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JOHNSON,A.R. Project Directorate I-3

SUBJECT: Forwards Rev 1 to EWR 5327, "Design Verification Ginna StatioContainment Foundation Mat Analysis," in response to 910625 request for addl info re containment integrity.

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July 11, 1991

U.S. Nuclear Regulatory Commission
Document Control Desk
Attn: Allen R. Johnson
Project Directorate I-3
Washington, D.C. 20555

Subject: Ginna Containment Integrity
Request for Additional Information
R.E. Ginna Nuclear Power Plant
Docket No. 50-244 (TAC No. 80494)

Dear Mr. Johnson:

This letter transmits to you the additional information requested by you in your June 25, 1991 letter (TAC No. 80494).

Table 1 presents all the load cases and parametric variations on properties and boundary conditions that have been analyzed in this evaluation. RG&E believes that the true behavior of the cylinder ring beam connection is bounded by "Run Names" RGE08 to RGE12 inclusive (refer to Table 2). These runs simulate respectively a truly pinned connection, increasing variations in radial restraining moment, and a fully fixed condition. The fully fixed condition is judged not to exist based on the physical examination of the neoprene and based on the historically consistent results of the tendon lift off tests.

As an additional means of judging the integrity of the containment, RG&E compared the results of the analyses for the condition of fully pinned to fully fixed for the assumption of sliding and no sliding (Run Names RGE08 to RGE12 and RGE14 to RGE20 respectively). Table 3 presents the results of all those comparison of the critical moments considered in the UFSAR load combinations to the ultimate section capacities.

Figure 1 is a graph of radial displacements vs moment for the full range of base rotational resistance due to internal pressure. They demonstrate the response of the structure for the sliding and non-sliding boundary conditions. As can be seen, the upper bound for both deflection and moment is at the pinned condition, and decreases as rotational resistance increases.

Figures 2 is a plot of radial displacements of the containment for RGE08 (pinned), RGE12 (fixed), and the results of the original Structural Integrity Test (SIT). Also shown are the displacements

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for RGE03. RGE03 is the lower bound for displacements because it was run with the hoop stiffness assumed to be based on an uncracked concrete section. RGE08 and RGE12 are predictably higher than this case since these analyses were done with the hoop stiffness based on the reinforcing steel alone, which is orders of magnitude less than an uncracked section. As expected, the SIT results are between these values because the actual stiffness at the test condition, is a combination of cracked and uncracked sections.

With this as an introduction, the specific issues will now be addressed.

Issue #1

In reference 2, it is stated (p. 5 of the report), "For all cases, the results have shown no more than 10% increase from the original design value". The staff review of attachment 1 of reference 1 indicates that at 3 ft. above the base, the magnitude of the meridional moments can be larger than twice the original design value and under some conditions (fixed) they could be in the opposite direction. Provide justification for 10% claim in the statement.

Response

Table 2 presents a comparison of the meridional moments obtained from the parametric analyses to the values listed in the UFSAR. The results of these analyses were compared to the moments at the critical section in the cylinder which are listed in the UFSAR. The critical section for the cylinder is ten (10) feet above the ring beam. The results of those comparisons for all analyses are shown in Table 2. As can be seen, the effect of increasing rotational stiffness is a decrease in moment at the critical section. The results for the bounding cases (cases RGE08 to RGE012) are shown to be below the UFSAR values. A review of all other computer runs shows that the maximum increases is about 10% which occurs in run RGE14. This case is similar to RGE12 except that additional conservatism is added. Elastic elongation of the tension rods is not permitted which is not considered representative of actual behavior. The 10% increase stated in the January 28, 1991 letter was intended to apply to those moments at the critical section only.

A discussion of the response at the 3 ft. level is given below.

Issue #2

Provide interaction diagrams for negative meridional moments (liner in tension). Provide comparison of meridional moments found in the reanalyses that you have already performed for various base conditions against the capacity at 3 ft. and 6 ft. above the base.

