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P. O. BOX 1640, JACKSON, MISSISSIPPI 39205

October 2, 1980

NUCLEAR PRODUCTION DEPARTMENT

U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, D.C. 20555

Attention: Mr. Harold R. Denton, Director

Dear Sir:

SUBJECT: Grand Gulf Nuclear Station
Units 1 and 2
Docket Nos. 50-416 and 50-417
File 0260/0277/L-860.0
Category I Masonry Walls
AECM-80/206

Attached is our response to your request of April 21, 1980, entitled "Information Request on Category I Masonry Walls Employed by Plants under CP and OL Review." If you have any questions, please advise.

Yours truly,

L. F. Dale
Nuclear Project Manager

MRK/JDR:lm
Attachment

cc: Mr. N. L. Stampley
Mr. R. B. McGehee
Mr. T. B. Conner

Mr. Victor Stello, Jr., Director
Division of Inspection & Enforcement
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dr. Franz Schauer, Chief*
Structural Engineering Branch
Nuclear Regulatory Commission
Washington, D.C. 20555

* To Receive Drawings

B001
S
1/1
SEND Dwgs to:
TSRA (Return to Reg files after filming)

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A

RESPONSE TO NRC QUESTIONS ON

INFORMATION REQUEST FOR CATEGORY I MASONRY WALLS

1. Are there any concrete masonry walls being used in any of the Category I structures of your plant? If the answer is "No" to this question there is no need to answer the following questions.

RESPONSE

There are concrete masonry walls in the Auxiliary and Control Buildings at Grand Gulf. The masonry walls in Category I buildings are designed to Category I requirements where Category I systems, equipment and components are attached to them and where safety related equipment, systems or components exist in the proximity.

Masonry walls that are not in the vicinity of safety related equipment or systems and have no Category I attachments are designed as Non-Category I walls.

No masonry walls in Category I structures function as shear walls to resist lateral loads. With a few minor exceptions, the masonry walls are designed as non-load bearing walls and have a nominal gap of 1 inch at the ceiling interface. The exceptions are bearing walls that sustain stair landings, isolated room roofs, etc.

2. Indicate the loads and load combinations to which the walls were designed to resist. If load factors other than one (1) have been employed, please indicate their magnitudes.

RESPONSE

The following loads are used for masonry walls designed as Category I:

D	=	Dead load of wall
L	=	Live load, equipment, system or component supported from the wall
E, E'	=	Operating earthquake, safe shutdown earthquake, respectively
W'	=	Tornado depressurization load for interior walls (there are no exterior concrete masonry walls in Category I structures)
Pa, Ta, Ra	=	Pressures, temperatures, forces due to pipe break accident
To	=	Thermal gradient and/or pipe reaction on walls from piping systems during operating condition. (Only Non-Category I, 2" diameter and under piping is installed on block walls)

Load combinations for above are as follows:

1.	D + L + To	$\leq$ 1.0S
2.	D + L + To + E	$\leq$ 1.25S
3.	D + L + Ta + Ra + 1.25 Pa + 1.25 E	$\leq$ 1.33S
4.	D + L + Ta + Ra + 1.0 Pa + 1.0 E'	$\leq$ 1.33S
5.	D + L + Ta + E'	$\leq$ 1.33S
6.	D + L + To + W'	$\leq$ 1.33S

S = Allowable working stress as defined in National Concrete Masonry Association's "Specification for Design and Construction of Load Bearing Concrete Masonry" August, 1970

The following loads are used for masonry walls designed as Non-Category I:

D = Dead load of wall
E = Earthquake load as defined in the Uniform Building Code (UBC) 1970 Edition for Zone 1
W = Wind load

Load combinations for above:

1. D $\leq$ 1.0S
2. D + E $\leq$ 1.33S
3. D + W $\leq$ 1.33S

3. In addition to complying with the applicable requirements of the SRP Sections 3.5, 3.7 and 3.8, is there any other code, such as the "Uniform Building Code" or the "Building Code Requirements for Concrete Masonry Structures" (proposed by the American Concrete Institute) which was or is being used to guide the design of these walls? Please identify and discuss any exceptions or deviations from the SRP requirements or the aforementioned codes.

RESPONSE

The following codes and national specifications are used for the masonry walls:

1. Uniform Building Code (UBC) 1970 Edition, earthquake regulations to define seismic forces on walls designed as Non-Category I.

2. "Specification for the design and construction of load bearing concrete masonry by NCMA (National Concrete Masonry Association) August, 1970.

Please refer to Grand Gulf FSAR paragraphs 3.5, 3.7 and 3.8 for exceptions and deviations from the SRP requirements.

4. Indicate the method that you used to calculate the dynamic forces in masonry walls due to earthquake, i.e., whether it is a code's method such as Uniform Building Code, or a dynamic analysis. Identify the code and its effective date if the code's method has been used. Indicate the input motion if a dynamic analysis has been performed.

RESPONSE

A dynamic analysis is used for walls designed to Category I requirements as described here. Out-of-plane seismic response is determined by calculating the natural frequency of the wall and considering the actual load and boundary conditions. Accelerations in G's are taken from floor response spectrum curves of the floor on which the wall is supported. The acceleration is multiplied with a factor of 1.20 to account for higher mode effects and system coupling. Critical damping of 2% and 5% is used for "OBE" and "SSE" respectively. The stiffness of the masonry walls is determined by considering cracked section analysis.

For walls designed as Non-Category I, a static equivalent load is used as described in UBC, 1970 Edition.

5. How were the masonry walls and the piping/equipment supports attached to them designed? Provide enough numerical examples including details of reinforcement and attachments to illustrate the methods and procedures used to analyze and design the walls and the anchors needed for supporting piping/equipment (as applicable).

RESPONSE

There are only Non-Category I small pipe ($D \leq 2"$) and light Category I equipment supported on masonry block walls. The equipment includes Electrical, HVAC and instrumentation compenents. Standard details using a through bolt and plate system are typically used to attach these supports on the walls.

Attachment locations are selected by Field Engineers and reviewed by a survey performed periodically by the Design Engineer. The survey information provides the approximate locations and approximate weight of the attachments marked on a wall elevation drawing. Weights heavier than 100 lbs. are included in the dynamic analysis of the wall as concentrated loads. Weights less than 100 lbs. are taken into account as uniformly distributed loads. These loads are considered as live loads. According to the intensity of these light attachments, a 5 PSF or 10 PSF load is assigned for each face of the wall. The penetration openings that provide access for the systems are taken into account in determining the strength of the walls.

The following sample design calculations and details are provided:

Pages 1 and 2:	Formula used for seismic loads; material properties
Pages 3 and 4:	Capacity of section and moment inertia of section calculations for 8" and 12" thick walls
Pages 5 and 6:	Frequency and response calculations for different wall spans, check for tornado depressurization and final comparison with section capacity.
Pages 7 thru 14:	Reinforcing and connection details for a typical masonry wall
Page 15:	Typical attachment detail with through bolt and plate assembly for 2" diameter and under Non-Category I piping

6. Provide plan and elevation views of the plant structures showing the location of all masonry walls for your facility.

RESPONSE

The attached drawings show the plan and elevation views of the plant structures, showing the location of the Category I masonry walls within the Category I structures of Grand Gulf. Due to the continuously ongoing work operations, some wall elevations do not show all current penetration and structural repair work.

