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O. W. DIXON, JR.
VICE PRESIDENT
NUCLEAR OPERATIONS

July 10, 1984

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Virgil C. Summer Nuclear Station
Docket No. 50/395
Operating License No. NPF-12
Spent Fuel Pool Rerack Modification

Dear Mr. Denton:

In a letter dated January 23, 1984, South Carolina Electric and Gas Company (SCE&G) requested approval from the Nuclear Regulatory Commission (NRC) for a proposed rerack modification to the spent fuel pool at the Virgil C. Summer Nuclear Station. In letters dated March 6, 1984, April 4, 1984, April 17, 1984, May 11, 1984, May 18, 1984 and May 30, 1984, SCE&G provided responses to NRC Staff questions on the proposed rerack modification. This letter is provided in response to additional questions raised by the Staff in the modification review process.

The first question concerns the basis for the seismic inputs used for the rack design and analysis. The basis and justification for assuming the Safe Shutdown Earthquake (SSE) response spectrum envelope accelerations equal to 1.62 times that of the Operation Basis Earthquake (OBE) is found in section 3.7.2.2, "Natural Frequencies and Response Loads" of the Virgil C. Summer Nuclear Station Final Safety Analysis Report (FSAR). Section 3.7.3.6, "Three Components of Earthquake Motion" of the FSAR describes the analysis used to obtain the maximum value of a response due to the simultaneous action of three (3) earthquake components. As stated in this section, the calculations are in conformance with Regulatory Guide 1.92, "Combining Model Responses and Spatial Components in Seismic Response Analysis."

The second question requests the time step of integration used in the seismic analysis. The time step used for all runs was .00002 seconds. This interval was obtained by using a fraction of the period associated with the highest expected system frequency.

The third question asks for further clarification on which modules were seismically analyzed supplemented by more detail on the analysis results. Detailed analyses were performed on racks A2 and C1 (see attached Figure 2.1). These were the largest modules and representative of the different types of

A001

internal constructions used in the separate regions. The vertical reaction histories for racks A2 and C1 are enclosed as attachments 2 and 3, respectively. These rack histories assume the SSE case with a coefficient of friction equal to .8.

The fourth question requests the loading pattern used in the analysis. The racks were analyzed assuming a symmetrical (within ten percent (10%)) loading pattern.

The fifth question concerns the results obtained from the tipping analysis. The small deflection analysis was used for the tipping calculation and the potential for impact was disregarded. If the maximum horizontal rack deflection exceeded 3% of the total rack height under the assumed 1.5 SSE horizontal quake, an alternate analysis method would have been utilized. However, in the tipping analyses performed for rack module A2, the maximum corner displacements obtained were 1.62 inches in the east-west direction (see Figure 2.1) and 1.55 inches in the north-south direction. Additional analyses were also performed to determine the displacements for rack B (see Figure 2.1). These displacements were .74 inches in the north-south direction and 1.0 inches in the east-west direction.

The sixth question requests detailed drawings of the rack modules. Chapter 3 of the original licensing submittal contains drawings of all the rack modules. These drawings include schematics demonstrating typical rack assembly and overall dimensions. Also included in these drawings is the welding sequence utilized for the module fabrication. If additional drawings are required, SCE&G can provide further detailed proprietary drawings from Joseph Oat Corporation, the designers and fabricators of the racks.

The seventh question requests information on the model and computer code used for the spent fuel pool structural analysis. The computer code used for the re-evaluation of the pool structure under the new rack loading is "Inhouse McAuto ICES STRUDL, GAI Program #S110 Revision 3," certified to Gilbert Associates' Computer Application Manual (CAM). The models used for this analysis are shown on the enclosed attachments 4 and 5. The beam strip theory was considered to be a conservative analysis method because of the thickness of the slab in relation to the span and column width.

The eighth question concerns the forces in the pool structure resulting from seismic activity. The seismic forces generated by the mass of the concrete and water were determined using accelerations obtained from the building structure seismic analysis floor response spectra for the appropriate elevations in the structure.

The equivalent static load factor approach (i.e., some factor times the overall weight of the rack) was only used for the evaluation of vertical impact loads from the new racks and fuel. Based on previous experience with similar racks and analyses, an equivalent static factor of two (2) was recommended by the rack fabricators (Joseph Oat Corporation) to account for seismic SSE vertical impact rack forces. The factor of 2 was used for the overall effect of the rack seismic analysis and was conservatively increased to 3 to account for localized effects. Further calculations using the results obtained from the seismic analyses support the selection of these load factors.

A factor of 1.23 was initially used for the OBE condition. Further computational analyses indicted that a factor of 1.62 was the factor which would allow the same degree of conservatism for OBE as the 2 factor provided for SSE. However, subsequent review of the structural analysis showed that for the load combinations governing maximum tension on the outside face of the walls and slab, the seismic contribution was only approximately 5% of the total while the temperature gradient effects accounted for approximately 80% of the total. In addition, the seismic portion of the load combination for the inside face of the structure did not exceed 25% of the total. Therefore, our conclusion was that since the overall seismic force contribution was small relative to the thermal effects, a slight increase in the OBE factor from 1.23 to 1.62 would have a minimal effect on the overall calculated required pool structural capacity. As shown in Table 7.2 of the January 23, 1984 submittal, ample margin exists between the calculated required pool capacity and the available pool capacity.