Response

The interaction diagram for negative meridional moment was transmitted to you in our April 8, 1991 letter. The "Tendon Only" curve is applicable for resisting negative moments. Table 3 presents the comparison of meridional moments to section capacities. As can be seen in Table 3, the capacity of the section is exceeded for only two cases, both of which are a fully fixed condition. RG&E does not consider this a concern because the "fixed" condition with no sliding cannot be physically achieved and the load combinations in which they occur include a factored internal pressure of 90 psi (50% greater than design).

Issue #3

In the above comparisons where the capacity falls short of the demand induced by the appropriate load combination, provide the necessary justification for assuring containment integrity and propose what physical evidence can be obtained about the true base condition during an integrated leak rate test.

Response

The subject of capacity versus induced moments is discussed above.

The results of the original Structural Integrity Tests have been reviewed. One data point at which radial displacement was measured was at 4 inches above the base. A second data point for the same measurement was at 72 inches above the base. The measured displacements at the 72 inch point and all points above are positive outward. The displacement at the 4 inch point is negative inward. The tension bars at the joint are located approximately 12 inches above the base. These measured displacements above and below the tension bars would imply that a rotation about the bars had occurred. Although the rotation itself was not measured, we have extrapolated a value, based on the radial displacements to be approximately 0.20 degrees.

The analytical results for a fully pinned condition indicate a rotation at the base of less than 0.20 degree. Since a fully pinned condition is achieved with this small rotation, the extrapolated rotation from the SIT implies that the response of the containment was as designed and no negative moments can be developed in the section.

The graph, Figure 2, displays the expected behavior of three models in relation to the SIT results. RGE03 (pinned, sliding base, uncracked concrete) matches fairly closely the SIT results near the base where you would not expect much cracking due to the presence of the radial tension bars. At higher elevations, RGE03 understates the displacements because there is cracking. The results of RGE09 (pinned, sliding base, cracked concrete) and RGE12 (fixed sliding base, cracked concrete), overstate the displacements at all locations, as expected, but are closer to the SIT values at higher elevations.

Issue #4

Provide calculations (or results of computer output) for maximum shear stresses in the basemat of the containment under hydrostatic pressure due to highest groundwater level to be considered in the design, and how the thinnest basemat sections can withstand the shear stresses.

Response

Attachment A transmits the analysis of the base slab in which concrete shear stresses are checked and are shown to be within allowable values.

Very truly yours,

Robert C. Mecredy

LAS/231.ADD

xc: Mr. Allen R. Johnson (Mail Stop 14D1)
Project Directorate I-3
Washington, D.C. 20555