Drawings provided are as follows:

Title	Drawing No.	Rev.
Units 1 & 2 CMU Wall Penetrations Control Bldg. Access Control Plan @ El. 93'-0"	A-0850	6
Units 1 & 2 CMU Wall Penetrations Control Bldg. Switchgear Room Plan @ El. 111'-0"	A-0851	8
Units 1 & 2 CMU Wall Penetrations Control Bldg. HVAC Equip. Room Plan @ El. 133'-0"	A-0852	5
Units 1 & 2 CMU Wall Penetrations Control Bldg. Computer Room Plan @ El. 148'-0"	A-0853	11
Units 1 & 2 CMU Wall Penetrations Control Bldg. Control Room Plan @ El. 166'-0"	A-0854	6
Units 1 & 2 CMU Wall Penetrations Control Bldg. Control Room Viewing Gallery Plan @ El. 177'-0"	A-0855	6
Units 1 & 2 CMU Wall Penetrations Schedule Control Bldg. @ El. 93'-0"	A-0870A	1
Units 1 & 2 CMU Wall Penetrations Schedule Control Bldg. @ El. 93'-0"	A-0870B	1
Units 1 & 2 CMU Wall Penetrations Schedule Control Bldg. @ El. 111'-0"	A-0871A	1
Units 1 & 2 CMU Wall Penetrations Schedule Control Bldg. @ El. 111'-0"	A-0871B	1
Units 1 & 2 CMU Wall Penetrations Schedule Control Bldg. @ El. 133'-0"	A-0872	4
Units 1 & 2 CMU Wall Penetrations Schedule Control Bldg. @ El. 148'-0"	A-0873A	1
Units 1 & 2 CMU Wall Penetrations Schedule Control Bldg. @ El. 148'-0"	A-0873B	1
Units 1 & 2 CMU Wall Penetrations Schedule Control Bldg. @ El. 166'-0" and 177'-0"	A-0874A	1

Units 1 & 2 CMU Wall Penetrations Schedule Control Bldg. @ El. 166'-0" and 177'-0"	A-0874B	1
Units 1 & 2 CMU Wall Penetrations Schedule Control Bldg. @ El. 93'-0"	A-0877A	1
Units 1 & 2 CMU Wall Penetrations Elevations Control Bldg. @ El. 93'-0"	A-0877B	0
Units 1 & 2 CMU Wall Penetrations Elevations Control Bldg. @ El. 111'-0"	A-0878	7
Control Bldg. Structural & Masonry Sections and Details	A-0879	4
Control Bldg. Structural & Masonry Sections and Details	A-0880	5
Units 1 & 2 CMU Wall Penetrations Control Bldg. @ El. 133'-0"	A-0881	1
Units 1 & 2 CMU Wall Penetrations Elevations Control Bldg. @ El. 148'-0"	A-0882A	1
Units 1 & 2 CMU Wall Penetrations Elevations Control Bldg. @ El. 148'-0"	A-0882B	2
Units 1 & 2 CMU Wall Penetrations Elevations Control Bldg. @ El. 148'-0"	A-0882C	1
Units 1 & 2 CMU Wall Penetrations Elevations Control Bldg. @ El. 166'-0"	A-0883A	1
Units 1 & 2 CMU Wall Penetrations Elevations Control Bldg. @ El. 166'-0"	A-0883B	1
Units 1 & 2 CMU Wall Penetrations Elevations Control Bldg. @ El. 177'-0"	A-0884A	1
Units 1 & 2 CMU Wall Penetrations Elevations Control Bldg. @ El. 177'-0"	A-0884B	1
Units 1 & 2 CMU Wall Penetrations Elevations Control Bldg. @ El. 189'-0"	A-0884C	0
Units 1 & 2 Wall Penetrations Details Control Building	A-0890	5
Unit 1 CMU Wall Penetrations Auxiliary Bldg. Plans	A-1150	0
Unit 1 CMU Wall Penetrations Auxiliary Bldg. Plans	A-1151	0
Unit 1 CMU Wall Penetrations Elevations Auxiliary Building	A-1160	0

Unit 1 CMU Wall Penetrations Elevations Auxiliary Building	A-1161	0

SAMPLE DESIGN CALCULATIONS & DETAILS

FORMULAS USED FOR SEISMIC LOADS

NATURAL FREQUENCY — FROM CHAPTER II, "FUNDAMENTALS OF THE THEORY OF VIBRATION" p79

N_i (cycles/min) $= 9.55\, \zeta_i \sqrt{EI/\mu L^4}$ where μ is mass per unit L.

DIVIDE ABOVE BY 60 TO OBTAIN Hz

FOR SIMPLY SUPPORTED BEAM $\zeta_1 = \pi^2 = 9.87$
$\zeta_2 = (2\pi)^2 = 39.5$
$\zeta_3 = 88.9$

FOR CANTILEVER BEAM $\zeta_1 = 3.52$
$\zeta_2 = 22.4$
$\zeta_3 = 61.7$

AVERAGE WEIGHT OF CONCRETE MASONRY UNITS

WALL THICKNESS		LIGHTWEIGHT AGGREGATE				SAND-GRAVEL AGGREGATE			
		4"	6"	8"	12"	4"	6"	8"	12"
Individual Block	4" high units	9	11	13	18	10	16	19	28
	8" high units	16	22	26	37	20	33	38	56

AVERAGE WEIGHT OF COMPLETED WALL AND SOLID THICKNESS

WALL THICKNESS		LIGHTWEIGHT AGGREGATE			SAND-GRAVEL AGGREGATE			EQUIV. SOLID THICKNESS		
		6"	8"	12"	6"	8"	12"	6"	8"	12"
Solid grouted wall		56	77	118	68	92	140	5.6	7.6	11.6
Vertical cores grouted at	16" o.c.	46	60	90	58	75	111	4.5	5.8	8.5
	24" o.c.	42	53	79	53	68	99	4.1	5.2	7.5
	32" o.c.	40	50	73	51	65	93	3.9	4.9	7.0
	40" o.c.	38	47	70	50	62	89	3.8	4.7	6.7
	48" o.c.	37	46	68	49	61	87	3.7	4.6	6.5
No grout in wall		31	35	50	43	50	69	3.4	4.0	5.5

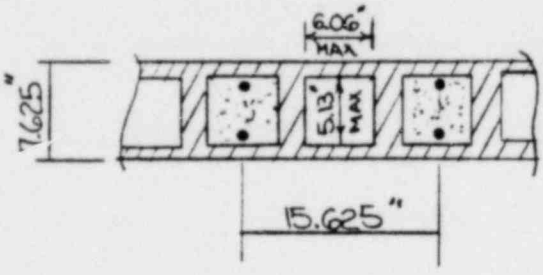
Note: The above table gives the average weights of completed walls of various thickness in pounds per square foot of wall face area. An average amount has been added into these values to include the weight of bond beams and reinforcing steel. Grout and mortar are assumed to use sand-gravel aggregates.
EQUIVALENT SOLID THICKNESS means the calculated thickness of the wall if there were no hollow cores, and is obtained by dividing the volume of solid material in the wall by the face area of the wall.

