Commonwealth Edison
One First National Plaza, Chicago, Illinois
Address Reply to: Post Office Box 767
Chicago, Illinois 60690

February 23, 1976

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

Subject: Dresden Station Units 2 and 3
Quad-Cities Station Units 1 and 2
NRC Docket Nos. 50-237, 50-249,
50-254, and 50-265

Dear Mr. Paulson:

As requested by Mr. Scinto, we enclose one copy of the letter from Mr. K. W. Hess of General Electric which was listed as a reference in our February 6, 1976 reports concerning the Mark I containment matter. In using this letter, the following facts should be borne in mind.

1. The letter and attachments constitute a package of materials which were telecopied at various times on February 5, with additional modifications and annotations made by Mr. Galle of Commonwealth Edison as a result of telephone conversations with Mr. Hess.

2. The letter represents a preliminary draft of information some of which was incorporated into our February 6, 1976 letter report. Some of this material was employed in conjunction with evaluations and information derived from other organizations and some of the numbers referred to were modified in the design verification process. We believe the numbers remain correct as they relate to Commonwealth Edison Company's plants, but wish to point out that there may have been modifications with respect to the calculations for other facilities and the February 6 letters and any subsequent correspondence from the owners of such facilities should be relied upon in this respect.

Mr. Hess is currently the Acting Project Manager for General Electric's Mark I containment effort and Mr. Galle is the Commonwealth Edison's Section Engineer with responsibility for the Dresden and Quad-Cities analyses. We continue to believe that the information from this letter which was relied upon in Commonwealth Edison Company's

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reports is true and correct.

For your information, we have now obtained actual certification of material strength for the inside torus support columns at the Dresden units. We will submit an addendum to the February 6, 1976 report with this information as soon as possible. While the measured strengths are somewhat different than those referred to by analogy in the report, our judgment that there is strength in addition to the specification value is confirmed.

Very truly yours,

G. A. Abrell
Nuclear Licensing Administrator
Boiling Water Reactors

Enclosure

GENERAL ELECTRIC

D. P. Galle
Commonwealth Edison Company

February 5, 1976
MI-6-03

To: MARK I UTILITIES

From: K. W. HESS

Subject: INFORMATION FOR FEBRUARY 6 LETTERS

Attached are copies of the promised information:

1. Update of ratio values. — Rec'v'd telecon 2/5 6 PM

2. Spectrum analysis of liquid or steam break sizes below which downward load factors occur. This has been augmented by a copy of Section 4.0 of the Vermont Yankee report to illustrate how the break sizes should be applied to your plant.

3. Conservatism discussion to amplify on the three flimsies presented in Washington, D.C.

4. General Electric will evaluate available test data to determine if we can defend reduction of submergence below four feet. We cannot at this time promise that an adequate data base is available so any statement to the NRC should be carefully qualified.

5. A write-up on the probability aspects of a primary system pipe break is attached. Vermont Yankee also has such a paper prepared by them for use with the NRC. NUTECH has copies recieved from Joe Turnage of Vermont Yankee.

6. Bechtels writeup on Plt Evaluations

I would appreciate receiving a copy of your February 6 letter as soon as possible after you have finalized it.

K. W. Hess

K. W. Hess
Acting Project Manager
Mark I Containments
MC 889, Ext. 1330

psj

P.S. This telecopy transmittal will cover Northern States and Iowa Electric. A set of material will be mailed to them.

