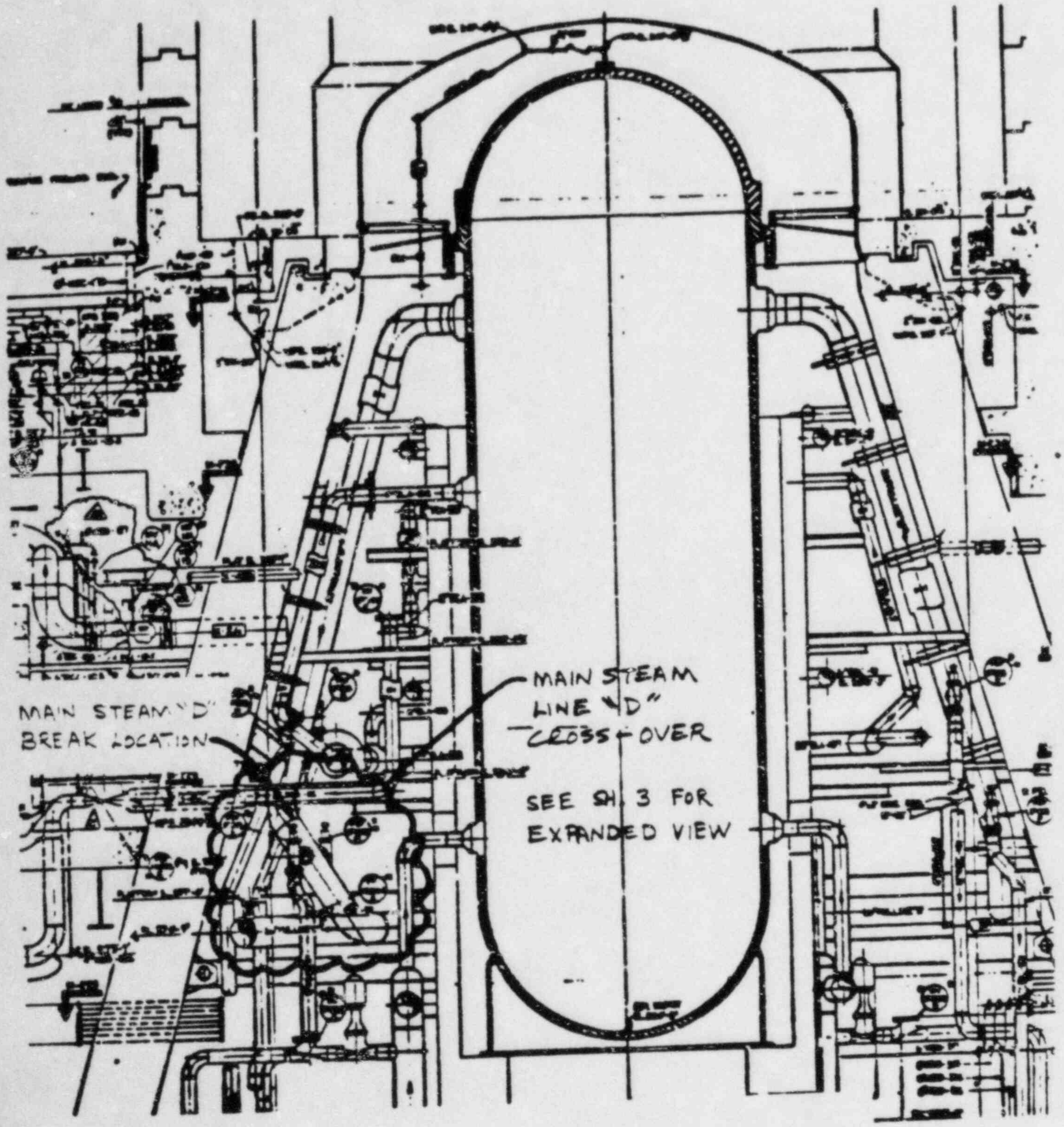
SUPPRESSION POOL SUCTION STRAINERS

~~FIGURE 6.2-51~~ ~~REV. 11, 10/82~~

3/16/84

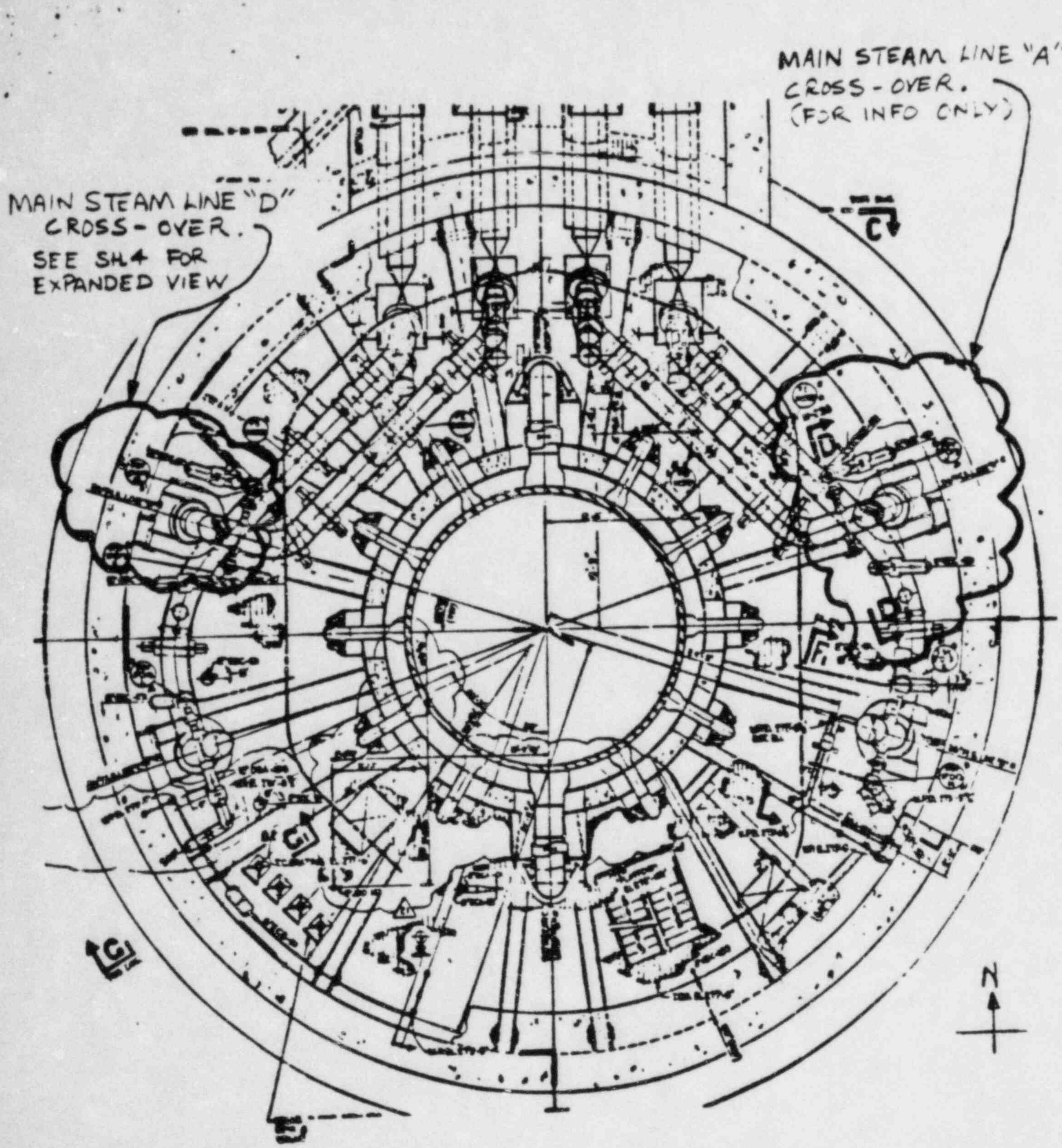