STANDARD REINFORCING BARS

BAR SIZE NUMBERS	NOMINAL DIMENSIONS — ROUND SECTIONS				WEIGHT POUNDS PER FOOT	AREA OF STEEL PER FOOT OF WALL					
	Diameter Inches		Cross Sectional Area Sq. Inches	Perimeter Inches		Bar Spacing in Inches					
						8	16	24	32	40	48
2	1/4"	.250	.05	.786	.167	.08	.04	.03	.02		
3	3/8"	.375	.11	1.178	.376	.17	.08	.06	.04	.03	
4	1/2"	.500	.20	1.571	.668	.30	.15	.10	.08	.06	.05
5	5/8"	.625	.31	1.963	1.043	.47	.23	.16	.12	.09	.08
6	3/4"	.750	.44	2.356	1.502	.66	.33	.22	.18	.13	.11
7	7/8"	.875	.60	2.749	2.044	.90	.45	.30	.23	.18	.15
8	1"	1.000	.79	3.142	2.670	1.19	.59	.40	.30	.24	.20
9	1-1/8"	1.128	1.00	3.544	3.400	1.50	.75	.50	.38	.30	.25
WIRE											
2 #-9		.148	.035	0.93	.117	.052	.026	.017	.013	.010	.008
2 #-8		.162	.041	1.02	.140	.062	.031	.021	.015	.012	.010
2 #-6	3/16"	.192	.058	1.21	.197	.087	.043	.029	.022	.017	.014

DESIGN BASES FOR CMU WALLS

SECTION PROPERTIES - 8" WALL, ALTERNATE CELLS REINFORCED



LOCATIONS OF BARS NOT CONTROLLED IN CELLS.

USE $d = \frac{7.625}{2} + \frac{.625}{2} = 4.13"$ (MID-CELL) (#5)

USE WORKING STRENGTH METHODS

$F_s = 24$ KSI ; $F_m = 450$ psi - SPECIAL INSPECTION PROVIDED

$E_m = 1350$ KSI $E_s = 29000$ KSI $n = 22$

$b = 15.625$ IN. $d = 4.13$ IN $A_s = 0.31$ SQ IN

$k = \sqrt{2np + (np)^2} - np = 0.3661$ $j = 1 - k/3 = 0.8780$

$M = \frac{F_m}{2} k j b d^2 = \frac{.450}{2}(.3661)(.8780)(15.625)(4.13)^2 = 19.3$ IN-K

$M_{CAP} = \frac{12}{15.625}(19.3)(1.333) = 19760$ IN-LB/FT OF WALL

($\frac{1}{3}$ STRESS INCREASE FOR SSE OR 'N')

NOTE: EFFECT OF WALL WEIGHT NEGLECTED - CONSERVATIVE

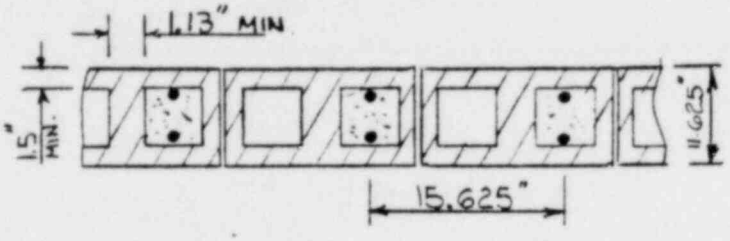
$I_G = \left[\frac{(15.625)(7.625)^3}{12} - \frac{6.06(5.13)^3}{12}\right] 12/15.625 = 391$ IN^4/FT

$I_{CR} = \left[\frac{b(kd)^3}{3} + nA_s(d[1-k])^2\right](12/15.625) = 65.2(12/15.625) = 50$ IN^4/FT

USE $I_A = \frac{1}{2}(I_G + I_{CR}) = 221$ IN^4/FT

DESIGN BASES FOR CMU WALLS

CAPACITY OF 12 IN WALL WITH ALT CELLS FILLED



LOCATIONS OF BARS NOT CONTROLLED IN CELLS.
USE $d = \frac{11.625}{2} + \frac{.625}{2} = 6.13$ IN.
(MIDCELL) .5

USE WORKING STRENGTH METHODS

$F_s = 24$ ksi — INSPECTION PROVIDED
$F_m = 450$ psi

$E_m = 1350$ ksi ; $E_s = 29000$ ksi ; $n = 22$

$b = 15.625"$ $d = 6.13"$ $A_s = 0.31$ $p = .31/(15.625)(6.13) = .0032$

$k = \sqrt{2np + (np)^2} - np = 0.3114$ $j = 1 - k/3 = 0.8962$

$M = \frac{F_m}{2} k j b d^2 = \frac{450}{2}(.3114)(.8962)(15.625)(6.13)^2 = 36.9$ IN-K

$\therefore M_{CAP} = (12/15.625)(369)(1.333) = 37740$ IN-LB
(1.333 ← 1/3 ALLOW INCREASE FOR SSE OR W)

$\mu = 90$ PSF $/ (32.2 \times 12 \times 12) = 0.0194$ $\frac{LB\text{-}SEC^2}{IN^2}/FT$

$I_g = \left[15.625(11.625)^3/12 - (6.13)(8.63)^3/12\right] 12/15.625 = 1320$ IN^4/FT

$I_{CR} = \left[\frac{b(kd)^3}{3} + nA_s(d(1-k))^2\right](12/15.625) = 120$ IN^4/FT

USE $I_a = \frac{1}{2}[I_g + I_{cr}] = 720$ IN^4/FT

INTERIOR WALLS EL 133'

2) STAIRWELL

$\mu = 0.0129 \frac{LB-SEC^2}{IN^2}$

$N = 9.55(9.87)\sqrt{\frac{1350000(221)}{(.0129)(14\times12)^4}}\left(\frac{1}{60}\right) = 8.5$ HZ

$\alpha = 0.64g$, E-W SSE W/ 5% DAMPING

$M = .129(.0129)(14\times12)^2(1.04)(.64\times386) = 12070 \frac{IN-LB}{FT}$

ADD 20% FOR HIGER MODES, $M = 14480 \frac{IN-LB}{FT}$ ← (CONTROLS)

$M_{W'} = \frac{1}{8}(30.8)(12)(14)^2 = 9060 \frac{IN-LB}{FT}$

$M = 14480 < M_{CAP} = 19760$

► CORRIDOR

REF: SECT 4/A-0881 EAST $W' = \begin{cases} 30.8 \text{ PSF SOUTH} \\ 55.3 \text{ PSF NORTH} \end{cases}$ (CALC. T-455.0, P197)

1) EVALUATE HORIZONTAL REINFORCING OVER SOUTH DOOR

SPAN = 10 FT BETWEEN WALLS
EFFECTIVE WIDTH = 3.5 FT
WIDTH = 5.5 FT

M_{SSE} - SIM. TO HVAC EQUIP. RM. OK

$M_{W'} = \frac{1}{8}(30.8\times5.5)12(10)^2/3.5 = 7260$

$M_{W'} < M_{CAP} = 10420 \frac{IN-LB}{FT}$

2) NORTH DOOR

M_{SSE} - SIM. TO HVAC EQUIP. RM OK

SPAN = 8 FT BETWEEN WALLS
EFFECTIVE WIDTH = 4.0 FT (UNDER PENET) $M_{W'} = \frac{1}{8}(55.3\times6.5)12(8)^2/4.0 = 8630$
WIDTH = 6.5 FT

$M_{W'} < M_{CAP} = 10420 \frac{IN-LB}{FT}$

6/15

INTERIOR WALLS EL 133'

► HVAC EQUIPMENT ROOM

REF: SECT 2/A-0881, SOUTH (W'=40.7 PSF, CT-4550, REV.0, P197)

1) EAST END AT DOOR

WIDTH OF WALL SEGMENT APPROX. 8'-6" WITH MOST VERTICAL REINFORCING INTERRUPTED BY DOOR & PENETS. ANALYZE WALL FOR HORIZONTAL ACTION.