U.S. Nuclear Regulatory Commission
Region I
475 Allendale Road

Ginna Senior Resident Inspector

Case Reference Chart - Shell Model

		Run Name	Load Cases (1)	Applicable Loads (1)	Base Boundary Conditions					Material Properties			
										Modulus			Poisson Ratio
					Tie-Rods	Tangential	Vertical	Rotational [ft-lbs/ft]	Radial	Meridional [psi]	Circumferencial [psi]	Dome [psi]	
SEISMIC ONLY		RGE01	D,PS,P,2E	2E	Inactive	Fixed	Fixed	Free	Fixed	4.10E+06	4.10E+06	Uncracked	0.15
SEISMIC ONLY		RGE02	D,PS,P,2E	2E	Inactive	Free	Fixed	Free	Fixed	4.10E+06	4.10E+06	Uncracked	0.15
SEISMIC ONLY		RGE03	D,PS,P,2E	2E	Active	Free	Fixed	Free	Free	4.10E+06	4.10E+06	Uncracked	0.15
CONSTANT HOOP REINFORCEMENT		RGE04	D,PS,P,2E	D,PS,P	Inactive	Fixed	Fixed	Free	Fixed	4.10E+06	3#18@9"	Uncracked	0
CONSTANT HOOP REINFORCEMENT		RGE05	D,PS,P,2E	D,PS,P	Inactive	Free	Fixed	Free	Fixed	4.10E+06	3#18@9"	Uncracked	0
CONSTANT HOOP REINFORCEMENT		RGE06	D,PS,P,2E	D,PS,P	Active	Free	Fixed	Free	Free	4.10E+06	3#18@9"	Uncracked	0
SEISMIC ONLY		RGE07	D,PS,P,2E	2E	Active	Liner(2)	Fixed	Free	Free	4.10E+06	4.10E+06	Uncracked	0.15
RADIAL SLIDING	PINNED	RGE08	D,PS,P,2E	D,PS,P	Active	Fixed	Fixed	Free	Free	4.10E+06	Rebar Varies	Cracked	0
RADIAL SLIDING	ROTATIONAL RESISTANCE INCREASING ↓	RGE09	D,PS,P,2E	D,PS,P	Active	Fixed	Fixed	3.00E+01	Free	4.10E+06	Rebar Varies	Cracked	0
RADIAL SLIDING	ROTATIONAL RESISTANCE INCREASING ↓	RGE10	D,PS,P,2E	D,PS,P	Active	Fixed	Fixed	9.00E+01	Free	4.10E+06	Rebar Varies	Cracked	0
RADIAL SLIDING	ROTATIONAL RESISTANCE INCREASING ↓	RGE11	D,PS,P,2E	D,PS,P	Active	Fixed	Fixed	3.00E+02	Free	4.10E+06	Rebar Varies	Cracked	0
RADIAL SLIDING	FIXED	RGE12	D,PS,P,2E	D,PS,P	Active	Fixed	Fixed	Fixed	Free	4.10E+06	Rebar Varies	Cracked	0
NO RADIAL SLIDING	PINNED	RGE14	D,PS,P,2E	D,PS,P	Inactive	Fixed	Fixed	Free	Fixed	4.10E+06	Rebar Varies	Cracked	0
NO RADIAL SLIDING	ROTATIONAL RESISTANCE INCREASING ↓	RGE15	D,PS,P,2E	D,PS,P	Inactive	Fixed	Fixed	3.00E+01	Fixed	4.10E+06	Rebar Varies	Cracked	0
NO RADIAL SLIDING	ROTATIONAL RESISTANCE INCREASING ↓	RGE16	D,PS,P,2E	D,PS,P	Inactive	Fixed	Fixed	9.00E+01	Fixed	4.10E+06	Rebar Varies	Cracked	0
NO RADIAL SLIDING	ROTATIONAL RESISTANCE INCREASING ↓	RGE17	D,PS,P,2E	D,PS,P	Inactive	Fixed	Fixed	3.00E+02	Fixed	4.10E+06	Rebar Varies	Cracked	0
NO RADIAL SLIDING	FIXED	RGE18	D,PS,P,2E	D,PS,P	Inactive	Fixed	Fixed	Fixed	Fixed	4.10E+06	Rebar Varies	Cracked	0
SEISMIC ONLY		RGE20	D,PS,P,2E	2E	Active	Free	Fixed	Free	(90-180°)Fxd	4.10E+06	4.10E+06	Uncracked	0.15
SEISMIC ONLY		RGE21	D,PS,P,2E	2E	Inactive	Free	Fixed	Free	(72-180°)Fxd	4.10E+06	4.10E+06	Uncracked	0.15
SEISMIC ONLY		RGE22	D,PS,P,2E	2E	Inactive	Free	Fixed	Free	(81-180°)Fxd	4.10E+06	Rebar Varies	Cracked	0

(1) D = Dead Weight
PS = Tendon Prestress
P = 60 psi Internal Presure

(2) Liner = The tangential stiffness associated with the steel containment liner

TABLE 1

TABLE 2

(60 PSIG INTERNAL PRESSURE ONLY)

MERIDIONAL MOMENT (FT-KIPS/FT)

