Item #3. Sh. 1

EQE ENGINEERING CONSULTANTS

CALCULATION COVER SHEET

Calculation No: 42103-C-001

Project: BOSTON EDISON ARS GENERATION

Calculation Title: REACTOR BUILDING SEISMIC MODEL

References: SEE SH. 14

Attachments: SEE SH. 4

Total Number of Pages (including Cover Sheet): 164

Revision Number	Approval Date	Description of Revision	Originator	Checker	Approver
0	7-29-93	ORIGINAL ISSUE — SH. 1→78, 103→115, 117→156	JLW	[illegible]	[illegible]
		SH. 79→102, 116	GSB	JLW	[illegible]

12312-01/Coversht (7/91)

EQE

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1.0 PURPOSE

The purpose of this calculation is to construct an equivalent lumped mass model of the PNPS Reactor Building and internal structures. This model is required to generate Regulatory Guide 1.60 and PNPS FSAR (Housner) response spectra suitable for use in future design activities.

2.0 METHODOLOGY

The Reactor Building is a rectangular reinforced concrete structure up to the refueling floor at EL. 117. Above that it is a steel frame with exterior precast concrete panels.

The foundation mat is 144.5 feet square and 10 feet thick with the finished top surface at El. -17.5. It rests on a 6 inch thick concrete working slab. There is an extension of about 40 feet by 60 feet on the northwest side under the Auxiliary Bay. The building is rectangular for the remainder of its height with an interior grid of walls between floor levels. Grade is approximately at El. 23.

The drywell containment vessel is an axisymmetric steel structure surrounded by a reinforced concrete shield wall which follows the contour of the vessel from the foundation of the drywell up to the operating floor. The drywell shield is an integral part of the main building structure. The centerline of the drywell vessel is not coincident with the centerline of the reactor building, introducing significant eccentricity. The torus suppression pool is located below the drywell and is supported by the mat.

The reactor pressure vessel is supported by a reinforced concrete pedestal inside the drywell. The vessel is surrounded by a biological shield wall built up of welded steel sections and infill concrete. The biological shield is supported on the reactor pedestal. The pedestal and drywell are supported on a solid concrete section extending about 25 feet above the top of the mat.

The interior structures are braced to the Reactor Building structure at El. 81.8. The reactor vessel is braced to the top of the biological shield by a stabilizer system which resists lateral movement and torsion but not vertical movement or overturning (it also allows radial growth, but this is

not relevant to seismic response). The biological shield is braced to the drywell by the star truss which acts similarity to the stabilizer. The drywell is connected to the drywell shield concrete by heavy steel lugs which also restrain only lateral and torsional movement.

The Reactor Building model is a 3-D model incorporating vertical and torsional properties.

Internal structures are modeled separately: (1) the drywell vessel, (2) the torus suppression pool, (3) the biological shield, (4) the reactor pressure vessel, and (5) the reactor pedestal.

2.1 Reactor Building Model

The methodology for developing the Reactor Building model consists of the following:

2.1.1 The reference drawings are reviewed and representative building cross sections are determined. Major structural walls and floors are identified for inclusion into the model. All reinforced concrete walls extending from floor to floor with adequate length to develop properly are included. Walls with small openings infilled with block are considered continuous if it is judged that the block infill would transmit shear. Full height reinforced block walls two feet or more thick are also included. The modulus of elasticity for these walls is adjusted to reflect the lower stiffness of concrete block construction. Major floor and wall openings are identified and included in the model.

2.1.2 The weight of each main floor level is calculated, including the weight of concrete, steel framing, secondary walls, platforms, piping, equipment and miscellaneous dead and live loads. A total mass density is then determined by spreading the mass over the floor area.

2.1.3 Finite element models of the walls between each main floor level are constructed using ANSYS PC/Linear Revision 4.4A. Models are constructed between the following floor levels:

From Elevation	To Elevation
-17'-6"	23'-0"
23'-0"	51'-0"
51'-0"	74'-3"
74'-3"	91'-3"
91'-3"	117'-0"

ANSYS keypoints are used as input to generate the finite element mesh. The centroid, mass and mass moments of inertia of the primary walls are determined using ANSYS.

2.1.4 ANSYS models of each floor level are generated to calculate the centroid, and mass moments of inertia.

2.1.5 The floor and wall properties are combined to determine the net mass, centroid and mass moments of inertia.

2.1.6 The ANSYS wall models are used to determine 12 x 12 stiffness matrices to represent the stiffness between each floor level. The nodes at the top and bottom of the wall meshes are rigidly connected to nodes at the z-axis (reactor centerline). These nodes are then given unit displacements and rotations. Stiffness matrices are assembled using the reaction forces.

2.1.7 The drywell stabilizer insert lugs connect to the Reactor Building at El. 81.8' which is between floors. To model this connection a node is included between El. 74.25 and 91.25. This node is connected to the floors by beam elements representing the drywell shield cross-section. The stiffness of this cross-section is then subtracted from the stiffness matrix of the element connecting the two floors.

2.1.8 The superstructure above the operating floor consists of steel columns with exterior precast concrete panels. The panels are adequately connected to the columns to provide shear transfer. The stiffness properties are determined based on a composite of the precast panels and the columns at the perimeter of the building. This is represented in the model by an equivalent beam element. Beam element properties, centroid and mass moments of inertia are calculated by hand.

2.2 Drywell Shell

The drywell shell is modeled as a series of cylindrical sections. The transition points are determined by the locations of changes in thickness. The base of the shell is anchored at elevation 9'-2" at the top of the concrete floor level inside the drywell.

The mass properties for the drywell are calculated based on the weight of the spherical or cylindrical sections. Because the rotational inertia's have negligible effect on the response of the model, they are not calculated.

2.3 Pedestal, Biological Shield and Reactor Vessel

The stiffness properties of the biological shield, reactor vessel and reactor pedestal are taken from prior work by Bechtel and General Electric (Reference 9). Likewise, the stiffnesses of the star truss and stabilizer are taken from this documentation. The torsional stiffnesses for the star truss and stabilizer are estimated using the lateral (tangential) stiffness and mean radius between the connected structures.

The mass properties of the biological shield, reactor vessel and reactor pedestal are also taken from Reference 9. The mass of the reactor internals is condensed and lumped at the point of connection with the vessel. This simplification is considered acceptable because the high stiffness of the vessel will isolate it from effects of the internals. This is supported by examination of the original vessel spectra in Reference 13 which shows a single predominant peak at the fundamental Reactor Building frequency.

2.4 Torus

The torus structure is rigid, based on a review of drawings and References 11 and 12. It is modeled as four nodes around the circumference of the vessel and joined by rigid elements to the base mat center of mass. The mass properties of the torus are combined into the base mat mass properties.

3.0 ASSUMPTIONS

The following assumptions are made for simplification purposes.

1. Full height shielding block walls are included in the model if they are two feet thick or more and judged to have adequate length to develop properly. Block walls less than two feet thick are not included based on the judgment that they will have insignificant effect on overall lateral stiffness.

2. All reinforced concrete walls extending from floor to floor with adequate length to develop properly are included.

3. The mass of walls which do not extend from floor to ceiling is in general lumped in with the mass of the supporting floor level.

4. The steel columns are neglected in the modeling of the stiffness between floors, and their contribution to the mass moment of inertia is also neglected since the concrete walls and slabs are much stiffer than these columns. Allowance for column mass have been included.

5. The weights of major equipment have been estimated in Attachment A and included separately in the mass estimation. Allowances for dead and live load for miscellaneous equipment, piping, raceways, platforms, etc. are included based on judgment of the concentration of these items at each floor level. This estimate ranges from 60 to 120 psf, except the Torus compartment slab at El. -17.5' which is estimated at 30 psf.

6. An allowance for roof snow load or ponding load of 10 psf is included in the mass calculation for the reactor building roof at El. 164.5'.

7. The mass of the fuel pool water is assumed to be equally distributed to the north and south fuel pool walls.

8. The weight per area of steel framing for all levels is based on a detailed estimate of the steel weight at the El. 23' slab. The weight for each floor level is estimated by reviewing the steel drawings and comparing the steel weight with the 23' level on a judgment basis. An allowance of 15% has been added to account for the weight of baseplates, connections, miscellaneous steel, stiffeners, etc.

9. Small openings (less than approximately 15' x 15') in the walls and slabs will not significantly affect overall stiffness, and are therefore neglected in the modeling.

10. Other assumptions are as noted in the body of the calculation.

4.0 DRAWINGS USED FOR DESIGN INPUT

The following drawings were used to obtain design input for the Reactor Building Model:

DWG. NO.	REV.	DWG. NO.	REV.
M11	E7	A23	7
M12	E8	A28	6
M13	E9	CIA-6-8	
M14	E8	CIA-16-4	
M15	E1	CIA2-11	E2
M16	E1	CIA-7-6	
M17	E3	CIA-1-8	
M18	E6	M1A48-4 Sh.2	E6
M19	E7	((M1A) 1979-8-5	(GE Dwg. 232 -336-3)
M20	E1		
M21	E4	M36-2-5	
M22	E6	CIA-62-4	3
M23	E4	C-60	E1
M24	E6	C-61	E1
M25	E6	C-62	E2
M26	E4	C-63 Sh.1	E2
M27	E5	C-64	E1
A16	E1	C-65	E1
A17	E1	C-66	6
A20	6	C-67	5
A21	6	C-68	E2
A22	12	C-69	5

4.0 DRAWINGS USED FOR DESIGN INPUT (CONT.)

DWG. NO.	REV.	DWG. NO.	REV.
C-70	E1	C-152	E4
C-71	5	C-153	E5
C-72	10	C-156	E1
C-73	10	C-157	3
C-74	5	C-158	2
C-91	7	C-162 Sh.1/2	E1
C-94	5	C-177	5
C-95	3	C-184	E1
C-96	E1	C-185	E3
C-99	12	C-186	11
C-109	4	C-187	E1
C-112	6	C-188	E2
C-115	6	C-189	6
C-120 Sh.1	E2	C-367	E3
C-121	8	C-201	E1
C-122	7	C-205	4
C-130	E1	C-207	6
C-132	6	C-217	E1
C-134	E3	C-285	E1
C-136	E1	C-289	E3
C-138	7	C-299	E3
C-140	E1	C-300	E1
C-146 Sh.1	E3	C-148	E3
C-147	E1	C-149	13
C-151	8	C-190	E3

4.0 DRAWINGS USED FOR DESIGN INPUT (CONT.)

DWG. NO.	REV.
C-191	E6
C-192	E1
C-194	E5
C-195	E3
C-196	E1
C-197	E2
C-198	E4
C-199	E4

5.0 REFERENCES

1. Bechtel Study Z87-001, "Review of Seismic Separation Design Basis at Pilgrim Nuclear Power Station", April 1987, SUDDS/RF #87-760.

2. Boston Edison Specification C-86-ER-Q-E5 "Design, Installation and Inspection of Hilti Kwik Bolt and Super Kwik-Bolt Concrete Anchors".

3. Boston Edison NEDWI 374, Revision 0, (Block Wall Procedure).

4. Winter & Nelson, "Design of Concrete Structures", 8th Edition.

5. ACI Building Code Requirements for Reinforced Concrete, ACI 318-89.

6. AISC Manual of Steel Construction, 9th Edition.

7. Roark & Young, "Formulas for Stress and Strain", 5th Edition.

8. Boston Edison notes of project meeting, 4-5-93, EQE File No. 42103-I-001.

9. Bechtel Calculation, "Seismic Analysis-Biological Shield", File No. Vol. 79, Calc. No. 085-C1, Revision 0, 1-23-81.

10. Beer & Johnson, "Vector Mechanics for Engineers: Dynamics", McGraw Hill, 2nd Edition.

11. Teledyne Report 5310-23, Revision 0 (10-7-82), "Pilgrim Torus Saddle Analysis", (Cart 5596, Frame 0814).

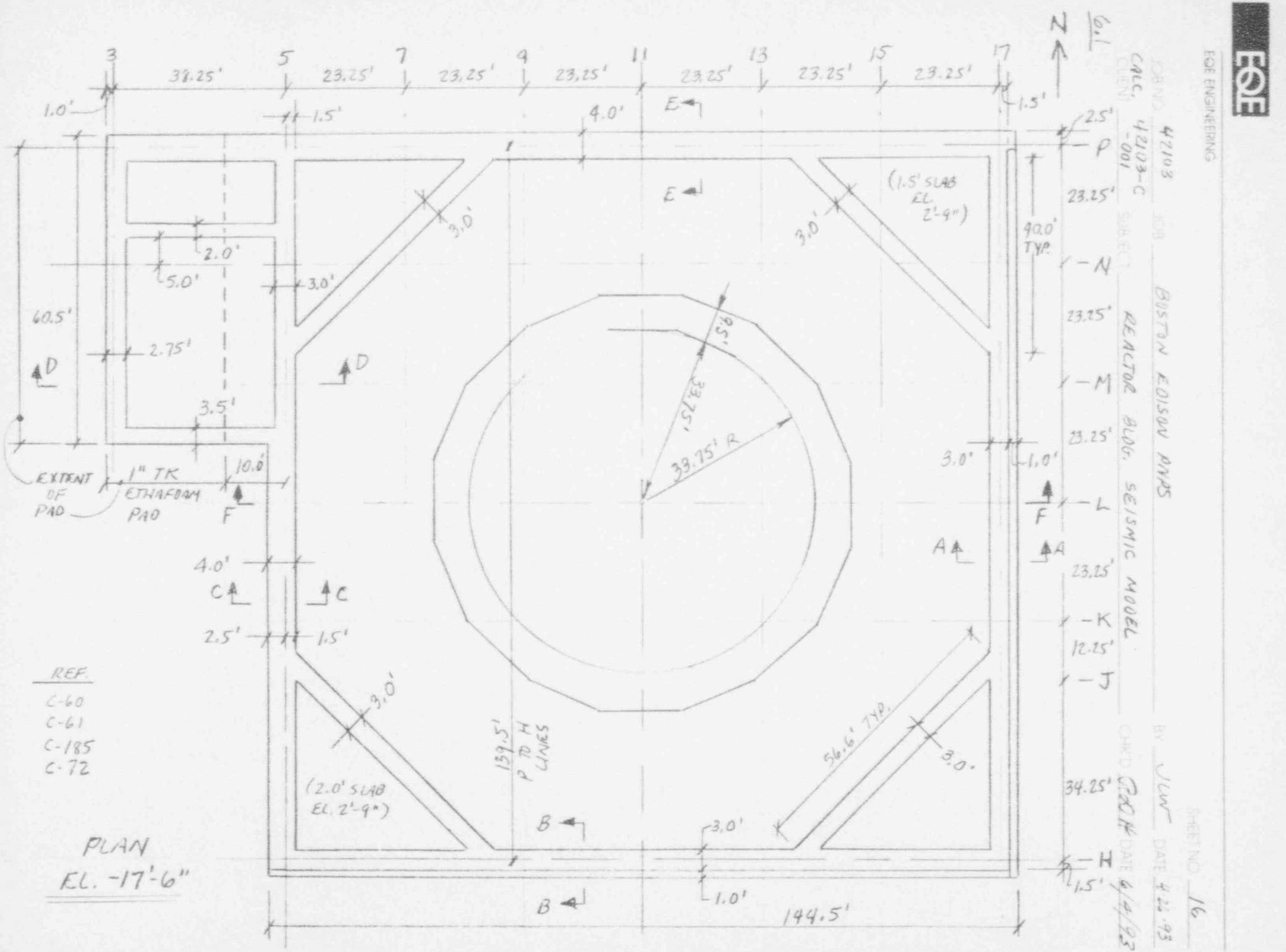
12. Teledyne Technical Report TR-5310-1, Rev. 2, "Mark I Containment Program, Plant-Unique Analysis Report of the Torus Suppression Chamber for Pilgrim Station-Unit 1", September 14, 1984.

13. BECo Specification C-114-ER-Q-EO, "Specification for Seismic Response Spectra".

5.0 REFERENCES (CONTINUED)

14. AISC Manual of Steel Construction, 8th Edition.

15. Gaylord & Gaylord, "Structural Engineering Handbook", McGraw Hill, 1968.



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6.1

JOB NO. 42103 JOB BOSTON EDISON RNPS BY JLW DATE 4.22.93

CALC. 42103-C -001 SUBJECT REACTOR BLDG. SEISMIC MODEL CHKD PDH DATE 6/4/93

CHKD DATE

SHEET NO. 16

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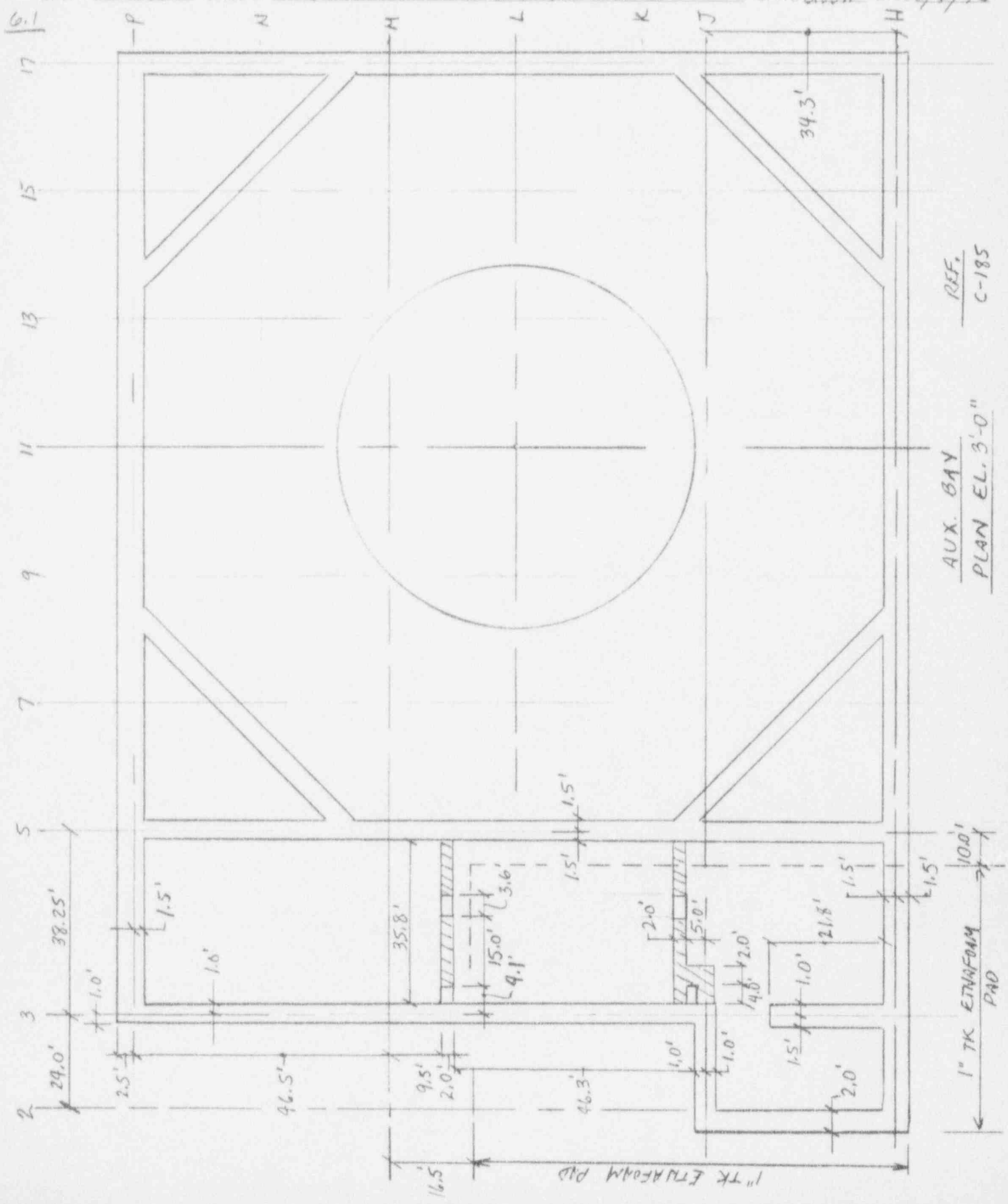
SHEET NO. 17

JOB NO. 42103 JOB BOSTON EDISON PNRS BY JW DATE 4-26-93

CALC. 42103-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDK DATE 6/4/93



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SHEET NO. 16

JOB NO. 42103 JOB BOSTON EDISON PNPS BY JW DATE 4-26-93

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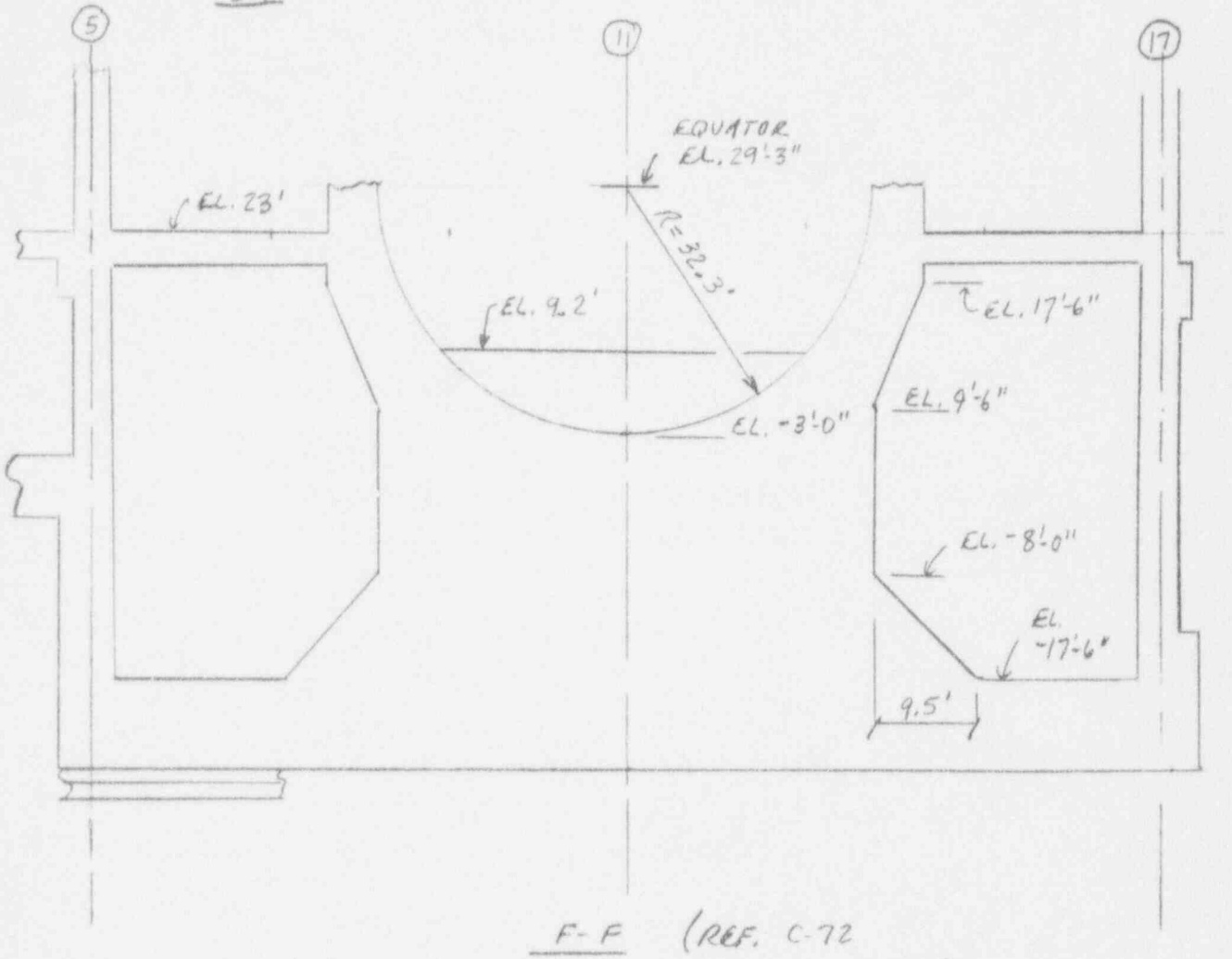

F-F (REF. C-72 SECT. A, C-151)

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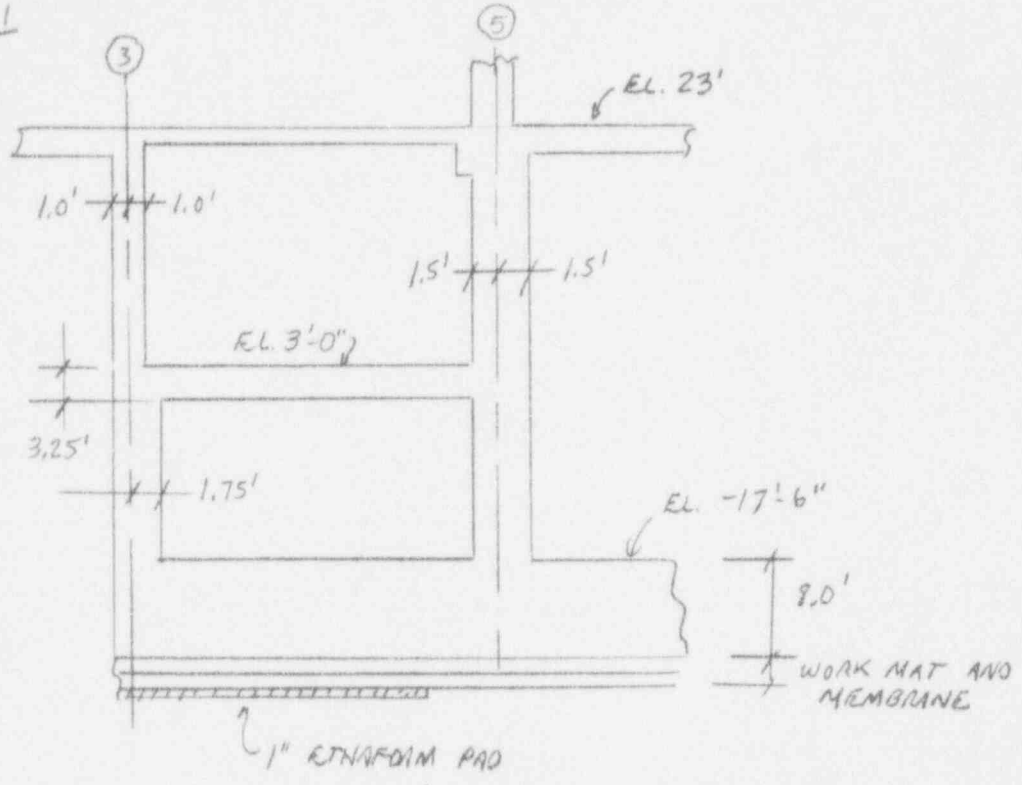
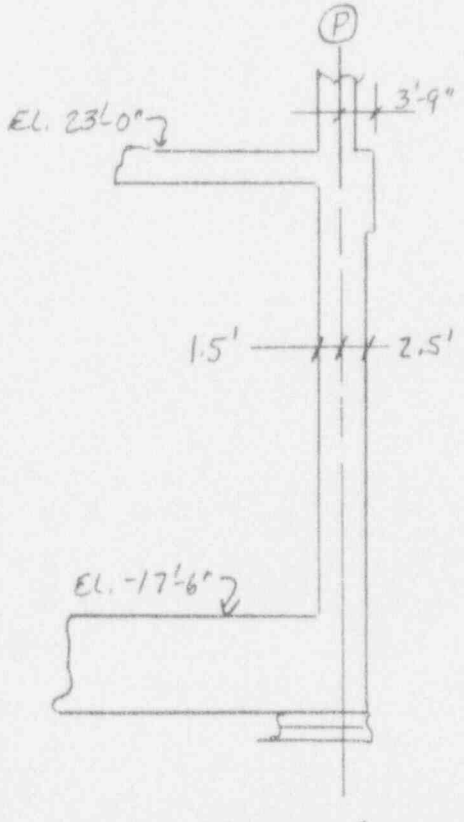


D-D (REF. C-186 SECT. F)



E-E (REF C-73 SECT. J, K, N)

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SHEET NO. 20

JOB NO. 42103 JOB BOSTON EDISON PNPS BY JLW DATE 4-26-93

CLIENT 42103-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D R.D.K DATE 6/4/93

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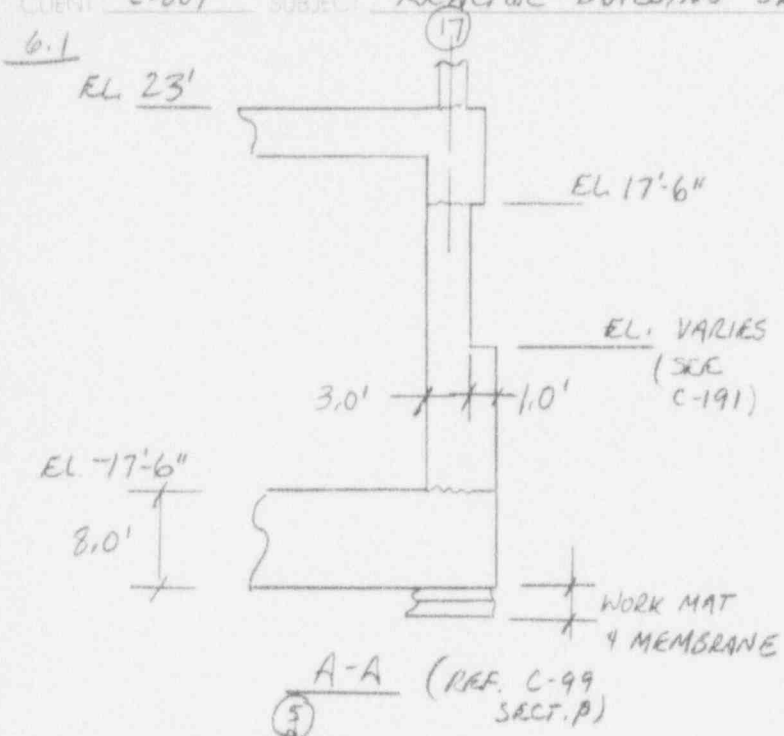
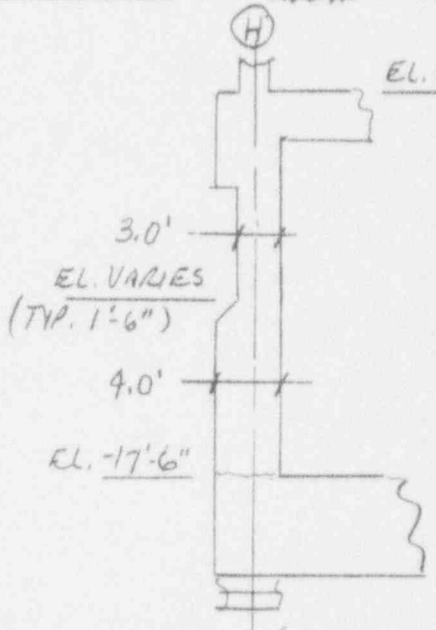


A-A (REF. C-99 SECT. P)



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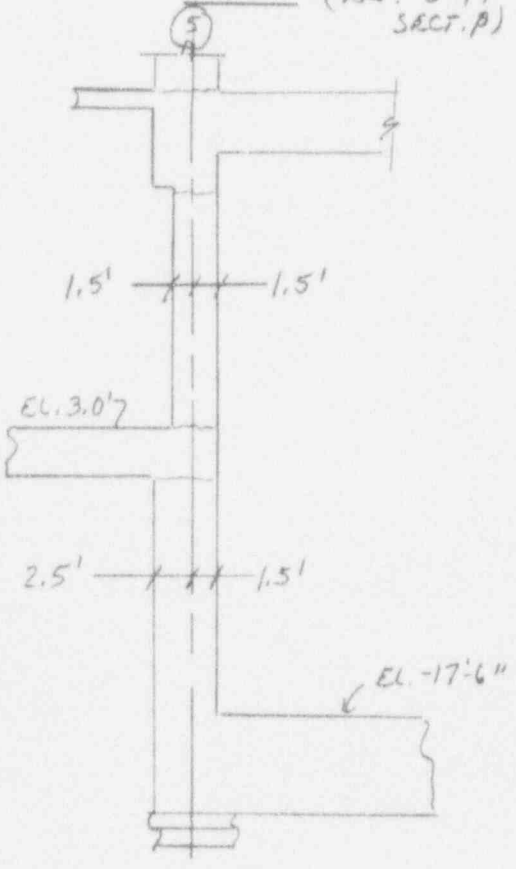

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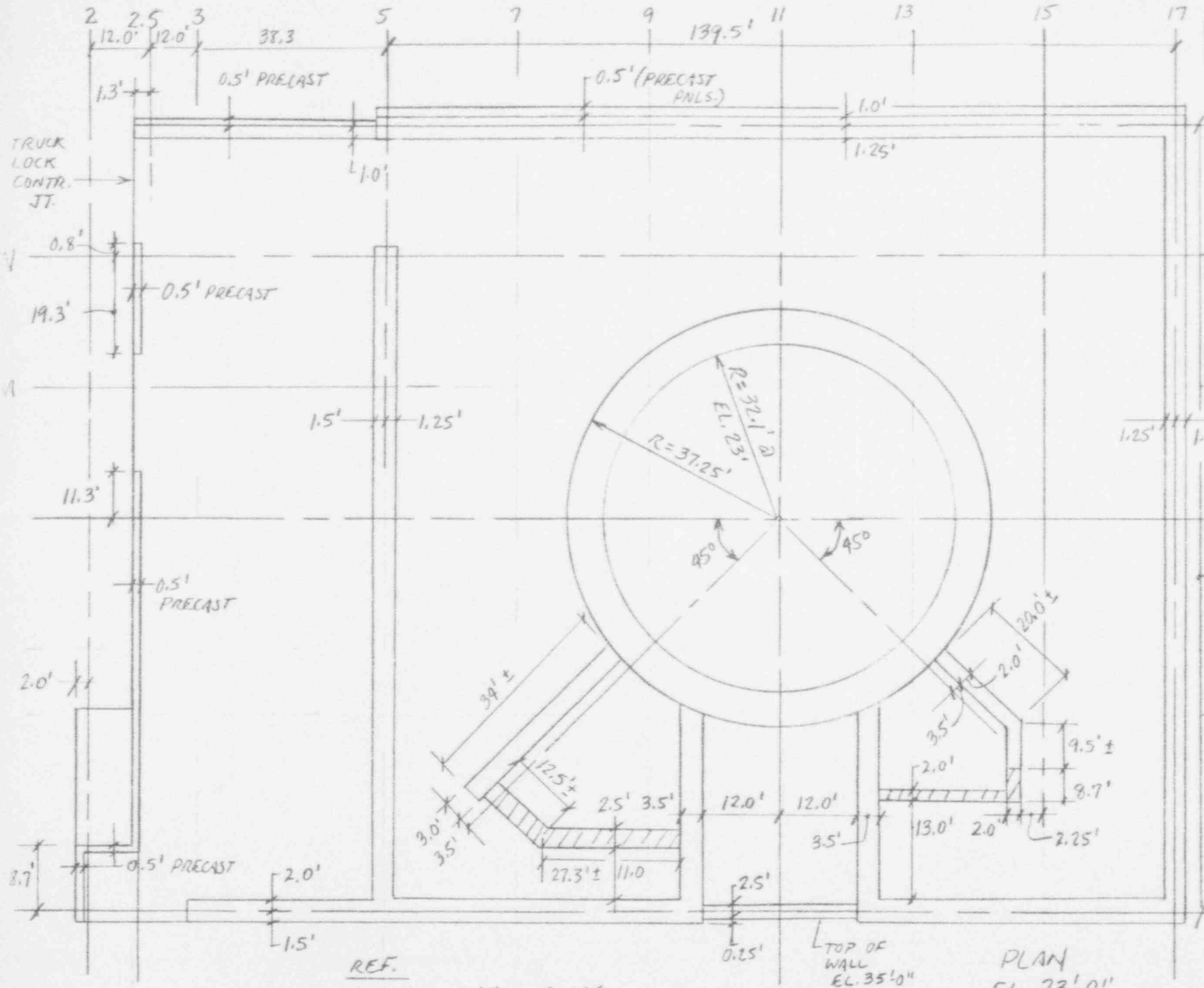
(REF. C-73 SECT. R)



REF.

C-367 C-63 C-188
C-62 C-184

PLAN
EL. 23'-0"

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JOB NO. 42103 JOB BOSTON EDISON PNPS

CLIENT 42103-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL

BY JAN DATE 4.26.93

CHKD TRH DATE 6/4/93

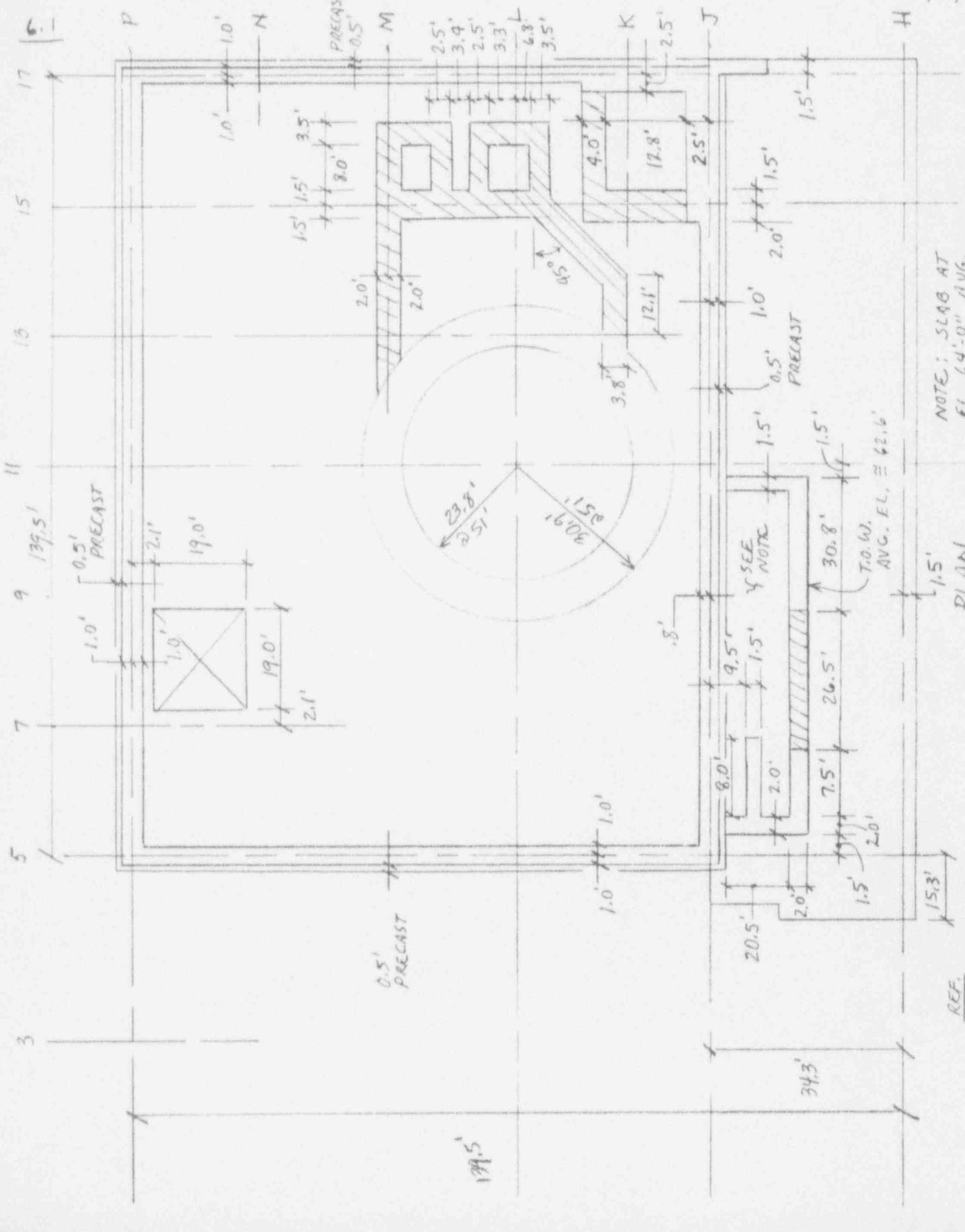
SHEET NO. 21

EQE ENGINEERING

SHEET NO. 22

JOB NO. 42103 JOB BOSTON EDISON PNPS BY JLW DATE 4-26-93

CALC. NO. 42103-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDA DATE 6/4/93



NOTE: SLAB AT EL. 64'-0" AVG. THICK. = 15" + 4½" DECK/2 = 1.4 TK

PLAN EL. 51'-0"

REF. C-64, C-65, C-184, C-94, C-95

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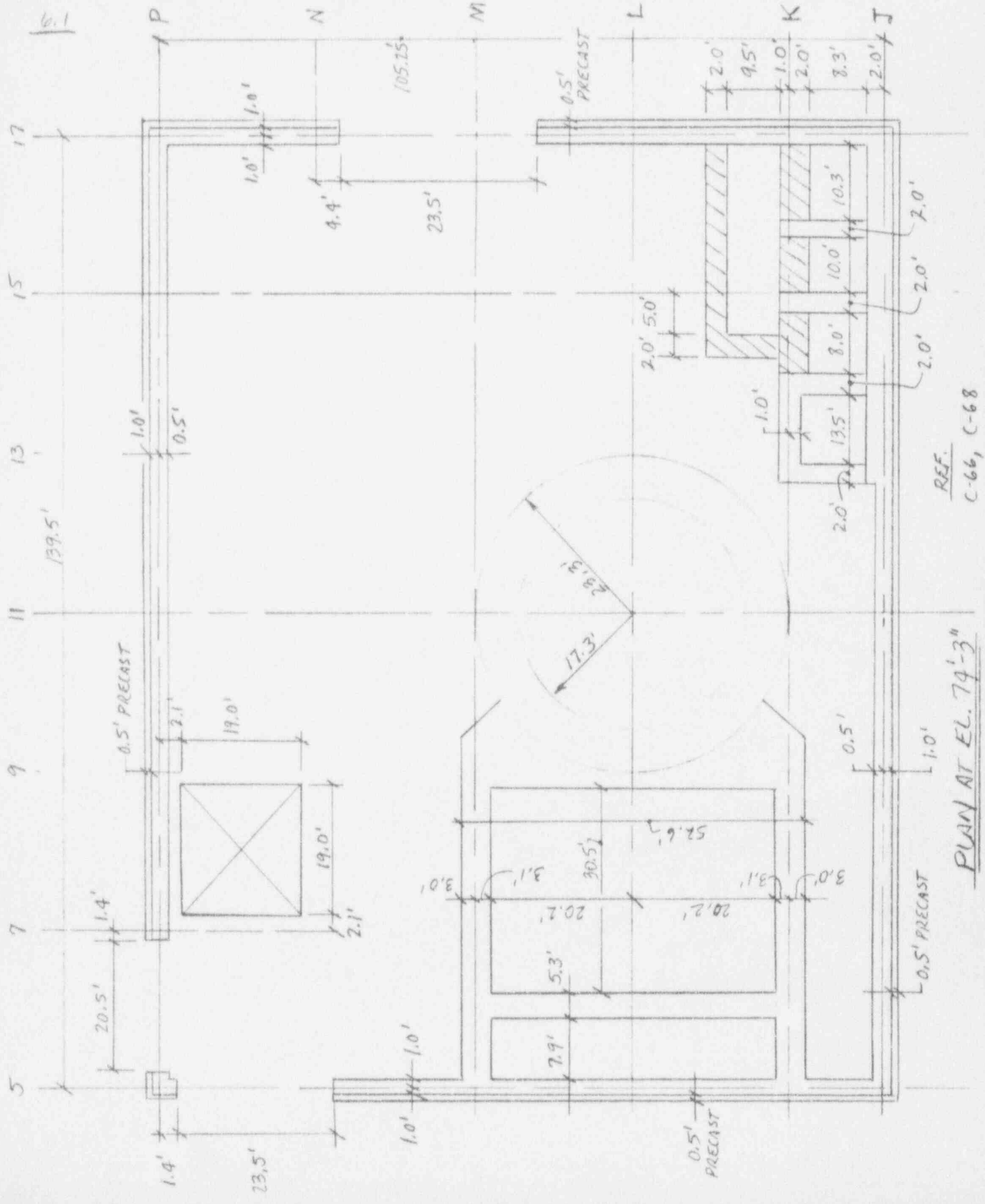
SHEET NO. 23

JOB NO. 42103 JOB BOSTON EDISON PNPS BY JWW DATE 4-26-93

CALC. NO. 42103-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDH DATE 6/4/93

6.1



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SHEET NO 24

JOB NO 42103 JOB BOSTON EDISON PNPS BY JWI DATE 4-26-93

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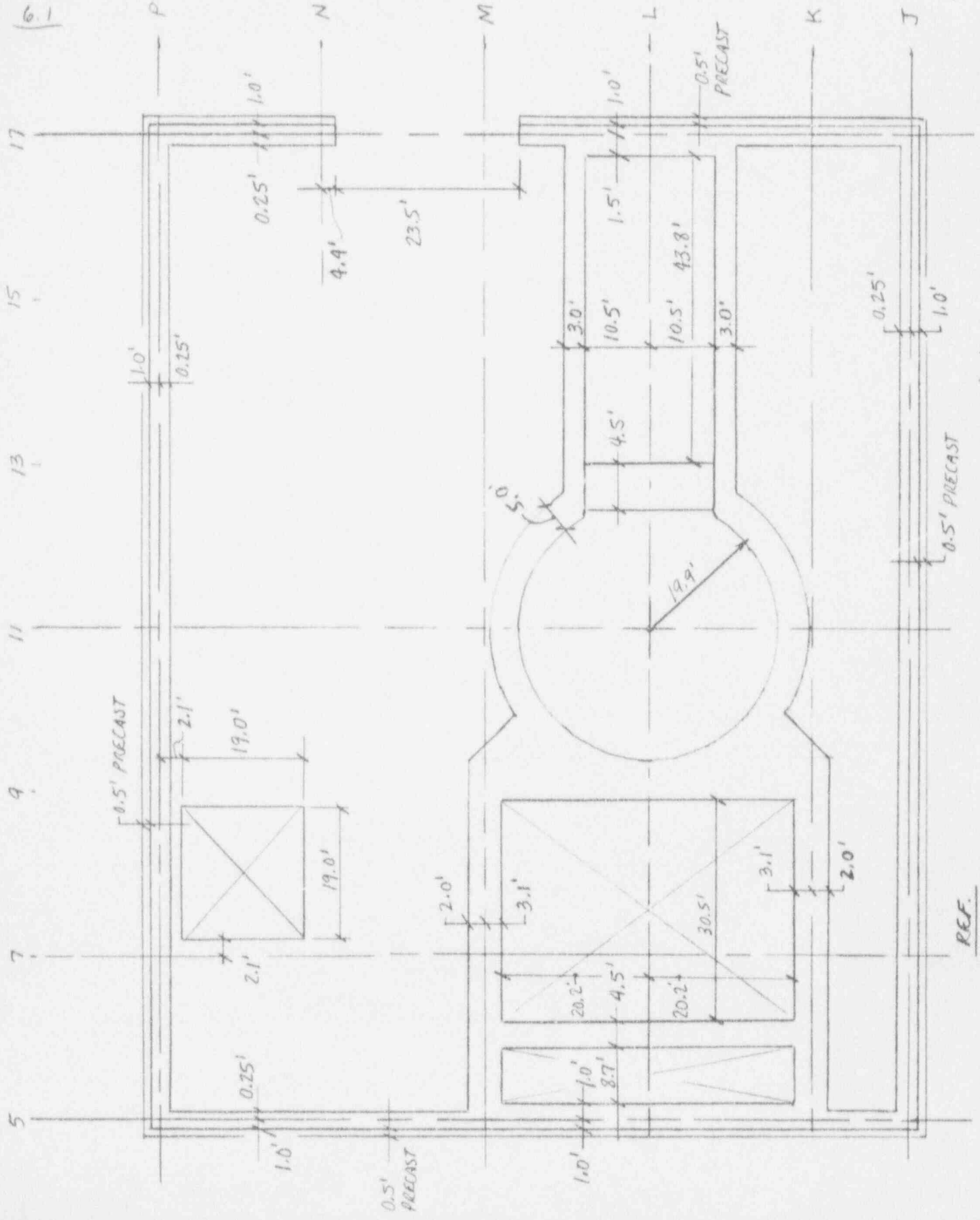

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SHEET NO. 25

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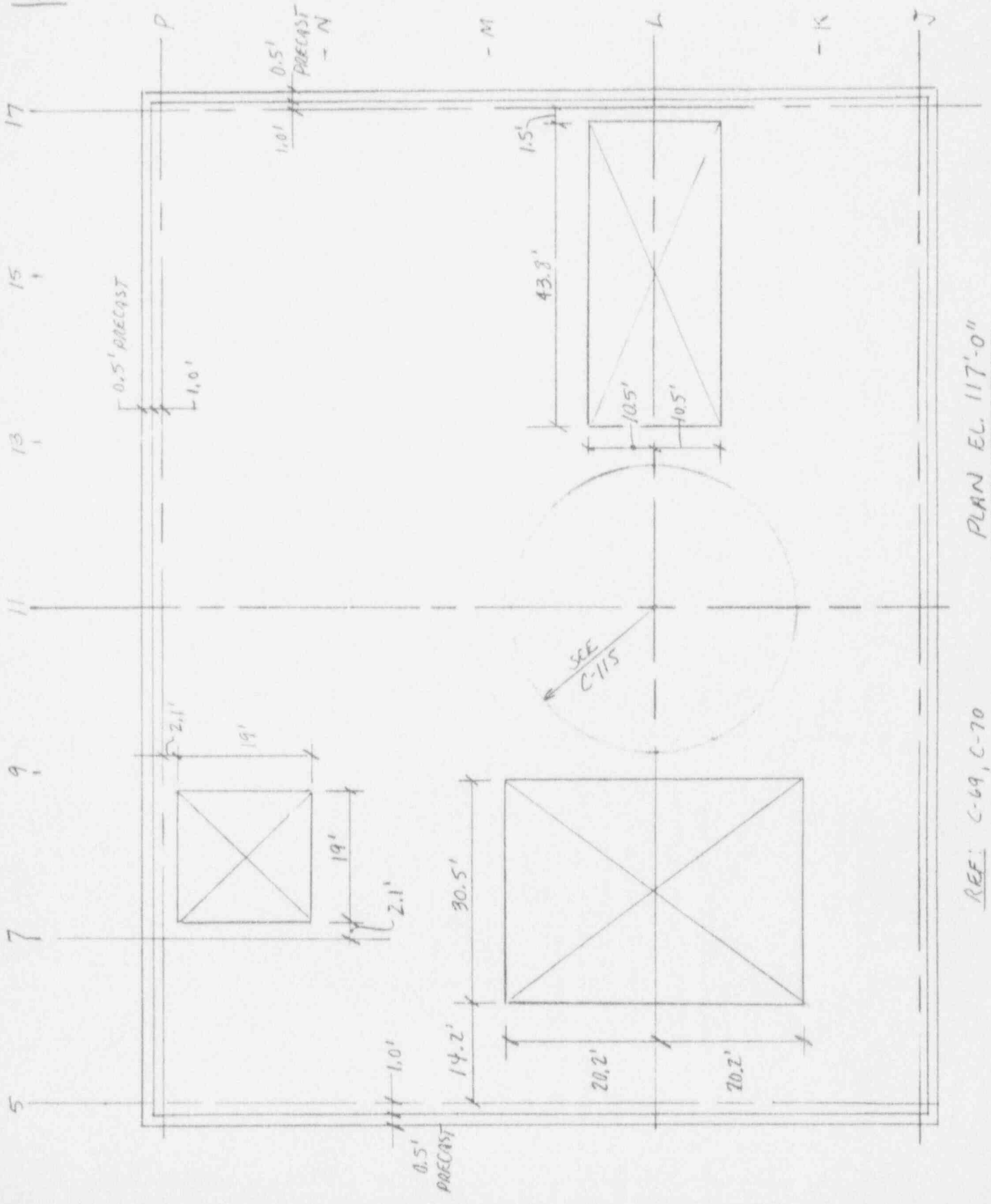

PLAN EL. 117'-0"

REF: C-69, C-70
C-115

6.2 FLOOR WEIGHTS

DETERMINE WEIGHT CONCENTRATED AT EACH FLOOR LEVEL:

- INCLUDE MAJOR EQUIPMENT WEIGHT
- INCLUDE MISC. WALLS AND SLABS WHICH DO NOT CONTRIBUTE TO HORIZONTAL STIFFNESS.
- EXCLUDE WALLS WHICH CONTRIBUTE TO HORIZONTAL STIFFNESS (THESE WILL BE FIGURED SEPARATELY IN ANSYS MODEL.)