$\mu = 0.0129 \frac{LB\text{-}SEC^2}{IN^2}$ PER FOOT, $L = 8.5$ FT, $I_a = 170 \frac{IN^4}{FT}$

$N = 9.55(9.87)\sqrt{\frac{1350000(170)}{.0129(8.5\times12)^4}}\left(\frac{1}{60}\right) = 20$ HZ

$a = 0.5g^I$, N-S SEE $\omega/5\%$ DAMPING

$M = 0.129(0.0129)(8.5\times12)^2(1.04)(0.5\times386) = 3475 \frac{IN\text{-}LB}{FT}$

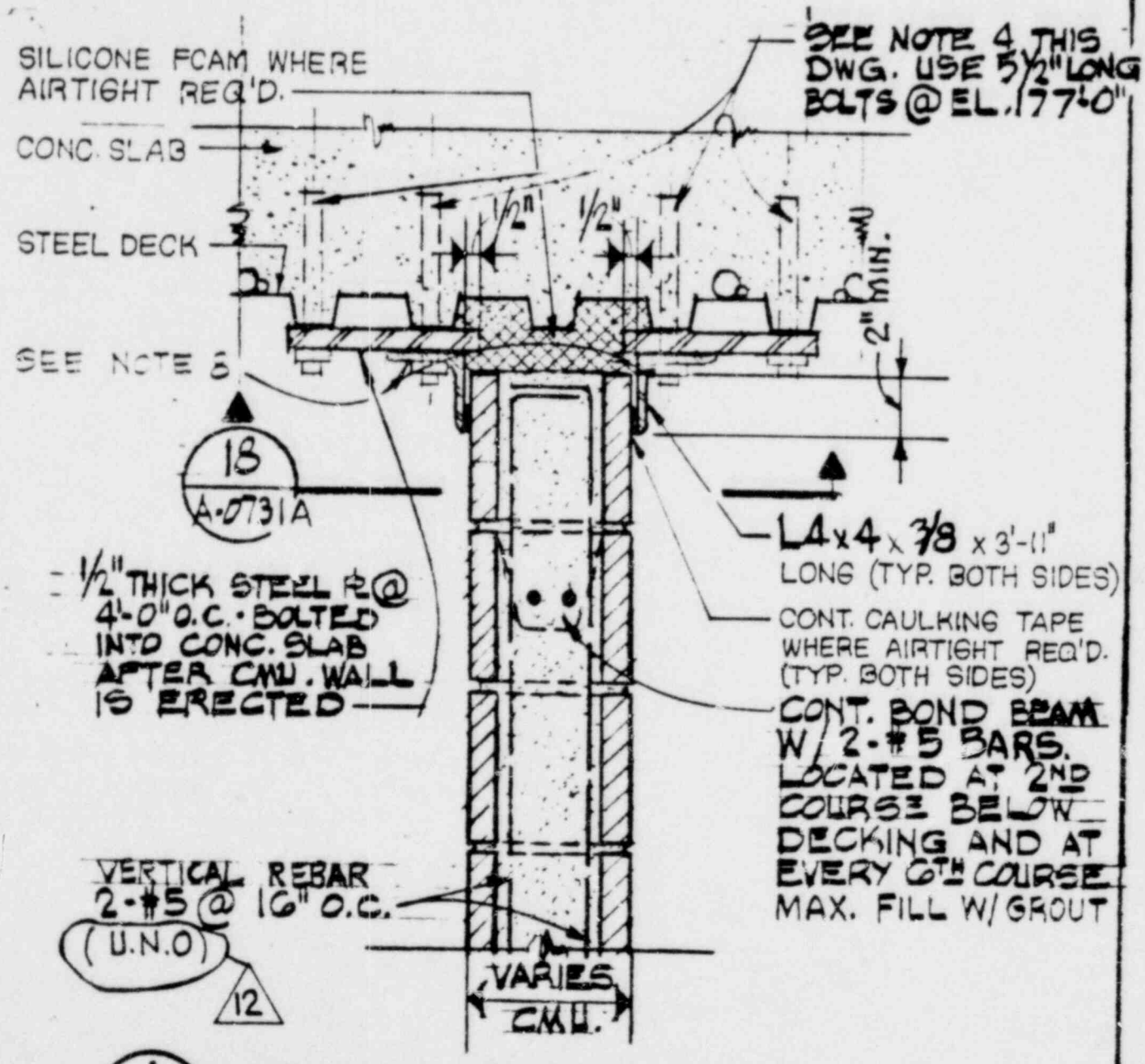
USE $M_{USE} = 1.20M = 4170 \frac{IN\text{-}LB}{FT}$

$M_{W'} = \frac{1}{8}(40.7)(8.5)^2(12) = 4410 \frac{IN\text{-}LB}{FT}$ (CONTROLS) $< M_{CAP} = 10420$

2) WALL SEGMENT BETWEEN LINE G.6 AND N-S CMU WALL (EAST END)