REV. 4

FIG. 2-4



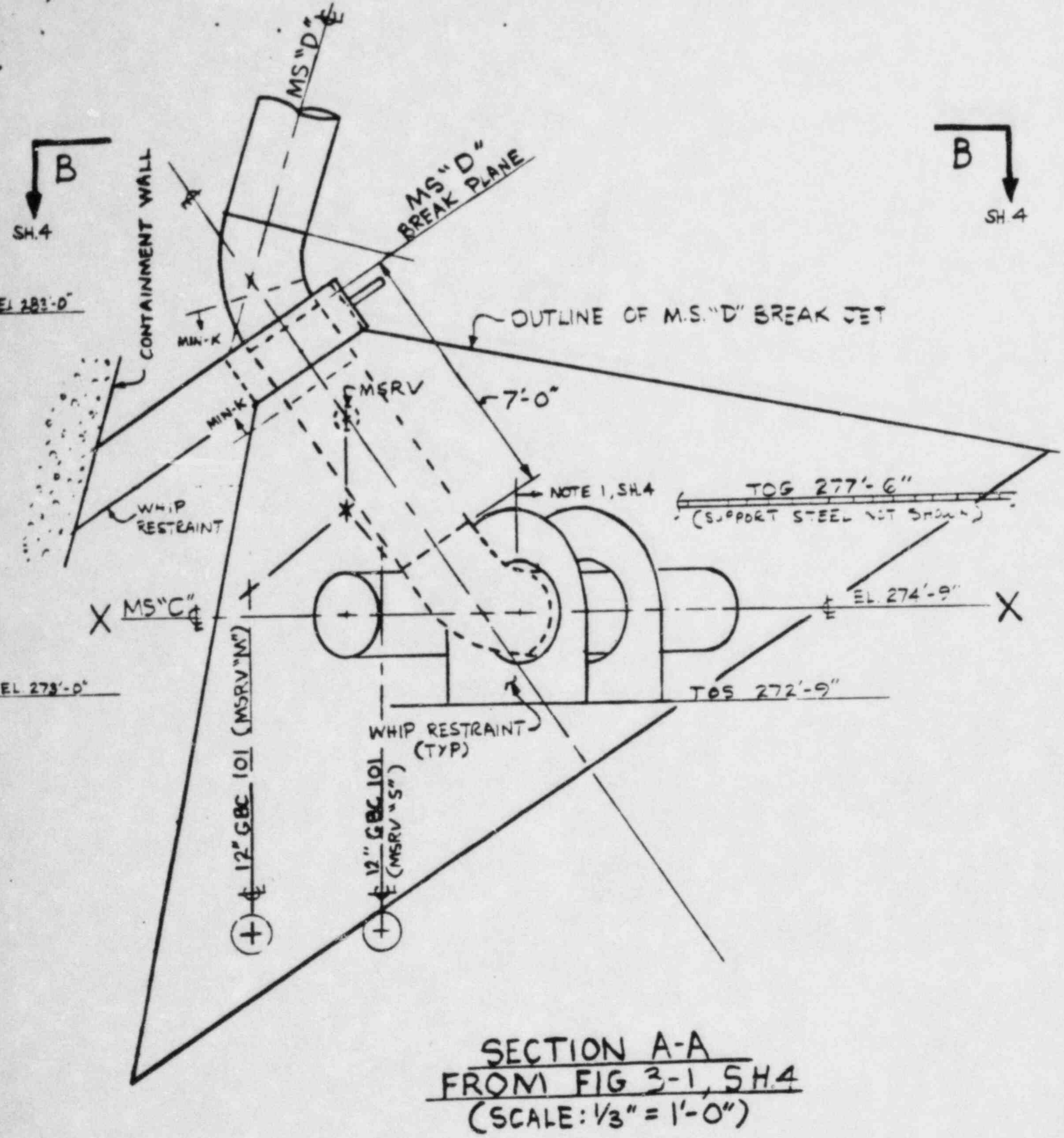
REACTOR ENCLOSURE
DRYWELL SECTION
(REF. DWG 8031-M-215)

LIMERICK	UNITS 1 & 2