WEIGHT AT EL -17'-6" (SEE SH. 16) (REF. M-15)

- EXCLUDE WT. OF TORUS AND WATER (FIGURED SEPARATELY)

ITEM			KIPS
REACTOR WORK MAT (6" TK)	(.5)(144.5)(144.5)(.15)	=	1566
REACTOR MAT (8.0' TK)	(8.0)(144.5)(144.5)(.15)	=	25 056
AUX. BAY WORK MAT (6" TK)	(.5)(60.5)(39.25-2.5)(.15)	=	167
AUX. BAY MAT (8.0' TK)	(8.0)(60.5)(39.25-2.5)(.15)	=	2668
HPCI TURBINE (ATTACH. A)		=	21
RCIC TURBINE + PUMP	3+9	=	12
RHR HT. EXCH.	(40)x(2)	=	80
RHR PUMPS	(4)(11)	=	44
CRD PUMPS	(7)(2)	=	14
MIS. PIPING, PLATFORMS, EQUIP. SHIELDING (ETC.)	(EST.)	=	200
HPCI TURB. FOUNDATION	(4.9)(15.0)(3.3)(.15)	=	36
" " "	(12.0)(6.2)(2.0)(.15)	=	22
MISC. FOUNDATIONS + SHIELD WALLS	(EST.)	=	30
LIVE LOAD TORUS (EST 10 LBS/FT²)	(.010)(144.5)(144.5)	=	209
LIVE LOAD (AUX. BAY) (EST. 20 LBS/FT²)	(.020)(60.5)(39.25-2.5)	=	44
CORE SPRAY PUMPS (ATTACH. A)	(9)(2)	=	18
	TOTAL	=	30,187

6.2 FLOOR WEIGHTS (CONT'D)

WEIGHT AT EL. 3'-0" (RB AUX. BAY) (SEE SH. 17) (REF. M-15)

ITEM		KIPS	
FLOOR SLAB (NORTH OF HPCI)	(3.3)(35.8)(56.5)(.15)	= 1001	
FLOOR SLAB (SOUTH OF HPCI) (3'-6" TK PLUS 6" WORK MAT)	(3.5+.5)(35.8)(48.3)(.15)	= 1037	
FLOOR SLAB & MAT	(3.5+.5)(34.3-1.5)(24+38.3-4.0)(.15)	= 1147	
RBCCW HT. EXCH. (2)	(ATTACH. A) (2)(67)	= 134	1253
TBCCW HT. EXCH. (2)	(ATTACH. A) (2)(29)	= 58	
CW PUMPS (8)	EST. 6 K/ PUMP	= 48	
MISC. PUMPS (9)	EST. 3 K/ PUMP	= 27	
MISC. TANKS	EST 35 K	= 35	
DL PIPING + EQUIP.	(EST. 100 LBS/FT²)(.10)(136.5)(35.8)	= 489	
" " "	(.10)(23.0)(32.3)	= 74	
MISC. DL (EST. 20 LBS/FT²)	(.20)(136.5)(35.8)	= 98	
" " "	(.20)(23.0)(32.3)	= 15	
MISC. MASONRY WALLS	(EST. 275 K)	= 275	
TOTAL		= 4438	

DISTRIBUTE MASS FOR ANSYS INPUT:

TOTAL FLOOR AREA (FROM KEYPOINTS) = 6209 FT²

$$\text{TOTAL MASS/AREA} = \frac{4438^{K}}{(6209\ FT^2)(32.2\ FT/SEC^2)} = 2.2\times10^{-2}\ \frac{K\text{-}SEC^2}{FT^3}$$

$$\text{MASS DENSITY} = \frac{2.2\times10^{-2}}{3.3\ FT}\ \frac{K\text{-}SEC^2}{FT^3} = 6.73\times10^{-3}\ \frac{K\text{-}SEC^2}{FT^4}$$

3.3 FT — AVG. SLAB THICKNESS

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SHEET NO. 28

JOB NO. 42103 JOB BOSTON EDISON PNPS BY JLW DATE 4-26-93

CALC. NO. 42103-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDA DATE 6/4/93

6.2 FLOOR WEIGHTS (CONT'D)

WEIGHT AT EL. 23' REACTOR BLDG, AUX BAY SEE SH. 21, REF. M-16
REF. C-146, 147, 188

ITEM	KIPS
STRUCTURAL STEEL + DECK (ASSUME 25 PSF)	
6592 SF (25 PSF) [(38.3)(139.5) + (34.3)(12) + (12)(69.8)]	= 165
TOS 21'-6" ½ DK 2 = 21'8	
SLAB (1.3)[(50.1)(136.5) + (12.7)(35.8)] (.15) (7293 FT²)	= 1422
23'0 - 21'8 = 1'4" WALLS AND SLABS ABOVE EL. 23':	
(1.0)(48.8)(24.4)(.12)	= 143
(.7)(39.3)(8.3)(.12)	= 27
(.7)(56.6)(15)(.12)	= 71
(.8)(38.8)(11.8)(.15)	= 55
(.7)(28.8)(7.6)(.15)	= 23
(.8)(13)(6.1)(.15)	= 10
(.5)(90)(4.0)(.15)	= 27
(.7)(25.8)(24.4)(.12)	= 53
(1.0)(32)(24.4)(.12)	= 94
(3)(2.0)(8)(14)(.15)	= 101
(2.0)(18.5)(14)(.12)	= 62
(1.0)(54.3)(10)(.12)	= 65
MISC. WALLS + PADS (EST. 80K)	= 80
½ OF PRECAST PANEL WALLS:	
(.5)(.5)(139.5 - 20.4 + 14)(28)(.15)	= 140
½ OF STRUCT STEEL COLUMNS + GIRTS ABOVE EL. 23':	
(.5)(8)(39)(28) = 4K SAY USE 6K INCL. GIRTS	= 6
½ OF P LINE WALL + PRECAST	
(.5)(1.5)(50.1)(51-23)(.15)	= 158
½ OF N LINE WALL	
(.5)(3.5)(38.3)(51-23)(.15)	= 282
SUB TOTAL	= 2984

EQE ENGINEERING

SHEET NO. 29

JOB NO. 42103 JOB BOSTON EDISON PNPS BY JLM DATE 4-26-93

CALC. NO. 42103-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDH DATE 6/4/93

6,2 FLOOR WEIGHTS (CONT'D)

WT. AT EL. 23' R.B. AUX BAY (CONT'D)

ITEM			KIPS
AUX. PLANT HTG. BOILERS	(ATTACH. A)	(2)(47)	= 94
ACID STR. TANK	↓	(95)	= 95
CAUSTIC STR. TANK		(30)	= 30
DL PIPING AND EQUIP. EST. 80 PSF		(80)(7293 FT²)	= 583
MISC. DL EST. 20 PSF		(20)(7293 FT²)	= 146
SUB TOTAL (PREVIOUS SHT.)			= 2984
TOTAL			3932

6.2 FLOOR WEIGHTS (CONT'D)

WEIGHT AT EL. 23 (REACTOR BLDG.) SEE SH. 21, REF. M-16

STRUCT. STEEL (REF. C-132). ESTIMATE FROM 5 TO 11 LINES AND DOUBLE RESULTS.

NO.	LG.	WT/FT	TOTAL (LBS.)
1	34	230	7820
1	28	230	6440
1	22	190	4180
1	13	99	1287
1	21	124	2604
1	29	190	5510
1	38	190	7220
1	46	172	7912
1	44	210	9240
2	40	172	13760
2	38	172	13148
1	37	172	6364
1	40	172	6880
1	46	172	7912
1	47	(210+41)	11797
1	38	(190+41)	8778
1	8	190	1520
1	8	43	344
1	30	108	3240
1	21	108	2268
1	13	99	1287
1	15	99	1485
1	24	99	2376
1	34	172	5848
1	46	(300+77)	17342
1	42	190	7980
1	40	360	14400
1	38	108	4104
1	37	108	3996
1	47	531	24957
2	9	43	774
1	40	230	9200
1	37	230	8510
1	37	375	13875
1	74	300	22200
1	8	43	344
			266,902

TOTAL WT. = (266,902)(2) = 534 K

ASSUME 15% FOR CONNECTIONS, WALL KE'S PAINT + MISC. STEEL

TOTAL WT. STEEL = (534)/(1.15) = 614 KIPS

METAL DECK 4½" 18 OR 20 GA. ASSUME 5 LBS/FT²

WT. DECK = $(5)\left[(139.5)(139.5) - (2)(39)(39) - (\pi)(37')^2\right]$ = 61 K

6.2 FLOOR WEIGHTS (CONT'D)

WEIGHT AT EL. 23' (CONT'D)

ITEM			KIPS
SLAB (AVG. 2'-2" DP. + 4½" DECK (14410 FT²) SAY USE 2.4' TK)	$(2.4)\left[(137.0)^2-(\pi(37.25)^2)\right](.15)$	=	5188
"NON-SHEAR" WALLS AND SLABS ABOVE EL. 23':			
STAIRS	(1.0)(25)(15)(.12)	=	45
	(2.5)(6)(8)(.12)	=	14
	(2.5)(10.5)(9.5)(.12)	=	30
	(2.5)(10.5)(9.5)(.15)	=	37
	(3.0)(24.0)(9.5)(.15)	=	103
	(2.5)(26)(15)(.15)	=	146
	(4.0)(25)(10)(.15)	=	150
PCRS,	(2.0)(14)(10)(.15)	=	42
LOCK	(2.0)(7)(10)(.15)	=	21
AREA	(2.0)(10.8)(10)(.15)	=	32
	(2.0)(2)(10)(.15)	=	6
	(3.0)(22.8)(15.5)(.15)	=	159
ACC. CONTR.	(.7)(23)(8)(.12)	=	15
ROOF ACC. CONTR.	(.5)(8)(8)(.15)	=	5
STOR. RM	(.7)(40.7)(12.6)(.12)	=	43
ROOF	(.5)(12.7)(16.7)(.15)	=	16
½ OF ELEVATOR	(1)(22.5)(27)(.12)(.5)	=	36
PADS-HCU'S	(8)(.5)(17)(2.5)(.15)	=	26
X-6	(2.5)(11.5)(10)(.15)	=	43
½ OF PIPEWAY	(2.5)(18)(27)(.12)(.5)	=	73
RHR	(2)(6.7)(10)(.12)	=	16
RHR	(2)(8.0)(10.5)(.12)	=	20
RHR SLAB	(2)(5.3)(10.5)(.15)	=	17
TIP	(1)(10.0)(8)(.12)	=	10
TIP	(1.5)(8)(5)(.12)	=	7
C-367	(2)(8)(7.6)(.15)		18
C-367 RUPTURE REST'S (EST 25K)		=	25
	SUB TOTAL		6343

EQE ENGINEERING

JOB NO. 4203 JOB BOSTON EDISON PNPS BY JWN DATE 4-26-93

CALC. NO. 4203-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDH DATE 6/4/93

6.2 FLOOR WEIGHTS (CONT'D)

WT. AT EL. 23' (CONT'D)

ITEM			KIPS
C-127 PIPE SPT. STEEL (EST. 15K)			= 15
CRD STOR.	(1)(30.8)(13.3)(.12)		= 49
SLAB	(.5)(4.8)(27)(.15)		= 10
WALL	(1)(18.5)(8)(.12)		= 18
CRD HCU'S	(145)(.785)	(ATTACH. A)	= 114
SCRAM DISCH. VOL TNKS + SHIELDING		(2)(45)	= 90
ENVIRON. ENCLOSURES	B18	(1)(20)	= 20
	D7	(1)(17)	= 17
	D8+D9	(1)(25)	= 25
	B20	(1)(14)	= 14
	B17	(1)(16)	= 16
DL PIPING + EQUIPMENT EST. 100 LBS/FT² × (14410)			= 1441
MISC. DL (EST. 20 LBS/FT²) (.02)(14410)			= 288
1/2 STEEL INTERIOR COLUMNS ABOVE EL. 23': SAY 16 COL'S × 5K EA × 1/2			= 40
STRUCT. STEEL			= 614
METAL DECK			= 61
SUB TOTAL (PREVIOUS SHT)			= 6343
TOTAL			= 9,175

6.2 FLOOR WEIGHTS (CONT'D)

WEIGHT AT EL. 51' SEE SH. 22 REF. C-64, C-65, C-134

STEEL WEIGHT.

AT EL. 23', STEEL WT/AREA = $614^K / 14410\ FT^2 = 43$ PSF

REF. C-134 FOR STEEL AT 51', ASSUME 36 PSF FROM J TO N AND 40 PSF FROM P TO L

TOTAL WT. STEEL = $(36)(34.25)(139.5) = 172^K$

$(40)[(105.25)(139.5) - (\pi)(30.9)^2] = 467^K$

STEEL TOTAL = 639^K

(16461 FT²)

WT. METAL DECK $(5\ LBS/FT^2)[(139.5)^2 - \pi(30.9)^2] = 82^K$

ITEM		KIPS
STRUCT. STEEL	=	639
METAL DECK	=	82
CONC. SLAB:		
(1'-6" PLUS DECK)(J-H)(1.7)(34.3)(139.5+1.5+15.3)(.15)	=	1367
2'-6" SLAB (J-H) (1.0) (19.5) (38) (.15)	=	111
3'-6" SLAB (J-H) (2.0)(34.3 (26) (.15)	=	268
2'-0" SLAB (J-H) (.5) (17) (34) (.15)	=	43
5 TO 7, P TO K (1.9)(93-1.0)(23.3-1.0)(.15)	=	585
SLAB-REMAIN. AREA, ASSUME AVG. = 2.0' TK: (2.0)[(116.3-1.0)(108.3) - (π)(30.9)² - (9)²](.15)	=	2568
"NON-SHEAR" WALLS ABOVE 51':		
1/2 X 7 LINE WALL (1.0)(139.5-12.3)(74.3-1.4-51)(.12)(.5)	=	167
1/2 X STAIR WALL (.7)(23.3)(21.9)(.12)(.5)	=	21
INST. SHOP (.7)(4)(23.3)(63.6-.8-51)(.12)	=	92
INST. SHOP (.6)(23.9)(23.9)(.15)	=	51
1/2 X ELEVATOR WALL (.7)(25)(21.9)(.12)(.5)	=	23
MISC. SHIELD WALLS (EST. - 125^K)	=	125
SUB TOTAL		6142

JOB NO. 42103 JOB BOSTON EDISON PNPS BY JWN DATE 4-26-93

CALC. NO. 42103 C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDH DATE 6/4/93

6.2 FLOOR WEIGHTS (CONT'D)

WEIGHT AT EL. 51'

ITEM		KIPS
1/2 OF NON SHEAR WALLS BELOW 51':		
- PIPEWAY	=	73
- ELEVATOR	=	36
	=	
1/2 OF STEEL COLUMNS ABOVE & BELOW (EST. 80K)	=	80
1/2 OF N LINE WALL: (ABOVE 51')		
(.7)(.5)(80-51)(139.5 + 20)(.12)	=	194
SBGT FILTER ASSEMBLY (ATTACH. A) (2)(7)	=	14
T.B. SUPPLY FANS (3)(8)	=	24
CU BACKWASH REC. TANK (1)(17)	=	17
CU REGEN NT. EXCH. (3)(8)	=	24
CU NON-REGEN NT. EXCH. (2)(5)	=	10
MG SET: (X204A, X204B) (2)(95)	=	190
DL PIPING AND EQUIP.:		
EST. 80 LBS/FT² × 16461 FT²	=	1317
MIS. DL EST. 20 LBS/FT² × 16461	=	329
SUB TOTAL (PREVIOUS SH.)	=	6142
TOTAL	=	8450

SBGT SLAB AT EL. 64.0' - MASS DENSITY FOR ANSYS INPUT:

AREA (FROM KEYPOINT LOCATIONS) = 1473.5 FT²

WT. SLAB = (1.4')(1473.5 FT²)(.15) = 309K

DL+LL = (.040 KSF)(1473.5) = 59

368K

$$\text{MASS DENSITY} = \frac{368^K}{(1473\ FT^2)(32.2\ FT/SEC^2)(1.4\ FT)} = 5.54 \times 10^{-3}\ \frac{K\text{-}SEC^2}{FT^4}$$

6.2 FLOOR WEIGHTS (CONT'D)

WEIGHT AT EL. 74'-3" SEE SN. 23 REF. C-66, C-68, C-136

ITEM		KIPS
STRUCT. STEEL	USE 30 PSF + DECK (5 PSF) = 35 PSF	
	$(35)\left[(139.5)(105.3) - (\pi)(23.9)^2 - (19)^2\right]$ = (C-136)	= 439
137.5	SLAB NORTH OF M: 1'-0" TK + DECK = USE 1.2' TK	
5969 FT²	$(1.2)\left[(146.0)(137.5) - (19)^2\right](.15)$ =	= 1074
	SLAB SOUTH OF M (ASSUME 3' TK AVG.)	
6311 FT²	$(3.0)\left[(58.3)(137.5) - (\pi)(17.3)^2\right](.15)$	= 2840
	½ OF "NON-SHEAR" WALLS BELOW EL. 74'-3"	
	½ × 7 LINE WALL	= 167
	½ × STAIR WALL	= 21
	½ × ELEVATOR	= 23
	½ OF "NON-SHEAR WALLS ABOVE EL. 74'-3":	
15.3' H	- FAN RM 5 $(.7)(89)(89.6 - 74.3)(.12)(.5)$	= 57
	- ELEVATOR $(.7)(25)(15.3)(.12)(.5)$	= 16
	- FAN RM 3+4 $(.7)(144.7)(15.3)(.12)(.5)$	= 93
	- HT EXCH. WALLS $(1.0)(38.8)(15.3)(.12)(.5)$	= 36
	- 9 LINE $(1.0)(8.8)(15.3)(.12)(.5)$	= 8
	- NR. 9 LINE $(1.5)(11)(15.3)(.12)(.5)$	= 15
	$(2.0)(5)(15.3)(.12)(.5)$	= 9
	$(1.0)(5)(15.3)(.12)(.5)$	= 5
		} 37
X-42 WALLS	$(2.0)(4)(8)(.12)$	= 8
	$(2)(1.0)(3)(8)(.12)$	= 6
BOT. FUEL POOL SLAB	$(4.0)(30.5)(40.3)(.15)$	= 737
	SUB TOTAL	= 55554

6.2 FLOOR WEIGHTS (CONT'D)

WT AT EL. 74'-3" CONT'D

ITEM		KIPS
FUEL POOL DEMIN. (T-204) (ATTACH. A)		= 13
FUEL POOL HT. EXCH.	(2)(4)	= 8
FUEL CASK (NOT USED - SEE ATTACH. A)		
FUEL POOL WATER - LUMP WITH WALLS		
CU POWDEX UNITS (T216A, T216B)	(2)(9)	= 18
DL PIPING AND EQUIP. (EST. 80 LBS/FT²)		
10,170 FT² (80 PSF) [(139.5)(105.25) - (π)(23.3)² - (19)² - (52.6)(46.5)] (F.P. AREA)		= 814
MISC. DL (EST. 20 LBS/FT²) (20 PSF)(10,170)		= 203
DL PIPING + EQUIP BELOW FUEL POOL AREA ASSUME (40 PSF)(52.6)(46.5)		= 98
½ OF STEEL COLUMNS ABOVE + BELOW (EST 30ᴷ)		= 30
SUB TOTAL (PREVIOUS SHT)		= 5554
TOTAL EL. 74'-3" (EXCL. FUEL AND FUEL RACKS)		= 6738
FUEL RACKS (ATTACH. A) (2.5 KSF)(30.5)(40.4)		= 3081

EQE ENGINEERING

SHEET NO. 37

JOB NO. 42103 JOB BOSTON EDISON PNPS BY JLW DATE 4-26-93

CALC NO. 42103 C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDA DATE 6/4/93

6.2 FLOOR WEIGHTS (CONT'D)

WEIGHT AT EL. 91'-3" SEE SH. 24, REF. C-67, C-68, C-109, C-138

ITEM		KIPS
STRUCT. STEEL + DECK - USE 25 PSF OVER 10,170 FT²		
	(25 PSF)(10,170 FT²) =	254
SLAB WT.:	(9749 SF)	
1' SLAB	(.15)(1.2)[(139.0)(104.8) - (19)² - (π)(24.9)² - (50.6)(49.6)] =	1755
DRY + SEP. SLAB	(1.2)(21)(93.8)(.15) =	166
2' SE CORNER SLAB	(1.0)(21.8)(30)(.15) =	98
3'-6" SE CORNER SLAB	(2.5)(23)(12)(.15) =	104
½ OF "NON-SHEAR" WALLS BELOW 91'-3":		
- FAN RM. 5	(57K) =	57
- ELEVATOR	(16K) =	16
- FAN RM 344	(93K) =	93
- HT EXCH. WALLS	(36K) =	36
- 9 LINE	(37K) =	37
½ OF "NON-SHEAR WALLS ABOVE 91'-3":		
- SHIELD	(1.5)(7.8)(102.3 - 91.3)(.15)(.5) =	10
- ELEVATOR	(.7)(25)(113.3 - 91.3)(.12)(.5) =	23
- FAN RM	(.7)(64)(22)(.12)(.5) =	59
WALLS ABOVE 91'-3":		
S. SIDE	(2)(1.0)(7)(11)(.15) =	23
½ OF STEEL COLUMNS ABOVE + BELOW (EST. 12K)	=	12
SUB TOTAL	=	2743

69.75 - 19.9 - .25 = 49.6

92.0 - 88.6 = 3.4 - 1.2 = 2.2

DAY BOS = 113'-4"

EQE ENGINEERING

SHEET NO. 38

JOB NO. 42103 JOB BOSTON EDISON PNPS BY JWV DATE 4-26-93

CALC. NO 42103-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDA DATE 6/4/93

6.2 FLOOR WEIGHTS (CONT'D)

WT. AT EL. 91'-3" (CONT'D)

ITEM	KIPS
S.B. LIQUID CONTROL TANK (T205) (ATTACH. A)	= 47
CW SURGE TANKS (T201A, T201B) ↓ (2X6)	= 12
NEW FUEL STORAGE (SAY COVERED BY GEN. AREA DL+LL)	
DRY. & SEP. STOR POOL (EMPTY DURING OPERATIONS)	= 0
DL PIPING AND EQUIPMENT (EST. 60 PSF)	
8445 FT² (60 PSF) [(9,749 FT²) - (27)(98.3)]	= 507
(SAY 30 PSF AREA BELOW DRY. & SEP. STORAGE POOL)	
(30 PSF) (27)(98.3)	= 39
MISC. DL (EST. 20 PSF)	
(20 PSF) (8445 FT²)	= 169
SUB TOTAL (PREVIOUS SHT)	= 2743
TOTAL	3517

JOB NO. 42103 JOB BOSTON EDISON PNPS BY VWT DATE 4-26-93

CALC. NO. 42103-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDM DATE 6/4/93

6.2 FLOOR WEIGHTS (CONT'D)

WEIGHT AT EL. 117'-0" SEE SN. 25, REF. C-69, C-70, C-140

- INCLUDE STEEL AND PRECAST WALLS ABOVE 117'-0".

ITEM	KIPS
STRUCT. STEEL + DECK - USE 25 PSF (INCLUDES COLUMNS BELOW 117')	
TOS 115'-4" / 4½" DECK / 11468 FT² (25 PSF)(10,170 FT²)	= 254
SLAB WT: (1.5)[(142.5)(108.3) - (19)(19) - (π)(21.5)² - (40.4)(30.5) - (43.8)(21)] (.15)	= 2580
SHIELD PLUGS (REF. C-177) (6.0)(π)(21.5)²(.15)	= 1307
½ OF "NON-SHEAR" WALLS BELOW 117'-0":	
- SHIELD (10K)	= 10
- ELEVATOR (23K)	= 23
- FAN RM (59K)	= 59
- FUEL STORAGE VAULT (1.0)(23.3)(13.9)(.5)(.15)	= 24
133 − 117 = 16 ELEVATOR WALLS + SLAB (.7)(25)(16)(.12)	= 34
(.3)(10)(12)(.15)	= 5
REFUELING CRANE (ATTACH. A)	= 40
DL PIPING + EQUIPMENT (EST. 40 PSF) (40 PSF)(11468 FT²)	= 459
MISC. DL (EST. 20 PSF) (20 PSF)(11468 FT²)	= 229
½ WT PRECAST WALLS BET. 117' AND 145': (.5)(.5)[(139.2)(2) + (105.3)(2)](145-117)(.15)	= 514
½ WT PRECAST COLUMNS BET. 117' AND 145':	
- CORNER (EST. 15 FT²) (.5)(4)(28)(15)(.15)	= 126
- INTR. (EST. 5 FT²) (.5)(16)(28)(5)(.15)	= 168
SUB TOTAL	= 5832

EQE ENGINEERING

SHEET NO. 40

JOB NO. 42103 JOB BOSTON EDISON BNPS BY JWK DATE 4-26-93

CALC. NO. 42103 C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDH DATE 6/4/93

6.2 FLOOR WEIGHTS (CONT'D)

WT. AT EL. 117'-0" (CONT'D)

ITEM		KIPS
	INC. BY 15% FOR CONNECTIONS	
1/2 WT. STEEL COL's BET. 117 AND 145':		
-24 WF 110	(.5)(14)(110)(145-116.6)(1.15)	= 25
-12 WF 65	(.5)(10)(65)(28.4)(1.15)	= 11
SUB TOTAL (PREVIOUS SNT)		= 5832
TOTAL INCL. WT. ABOVE EL. 117'-0" =		5868

WT. WALLS ABOVE 117'-0" = 514
PRECAST COLUMNS (126+168) = 294
STEEL COLUMNS (25+11) = 36
844K

TOTAL WT. EXCLUDING ITEMS ABOVE 117'-0" = 5368 - 844 = 5024K

EQE ENGINEERING

SHEET NO. 41

JOB NO 42103 JOB BOSTON EDISON PNPS BY JWF DATE 4-26-93

CALC. NO 42103-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDH DATE 6/4/93

6.2 FLOOR WEIGHTS (CONT'D)

WEIGHT AT EL. 145'-0" (TOP OF CRANE RAIL)

REF. A-28, C-130, C-156, C-157, C-158

NOTE: INCREASE CALCULATED STEEL WEIGHTS BY 15% TO ACCOUNT FOR CONNECTIONS, GUSSETS, PLATES, ETC.

	ITEM		KIPS
	½ WT. PRECAST BELOW 145'		
28'-H		$(.5)(.5)\{(139.5)(2)+(105.3)(2)\}(145-117)(.15)$	= 514
	½ WT. PRECAST COLUMNS BELOW 145'		
	- CORNER (EST. 15 FT²)	$(.5)(4)(28)(15)(.15)$	= 126
	- INTERMEDIATE (EST. 5 FT²)	$(.5)(16)(28)(5)(.15)$	= 168
TOP EL. 166'-0½"	½ WT. PRECAST COLUMNS ABOVE 145'		
21'-H		$(.5)(4)(166.0-145)(15)(.15)$	= 95
		$(.5)(16)(21)(5)(.15)$	= 126
	½ WT. STEEL COLUMNS BELOW 145'		
	- 24 WF 110	$(.5)(14)(110)(145-116.6)(1.15)$	= 25
	- 12 WF 65	$(.5)(10)(65)(28.4)(1.15)$	= 11
TOP 164'-7"	½ WT. STEEL COL'S ABOVE 145'		
		$(.5)(14)(110)(164.7-145)(1.15)$	= 17
		$(.5)(10)(65)(19.5)(1.15)$	= 73
	CRANE RAILS (EST. 470 LBS/FT)		
		$(2)(470)(139.5)(1.15)$	= 151
	BRIDGE CRANE + TROLLY (ATTACH. A)		= 252
	½ WT. PRECAST WALL PANELS ABOVE 145'		
		$(.5)(.5)\{(139.5)(2)+(105.3)(2)\}(166.0-145)(.15)$	= 386
	TOTAL INCL. BRIDGE CRANE		= 1944
			- 252
	TOTAL EXCL. BRIDGE CRANE		1692

EQE ENGINEERING

SHEET NO. 42

JOB NO. 42103 JOB BOSTON EDISON PNPS BY JLW DATE 4-26-93

CALC. NO. 42103 C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDH DATE 6/4/93

6.2 FLOOR WEIGHTS (CONT'D)

WEIGHT AT EL. 164'-6" (AVG. ELEV. OF ROOF)

REF. A-28, C-130, C-156, C-157, C-158

NOTE: INCREASE CALC. STEEL WTS BY 15% TO ACCOUNT FOR CONNECTIONS, GUSSET, PLATES, ETC.

ITEM		KIPS
1/2 WT. OF PRECAST WALLS EL. 166.0 TO 145':	=	386
1/2 WT PRECAST COLUMNS ABOVE 145'	=	95
↓	=	126
1/2 WT. STEEL COLUMNS ABOVE 145'	=	17
↓	=	73
ROOF DECK + ROOFING ASSUME = 12 PSF (141.5)(107.3)(.012)	=	182
ROOF BEAMS (78)(27)(23.3)(1.15)	=	59
↓ (8)(95)(26.3)(1.15)	=	11
LOWER CHORD BMS (11)(79)(23.3)(1.15)	=	23
(1)(62)(23.3)(1.15)	=	2
(7)(79)(26.3)(1.15)	=	17
(1)(62)(26.3)(1.15)	=	2
(15)(47.5)(23.3)(1.15)	=	19
(3)(34)(23.3)(1.15)	=	3
LOWER CHORD BRCG. (32)(47.5)(35.1)(1.15)	=	61
VERT BRCG. (8)(4.9)(2)(14.1)(1.15)	=	1
TRUSSES (EST. 14.1K EA.) (5)(14.1)	=	71

.3 : 35.1 : 23.3

ROOF SNOW LOAD - ASSUME NORMAL SNOW LOAD AND/OR PONDING LOAD EQUAL TO 10 PSF (COVERS APPX. 2" DP. PONDING LOAD)

(141.5)(107.3)(.010) = 152

TOTAL = 1300

6.3 BUILDING INTERFACE LOCATIONS

THE REACTOR BUILDING IS GENERALLY ISOLATED FROM THE ADJACENT BUILDINGS (TURBINE, RADWASTE AND DIESEL GENERATOR) BY EXPANSION JOINTS. BASED ON A REVIEW OF DRAWINGS AND REF. 1 IT IS CONCLUDED THAT THE EXPANSION JOINTS ARE ADEQUATE TO PREVENT SEISMIC COUPLING OF THE BUILDINGS. IT IS ALSO CONCLUDED THAT THE INTERFACE LOCATIONS WILL HAVE NEGLIGIBLE EFFECT ON THE REACTOR BUILDING MODEL. HOWEVER, SOME INTERFACE LOCATIONS ALLOW TRANSMISSION OF VERTICAL FORCES DUE TO THE REACTOR WALLS PROVIDING VERTICAL SUPPORT FOR STEEL FRAMING. TO ACCOUNT FOR THIS EFFECT, CALCULATE THE MASS CONTRIBUTION OF INTERFACE FRAMING LEVELS AND INCLUDE IN REACTOR BUILDING FLOOR MASS.

THE FOLLOWING INTERFACE LEVELS MAY CONTRIBUTE MASS WHICH SHOULD BE INCLUDED IN THE REACTOR BUILDING MASS CALCULATIONS:

R.B. AUX. BAY ROOF (EL. 50'±)
TURBINE BLDG. EL. 51'-0"
TURBINE "AUX. BAY" ROOF EL. 82'-0"
RADWASTE ROOF EL. 51'-0"

ALL OTHER INTERFACE AREAS (SUCH AS TURBINE BLDG. EL's 23.0' AND 37', RADWASTE EL. 37') HAVE INSIGNIFICANT MASS CONTRIBUTION AND NEGLIGIBLE EFFECT. THE MASS OF THESE AREAS IS CONSIDERED COVERED BY THE DEAD LOAD ALLOWANCES FIGURED IN AT THE FLOOR LEVELS.

6.3 BUILDING INTERFACE LOCATIONS (CONT'D)

WT. CONTRIBUTION - R.B. AUX. BAY ROOF (EL. 50'±) (REF. C-146)

ASSUME ENTIRE ROOF WT. AND 1/2 OF PRECAST PANEL WALL WT. IS DISTRIBUTED TO R.B. EL. 51' SLAB.

ASSUME STEEL DL = 12 PSF (INCL. COLUMNS)
DECK DL = 5 PSF
ROOFING DL = 6 PSF
NORMAL SNOW LL = 10 PSF
PIPING, CONDUIT DL = 10 PSF
43 PSF

38 3
12 0
50 3
- 2 4
47 11

ROOF LOAD = (.043 KSF)(47.9)(139.5) = 287 K
1/2 PRECAST PANELS (SH. 28) = 140
427 K TOTAL TO R.B. EL. 51.0'

WT. CONTRIBUTION - TURBINE BLDG. EL. 51'-0" (REF. M-14, C-289)

ASSUME STEEL DL = 10 PSF
DECK DL = 5 PSF
1' SLAB DL = 150 PSF
MISC. DL+LL = 60 PSF
225 PSF

ASSUME WT. CONTRIBUTION IS 1/2 OF SPAN
WT. = (.225 KSF)(19)(.5)(139.5) = 298 K TOTAL TO R.B. EL. 51.0'

BY INSPECTION OF CONNECTION DETAIL (SECT. A, DWG C-289) A SLOTTED CONNECTION WAS USED WITH AN EXPANSION JOINT. THIS DETAIL WILL ALLOW MASS TO BE TRANSMITTED TO THE REACTOR BUILDING ONLY IN THE VERTICAL DIRECTION AND TO SOME EXTENT (DEPENDING ON BEAM STIFFNESS) IN THE EAST-WEST DIRECTION. THE CALCULATED WEIGHT ABOVE IS LESS THAN 3% OF THE TOTAL WEIGHT AT EL. 51', AND IT WILL HAVE INSIGNIFICANT EFFECT ON THE REACTOR BLDG. RESPONSE. THEREFORE, ASSUME THE MASS THAT ACTUALLY CONTRIBUTES FOR THIS AREA IS COVERED BY THE GENERAL AREA DL.

6.3 BUILDING INTERFACE LOCATIONS (CONT'D)

WT. CONTRIBUTION - TURBINE "AUX-BAY" ROOF EL. 82'-0" (REF. C-285)

ASSUME 1/2 OF THE BEAM SPAN BETWEEN H & J LINES CONTRIBUTES MASS AT EL. 82'. ASSUME 1/2 OF THIS MASS IS DISTRIBUTED TO EACH EL. 79'-3" AND 91'-3".

34.3
- 1.5
32.8

ASSUME STEEL DL = 10 PSF
DECK DL = 5 PSF
ROOFING DL = 6 PSF
NORMAL SNOW LL = 10 PSF
MISC. DL + LL = 20 PSF
51 PSF

WT = (.051 KSF)(26.3)(20.8)(.5) = 14 (R.W SIDE)
WT. = (.051 KSF)(139.5)(32.8)(.5) = 117 (T.B. SIDE)
TOTAL = 131

CONTRIBUTION TO EL. 79'-3" = (.5)(131) = 66^K
" TO EL 91'-3" = (.5)(131) = 66^K

WT. CONTRIBUTION - RADWASTE ROOF EL. 51'-0" (REF. C-148)

ROOF CONNECTS NORTH OF K.6 LINE. ASSUME CONTRIBUTION IS 1/2 OF BEAM SPAN (APPX. 21'). USE SAME LOADING AS ABOVE (51 PSF.)

WT. = (.051 KSF)(21)(.5)(79.0) = 42^K CONTRIBUTION TO R.B. EL. 51.0'

6.4 ANSYS INPUT INFORMATION

CONSTANTS - UNITS: USE FEET, KIPS, SECONDS

CONCRETE f'_c = 4000 PSI (REF. 2 TABLE 7.3)
= (4 KSI)(144 in^2/ft^2) = 576 KSF

BLOCK WALLS - POISSON'S RATIO = 0.2
E_c = MODULUS OF ELASTICITY OF MASONRY = 1000 f'_M = 1.35×10^3 KSI } REF. 3 P. 8
$E_c = (1.35 \times 10^3 \text{ KSI})(144 \text{ in}^2/\text{ft}^2) = 1.94 \times 10^5$ KSF

BLOCK WALL DENSITY ASSUME = 120 PCF
" " MASS DENSITY = $\frac{.120 \text{ K/FT}^3}{32.2 \text{ FT/SEC}^2} = 3.73 \times 10^{-3} \frac{\text{K-SEC}^2}{\text{FT}^4}$

CONCRETE DENSITY ASSUME = 150 PCF
CONCRETE MASS DENSITY = $\frac{.150 \text{ K/FT}^3}{32.2 \text{ FT/SEC}^2} = 4.66 \times 10^{-3} \frac{\text{K-SEC}^2}{\text{FT}^4}$

POISSON'S RATIO CONCRETE = .17 (REF. 4 P. 18)

MODULUS OF ELASTICITY CONCRETE = $57{,}000\sqrt{f'_c}$ (REF 5, 8.5.1)

$$= \frac{57\sqrt{4000 \text{ K/in}^2} \times 144 \text{ in}^2}{\text{FT}^2}$$

$$= 5.19 \times 10^5 \text{ KSF}$$

JOB NO. 42103 JOB BOSTON EDISON PNPS BY JWN DATE 4-26-93

CALC. NO. 42103-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDH DATE 6/4/93

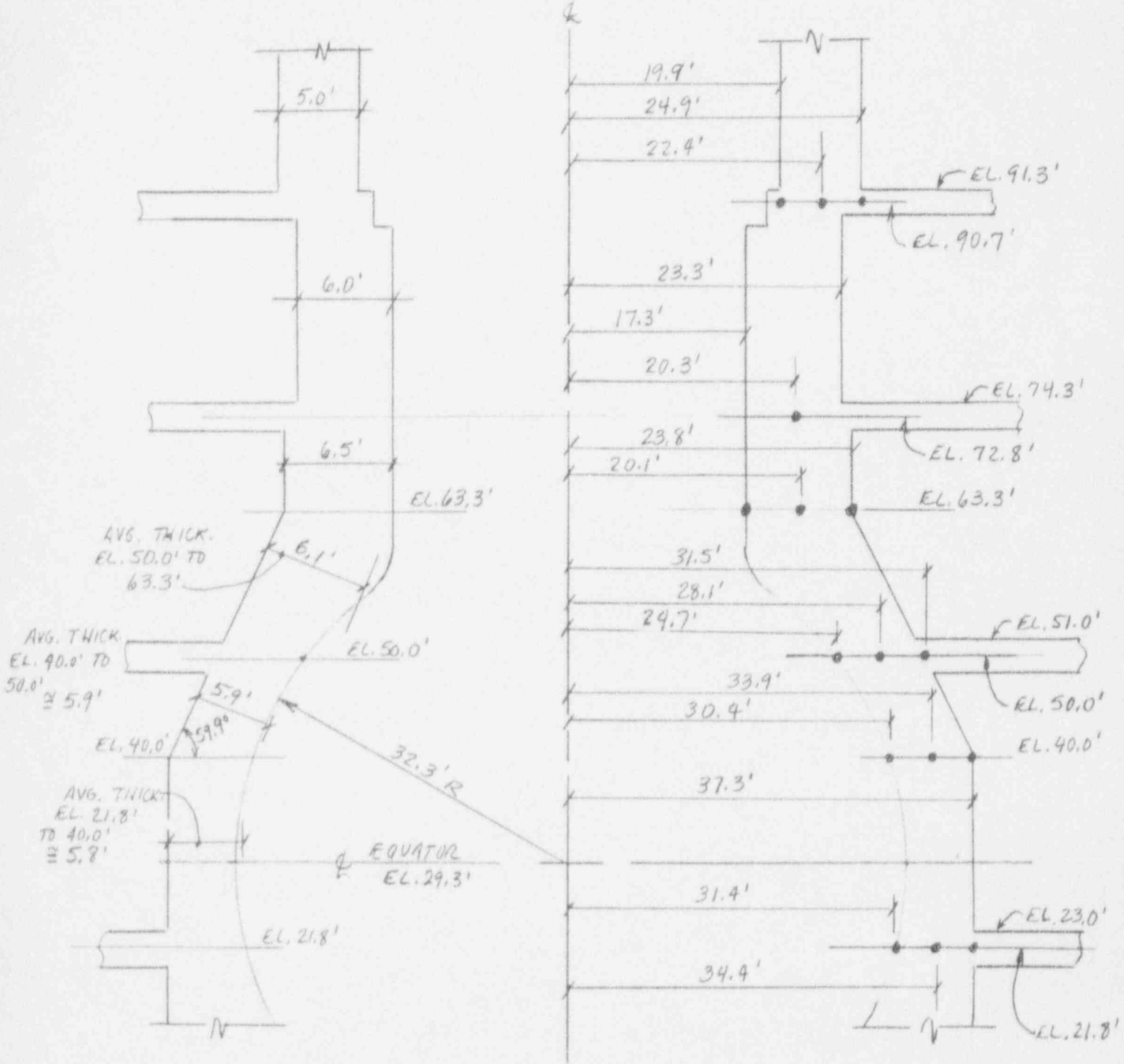
6.4 ANSYS INPUT INFORMATION (CONT'D)

DETERMINE ELEVATIONS OF AVG. SLAB THICKNESS

AREA	ELEV. AT TOP OF SLAB	AVG. THICKNESS (FT.)	ELEV. AT ℄ SLAB (FT)	Z COORDINATE (FT)
AUX. BAY	3.0'	3.3	1.4	18.9
AUX. BAY	23.0'	1.3	22.3	39.8
REACTOR	23.0'	2.4	21.8	39.3 ← USE
↓	51.0'	2.0	50.0	67.5
	74.3'	3.0	72.8	90.3
	91.3'	1.2	90.7	108.2
	117.0'	1.5	116.3	133.8

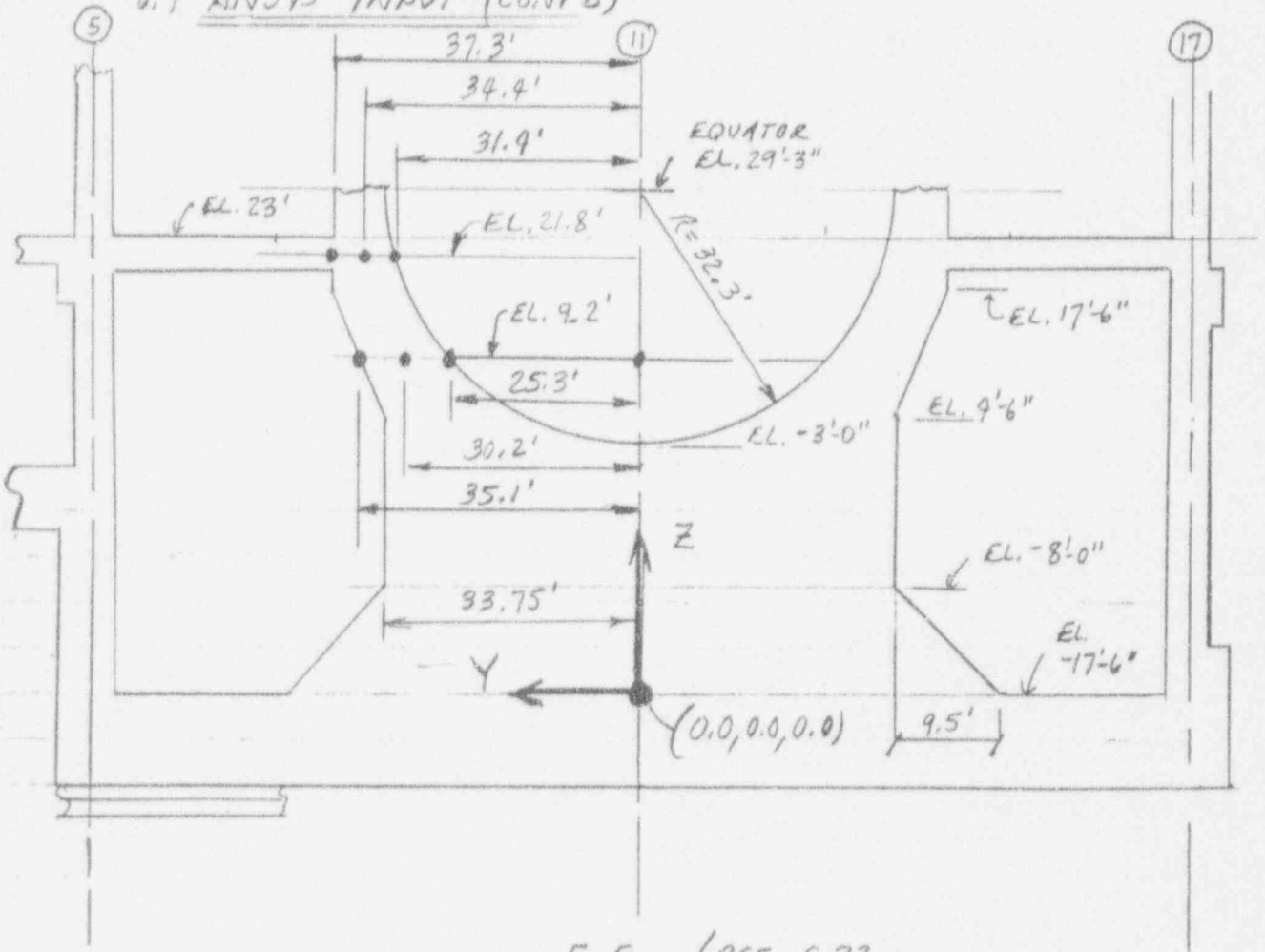
NOTE: FOR MODELING PURPOSES AT EL. 23' USE Z COORDINATE FOR REACTOR AREA FOR ALL AREAS INCL. AUX. BAY.