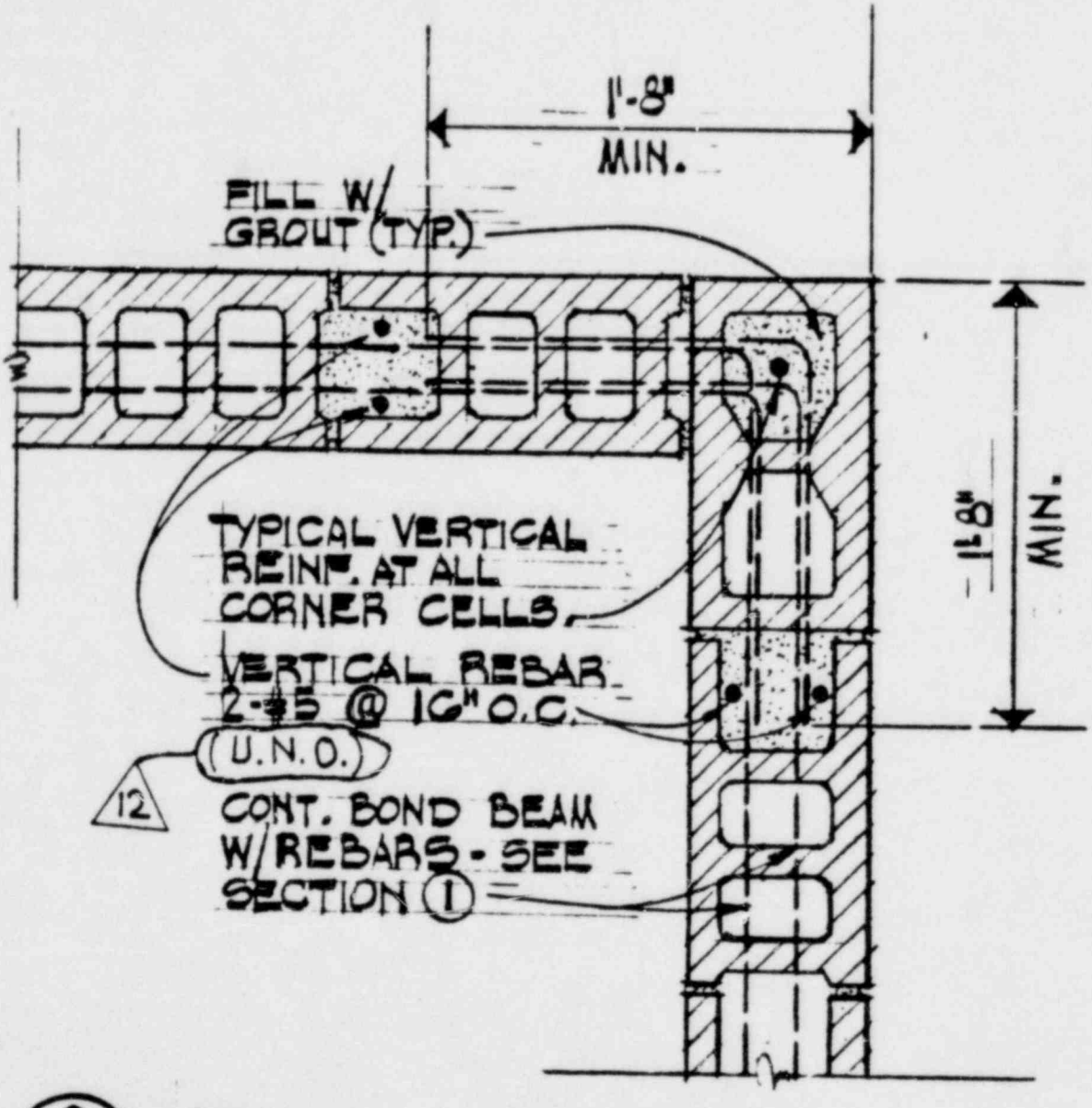
ORIENTATION AND SIZE OF PENETRATIONS RESULT IN AN ESTIMATED 65% OF VERTICAL REINFORCING CUT.