KWH

Telecon changes - Bill Hess. 2/5/76 6⁰⁰/PM

To Be X'mitted Officially Later

PLANT	COLUMNS (max. load) Load	Strength	Ratio	LUGS Load	Strength	Ratio	PINS Load	Strength	Ratio	WELDS Load	Strength	Ratio	RING GIRDERS SHELL STRESSES Stress ksi	dyn. yield	Ratio
OYSTER CREEK	727	771	.94	643	1155	.56	643	949	.68	786	1914	.41	56	56*	1.0
9-MILE POINT	711	1001	.71	711	1155	.62	711	1328	.54	711	1133	.63	34	42	.81
✓DRESDEN 2&3	898	814	1.10	898	907	① .99	898	1139	.79	1098	2222	.49	27	42	.64
✓QUAD ~~ALIES~~ CITIES 1&2	1003	1441	.70	NA			NA			1003	1122	.89 **	34	42	.81
MILLSTONE 1	823	730	1.13	823	907	.91	823	1139	.72	1006	1914	.53	35	42	.82
✓MONTICELLO	746	814	.92	912	907	1.0	912	1139	.80	912	1881	.48	21	42	.50
VERMONT YANKEE	968	1441	.67		NA			NA		968	1100	.88	28	42	.67
PILGRIM	993	1474	.67		NA			NA		993	1320	.75	28	42	.67
PEACH BOTTOM	1155	1584	.73		NA			NA		1155	1617	.71	28	42	.67
FITSPATRICK	1105	1595	.69		NA			NA		1105	1320	.84	23	42	.55
✓COOPER	1051	1364	.77		NA			NA		1051	~~836~~ 1126	~~1.25~~ 0.93	24	42	.57
✓DUANE ARNOLD	687	858	~~.87~~ .80		NA			NA		687	1496	.46	34	42	.81
HATCH 1	968	1595	.61		NA			NA		968	1001	.97**	29	42	.69
HATCH 2	826	1188	.70		NA			NA		826	1210	.68	26	42	.62
FERMI 2	900	1892	.48		NA			NA		900	1573	.57	25	42	.60

*Actual material properties

~~Column~~ All Strength increased 10% for dynamic loads & material properties

LOADS SUMMARY

① Corrected errors in calc. D.V. by Bechtel

** Indicates discrepancies in field data. To be verified. Numbers may change slightly.

DOWNWARD LOAD

BREAK AREA SENSITIVITY SUMMARY

PLANT	LOAD RATIO (1)	BREAK AREA FRACTION (2)	DBA BREAK, FT^2 (3)	ALLOWABLE BREAK AREA (4)
OYSTER CREEK	1.0	.73	4.69	3.44
DRESDEN 2&3	1.1	.57	4.40	2.51
MILLSTONE	1.18 (5)	.53	4.35	2.31
MONTICELLO	1.0	.79	3.90	3.09
COOPER	1.03	.69	4.67	3.22

(1) MAXIMUM DOWN LOAD/ALLOWABLE DOWN LOAD - WORSE CASE.

(2) REDUCTION IN DBA BREAK AREA REQUIRED TO REDUCE LOAD TO 90% OF THE ALLOWABLE LOAD.

(3) DBA AREA USED FOR LOAD EVALUATION

(4) ALLOWABLE VESSEL LIQUID FLOW AREA.

(5) INCLUDES CORRECTION FOR REVISED DEPTH-OF-SUBMERGENCE.

2/4/76

Item 2: From Vermont Yankee report. Use as an example of how to apply break spectrum values.

4.0 SENSITIVITY TO PIPE BREAK SIZE

4.2 Primary System Line Sizes

The Vermont Yankee plant piping systems were surveyed for pipe sizes that would exceed the 1.77 sq. ft. liquid break area or 2.29 sq. ft. steam break area. The survey of the primary system pressure boundary was accomplished by reviewing the piping drawings and tabulating all major piping systems which connect to the reactor vessel.

The review was confined to piping inside the drywell since a pipe rupture outside the drywell does not pressurize the drywell and release energy to the torus. The review considered all the piping from the reactor vessel to normally close/isolation valves.

The review of the piping arrangement included the classification of the postulated pipe breaks as either double ended or single ended. The criteria for the piping systems depends upon how the piping system being reviewed is connected to the reactor. Thus, the recirculation piping is double ended since both sides of the pipe break connect to the reactor vessel and there are no in-line check valves or quick-acting (within the frame of interest) isolation valves. The core spray piping is a single energy source with one way flow. The core spray piping connects to the reactor vessel, is not interconnected to another piping system inside the drywell, and originates outside containment in a low pressure-low temperature pumping system.

Utilizing these review criteria, one piping system was identified that requires further evaluation. This system, the 16-inch feedwater line, was excluded from the double ended list although two times its cross-sectional area is greater than 1.77 ft^2. It is appropriate not to include this line since the mass release rate from the feedwater pump side of the break with headed feedwater at 375°F is significantly less than that which results from choked flow at the sparger. Thus, when an equivalent break area for the feedwater pump side is computed and added to the pressure vessel side, the sum is less than 1.77 ft^2.

The piping systems and the number of welds in that system which exceed the 1.77 sq.ft. liquid break or the 2.29 sq.ft. steam breakway are listed in Table 4.