6.4 ANSYS INPUT (CONT'D)



ELEVATION - DRYWELL SHIELD WALL
SHOWING DIMENSIONS USED FOR
DETERMINING KEYPOINT LOCATIONS
REF. C-72, C-112

6.4 ANSYS INPUT (CONT'D)



F-F (REF. C-72 SECT. A, C-151)

LOWER DRYWELL SHIELD WALL WILL BE REPRESENTED AS A BEAM ELEMENT IN ANSYS MODEL.

PROPERTIES FROM EL. -17.5' TO 9.2'

SOLID CYLINDER WITH $R = 33.75'$ (REF. C-72)

$$A = \pi R^2 = (\pi)(33.75)^2 = 3578 \text{ FT}^2$$

$$I = .7854\, R^4 = (.7854)(33.75)^4 = 1.019 \times 10^6 \text{ FT}^4 \text{ (REF. 6)}$$

EQE

EQE ENGINEERING

SHEET NO. 50

JOB NO. 42103 JOB BOSTON EDISON PNPS BY JLW DATE 4-26-93

CALC. NO 42103-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDA DATE 6/9/93

6.4 ANSYS INPUT (CONT'D)

LOWER DRYWELL SHIELD WALL (CONT'D)

PROPERTIES FROM EL. 9.2' TO 21.8'

REPRESENT AS A CYLINDER

AT EL. 21.8': O.D. = 74.6' I.D. = 62.8'

AT EL. 9.2': O.D. = 70.2' I.D. = 50.6'

AVG. O.D. = (74.6 + 70.2)/2 = 72.4'

AVG I.D. = (62.8 + 50.6)/2 = 56.7'

(REF. 6) $A = .7854\ (OD^2 - ID^2) = (.7854)[(72.4)^2 - (56.7)^2] = 1592\ FT^2$

(REF. 6) $I = .0491\ (OD^4 - ID^4) = (.0491)[(72.4)^4 - (56.7)^4] = 9.41 \times 10^5\ FT^4$

JOB NO 42103 JOB BOSTON EDISON PNPS BY JWS DATE 4-26-93

CALC. NO. 42103-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D. RDM DATE 6/4/93

6.4 ANSYS INPUT (CONT'D)

DETERMINE MASS OF FUEL POOL WATER

FUEL POOL WATER WEIGHT WILL BE INPUT TO ANSYS MODEL AS A DISTRIBUTED MASS ON THE NORTH AND SOUTH FUEL POOL WALLS.

- FOR WALLS EL. 74.3' TO 91.3':

℄ SLAB = EL. 90.7'

F.P. SLAB - TOP CONCRETE $-\frac{78.3'}{12.4'}$ (REF C-109)

$$\text{TOTAL WATER WT.} = \left(.0624 \frac{K}{FT^3}\right)(12.4)(20.2)(30.3) = 476.7^K$$

ANSYS AREA (FROM KEYPOINT COORDINATES)
$= (34.9)(17.9) = 624.7\ FT^2$

- TOTAL MASS DISTRIBUTION DISTRIBUTED OVER ANSYS WALL AREA (WATER + CONCRETE)

$$\text{WATER} = \frac{476.7^K}{(624.7\ FT^2)(6.1')} = .125\ KCF$$

↑ t WALL

TOTAL WATER + CONC. $= (.125 + .150) = .275\ KCF$

$$\text{MASS DENSITY} = \frac{.275\ KCF}{32.2\ FT/SEC^2} = 8.5 \times 10^{-3} \frac{K\text{-}SEC^2}{FT^4}$$

↑ TOTAL FOR WALLS EL. 74.3' TO 91.3'

6.4 ANSYS INPUT (CONT'D)

FUEL POOL WATER MASS DENSITY (CONT'D)

- FOR WALLS EL. 91.3' TO 117.0':

NORMAL WATER LEVEL = EL. 116' (REF. M-23)

& SLAG = -90.7

25.3'

WATER WT. = $(62.4)(25.3)(30.5)(20.2) = 972.6^K$

ANSYS AREA = $(35)(25.6) = 896\ FT^2$

WATER DISTRIBUTION = $\frac{972.6^K}{(896\ FT^2)(5.1')} = .213\ KCF$ ← L. WALL

TOTAL WATER + CONC. = .213 + .150 = .363 KCF

MASS DENSITY = $\frac{.363\ KCF}{32.2\ FT/SEC^2} = 11.27 \times 10^{-3}\ \frac{K\text{-}SEC^2}{FT^4}$

TOTAL FOR WALLS EL. 91.3' TO 117.0'

EQE ENGINEERING

SHEET NO. 53

JOB NO. 42103 JOB BOSTON EDISON PNPS BY JLW DATE 4-26-93

CALC NO. 42103-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDH DATE 6/4/93

6.4 ANSYS INPUT (CONT'D)

DETERMINE EQUIVALENT MASS DENSITY AT EACH FLOOR LEVEL

EL. -17'-6": TOTAL SLAB WEIGHT = 30,187 K (SH. 26)
TORUS WEIGHT = 6097
TOTAL 36,284 K

SURFACE AREA = 23,130 FT² (FILE MF-17.RO) (SH. 79)

$$\text{MASS DENSITY} = \frac{(36284^{K})}{(1FT)(23{,}130\ FT^2)(32.2\ FT/SEC^2)} = 4.87\times10^{-2}\ \frac{K\text{-}SEC^2}{FT^4}$$

↑ UNIT THICKNESS

EL. 23'-0":

- SEPARATE AUX. BAY DENSITY

TOTAL WT. AUX. BAY = 3932 K (SH. 29)
SURFACE AREA AUX BAY = 7486 FT² (FILE MF-23.RO) (SH. 81)

$$\text{MASS DENSITY (AUX BAY)} = \frac{(3932^{K})}{(1FT)(7486\ FT^2)(32.2\ FT/SEC^2)} = 1.63\times10^{-2}\ \frac{K\text{-}SEC^2}{FT^4}$$

WT. R.B EL. 23' = 9,175 K (SH. 32)
SURF. AREA R.B. = 14,478 FT² (FILE MF-23.RO) (SH. 81)

$$\text{MASS DEN. R.B.} = \frac{9175^{K}}{(1FT)(14{,}478\ FT^2)(32.2\ FT/SEC^2)} = 1.97\times10^{-2}\ \frac{K\text{-}SEC^2}{FT^4}$$

TOTAL SURFACE AREA = 7486 + 14,478 = 21,964 FT²

↑ (FILE MF-23.RO) (SH. 81)

6.4 ANSYS INPUT (CONT'D)

EQUIVALENT MASS DENSITY AT EACH FLOOR LEVEL (CONT'D)

EL. 51'-0":

WT. EL. 51' =	8450 K	(SH. 34)
AUX BAY ROOF =	427 K	(SH. 44)
R.W. ROOF EL. 51' =	42 K	(SH. 45)
TOTAL =	8919 K	

SURFACE AREA = 16,404 FT² (FILE MF-51.RD) (SH. 82)

$$\text{MASS DENSITY} = \frac{(8919\,K)}{(1\,FT)(16{,}404\,FT^2)(32.2\,FT/SEC^2)} = 1.69\times10^{-2}\,\frac{K\text{-}SEC^2}{FT^4}$$

EL. 74'-3":

WT. EXCLUDING FUEL RACKS =	6738 K	(SH. 36)
T.B. AUX BAY ROOF =	66 K	(SH. 45)
TOTAL =	6804	

SURF. AREA = 12,256 FT² (FILE MF-74.RD) (SH. 85)

$$\text{MASS DENSITY} = \frac{(6804\,K)}{(1\,FT)(12{,}256\,FT^2)(32.2\,FT/SEC^2)} = 1.72\times10^{-2}\,\frac{K\text{-}SEC^2}{FT^4}$$

- DETERMINE SEPARATE MASS DENSITY FOR FUEL POOL:

FUEL RACKS - BUOYANT FORCE (ASSUME ALL STEEL)

TOTAL WT. = 3081 K (SH. 36)

$$\text{STEEL VOLUME} = \frac{3081\,K}{.490\,K/FT^3} = 6288\,FT^3$$

6.4 ANSYS INPUT (CONT'D)

EQUIVALENT MASS DENSITY (CONT'D)

EL. 79'-3": (CONT'D)

$$\text{BUOYANT FORCE} = \frac{(6288\ FT^3)\ 62.4\ LBS/FT^3}{1000\ LBS/K} = 392^K$$

NET WEIGHT = $3081 - 392 = 2689^K$

FUEL POOL AREA = $(52.6)(30.5) = 1604\ FT^2$

$$\text{MASS DENSITY FUEL RACKS} = \frac{2689^K}{(1FT)(1604\ FT^2)(32.2\ FT/SEC^2)} = 5.21 \times 10^{-2}\ \frac{K\text{-}SEC^2}{FT^4}$$

TOTAL MASS DENSITY OVER FUEL RACK AREA = $5.21 \times 10^{-2} + 1.72 \times 10^{-2} = 6.93 \times 10^{-2}\ K\text{-}SEC^2/FT^4$

EL. 91'-3":

TOTAL WT. = 3517^K (SH. 38)

T.B. AUX. BAY ROOF = 66^K (SH. 45)

3583^K

SURFACE AREA = $9753\ FT^2$ (FILE MF-91.R0) (SH. 87)

$$\text{MASS DENSITY} = \frac{3583^K}{(1FT)(9753\ FT^2)(32.2\ FT/SEC^2)} = 1.14 \times 10^{-2}\ \frac{K\text{-}SEC^2}{FT^4}$$

6.4 ANSYS INPUT (CONT'D)

EQUIVALENT MASS DENSITY (CONT'D)

EL. 117'-0":

TOTAL WT. (EXCL. ITEMS ABOVE 117') = 5024^K (SEE SN 40)

SURFACE AREA = 12,681 FT^2 (FILE MF-117.20) (SN. 89)

$$\text{MASS DENSITY} = \frac{5024^K}{(1\ \text{FT})(12{,}681\ \text{FT}^2)(32.2\ \text{FT/SEC}^2)} = 1.23 \times 10^{-2}\ \frac{\text{K-SEC}^2}{\text{FT}^4}$$

JOB NO. 42103 JOB BOSTON EDISON ANPS BY NLH DATE 4-26-93

CALC NO. 42103-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D CRD # DATE 6/4/93

6.4 ANSYS INPUT (CONT'D)

- DETERMINE DRYWELL SHELL BEAM PROPERTIES FROM EL. 74.25' TO EL. 91.25' FOR SEPARATE BEAM IN BUILDING MODEL (TO CONNECT STAR TRUSS AT EL. 81.8') FOR A CYLINDER: (REF. 7)

O.D. = 46.6' I.D. = 34.6' (SEE SN. 48)

$A = .7854 (OD^2 - ID^2) = .7854 (46.6^2 - 34.6^2)$
$= 765.3 \text{ FT}^2$

$I = .0491 (OD^4 - ID^4) = .0491 (46.6^4 - 34.6^4)$
$= 161170 \text{ FT}^4$

SHEAR AREA $= A/2 = 765.3/2 = 382.7 \text{ FT}^2$

$J = 2 \times I = (2)(161170) = 322340 \text{ FT}^4$

6.5 ANSYS INPUT (CONT'D) KEYPOINTS FOR WALLS

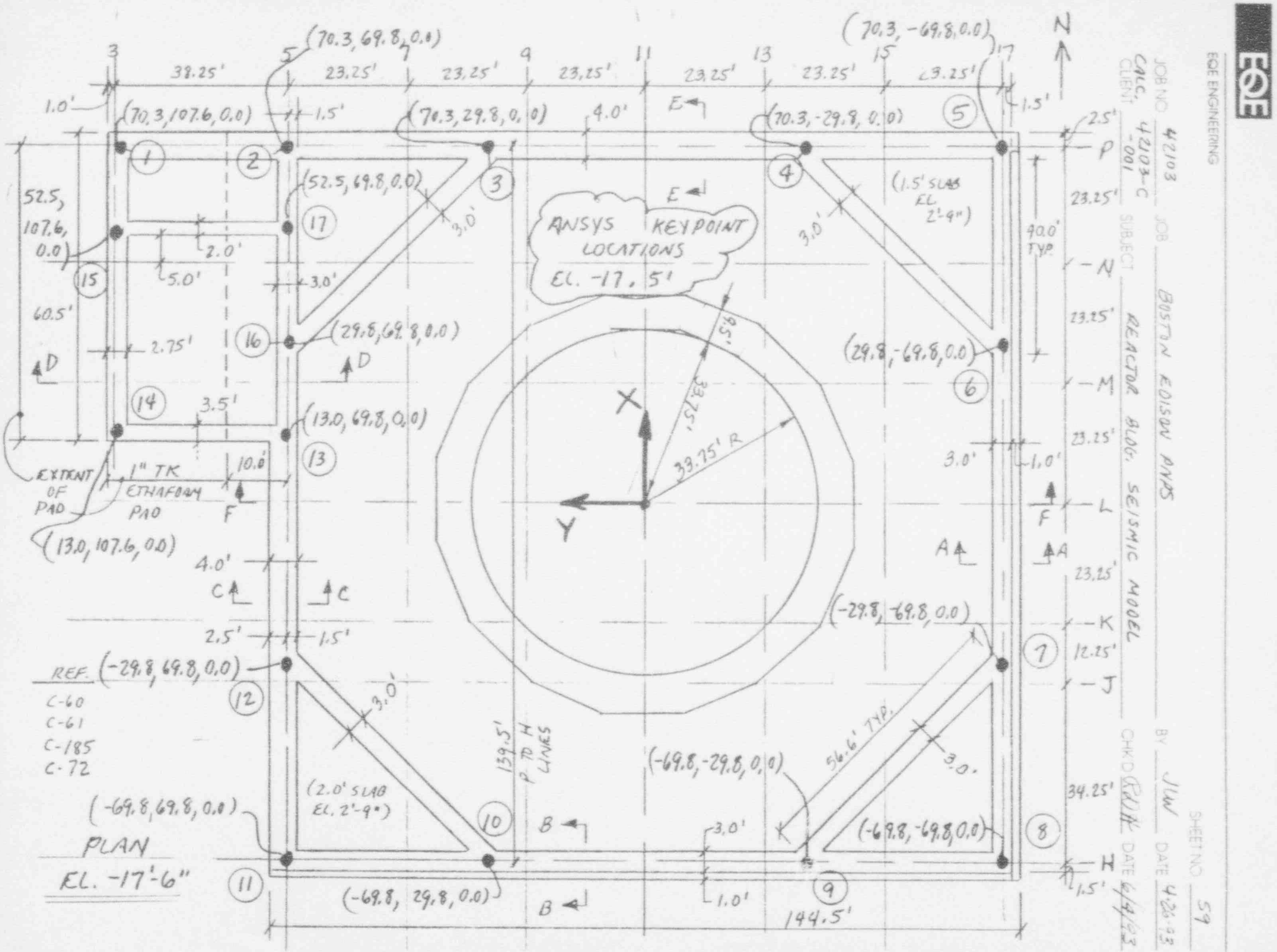
THE FOLLOWING SHEETS SHOW THE KEYPOINTS USED TO GENERATE THE FINITE ELEMENT MESH FOR THE WALLS BETWEEN EL. -17.5' TO 21.8'

21.8' TO 50.0'

50.0' TO 72.8'

72.8' TO 90.7'

90.7' TO 116.3'



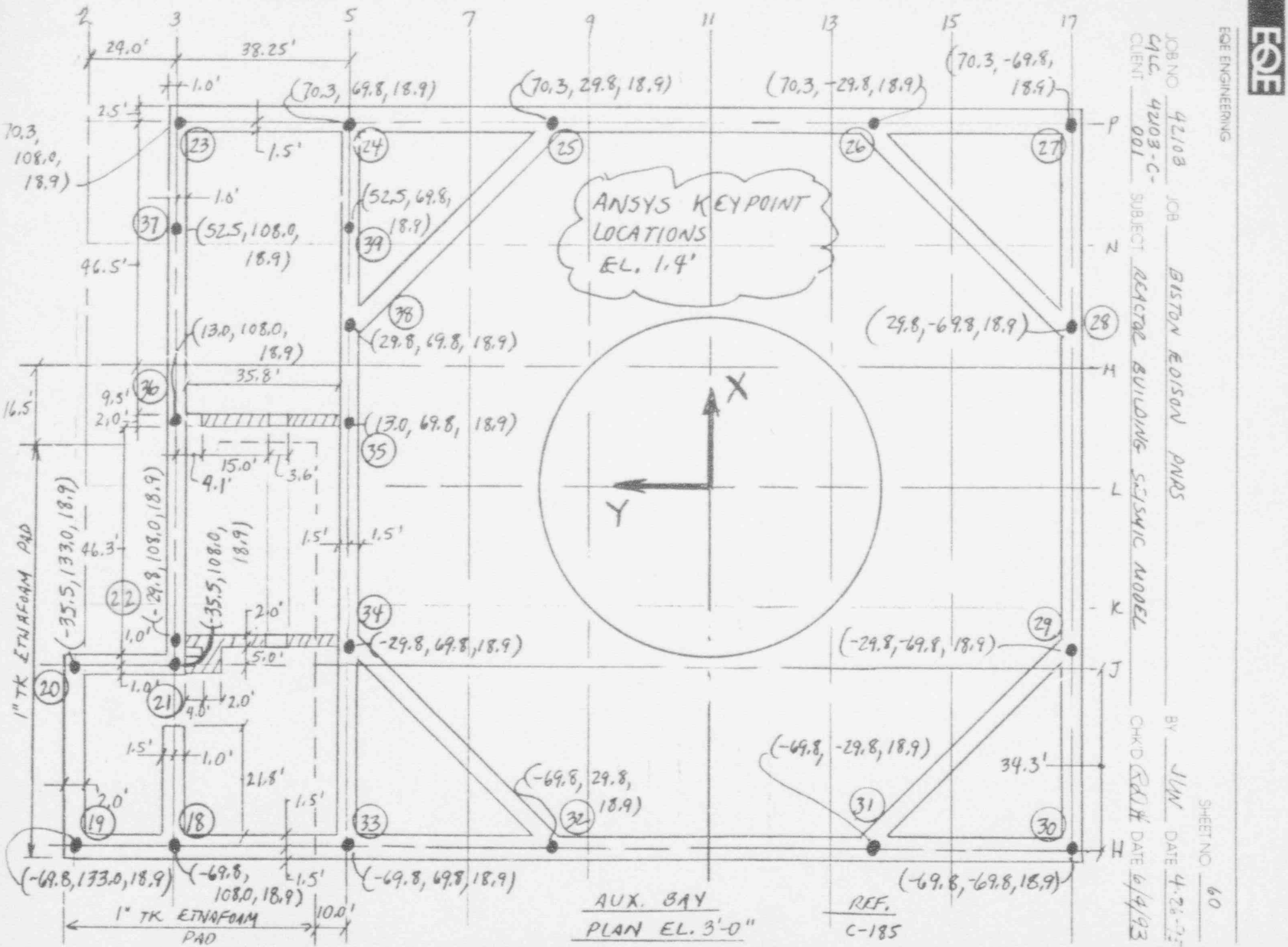
EQE ENGINEERING

JOB NO 42103 JOB BOSTON EDISON ANPS SHEET NO 59

CALC. 42103-C-001 SUBJECT REACTOR BLDG. SEISMIC MODEL

CLIENT CHKD RWK DATE 6/4/93

BY JW DATE 4-26-93



EQE ENGINEERING

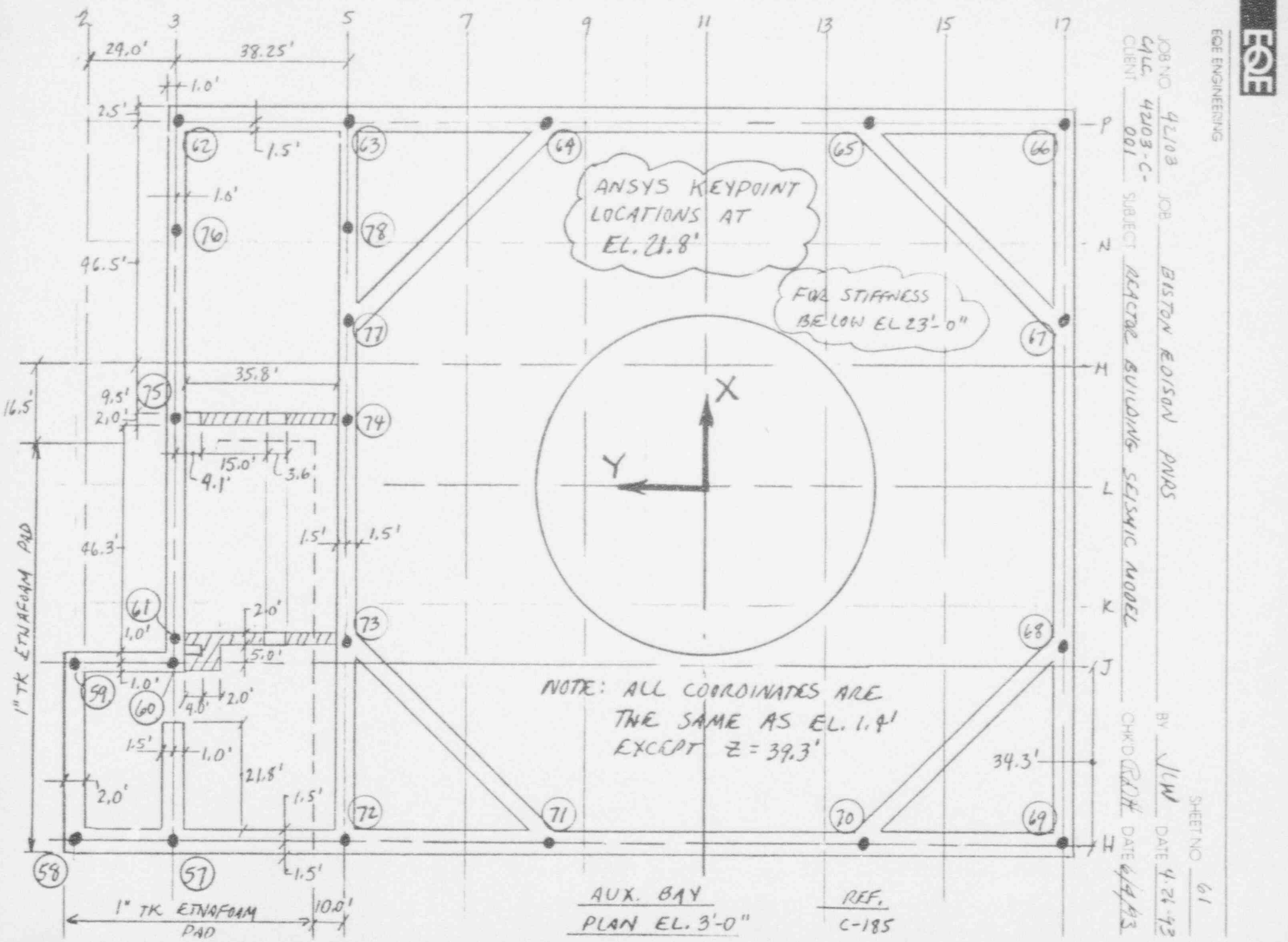
JOB NO. 42103 JOB BIGTON EDISON PNAS

CLIENT G4LC. 42103-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL

BY JJW DATE 4-26-93

CHK'D [illegible] DATE 6/4/93

SHEET NO. 60



EQE ENGINEERING

JOB NO 4203 JOB BISTON EDISON PWRS SHEET NO 61

CLIENT G&LC, 4203-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL

BY JLW DATE 4-24-93

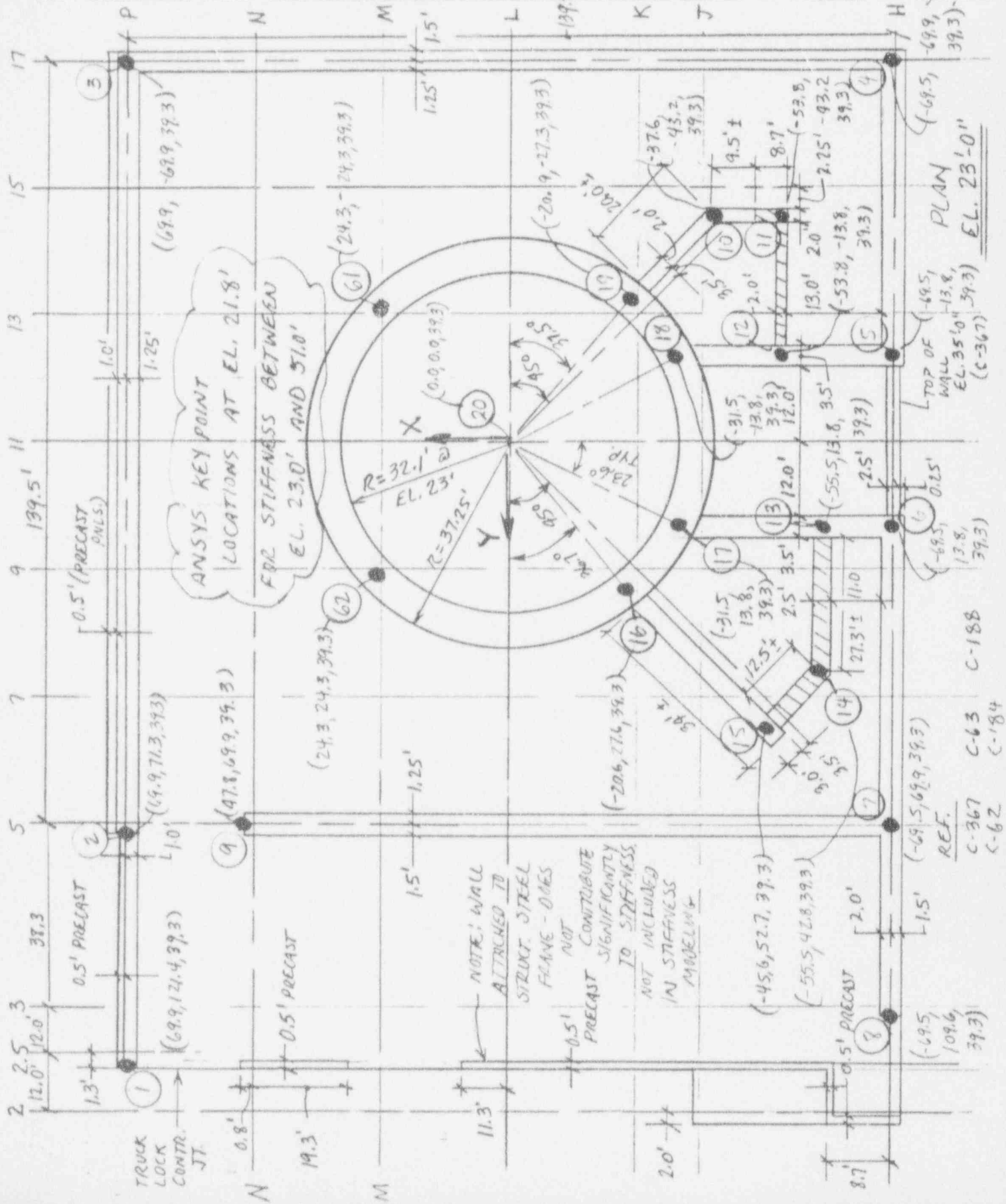
CHKD RDH DATE 4/4/93

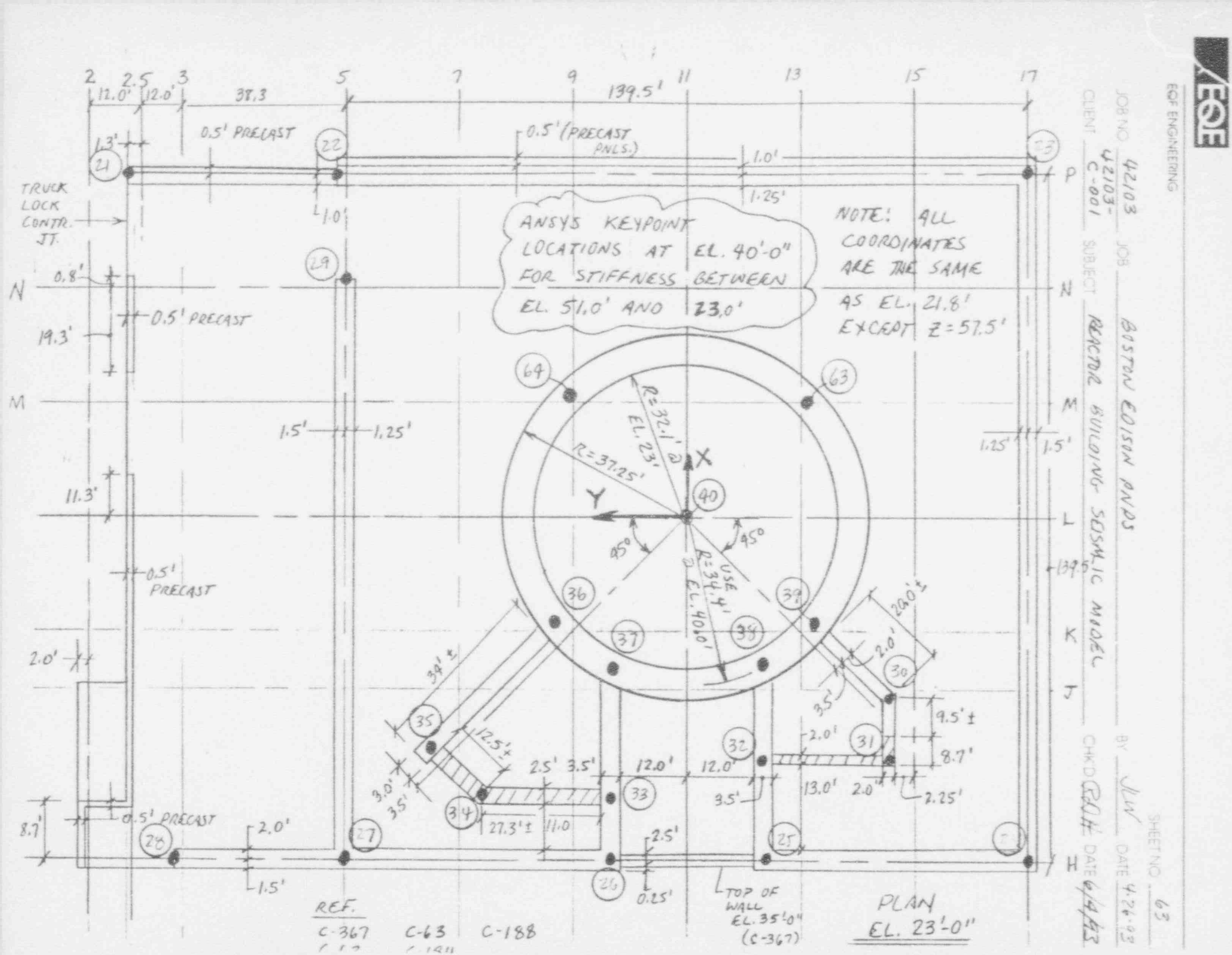
EQE ENGINEERING

SHEET NO. 62

JOB NO. 42103 / 42103-C-001 JOB BOSTON EDISON ANDS BY JLW DATE 4-26-93

CLIENT SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDA DATE 6/4/93



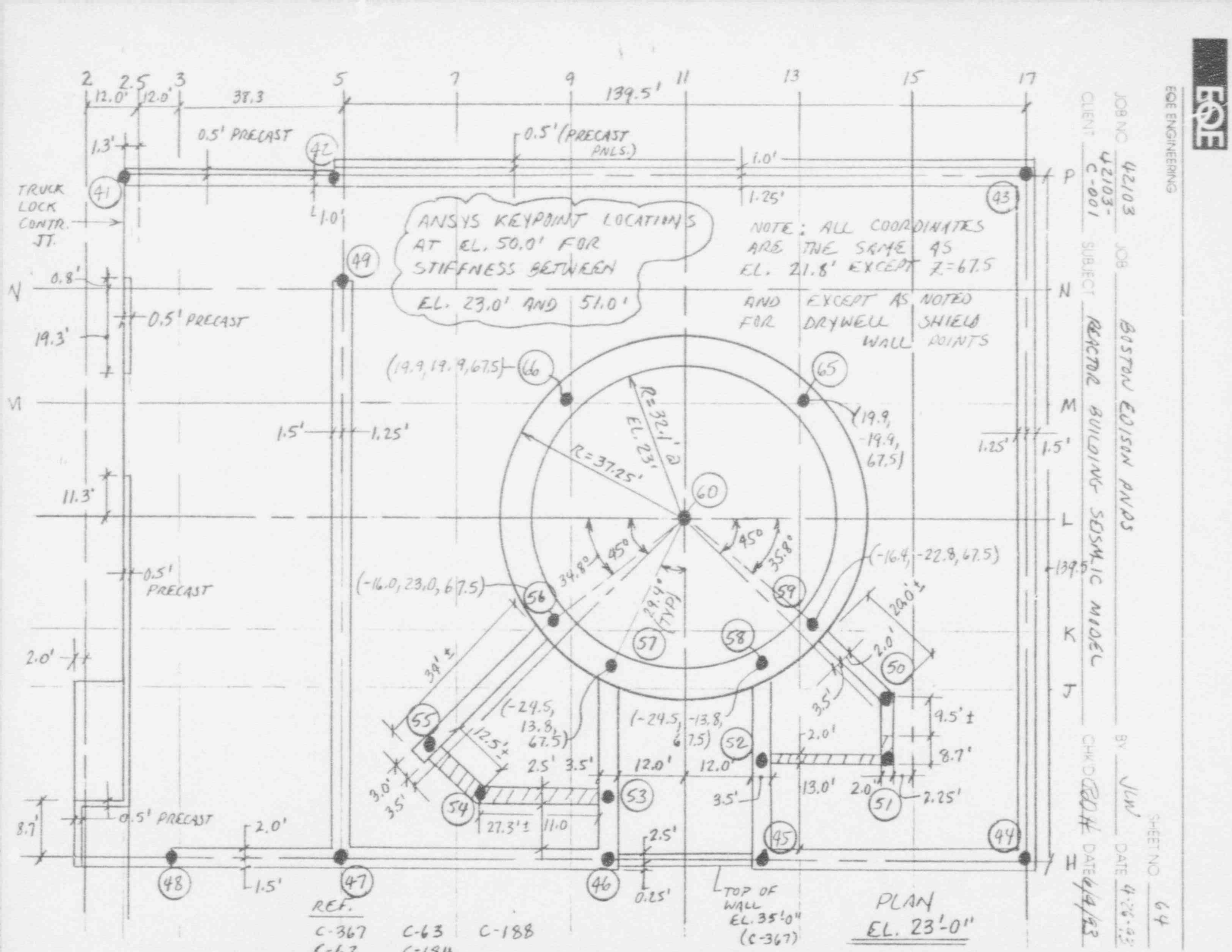


REF.
C-367
C-63
C-188

TOP OF WALL EL. 35'-0" (C-367)

PLAN
EL. 23'-0"

EQE ENGINEERING
JOB NO. 42103 JOB BOSTON EDISON ANPS
CLIENT 42103-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL
BY JLW DATE 4-26-93
CHKD RDH DATE 6/4/93
SHEET NO. 63

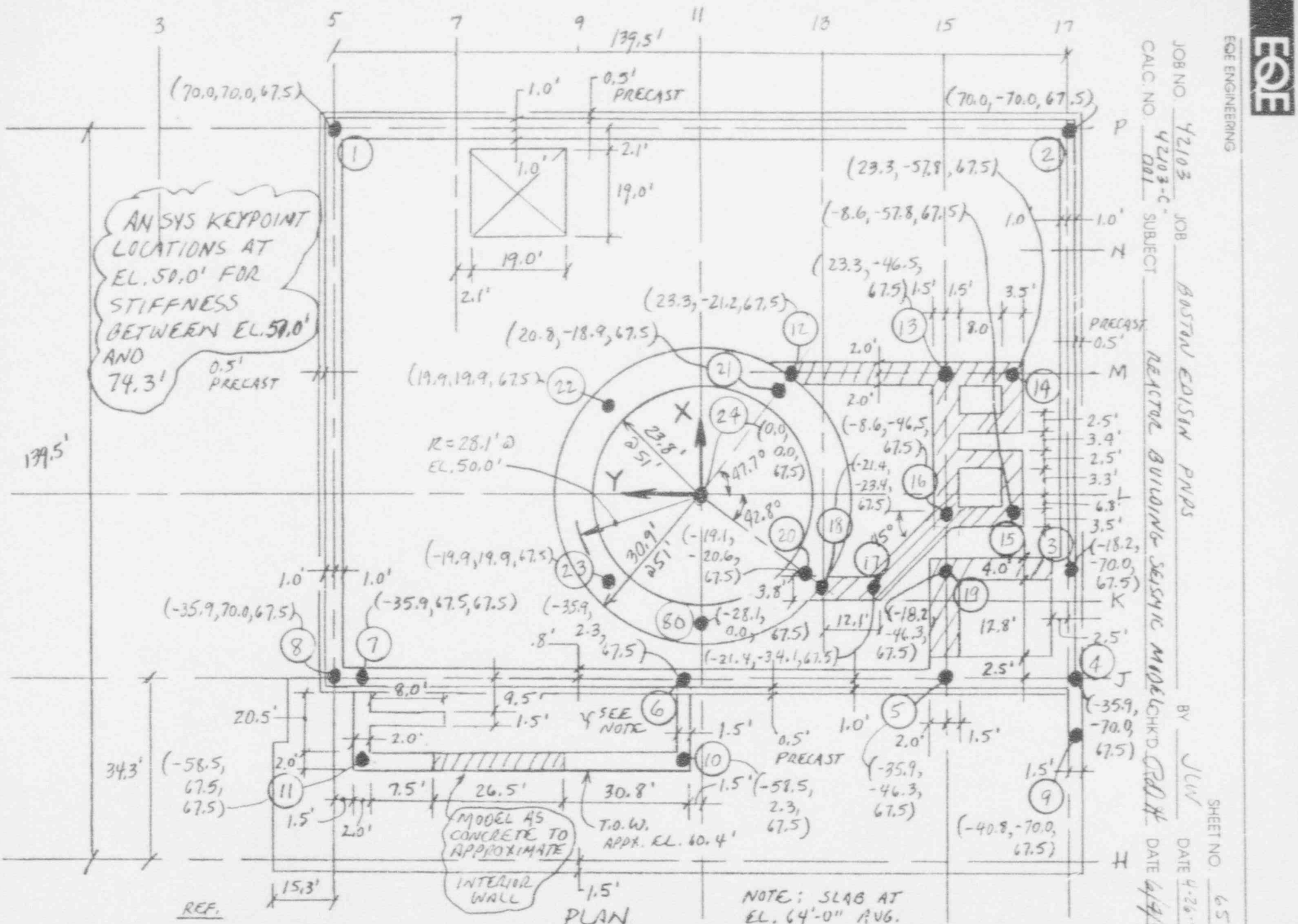


EQE ENGINEERING

JOB NO. 42103 JOB BOSTON EDISON PAPS SHEET NO. 64

CLIENT 42103-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL BY JLW DATE 4-26-93

CHKD DATE 6/4/93



EQE ENGINEERING

JOB NO. 42103 JOB BOSTON EDISON PNPS BY JLW DATE 4-26-93

CALC. NO. 42103-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D GRD DATE 4/7/93

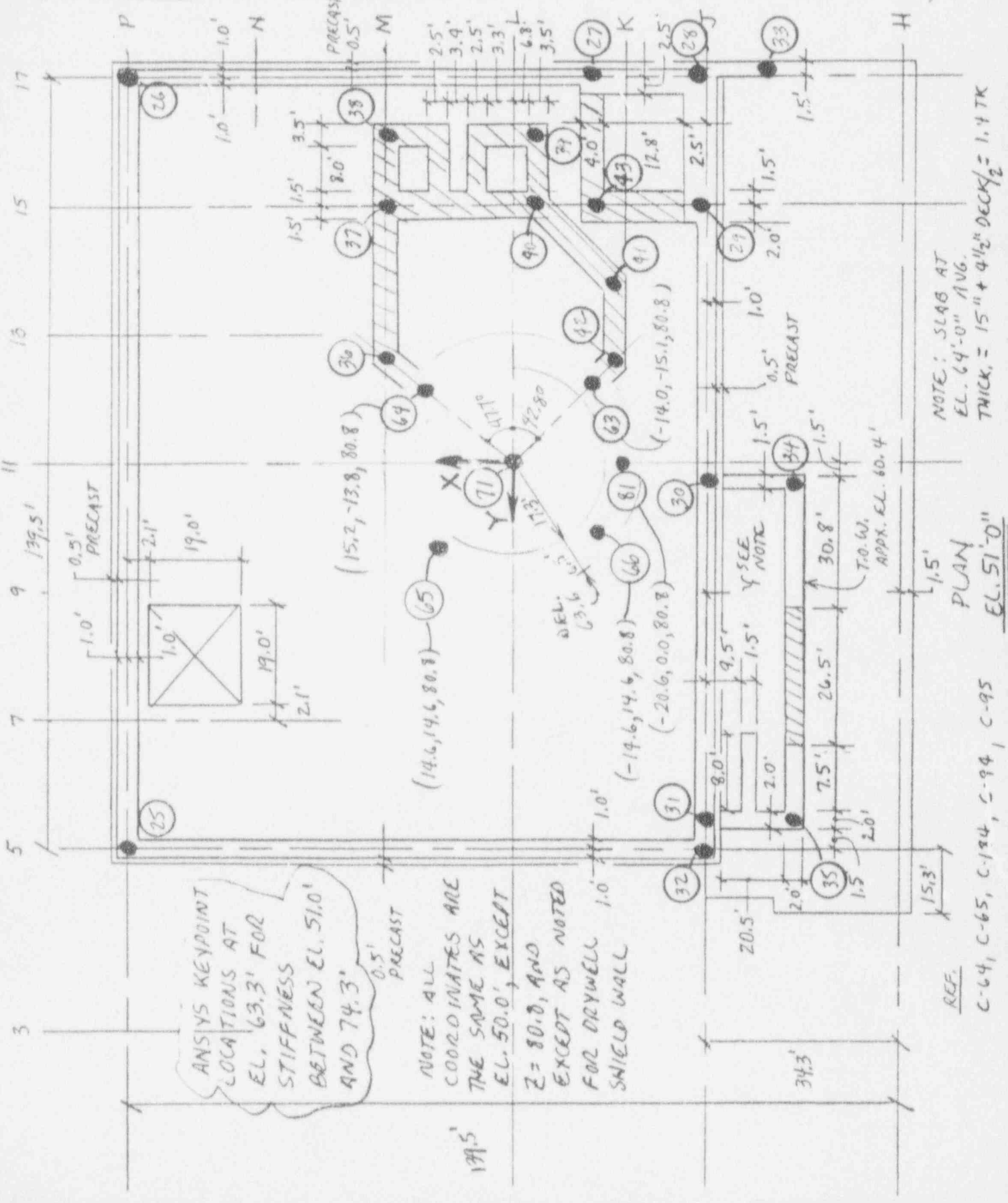
SHEET NO. 65

EQE ENGINEERING

SHEET NO. 66

JOB NO 42103 JOB BOSTON EDISON PNPS BY JW DATE 4-26-93

CALC. NO 42103-C-001 SUBJECT REACTOR BUILDING SEIS. IC MODEL CHK'D [illegible] DATE 6/4/93

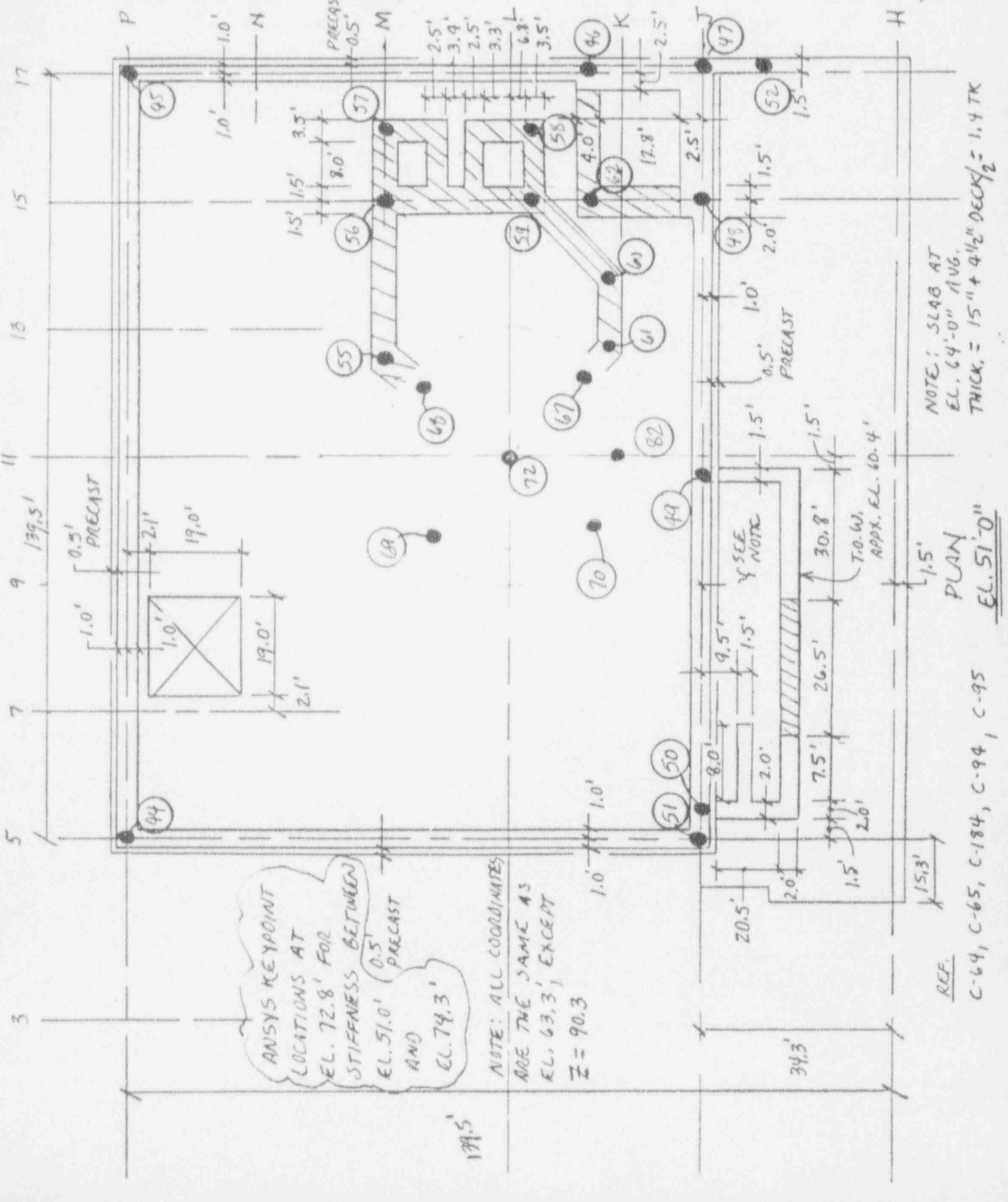


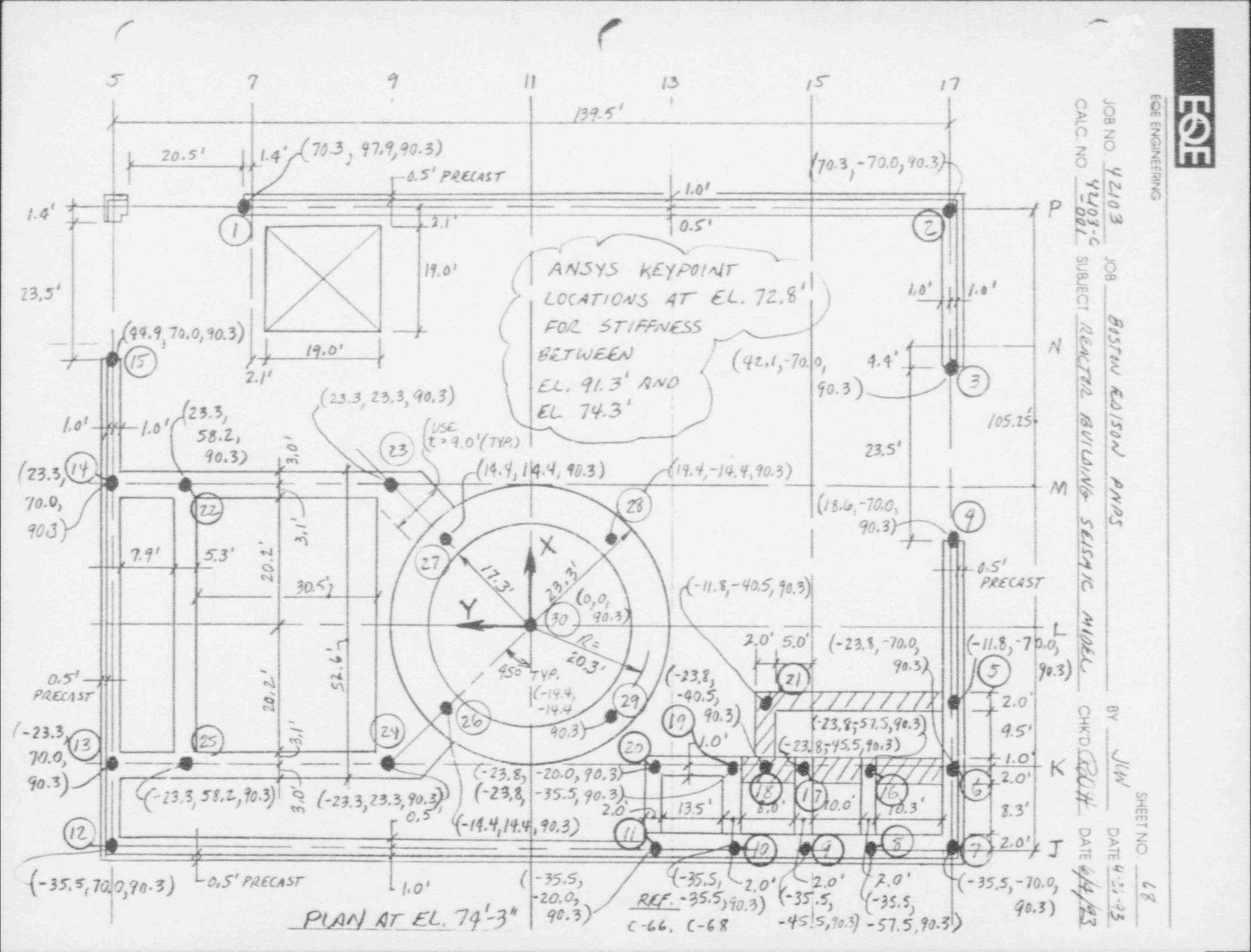
EQE ENGINEERING

SHEET NO. 67

JOB NO. 42103 JOB BOSTON EDISON PNPS BY JUN DATE 4-26-93

CALC. NO. 42103-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D [illegible] DATE 6/4/93