MAIN STEAM LINE	BREAK
FIG. 3-1, SH. 1 OF 4	REV. 4



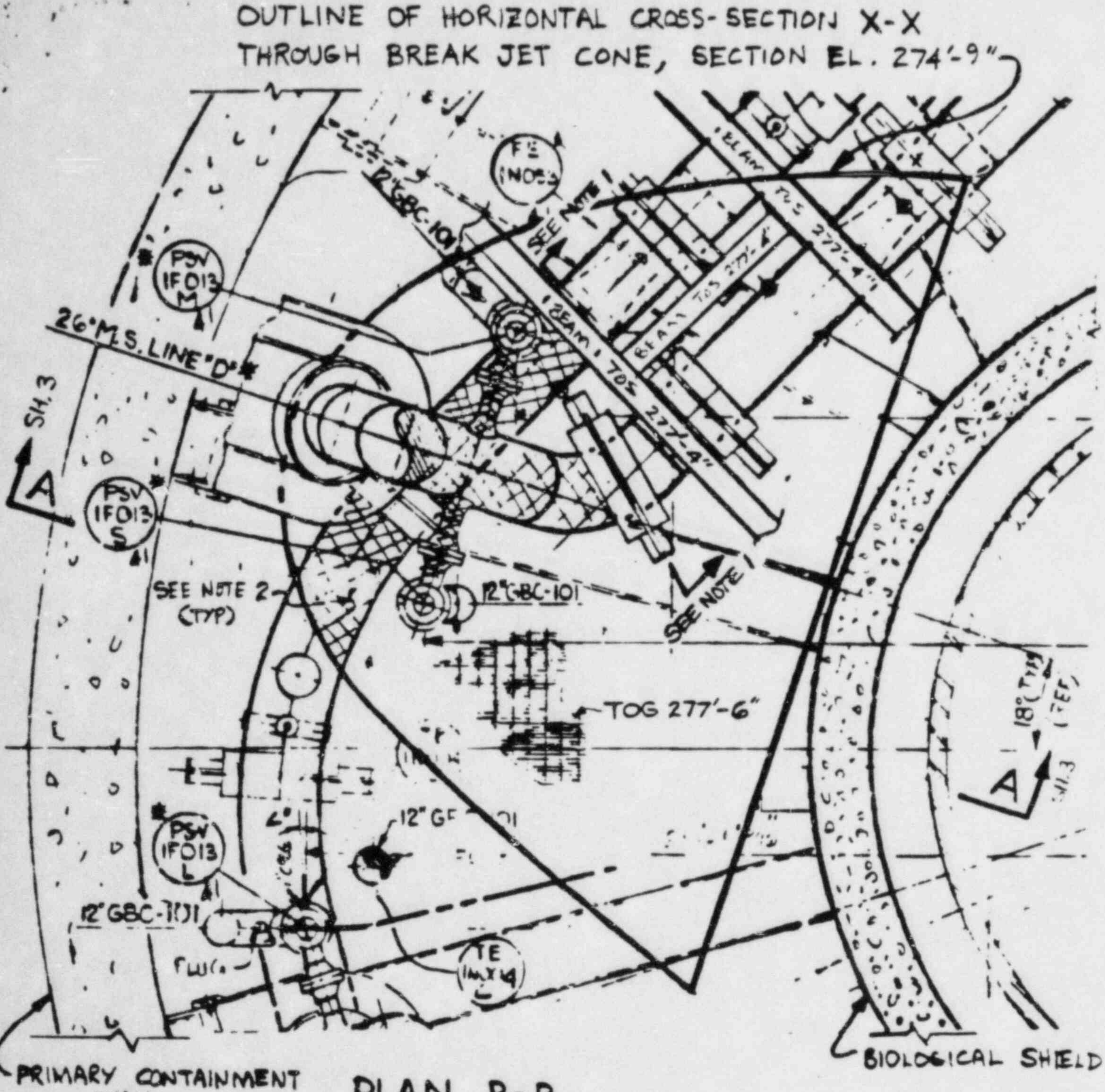
PLAN VIEW
PRIMARY CONTAINMENT
DRYWELL ELEV. 272'-9"
(REF. 8031-M-226)