All other piping systems are of sizes or configurations which result in less than 1.77 sq.ft. effective break area. The most significant piping systems in this category are listed in Table 5.

The following Ebasco Flow Diagrams were used to make this evaluation:

G-191156	Rev. 7	Main, Extraction and Auxilliary Steam
G-191167	Rev. 15	Nuclear Boiler
G-191168	Rev. 11	Core Spray System
G-191169	Rev. 12	High Pressure Coolant Injection
G-191172	Rev. 13	Residual Heat Removal System
G-191174	Rev. 10	Reactor Core Isolation Cooling System
G-191178	Rev. 9	Reactor Water Cleanup

TABLE 4

VERMONT YANKEE PRIMARY PIPING SYSTEM EXCEEDING EFFECTIVE BREAK AREA AND THE NUMBER OF WELDS IN THAT SYSTEM

	Size	No. of Welds
Recirculation System	28"	37
	22"	20 (including 10 sweepolets)
RHR Return Line	24"	32
RHR Suction Lines	20"	13
TOTAL		102

Note: The above weld count quanitites were obtained from Vermont Yankee personnel by counting the welds that actually exist.

TABLE 5

VERMONT YANKEE - PIPING SYSTEMS HAVING LESS THAN   EFFECTIVE BREAK AREA

SYSTEM	PIPE SIZE
Recirculation	12"
Feedwater	16"
	10"
Main Steam	18"
Core Spray	8"
HPCI (Steam)	10"
LPCI	3"
Cleanup	4"
CRD Hydraulic	3"
RPV Head Flanges	4-6"
Various Instrumentation	1-2"
Standby Liquid Control	1-1/2"

2/4/76

DISCUSSION OF STRUCTURAL CONSERVATISMS

1. Specified Minimum Yield Used vs. Actual Yield

   The actual strengths of materials used in construction generally exceed specified minimum allowable strengths by relatively large margins. For example, tests of A516-GR70 steel (1388 samples from 111 heats) showed that mean yield strength was 32% higher than specified minimum, and mean tensile strength (ultimate) was 10% higher than minimum.

2. Tests Have Always Shown Margins To Calculated Failure

   During the Short Term Program, structural tests were performed on vent support components, downcomer-header assembly, and bellows. Comparisons of test results with analytical predictions have confirmed that analytical procedures are conservative, underestimating actual component strengths.

CONSERVATISMS IN LOAD DEFINITION

Introduction

The methods used in the determination of the upward and downward pressure loads on the Mark I torus exceed a most probable load analysis approach by incorporating many conservatisms in data interpretation and analytical technique. As a result, the loads defined are conservative for the Short Term Programs and provide additional confidence in the results. Among the conservatisms included in the load analysis are application of conservatively calculated FSAR drywell pressurization rate, use of a 100% air flow in the vent system inconsistent with the FSAR pressure history assumptions, and direct application of test data collected for these severe boundary conditions. Significant conservatisms included in the definition of the upward and downward pressure loads on the torus are discussed below.

Upward Load Conservatisms

The upward pressure load is sensitive to the pressure history of the drywell following a postulated LOCA because the driving force for the pool swell and the resulting torus air space compression is increased with a greater drywell pressurization rate. The upward pressure load on the torus has been defined for the Short Term Program by application of the highly conservative calculated FSAR drywell pressurization rate. Specifically, the 1/12th scale tests were run and anlyzed to obtain loads based on the FSAR pressurization history. However, since this pressure history has been used to assure the adequacy of the drywell design pressure, it is biased towards high values. The FSAR pressure history assumes an instantaneous break (mass fluxes evaluated using the Moody Critical flow model assuming slip), no steam condensation in the drywell, and a homogeneous air-steam-liquid flow mixture in the vent. This results in a high pressurization rate and increases the upward load definition.

As an example of the conservatism for the upward pressure load produced by the application of the FSAR pressure rate, consider the reduction in mass flux which occurs with the application of the homogeneous rather than the slip formulation of the Moody Critical flow model. Even for the 20 Btu/lbm subcooled liquid in the recirculation system, the homogeneous model shows a reduction in the mass flux from 8100 to 7100 lb m/sec. ft^2. Using the sensitivity curves, this flow reduction produces a reduction in the upward pressure load of 2 percent. When this margin is applied to the reference plant the net upward load is reduced from 0.19 psid to 0.98 x 5.06 - 4.87 = 0.09 psid. The other conservatisms in the FSAR pressure history will add to this margin.