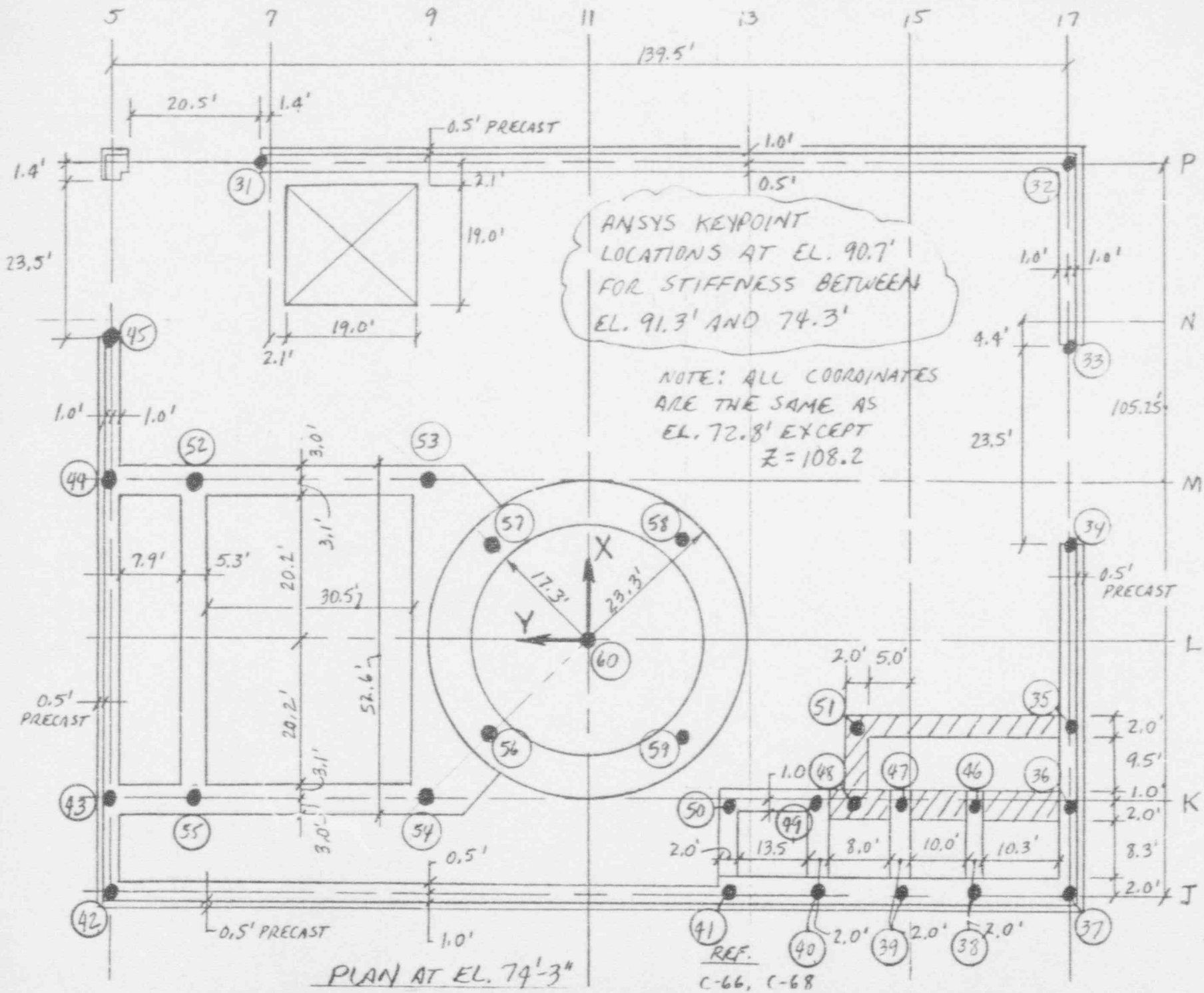


EQE ENGINEERING

JOB NO. 42103 JOB BOSTON EDISON ANPS SHEET NO. 68

CALC NO. 42103-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL BY JLN DATE 4-21-93

CHK'D [illegible] DATE 6/4/93

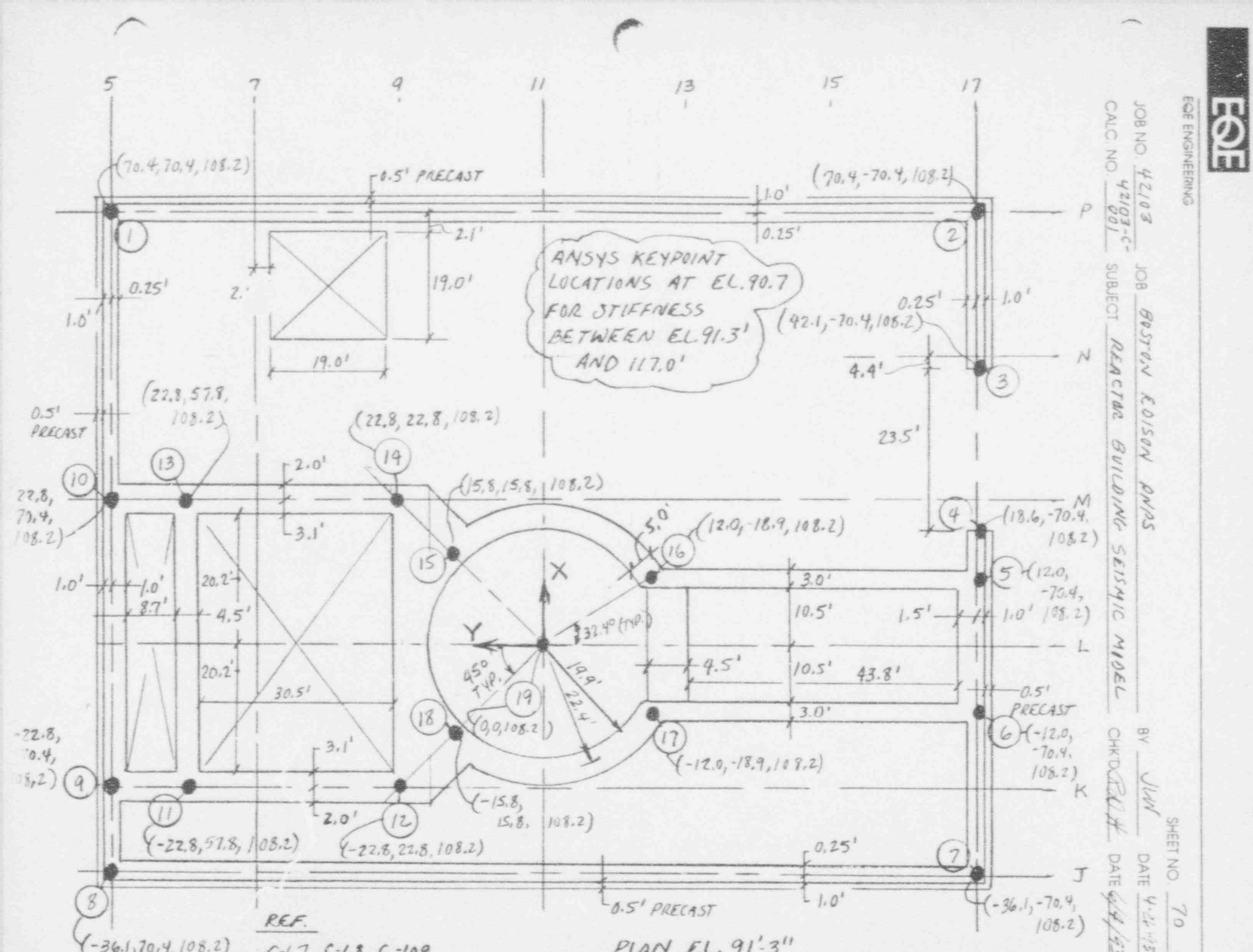


EQE ENGINEERING

JOB NO. 42103 JOB BOSTON EDISON ANPS SHEET NO. 69

CALC. NO. 42103-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL BY JW DATE 4-26-92

CHK'D DATE

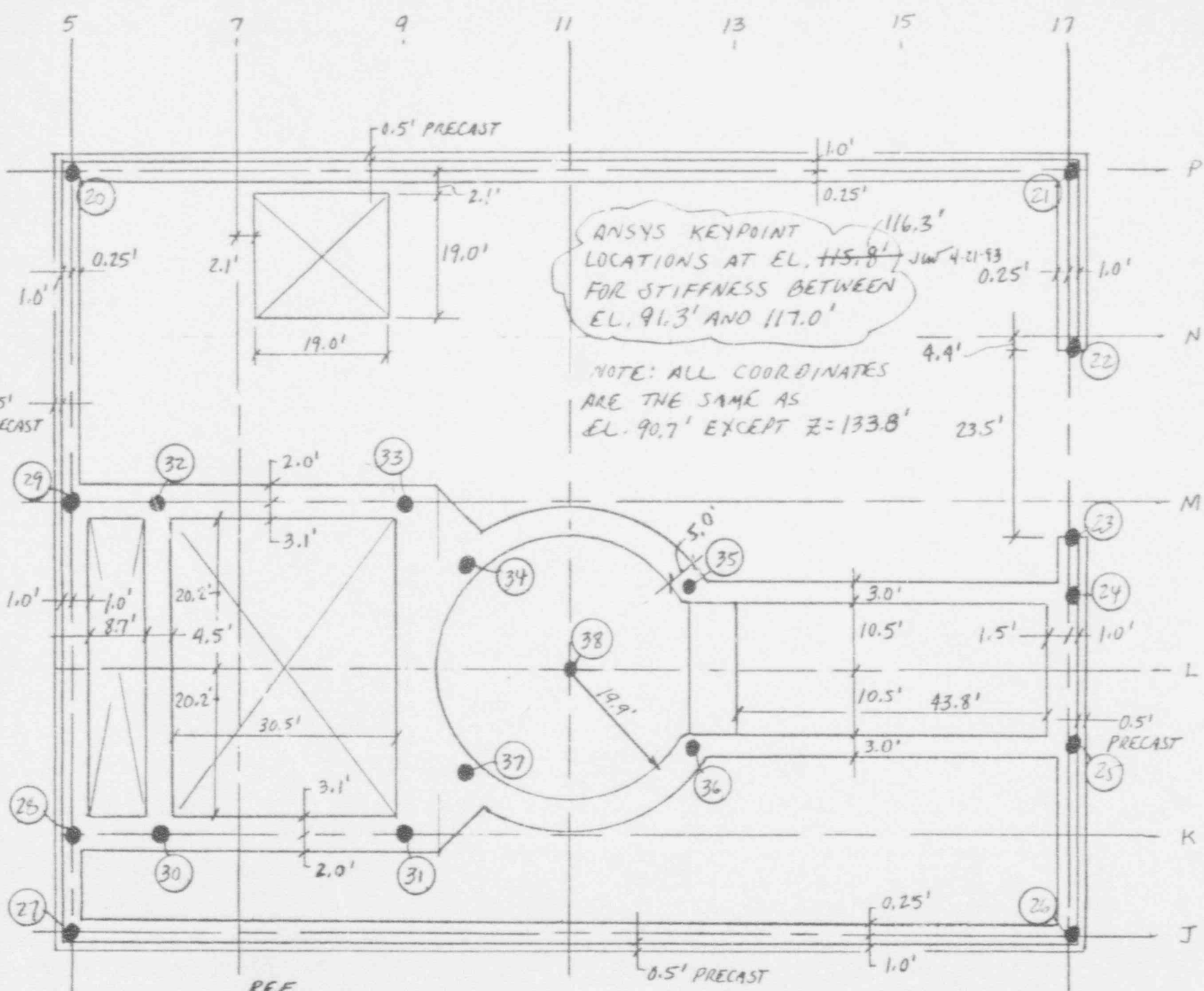


REF.
C-67, C-68, C-109

PLAN EL. 91'-3"

EQE ENGINEERING

JOB NO. 42103
CALC NO. 42103-C-001
JOB BOSTON EDISON ANPS
SUBJECT REACTOR BUILDING SEISMIC MODEL
BY JHH
CHKD
DATE 4-24-93
DATE 6/4/93
SHEET NO. 70



REF.

C-67, C-68, C-109

PLAN EL. 91'-3"

EQE ENGINEERING

JOB NO. 42103 JOB BOSTON EDISON ANPS SHEET NO. 71

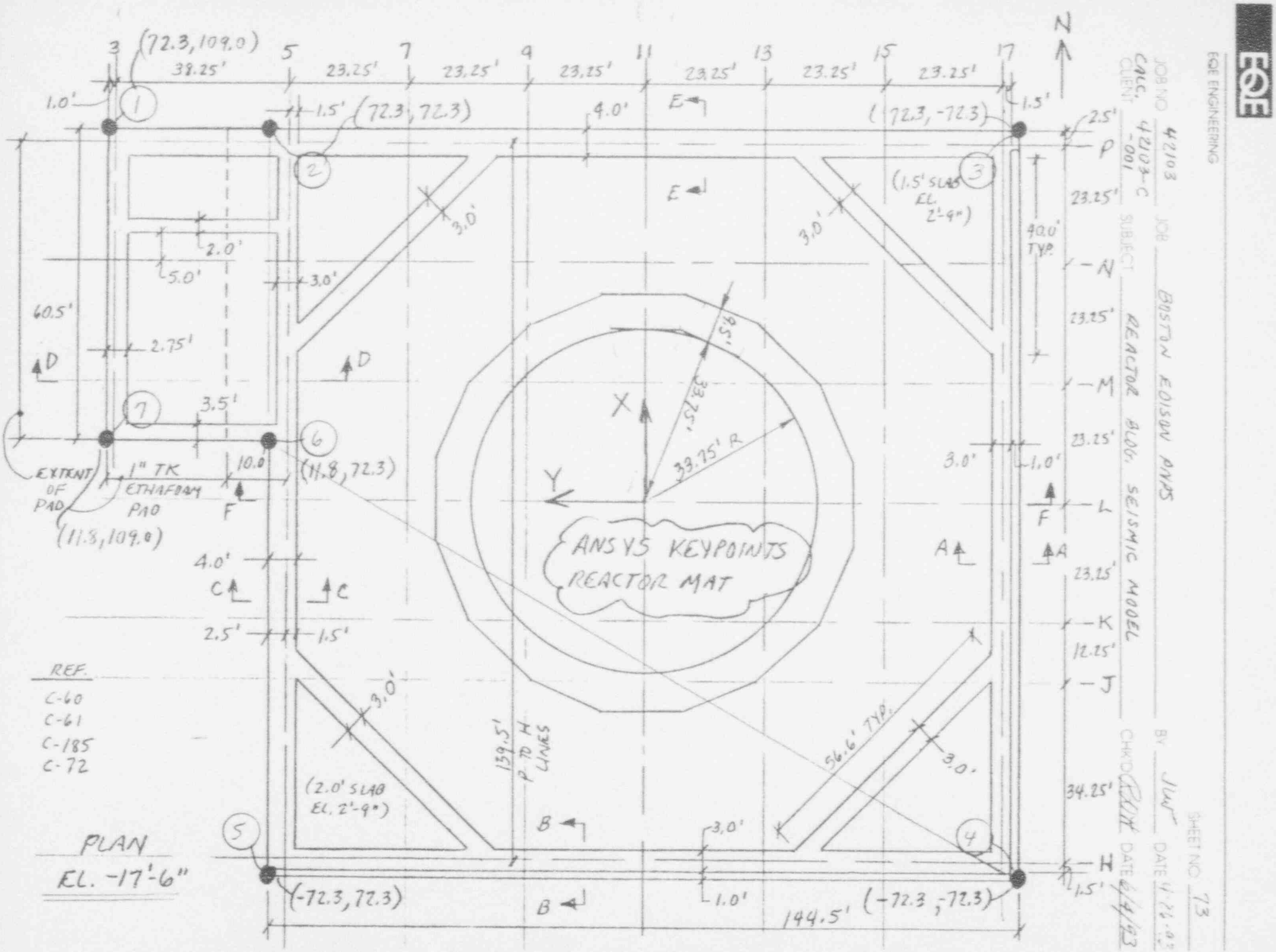
CALC NO. 42103-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL BY JLW DATE 4-29-93

CHK'D RLK DATE 4/29/93

6.6 ANSYS INPUT (CONT'D) KEYPOINTS FOR FLOORS

THE FOLLOWING SHEETS SHOW THE KEYPOINTS USED FOR GENERATING THE FINITE ELEMENT MESH FOR THE SLABS AT EL. -17'-6", 23'-6" (℄ 21.8'), 50'-6" (℄ 50.0'), 74'-3" (℄ 72.8'), 91'-3" (℄ 90.7') AND 117'-0" (℄ 116.3').

SURFACE AREAS ARE DIVIDED UP AS TRIANGLES OR QUADRILATERALS FOR ANSYS TO CALCULATE SLAB PROPERTIES.



EQE ENGINEERING

EQE

JOB NO 42103 JOB BOSTON EDISON ANYS SHEET NO 73

CALC. 42103-C-001 SUBJECT REACTOR BLDG. SEISMIC MODEL BY JLW DATE 4.22.93

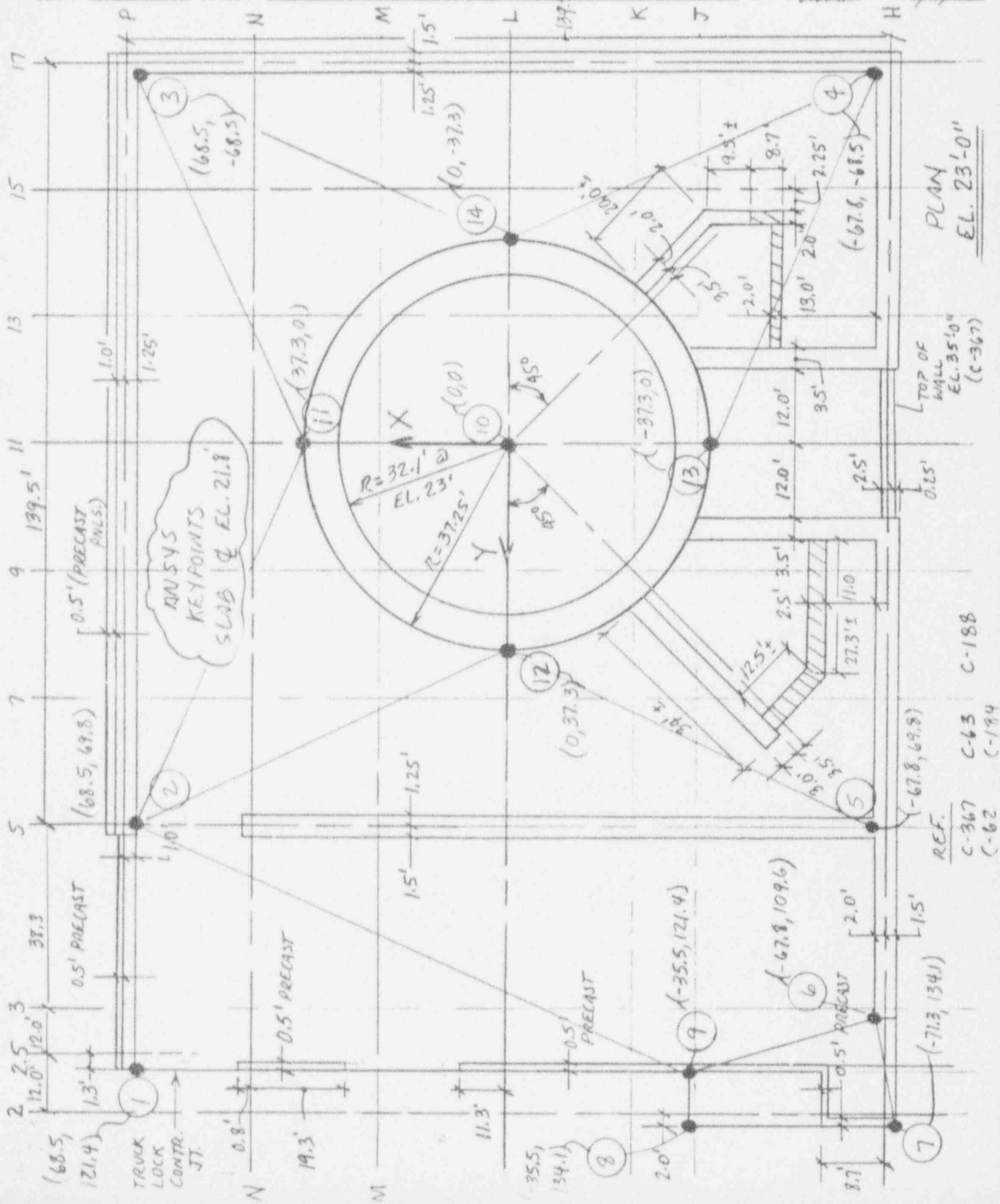
CLIENT CHKD CLW DATE 6/4/93

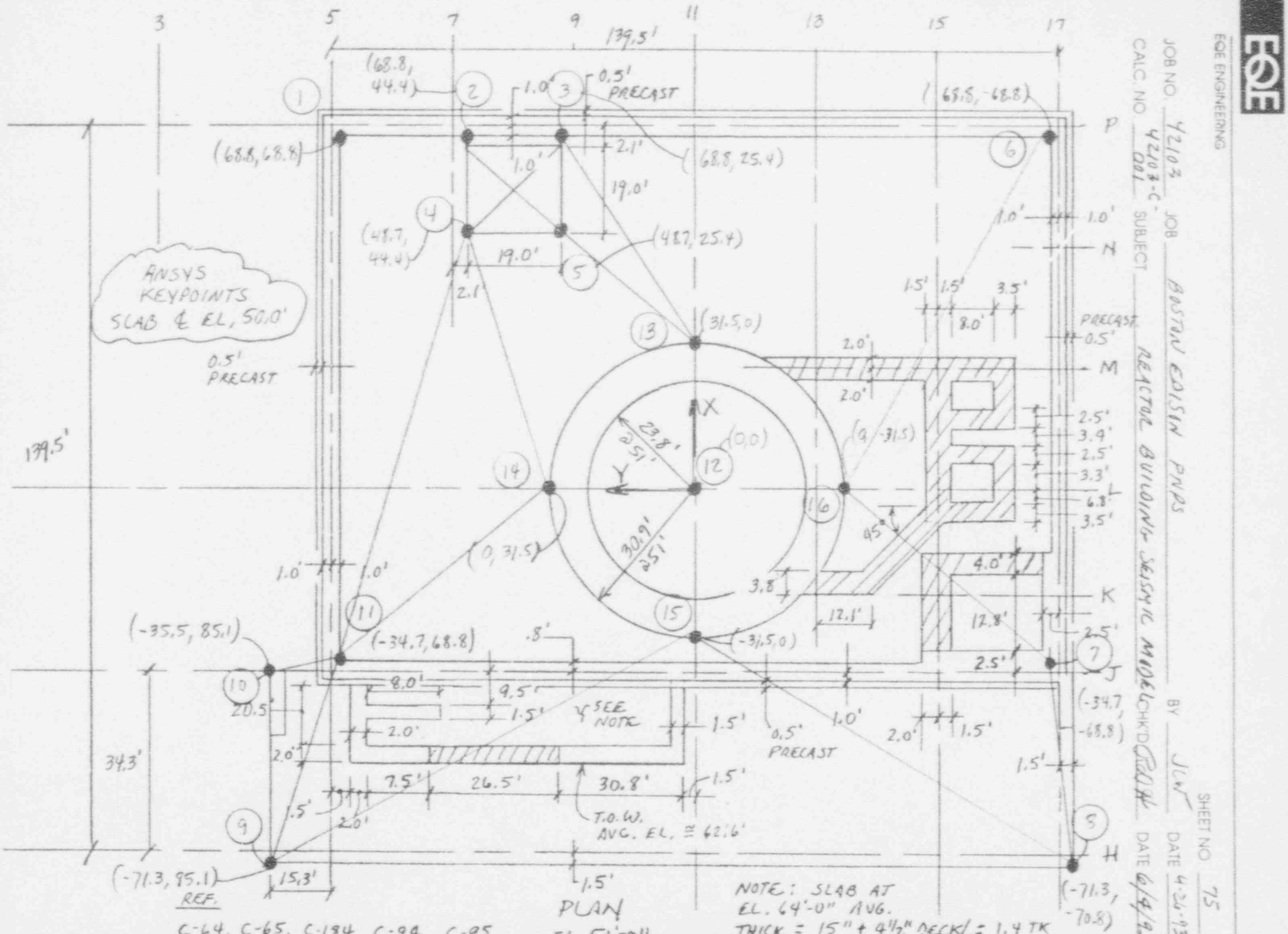
EQE ENGINEERING

SHEET NO. 74

JOB NO. 42103 JOB BOSTON EDISON ANPS BY JLW DATE 4-24-93

CLIENT 42103-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RLK DATE 6/7/93





REF.
C-64, C-65, C-184, C-94, C-95

PLAN
EL. 51'-0"

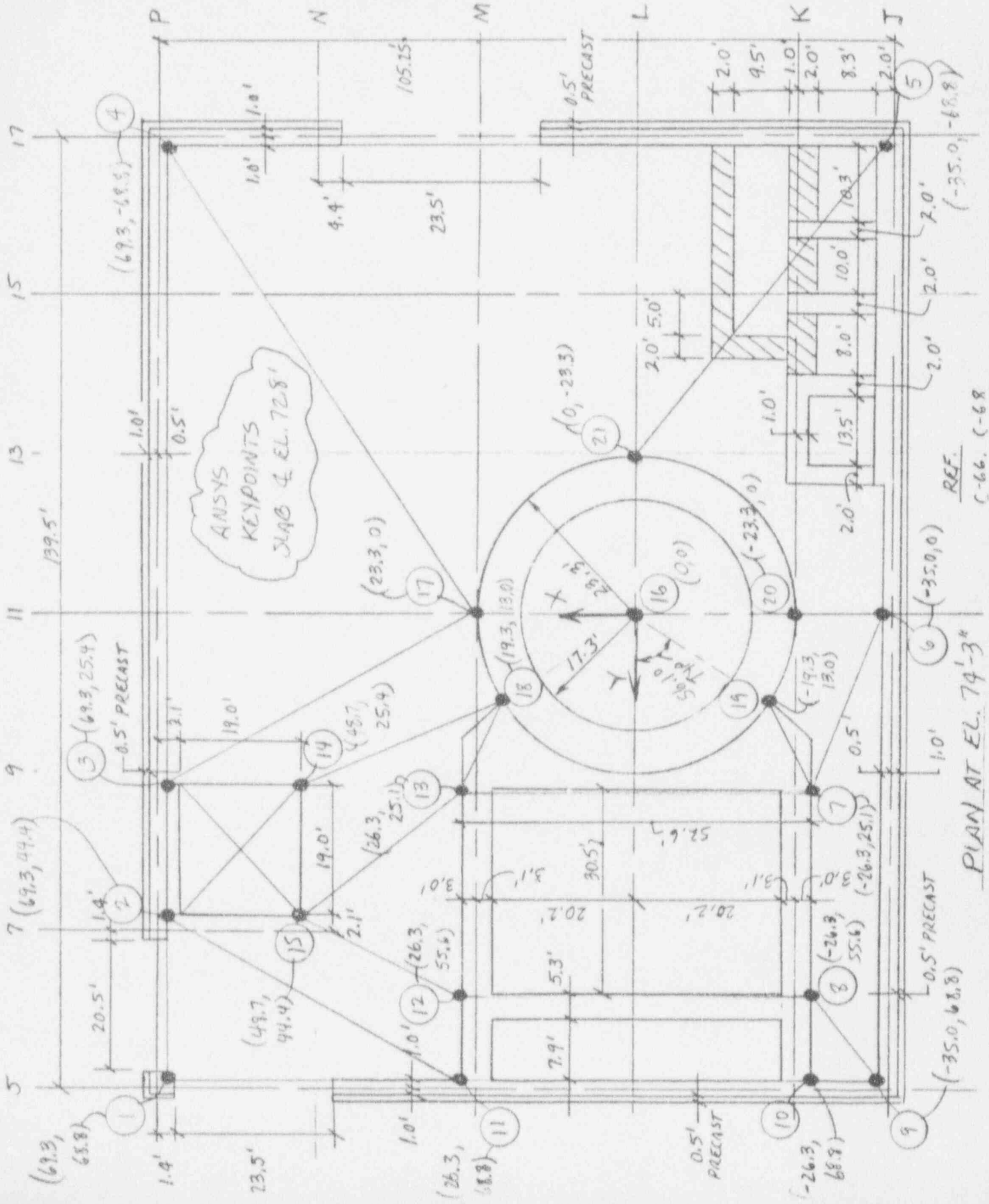
NOTE: SLAB AT EL. 64'-0" AVG. THICK. = 15" + 4½" DECK/, = 1.4 TK

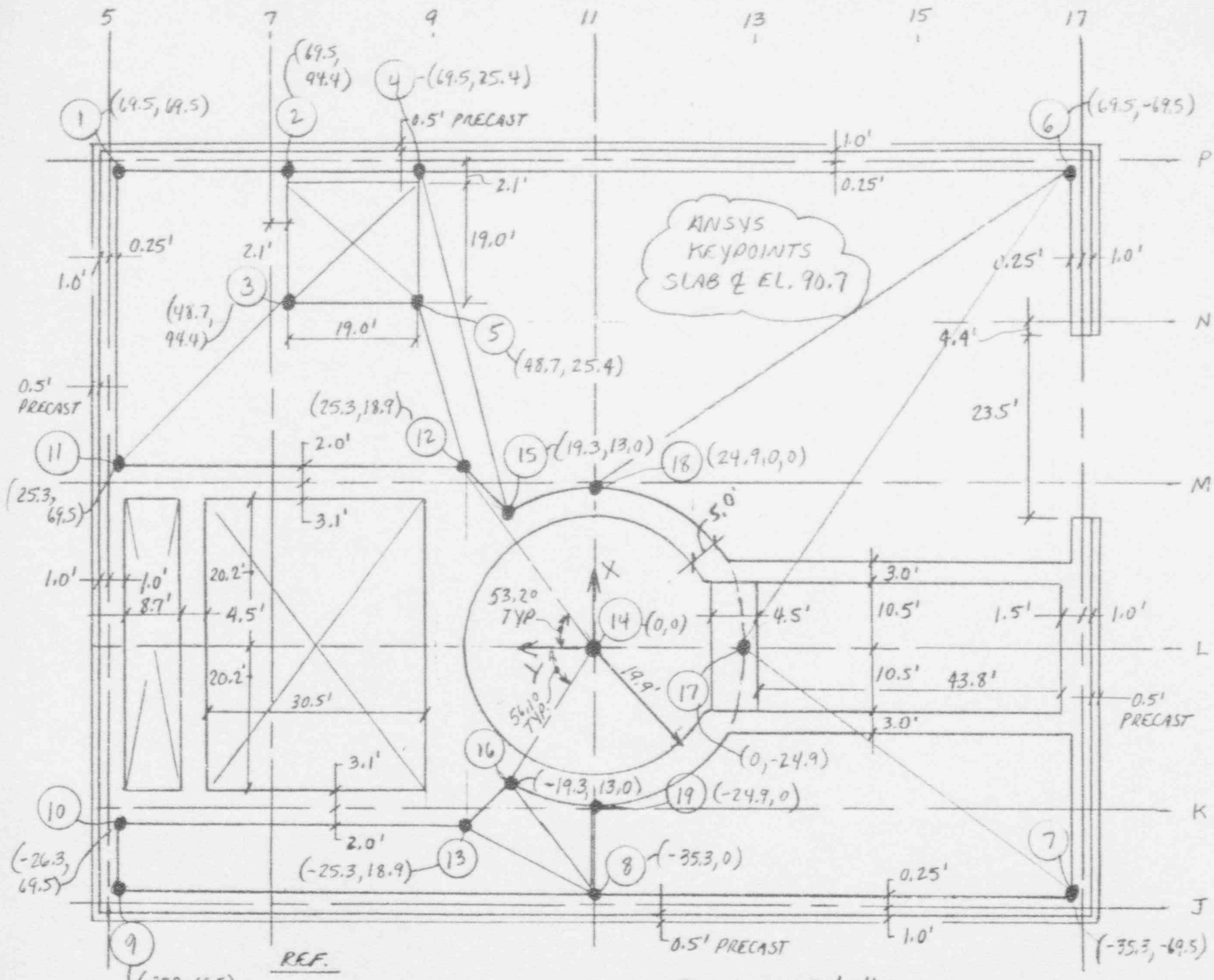
EQE ENGINEERING

SHEET NO. 76

JOB NO. 42103 JOB BOSTON EDISON PNPS BY JLW DATE 4-26-93

CALC. NO. 4403-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDH DATE 6/4/93





EQE ENGINEERING

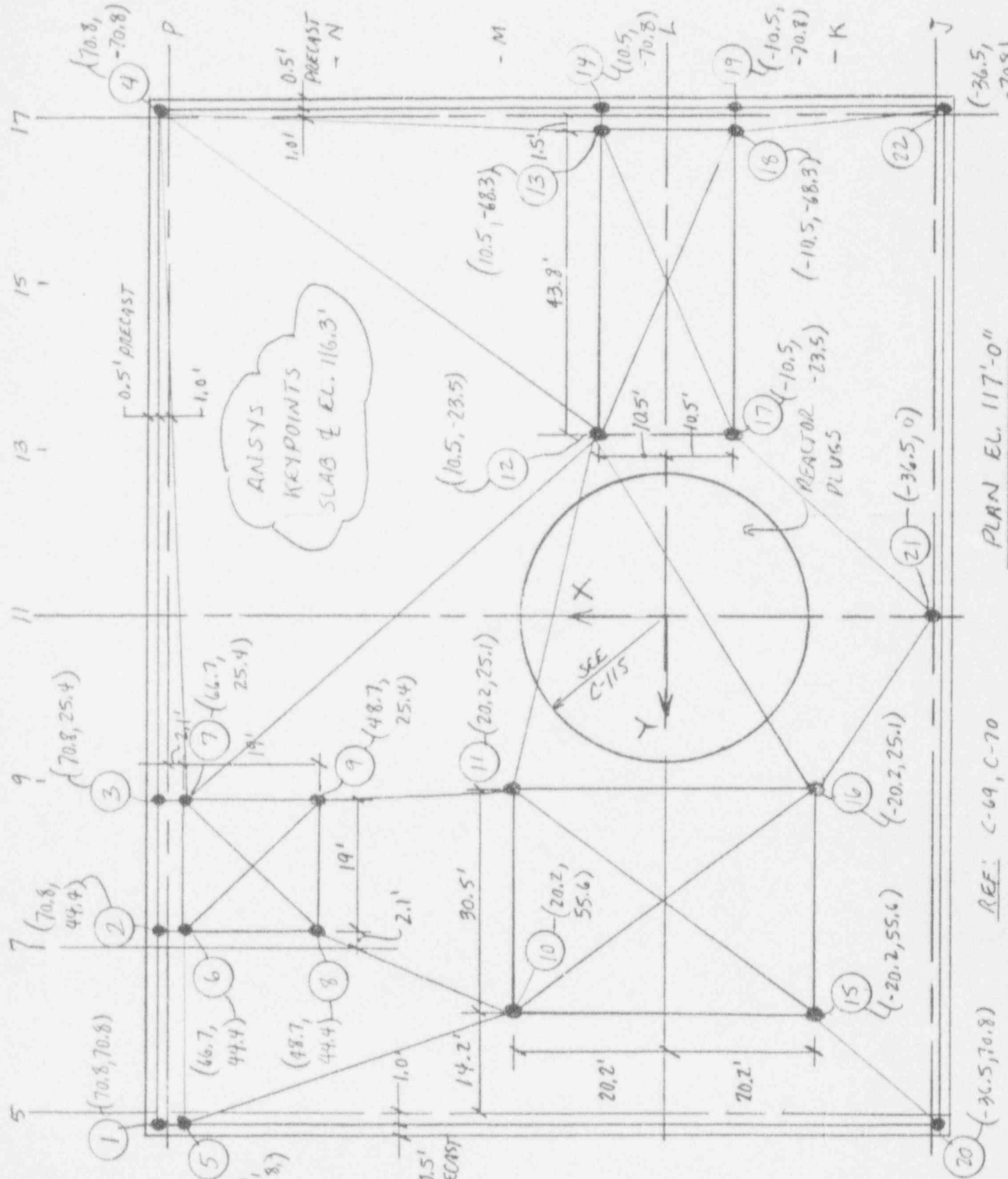
JOB NO. 42103
CALC. NO. 42103-C-001
JOB BOSTON EDISON DNPS
SUBJECT REACTOR BUILDING SEISMIC MODEL
BY JLW DATE 6-2-93
CHK'D [illegible] DATE 6/4/93
SHEET NO. 77

EQE ENGINEERING

SHEET NO. 78

JOB NO. 42103 JOB BOSTON EDISON PNPS BY JLW DATE 4-26-93

CALC. NO. 42103 C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDH DATE 6/4/93



8.7 ANSYS OUTPUT

BY: GSB DATE: 5.24.93

CK: JWT DATE: 5.24.93

```
 TOTAL NUMBER OF AREAS SELECTED =     3  (OUT OF      3 DEFINED)

 TOTAL SURFACE AREA OF ALL SELECTED AREAS =   23130.
 TOTAL VOLUME =   23130.
 TOTAL MASS =   1126.4

 CENTROID:  XC=  4.0366      YC=  8.7021      ZC= 0.00000E+00

                 *** MOMENTS OF INERTIA ***

          ABOUT ORIGIN      ABOUT CENTROID       PRINCIPAL
   IXX =   0.26750E+07       0.25897E+07       0.27663E+07
   IYY =   0.19985E+07       0.19801E+07       0.18035E+07
   IZZ =   0.46734E+07       0.45698E+07       0.45698E+07
   IXY =  -0.41218E+06      -0.37261E+06
   IYZ =   0.00000E+00       0.00000E+00
   IXZ =   0.00000E+00       0.00000E+00

   PRINCIPAL ORIENTATION VECTORS (X,Y,Z):
     0.904 -0.428  0.000    0.428  0.904  0.000    0.000  0.000  1.000
     (THXY=  -25.359  THYZ=    0.000  THXZ=    0.000)

ALL CURRENT PREP7 DATA WRITTEN TO FILE16   NAME= FILE16.DAT
 FOR POSSIBLE RESUME FROM THIS POINT


***** ROUTINE COMPLETED *****  CP =        51.410

/EOF ENCOUNTERED ON FILE18


***** RUN COMPLETED *****  CP=       51.5200   TIME=   17.4846
```

C:\GORDON\BECO\REACTOR\RB-17-23\MW-17-23.RO
Wednesday April 7, 1993 03:49:18 pm

6.7 ANSYS OUTPUT

BY: GSB DATE: 5.24.93
CK: JLW DATE: 5.24 93

***** CENTROID, MASS, AND MASS MOMENTS OF INERTIA *****

CALCULATIONS ASSUME ELEMENT MASS AT ELEMENT CENTROID

TOTAL MASS = 1254.2 ← SEE NOTE BELOW

CENTROID		MOM. OF INERTIA ABOUT ORIGIN		MOM. OF INERTIA ABOUT CENTROID	
XC =	1.6190	IXX =	0.4447E+07	IXX =	0.3482E+07
YC =	20.830	IYY =	0.2586E+07	IYY =	0.2162E+07
ZC =	18.318	IZZ =	0.5990E+07	IZZ =	0.5443E+07
		IXY =	0.4553E+05	IXY =	0.8782E+05
		IYZ =	-0.5317E+06	IYZ =	-0.5320E+05
		IZX =	-0.1333E+05	IZX =	0.2386E+05

*** MASS SUMMARY BY ELEMENT TYPE ***

TYPE	MASS
1	522.746
4	159.125
5	354.497
6	49.6149
7	11.6522
8	5.44536
9	13.8783
10	137.204

CHECKER'S NOTE: ACTUAL TOTAL MASS USED IN THE MODEL SPREAD SHEET IS 1252.2. DIFFERENCE IS NEGLIGIBLE, USE VALUE OF 1252.2

CALC. NO. 42103 -C-001 SH. NO. 81

C:\GORDON\BECO\REACTOR\RB-23-51\MF-23.RO Page: 1
Wednesday April 7, 1993 03:49:48 pm

6.7 RNSYS OUTPUT

BY: GSB DATE: 5.24.93
CK: JWT DATE: 5-24-93

TOTAL NUMBER OF AREAS SELECTED = 10 (OUT OF 10 DEFINED)

TOTAL SURFACE AREA OF ALL SELECTED AREAS = 21964.
TOTAL VOLUME = 21964.
TOTAL MASS = 407.25

SEE NOTE BELOW

CENTROID: XC=-0.54870 YC= 29.818 ZC= 0.00000E+00

*** MOMENTS OF INERTIA ***

	ABOUT ORIGIN	ABOUT CENTROID	PRINCIPAL
IXX =	0.17556E+07	0.13935E+07	0.13959E+07
IYY =	0.74422E+06	0.74409E+06	0.74169E+06
IZZ =	0.24998E+07	0.21376E+07	0.21376E+07
IXY =	46270.	39607.	
IYZ =	0.00000E+00	0.00000E+00	
IXZ =	0.00000E+00	0.00000E+00	

PRINCIPAL ORIENTATION VECTORS (X,Y,Z):
0.998 0.061 0.000 -0.061 0.998 0.000 0.000 0.000 1.000
(THXY= 3.477 THYZ= 0.000 THXZ= 0.000)

ALL CURRENT PREP7 DATA WRITTEN TO FILE16 NAME= FILE16.DAT
FOR POSSIBLE RESUME FROM THIS POINT

***** ROUTINE COMPLETED ***** CP = 29.330

/EOF ENCOUNTERED ON FILE18

***** RUN COMPLETED ***** CP= 29.3900 TIME= 11.9044

CHECKER'S NOTE: VALUE FOR XC ENTERED IN MODEL SUMMARY SPREAD SHEET IS -.49 FT. THE DIFFERENCE IS .06 FT WHICH IS APPX. 3/4" - INSIGNIFICANT. USE -.49'

CALC. NO. 42103 -C-001 SH. NO. 82

C:\GORDON\BECO\REACTOR\RB-23-51\MW-23-51.RO
Wednesday April 7, 1993 03:49:58 pm

6.7 ANSYS OUTPUT

BY: GSB DATE: 5.24.93

CK: JWT DATE: 5-24-93

TOTAL NUMBER OF AREAS SELECTED = 47 (OUT OF 47 DEFINED)

TOTAL SURFACE AREA OF ALL SELECTED AREAS = 30094.
TOTAL VOLUME = 0.10351E+06
TOTAL MASS = 477.99

CENTROID: XC= -10.562 YC= 5.1345 ZC= 53.460

*** MOMENTS OF INERTIA ***

	ABOUT ORIGIN	ABOUT CENTROID	PRINCIPAL
IXX =	0.24443E+07	0.10657E+07	0.11247E+07
IYY =	0.24662E+07	0.10468E+07	0.98776E+06
IZZ =	0.21151E+07	0.20491E+07	0.20492E+07
IXY =	93709.	67788.	
IYZ =	-0.13111E+06	98.734	
IXZ =	0.26806E+06	-1826.9	

PRINCIPAL ORIENTATION VECTORS (X,Y,Z):
0.754 0.657 0.001 -0.657 0.754 -0.001 -0.002 0.000 1.000
(THXY= 41.019 THYZ= 0.081 THXZ= -0.069)

ALL CURRENT PREP7 DATA WRITTEN TO FILE16 NAME= FILE16.DAT
FOR POSSIBLE RESUME FROM THIS POINT

***** ROUTINE COMPLETED ***** CP = 27.020

/EOF ENCOUNTERED ON FILE18

***** RUN COMPLETED ***** CP= 27.2400 TIME= 12.0083

6.7 ANSYS OUTPUT

BY: GSB DATE: 5-24-93
CK: JWS DATE: 5-24-93

```
  TOTAL NUMBER OF AREAS SELECTED =    10  (OUT OF     10 DEFINED)

  TOTAL SURFACE AREA OF ALL SELECTED AREAS =   16404.
  TOTAL VOLUME =   16404.
  TOTAL MASS =   277.23

  CENTROID:  XC= -4.8821      YC=  1.7993      ZC= 0.00000E+00

                  *** MOMENTS OF INERTIA ***

          ABOUT ORIGIN     ABOUT CENTROID       PRINCIPAL
    IXX =  0.55512E+06       0.55422E+06       0.59001E+06
    IYY =  0.52935E+06       0.52274E+06       0.48695E+06
    IZZ =  0.10845E+07       0.10770E+07       0.10770E+07
    IXY =   51504.            49069.
    IYZ =  0.00000E+00       0.00000E+00
    IXZ =  0.00000E+00       0.00000E+00

    PRINCIPAL ORIENTATION VECTORS (X,Y,Z):
      0.808  0.589  0.000   -0.589  0.808  0.000    0.000  0.000  1.000
      (THXY=   36.108  THYZ=    0.000  THXZ=    0.000)

ALL CURRENT PREP7 DATA WRITTEN TO FILE16   NAME= FILE16.DAT
 FOR POSSIBLE RESUME FROM THIS POINT


***** ROUTINE COMPLETED *****  CP =        25.100

/EOF ENCOUNTERED ON FILE18


***** RUN COMPLETED *****  CP=       25.2100   TIME=   16.2031
```

6.7 ANSYS OUTPUT

BY: GSB DATE: 5.24.93
CK: JWT DATE: 5.24.93

TOTAL NUMBER OF AREAS SELECTED = 54 (OUT OF 54 DEFINED)

TOTAL SURFACE AREA OF ALL SELECTED AREAS = 22382.
TOTAL VOLUME = 72745.
TOTAL MASS = 325.32

CENTROID: XC= 2.3930 YC= -7.3040 ZC= 78.502

*** MOMENTS OF INERTIA ***

	ABOUT ORIGIN	ABOUT CENTROID	PRINCIPAL
IXX =	0.26466E+07	0.62445E+06	0.62618E+06
IYY =	0.24359E+07	0.42919E+06	0.42744E+06
IZZ =	0.10456E+07	0.10264E+07	0.10264E+07
IXY =	24218.	18532.	
IYZ =	0.18916E+06	2627.5	
IXZ =	-63753.	-2640.6	

PRINCIPAL ORIENTATION VECTORS (X,Y,Z):
0.996 0.094 0.006 -0.094 0.996 -0.005 -0.006 0.004 1.000
(THXY= 5.379 THYZ= 0.341 THXZ= -0.274)

ALL CURRENT PREP7 DATA WRITTEN TO FILE16 NAME= FILE16.DAT
FOR POSSIBLE RESUME FROM THIS POINT

***** ROUTINE COMPLETED ***** CP = 28.400

/EOF ENCOUNTERED ON FILE18

***** RUN COMPLETED ***** CP= 28.6200 TIME= 22.0584

6.7 ANSYS OUTPUT

BY: GSB DATE: 5.24.93
CK: JWT DATE: 5.24.93

```
 TOTAL NUMBER OF AREAS SELECTED =    14  (OUT OF     14 DEFINED)

 TOTAL SURFACE AREA OF ALL SELECTED AREAS =   12256.
 TOTAL VOLUME =   12256.
 TOTAL MASS =   294.40

 CENTROID:  XC=  13.031      YC=  10.660      ZC= 0.00000E+00

                 *** MOMENTS OF INERTIA ***

         ABOUT ORIGIN      ABOUT CENTROID       PRINCIPAL
   IXX =  0.51967E+06       0.48622E+06       0.49776E+06
   IYY =  0.28800E+06       0.23801E+06       0.22647E+06
   IZZ =  0.80768E+06       0.72423E+06       0.72423E+06
   IXY =   13862.            54758.
   IYZ =  0.00000E+00       0.00000E+00
   IXZ =  0.00000E+00       0.00000E+00

   PRINCIPAL ORIENTATION VECTORS (X,Y,Z):
     0.978  0.206  0.000   -0.206  0.978  0.000    0.000  0.000  1.000
     (THXY=   11.904  THYZ=    0.000  THXZ=    0.000)

ALL CURRENT PREP7 DATA WRITTEN TO FILE16   NAME= FILE16.DAT
 FOR POSSIBLE RESUME FROM THIS POINT


***** ROUTINE COMPLETED *****  CP =        19.120

/EOF ENCOUNTERED ON FILE18


***** RUN COMPLETED *****  CP=       19.3400   TIME=   16.0817
```

6.7 ANSYS OUTPUT

BY: GSB DATE: 5.24.93
CK: JLW DATE: 5.24.93

```
  TOTAL NUMBER OF AREAS SELECTED =    35  (OUT OF     35 DEFINED)

  TOTAL SURFACE AREA OF ALL SELECTED AREAS =   15254.
  TOTAL VOLUME =   53152.
  TOTAL MASS =   274.16

  CENTROID:  XC= 0.41204      YC=  11.617      ZC=  99.250

                  *** MOMENTS OF INERTIA ***

          ABOUT ORIGIN      ABOUT CENTROID       PRINCIPAL
    IXX =   0.32516E+07       0.51405E+06       0.51418E+06
    IYY =   0.29490E+07       0.24831E+06       0.24819E+06
    IZZ =   0.78477E+06       0.74772E+06       0.74772E+06
    IXY =   -7049.2           -5736.9
    IYZ =  -0.31611E+06       0.64475E-05
    IXZ =   -11212.          -0.24453E-05

    PRINCIPAL ORIENTATION VECTORS (X,Y,Z):
      1.000 -0.022  0.000    0.022  1.000  0.000    0.000  0.000  1.000
      (THXY=   -1.236  THYZ=    0.000  THXZ=    0.000)

ALL CURRENT PREP7 DATA WRITTEN TO FILE16   NAME= FILE16.DAT
 FOR POSSIBLE RESUME FROM THIS POINT


***** ROUTINE COMPLETED *****  CP =        19.110

/EOF ENCOUNTERED ON FILE18


***** RUN COMPLETED *****  CP=       19.3300   TIME=   22.1737
```

C:\GORDON\BECO\REACTOR\R-91-117\MF-91.RO Page: 1
Wednesday April 7, 1993 03:48:10 pm

6.7 ANSYS OUTPUT

BY: GSB DATE: 5.24.93
CK: JWT DATE: 5.24.93

```
 TOTAL NUMBER OF AREAS SELECTED =    10  (OUT OF     10 DEFINED)

 TOTAL SURFACE AREA OF ALL SELECTED AREAS =   9752.6
 TOTAL VOLUME =   9752.6
 TOTAL MASS =   111.18

 CENTROID:  XC=  23.147      YC= -12.804      ZC= 0.00000E+00

                *** MOMENTS OF INERTIA ***

         ABOUT ORIGIN      ABOUT CENTROID       PRINCIPAL
   IXX =  0.19561E+06       0.17738E+06       0.18537E+06
   IYY =  0.17484E+06       0.11528E+06       0.10729E+06
   IZZ =  0.37045E+06       0.29266E+06       0.29266E+06
   IXY =   9292.5           -23659.
   IYZ =  0.00000E+00       0.00000E+00
   IXZ =  0.00000E+00       0.00000E+00

   PRINCIPAL ORIENTATION VECTORS (X,Y,Z):
     0.947 -0.320  0.000    0.320  0.947  0.000    0.000  0.000  1.000
     (THXY=  -18.652  THYZ=    0.000  THXZ=    0.000)

ALL CURRENT PREP7 DATA WRITTEN TO FILE16   NAME= FILE16.DAT
 FOR POSSIBLE RESUME FROM THIS POINT


***** ROUTINE COMPLETED *****  CP =        22.190

/EOF ENCOUNTERED ON FILE18


***** RUN COMPLETED *****  CP=       22.3600   TIME=    9.4828
```

CALC. NO. 42103 -C-001 SH. NO. 88

6.7 ANSYS OUTPUT

BY: GSB DATE: 5.24.93
CK: VLW DATE: 5.24-93

```
 TOTAL NUMBER OF AREAS SELECTED =    22  (OUT OF     22 DEFINED)

 TOTAL SURFACE AREA OF ALL SELECTED AREAS =   22371.
 TOTAL VOLUME =   70407.
 TOTAL MASS =   388.51

 CENTROID:  XC=  4.174      YC=  14.847      ZC=  121.00

                 *** MOMENTS OF INERTIA ***

         ABOUT ORIGIN      ABOUT CENTROID       PRINCIPAL
  IXX =   0.64717E+07       0.69789E+06       0.69842E+06
  IYY =   0.60445E+07       0.34955E+06       0.34902E+06
  IZZ =   0.10974E+07       0.10050E+07       0.10050E+07
  IXY =   -10482.            13598.
  IYZ =  -0.69794E+06       0.13459E-04
  IXZ =  -0.19626E+06      -0.12950E-04

   PRINCIPAL ORIENTATION VECTORS (X,Y,Z):
     0.999  0.039  0.000   -0.039  0.999  0.000    0.000  0.000  1.000
     (THXY=    2.232  THYZ=    0.000  THXZ=    0.000)

ALL CURRENT PREP7 DATA WRITTEN TO FILE16   NAME= FILE16.DAT
 FOR POSSIBLE RESUME FROM THIS POINT


***** ROUTINE COMPLETED *****  CP =        17.250

/EOF ENCOUNTERED ON FILE18


***** RUN COMPLETED *****  CP=       17.4100   TIME=   22.2903
```

SH. NO. 89

CALC. NO. 42103 -C-001

6.7 ANSYS OUTPUT

BY: GSB DATE: 5.24.