COMPUTER RUN NAME	MOMENT AT 10 FT	PERCENT OF UFSAR VALUE	MOMENT AT 15 FT	PERCENT OF UFSAR VALUE	COMMENT
RGE01	129.8	53.3	101.5	41.7	
RGE02	129.8	53.3	101.5	41.7	
RGE03	99.3	40.8	78.5	32.2	
RGE04	258	105.9	249.7	102.5	
RGE05	258	105.9	249.7	102.5	
RGE06	223.8	91.9	217.1	89.1	
RGE07	99.4	40.8	12.7	5.2	
RGE08	231.8	95.2	223.8	91.9	PINNED CONDITION
RGE09	217.7	89.4	216	88.7	ORIG. DESIGN COND. (ODC)
RGE10	191.5	78.6	202.5	83.1	THREE (3)X(ODC) MOMENT
RGE11	100.1	41.1	155.3	63.8	TEN (10)X(ODC) MOMENT
RGE12	-26.2	-10.8	90.9	37.3	ROTATION FIXED
RGE14	268.8	110.3	259.5	106.5	SIMILAR TO RGE08 NO SLIDING
RGE15	254.4	104.4	206.8	84.9	SIMILAR TO RGE09 NO SLIDING
RGE16	234.7	96.3	244.1	100.2	SIMILAR TO RGE10 NO SLIDING
RGE17	155	63.6	208.3	85.5	SIMILAR TO RGE11 NO SLIDING
RGE18	-38.1	-15.6	121.3	49.8	SIMILAR TO RGE12 NO SLIDING
RGE20	113	46.4	88.7	36.4	

UFSAR - 243.8 FT-K/FT AT 60 PSI AT TEN FEET

TABLE 3

LOAD COMBINATION 29 "a"   MERIDIONAL MOMENT FT-K/FT

(1.0*DL) + (1.0*VP) + (1.0*OTw) + (1.5*IP) + (1.0*AT90)

ROTATIONAL BASE FIXITY	LOCATION ABOVE BASE(FT)	MOMENT- SLIDING PERMITTED	PERCENT ULTIMATE CAPACITY	MOMENT- NO SLIDING PERMITTED	PERCENT ULTIMATE CAPACITY
FREE (PINNED)	3	158	24.7	185	28.9
	6	282.9	32.5	328.1	37.7
	10	373.2	42.9	428.7	49.3
	15	401	46.1	454.5	52.2
30 FT-K/FT	3	120	18.8	149	23.3
	6	252.5	29	301.1	34.6
	10	351.9	40.4	411.6	47.3
	15	389.3	44.7	446.8	51.4
90 FT-K/FT	3	46	7.2	78	12.2
	6	194.3	22.3	246.9	28.4
	10	312.8	36	377.4	43.4
	15	369	42.4	431.4	49.6
300 FT-K/FT	3	-212	33.1	-173	27
	6	-9.5	1.5	57.55	6.6
	10	175.6	20.2	257.9	29.6
	15	298.2	34.3	377.6	43.4
FIXED	3	-574	89.7	-780	121.9
	6	-293.4	45.8	-401.1	62.7
	10	-14	2.2	-31.9	5
	15	201.6	23.2	247.2	28.4

DL = DEAD LOAD
VP = TENDON PRESTRESS
OTw = OPERATING TEMPERATURE WINTER
IP = INTERNAL PRESSURE (60PSI)
AT90 = ACCIDENT PRESSURE (90PSI) T = 312 F

TABLE 3

LOAD COMBINATION 31 "b"   MERIDIONAL MOMENT FT-K/FT

(1.0*DL) + (1.0*VP) + (1.0*OTs) + (1.5*IP) + (1.0*AT90)

ROTATIONAL BASE FIXITY	LOCATION ABOVE BASE(FT)	MOMENT-SLIDING PERMITTED	PERCENT ULTIMATE CAPACITY	MOMENT-NO SLIDING PERMITTED	PERCENT ULTIMATE CAPACITY
FREE (PINNED)	3	184	28.8	211	33
	6	312.4	35.9	357.6	41.1
	10	385	44.3	440.5	50.6
	15	372.2	42.8	425.7	48.9
30 FT-K/FT	3	146	22.8	175	27.3
	6	282	32.4	330.6	38
	10	363.7	41.8	423.4	48.7
	15	360.5	41.4	418	48
90 FT-K/FT	3	72	11.3	103	16.1
	6	223.8	25.7	276.4	31.8
	10	324.6	37.3	389.2	44.7
	15	340.2	39.1	402.6	46.3
300 FT-K/FT	3	-186	29.1	-166	25.9
	6	20	2.3	87	10
	10	187.4	21.5	269.7	31
	15	269.4	31	348.8	40.1
FIXED	3	-548	85.6	-754	117.8
	6	-263.9	41.2	-372.3	58.2
	10	-2.2	0.3	20	2.3
	15	172.8	19.9	218	25.1