Another conservatism for the upward load used in the Short Term Program is the assumption of a 100% air flow in the vent system. This conservatism conflicts directly with the homogeneous air-steam-liquid vent flow assumption used to define the FSAR pressurization rate. More consistent assumptions aimed at determining the most probable load basis are possible. One alternative is to apply the FSAR homogeneous air-steam-liquid vent flow assumption for both the pressure history and the non-condensible flow rate into the bubble. The other alternative is to assume 100% air vent flow for both the pressure history and the flow rate into the bubble. If, for example, the former is evaluated, the non-condensible bubble flow rate is reduced by a factor of three and the sensitivity analysis for (A pool/A vent) shows that the maximum upward load will be reduced by a factor of two.

Another contribution to the total upward load on the torus structure is the impact load on the vent header. The impact pressure on the vent header for the Short Term Program was determined by applying the impact velocity measured in the 1/12th Scale tests and the results of the PSTF impact data. However, the PSTF data was obtained for the impact of a slug having a thickness greater than the diameter of the target. In contrast, the 1/12th Scale slug thickness is thinner than the vent header. The reduced slug thickness in the torus allows the liquid to be quickly decelerated under the header immediately following impact. This deceleration, which was observed in the 1/12th Scale tests, would be expected to yield a lower impact load. Indeed, the impact pressure history measured in the 1/12th Scale test by a strain gage on the vent header was a factor of three less in magnitude and three times longer in duration. The more conservative vent header impact pressure was used in the analysis as an added conservation. The 1/12th Scale test results will be substantiated by future testing. (1/6th Scale)

The most probable break size (given that a LOCA will occur) is not in the largest pipe, nor is it necessarily at the worst location of the largest pipe. Of the total number of welds (or maximum stress locations) in all the significantly large size piping in the drywell, only a limited number are in the two recirculation loops in locations which would cause the break size to approach the effective blowdown area necessary to produce uplift for any of the Mark I containment plants. Thus, for these two reasons the most probable or "realistic" effective break size can be expected to be significantly smaller than the DBA assumed for the Short Term Program.

<u>Downward Load Conservatisms</u>

Similar conservatisms have been used in defining the downward pressure load on the torus. The calculated FSAR pressure rate was also used to establish the downward pressure load on the torus. If the finite opening time of the break, reduced mass flux at the break, and steam condensation in the drywell were accounted for, the drywell pressure at vent clearing would be less and the downward pressure load would be reduced. The reduction in the downward pressure load for using a mass flux of 7100 instead of 8100 lb m/sec. ft^2 is 6%.

The data used from the 1/12th Scale tests to define the downward pressure loads was also analyzed in a conservative manner. There was some variation in the maximum downward pressure loads measured for the medium orifice runs considered as a group and for the large orifice runs considered as a group. Instead of averaging the loads measured for the medium and large orifice runs, the greatest magnitude downward pressure loads were identified for both orifice sizes. The Reference Plant downward pressure load was then determined by interpolating between the maximum of the maximum downward pressure loads.

The analysis of the 1/12th Scale test results also did not take credit for any reduction in the downward force due to three dimensional effects and pressure attenuation. The submerged pressure transducers are located at the mid-width of the test section and will feel most directly the pressure of the bubble formed at the downcomers and the water jet forces. Both the bubble pressure and the water jet force will attenuate as one moves circumferentially away from directly below the downcomers. However, since the pressures measured by the transducers were assumed to act uniformly over the width of the test section, a higher than actual reaction force was calculated.

In the typical torus, the downcomers are not spaced uniformly leaving a large section below the vent pipe where the influence of the downcomers is decreased. The downward pressure load produced by the bubble pressure at the downcomers and the water jet forces will be reduced in this section because of the increased distance to the nearest downcomers. However, the pressure loads should not be significantly increased where the downcomers are closely spaced because the measured pressure load of 16.33 psid approaches the driving pressure, the drywell pressure is 17.0 psig at the time of vent clearing. Therefore, due to three dimensional effects and variable downcomer spacing the maximum downward pressure cited for the reference plant of 16.33 psid is conservative.

Bechtel's updated ratio table will be sent later today.