CK: JCW DATE: 5.24.93

C:\GORDON\BECO\REACTOR\R-91-117\MF-117.RO Page: 1
Wednesday April 7, 1993 03:47:56 pm

TOTAL NUMBER OF AREAS SELECTED = 16 (OUT OF 16 DEFINED)

TOTAL SURFACE AREA OF ALL SELECTED AREAS = 12681.
TOTAL VOLUME = 12681.
TOTAL MASS = 155.97

CENTROID: XC= 18.892 YC= -1.5488 ZC= 0.00000E+00

*** MOMENTS OF INERTIA ***

	ABOUT ORIGIN	ABOUT CENTROID	PRINCIPAL
IXX =	0.25470E+06	0.25432E+06	0.25454E+06
IYY =	0.21662E+06	0.16095E+06	0.16074E+06
IZZ =	0.47132E+06	0.41528E+06	0.41528E+06
IXY =	9019.0	4455.4	
IYZ =	0.00000E+00	0.00000E+00	
IXZ =	0.00000E+00	0.00000E+00	

SEE NOTE BELOW

PRINCIPAL ORIENTATION VECTORS (X,Y,Z):
0.999 0.048 0.000 -0.048 0.999 0.000 0.000 0.000 1.000
(THXY= 2.726 THYZ= 0.000 THXZ= 0.000)

ALL CURRENT PREP7 DATA WRITTEN TO FILE16 NAME= FILE16.DAT
FOR POSSIBLE RESUME FROM THIS POINT

***** ROUTINE COMPLETED ***** CP = 25.920

/EOF ENCOUNTERED ON FILE18

***** RUN COMPLETED ***** CP= 26.1400 TIME= 14.5262

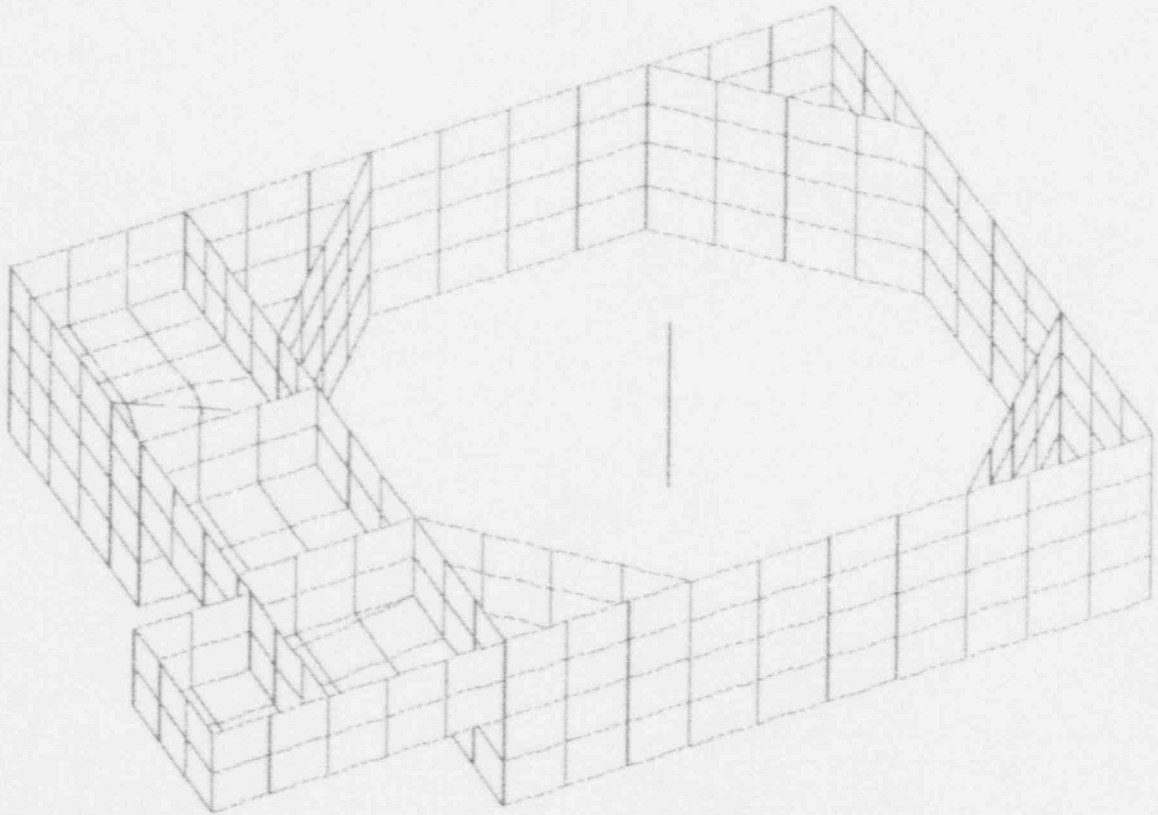
CHECKER'S NOTE: THE ACTUAL VALUES OF MASS MOMENT OF INERTIA ABOUT THE CENTROID ENTERED INTO THE SPREAD SHEET (SH. 116) ARE AS FOLLOWS:

$I_{xx} = 297{,}800$ $I_{yy} = 188400$ $I_{zz} = 486200$

THE DIFFERENCE OF THE RESULT ON THIS SHEET AND THE VALUES USED IN THE SPREAD SHEET WILL HAVE NO EFFECT ON THE FINAL SPECTRA. THESE TERMS DO NOT AFFECT STRUCTURAL RESPONSE MODES BECAUSE THEY ARE GOVERNED BY SHEAR DEFORMATIONS. THESE TERMS ONLY AFFECT RIGID BODY ROTATION DUE TO SOIL MODES. THE TOTAL MASS MOMENT OF INERTIA ABOUT THE BASE IS WHAT WILL INFLUENCE THE ROTATIONAL SOIL MODES. FOR EXAMPLE, THE SUM OF I_{xx} FROM BELOW EL. 117' TO THE BASE MAT IS 1.15×10^7 (ADDING UP THE I_{xx} COLUMN ON SH. 116). THE DIFFERENCE IN I_{xx} BETWEEN THE CALCULATED VALUE AND THE VALUE USED IS $297{,}800 - 254300 = 43{,}500$. THE PERCENT CHANGE IS $43{,}500 / 1.15 \times 10^7 = .4\%$. THE ACTUAL RESULT WILL EVEN HAVE A LOWER % INFLUENCE WHEN THE MASS TIMES DISTANCE ABOVE THE MAT SQUARED TERMS ARE ADDED IN.

THEREFORE IT IS ACCEPTABLE TO USE SPREAD SHEET VALUES ON THE BASIS THAT THE DIFFERENCE IS INSIGNIFICANT.

EQE - PNPS Reactor Building between Elev.-17'-6" & 23'-0"



PLOT NO. 2
POST1 ELEMENTS
TYPE NUM

XV = -1
YV = 0.5
ZV = 1
DIST = 134.225
XF = 0.25
YF = 31.6
ZF = 17.65
RNGZ = 108.43
PRECISE HIDDEN

6.8 GEOMETRY PLOTS

EQE Engineering

JOB NO. 42103 JOB: Boston Edison PNPS

GEOMETRY PLOT CALC. NO. 42103-C-001 SUBJECT: Reactor Building Seismic Model

PREPARED BY: GSB DATE: 4.29.93

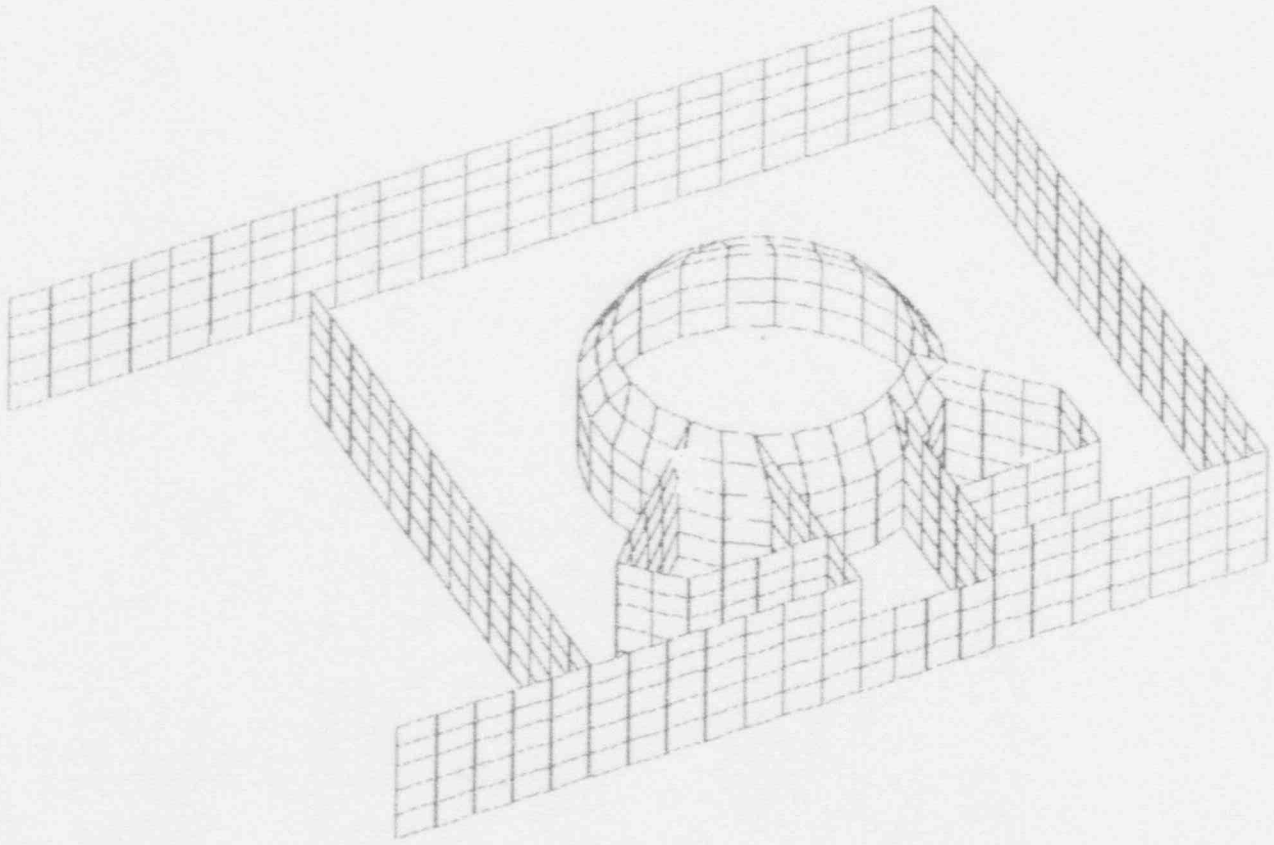
CHECKED BY: JLW DATE: 4-29-93

SHEET NO. 90

EQE - PNPS Reactor Building between Elev. 23'-0" & 51'-0"

```
ANSYS-PC 4.4A1
APR 29 1993
11:25:58
PLOT NO.    2
POST1 ELEMENTS
TYPE NUM

XV   =-1
YV   =0.5
ZV   =1
DIST=128.395
XF   =0.2
YF   =25.75
ZF   =53.4
ANGZ=108.43
PRECISE HIDDEN
```



6.0 GEOMETRY PLOTS

EQE Engineering

JOB NO. 42103 JOB: Boston Edison PNPS

CALC NO. 42103-C-001 SUBJECT: Reactor Building Seismic Model

PREPARED BY: GSB DATE: 4.29.93

CHECKED BY: JLW DATE: 4-29-93

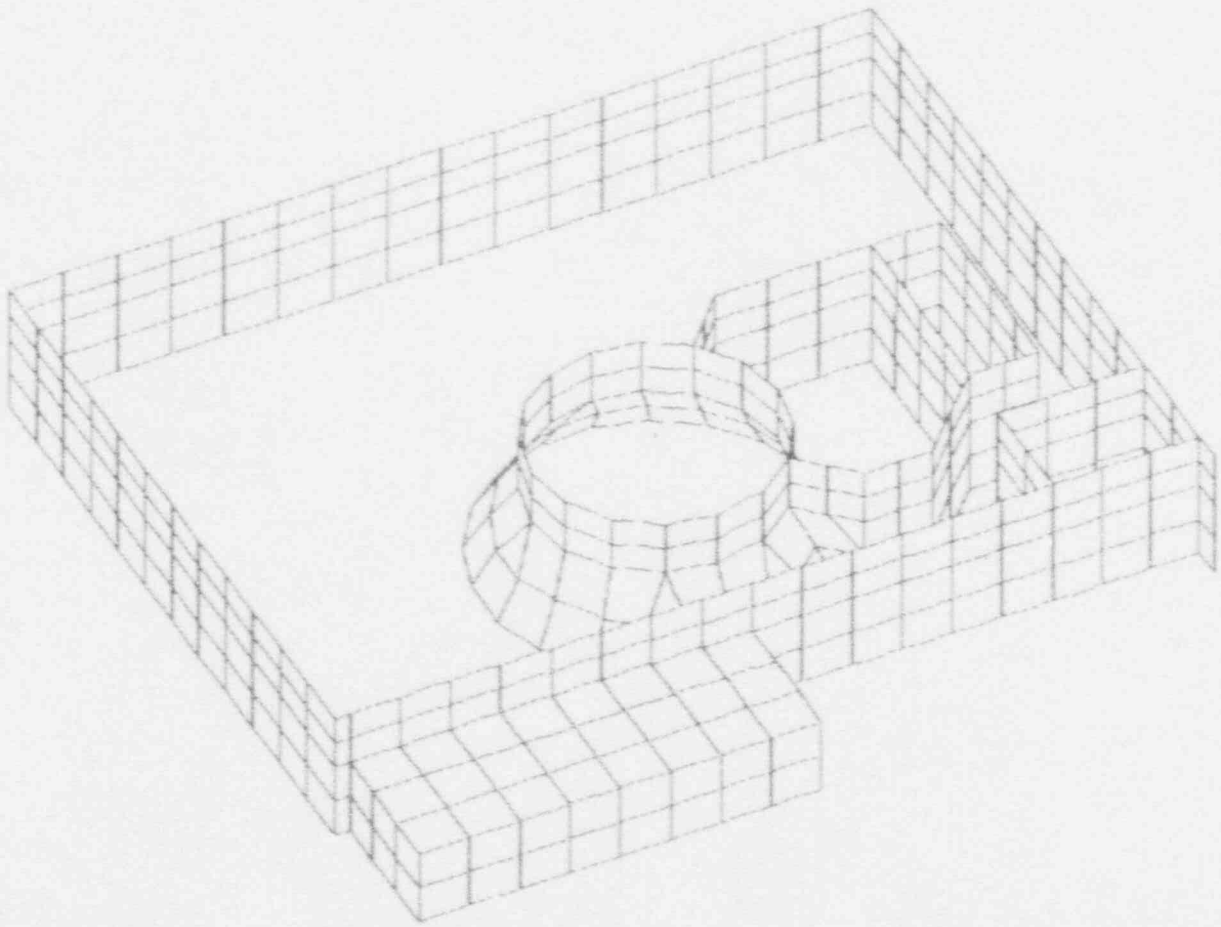
SHEET NO. 11

GEOMETRY PLOT

EQE - PNPS Reactor Building between Elev. 51'-0" & 74'-3"

PNSYS-PC 4.4A1
APR 29 1993
15:06:43
PLOT NO. 2
POST1 ELEMENTS
TYPE NUM

XV =-1
YV =0.5
ZV =1
DIST=100.477
XF =5.75
ZF =78.9
RNGZ=108.43
PRECISE HIDDEN



6.8 GEOMETRY PLOTS

EQE Engineering

SHEET NO. 92

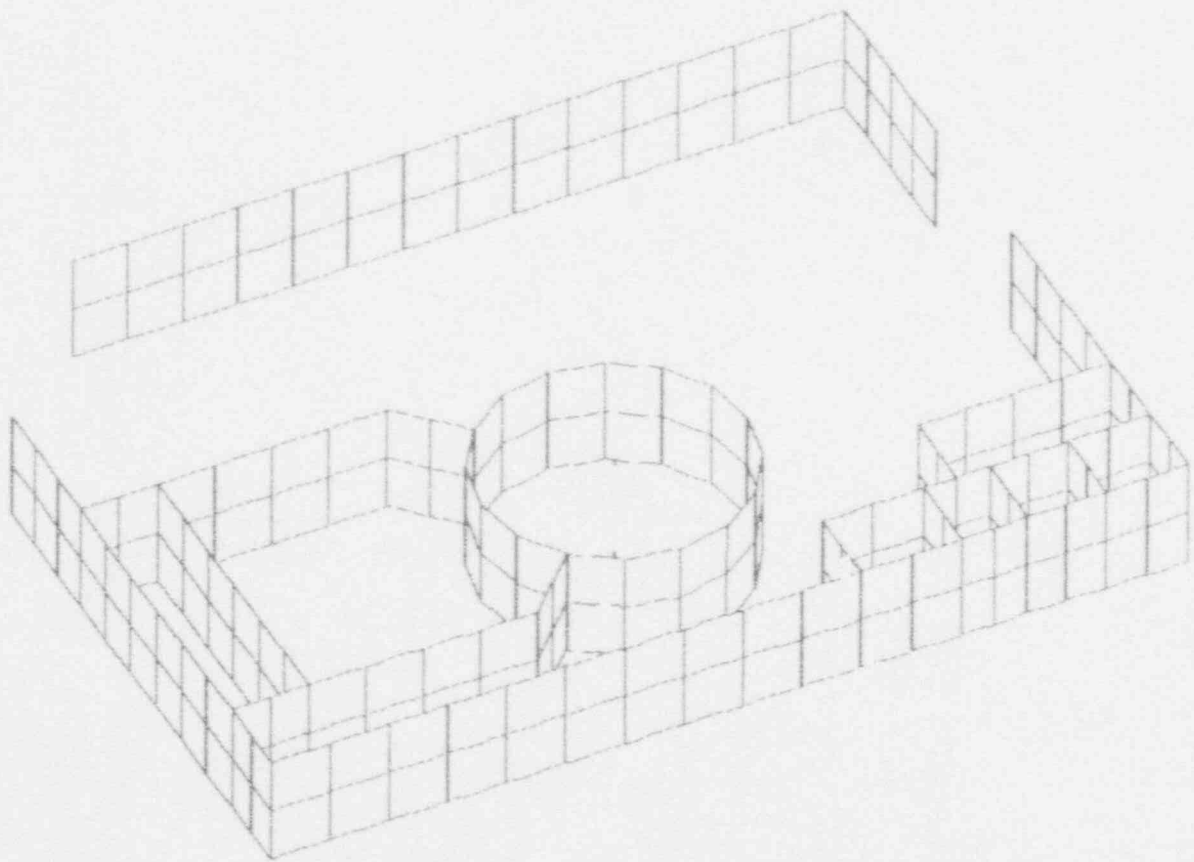
JOB NO. 42103 JOB: Boston Edison PNPS PREPARED BY: GSB DATE: 4.29.93

GEOMETRY PLOT CALC NO. 42103-C-001 SUBJECT: Reactor Building Seismic Model CHECKED BY: JLW DATE: 4-29-93

EQE - PNPS Reactor Building between Elev. 74'-3" & 91'-3"

```
PNSYS-PC 4.4A1
APR 29 1993
15:36:37
PLOT NO.    2
POST1 ELEMENTS
TYPE NUM

XV   =-1
YV   =0.5
ZV   =1
DIST=94.894
XF   =17.4
ZF   =99.25
ANGZ=108.43
PRECISE HIDDEN
```



6.8 GEOMETRY PLOTS

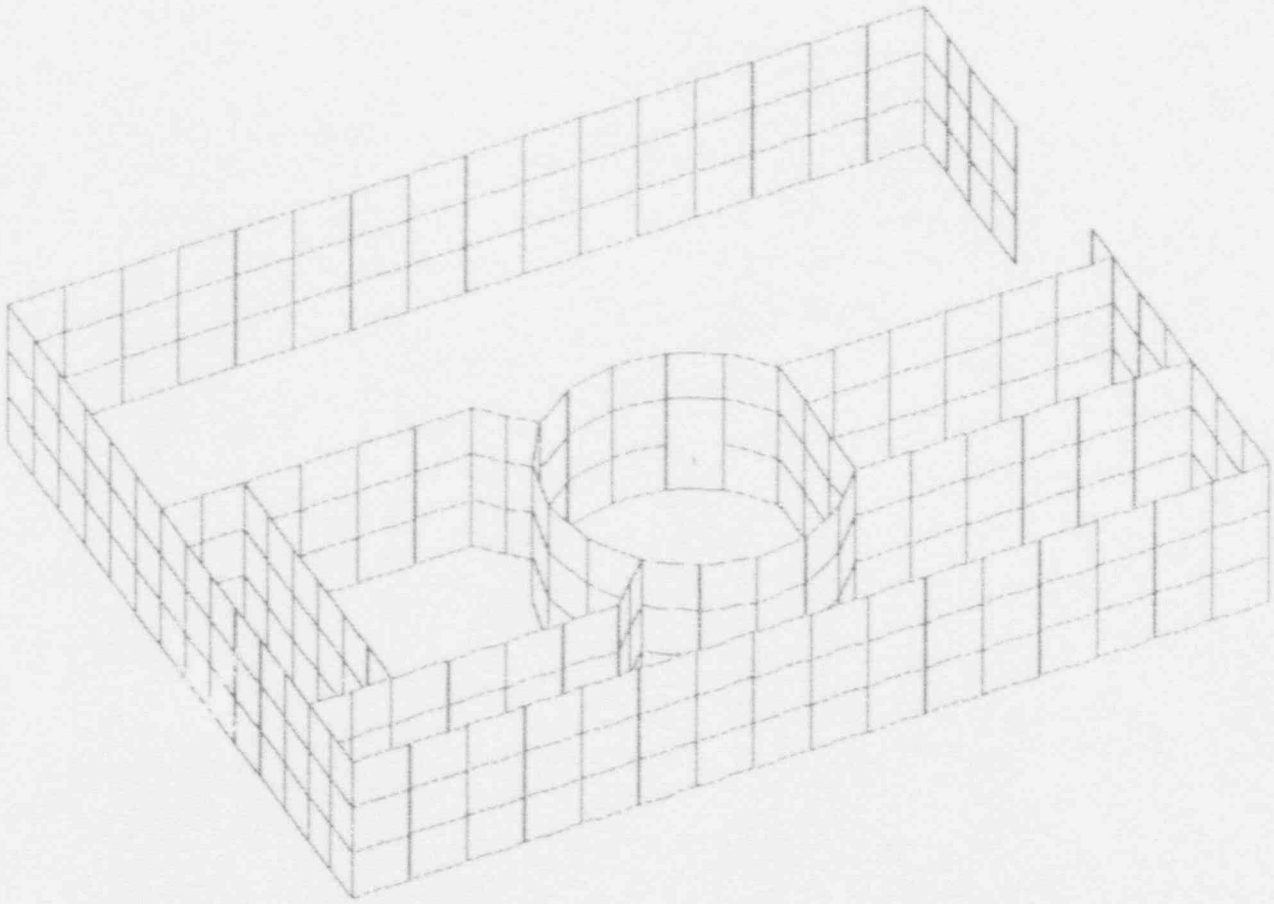
EQE Engineering

JOB NO. 42103 JOB: Boston Edison PNPS PREPARED BY: GSB DATE: 4.29.93

GEOMETRY PLOT CALC NO. 42103-C-001 SUBJECT: Reactor Building Seismic Model CHECKED BY: JCW DATE: 4.29.93

SHEET NO. 93

EQE - PNPS Reactor Building between Elev. 91'-3" & 117'-0"



ANSYS-PC 4.4A1
APR 29 1993
15:46:40
PLOT NO. 2
PREP7 ELEMENTS
TYPE NUM

XV = -1
YV = 0.5
ZV = 1
DIST=95.46
XF = 17.15
ZF = 121
ANGZ=108.43
PRECISE HIDDEN

6.0 GEOMETRY PLOTS

EQE Engineering

JOB NO. 42103 JOB: Boston Edison PNPS

GEOMETRY PLOT CALC NO. 42103-C-001 SUBJECT: Reactor Building Seismic Model

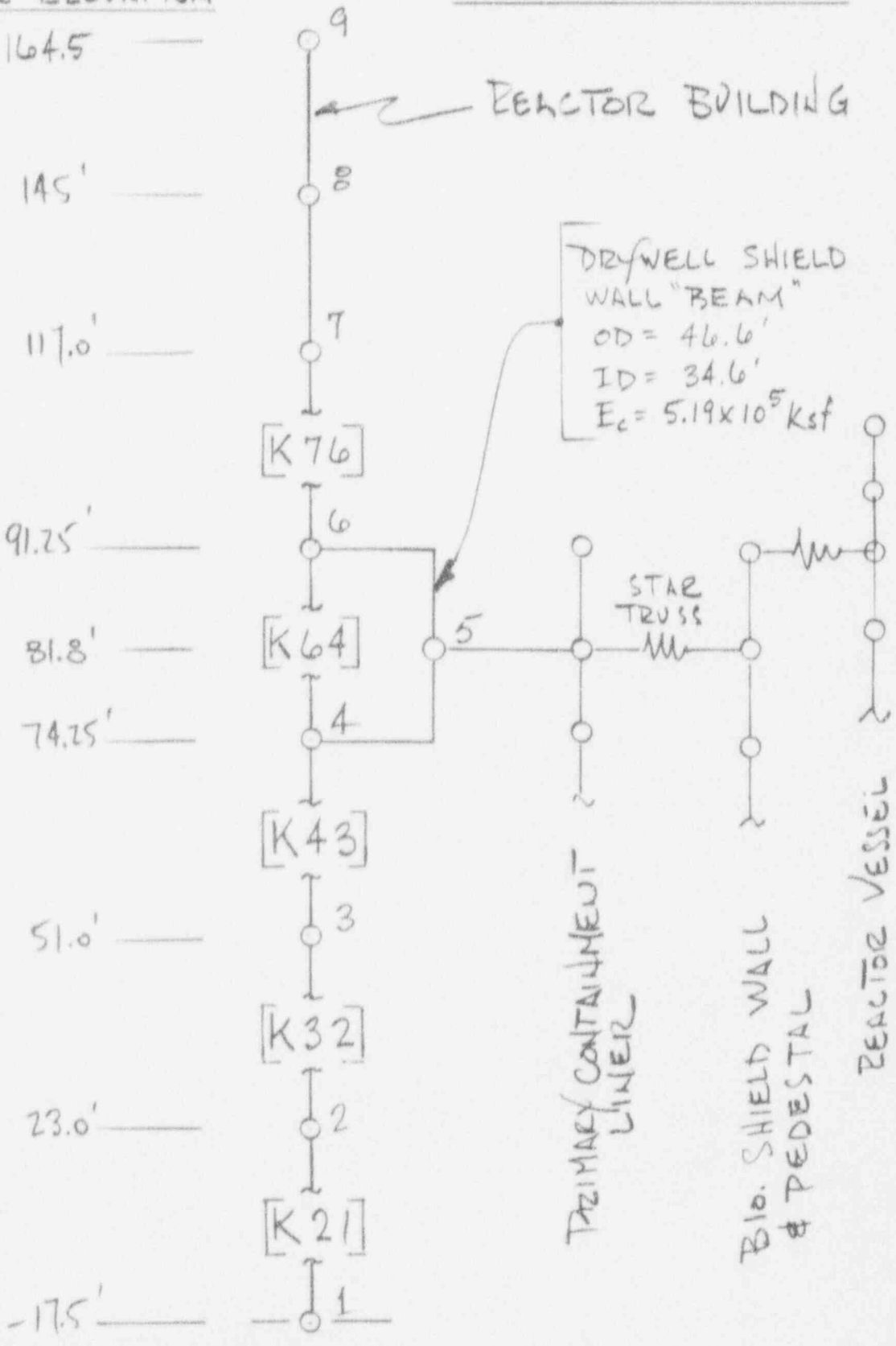
PREPARED BY: GSB DATE: 4.29.93

CHECKED BY: JCW DATE: 4-29-93

SHEET NO. 94

FLOOR ELEVATION

6.9 STIFFNESS MATRICES



REACTOR BUILDING

6.9 Pilgrim Station Reactor Building Stiffness Matrix between Elevations (-)17'-6" and 23'-0"

Stiffness Matrix Designation = K21

Dynamic Model Node Number	Node Distance from Top of Base Mat (feet)	Horizontal Location
2	39.3	Reactor CL
1	(-)4.0	Reactor CL

ANSYS Reference Output Filename: K-17-23.OUT

ANSYS Global Coordinate System for Stiffness Matrix Derivation:
Origin Located at Reactor Centerline and Top of Base Mat (El. -17'-6")
X = North, Y = West, and Z = Vertical Up

Units = Kips and Feet

Displacement		DX	DY	DZ	Rot X	Rot Y	Rot Z	DX	DY	DZ	Rot X	Rot	Rot Z
Force	Node	2	2	2	2	2	2	1	1	1	1	1	1
FX	2	13867270	-56044	-35675	-6003856	-293783300	-103689700	-13867270	56044	35675	3577129	-306669600	103689700
FY	2	-56044	14835600	51919	312879300	10333900	108215600	-56044	-14835600	-51919	329502100	-7907175	-108215600
FZ	2	-35675	51919	64190980	466242900	-306969600	-4648923	35675	-51919	-64190980	-463994800	308514400	4648923
MX	2	-6003856	312879300	466242900	1531233000000	-17571040000	-2120677000	6003856	-312879300	-466242900	-1395756000000	17831010000	-2120677000
MY	2	-293783300	10333900	-306969600	-17571040000	1280604000000	2461556000	293783300	-10333900	306969600	18018500000	-1153396000000	-2461556000
MZ	2	-103689700	108215600	-4648923	2120677000	2461556000	88776680000	103689700	-108215600	4648923	2565057000	2028210000	-88776680000
FX	1	-13867270	56044	35675	6003856	293783300	103689700	13867270	-56044	-35675	-3577129	306669600	-103689700
FY	1	56044	-14835600	-51919	-312879300	-10333900	-108215600	-56044	14835600	51919	-329502100	7907175	108215600
FZ	1	-35675	-51919	-64190980	-466242900	306969600	4648923	-35675	51919	64190980	463994800	-308514400	-4648923
MX	1	3577129	329502100	-463994800	-1395756000000	18018500000	2565057000	-3577129	-329502100	463994800	153843100000	-18173390000	-2565057000
MY	1	-306669600	-7907175	308514400	17831010000	-1153396000000	2028210000	306669600	7907175	-308514400	-18173390000	1286184000000	-2028210000
MZ	1	103689700	-108215600	4648923	-2120677000	-2461556000	-88776680000	-103689700	108215600	-4648923	-2565057000	-2028210000	88776680000

EQE Engineering

JOB NO. 42103 JOB: Boston Edison PNPS PREPARED BY: GSB SHEET NO. 96

CALC. NO. 42103-C-001 SUBJECT: Reactor Building Seismic Model CHECKED BY: JW DATE: 5-27-93

DATE: 5-27-93

6.9 Pilgrim Station Reactor Building Stiffness Matrix between Elevations 23'-0" and 51'-0"

Stiffness Matrix Designation = K32

Dynamic Model Node Number	Node Distance from Top of Base Mat (feet)	Horizontal Location
3	67.5	Reactor CL
2	39.3	Reactor CL

ANSYS Reference Output Filename: K-23-51.OUT

ANSYS Global Coordinate System for Stiffness Matrix Derivation:
Origin Located at Reactor Centerline and Top of Base Mat (El. -17'-6")
X = North, Y = West, and Z = Vertical Up

Units = Kips and Feet

Displacement		DX	DY	DZ	Rot X	Rot Y	Rot Z	DX	DY	DZ	Rot X	Rot Y	Rot Z
Force	Node	3	3	3	3	3	3	2	2	2	2	2	2
FX	3	13384720	-165354	-144408	-2596611	-132904200	40450500	-13384720	165354	144408	-2066371	-244544800	-40450500
FY	3	-165354	13724160	819	140444100	2751745	-69472280	165354	-13724160	-819	246577300	1911238	69472280
FZ	3	-144408	819	58245400	336419400	638694700	-158460	144408	-819	-58245400	-336396300	-634622400	158460
MX	3	-2596611	140444100	336419400	1448231000000	12647420000	-1065470000	2596611	-140444100	-336419400	-1408626000000	-12574200000	1065470000
MY	3	-132904200	2751745	638694700	12647420000	1433092000000	-570854200	132904200	-2751745	-638694700	-12569820000	-1395613000000	570854200
MZ	3	40450500	-69472280	-158460	-1065470000	-570854200	77802040000	-40450500	69472280	158460	-893648400	-569849800	-77802040000
FX	2	-13384720	165354	144408	2596611	132904200	-40450500	13384720	-165354	-144408	2066371	244544800	40450500
FY	2	165354	-13724160	-819	-140444100	-2751745	69472280	-165354	13724160	819	-246577300	-1911238	-69472280
FZ	2	144408	-819	-58245400	-336419400	-638694700	158460	-144408	819	58245400	336396300	634622400	-158460
MX	2	-2066371	246577300	-336396300	-1408626000000	-12569820000	-893648400	2066371	-246577300	336396300	1478151000000	12628090000	893648400
MY	2	-244544800	1911238	-634622400	-12574200000	-1395613000000	-569849800	244544800	-1911238	634622400	12628090000	1464574000000	569849800
MZ	2	-40450500	69472280	158460	1065470000	570854200	-77802040000	40450500	-69472280	-158460	893648400	569849800	77802040000

EQE Engineering

JOB NO. 42103 JOB: Boston Edison PNPS PREPARED BY: GSB SHEET NO. 97

CALC. NO. 42103-C-001 SUBJECT: Reactor Building Seismic Model CHECKED BY: [illegible] DATE: 5.27.93

6.9 Pilgrim Station Reactor Building Stiffness Matrix between Elevations 51'-0" and 74'-3"

Stiffness Matrix Designation = K43

Dynamic Model Node Number	Node Distance from Top of Base Mat (feet)	Horizontal Location
4	90.3	Reactor CL
3	67.5	Reactor CL

ANSYS Reference Output Filename: K-51-74.OUT

ANSYS Global Coordinate System for Stiffness Matrix Derivation
Origin Located at Reactor Centerline and Top of Base Mat (El. -17'-6")
X = North, Y = West, and Z = Vertical Up

Units = Kips and Feet

Displacement		DX	DY	DZ	Rot X	Rot Y	Rot Z	DX	DY	DZ	Rot X	Rot Y	Rot Z
Force	Node	4	4	4	4	4	4	3	3	3	3	3	3
FX	4	12775650	-132149	85322	2662938	-85032070	72381710	-12775650	132149	-85322	-5675945	-206252600	-72381710
FY	4	-132149	14366390	18156	105159900	1075829	99045220	132149	-14366390	-18156	222393900	1937178	-99045220
FZ	4	85322	18156	51131220	-383118100	-445087900	-3838513	-85322	-18156	-51131220	383532100	443142500	3838513
MX	4	2662938	105159900	-383118100	111405400000	-3708789000	952755900	-2662938	-105159900	383118100	-109007700000	3648074000	-952755900
MY	4	-85032070	1075829	-445087900	-3708789000	73126620000	-998442400	85032070	-1075829	445087900	3733318000	-71187890000	998442400
MZ	4	72381710	99045220	-3838513	952755900	-998442400	56585020000	-72381710	-99045220	3838513	1305475000	-651860700	-56585020000
FX	3	-12775650	132149	-85322	-2662938	85032070	-72381710	12775650	-132149	85322	5675945	206252600	72381710
FY	3	132149	-14366390	-18156	-105159900	-1075829	-99045220	-132149	14366390	18156	-222393900	-1937178	99045220
FZ	3	-85322	-18156	-51131220	383118100	445087900	3838513	85322	18156	51131220	-383532100	-443142500	-3838513
MX	3	-5675945	222393900	383532100	-109007700000	3733318000	1305475000	5675945	-222393900	-383532100	114078300000	-3603907000	-1305475000
MY	3	-206252600	1937178	443142500	3648074000	-71187890000	-651860700	206252600	-1937178	-443142500	-3603907000	75890450000	651860700
MZ	3	-72381710	-99045220	3838513	-952755900	998442400	-56585020000	72381710	99045220	-3838513	-1305475000	651860700	56585020000

EQE Engineering

JOB NO. 42103 JOB: Boston Edison PNPS PREPARED BY: GSB DATE: 5.27.93

CALC. NO. 42103-C-001 SUBJECT: Reactor Building Seismic Model CHECKED BY: JWI DATE: 5-27-93

SHEET NO. 98

6.9 Pilgrim Station Reactor Building Stiffness Matrix between Elevations 74'-3" and 91'-3"

Stiffness Matrix Designation = KT64

(KT64 is the TOTAL stiffness of all structural members between the elevations.)

Dynamic Model Node Number	Node Distance from Top of Base Mat (feet)	Horizontal Location
6	108.2	Reactor CL
4	90.3	Reactor CL

ANSYS Reference Output Filename: KT-74-91.OUT

ANSYS Global Coordinate System for Stiffness Matrix Derivation
Origin Located at Reactor Centerline and Top of Base Mat (El. -17'-6")
X = North, Y = West, and Z = Vertical Up

Units = Kips and Feet

Displacement		DX	DY	DZ	Rot X	Rot Y	Rot Z	DX	DY	DZ	Rot X	Rot Y	Rot Z
Force	Node	6	6	6	6	6	6	4	4	4	4	4	4
FX	6	17538750	500	0	4476	-160000000	-210000000	-18000000	-500	0	4476	-160000000	210000000
FY	6	500	22314380	0	200000000	-4476	22250730	-500	-22000000	0	200000000	-4476	-22000000
FZ	6	0	0	84700500	830000000	-86000000	0	0	0	-85000000	-830000000	85620770	0
MX	6	4476	200000000	830000000	170000000000	-180000000	199000000	-4476	-200000000	-830000000	-170000000000	178000000	-200000000
MY	6	-160000000	-4476	-86000000	-180000000	80600000000	1880000000	157000000	4476	85620770	178000000	-78000000000	-1900000000
MZ	6	-210000000	22250730	0	199000000	1880000000	69300000000	210000000	-22000000	0	199000000	1880000000	-69000000000
FX	4	-18000000	-500	0	-4476	157000000	210000000	17538750	500	0	-4476	157000000	-210000000
FY	4	-500	-22000000	0	-200000000	4476	-22000000	500	22314380	0	-200000000	4476	22250730
FZ	4	0	0	-85000000	-830000000	85620770	0	0	0	84700500	830000000	-86000000	0
MX	4	4476	200000000	-830000000	-170000000000	178000000	199000000	-4476	-200000000	830000000	170000000000	-180000000	-200000000
MY	4	-160000000	-4476	85620770	178000000	-78000000000	1880000000	157000000	4476	-86000000	-180000000	80600000000	-1900000000
MZ	4	210000000	-22000000	0	-200000000	-1900000000	-69000000000	-210000000	22250730	0	-200000000	-1900000000	69300000000

6.9 Pilgrim Station Reactor Building Stiffness Matrix between Elevations 74'-3" and 91'-3"

Stiffness Matrix Designation = KD64

(KD64 is the stiffness of only the DRYWELL Shield Wall between the elevations.)

Dynamic Model Node Number	Node Distance from Top of Base Mat (feet)	Horizontal Location
6	108.2	Reactor CL
4	90.3	Reactor CL

ANSYS Reference Output Filename: KD-74-91.OUT

ANSYS Global Coordinate System for Stiffness Matrix Derivation
Origin Located at Reactor Centerline and Top of Base Mat (El. -17'-6")
X = North, Y = West, and Z = Vertical Up

Units = Kips and Feet

Displacement		DX	DY	DZ	Rot X	Rot Y	Rot Z	DX	DY	DZ	Rot X	Rot Y	Rot Z
Force	Node	6	6	6	6	6	6	4	4	4	4	4	4
FX	6	4614380	0	0	0	-41298700	0	-4614380	0	0	0	-41298700	0
FY	6	0	4614380	0	41298700	0	0	0	-4614380	0	41298700	0	0
FZ	6	0	0	22180730	0	0	0	0	0	-22180730	0	0	0
MX	6	0	41298700	0	5037724000	0	0	0	-41298700	0	-4298477000	0	0
MY	6	-41298700	0	0	0	5037724000	0	41298700	0	0	0	-4298477000	0
MZ	6	0	0	0	0	0	3989830000	0	0	0	0	0	-3989830000
FX	4	-4614380	0	0	0	41298700	0	4614380	0	0	0	41298700	0
FY	4	0	-4614380	0	-41298700	0	0	0	4614380	0	-41298700	0	0
FZ	4	0	0	-22180730	0	0	0	0	0	22180730	0	0	0
MX	4	0	41298700	0	-4298477000	0	0	0	-41298700	0	5037724000	0	0
MY	4	-41298700	0	0	0	-4298477000	0	41298700	0	0	0	5037724000	0
MZ	4	0	0	0	0	0	-3989830000	0	0	0	0	0	3989830000

EQE Engineering

JOB NO. 42103 JOB: Boston Edison PNPS PREPARED BY: GSB SHEET NO. 100

CALC. NO. 42103-C-001 SUBJECT: Reactor Building Seismic Model CHECKED BY: JWV DATE: 5-27-93

DATE: 5-27-93

CHECKER'S NOTE: BECAUSE OF THE [illegible] OF SIGNIFICANT DIGITS, SOME ROUND OFF OF NUMBERS HAS OCCURRED. DIFFERENCES ARE NOT SIGNIFICANT.

6.9

Pilgrim Station Reactor Building Stiffness Matrix between Elevations 74'-3" and 91'-3"

Stiffness Matrix Designation = K64 (K64 = KT64 - KD64)

K64 is the TOTAL stiffness between the elevations, minus the stiffness of the DRYWELL Shield Wall.