LIMERICK	UNITS 1 & 2
MAIN STEAM LINE	BREAK
FIG. 3-1, SH. 2 OF 4	REV. 4



SECTION A-A
FROM FIG 3-1, SH.4
(SCALE: 1/3" = 1'-0")

LIMERICK	UNITS 1 & 2
MAIN STEAM LINE	BREAK
FIG. 3-1, SH. 3 OF 4	REV. 4



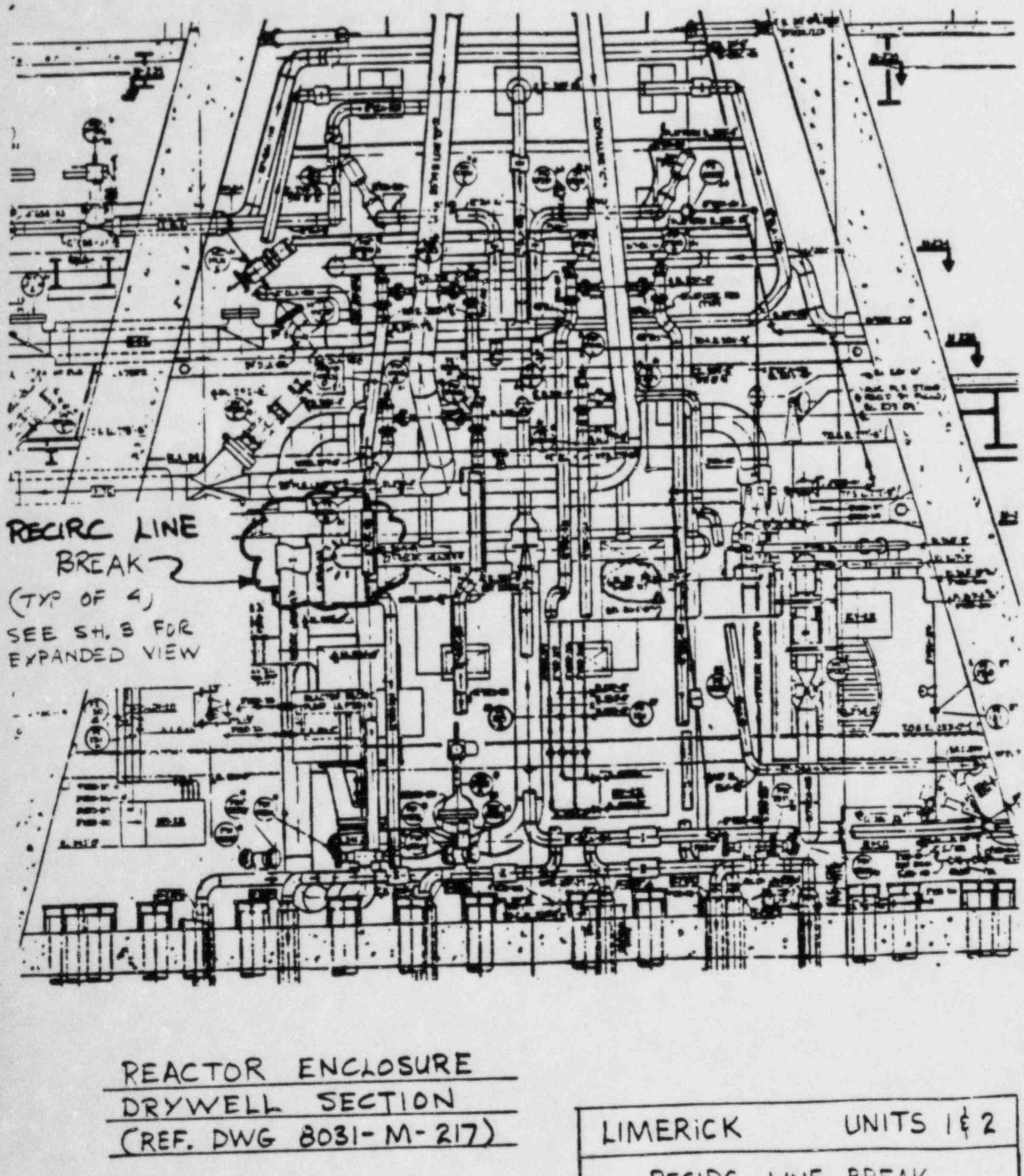
PLAN B-B
FROM FIG. 3-1, SH. 3
(SCALE: 1/4" = 1'-0")