ADDITIONAL REINFORCING WILL BE REQUIRED



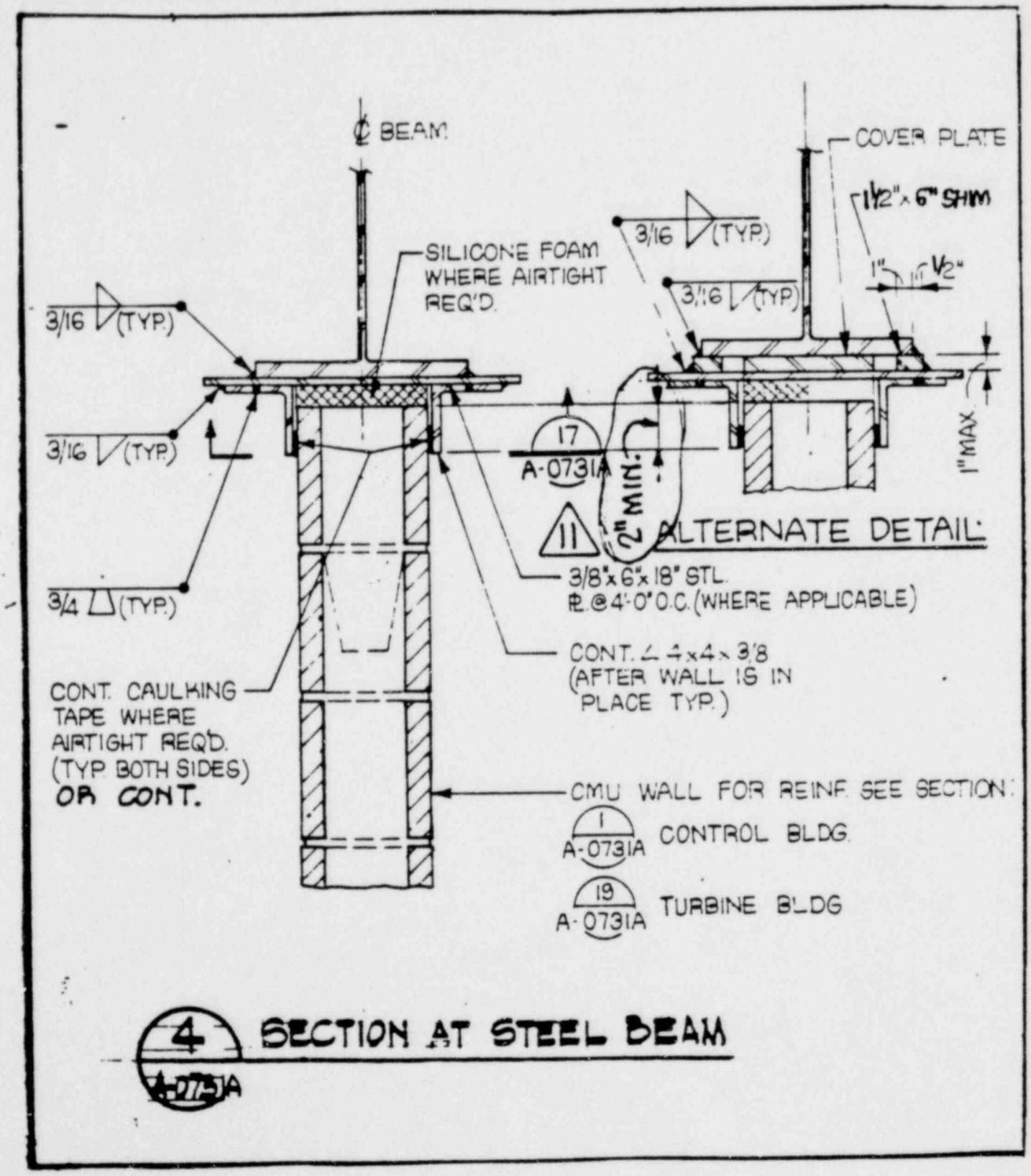
1 / A-0731A SECTION AT STEEL DECK

CONTROL BUILDING ONLY

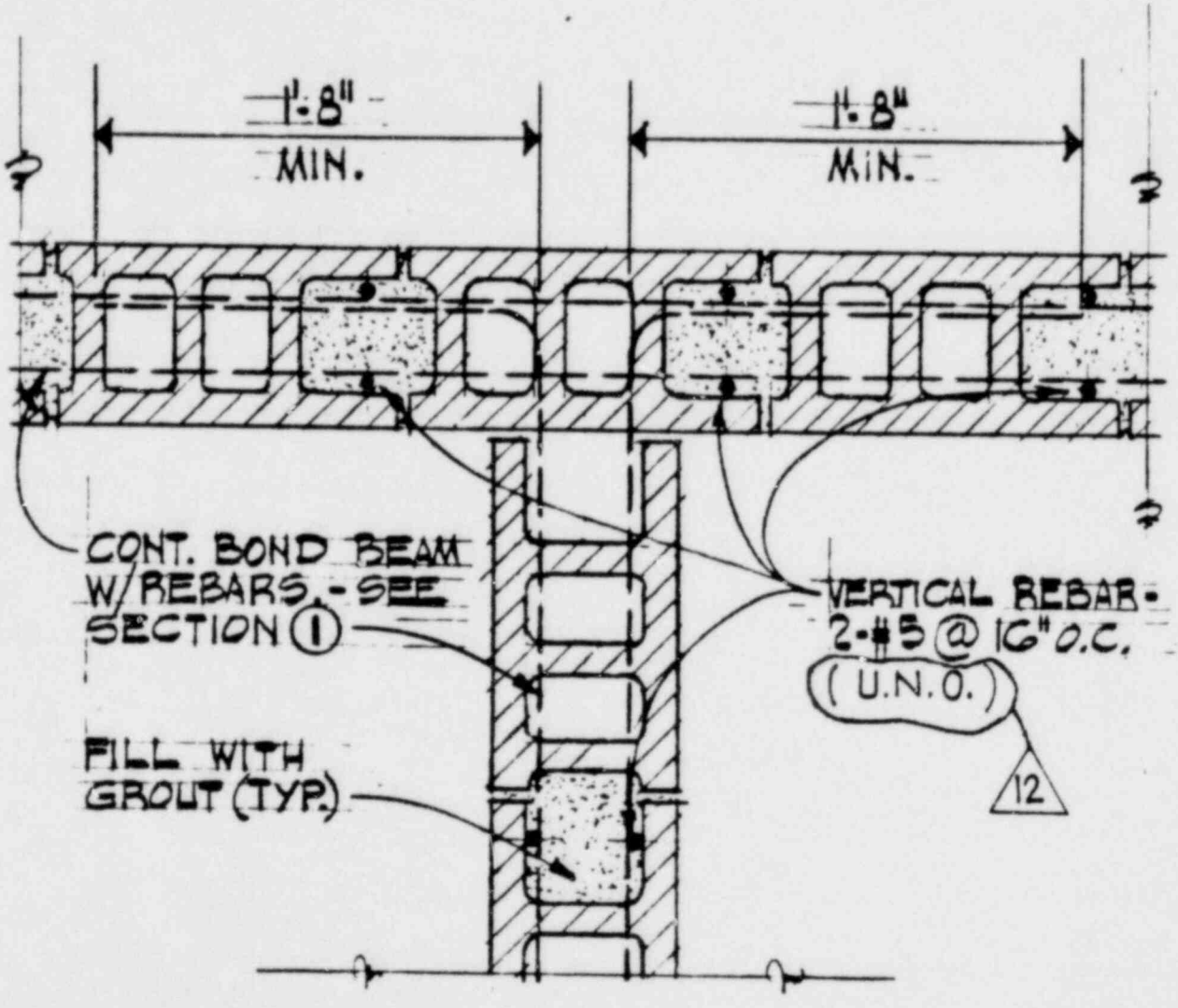


2 SECTION AT CORNER WALLS