KKHess 2/5/76

BWR SYSTEMS DEPARTMENT
SAN JOSE, CALIFORNIA

February 4, 1976

TO: K. W. Hess, Acting Project Manager
Mark I Containments
MC 809

FROM: S. A. Wilson

SUBJECT: The Probability of LOCA In Piping 18" and Larger, In the Ensuing 60-Day Operating Period

-PRELIMINARY-

For a basis we take the annual occurrence rate of LOCAs, per BWR plant, in lines 6" and larger between the vessel and second isolation valve (primary pressure boundary), estimated by Rasmussen in WASH-1400, to be 10^{-4}. This is the expected number of occurrences per year, identically the mean occurrence rate; and practically, the probability of one occurrence per year. We assume, for the present, that this rate is constant in time, and per piping component and one related joint. We recognize that LOCAs require some stress value, due to normal operation or not; and that stress value must be at the same location and acting transverse to some crack, or not if the stress magnitude is large enough.

The 10^{-4} value may be reduced quantitatively to arrive at the subject probability, in the following ways:

1. Consider the shorter time period. Assuming that the rate stated applies to 360 days in the year, multiply by 60/360, or 1/6. (This fraction could be adjusted upward slightly to reflect annual operating days - less than 360 - of the plants considered in the 10^{-4} figure.)

2. Consider the fraction of piping involved. Since piping cracks are nearly always at joints, use the fraction of joints. Multiply by (number of joints in piping 18" and larger/total number of joints 6" and larger), both in primary pressure boundary, and both for carbon and stainless steel, or any other materials used. This is typically a ratio of 70/175, or 1/2.5.

3. Consider involvement of only large piping, compared to all piping 6" and larger. Due to judgements such as decreased likelihood of high stress, the ratio of probability of severance in pipe size range 16" and greater compared to that 6" and greater, can be found from Table 10-2 in GEAP-20615 to be approximately 1/12. However, the judgements in GEAP-20615 must be understood and accepted by the user as reasonable before applying this factor.

The 10^{-4} value may be subject to qualitative reduction for the following reasons:

1. The instantaneous, double-ended break may not always characterize a piping severance, because of restriction of piping movement due to presence of seismic restraints and other pipe. Slow crack propagation does not appear to be indicated, however, where average speed in BMI-1866 is 375 feet per second steady state, preceded by a few inches of propagation at approximately 1/10th this speed. Such speeds give full circumferential separations in less than 0.1 second in large piping.

2. No IGSCC cracks due to intergranular stress corrosion cracking (IGSCC), a possible damage mechanism pertinent to stainless steel, have been found in any BWR piping systems using sizes 18" and larger.

The question of the benefit of a special program of nondestructive testing for cracks may be considered. For illustration, hypothesize the following:

1. The 10^{-4} value applies without any in-service inspection program.

2. All LOCAs are due to large cracks.

3. Such large cracks have taken exactly three years to grow, (based on growth through the wall of 0.001" per day (IGSCC average, NEDO-21000-1), x 365 x 3 = 1.095" in three years, the approximate wall thickness of piping 18" and larger).

4. A crack is available for detection for the entire three years.

5. In-service inspection is 100% effective.

Thus, for some consecutive three years in 10,000 one joint in primary piping 6" and larger has a crack available for detection, which will lead to a LOCA, but if inspected for, will certainly be detected. If no inspection is ever performed, the 10^{-4} value applies (and there may be leaks, at least 20 times as frequently as a severance; see SEAP-4574.) If inspection is performed on all joints once every three years, no LOCA will ever occur. Neither will it occur if inspection is performed oftener than every three years. If complete system inspection is performed every four years, the probability per year of a LOCA is $(1/4)\times10^{-4}$; if complete system inspection is performed every ten years, the probability per year of a LOCA is $(7/10)\times10^{-4}$. We assume complete system inspection was performed prior to startup, eliminating any cracks remaining from manufacture, and that these did not play a major role in the 10^{-4} value. Now, for a LOCA to occur in the next 60 days, it must be due to a crack which began in the 60 day period following three years ago. That probability is the same as that a LOCA will occur in piping 18" and greater in size in the next 60 days: $10^{-4} \times (1/6) \times (1/2.5) \times (1/12) = 5.45 \times 10^{-7}$. This probability can be reduced to zero by inspecting all piping 18" and larger now. There is, of course, a probability of but 5.45×10^{-7} of encountering a crack which will cause a LOCA in the next 60 days, which may appear to be negligible; but that figure can be reduced to zero by such inspection. The question is merely whether, on balance, the greatest benefit derives from reducing that figure.