NOTES:

1. PIPE BEYOND SECTION IS IN SHADOW OF AN OBSTRUCTION IN THE JET BLAST CONE AND IS NOT EXPOSED TO DIRECT JET IMPINGEMENT.

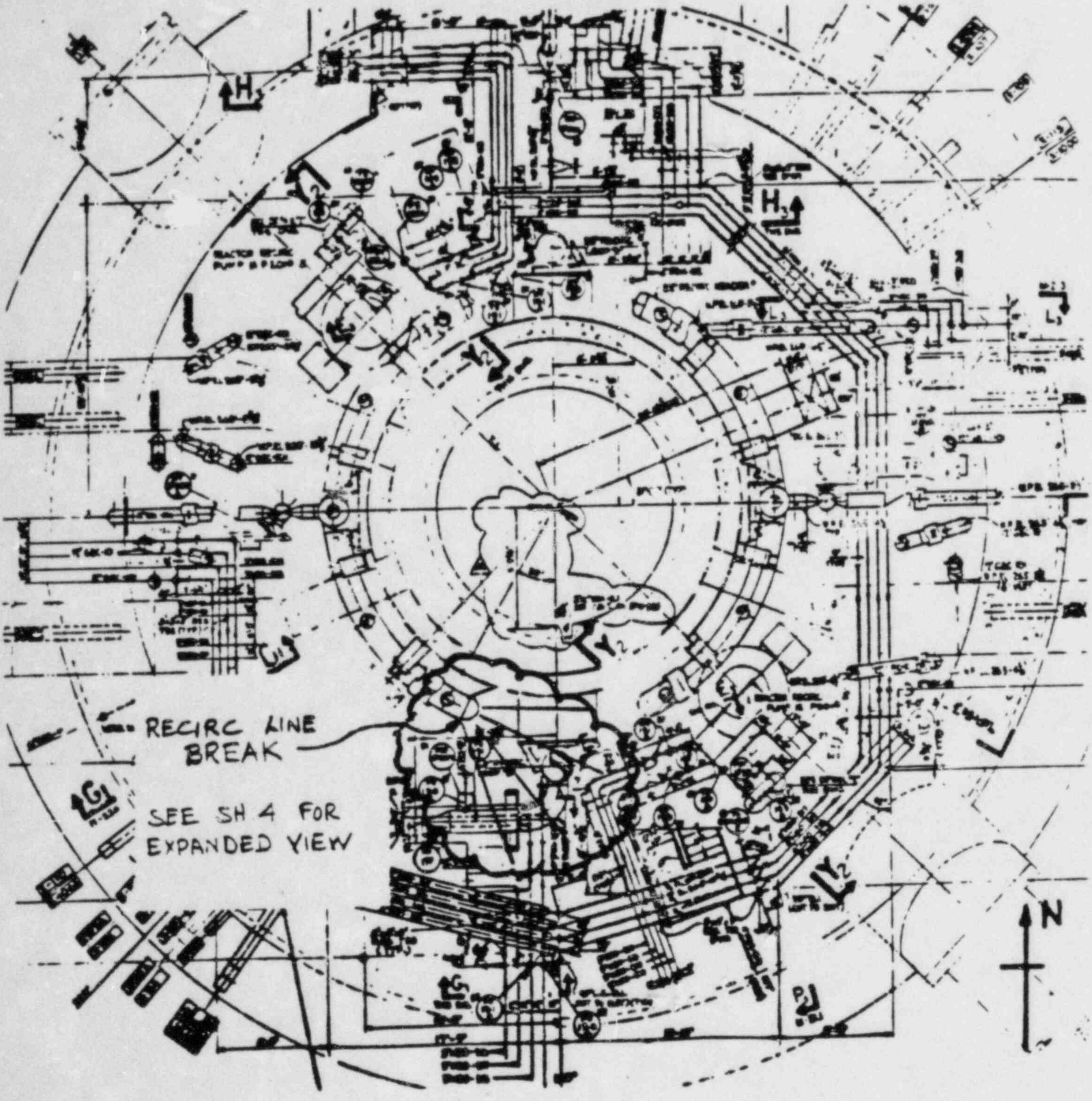
2. CROSS-HATCHING INDICATES PORTION OF PIPE EXPOSED TO REGION I JET IMPINGEMENT.