A-7/13|A

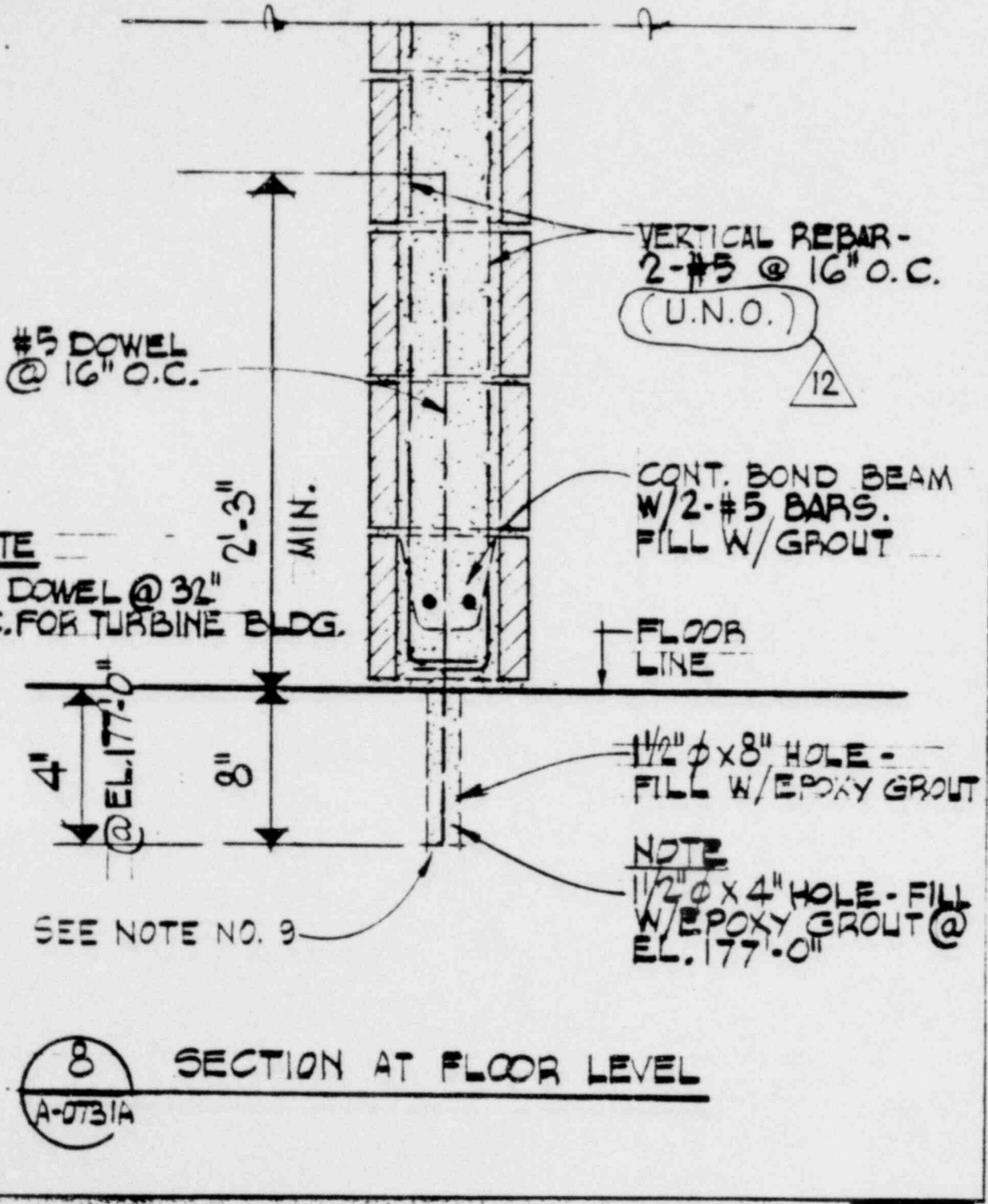
9/15



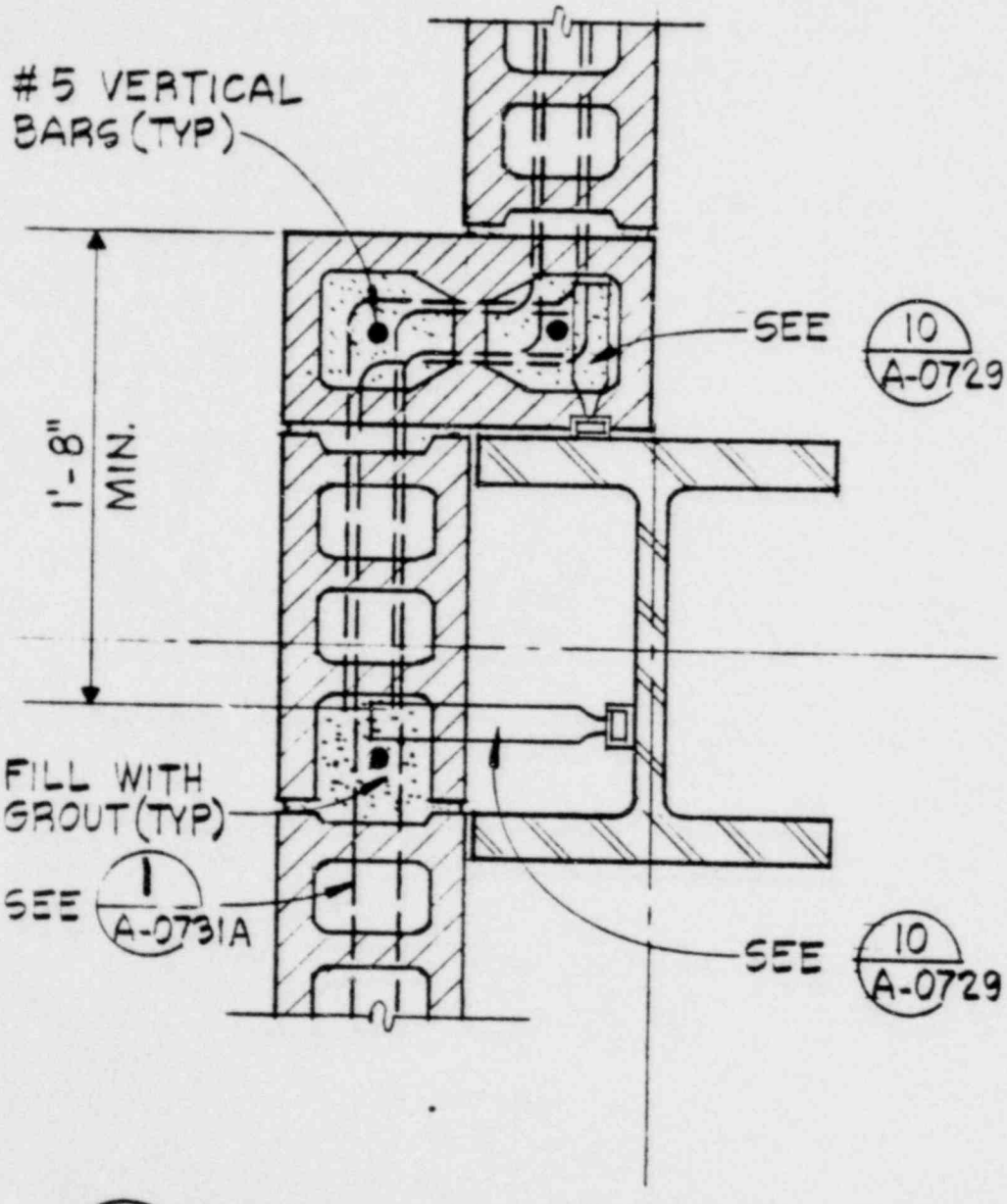
4 SECTION AT STEEL BEAM
A-0731A



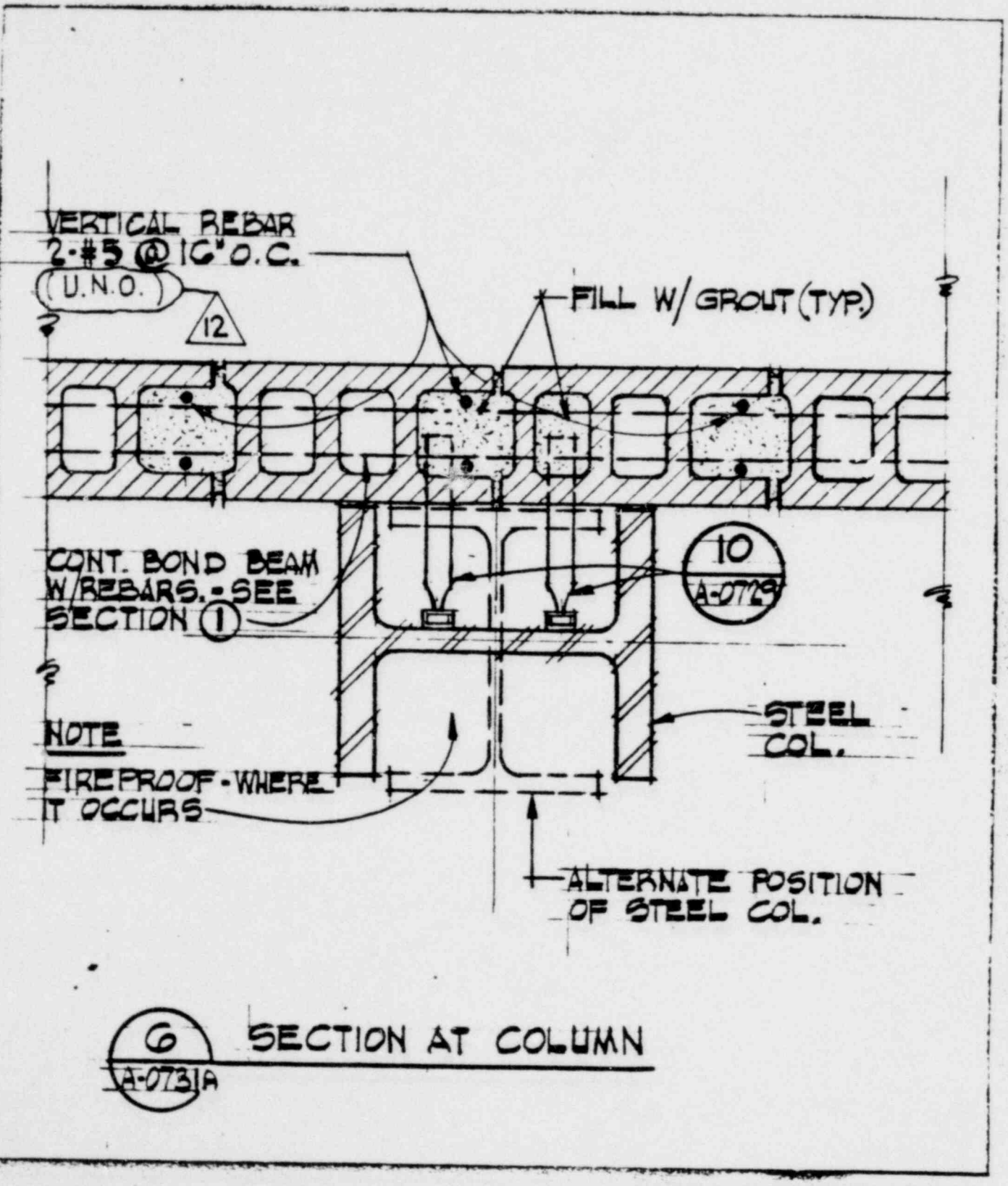
7 / A-07.31A SECTION AT WALL INTERSECTION