With respect to the hypotheses:

1. ISI has not been a common practice in the past in other types of plants on which the 10^{-4} figure is based, so this hypothesis if probably valid.

2. Causes of LOCA can be hypothesized which do involve high stress, but not necessarily large cracks. The probability of LOCA due to their occurrence will not be reduced by ISI.

3. Growth time will vary, depending on stress, material condition, cycling frequency, and environment. A wide distribution could be considered, but with little impact on the final result.

4. Effectiveness of ISI increases with crack size, and varies with exact crack orientation, location and configuration; but "visibility" up to the weld, on the inside surface, is regarded as best in large pipe (due to relationships between transducer beam angle, transducer diameter, angle of weld bevel, and wall thickness).

5. Probability of detection in the first year of such a growing crack is probably less than in the last year. But only a "last year" crack can cause LOCA in the next 60 days, so ISI effectiveness in detecting such a crack can be considered high.

S. A. Wilson, Statistician
Applied Mechanics Unit

SAW/et

Summary of Plant Evaluations

The torus support systems were reviewed in detail to determine the available strengths of the structural details and components that transmitted the loads to the foundation. This was a scoping review that used regular design rules and handbook methods for ultimate strength estimates. These strengths were uniformly increased by 10% to represent an expected increase in material properties beyond specification minimums and also to account for a dynamic increase due to an extremely short duration of maximum loads for about 50 milliseconds.

The ratios of load/strength for each detail or component were formed so that the adequacy could be quickly assessed. Where the ratio is below 1.0 then the estimated load is below the estimated strength and vice versa for ratios greater than unity. The significance of ratios greater than one is discussed next.

COLUMNS

The maximum ultimate capacity of columns was determined by standard methods using interaction formulas to account for moments. An eccentricity of 0.8" for moments and k-factor of 1.0 was assumed for all plants. The behavior of a column loaded up to its maximum capacity was assumed to be effectively represented by an elastic - perfectly plastic load-deflection curve. This assumes that the column load carrying capacity neither increases nor suddenly decreases when the buckling limit is reached. Since the loads are applied rapidly and are of short duration then the expected behavior is to cause local excursions into yield for the affected columns, hence local damage, and finally recovery without failure. An elastoplastic computer model was arranged to yield at loads of 1215 kips, 1000 kips and 800 kips. These were loaded by a column reaction-time history that peaked at 1215 kips. These models showed that the maximum deflections of columns loaded to their capacity should remain below a ductility ratio of 10 and the deflections should not become unlimited.

PIN JOINTS

Only five plants have columns with lug and pin details at the lower ends. The most critical ratios are for loads reaching the ultimate bearing capacity of lugs or pins. The bearing strength was determined for an ultimate stress of 80 ksi. This was a compromise between a 10% increase on the ultimate tensile of 70 ksi and evidence that suggests an ultimate bearing of 90 ksi may be used. The significance of ratios close to or greater than 1.0 in that local contact damage can be expected.

WELDED JOINT

The torus columns are welded to the ring girders. A conservative approach was used with H-section connections, according to conventional design methods. The resultant shear (tangential to the girder) was assigned to the web welds and bending forces were assumed taken by the flanges. Hence the flange contribution to shear resistance was ignored. Ultimate shear capacity was derived from 60% of tensile ultimate. Because of the conservative estimate of strength and since compressive stresses act across the shear zone, and since the loading duration is short (50 milli-seconds), then it was judged that these welds, loaded at or above the estimated capacity, would not be expected to fail.

RING GIRDER

Ring girder stresses for the plants were estimated from static equivalent analyses based on the results of dynamic analyses of the reference plant. These stresses were compared to the material yield stress, increased by 10% as previously described. Hence the capacity ratios in this case did not signify ultimate capacity being reached but whether elastic capacity had been exceeded. A ratio of 1.0 would indicate the beginning of activating the local plastic moment capacity. A significant load capacity is available in these ring girders beyond first yield so that any ratios near 1.0 do not signify a failure of the system, especially under short-duration loads.

H.A.F. / [illegible]

BECHTEL

Discussion of Conservatisms in Load Definition and Bechtel's updated ratio will be sent later today.

2/5/76 KWHess