DL = DEAD LOAD
VP = TENDON PRESTRESS
OTs = OPERATING TEMP. SUMMER
IP = INTERNAL PRESSURE (60PSI)
AT90 = ACCIDENT PRESSURE (90PSI) T = 312 F

TABLE 3

LOAD COMBINATION 41 "c" MERIDIONAL MOMENT FT-K/FT

(1.0*DL) + (1.0*VP) + (1.0*OTW) + (1.0*IP) + (1.0*AT60) + (2.0*E)

ROTATIONAL BASE FIXITY	LOCATION ABOVE BASE(FT)	MOMENT-SLIDING PERMITTED	PERCENT ULTIMATE CAPACITY	MOMENT-NO SLIDING PERMITTED	PERCENT ULTIMATE CAPACITY
FREE (PINNED)	3	100	15.6	118	18.4
	6	184.3	21.2	214.5	24.7
	10	253	29.1	290	33.3
	15	286.4	32.9	322.1	37
30 FT-K/FT	3	75	11.7	94	14.7
	6	164	18.9	196.4	22.6
	10	238.8	27.4	278.6	32
	15	278.6	32	317	36.4
90 FT-K/FT	3	25	3.9	46	7.2
	6	125.2	14.4	160.3	18.4
	10	212.7	24.4	255.8	29.4
	15	265.2	30.5	306.8	35.3
300 FT-K/FT	3	-147	23	-120	18.8
	6	-10.7	1.7	34.1	3.9
	10	121.2	13.9	176.1	20.2
	15	217.9	25	270.9	31.1
FIXED	3	-388	60.6	-525	82
	6	-199.9	31.2	-272.2	42.5
	10	-5.2	0.8	-17.1	2.7
	15	153.6	17.7	183.9	21.1

DL = DEAD LOAD
VP = TENDON PRESTRESS
OTW = OPERATING TEMPERATURE WINTER
IP = INTERNAL PRESSURE (60PSI)
AT60 = ACCIDENT PRESSURE (60PSI) T = 286 F
E = 0.10 G EARTHQUAKE HORIZONTAL + VERTICAL

TABLE 3

LOAD COMBINATION 43 "d" MERIDIONAL MOMENT FT-K/FT

(1.0*DL) + (1.0*VP) + (1.0*OTs) + (1.0*IP) + (1.0*AT60) + (2.0*E)

ROTATIONAL BASE FIXITY	LOCATION ABOVE BASE(FT)	MOMENT-SLIDING PERMITTED	PERCENT ULTIMATE CAPACITY	MOMENT-NO SLIDING PERMITTED	PERCENT ULTIMATE CAPACITY
FREE (PINNED)	3	125.8	19.7	144	22.5
	6	213.8	24.6	244	28
	10	264.8	30.4	301.8	34.7
	15	257.6	29.6	293.3	33.7
30 FT-K/FT	3	100	15.6	119	18.6
	6	193.5	22.2	225.9	26
	10	250.6	28.8	290.4	33.4
	15	249.8	28.7	288.2	33.1
90 FT-K/FT	3	51	8	72	11.3
	6	154.7	17.8	189.8	21.8
	10	224.5	25.8	267.6	30.8
	15	236.4	27.2	278	32
300 FT-K/FT	3	-121	18.9	-95	14.8
	6	18.8	2.2	63.6	7.3
	10	133	15.3	187.9	21.6
	15	189.1	21.7	242.1	27.8
FIXED	3	-363	56.7	-500	78.1
	6	-170.4	26.6	-242.7	37.9
	10	6.6	0.8	-5.3	0.8
	15	124.8	14.3	155.1	17.8

DL = DEAD LOAD
VP = TENDON PRESTRESSS
OTs = OPERATING TEMPERATURE SUMMER
IP = INTERNAL PRESSURE (60PSI)
AT60 = ACCIDENT PRESSURE (60PSI) T = 286 F
E = 0.10 G EARTHQUAKE HORIZONTAL + VERTICAL