Dynamic Model Node Number	Node Distance from Top of Base Mat (feet)	Horizontal Location
6	108.2	Reactor CL
4	90.3	Reactor CL

ANSYS Reference Output Filename: NA

ANSYS Global Coordinate System for Stiffness Matrix Derivation
Origin Located at Reactor Centerline and Top of Base Mat (El. -17'-6")
X = North, Y = West, and Z = Vertical Up

Units = Kips and Feet

Displacement		DX	DY	DZ	Rot X	Rot Y	Rot Z	DX	DY	DZ	Rot X	Rot Y	Rot Z
Force	Node	6	6	6	6	6	6	4	4	4	4	4	4
FX	6	12924370	500	0	4476	-118701300	-210000000	-13385620	-500	0	4476	-118701300	210000000
FY	6	500	17700000	0	158701300	-4476	22250730	-500	-17385620	0	158701300	-4476	-22000000
FZ	6	0	0	62519770	830000000	-86000000	0	0	0	-62819270	-830000000	85620770	0
MX	6	4476	158701300	830000000	164862300000	-180000000	199000000	-4476	-158701300	-830000000	-165701500000	178000000	-200000000
MY	6	-118701300	-4476	-86000000	-180000000	75562280000	1880000000	115701300	4476	85620770	178000000	-73701520000	-1900000000
MZ	6	-210000000	22250730	0	199000000	1880000000	65310170000	210000000	-22000000	0	199000000	1880000000	-65010170000
FX	4	-13385620	-500	0	-4476	115701300	210000000	12924370	500	0	-4476	115701300	-210000000
FY	4	-500	-17385620	0	-158701300	4476	-22000000	500	17700000	0	-158701300	4476	22250730
FZ	4	0	0	-62819270	-830000000	85620770	0	0	0	62519770	830000000	-86000000	0
MX	4	4476	158701300	-830000000	-165701500000	178000000	199000000	-4476	-158701300	830000000	164862300000	-180000000	-200000000
MY	4	-118701300	-4476	85620770	178000000	-73701520000	1880000000	115701300	4476	-86000000	-180000000	75562280000	-1900000000
MZ	4	210000000	-22000000	0	-200000000	-1900000000	-65010170000	-210000000	22250730	0	-200000000	-1900000000	65310170000

EQE Engineering

JOB NO. 42103 JOB: Boston Edison PNPS PREPARED BY: GSB SHEET NO. 101

CALC. NO. 42103-C-001 SUBJECT: Reactor Building Seismic Model CHECKED BY: JLW DATE: 5-27-93

SEE CHECKER'S NOTE ON SHEET 120

6.9 Pilgrim Station Reactor Building Stiffness Matrix between Elevations 91'-3" and 117'-0"

Stiffness Matrix Designation = K76

Dynamic Model Node Number	Node Distance from Top of Base Mat (Feet)	Horizontal Location
7	137.8	Reactor CL
6	108.2	Reactor CL

ANSYS Reference Output Filename: K-91-117.OUT

ANSYS Global Coordinate System for Stiffness Matrix Derivation
Origin Located at Reactor Centerline and Top of Base Mat (El. -17'-6")
X = North, Y = West, and Z = Vertical Up

Units = Kips and Feet

Displacement		DX	DY	DZ	Rot X	Rot Y	Rot Z	DX	DY	DZ	Rot X	Rot Y	Rot Z
Force	Node	7	7	7	7	7	7	6	6	6	6	6	6
FX	7	8343795	12704	0	162609	-106800600	-182994700	-8343795	-12704	0	162609	-106800600	182994700
FY	7	12704	15035630	0	192456000	-162609	72372530	-12704	-15035630	0	192456000	-162609	-72372530
FZ	7	0	0	54734650	621704300	-281977300	0	0	0	-54734650	-621704300	281977300	0
MX	7	162609	192456000	621704300	115751700000	-1874688000	926368400	-162609	-192456000	-621704300	-110824800000	1870525000	-926368400
MY	7	-106800500	-162609	-281977300	-1874688000	54017440000	2342332000	106800600	162609	281977300	1870525000	-51283350000	-2342332000
MZ	7	-182994700	72372530	0	926368400	2342332000	42193720000	182994700	-72372530	0	926368400	2342332000	-42193720000
FX	6	-8343795	-12704	0	-162609	106800800	182994700	8343795	12704	0	-162609	106800600	-182994700
FY	6	-12704	-15035630	0	-192456000	162609	-72372530	12704	15035630	0	-192456000	162609	72372530
FZ	6	0	0	-54734650	-621704300	281977300	0	0	0	54734650	621704300	-281977300	0
MX	6	162609	192456000	-621704300	-110824800000	1870525000	926368400	-162609	-192456000	621704300	115751700000	-1874688000	-926368400
MY	6	-106800600	-162609	281977300	1870525000	-51283350000	2342332000	106800600	162609	-281977300	-1874688000	54017440000	-2342332000
MZ	6	182994700	-72372530	0	-926368400	-2342332000	-42193720000	-182994700	72372530	0	-926368400	-2342332000	42193720000

EQE Engineering

JOB NO. 42103 JOB: Boston Edison PNPS PREPARED BY: GSB SHEET NO. 102

CALC. NO. 42103-C-001 SUBJECT: Reactor Building Seismic Model CHECKED BY: JLW DATE: 5-27-93

EQE ENGINEERING

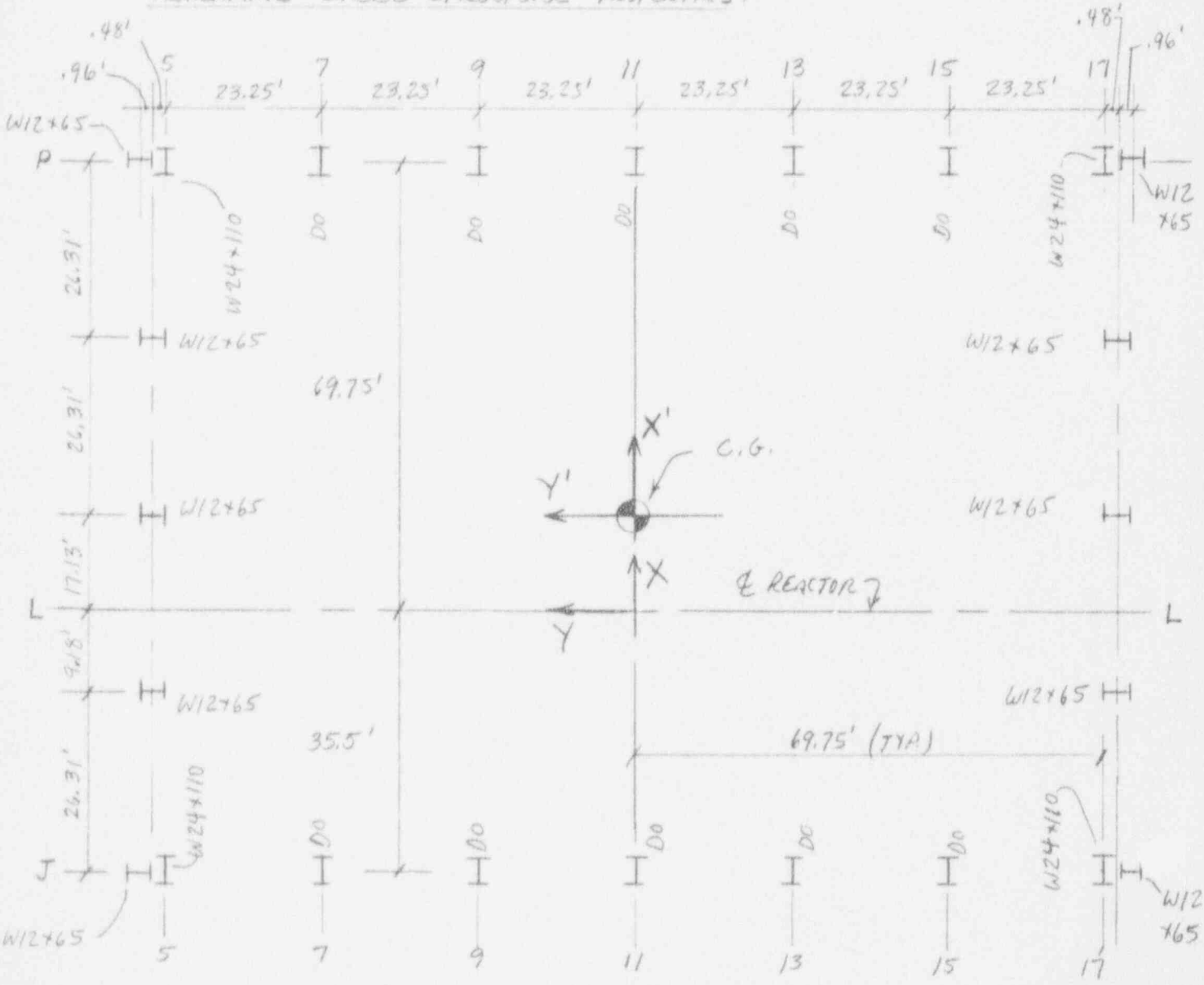
SHEET NO. 103

JOB NO. 42103 JOB BOSTON EDISON PNPS BY JVN DATE 5-3-93

CALC NO. 42103-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D ROH DATE 6/4/93

6.10 BUILDING PROPERTIES ABOVE EL. 117'-0"

DETERMINE STEEL STRUCTURE PROPERTIES:



PLAN - STEEL COLUMNS ABOVE EL. 117'-0"

REF.
C-130
C-156
C-157

6.10 BLDG. PROPERTIES ABOVE EL. 117'-0" (CONT'D)

STRUCT. STEEL PROPERTIES (CONT'D):

TRANSFORM STEEL TO BE EQUIVALENT TO CONCRETE

$E_c = 57{,}000\sqrt{f_c'}$ (REF. 4 P. 18)

$f_c' = 4000$ PRECAST PANELS (REF. A29 NOTE 9)

$E_s = 29{,}000$ KSI (REF. 6, P. 5-202)

$$n = \frac{E_s}{E_c} = \frac{29{,}000{,}000}{57{,}000\sqrt{4000}} = 8.04$$

W24×110 $A = 32.5\ in^2$ $A_t = \frac{(8.04)(32.5)}{144} = 1.82\ FT^2$

W12×65 $A = 19.1\ in^2$ $A_t = \frac{(8.04)(19.1)}{144} = 1.07\ FT^2$

EQE ENGINEERING

SHEET NO. 105

JOB NO. 42103 JOB BOSTON EDISON PNPS BY JLW DATE 5-3-93

CALC. NO. 42103-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDH DATE 6/4/93

6.10 BLDG. PROPERTIES ABOVE EL. 117'-0" (CONT'D)
STRUCT. STEEL PROPERTIES (CONT'D)

MOMENT OF INERTIA OF TRANSFORMED AREAS ABOUT C.G.:

	A	$\bar{x}$	$\bar{y}$	$A\bar{x}^2$	$A\bar{y}^2$
P-LINE	1.07	52.62	71.19	2963	5423
	1.82	52.62	69.75	5039	8854
	1.82		46.50	5039	3935
	1.82		23.25	5039	984
	1.82		0	5039	0
	1.82		23.25	5039	984
	1.82		46.50	5039	3935
	1.82	52.62	69.75	5039	8854
P-LINE	1.07	52.62	71.19	2963	5423
	1.07	26.31	70.23	741	5278
	1.07	26.31		741	5278
	1.07	0		0	5278
	1.07	0		0	5278
	1.07	26.31		741	5278
	1.07	26.31	70.23	741	5278
J-LINE	1.07	52.62	71.19	2963	5423
	1.82		69.75	5039	8854
	1.82		46.50	5039	3935
	1.82		23.25	5039	984
	1.82		0	5039	0
	1.82		23.25	5039	984
	1.82		46.5	5039	3935
	1.82		69.75	5039	8854
J-LINE	1.07	52.62	71.19	2963	5423
Σ =				85,362 (FT4)	108,452 (FT4)

EQE ENGINEERING

SHEET NO. 106

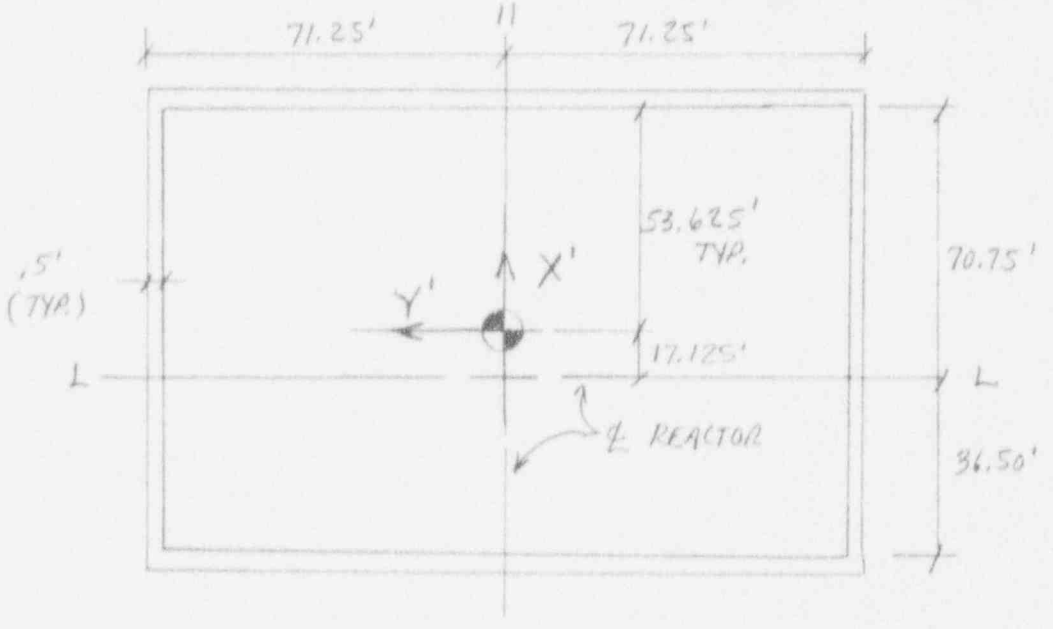
JC3 NO. 42103 JOB BOSTON EDISON PNPS BY JWW DATE 5-3-93

CALC. NO. 42103-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDH DATE 6/7/93

6.10 BLDG. PROPERTIES ABOVE EL. 117'-0" (CONT'D)

DETERMINE COMBINED CONCRETE AND STEEL PROPERTIES:

PRECAST PANEL GEOMETRY: (REF. SN. 25)



PLAN ABOVE EL. 117'-0"

$$I_X = \frac{bh^3}{12} = \frac{(71.25 \times 2)^3 (.5)}{12} = 120,568 \text{ FT}^4$$

$$I_Y = \frac{(107.25)^3 (.5)}{12} = 51,402 \text{ FT}^4$$

$$A_X{}^2 = (142.5)(.5)(53.63)^2 + (142.5)(.5)(53.63)^2 = 409,855 \text{ FT}^4$$

$$A_Y{}^2 = (107.25)(.5)(2)(71.0)^2 = 540,647 \text{ FT}^4$$

$$I_{X \text{ TOTAL}} = (2)(120,568) + (540,647) + (108,452) = \underline{890,235 \text{ FT}^4}$$

$$I_{Y \text{ TOTAL}} = (2)(51,402) + (409,855) + (85,362) = \underline{598,021 \text{ FT}^4}$$

JOB NO. 42103 JOB BOSTON EDISON DNAS BY JLW DATE 5-3-93

CALC. NO. 42103-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDH DATE 6/4/93

6.10 BLDG. PROPERTIES ABOVE EL. 117'0" (CONT'D)

DETERMINE SHEAR AREA

BASED ON A REVIEW OF POURED IN PLACE COLUMN DETAILS AT PRECAST PANEL/STEEL COLUMN INTERFACE LOCATIONS (REF DWG. A-28), IT IS JUDGED THAT THE FULL AREA OF THE PRECAST PANEL IS EFFECTIVE IN RESISTING SHEAR DEFORMATIONS. IT IS ALSO JUDGED THAT THE TRANSFORMED AREA OF ONE FLANGE OF EACH STEEL COLUMN IS ALSO EFFECTIVE (IN THE APPLICABLE DIRECTION).

109.25'

A_x (PANELS) = 2 (.5 + 70.75 + 36.5 + .5)(.5) = 108.3 FT²

A_y (PANELS) = 2 (71.25 + 71.25)(.5) = 142.5 FT²

TRANSFORMED AREAS OF ONE FLANGE:

W24 × 110 = (12.04)(.855)(8.04) = 82.77/144 = .57 FT²

W12 × 65 = (12.0)(.606)(8.04) = 58.47/144 = .41 FT²

A_x (COLUMNS) = (10)(.41) = 4.10 FT²

A_y (COLUMNS) = (14)(.57) = 7.98 FT²

TOTAL A_x = (4.10) + 108.3 = 112.4 FT² SHEAR AREA

A_y = 7.98 + 142.5 = 150.48 FT² SHEAR AREA

TOTAL AREA = $A_x + A_y$ = (112.4) + (150.48) = 262.88 FT²

EQE ENGINEERING

SHEET NO. 108

JOB NO. 42103 JOB BOSTON EDISON PNPS BY JCW DATE 5-3-93

CALC NO. 42103 C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D. RDH DATE 6/4/93

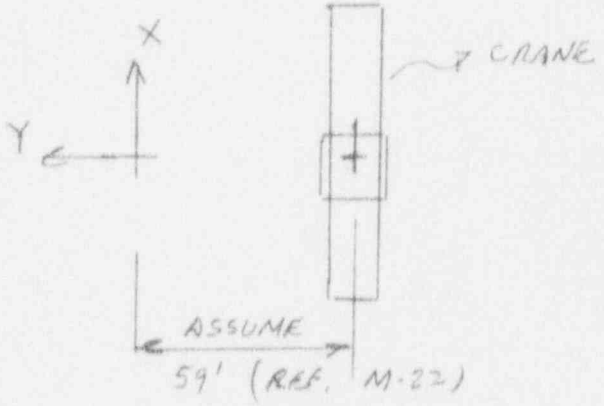
6.10 BLDG. PROPERTIES ABOVE EL. 117'-0"

DETERMINE MASS OF CRANE AND FLOORS

FROM SH. 41, TOTAL WT. EXCL. CRANE = 1692^K

CRANE WT. = 252^K

CRANE IS NORMALLY LOCATED AT EAST END OF BLDG. (REF. 8). ASSUME WEIGHT IS CENTERED IN NORTH-SOUTH DIRECTION (TROLLEY WEIGHT LOCATION WILL NOT SIGNIFICANTLY AFFECT RESULTS).



PLAN

FLOOR MASS = 1692/32.2 = 52.5 K-SEC^2/FT

CRANE MASS = 252/32.2 = 7.8 K-SEC^2/FT

TOTAL 60.3

MASS AT EL 164'-6" = 1300/32.2 = 40.4 K-SEC^2/FT (SH. 42)

EQE ENGINEERING

SHEET NO. 109

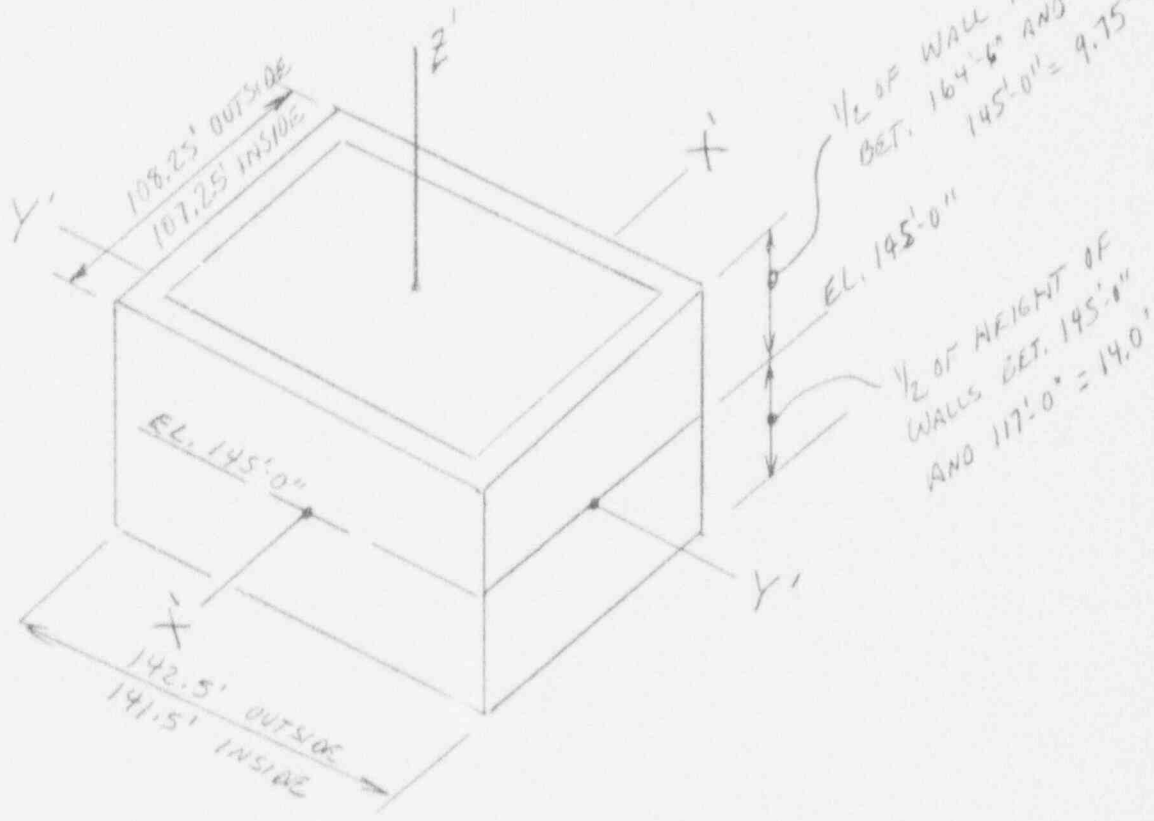
JOB NO. 42103 JOB BOSTON EDISON RNPS BY JLW DATE 5-3-93

CALC. NO. 42103 C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D [illegible] DATE 6/4/93

6.10 BLDG. PROPERTIES ABOVE EL. 117'-0" (CONT'D)

CALCULATE MASS MOMENTS OF INERTIA ABOUT MASS CENTROID:

- MASS CENTROID OF WALLS COINCIDES WITH GEOMETRIC CENTER
- DETERMINE PROPERTIES AT EL 145'-0":



WEIGHT OF WALLS, STEEL ETC. (EXCLUDING CRANE) = 1692^K (SH. 41)

$$\text{MASS} = \frac{1692}{32.2} = 52.54 \text{ K-SEC}^2/\text{FT}$$

14
9.75
23.75

VOLUME OF WALLS = $(23.75)(108.25)(142.5) - (23.75)(107.25)(141.5) = 5931.6 \text{ FT}^3$

MASS DENSITY OF WALLS = $52.54/5931.6 = 8.86 \times 10^{-3}$ K-SEC^2/FT^4

MASS OF OUTSIDE 'BLOCK' = $(8.86 \times 10^{-3})(23.75)(108.25)(142.5) = 3245$ K-SEC^2/FT

MASS OF INSIDE 'BLOCK' = $(8.86 \times 10^{-3})(23.75)(107.25)(141.5) = 3193$ K-SEC^2/FT

FROM REF. 10 (INSIDE BACK COVER, FORMULAS FOR MASS MOMENT OF INERTIA):

$$\text{MASS } I_{YY} = \left[\frac{3245}{12}(23.75^2 + 108.25^2)\right] - \left[\frac{3193}{12}(23.75^2 + 107.25^2)\right]$$

$$= 110563 \text{ K-SEC}^2\text{-FT}$$

6.1.1 BLDG. PROPERTIES ABOVE 117'-0" (CONT'D)

$$\text{MASS } I_{ZZ} = \text{MASS } I_{XX} + \text{MASS } I_{YY}$$
$$= 110563 + 166006$$
$$= 276569 \text{ K-SEC}^2\text{-FT}$$

$$\text{MASS } I_{XX} = \left[\frac{3245}{12}\left(142.5^2 + 23.75^2\right)\right] - \left[\frac{3193}{12}\left(141.5^2 + 23.75^2\right)\right]$$
$$= 166006 \text{ K-SEC}^2\text{-FT}$$

- DETERMINE PROPERTIES AT EL. 164'-6":

WALLS EXTEND ABOVE EL. 164'-6" TO EL. 166'-0"

WALLS - USE 1/2 OF WALL WEIGHT BETWEEN 145'-0" AND 164'-6" PLUS WEIGHT FROM 164'-6" TO 166'-0":

$164.5 - 145.0 = 19.5/2 = 9.75 + (166.0 - 164.5) = 11.25'$

MASS OF WALLS, STEEL, PRECAST COLUMNS (SEE SH. 41)

$= 386 + 95 + 126 + 17 + 73 = 697^K/_{32.2} = \underline{21.65}$ K-SEC²/FT

VOLUME OF WALLS $= (11.25)(108.25)(142.5) - (11.25)(107.25)(141.5) = 2809.7$ FT³

MASS DENSITY OF WALLS $= 21.65/2809.7 = 7.71 \times 10^{-3}$ K-SEC²/FT⁴

MASS OF OUTSIDE 'BLOCK' $= (7.71 \times 10^{-3})(11.25)(108.25)(142.5) = 1337$ SEC²/FT

MASS OF INSIDE 'BLOCK' $= (7.71 \times 10^{-3})(11.25)(107.25)(141.5) = 1316$ K-SEC²/FT

$$\text{MASS } I_{ZZ} = \text{MASS } I_{XX} + \text{MASS } I_{YY} = 66903 + 44361$$
$$= 111269 \text{ K-SEC}^2\text{-FT}$$

$$\text{MASS } I_{XX} = \left[\frac{1337}{12}\left(142.5^2 + 11.25^2\right)\right] - \left[\frac{1316}{12}\left(141.5^2 + 11.25^2\right)\right]$$
$$= 66903 \text{ K-SEC}^2\text{-FT}$$

$$\text{MASS } I_{YY} = \left[\frac{1337}{12}\left(11.25^2 + 108.25^2\right)\right] - \left[\frac{1316}{12}\left(11.25^2 + 107.25^2\right)\right]$$
$$= 44361 \text{ K-SEC}^2\text{-FT}$$

THIS WALL GROUP EXTENDS FROM EL. $(164.5' - 9.75') = 154.75'$ TO EL. 166'-0", THE VERTICAL ℄ IS $154.75 + (11.25/2)$
$= 160.38'$

EQE ENGINEERING

SHEET NO. 111

JOB NO. 42103 JOB BOSTON EDISON PNPS BY JLW DATE 5-3-93

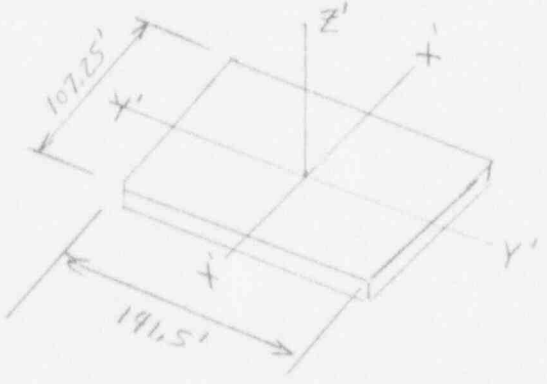
CALC. NO. 42103-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D ROA DATE 6/4/93

6.10 BLDG. PROPERTIES ABOVE 117'-0" (CONT'D)

ASSUME SHAPE OF A FLAT PLATE FOR MASS MOMENT OF INERTIA AT EL. 164'-6":

$$\text{MASS} = \frac{1300 - 697}{32.2} = 18.73 \text{ K-SEC}^2/\text{FT}$$ (SEE SH. 42)

FROM REF. 10 (BACK COVER)



$$\text{MASS } I_{YY} = \frac{18.73}{12}(107.5)^2$$

$$= 18037 \text{ K-SEC}^2\text{-FT}$$

$$\text{MASS } I_{XX} = \frac{18.73}{12}(141.5)^2$$

$$= 31251 \text{ K-SEC}^2\text{-FT}$$

$$\text{MASS } I_{ZZ} = \frac{18.73}{12}(141.5^2 + 107.5^2)$$

$$= 49289 \text{ K-SEC}^2\text{-FT}$$

CHECK: $I_{ZZ} = I_{XX} + I_{YY}$

EQE ENGINEERING

SHEET NO. 11

JOB NO. 42103 JOB BOSTON EDISON NPPS BY JCW DATE 5-3-93

CALC. NO. 42103 C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D ROH DATE 6/4/93

6.10 BLDG. PROPERTIES ABOVE 117'-0" (CONT'D)

DETERMINE WALL PROPERTIES - WALLS ABOVE EL. 117'-0"

- USE ½ OF WALL WEIGHT BETWEEN EL. 117.0' AND 145.0':

WEIGHT: PRECAST WALLS = 514 K = 514
PRECAST COLUMNS = 126+168 = 294
STEEL COLUMNS 25+11 = 36
844 K

} SH. 41

MASS = 844 K / 32.2 = 26.21 K-SEC²/FT

VOL. WALLS = (14)(108.25)(142.5) - (14)(117.25)(141.5) = 3496.5 FT³

MASS DENSITY = 26.21 / 3496.5 = 7.50 x 10⁻³ K-SEC²/FT⁴

MASS OF OUTSIDE BLOCK = (7.50x10⁻³)(14)(108.25)(142.5) = 1619 K-SEC²/FT

" " INSIDE BLOCK = (7.50x10⁻³)(14)(107.25)(141.5) = 1593 K-SEC²/FT

$$\text{MASS } I_{XX} = \left[\frac{1619}{12}(142.5^2 + 14^2)\right] - \left[\frac{1593}{12}(141.5^2 + 14^2)\right]$$

$$= 82123 \text{ K-SEC}^2\text{-FT}$$

$$\text{MASS } I_{YY} = \left[\frac{1619}{12}(14^2 + 108.25^2)\right] - \left[\frac{1593}{12}(14^2 + 107.25^2)\right]$$

$$= 54421 \text{ K-SEC}^2\text{-FT}$$

$$\text{MASS } I_{ZZ} = \text{MASS } I_{XX} + \text{MASS } I_{YY}$$

$$= 82123 + 54421 = 136544 \text{ K-SEC}^2\text{-FT}$$

6.10 BLDG. PROPERTIES ABOVE EL. 117'-0" (CONT'D)

- COMBINE MASS MOMENT OF INERTIAS AT EL. 145'-0"

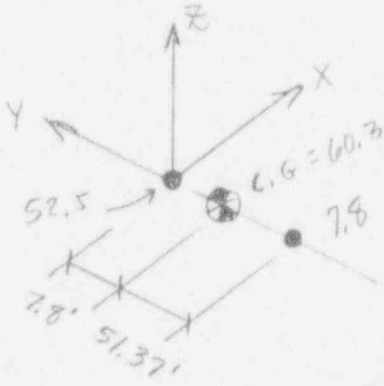
CENTER OF MASS:

ITEM	X	Y	MASS
CRANE	17.13	-59.0	7.8
WALLS	17.13	0.0	52.5

$\bar{X} = 17.13$ $\bar{Y} = \dfrac{(7.8)(-59)+(52.5)(0)}{(7.8+52.5)} = -7.63$

TOTAL MASS = $7.8 + 52.5 = 60.3$ K-Sec^2/FT

MASS MOMENTS OF INERTIA:



MASS $I_{XX} = 166,006 + 52.5(7.63)^2 + 7.8(51.37)^2$
$= 189,646$

MASS $I_{YY} = 110563$

MASS $I_{ZZ} = I_{XX} + I_{YY}$
$= 189,646 + 110563 = 300209$

CHECK MASS $I_{ZZ} = 276569 + 52.5(7.13)^2 + 7.8(51.37)^2$
$= 299821 \cong 300209$ OK

EQE ENGINEERING

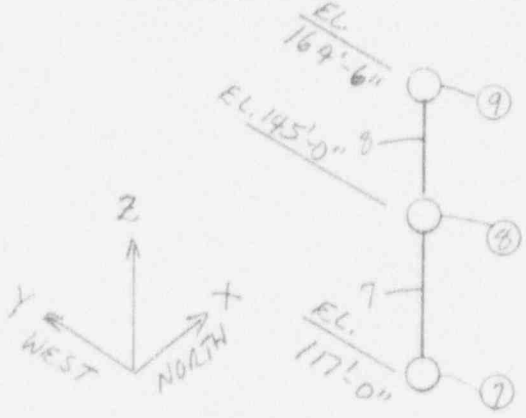
SHEET NO. 114

JOB NO. 42103 JOB BOSTON EDISON RHPS BY JLW DATE 5-3-93

CALC. NO. 42103 C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDA DATE 6/4/93

6.10 BUILDING PROPERTIES ABOVE EL. 117'-0"

SUMMARY OF BUILDING MODEL ABOVE 117'-0"



LUMPED MASS SUMMARY

MASS PT.	WEIGHT (KIPS)	MASS (K-SEC²/FT)	CENTROID COORDINATES (FT.) X	Y	Z (ELEV.)
8	1944	60.3	17.13	-7.63	145'-0"
9	603	18.7	17.13	0	164'-6"

ELEMENT PROPERTIES

ELEMENT	MOMENT OF INERTIA I_x (FT⁴)	I_y (FT⁴)	AREA FT²	SHEAR AREA * A_x (FT²)	A_y (FT²)
7	890235	654193	262.88	112.4	150.5
8	890235	654193	262.88	112.4	150.5

* CONCRETE $E_c = 5.19 \times 10^5$ KSF

EQE

EQE ENGINEERING

SHEET NO. 115

JOB NO. 42103 JOB BOSTON EDISON DNPS BY JCW DATE 5-3-93

CALC. NO. 42103 C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D [illegible] DATE 6/4/93

6.10 BUILDING PROPERTIES ABOVE 117'-0"

SUMMARY OF BLDG. MODEL ABOVE 117'-0" (CONT'D)

ELEV.	MEMBER GROUP	MASS MOMENTS OF INERTIA ABOUT MASS CENTROID (K-SEC²-FT) I_{xx}	I_{yy}	I_{zz}
164'-6"	ROOF AT EL. 164'-6"	31251	18037	49288
	WALLS EL. 166.0' TO 154.8'	66903	44361	111264
145'-0"	WALLS CENTERED AT 145'-0" (FROM EL. 154.8' TO 131.0')	189646	110563	300209
	WALLS EL. 131.0' TO 117.0'	82123	54421	136544

6.11 Pilgrim Station Reactor Building Lumped Mass Distribution for Elevations -17'-6" to 164'-6"

Units: Kips, Feet, Seconds

Model Node	Location (note 1)	Floor Elevation	Member Group	Member Group Values			Lumped Mass Results			Member Group Values			Lumped Mass Results		
				Mass	Centroid *		Mass	Centroid *		Mass Moments of Inertia **			Mass Moments of Inertia **		
					X	Y		X	Y	Ixx	Iyy	Izz	Ixx	Iyy	Izz
9	182.0'	164'-6"	roof	18.7	17.13	0.00	29.5	17.13	0	31251	18037	49288	64703	40218	104920
			walls	21.7	17.13	0.00				66903	44361	111264			
8	162.5'	145'-0"	crane rail	60.3	17.13	-7.63	60.3	17.13	-7.63	189646	110563	300209	189646	110563	300209
			walls	26.2	17.13	0.00				82123	54421	136544			
7	133.8'	117'-0"	floor	156.0	18.89	-1.55	363.4	10.96	7.27	297800	188400	486200	711800	409675	1121475
			walls	388.5	4.17	14.85				697900	349600	1005000			
6	108.2'	91'-3"	floor	111.2	23.15	-12.80	442.6	7.77	6.90	177400	115300	292700	841887	450498	1292385
			walls	274.2	0.41	11.62				514100	248300	747700			
4	90.3'	74'-3"	floor	294.4	13.03	10.66	594.2	7.21	5.96	486200	238000	724200	1094994	596840	1691834
			walls	325.3	2.39	-7.30				624500	429200	1026000			
3	67.5'	51'-0"	floor	277.2	-4.88	1.80	678.9	-5.14	0.79	554200	522700	1077000	1414880	1277062	2691942
			walls	478.0	-10.56	5.13				1066000	1047000	2049000			
2	39.3'	23'-0"	floor	407.3	-0.49	29.81	1272.4	-1.34	20.76	1394000	744100	2138000	3759749	2374697	6134446
			walls	1252.2	1.62	20.83				3482000	2162000	5443000			
1	(-)4.0'	(-) 17'-6"	floor	1126.4	4.04	8.70	1752.5	3.18	13.03	2590000	1980000	4570000	4390211	3063357	7453567

* Origin is located at the Reactor Centerline; X = North, Y = West

** Mass Moments of Inertia are about the Mass Centroid

Note 1 - The vertical location of the node is measured from the top of the base mat (elev. -17'-6").

EQE Engineering

JOB NO. 42103 JOB: Boston Edison PNPS PREPARED BY: GSB DATE: 5-27-93

CALC. NO. 42103-C-001 SUBJECT: Reactor Building Seismic Model CHECKED BY: JWS DATE: 5-27-93

SHEET NO. 116

EQE ENGINEERING

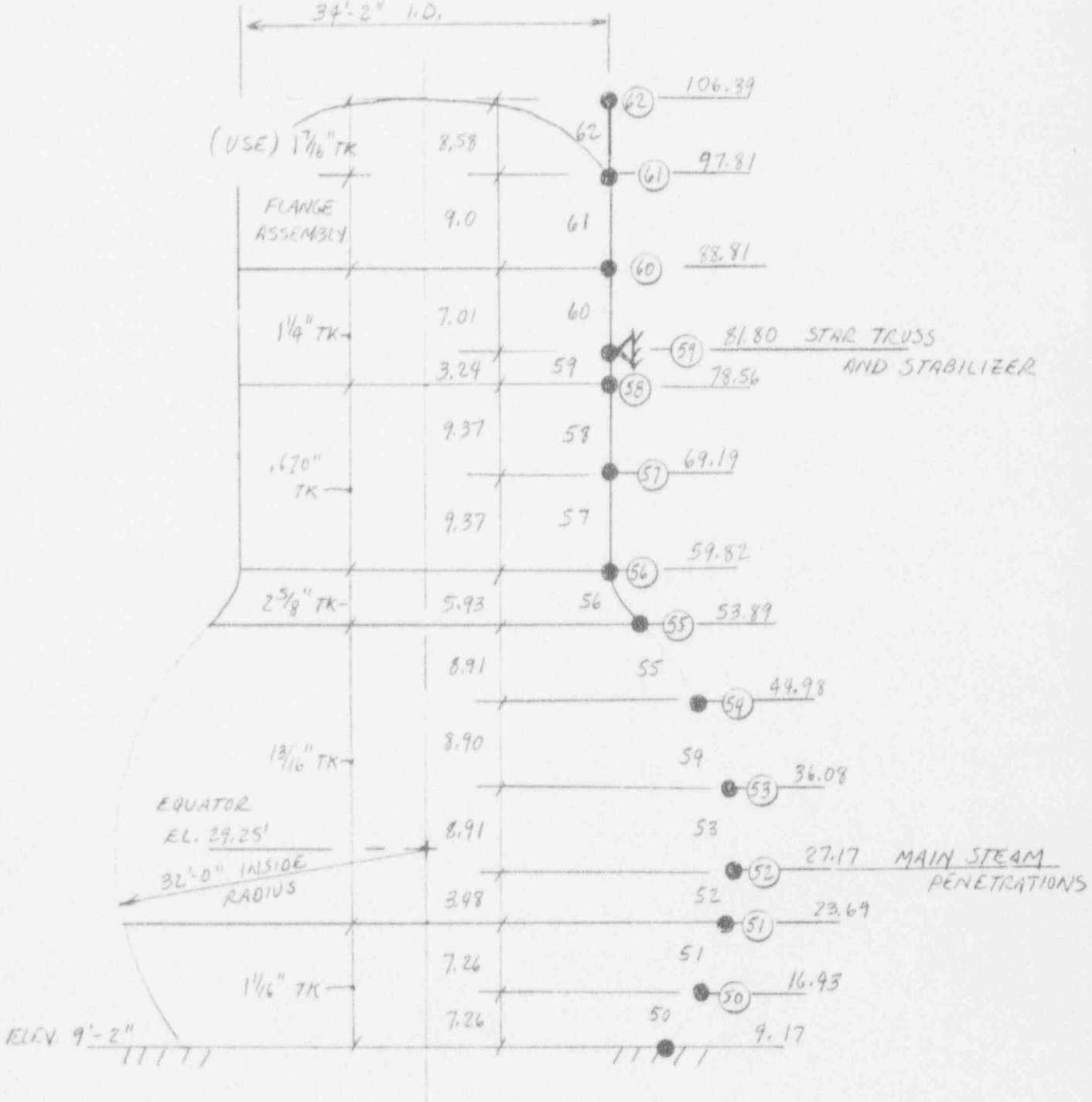
SHEET NO. 117

JOB NO. 42103 JOB BOSTON EDISON PNPS BY JLW DATE 5-3-93

CALC NO. 42103-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDM DATE 6/4/93

7.0 DRYWELL SHELL MODEL

7.1 DETERMINE DRYWELL SHELL PROPERTIES:



ELEVATION - DRYWELL SHELL
SHOWING NODE POINT LOCATIONS

REF. DWGS:
C-151, C-152
C1A-1-8, C1A-7-6
C1A-6-8

EQE ENGINEERING

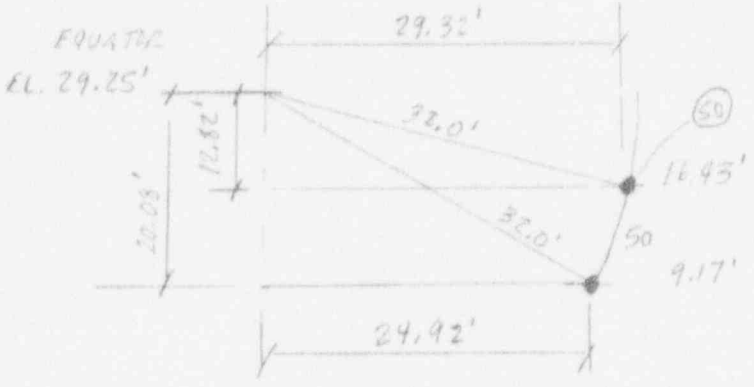
SHEET NO. 118

JOB NO. 42103 JOB BOSTON EDISON ANAS BY JWW DATE 5-3-93

CALC NO. 42103 C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D ROH DATE 6/4/93

7.1 DRYWELL SHELL MODEL PROPERTIES - REPRESENT EACH SEGMENT AS A CYLINDER, DETERMINE WEIGHT, AREA, SHEAR AREA AND MOMENT OF INERTIA.

SEGMENT 50



AVG. RADIUS = $\frac{29.32 + 24.92}{2} = 27.12'$

FOR A THIN WALLED CYLINDER: $A = 2\pi R t$, $I = \pi R^3 t$, $J = 2 \times I$, SHEAR AREA = $A/2$ } REF. 7 P. 66, 185

$$A = \frac{(2\pi)(27.12)(1.063)}{12} = 15.09 \text{ FT}^2$$

$$WT. = (15.09)(7.26)(.490) = 53.7^K$$

THIS AREA OF THE DRYWELL HAS THE DOWNCOMMER PENETRATIONS, ASSUME THE LOSS IN CROSS SECTIONAL AREA AND MOMENT OF INERTIA IS OFFSET BY THE STIFFENING EFFECT OF THE PENETRATIONS AND THEIR REINFORCEMENT. INCREASE WEIGHT ESTIMATE BY 10% TO ACCOUNT FOR INCREASE WT. OF PENETRATIONS.

$$WT. \text{ (ADJUSTED)} = (1.10)(53.7) = 59.1^K \leftarrow \text{NODE 50}$$

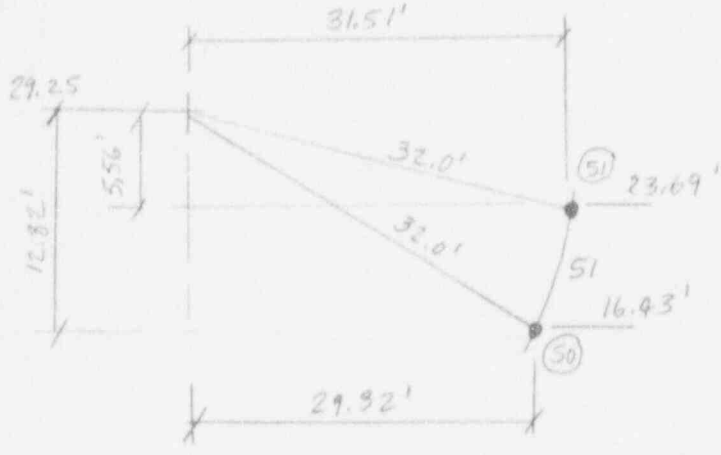
$$I = \frac{(\pi)(27.12)^3(1.063)}{(12)} = 5551 \text{ FT}^4$$

$$J = (5551)(2) = 11102 \text{ FT}^4$$

$$A_{SHEAR} = 15.09/2 = 7.55 \text{ FT}^2$$

7.1 DRYWELL SHELL MODEL PROPERTIES (CONT'D)

SEGMENT 51



$R_{AVG} = \frac{31.51 + 29.32}{2} = 30.42'$

$A = \frac{(2\pi)(30.42)\ 1.063}{12} = 16.93\ FT^2$

$WT_{51} = (16.93)(7.26)\quad(.490) = 60.2^K$

$I = \frac{(\pi)(30.42)^3/1.063)}{(12)} = 7834\ FT^4$

$WT_{NODE\ (51)} = (WT_{51} + WT_{52})/2$

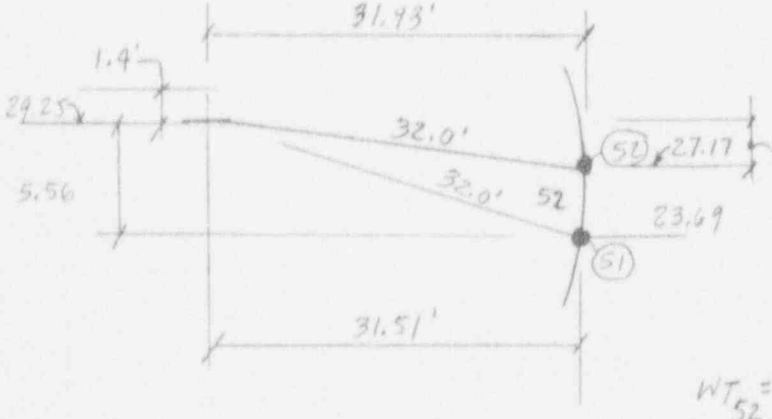
$= (60.2 + 23.0)/2 = 41.6^K$

ℓ_{BELOW} $\ell_{NODE\ (51)}$

$J = (2)(7834) = 15{,}668\ FT^4$

$A_{SHEAR} = 16.93/2 = 8.47\ FT^2$

SEGMENT 52



$R_{AVG}\quad \frac{31.51 + 31.93}{2} = 31.72'$

$A = \frac{(31.72)(2\pi)(.813)}{(12)} = 13.50\ FT^2$

$WT_{52} = (13.50)(5.56 - 2.08)(.490) = 23.0^K$

$I = \frac{(\pi)(31.72)^3(.813)}{(12)} = 6793\ FT^4$

$J = (6793)(2) = 13{,}586\ FT^4$

$A_{SHEAR} = (13.51)/2 = 6.76\ FT^2$

EQE ENGINEERING

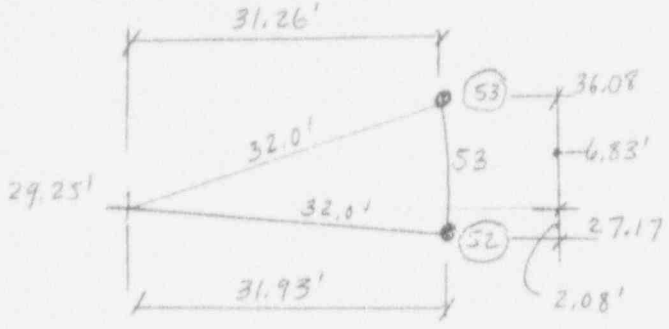
SHEET NO 120

JOB NO. 42103 JOB BOSTON EDISON PNPS BY JLW DATE 5-3-93

CALC. NO. 42103 C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDA DATE 6/4/93

7.1 DRYWELL SHELL MODEL PROPERTIES (CONT'D)

SEGMENT 53



$R_{AVG} = (31.93 + 31.26)/2 = 31.56'$

$A = \frac{(31.56)(2\pi)(.813)}{(12)} = 13.43\ FT^2$

$I = (\pi)(31.56)^3(.813)/12 = 6691\ FT^4$

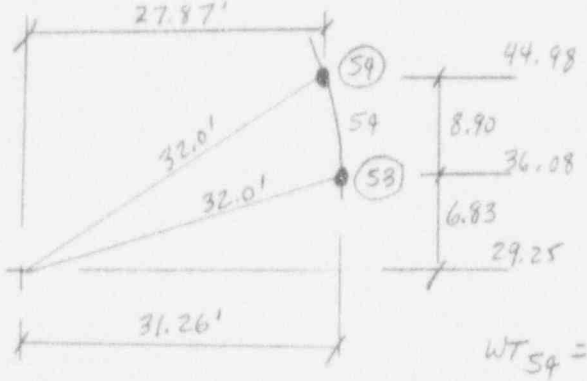
$J = (2)(6691) = 13,381\ FT^4$

$A_{SHEAR} = 13.45/2 = 6.72\ FT^2$

$WT_{53} = (13.43)(6.83 + 2.08)(.490) = 58.6^K$

WT NODE (52) $= (58.6 + 29.0)/2 = 40.8^K$

SEGMENT 54



$R_{AVG.} = (27.87 + 31.26)/2 = 29.57'$

$A = (2\pi)(29.57)(.813)/12 = 12.59\ FT^2$

$I = (\pi)(29.57)^3(.813)/12 = 5503\ FT^4$

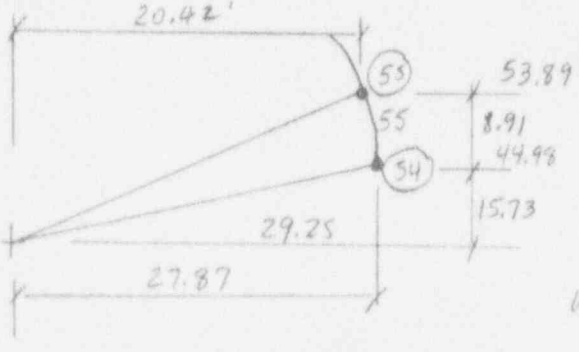
$J = (5503)(2) = 11,006\ FT^4$

$A_{SHEAR} = 12.59/2 = 6.30\ FT^2$

$WT_{54} = (12.59)(8.90)(.490) = 54.9^K$

WT NODE (53) $= (54.9 + 58.6)/2 = 56.8^K$

SEGMENT 55



$R_{AVG.} = (20.42 + 27.87)/2 = 24.15'$

$A = (2\pi)(24.15)(.813)/12 = 10.28\ FT^2$

$A_{SHEAR} = 10.28/2 = 5.14\ FT^2$

$I = (\pi)(24.15)^3(.813)/12 = 2998\ FT^4$

$J = (2998)(2) = 5996\ FT^4$

$WT_{55} = (10.28)(8.91)(.490) = 44.9^K$

WT NODE (54) $= (54.9 + 44.9)/2 = 49.9^K$

7.1 DRYWELL SHELL MODEL PROPERTIES (CONT'D)

SEGMENT 56

$R_{AVG.} = [(20.42) + (17.08)]/2 = 18.75'$

$A = (2\pi)(18.75)(2.625)/12 = 25.77\ FT^2$ $A_{SHEAR} = 25.77/2 = 12.89\ FT^2$

$I = (\pi)(18.75)^3(2.625)/12 = 4530\ FT^4$ $J = (4530)(2) = 9060\ FT^4$

$WT_{56} = (25.77)(5.93)(.490) = 74.9^K$

WT NODE (55) $= (74.9 + 44.9)/2 = 59.9^K$

SEGMENT 57 $R = 17.08'$ $A = (2\pi)(17.08)(.670)/12 = 5.99\ FT^2$

$A_{SHEAR} = 5.99/2 = 3.0\ FT^2$

$I = (\pi)(17.08)^3(.670)/12 = 874\ FT^4$ $J = (874)(2) = 1748\ FT^4$

$WT_{57} = (5.99)(9.37)(.490) = 27.5^K$

WT NODE (56) $= (27.5 + 74.9)/2 = 51.2^K$

SEGMENT 58 $R = 17.08'$ $A = 5.99\ FT^2$ $A_{SHEAR} = 3.0\ FT^2$

$I = 874\ FT^4$ $J = 1748\ FT^4$

$WT_{58} = WT_{57} = 27.5^K$

WT NODE (57) $= (27.5 + 27.5)/2 = 27.5^K$

SEGMENT 59 $R = 17.08'$ $A = (2\pi)(17.08)\ 1.25/12 = 11.18\ FT^2$

$A_{SHEAR} = 11.18/2 = 5.59\ FT^2$

$I = (\pi)(17.08)^3(1.25)/12 = 1631\ FT^4$ $J = (2)(1631) = 3262\ FT^4$

$WT_{59} = (11.18)(3.24)(.490) = 17.7^K$ $WT_{NODE\ (58)} = (27.5 + 17.7)/2 = 22.6^K$

SEGMENT 60 $R = 17.18'$ $A = 11.18\ FT^2$ $A_{SHEAR} = 5.59\ FT^2$

$I = 1631\ FT^4$ $J = 3262\ FT^4$

$WT_{60} = (11.18)(7.01)(.490) = 38.4^K$

WT NODE (59) $= (17.7 + 38.4)/2 = 28.1^K$

7.1 DRYWELL SHELL MODEL PROPERTIES (CONT'D)

SEGMENT 61

THIS SEGMENT INCLUDES THE FLANGE ASSEMBLY. THE SHELL THICKNESS IS 1 9/16", WITH REINFORCING RINGS AND STIFFENERS FOR BOLTING AND ATTACHING DRYWELL HEAD SEAL. DETERMINE PROPERTIES BASED ON 1 7/16" THICKNESS AND DOUBLE TO ACCOUNT FOR STIFFENING EFFECT OF ADDITIONAL MATERIAL. ALSO INCREASE WEIGHT ESTIMATE BY 50%.