LIMERICK	UNITS 1 & 2
MAIN STEAM LINE	BREAK
FIG. 3-1, SH. 4 OF 4	REV. 4



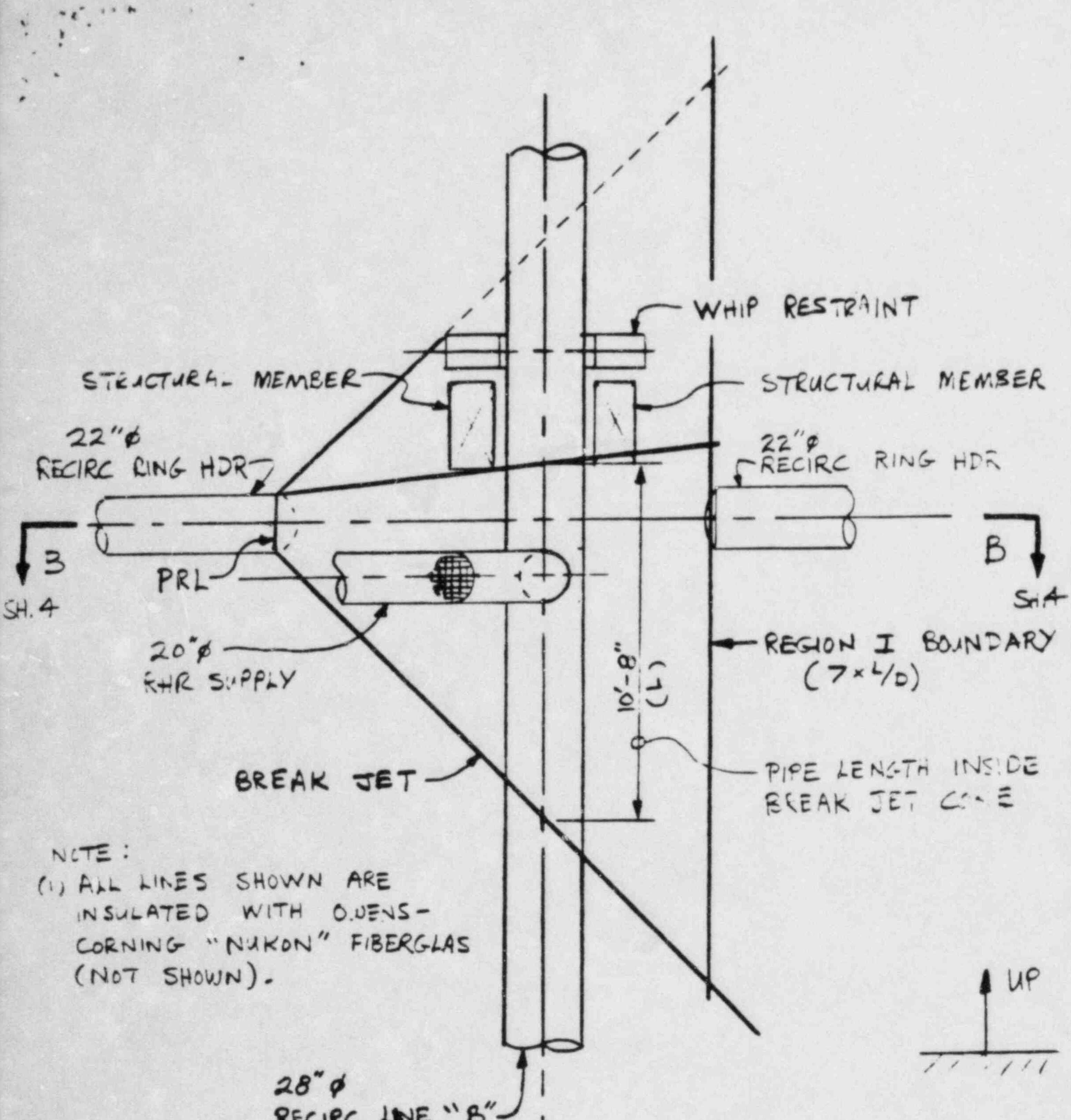
REACTOR ENCLOSURE
DRYWELL SECTION
(REF. DWG 8031-M-217)