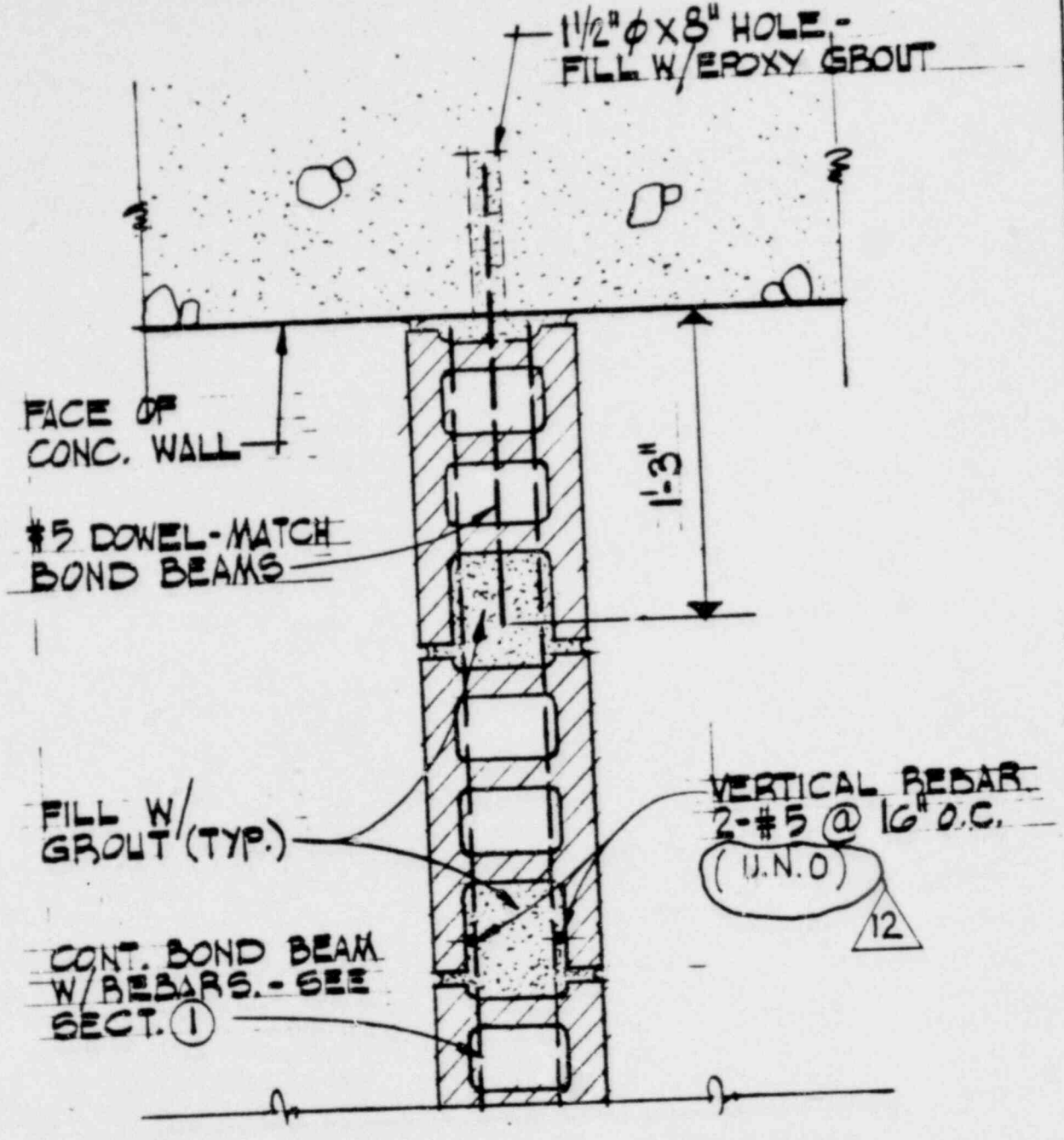
8 / A-0731A SECTION AT FLOOR LEVEL



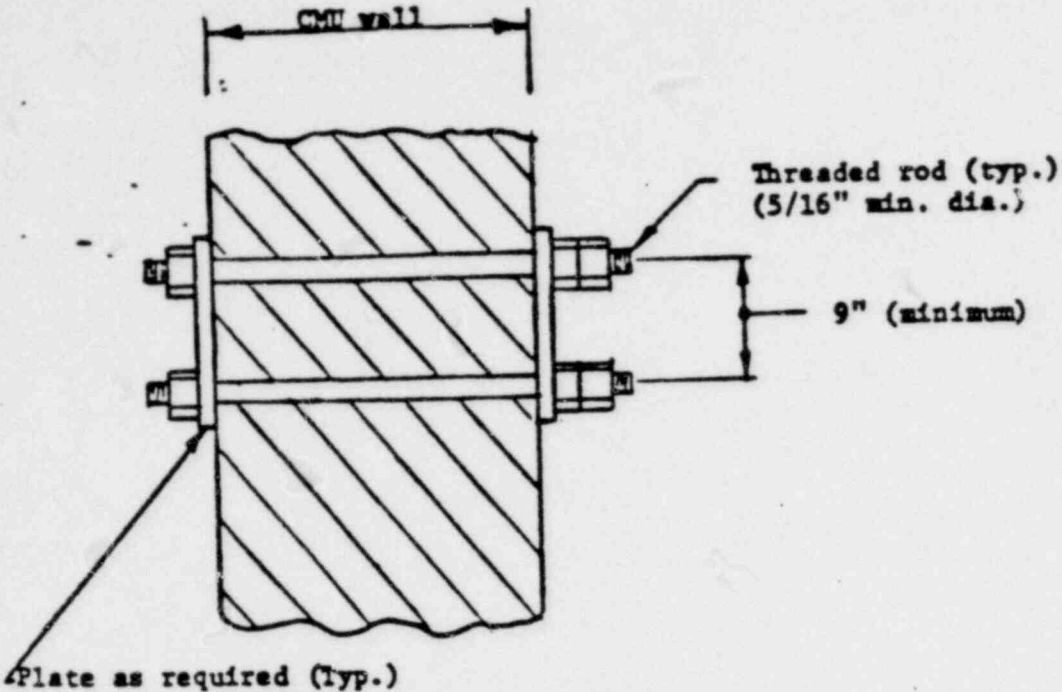
13 A-0731A PLAN SECTION



6 / A-0731A SECTION AT COLUMN



10 SECTION AT WALL INTERSECTION
A-073 | A ALTERNATE No. 2



NOTES:

1) Through bolts shall not be installed within 9 inches of any adjacent through bolt.

2) Through bolts shall be torqued to 5 ft-lbs minimum.

FIGURE 1: ATTACHMENTS TO HOLLOW CELL OR SOLID CMU WALLS

ATTACHMENT OF NONNUCLEAR 2-INCH AND SMALLER PIPE SUPPORTS TO CONCRETE MASONRY UNIT (CMU) WALLS GRAND GULF NUCLEAR STATION UNITS 1&2	JOB NO. 9645	
	9645-M-300.3	REV. 0
	Appendix U	
	SHEET 1	

8½ x 11 "A" SIZE