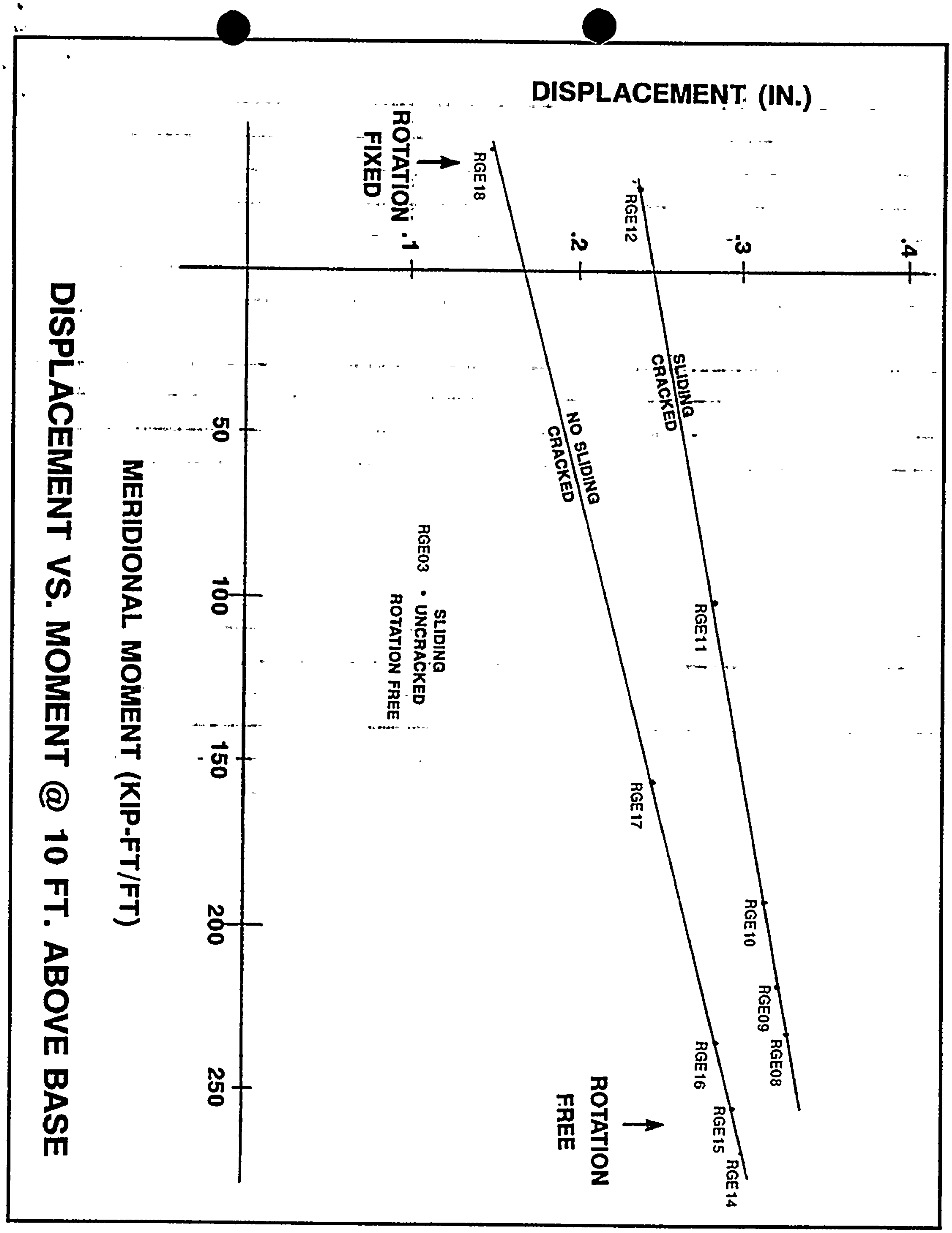
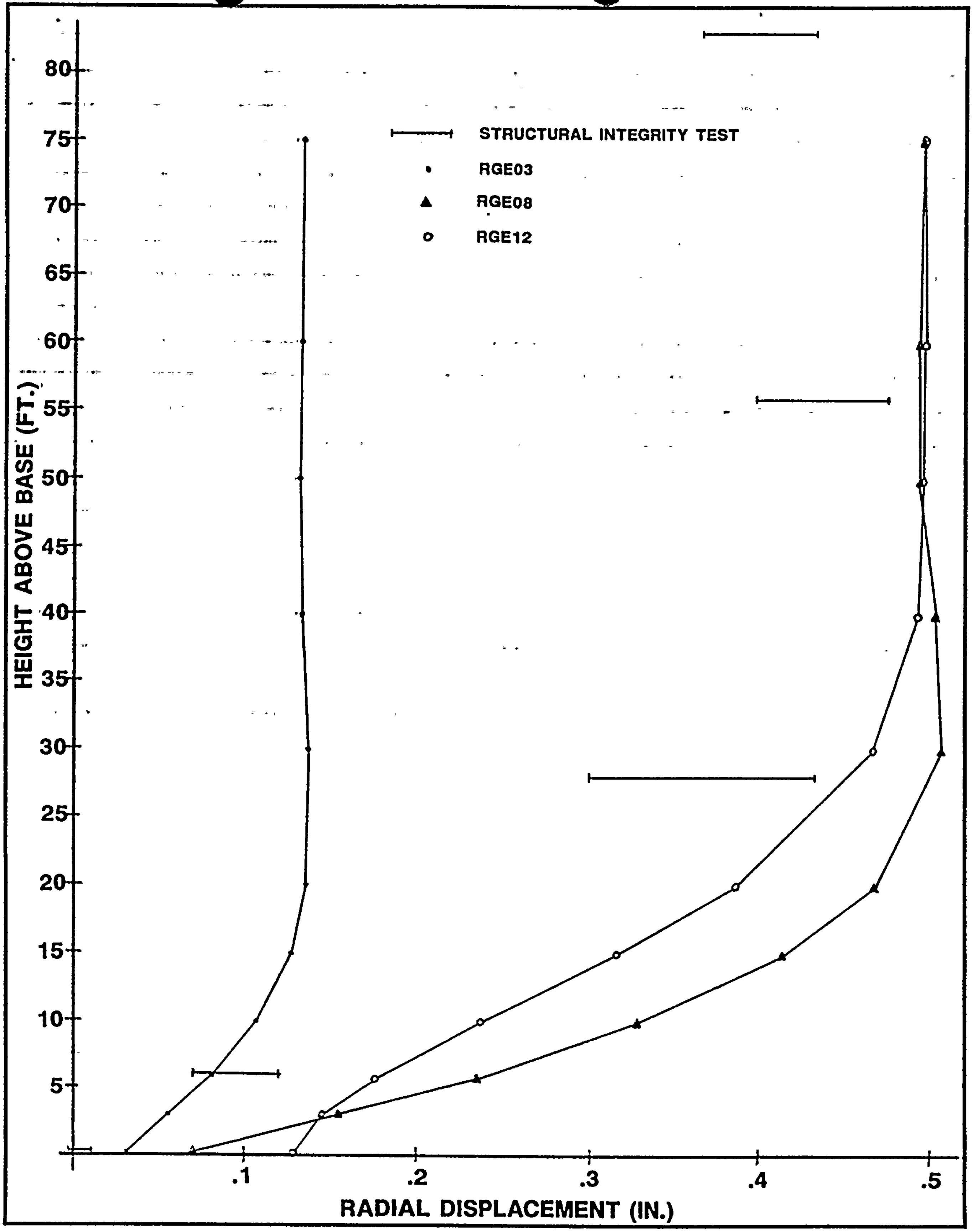

DISPLACEMENT (IN.)
.1
.2
.3
.4
ROTATION FIXED
ROTATION FREE
RGE18
RGE12
SLIDING CRACKED
NO SLIDING CRACKED
RGE11
RGE17
RGE10
RGE09
RGE08
RGE16
RGE15
RGE14
RGE03 • SLIDING UNCRACKED ROTATION FREE
50
100
150
200
250
MERIDIONAL MOMENT (KIP-FT/FT)
DISPLACEMENT VS. MOMENT @ 10 FT. ABOVE BASE

FIGURE 1



CONTAINMENT RADIAL DISPLACEMENT

FIGURE 2