LIMERICK	UNITS 1 & 2
RECIRC LINE BREAK	
FIG. 3-2, SH. 1 OF 4	REV. 4



REACTOR ENCLOSURE
DRYWELL PLAN - EL. 253'-0"
(REF. DWG 8031-M-225)

LIMERICK	UNITS 1 & 2
RECIRC LINE BREAK	
FIG. 3-2, SH. 2 OF 4	REV. 4



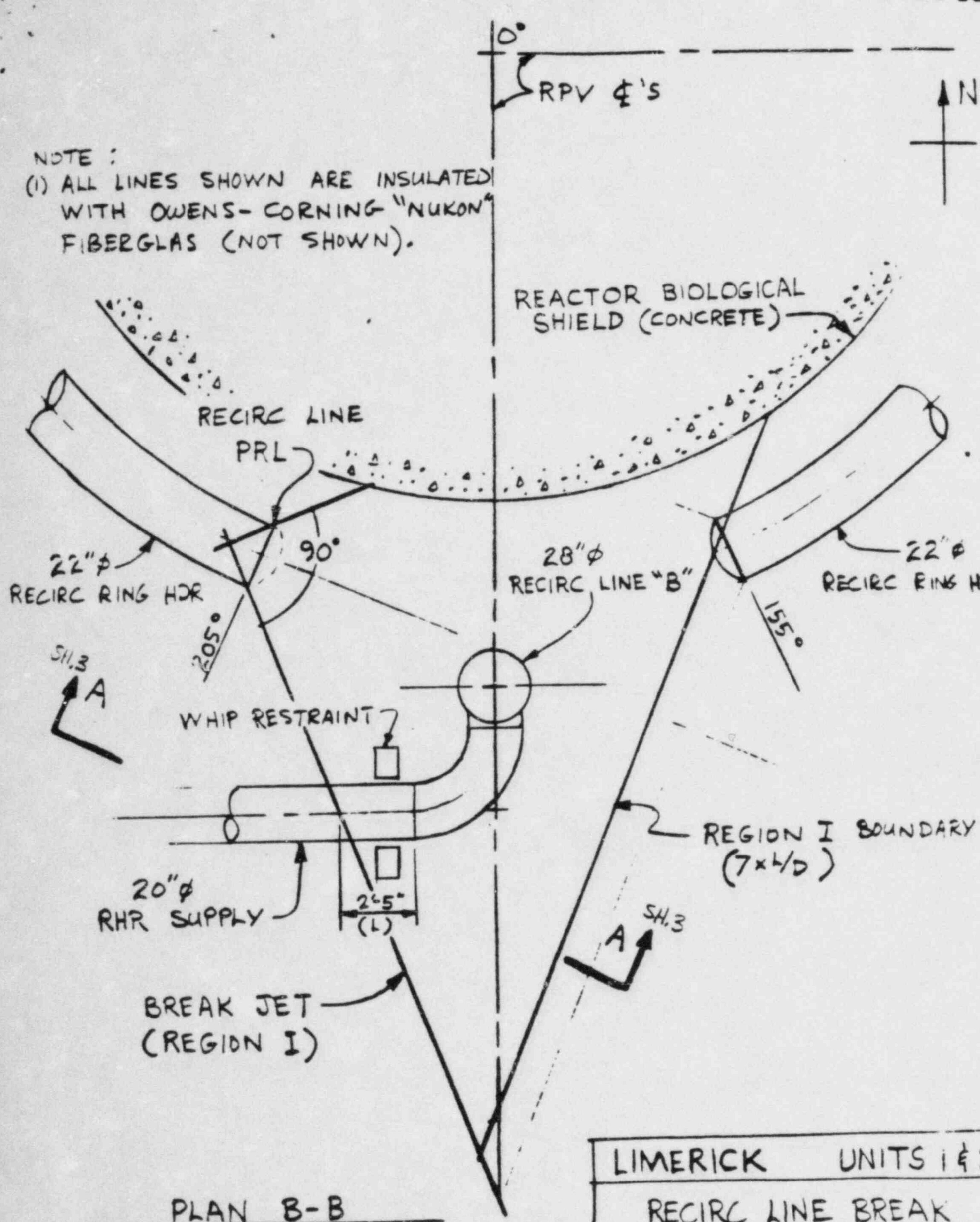
SECTION A-A
FROM FIG. 2-2, SH. 4

LIMERICK UNITS 1 & 2

RECIRC LINE BREAK

FIG. 3-2, SH. 3 OF 4 REV. 4

175943

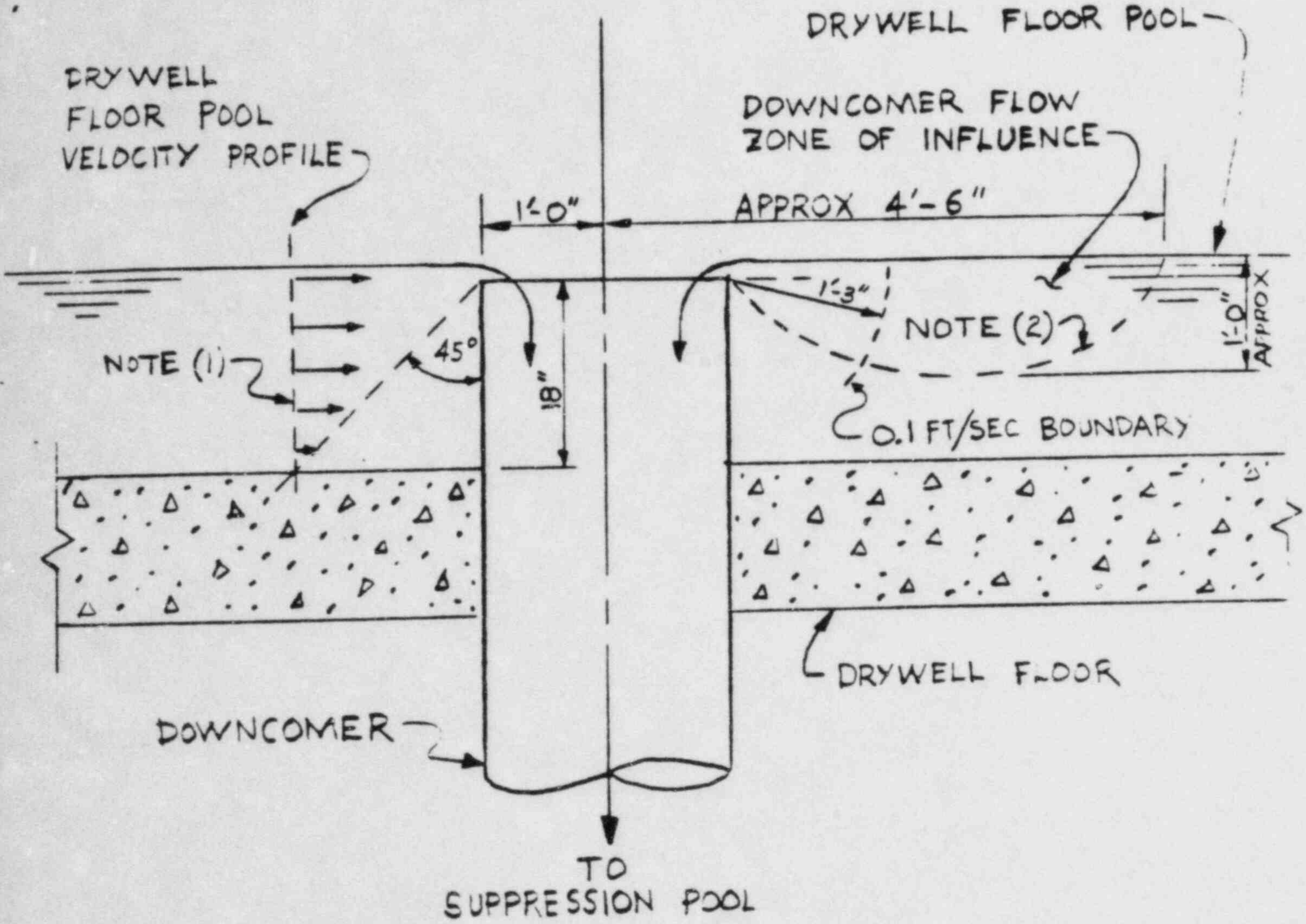


PLAN B-B

FROM FIG. 3-2, SH. 3

LIMERICK UNITS 1 & 2	
RECIRC LINE BREAK	
FIG. 3-2, SH. 4 OF 4	REV. 4

175943



NOTES

(1) THE BOTTOM FLOW VELOCITY IS ASSUMED TO BE MAXIMUM AT THE LOCATION SHOWN.

(2) THE FLOW ZONE OF INFLUENCE IS BOUNDED BY THE CALCULATED PATH OF THE FURTHEST SLOW SINKING FRAGMENT THAT IS CARRIED BY THE FLOW INTO THE DOWNCOMER.

LIMERICK UNITS 1 & 2	
FLOW ZONE OF INFLUENCE AROUND DOWNCOMER RIM	
FIG. 3-3	REV. 0