$R = 17.08'$ $A = (2\pi)(17.08)(1.44)(2)/12 = 25.76\ FT^2$

$A_{SHEAR} = 25.76/2 = 12.88\ FT^2$

$I = (\pi)(18.75)^3(2)(1.44)/12 = 4970\ FT^4$ $J = (2)(4970) = 9940\ FT^4$

$WT_{61} = (1.5)\left(\frac{25.76}{2}\right)(9.0)(.490) = 85.2^K$

WT NODE (60) $= (38.4 + 85.2)/2 = 61.8^K$

SEGMENT 62

$R_{AVG} = (17.08)(3/4) = 12.81'$

$A = (2\pi)(12.81)(1.44)/12 = 9.66\ FT^2$ $A_{SHEAR} = 4.83\ FT^2$

$I = (\pi)(12.81)^3(1.44)/12 = 792\ FT^4$ $J = (2)(792) = 1585\ FT^4$

$WT_{62} = (9.66)(8.58)(.490) = 40.6^K$

WT NODE (61) $= (85.2 + 40.6)/2 = 62.9^K$

WT NODE (62) $= (40.6)/2 = 20.3^K$

7.1 DRYWELL SHELL MODEL PROPERTIES (CONT'D)

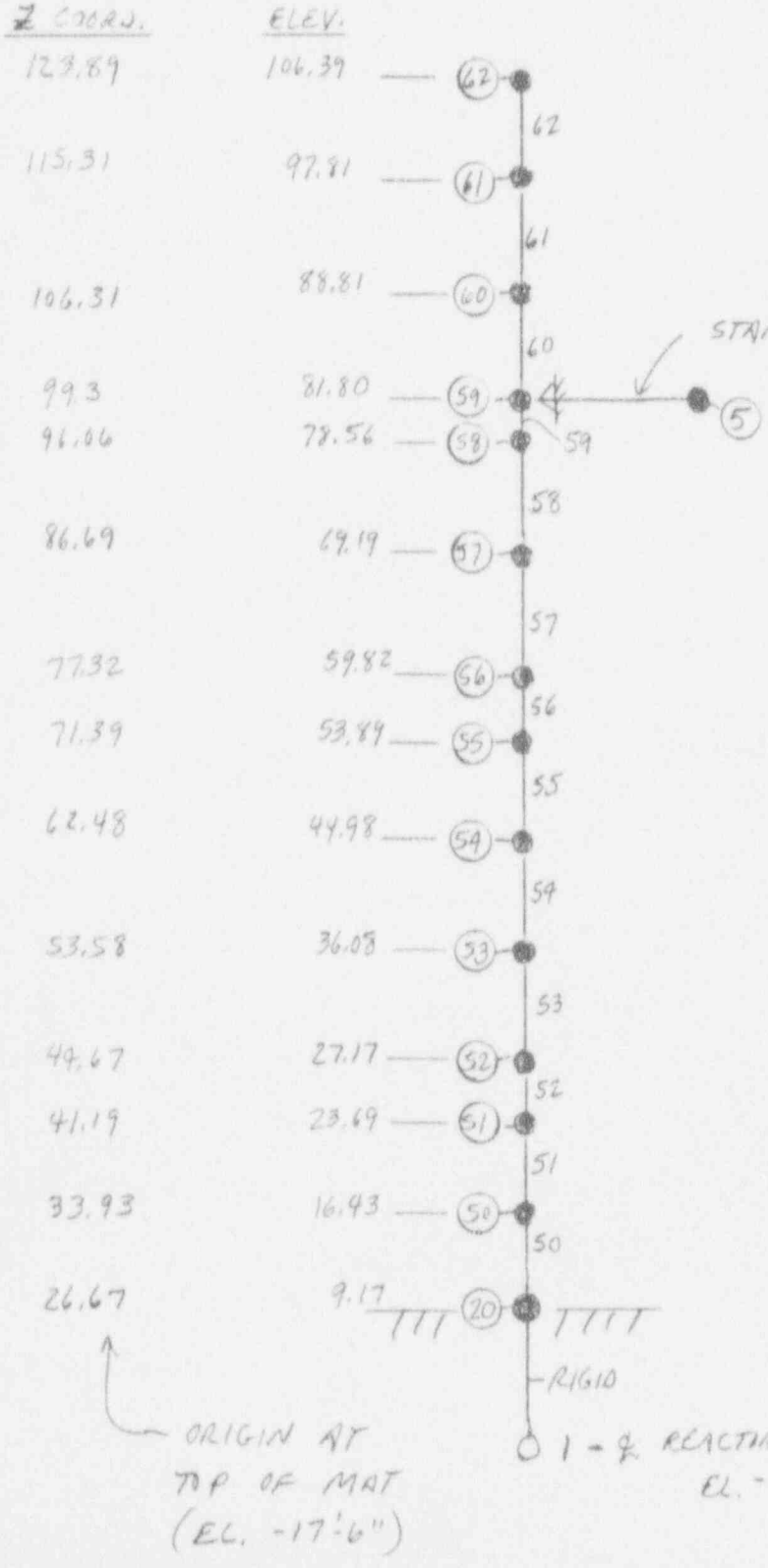
NOTES ON DRYWELL SHELL MODELING:

- IT IS ASSUMED THAT THE REDUCTION IN STIFFNESS DUE TO PENETRATION CUTOUTS IS OFFSET BY THE REINFORCING EFFECT OF THE PENETRATION ASSEMBLIES. IT IS ALSO ASSUMED THE MASS IS NOT SIGNIFICANTLY AFFECTED (UNLESS OTHERWISE ACCOUNTED FOR IN THE CALCULATION OF SEGMENT PROPERTIES).

- THE INTERIOR DRYWELL STEEL FRAMING LEVELS AT EL. 21'-11 3/4" AND 40'-8 1/4" ARE PROVIDED WITH LUBRITE PLATE, SLOTTED HOLES AND HAND TIGHTENED BOLTS AT THE DRYWELL SHELL CONNECTION. ASSUME THE MASS FOR THESE LEVELS PARTICIPATE AS PART OF THE REACTOR PEDESTAL, AND DO NOT CONTRIBUTE MASS TO THE DRYWELL SHELL MODEL.

- DRYWELL STEEL IS ASTM A516 GR. 70 (REF C1A2-11)
  USE $E_S = (29{,}000 \text{ KSI})\ 144\ \frac{\text{in}^2}{\text{FT}^2} = 4.18 \times 10^6 \text{ KSF}$ (REF. 6 P. 5-202)
  USE POISSON'S RATIO = 0.3 (REF. 14 P. XIV)

7.2 SUMMARY OF DRYWELL SHELL MODEL



MODEL IS SYMETRIC ABOUT ℄
X COORD. = 0
Y COORD. = 0

NODE	WT. (K)	MASS K-FT/SEC²
50	59.1	1.84
51	41.6	1.29
52	40.8	1.27
53	56.8	1.76
54	49.9	1.55
55	59.9	1.86
56	51.2	1.59
57	27.5	.85
58	22.6	.71
59	28.1	.87
60	61.8	1.92
61	62.9	1.95
62	20.3	.63

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CALC NO 42103 C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDH DATE 6/9/93

7.2 SUMMARY OF DRYWELL SHELL MODEL MEMBER PROPERTIES

SEGMENT	A FT2	A SHEAR FT2	$I_{x,y}$ FT4	J FT4
50	15.09	7.55	5551	11102
51	16.93	8.47	7834	15668
52	13.50	6.76	6793	13586
53	13.43	6.72	6691	13381
54	12.59	6.30	5503	11006
55	10.28	5.14	2998	5996
56	25.77	12.89	4530	9060
57	5.99	3.0	874	1748
58	5.99	3.0	874	1748
59	11.18	5.59	1631	3262
60	11.18	5.59	1631	3262
61	25.76	12.88	4970	9940
62	9.66	4.83	792	1585

EQE ENGINEERING

SHEET NO. 126

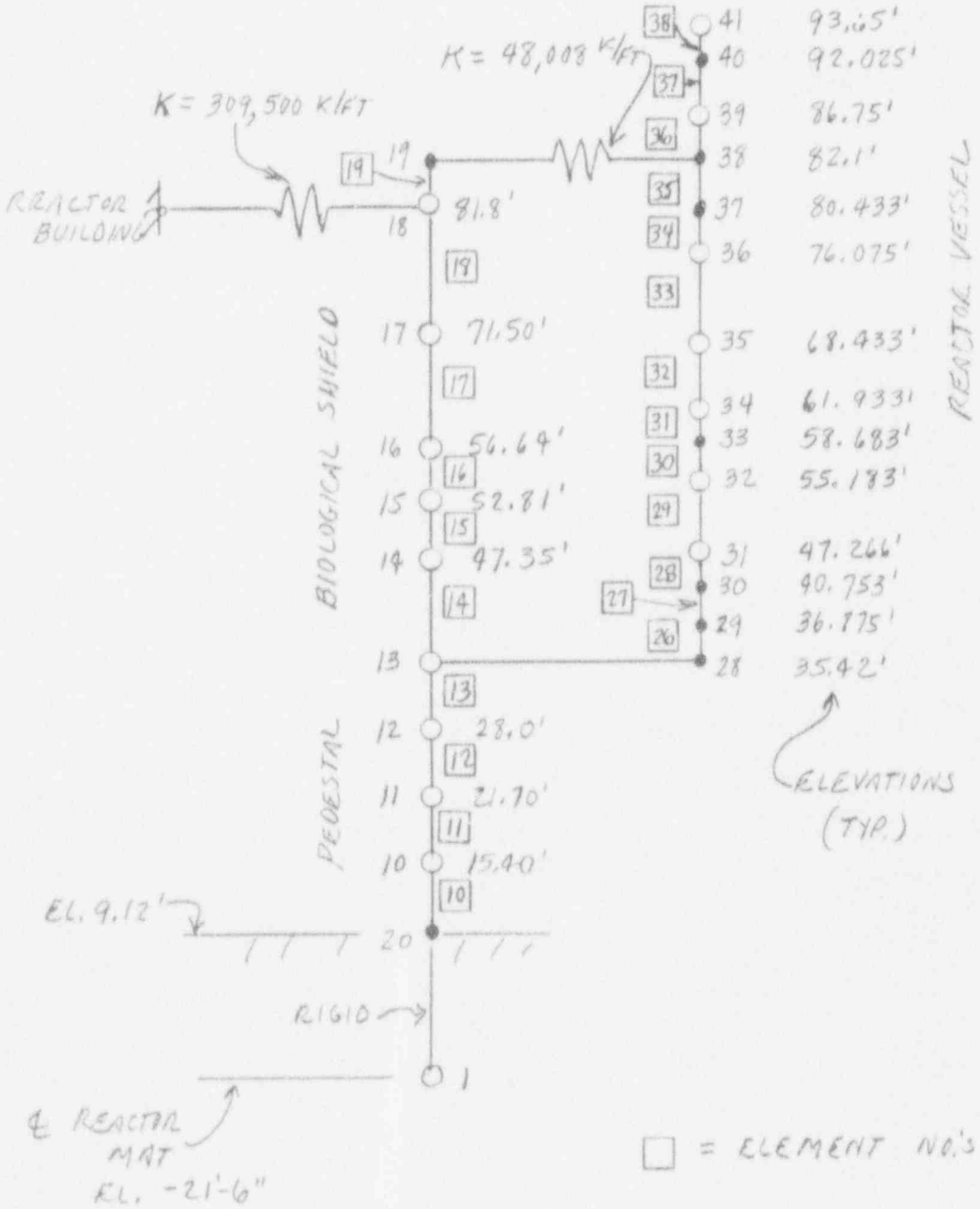
JOB NO. 42103 JOB BOSTON EDISON ANPS BY VW DATE 5-5-93

CALC NO. 42103 C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDH DATE 6/9/93

8.0 PEDESTAL, BIO. SHIELD AND REACTOR VESSEL MODEL PROPERTIES

8.1 MODEL DIAGRAM

THE MODEL PROPERTIES FOR THE REACTOR PEDESTAL, BIOLOGICAL SHIELD WALL AND REACTOR VESSEL ARE TAKEN FROM REF. 9. THE BECHTEL NODE AND ELEMENT NUMBERS ARE USED AS FOLLOWS:



EQE ENGINEERING

SHEET NO. 127

JOB NO. 42103 JOB BOSTON EDISON RWCS BY JLW DATE 5-3-93

CALC NO. 42103 C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDA DATE 6/4/93

PEDESTAL, BIO. SHIELD AND REACTOR VESSEL MODEL PROPERTIES (CONT'D)

8.1 MODEL DIAGRAM

DETERMINE EQUIVALENT MASS AND NODE POINT LOCATIONS FROM GE MODEL OF VESSEL. REF. ATTACHMENT "REF(2)" TO BECHTEL CALC. 085-C2 (REF. 9 TO THIS CALC.)

BECHTEL ELEMENT NO. (SH.3 REF.9)	TOP ELEV.	BOT. ELEV.	LENGTH	GE ELEMENT LENGTH FROM GE APPENDIX 1	GE ELEMENT NO. FROM GE APPENDIX 1	GE ELEMENT CODE
38	93.65	92.025	1.625	.1625 E 01	18	2
37	92.025	86.75	5.275	.5275 E 01	18	0
36	86.75	82.1	4.65	.465 E 01	19	0
35	82.1	80.433	1.667	.1667 E01	20	2
34	80.433	76.075	4.358	.4358 E01	20	0
33	76.075	68.433	7.642	.7642 E01	21	0
32	68.433	61.933	6.5	.65 E01	22	0
31	61.933	58.683	3.25	.325 E01	23	2
30	58.683	55.183	3.5	.350 E01	23	0
29	55.183	47.266	7.917	.7917 E01	24	0
NOTE 1 → 28	47.266	40.753	6.513	N.A.	25 ← SER. NOTE 1	4
NOTE 2 → 27	40.753	36.875	3.878	.3896 E01	26	2
NOTE 2 → 26	36.875	35.42	1.455	.1437 E01	26	0

↑ EQUIVALENT GE ELEMENT NO. TO BECHTEL NO.

NOTES:

1. THIS AGREES WITH BECHTEL'S NOTE ON P.216 OF THEIR CALCULATION "THE LENGTH OF ELEMENT 25* WAS BEEN ADJUSTED TO REFLECT THE ACTUAL STRUCTURAL CONFIGURATION." GE USED A 2x2 FLEXABILITY MATRIX FOR THIS ELEMENT. USE A BEAM ELEMENT TO APPROXIMATE THE VESSEL SHELL (SEE SH. 132)
2. THE SUM OF THE LENGTHS OF BECHTEL ELEMENTS 26 & 27, AND GE 26 (CODE 2) AND 26 (CODE 0) ARE 5.33', THUS THE TOTAL LENGTHS AGREE EVEN THOUGH THE INDIVIDUAL LENGTHS VARY SLIGHTLY.

PEDESTAL, BIO. SHIELD AND REACTOR VESSEL MODEL PROPERTIES (CONT'D)

8.2 SUMMARY OF LUMPED MASS (FROM REF. 9)

	MASS POINT NO.	WEIGHT K.IPS	MASS K-SEC²/FT	SOURCE
	10	256.75	7.97	ATTACH. TO BECHTEL CALC. 085-C1, SH 1/4
	11	485.5	15.08	
	12	325.6	10.11	
	13	587.5	18.25	
	14	236.4	7.34	
	15	88.5	2.75	
	16	299.2	9.29	
	17	356.6	11.07	
EQUIV. GE MASS PT NO.	18	88.6	2.75	
21 → 36	31	–	66.22	ATTACH. TO BECHTEL CALC. 085-C1, SH. 6/6
20	32	–	9.91	
19	34	–	8.70	
18	35	–	10.13	
17	36	–	9.55	
16	39	–	8.26	
15 & 14	41	–	5.38	

NOTE: MASS FOR THE VESSEL INTERNALS (SHROUD, GUIDE TUBE AND FUEL) IS LUMPED AT NODE 31. THIS IS CONSISTENT WITH BECHTEL CALC. 085-C1 (SEE NOTE 1 ON P. 2/6 OF BECHTEL'S ATTACHMENT)

EQE ENGINEERING

SHEET NO. 129

JOB NO. 42103 JOB BOSTON EDISON PWR BY JLH DATE 5-3-93

CALC. NO. 42103 C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDA DATE 6/4/93

PEDESTAL, BIO. SHIELD AND REACTOR VESSEL MODEL PROPERTIES (CONT'D)

8.3 SUMMARY

BIO. SHIELD AND PEDESTAL MEMBER PROPERTIES: (FROM REF. 9)

MEMBER	AREA FT²	SHEAR AREA (FT²)	INERTIA FT⁴	YOUNG'S MOD. K/FT²	NOTES
10	278.5	139.0	17664.8	457000	NORTH/SOUTH DIRECTION
11	278.5	139.0	17664.8		
12	278.5	139.0	17664.8		
13	354.0	177.0	20302.8		
14	241.8	120.5	17029.1		
15	196.0	98.0	13169.2		
SEE SN 130 16	104.5	52.3	7506.5		
SEE SN 130 17	306.4	153.3	23450.5		
18	152.9	76.0	12823.0	457000	
19	RIGID	RIGID	RIGID	RIGID	

MEMBER	AREA FT²	SHEAR AREA (FT²)	INERTIA FT⁴	YOUNG'S MOD. K/FT²	NOTES
10	278.5	139.0	17664.8	457000	EAST/WEST DIRECTION
11	278.5	139.0	17664.8		
12	278.5	139.0	17664.8		
13	354.0	177.0	20302.8		
14	241.8	120.5	17029.1		
15	196.0	98.0	13212.0		
SEE SN. 130 16	105.0	52.3	7506.5		
SEE SN. 130 17	306.4	153.3	23450.5		
18	152.9	76.5	9290.0	457000	
19	RIGID	RIGID	RIGID	RIGID	

PEDESTAL, BIO. SHIELD AND REACTOR VESSEL MODEL PROPERTIES (CONT'D)

BIO. SHIELD MEMBER PROPERTIES (CONT'D):

ELEMENTS 16 AND 17 ARE IN THE REGION OF THE ACTIVE CORE (EL. 55'-6 7/8" TO EL. 67'-6 1/4", REF. C-162 SH. 1/2), AND ARE THUS EXPOSED TO POSSIBLE CONCRETE DEGRADATION DUE TO NEUTRON RADIATION. REF. 9 GIVES MEMBER PROPERTIES FOR THESE ELEMENTS FOR BOTH THE FULLY DEGRADED & UN-DEGRADED CONDITIONS. REALISTIC MEMBER PROPERTIES WILL BE SOMEWHERE BETWEEN THESE TWO CONDITIONS. IT IS JUDGED THAT THE CONCRETE SHOULD BE CONSIDERED 1/4 DEGRADED. CALCULATE A WEIGHTED AVERAGE ON THIS BASIS.

ELEMENT 16, N-S DIRECTION:

$A_X = 121.36 - [(121.36 - 55.72)(.25)] = 105.0 \ FT^2$
$A_Y = 60.5 - [(60.5 - 27.8)(.25)] = 52.3 \ FT^2$
$I = 8685.5 - [(8685.5 - 3969.6)(.25)] = 7506.5 \ FT^4$

ELEMENT 17, N-S DIRECTION:

$A_X = 350 - [(350 - 175.7)(.25)] = 306.4 \ FT^2$
$A_Y = 175.0 - [(175.0 - 88.0)(.25)] = 153.3 \ FT^2$
$I = 26507.8 - [(26507.8 - 14279.7)(.25)] = 23450.5 \ FT^4$

ELEMENT 16, E-W DIRECTION

$A_X = 105.0 \ FT^2$
$A_Y = 52.3 \ FT^2$
$I = 7506.5 \ FT^4$

ELEMENT 17, E-W DIRECTION

$A_X = 306.4 \ FT^2$
$A_Y = 153.3 \ FT^2$
$I = 23450.5 \ FT^4$

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PEDESTAL, BIO. SHIELD AND REACTOR VESSEL MODEL PROPERTIES (CONT'D)

SUMMARY

REACTOR VESSEL MEMBER PROPERTIES: (FROM REF. 9)

GE DESIGNATIONS

ELEMENT NO.	ELEMENT NO.*	ELEMENT CODE**	INERTIA FT^4	SHEAR AREA FT^2	LENGTH FT	YOUNG MODULUS KIP/FT^2
38	18	2	0.3287000E 04	0.3361000E 02	0.1625000E 01	0.3740000E 07
37	18	0	0.1577000E 04	0.1696000E 02	0.5275000E 01	0.3740000E 07
36	19	0	0.1577000E 04	0.1696000E 02	0.4650000E 01	0.3740000E 07
35	20	2	0.1577000E 04	0.1696000E 02	0.1667000E 01	0.3740000E 07
34	20	0	0.1342000E 04	0.1443000E 02	0.4358000E 01	0.3740000E 07
33	21	0	0.1342000E 04	0.1443000E 02	0.7642000E 01	0.3740000E 07
32	22	0	0.1342000E 04	0.1443000E 02	0.6500000E 01	0.3740000E 07
31	23	2	0.1342000E 04	0.1443000E 02	0.3250000E 01	0.3740000E 07
30	23	0	0.1577000E 04	0.1696000E 02	0.3500000E 01	0.3740000E 07
29	24	0	0.1577000E 04	0.1696000E 02	0.7917000E 01	0.3740000E 07
28	25	-	0.4888 E03	0.705 E01	0.6513 E01	0.374 E07
27	26	2	0.2852000E 03	0.4280000E 01	0.3896000E 01	0.3950000E 07
26	26	0	0.1900000E 04	0.2500000E 02	0.1437000E 01	0.3950000E 07

SEE SH. ____

POISSON'S RATIO = .265 (TYP.)

POLAR MOMENT OF INERTIA $J = 2 \times I$ (REF. 7)

AREA = 2 × SHEAR AREA

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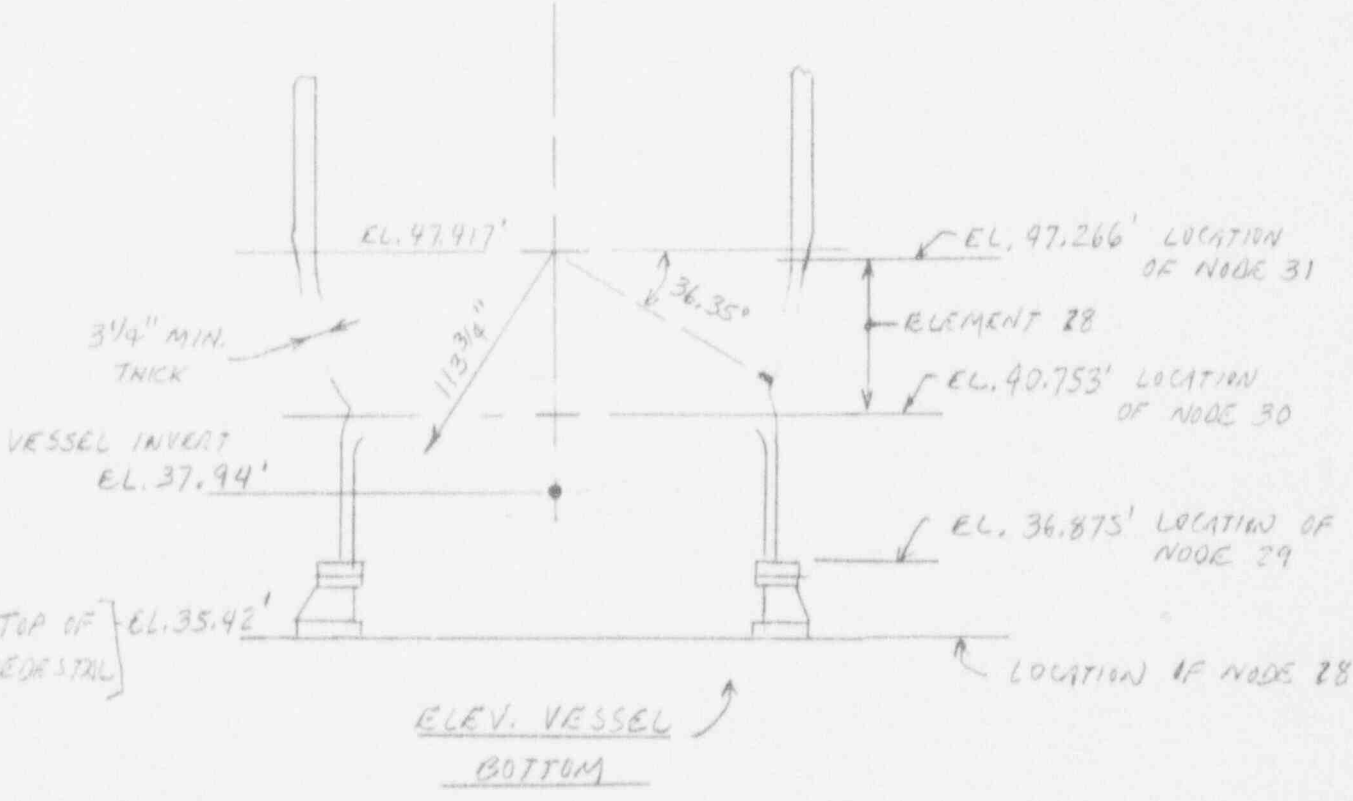
CALC NO 42103 C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDH DATE 6/4/93

PEDESTAL, BIO. SHIELD AND REACTOR VESSEL MODEL PROPERTIES (CONT'D)

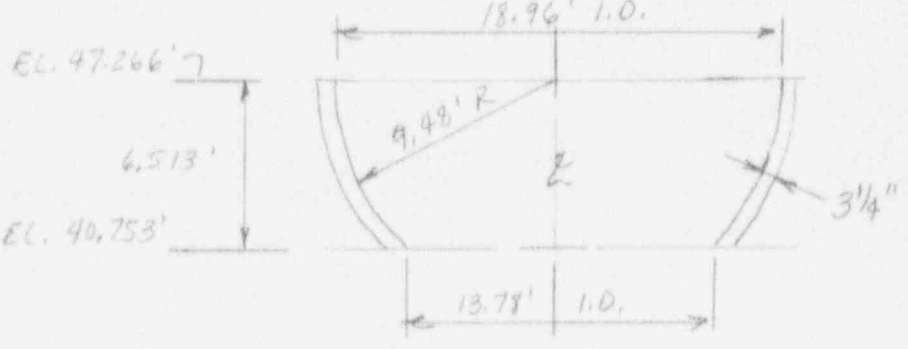
DETERMINE MEMBER PROPERTIES FOR VESSEL ELEMENT 28

BEAM PROPERTIES FOR REACTOR VESSEL ELEMENT 28 ARE NOT AVAILABLE FROM REF. 9. CALCULATE REPRESENTATIVE BEAM PROPERTIES BASED ON DRAWINGS M1A48-4 SH. 2 REV. E6 AND 1979-8-5 REV. 3. VESSEL ELEVATIONS ARE APPX AS FOLLOWS:



ELEV. VESSEL BOTTOM

USE THE FOLLOWING MODEL TO REPRESENT ELEMENT 28:



JOB NO. 42103 JOB BOSTON EDISON PNPS BY JLW DATE 5-3-93

CALC. NO. 42103 C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDH DATE 6/4/93

PEDESTAL, BIO SHIELD AND REACTOR VESSEL MODEL PROPERTIES (CONT'D)

- VESSEL ELEMENT 25 (CONT'D.)

USE PROPERTIES OF A CYLINDER: AVG I.D. = $\frac{18.96 + 13.78}{2} = 16.37'$

AVG. O.D. = $16.37 + \frac{(2)(3.25)}{12} = 16.91'$

(REF. 6) $A = .7854\,(OD^2 - ID^2) = (.7854)[(16.91)^2 - (16.37)^2] = 14.1\ FT^2$

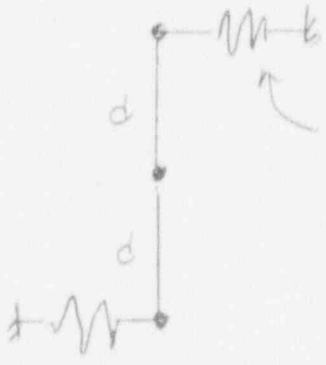
(REF. 6) $I = .0491\,(OD^4 - ID^4) = (.0491)[(16.91)^4 - (16.37)^4] = 488.8\ FT^4$

(REF. 7) SHEAR AREA = $\frac{A}{2} = \frac{14.1}{2} = 7.05\ FT^2$

$J = 2 \times I = (2)(488.8) = 977.6\ FT^4$

8.4 CALCULATE ROTATIONAL STIFFNESSES FOR STAR TRUSS AND REACTOR STABILIZER.

STAR TRUSS: CHECK AS 2 SPRINGS AS FOLLOWS:



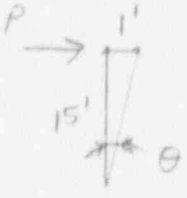
$K_{lateral} = 309500$ K/FT (REF. 9)

$K = \frac{1}{2} K_{lateral} = \frac{309500}{2} = 154,750$ K/FT

$d = \frac{1}{4}$ (I.D. DRYWELL + O.D. SHIELD WALL)

$= \frac{1}{4}(34.2 + 26.1) \cong 15'$ (REF. C-151 & C-162 SH. 1/2)

TO DEFLECT 1', $P = 154,750$ K



MOMENT TO ROTATE TO GET 1' Δ $= (2)(154750)(15) = 4642500$ FT-K

$\theta = 1/15$ RADIANS

$K_R = M/\theta = \frac{4642500}{1/15} = \underline{69,637,500 \text{ FT-K/RADIAN}}$

REACTOR STABILIZER: USE SIMILAR PROCEDURE

$K_{lateral} \cong 48,010$ K/FT (REF. 9)

USE I.D. OF SHIELD WALL $\cong 22'$ (REF. C-162 SH. 1/2)

MOMENT TO ROTATE $= \frac{(2)(48010)(22)}{(2)(2)} = 528110$ FT-K

$\theta = 1/11$ RADIANS

$K_R = M/\theta = \frac{528110}{1/11} = \underline{5,809,210 \text{ FT-K/RADIAN}}$

JOB NO. 42103 JOB BOSTON EDISON R.V.P.S. BY JWJ DATE 5-3-93

CALC NO. 42103 C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDH DATE 6/4/93

9.0 TORUS MODEL

9.1 TORUS MODEL PROPERTIES

DETERMINE TOTAL MASS:

FROM REF. 11, P. 21 OF 162, 1/32 NO MODEL LOAD SUMMARY EVENT 15 WRIGHT = 190,533 LBS

$$\text{TOTAL MASS} = \frac{(190.5)(32)}{(32.2)} = 189.3 \ \text{K}\cdot\text{SEC}^2/\text{FT}$$

DETERMINE TORUS FREQUENCIES:

FROM REF. 12, P. A4.2-20, THE ESTIMATED RING GIRDER FREQUENCY = 122 HZ. ALSO, BY INSPECTION OF EARTHQUAKE TIES SHOWN ON DWG. C1A-62-4 (REV. 3) LATERAL SHEAR WILL BE RESISTED BY RIGID PLATES LOADED IN PLANE.

FROM REF. 12 P. 116 (TABLE 3), THE TORUS SEISMIC ANALYSIS USED SEISMIC ACCELERATION VALUES EQUAL TO THE RIGID RANGE ACCELERATIONS FOR BOTH OBE AND SSE FOR HORIZONTAL GROUND AS FOLLOWS:

	OBE	SSE
VERTICAL	.06	.10
HORIZONTAL	.08	.15

(SEE REF. 13 SH. H-3 FOR HORIZONTAL GROUND SPECTRA)

THEREFORE THE TORUS WILL BE MODELED AS RIGID AND TIED TO THE REACTOR BUILDING MAT

LOCATE 4 NODE POINTS AT THE ℄ OF THE TORUS AND AT THE OUTSIDE SHELL (TO ACCOUNT FOR MOST SEVERE TORSIONAL EFFECTS).

TORUS ℄ = EL. -0'-3"

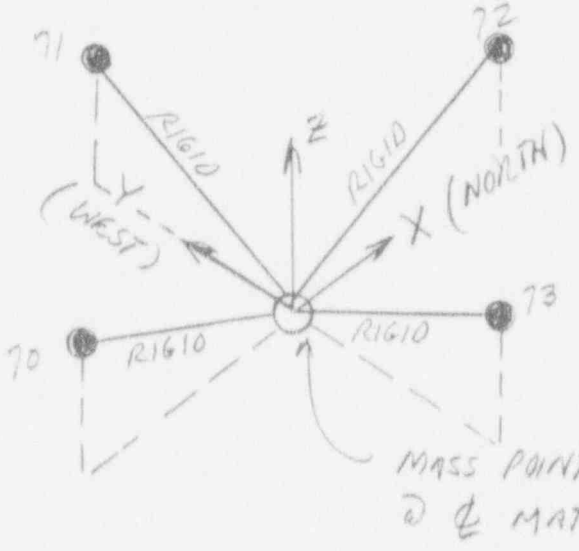
DISTANCE ℄ REACTOR TO OUTSIDE SHELL ≅ 51.0' + 29.5/2 = 65.75'
(REF. C-151)

JOB NO. 42103 JOB BOSTON EDISON DNPS BY JWN DATE 5-3-93

CALC. NO. 42103 C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D CRD # DATE 6/4/93

TORUS MODEL PROPERTIES

9.2 SUMMARY - TORUS MODEL



NODE POINT COORDINATES (FT.)

NODE	X	Y	Z (ELEVATION)
70	-65.75	0	-.25
71	0	65.75	-.25
72	65.75	0	-.25
73	0	-65.75	-.25

NOTE: MASS OF TORUS INCLUDED IN MASS POINT 1

JOB NO. 42103 JOB BOSTON EDISON PNPS BY JWI DATE 5-3-93

CALC NO. 42103 C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDH DATE 6/4/93

10.0 FLOOR FLEXIBILITY

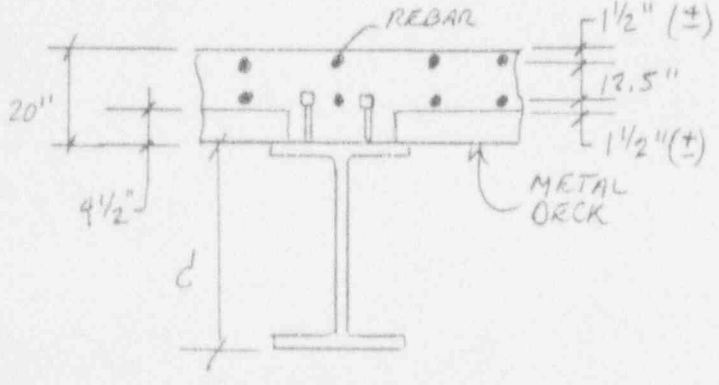
BY INSPECTION OF THE REACTOR BUILDING FLOOR LEVELS, THE 23', AND 51' WILL NOT SIGNIFICANTLY AMPLIFY RESPONSE DUE TO FLOOR FLEXIBILITY. THESE FLOORS HAVE SIGNIFICANT SUPPORT/STIFFNESS DUE TO THE SLAB THICKNESSES, BEAM SIZES AND WALLS. CHECK BEAMS ON THE 74'-3", 91'-3" AND 117'-0" LEVELS FOR FLEXIBILITY.

THE FOLLOWING BEAMS BY INSPECTION WILL BE REPRESENTATIVE OF THE MOST FLEXIBLE AREAS OF THE 74'-3", 91'-3" AND 117'-0" LEVELS:

REF. C-140 & C-69 → EL. 117'-0"
C-138, C-67, C-68 → EL. 91'-3"
C-136, C-66, C-68 → EL. 74'-3"

ELEV.	BEAM	COLUMN LOCATION
117.0'	24 WF 84	P → L ON 11 LINE
117.0'	36 WF 150	N → L.5 ON 15 LINE
117.0'	24 WF 145	K.5 → J, EAST OF 15
117.0'	21 WF 82	WEST OF 7, BETWEEN N
91.25'	21 WF 62	11 LINE BETWEEN P & N
91.25'	18 WF 50	9 LINE BETWEEN N & M
91.25'	30 WF 108	15 LINE BETWEEN N & L.5
74.25'	21 WF 62	13 LINE BETWEEN P & N

ALL BEAMS HAVE STUDS, THEREFORE ASSUME COMPOSITE ACTION. ALL BEAMS HAVE THE FOLLOWING CROSS SECTION, BASED ON REVIEW OF DWGS.



VARIABLES ARE THE FOLLOWING:

BEAM DEPTH - d
BEAM AREA - As
BEAM MOMENT OF INERTIA - I
LOADING - W (KIPS/FT)
SPAN, SPACING
REBAR - #6 @ 9" T&B (EL. 117.0')
#5 @ 9" T&B (EL. 91.25')
#5 @ 12" T&B (EL. 74.25')

EQE ENGINEERING

SHEET NO. 138

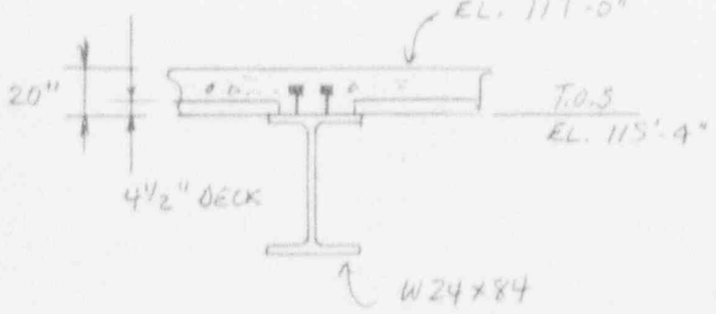
JOB NO. 42103 JOB BOSTON EDISON HNPS BY JCW DATE 5-3-93

CALC. NO. 42103 C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHKT. CRW DATE 6/4/93

10.0 FLOOR FLEXIBILITY

CHECK BY HAND, AND DUPLICATE USING SOFTWARE SHEET PROGRAM (TO QUALIFY PROCEDURE).

- CHECK NORTH SIDE - EL. 117'-0" AREA
  CHECK TYPICAL S4 W24 84 BEAM FROM P→L ON 11 LINE
  REF. C-140 & C-69
  MAX. SPAN = 23.25' SPACING = 7.75'



W24×84
I = 2370 IN⁴ d = 24.1"
A = 24.7 in²
CHECK AS COMPOSITE SECTION

CONC. SLAB EFFECTIVE WIDTH: (REF. 6 P.5-56)

$\frac{SPAN}{8} = \frac{23.25}{8} = 2.9'$ ← GOVERNS (EACH SIDE OF BM. ℄)

$\frac{DIST.\ ADJAC.\ BM}{2} = \frac{7.75}{2} = 3.9'$

$b = (2.9)(2)(12) = 69.6"$ $n = 8.04$ (SH. 104)

TRANSFORMED AREA = $\frac{(69.6)(15.5)}{8.04} = 134.2\ in^2$ ← NEGLECT DECK

FIND NEUTRAL AXIS:

$\left(\frac{24.1}{2}\right)(24.7) + (134.2)(24.1 + 4.5 + 15.5/2) = 5175.8$

$A_{TOT.} = (24.7 + 134.2) = 158.9\ in^2$

N. AXIS = 5175.8 / 158.9 = 32.6"

EQE ENGINEERING

SHEET NO 139

JOB NO 42103 JOB BOSTON EDISON PNPS BY VKN DATE 5-3-95

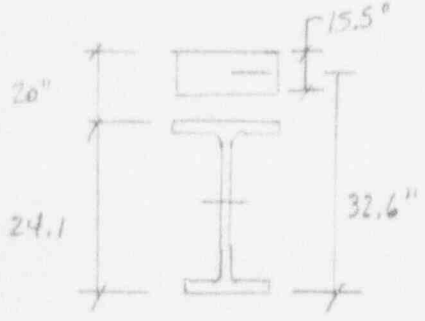
CALC. NO. 42103 C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDH DATE 6/4/93

10.0 FLOOR FLEXIBILITY

EL. 117'-0" (CONT'D)

$$I_{TOTAL} = 2370 + (24.7)\left(32.6 - 24.1/2\right)^2 + (134.2)\left(44.1 - 32.6 - 15.5/2\right)^2$$

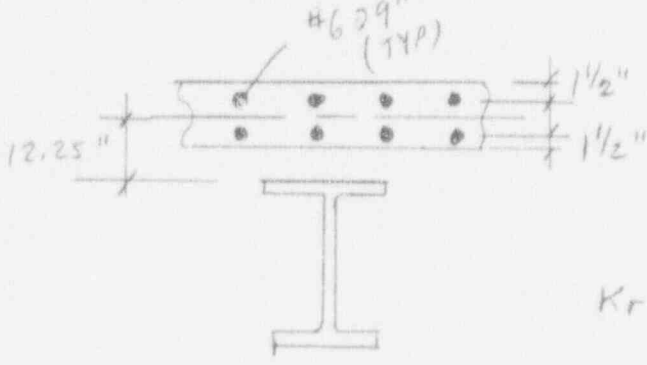
$$= 2370 + 10431 + 1887 = 14{,}688 \text{ in}^4$$



CHECK MOMENT OF INERTIA IF SLAB IS IN TENSION USING THE PROCEDURE ON P. 14-5 OF REF. 15

FROM C-69, STEEL REINF IS #6 @ 9"
USE 1½" TO ℄ STEEL REINF.

AREA #6 BAR = .44 in²



A_r = AREA OF REINF. (2 ROWS #6 @ 9")

$$= \frac{(.44)(12)(69.6)(2)}{9} = 81.66 \text{ in}^2$$

$$K_r = \frac{A_r}{A_s + A_r} = \frac{81.66}{81.66 + 24.7} = .768$$

$$\bar{y}_c = \left[(24.1/2) + (4.5) + (7.75)\right](.768) = 18.66"$$

$$I_c = \left\{\left[(24.1/2) + (12.25)\right](18.66)(24.7)\right\} + (2370) + \frac{(2)(81.86)(6.25)^2}{(2)}$$

$I_{COMPOSITE} = 16{,}768 \text{ in}^4 > 14{,}688 \text{ in}^4$ ← GOVERNS

$$\text{SLAB DEAD LOAD} = \frac{(15.5 + 4.5/2)}{12}(7.75)(150) = 1.72 \text{ K/FT}$$

DL DECK ≅ (5 PSF)(7.75) = .04 K/FT

GENERAL DL USE 100 PSF = (100 PSF)(7.75) = .78 K/FT

WT. STEEL = .08

2.62 K/FT

10.0 FLOOR FLEXIBILITY

EL. 117'0" (CONT'D) $E = (29{,}000\ KSI)(144\ in^2/ft^2) = 4.17 \times 10^6\ KSF$

ASSUME SIMPLE BEAM ACTION FOR FREQUENCY:

$$f_n = \frac{9.87}{2\pi}\sqrt{\frac{E I g}{W l^4}} \qquad \text{(REF. 7 P. 576) CASE 1b}$$

$$= \frac{9.87}{2\pi}\sqrt{\frac{(29{,}000)(144)(14688)(32.2)}{(2.62)(23.25)^4(12)^4}} = 17.52\ HZ.$$

CHECK USING FIXED END BEAM ACTION (REF. 7 P. 576, CASE 2D)

$$f_n = \frac{22.4}{2\pi}\sqrt{\frac{E I g}{W l^4}}$$

$$f_n = \frac{(22.4)(17.52)}{(9.87)} = 39.8\ HZ.$$

SPAN PARAMETERS

FLOOR LEVEL =	117-0	
BEAM SIZE =	W24x84	
SPAN (ft) =	23.3	
BEAM SPACING (ft) =	7.75	
BEAM AREA (As) in2 =	24.7	
BEAM I (in4) =	2,370	
BEAM DEPTH (d) INCHES =	24.1	
n =	8.04	
REIN. AREA (Ar) in2/ft =	1.17	
REBAR VERTICAL SPACING (Rvs) inches =	6.25	
YOUNG'S MODULUS OF ELASTICITY (STEEL) E =	29,000	ksi
WEIGHT OF BEAM (W) klf =	2.62	
SLAB DEPTH (S.D.) inches =	15.5	
BEAM DECK DEPTH (D.D.) inches =	4.5	

POSITIVE MOMENT

COMPUTE EFFECTIVE WIDTH (b)

b (ft) = SMALLER OF (2*(SPAN))/8 OR (2*(SPACING))/2

2*SPAN/8 = 5.81

2*(SPACING)/2 = 7.75 EFFECTIVE WIDTH (b) = 5.81 FT

= 69.75 INCHES

COMPUTE TRANSFORMED AREA OF CONCRETE

T.A. = (b*S.D.)/n

= 134.47 in2

LOCATE THE NEUTRAL AXIS

TOTAL AREA = As + T.A.

= 159.17 in2

N.A. = ((d*As)/2) + (T.A.)(d + D.D. + S.D./2))/(TOTAL AREA)

= 32.58 inches up from bottom of beam

TOTAL MOMENT OF INERTIA

I tot = I + (As*(N.A. - d/2)^2) + (T.A.)((d + S.D. + D.D. - N.A. - (S.D./2))^2)

= 14,691.76 in4

EQE ENGINEERING

SHEET NO. 142

JOB NO. 42103 JOB BOSTON EDISON RVFS BY JW DATE 5-3-93

CALC NO. 42103-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDH DATE 6/4/93

10.0 FLOOR FLEXIBILITY

FLOOR LEVEL = 117-0 BEAM SIZE = W24x84

NEGATIVE MOMENT

Kr = Ar*(b)/(As + (Ar) *(b))
= 0.768

Yc = ((d/2) + (D.D.) + (S.D.))*(Kr)
= 18.65 in

I tot = (((d/2) + D.D. + (S.D./2)) * (Yc) * (As)) + I + (((Ar) * (b) * (Rvs ^ 2))/2)
= 16,754 in4

MOMENT OF INERTIA FOR FREQUENCY CALCULATION IS THE
SMALLER OF THAT DETERMINED FOR THE POSITIVE OR NEGATIVE MOMENTS

USE I = 14,692 in4

ASSUME SIMPLE BEAM ACTION FOR FREQUENCY

Fn = (9.87 / (2 * pi)) * (SQRT ((E * I * g))/ (W * (SPAN ^ 4))
= 17.52 Hz

FIXED BEAM ACTION:

$$f_n = \frac{(22.4)(17.52)}{(9.87)} = 39.8 \text{ Hz}$$

SPAN PARAMETERS

FLOOR LEVEL =	117-0	
BEAM SIZE =	W36x150	
SPAN (ft) =	33.0	
BEAM SPACING (ft) =	7.75	
BEAM AREA (As) in2 =	44.2	
BEAM I (in4) =	9,040	
BEAM DEPTH (d) INCHES =	35.85	
n =	8.04	
REIN. AREA (Ar) in2/ft =	1.17	
REBAR VERTICAL SPACING (Rvs) inches =	6.25	
YOUNG'S MODULUS OF ELASTICITY (STEEL) E =	29,000	ksi
WEIGHT OF BEAM (W) klf =	2.69	
SLAB DEPTH (S.D.) inches =	15.5	
BEAM DECK DEPTH (D.D.) inches =	4.5	

POSITIVE MOMENT

COMPUTE EFFECTIVE WIDTH (b)

b (ft) = SMALLER OF (2*(SPAN))/8 OR (2*(SPACING))/2

2*SPAN/8 = 8.25

2*(SPACING)/2 = 7.75 EFFECTIVE WIDTH (b) = 7.75 FT

= 93 INCHES

COMPUTE TRANSFORMED AREA OF CONCRETE

T.A. = (b*S.D.)/n

= 179.29 in2

LOCATE THE NEUTRAL AXIS

TOTAL AREA = As + T.A.

= 223.49 in2

N.A. = ((d*As)/2) + (T.A.)(d + D.D. + S.D./2))/(TOTAL AREA)

= 42.13 inches up from bottom of beam

TOTAL MOMENT OF INERTIA

I tot = I + (As*(N.A. - d/2)^2) + (T.A.)((d + S.D. + D.D. - N.A. - (S.D./2))^2)

= 41,326.08 in4

EQE ENGINEERING

SHEET NO. 147

JOB NO. 42103 JOB BOSTON EDISON PNPS BY [illegible] DATE [illegible]

CALC. NO. 42103-C-001 SUBJECT RESTOR BUILDING SEISMIC MODEL CHK'D ROA DATE 6/4/93

10.0 FLOOR FLEXIBILITY

FLOOR LEVEL = 117-0 BEAM SIZE = W36x150

NEGATIVE MOMENT

Kr = Ar*(b)/(As + (Ar) *(b))
= 0.711

Yc = ((d/2) + (D.D.) + (S.D.))*(Kr)
= 21.46 in

I tot = (((d/2) + D.D. + (S.D./2)) * (Yc) * (As)) + I + (((Ar) * (b) * (Rvs ^ 2))/2)
= 41,910 in4

MOMENT OF INERTIA FOR FREQUENCY CALCULATION IS THE
SMALLER OF THAT DETERMINED FOR THE POSITIVE OR NEGATIVE MOMENTS

USE I = 41,326 in4

ASSUME SIMPLE BEAM ACTION FOR FREQUENCY

Fn = (9.87 / (2 * pi)) * (SQRT ((E * I * g))/ (W * (SPAN ^ 4))
= 14.40 Hz

FIXED BEAM ACTION

$$f_m = \frac{(22.4)(14.40)}{(9.87)} = 32.7 \text{ Hz}$$

10.0 FLOOR FLEXIBILITY

SPAN PARAMETERS

FLOOR LEVEL =	117-0	
BEAM SIZE =	W24x145	
SPAN (ft) =	22.0	
BEAM SPACING (ft) =	7.75	
BEAM AREA (As) in2 =	24.74	
BEAM I (in4) =	4,570	
BEAM DEPTH (d) INCHES =	24.74	
n =	8.04	
REIN. AREA (Ar) in2/ft =	1.17	
REBAR VERTICAL SPACING (Rvs) inches =	6.25	
YOUNG'S MODULUS OF ELASTICITY (STEEL) E =	29,000	ksi
WEIGHT OF BEAM (W) klf =	2.69	
SLAB DEPTH (S.D.) inches =	15.5	
BEAM DECK DEPTH (D.D.) inches =	4.5	

POSITIVE MOMENT

COMPUTE EFFECTIVE WIDTH (b)

b (ft) = SMALLER OF (2*(SPAN))/8 OR (2*(SPACING))/2

2*SPAN/8 = 5.50
2*(SPACING)/2 = 7.75

EFFECTIVE WIDTH (b) = 5.50 FT
= 66 INCHES

COMPUTE TRANSFORMED AREA OF CONCRETE

T.A. = (b*S.D.)/n
= 127.24 in2

LOCATE THE NEUTRAL AXIS

TOTAL AREA = As + T.A.
= 151.98 in2

N.A. = ((d*As)/2) + (T.A.)(d + D.D. + S.D./2))/(TOTAL AREA)
= 32.98 inches up from bottom of beam

TOTAL MOMENT OF INERTIA

I tot = I + (As*(N.A. - d/2)^2) + (T.A.)((d + S.D. + D.D. - N.A. - (S.D./2))^2)
= 17,124.87 in4

EQE ENGINEERING

SHEET NO. 146

JOB NO. 42103 JOB BOSTON EDISON ANRS BY JCH DATE 5-3-93

CALC. NO. 42103-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D SDH DATE 6/7/93

10.0 FLOOR FLEXIBILITY

FLOOR LEVEL = 117-0 BEAM SIZE = W24x145

NEGATIVE MOMENT

Kr = Ar*(b)/(As + (Ar) *(b))
= 0.757

Yc = ((d/2) + (D.D.) + (S.D.))*(Kr)
= 18.65 in

I tot = (((d/2) + D.D. + (S.D./2)) * (Yc) * (As)) + I + (((Ar) * (b) * (Rvs ^2))/2)
= 18,944 in4

MOMENT OF INERTIA FOR FREQUENCY CALCULATION IS THE SMALLER OF THAT DETERMINED FOR THE POSITIVE OR NEGATIVE MOMENTS

USE I = 17,125 in4

ASSUME SIMPLE BEAM ACTION FOR FREQUENCY

Fn = (9.87 / (2 * pi)) * (SQRT ((E * I * g))/ (W * (SPAN ^ 4))
= 20.85 Hz

FIXED BEAM ACTION

$$f_n = \frac{(20.85)(22.4)}{(9.87)} = 47.3 \text{ HZ}$$

SPAN PARAMETERS

FLOOR LEVEL =	117-0	
BEAM SIZE =	W21x82	
SPAN (ft) =	23.3	
BEAM SPACING (ft) =	7.75	
BEAM AREA (As) in2 =	24.2	
BEAM I (in4) =	1,760	
BEAM DEPTH (d) INCHES =	21.43	
n =	8.04	
REIN. AREA (Ar) in2/ft =	1.17	
REBAR VERTICAL SPACING (Rvs) inches =	6.25	
YOUNG'S MODULUS OF ELASTICITY (STEEL) E =	29,000	ksi
WEIGHT OF BEAM (W) klf =	2.62	
SLAB DEPTH (S.D.) inches =	15.5	
BEAM DECK DEPTH (D.D.) inches =	4.5	

POSITIVE MOMENT

COMPUTE EFFECTIVE WIDTH (b)

b (ft) = SMALLER OF (2*(SPAN))/8 OR (2*(SPACING))/2

2*SPAN/8 = 5.81

2*(SPACING)/2 = 7.75

EFFECTIVE WIDTH (b) = 5.81 FT

= 69.75 INCHES

COMPUTE TRANSFORMED AREA OF CONCRETE

T.A. = (b*S.D.)/n

= 134.47 in2

LOCATE THE NEUTRAL AXIS

TOTAL AREA = As + T.A.

= 158.67 in2

N.A. = ((d*As)/2) + (T.A.)(d + D.D. + S.D./2))/(TOTAL AREA)

= 30.18 inches up from bottom of beam

TOTAL MOMENT OF INERTIA

I tot = I + (As*(N.A. - d/2)^2) + (T.A.)((d + S.D. + D.D. - N.A. - (S.D./2))^2)

= 12,576.28 in4

EQE ENGINEERING

JOB NO 42103 JOB BOSTON EDISON PNPS BY JWJ DATE 5-3-93

CALC. NO 42103 - C - 001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDA DATE 6/4/93

10.0 FLOOR FLEXIBILITY

FLOOR LEVEL = 117-0 BEAM SIZE = W21x82

NEGATIVE MOMENT

Kr = Ar*(b)/(As + (Ar) *(b))
= 0.771

Yc = ((d/2) + (D.D.) + (S.D.))*(Kr)
= 17.71 in

I tot = (((d/2) + D.D. + (S.D./2)) * (Yc) * (As)) + I + (((Ar) * (b) * (Rvs ^ 2))/2)
= 14,792 in4

MOMENT OF INERTIA FOR FREQUENCY CALCULATION IS THE
SMALLER OF THAT DETERMINED FOR THE POSITIVE OR NEGATIVE MOMENTS

USE I = 12,576 in4

ASSUME SIMPLE BEAM ACTION FOR FREQUENCY

Fn = (9.87 / (2 * pi)) * (SQRT ((E * I * g))/ (W * (SPAN ^ 4))
= 16.21 Hz

FIXED BEAM ACTION

$$f_m = \frac{(16.21)(22.4)}{(9.87)} = 36.8 \text{ Hz}$$

SPAN PARAMETERS

FLOOR LEVEL =	91-3	
BEAM SIZE =	W21x62	
SPAN (ft) =	23.3	
BEAM SPACING (ft) =	7.75	
BEAM AREA (As) in2 =	18.3	
BEAM I (in4) =	1,330	
BEAM DEPTH (d) INCHES =	20.99	
n =	8.04	
REIN. AREA (Ar) in2/ft =	0.83	
REBAR VERTICAL SPACING (Rvs) inches =	6.25	
YOUNG'S MODULUS OF ELASTICITY (STEEL) E =	29,000	ksi
WEIGHT OF BEAM (W) klf =	2.62	
SLAB DEPTH (S.D.) inches =	15.5	
BEAM DECK DEPTH (D.D.) inches =	4.5	

POSITIVE MOMENT

COMPUTE EFFECTIVE WIDTH (b)

b (ft) = SMALLER OF (2*(SPAN))/8 OR (2*(SPACING))/2

2*SPAN/8 = 5.81
2*(SPACING)/2 = 7.75

EFFECTIVE WIDTH (b) = 5.81 FT
= 69.75 INCHES

COMPUTE TRANSFORMED AREA OF CONCRETE

T.A. = (b*S.D.)/n
= 134.47 in2

LOCATE THE NEUTRAL AXIS

TOTAL AREA = As + T.A.
= 152.77 in2

N.A. = ((d*As)/2) + (T.A.)(d + D.D. + S.D./2))/(TOTAL AREA)
= 30.52 inches up from bottom of beam

TOTAL MOMENT OF INERTIA

I tot = I + (As*(N.A. - d/2)^2) + (T.A.)((d + S.D. + D.D. - N.A. - (S.D./2))^2)
= 9,663.16 in4

EQE

EQE ENGINEERING

SHEET NO. 150

JOB NO. 42103 JOB BOSTON EDISON PNPS BY JWJ DATE 5-3-93

CALC. NO. 42103-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDH DATE 6/4/93

10.0 FLOOR FLEXIBILITY

FLOOR LEVEL = 91-3 BEAM SIZE = W21x62

NEGATIVE MOMENT

Kr = Ar*(b)/(As + (Ar) *(b))
= 0.760

Yc = ((d/2) + (D.D.) + (S.D.))*(Kr)
= 17.28 in

I tot = (((d/2) + D.D. + (S.D./2)) * (Yc) * (As)) + I + (((Ar) * (b) * (Rvs ^ 2))/2)
= 10,785 in4

MOMENT OF INERTIA FOR FREQUENCY CALCULATION IS THE
SMALLER OF THAT DETERMINED FOR THE POSITIVE OR NEGATIVE MOMENTS

USE I = 9,663 in4

ASSUME SIMPLE BEAM ACTION FOR FREQUENCY

Fn = (9.87 / (2 * pi)) * (SQRT ((E * I * g))/ (W * (SPAN ^ 4))
= 14.21 Hz

FIXED BEAM ACTION:

$$f_n = \frac{(14.21)(22.4)}{(9.87)} = 32.2 \text{ Hz}$$

SPAN PARAMETERS

FLOOR LEVEL =	91-3	
BEAM SIZE =	W18x50	
SPAN (ft) =	20.3	
BEAM SPACING (ft) =	7.75	
BEAM AREA (As) in2 =	14.7	
BEAM I (in4) =	802	
BEAM DEPTH (d) INCHES =	17.99	
n =	8.04	
REIN. AREA (Ar) in2/ft =	0.83	
REBAR VERTICAL SPACING (Rvs) inches =	6.25	
YOUNG'S MODULUS OF ELASTICITY (STEEL) E =	29,000	ksi
WEIGHT OF BEAM (W) klf =	2.62	
SLAB DEPTH (S.D.) inches =	15.5	
BEAM DECK DEPTH (D.D.) inches =	4.5	

POSITIVE MOMENT

COMPUTE EFFECTIVE WIDTH (b)

b (ft) = SMALLER OF (2*(SPAN))/8 OR (2*(SPACING))/2

2*SPAN/8 = 5.06

2*(SPACING)/2 = 7.75

EFFECTIVE WIDTH (b) = 5.06 FT

= 60.75 INCHES

COMPUTE TRANSFORMED AREA OF CONCRETE

T.A. = (b*S.D.)/n

= 117.12 in2

LOCATE THE NEUTRAL AXIS

TOTAL AREA = As + T.A.

= 131.82 in2

N.A. = ((d*As)/2) + (T.A.)(d + D.D. + S.D./2))/(TOTAL AREA)

= 27.87 inches up from bottom of beam

TOTAL MOMENT OF INERTIA

I tot = I + (As*(N.A. - d/2)^2) + (T.A.)((d + S.D. + D.D. - N.A. - (S.D./2))^2)

= 6,696.94 in4

EQE ENGINEERING

SHEET NO. 152

JOB NO. 42103 JOB BOSTON EDISON PNPS BY JWJ DATE 5-5-93

CALC. NO. 42103-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDH DATE 6/4/93

10.0 FLOOR FLEXIBILITY

FLOOR LEVEL = 91-3 BEAM SIZE = W18x50

NEGATIVE MOMENT

Kr = Ar*(b)/(As + (Ar) *(b))
= 0.774

Yc = ((d/2) + (D.D.) + (S.D.))*(Kr)
= 16.45 in

I tot = ((d/2) + D.D. + (S.D./2)) * (Yc) * (As)) + I + (((Ar) * (b) * (Rvs ^ 2))/2)
= 7,909 in4

MOMENT OF INERTIA FOR FREQUENCY CALCULATION IS THE SMALLER OF THAT DETERMINED FOR THE POSITIVE OR NEGATIVE MOMENTS

USE I = 6,697 in4

ASSUME SIMPLE BEAM ACTION FOR FREQUENCY

Fn = (9.87 / (2 * pi)) * (SQRT ((E * I * g))/ (W * (SPAN ^ 4))
= 15.60 Hz

FIXED BEAM ACTION

$$f_n = \frac{(15.60)(22.4)}{(9.87)} = 35.4 \text{ HZ.}$$

EQE ENGINEERING

JOB NO. 42103 JOB BOSTON EDISON PRAS BY JCH DATE 5-3-93

CALC. NO. 42103-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDH DATE 6/4/93

10.0 FLOOR FLEXIBILITY

SPAN PARAMETERS

FLOOR LEVEL	= 91-3	
BEAM SIZE	= W30x108	
SPAN (ft)	= 34.8	
BEAM SPACING (ft)	= 7.75	
BEAM AREA (As) in2	= 31.8	
BEAM I (in4)	= 4,470	
BEAM DEPTH (d) INCHES	= 29.83	
n	= 8.04	
REIN. AREA (Ar) in2/ft	= 0.83	
REBAR VERTICAL SPACING (Rvs) inches	= 6.25	
YOUNG'S MODULUS OF ELASTICITY (STEEL) E	= 29,000	ksi
WEIGHT OF BEAM (W) klf	= 2.65	
SLAB DEPTH (S.D.) inches	= 15.5	
BEAM DECK DEPTH (D.D.) inches	= 4.5	

POSITIVE MOMENT

COMPUTE EFFECTIVE WIDTH (b)

b (ft) = SMALLER OF (2*(SPAN))/8 OR (2*(SPACING))/2

2*SPAN/8 = 8.69
2*(SPACING)/2 = 7.75 EFFECTIVE WIDTH (b) = 7.75 FT
= 93 INCHES

COMPUTE TRANSFORMED AREA OF CONCRETE

T.A. = (b*S.D.)/n
= 179.29 in2

LOCATE THE NEUTRAL AXIS

TOTAL AREA = As + T.A.
= 211.09 in2

N.A. = ((d*As)/2) + (T.A.)(d + D.D. + S.D./2))/(TOTAL AREA)
= 37.99 inches up from bottom of beam

TOTAL MOMENT OF INERTIA

I tot = I + (As*(N.A. - d/2)^2) + (T.A.)((d + S.D. + D.D. - N.A. - (S.D./2))^2)
= 24,401.29 in4

EQE ENGINEERING

SHEET NO. 154

JOB NO. 42103 JOB BOSTON EDISON PNPS BY WW DATE 5-8-95

CALC. NO. 42103-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D ROH DATE 6/9/95

10.0 FLOOR FLEXIBILITY

FLOOR LEVEL = 91-3 BEAM SIZE = W30x108

NEGATIVE MOMENT

Kr = Ar*(b)/(As + (Ar) *(b))
= 0.708

Yc = ((d/2) + (D.D.) + (S.D.))*(Kr)
= 19.24 in

I tot = (((d/2) + D.D. + (S.D./2)) * (Yc) * (As)) + I + (((Ar) * (b) * (Rvs ^2))/2)
= 24,105 in4

MOMENT OF INERTIA FOR FREQUENCY CALCULATION IS THE SMALLER OF THAT DETERMINED FOR THE POSITIVE OR NEGATIVE MOMENTS

USE I = 24,105 in4

ASSUME SIMPLE BEAM ACTION FOR FREQUENCY

Fn = (9.87 / (2 * pi)) * (SQRT ((E * I * g))/ (W * (SPAN ^ 4))
= 9.99 Hz

CHECK FREQUENCY USING FIXED-END BEAM ACTION WHICH IS MORE APPROPRIATE FOR THIS SPAN BECAUSE OF RESTRAINT EFFECT OF CONCRETE SLAB.

FROM REF. 7 P.576 CASE 2b

$$f_m = \frac{22.4}{2\pi}\sqrt{\frac{EI_g}{wL^4}}$$

$$f_m = \frac{(9.99)\ 22.4}{9.87} = 22.7 \text{ HZ}$$

EQE ENGINEERING

JOB NO. 42103 JOB BOSTON EDISON PNPS BY JLC DATE 5-5-93

CALC NO. 42103-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D RDA DATE 6/4/93

10.0 FLOOR FLEXIBILITY

SPAN PARAMETERS

FLOOR LEVEL =	74-3	
BEAM SIZE =	W21x62	
SPAN (ft) =	23.3	
BEAM SPACING (ft) =	7.75	
BEAM AREA (As) in2 =	18.3	
BEAM I (in4) =	1,330	
BEAM DEPTH (d) INCHES =	20.99	
n =	8.04	
REIN. AREA (Ar) in2/ft =	0.62	
REBAR VERTICAL SPACING (Rvs) inches =	6.25	
YOUNG'S MODULUS OF ELASTICITY (STEEL) E =	29,000	ksi
WEIGHT OF BEAM (W) klf =	2.98	←
SLAB DEPTH (S.D.) inches =	15.5	
BEAM DECK DEPTH (D.D.) inches =	4.5	

FOR THIS LEVEL, ASSUME 150 PSF DISTRIBUTED LOAD:

SLAB DL = 1.72
DECK = .04
DIST. LO. = 1.16
DL. BM = .06
2.98 K/FT

POSITIVE MOMENT

COMPUTE EFFECTIVE WIDTH (b)

b (ft) = SMALLER OF (2*(SPAN))/8 OR (2*(SPACING))/2

2*SPAN/8 = 5.81
2*(SPACING)/2 = 7.75

EFFECTIVE WIDTH (b) = 5.81 FT
= 69.75 INCHES

COMPUTE TRANSFORMED AREA OF CONCRETE

T.A. = (b*S.D.)/n
= 134.47 in2

LOCATE THE NEUTRAL AXIS

TOTAL AREA = As + T.A.
= 152.77 in2

N.A. = ((d*As)/2) + (T.A.)(d + D.D. + S.D./2))/(TOTAL AREA)
= 30.52 inches up from bottom of beam

TOTAL MOMENT OF INERTIA

I tot = I + (As*(N.A. - d/2)^2) + (T.A.)((d + S.D. + D.D. - N.A. - (S.D./2))^2)
= 9,663.16 in4

EQE ENGINEERING

SHEET NO. 156

JOB NO. 42103 JOB BOSTON EDISON PINFS BY JWJ DATE 5-7-93

CALC. NO. 42103-C-001 SUBJECT REACTOR BUILDING SEISMIC MODEL CHK'D ROH DATE 6/4/93

10.0 FLOOR FLEXIBILITY

FLOOR LEVEL = 74-3 BEAM SIZE = W21x62

NEGATIVE MOMENT

Kr = Ar*(b)/(As + (Ar) *(b)) = 0.703

Yc = ((d/2) + (D.D.) + (S.D.))*(Kr) = 15.98 in

I tot = (((d/2) + D.D. + (S.D./2)) * (Yc) * (As)) + I + (((Ar) * (b) * (Rvs ^ 2))/2) = 9,671 in4

MOMENT OF INERTIA FOR FREQUENCY CALCULATION IS THE SMALLER OF THAT DETERMINED FOR THE FOSITIVE OR NEGATIVE MOMENTS

USE I = 9,663 in4

ASSUME SIMPLE BEAM ACTION FOR FREQUENCY

Fn = (9.87 / (2 * pi)) * (SQRT ((E * I * g))/ (W * (SPAN ^ 4)) = 13.33 Hz

FIXED BEAM ACTION

$$f_n = \frac{(13.33)(22.4)}{(9.87)} \approx 30.3 \text{ HZ.}$$

CONCLUSION FOR FLOOR FLEXIBILITY

BY INSPECTION OF FREQUENCY RESULTS, THE FLOORS WILL ACT RIGIDLY. THE MINIMUM FREQUENCY FOR FIXED END BEAM CONDITIONS IS 22.7 HZ (W30x108 AT THE 91.25' LEVEL). THE NATURAL FREQUENCY OF THE BUILDING (FIXED BASE MODEL) WILL BE MUCH LOWER THAN THIS VALUE (I.E. IN THE 4-6 HZ. RANGE.) THE FREQUENCIES OF BEAMS SELECTED FOR EVALUATION WILL BE REPRESENTATIVE OF THE LOWER BOUND OF THE OVERALL FLOOR NATURAL FREQUENCY.

Reactor Building Major Components List - Revision 0

Building	Elevation	Equip. ID	# of Items	Description	Weight/Item (lbs)	Reference Dwg.	SEEK Loc.	Notes
						(V,VM)=Vendor Doc.		
Reactor	(-) 17' - 6"	X203	1	HPCI Turbine	21,000	2300-1-10 (V)	41500-1462	1
		P205	1	HPCI Pump	16,310	2271-21-2 (V)	41500-1446	1
		X202	1	RCIC Turbine	2,500	2059-2-12 (V)	41500-1397	1
		P206	1	RCIC Pump	6,820	2287-23-3 (V)	41500-1459	1
		E207A,B	2	RHR Heat Exchanger	40,000	2521-5-4	41500-1653	2
		P203A,B,C,D	4	RHR Pumps	10,900	2331-12-5	41500-1496	3
		P209A,B	2	CRD Pumps	6,750	M9-13-1	41200-4428	1,3
						M9-14-1	41200-4429	
		P215A,B	2	Core Spray Pumps	9,330	2249-24-1 (V)	41500-1439	2,3
	23' - 0"	Various	145	CRD Hydraulic Control Units	785	M1D11-3	41500-0167	10
		SDIV East/West	2	Scram Discharge Volume Tanks	44,700	C15.0.1402, Rev. 0	2714-0685	16
		MCC D7	1	MCC Environmental Enclosure	17,196	CYGNA Calc. C7	3206-0271	4
		MCC D8	1	MCC Environmental Enclosure	19,361	CYGNA Calc. C7	3206-0271	5
		MCC D9	1	MCC Environmental Enclosure	20,861	CYGNA Calc. C7	3206-0271	6
		MCC B17	1	MCC Environmental Enclosure	16,118	CYGNA Calc. C7	3206-0271	7
		MCC B18	1	MCC Environmental Enclosure	19,512	CYGNA Calc. C7	3206-0271	8
		MCC B20	1	MCC Environmental Enclosure	14,286	CYGNA Calc. C7	3206-0271	9
	51' - 0"	VGTF201A,B	2	SBGT Filter Assembly	6,600	6498-M-50 (Spec.)	2705-0125	15
		VSF101A,B,C	3	Turbine Bldg. Supply Fans	8,000	M339	41100-2035	11
		T208	1	C.U. Backwash Receiving Tank	16,875	2718-1-2 (V)	41500-1897	2
		E208A,B,C	3	C.U. Regen Heat Exchanger	7,920	V1034 (VM)	4324-1844	2
		E216A,B	2	C.U. Non-Regen Heat Exchanger	4,675	V1034 (VM)	4324-1844	2
		X204A,B	2	Motor Generator (M.G.) Sets	95,000	2483-21-1 (V)	41500-1599	13
	74' - 3"	T204	1	Fuel Pool Demineralizer	13,200	M155-7-3 (V)	41200-7434	2
		E206A,B	2	Fuel Pool Heat Exchanger	3,900	M11-2-5	41200-4451	2
		T216A,B	2	C. U. Powdex Units	8,850	2640-003-5 (V)	41500-1712	2
		VSF204A,B	2	M.G. Sets for Supply Fans	1,880	M339	41100-2035	11
		N/A	N/A	Spent Fuel Cask	52,000	ELNRC1.2.83.181	1434-2081	18
	78' - 3"	N/A	1	Spent Fuel Pool	2,500#/sq.ft.	SUDDSRF 93-001	Not Available	24
	91' - 3"	T205	1	Standby Liquid Control Tank	46,500	2036-22-1	41500-1378	2,21
		T201A,B	2	C.W. Surge Tanks	5,800	M22-4-3 (V)	41200-4835	14
		X219	1	New Fuel Storage Vault	N/A	N/A	N/A	23
		N/A	N/A	Contaminated Storage Area	N/A	N/A	N/A	19
		N/A	N/A	Dryer/Separator Storage Pool	N/A	N/A	N/A	20

Building	Elevation	Equip. ID	# of Items	Description	Weight/Item (lbs)	Reference Dwg.	SEEK Loc.	Notes
Reactor	117' - 0"	H201	1	Reactor Building Crane	252,000	C158	41100-0236	17
		X208	1	Refueling Crane	40,000	M1MA-22	41201-0633	22
Aux. Bay	3' - 0"	E209A,B	2	RBCCW Heat Exchanger	67,000	M11-52-2	41200-0688	2
		E122A,B	2	TBCCW Heat Exchanger	29,000	M11-3-8	41200-4452	2
	23' - 0"	VHWB101A,B	2	Aux. Heating Boilers	46,700	M40-2-2BC	41200-5213	2,12
		T121	1	Acid Storage Tank	94,700	M22-1-4	41200-4832	2
		T122	1	Caustic Storage Tank	29,660	M22-2-4	41200-4833	2
Turbine	51' - 0"	P103A,B,C	3	Reactor Feed Pumps	39,050	M5-4-7	41200-4237	1,3

Notes:

1. Does not include pedestal weight / baseplate weight included
2. Includes fluid weight for full operational condition
3. Includes weight for pump and motor
4. D7 weight distribution: MCC=6,750#, Enclosure=8,686#, Insulation=1,760#; Ref. Dwg. E9-1 (41201-1080)
5. D8 weight distribution: MCC=3,750#, Enclosure=12,336#, Insulation=3,275#; Ref. Dwg. E9-2 (41201-1071)
6. D9 weight distribution: MCC=5,250#, Enclosure=12,336#, Insulation=3,275#; Ref. Dwg. E9-7-9 (41200-3367)
7. B17 weight distribution: MCC=7,150#, Enclosure=7,123#, Insulation=1,845#; Ref. Dwg. E8-13-8 (41200-3312)
8. B18 weight distribution: MCC=7,150#, Enclosure=9,712#, Insulation=2,650#; Ref. Dwg. E8-15-7 (41200-3314)
9. B20 weight distribution: MCC=6,500#, Enclosure=6,136#, Insulation=1,650#; Ref. Dwg. E8-19-9 (41200-3318)
10. Approx. 1/2 of total # of HCU's located west of drywell; 1/2 east of drywell; Ref. FSAR Fig. 3.4-9
11. Includes fan and motor weight without pedestal or grout pad.
12. Weight of water estimated from boiler tube heated surface area; approx. 1,000 gallons or 8,300 pounds.
13. Weight is for motor and generator as a set.
14. Weight of full tank computed using dimensions provided on dwg. M22-4-3.
15. Filter assembly unit weight when operational. Does not include weights of pipe supported valves.
16. Weight of tank, fluid, and shielding included.
17. Includes weight of bridge crane and trolley; Crane capacity rated at 100 tons.
18. Total lifted weight which includes load of spent fuel; BECo does not currently own or store a cask in the pool.
19. Minor items such as tools, maintenance equipment stored in this location; no weight estimate available.
20. During periods of operation, pool is normally empty; During refueling conditions pool contains water, dryer, and separator.
21. Total weight calculated using information from M1F3-2 (41500-0279) and listed reference drawing.
22. Total dead weight of refueling bridge without hoist loads.
23. Based on phone discussion with J. White of EQE, weight will be covered by floor deadweight allowance.
24. Weight in spent fuel pool after rerack to 3859 cells; each fuel bundle is 680# with 411,300# for the rack structure; water weight not included; surface area of pool is 40' - 4" X 30' - 6".

ATTACHMENT B

SH 159

SH. 1/3

CHECKING CRITERIA CHECKLIST

FOR SH. 1 → 78, 103 → 115, 117 → 156

Client BOSTON EDISON Project RX BLDG ARS

Job No. 7203 Calc. No. C-001

Revision No. 0

Criteria	Yes	No	N/A	Comment No.
1. Originator followed defined procedures.	✓			
2. Title, purpose and function of the work checked are adequately described.	✓			
3. Work method clearly stated and appropriate.	✓			
4. Assumptions identified. Open items flagged for subsequent verification where necessary.	✓			
5. Technical bases and references current, correctly selected, and incorporated.	✓			
6. Technical input properly selected and adequately identified. Any specific input to be excluded are adequately identified.	✓			
7. Applicable codes, standards and regulatory requirements identified and properly used.	✓			
8. Analytical steps can be verified without recourse to originator.	✓			
9. Each page of the work identified and traceable to originator, date and job or equivalent control number.	✓			
10. All markings legible and identifiable.	✓			

SH. 2/3

CHECKING CRITERIA CHECKLIST

FOR SH. 1 → 78, 103 → 115, 117 → 156

Client: BOSTON EDISON Project: RX BLDG ARS

Job No.: 42103 Calc. No.: C-001

Revision No.: 0

Criteria	Yes	No	N/A	Comment No.
11. Work clearly references any final supporting computer runs			✓	
12. Final computer runs include input listing and output.			✓	
13. Final computer runs contain unique number identifier.			✓	
14. Results consistent with inputs, technical procedures, and other project criteria.	✓			
15. Results are reasonable.	✓			
16. Revisions are clearly documented.			✓	
17. Technical interface requirements in the Project Plan have been satisfied.			✓	
18. All documentation available to checker.	✓			
19. Computer program version identified.			✓	
20. Computer program version certified and application valid.			✓	

Checked by: R.D. Hardaway Date: 6/4/93

ATTACHMENT B

SH. 161

SH. 3/3

CHECKING CRITERIA CHECKLIST

FOR SH. 1 → 78, 103 → 115, 117 → 156

Client BOSTON EDISON

Project RX BLDG ARS

Job No. 42103

Calc. No. C-001

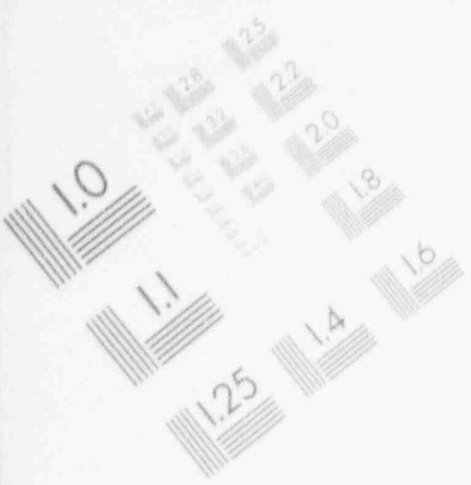
Revision No. 0

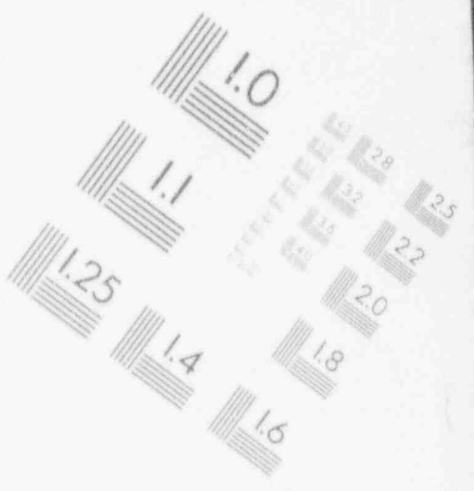
CHECKING CRITERIA CHECKLIST

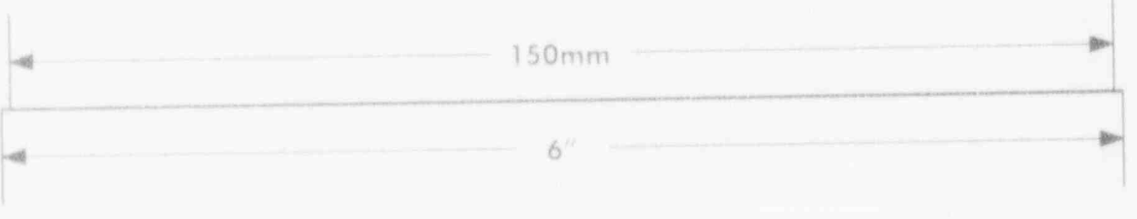
Comment No.	Comment	Resolved by: Date:
	NONE	

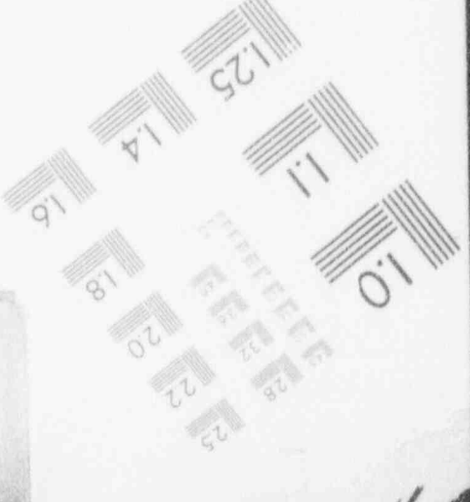
1

IMAGE EVALUATION
TEST TARGET (MT-3)





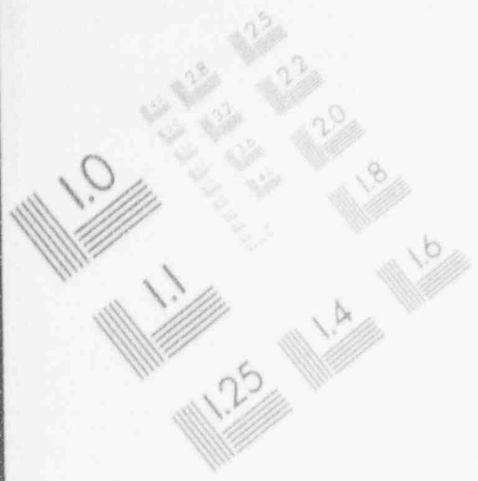


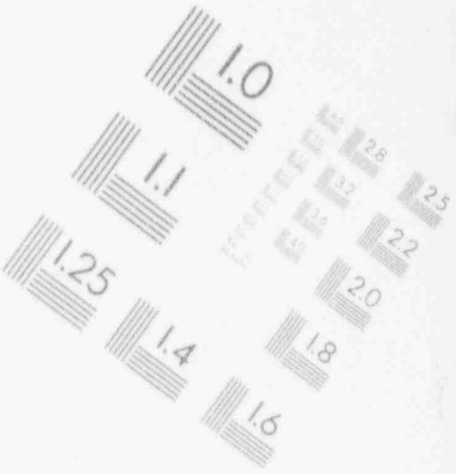


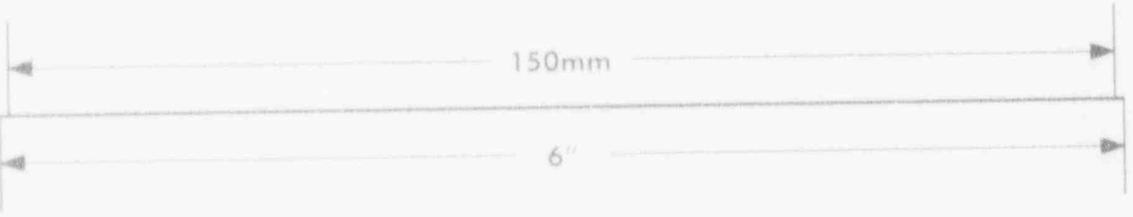

1
IMAGE EVALUATION
TEST TARGET (MT-3)
1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
150mm
6"

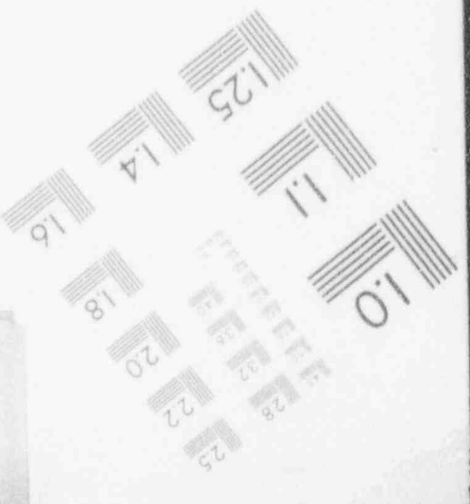
1

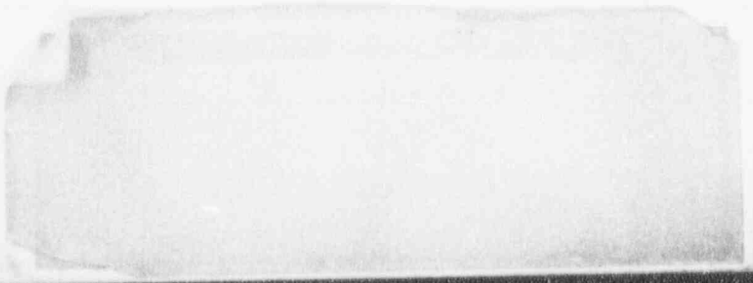
IMAGE EVALUATION TEST TARGET (MT-3)

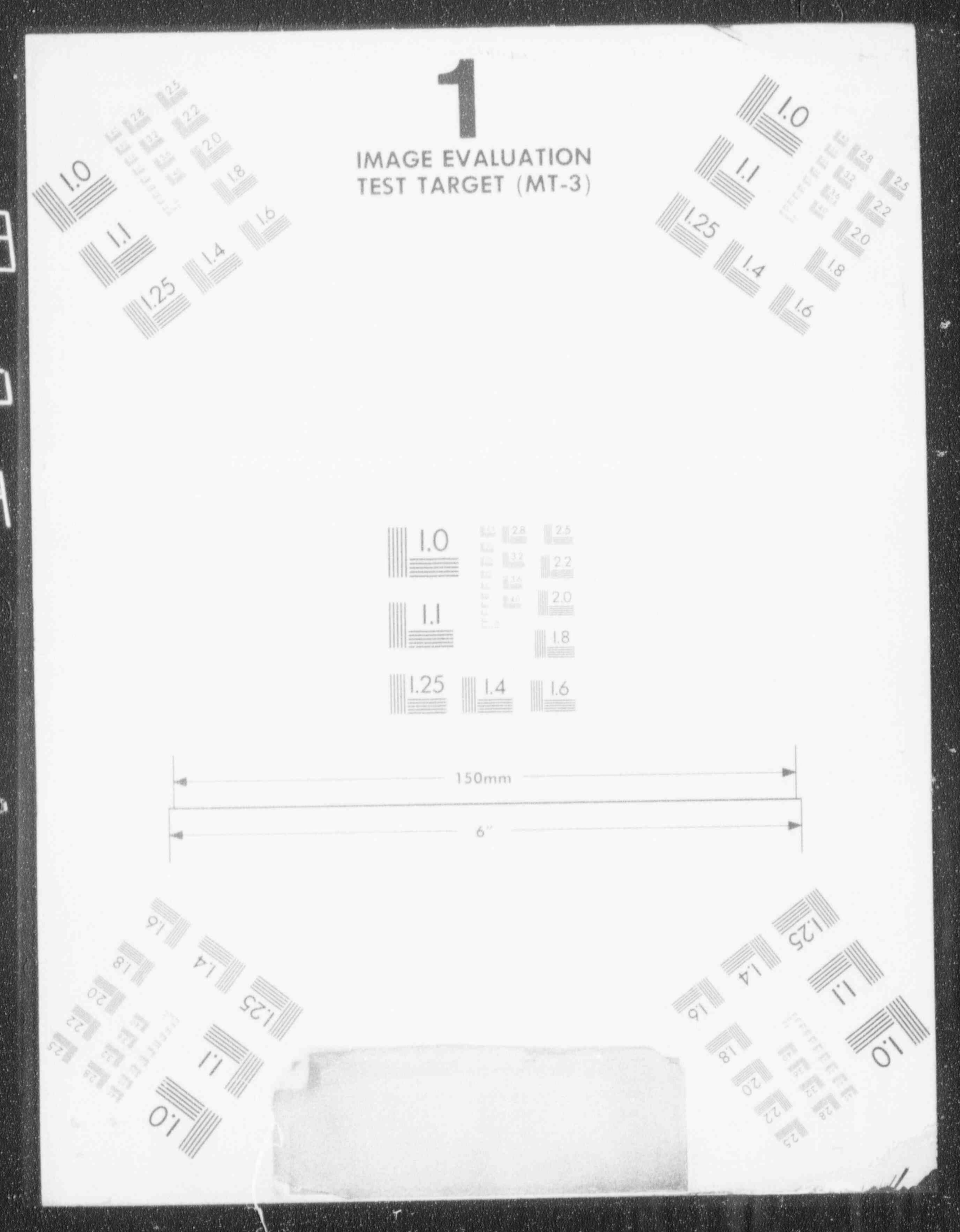











1
IMAGE EVALUATION
TEST TARGET (MT-3)
1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
150mm
6"

ATTACHMENT C

SH. 1/3

CHECKING CRITERIA CHECKLIST

FOR SH. 79 THROUGH 102, AND 116 ONLY

Client BOSTON EDISON Project R.B. SEISMIC MODEL

Job No. 42103 Calc. No. 42103-C-001

Revision No. 0

Criteria	Yes	No	N/A	Comment No.
1. Originator followed defined procedures.	X			
2. Title, purpose and function of the work checked are adequately described.	X			
3. Work method clearly stated and appropriate.	X			
4. Assumptions identified. Open items flagged for subsequent verification where necessary.	X			
5. Technical bases and references current, correctly selected, and incorporated.	X			
6. Technical input properly selected and adequately identified. Any specific input to be excluded are adequately identified.	X			
7. Applicable codes, standards and regulatory requirements identified and properly used.	X			
8. Analytical steps can be verified without recourse to originator.	X			
9. Each page of the work identified and traceable to originator, date and job or equivalent control number.	X			
10. All markings legible and identifiable.	X			

ATTACHMENT 2
SH. 2/3

CHECKING CRITERIA CHECKLIST

FOR SH. 79 THROUGH 103, AND 116 ONLY

Client BOSTON EDISON Project R.B. SEISMIC MODEL

Job No. 42103 Calc. No. 42103-C-001

Revision No. 0

Criteria	Yes	No	N/A	Comment No.
11. Work clearly references any final supporting computer runs.	X			
12. Final computer runs include input listing and output.	X			(1)
13. Final computer runs contain unique number identifier.	X			
14. Results consistent with inputs, technical procedures, and other project criteria.	X			
15. Results are reasonable.	X			
16. Revisions are clearly documented.			X	
17. Technical interface requirements in the Project Plan have been satisfied.			X	
18. All documentation available to checker.	X			
19. Computer program version identified.	X			
20. Computer program version certified and application valid.	X			(2)

Checked by: [signature] Date: 6-10-93

ATTACHMENT C

SH. 3/3

CHECKING CRITERIA CHECKLIST

FOR SH. 79 THROUGH 102, AND 116 ONLY

Client BOSTON EDISON Project R.B. SEISMIC MODEL

Job No. 42103 Calc. No. 42103-C-001

Revision No. 0

CHECKING CRITERIA CHECKLIST

Comment No.	Comment	Resolved by: Date:
(1)	INPUT AND OUTPUT FILES ARE TOO LARGE TO PRINT IN THE CALCULATION. COMPUTER TAPES ARE INCLUDED IN THE PROJECT FILES. SUMMARY INPUT AND OUTPUT DATA ARE INCLUDED IN THE CALC.	JWL 6-10-93
(2)	COMPUTER PROGRAM ANSYS PC/LINEAR REVISION 4.4A WAS USED. REFER TO CALCULATION 42103-C-003 FOR PROJECT UNIQUE CERTIFICATION	JWL 6-10-93