Seismic horizontal forces transferred by friction to the pool floor from the feet of the rack modules were not included in the analysis because these moment effects on the floor slab are minimal compared to those moments generated by vertically applied loads. In addition, the rack modules will respond out of phase to each other thus minimizing the net moment result. However, a check was made on the floor plates to ensure that these localized friction forces could be safely transferred to the concrete pool slab.

It is noted that rack module impact loads cause high localized stresses on the concrete directly underneath the leg. However, the pool slab and walls are protected with a 1/4 inch thick stainless steel liner plate. Even under the most adverse conditions, assuming the total impact load from a module is transmitted through one support leg, the allowable concrete bearing stress is not exceeded.

The ninth question requested information on the type of cracked and uncracked analysis performed to determine the stresses due to thermal gradients in the pool. The principles used to perform the cracked section analysis were similar to those described in ACI 349.1R-8, "Reinforced Concrete Design for Thermal Effects on Nuclear Power Plant Structures." The uncracked section analysis results were extracted from the STRUDL computer code referenced previously.

If you have any further questions, please advise.

Very truly yours,

O. W. Dixon, Jr.

AMM/OWD/gj

cc: V. C. Summer
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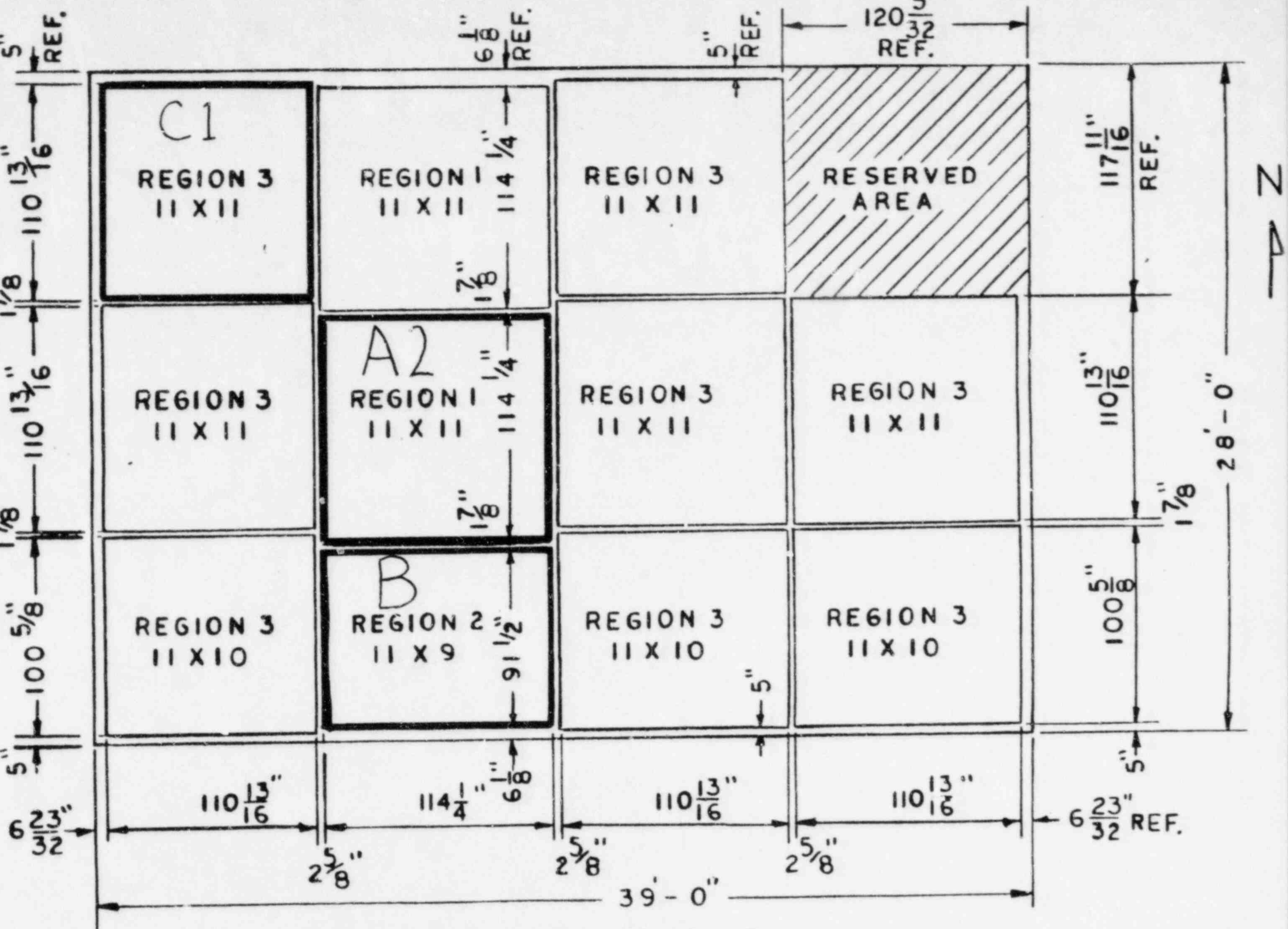
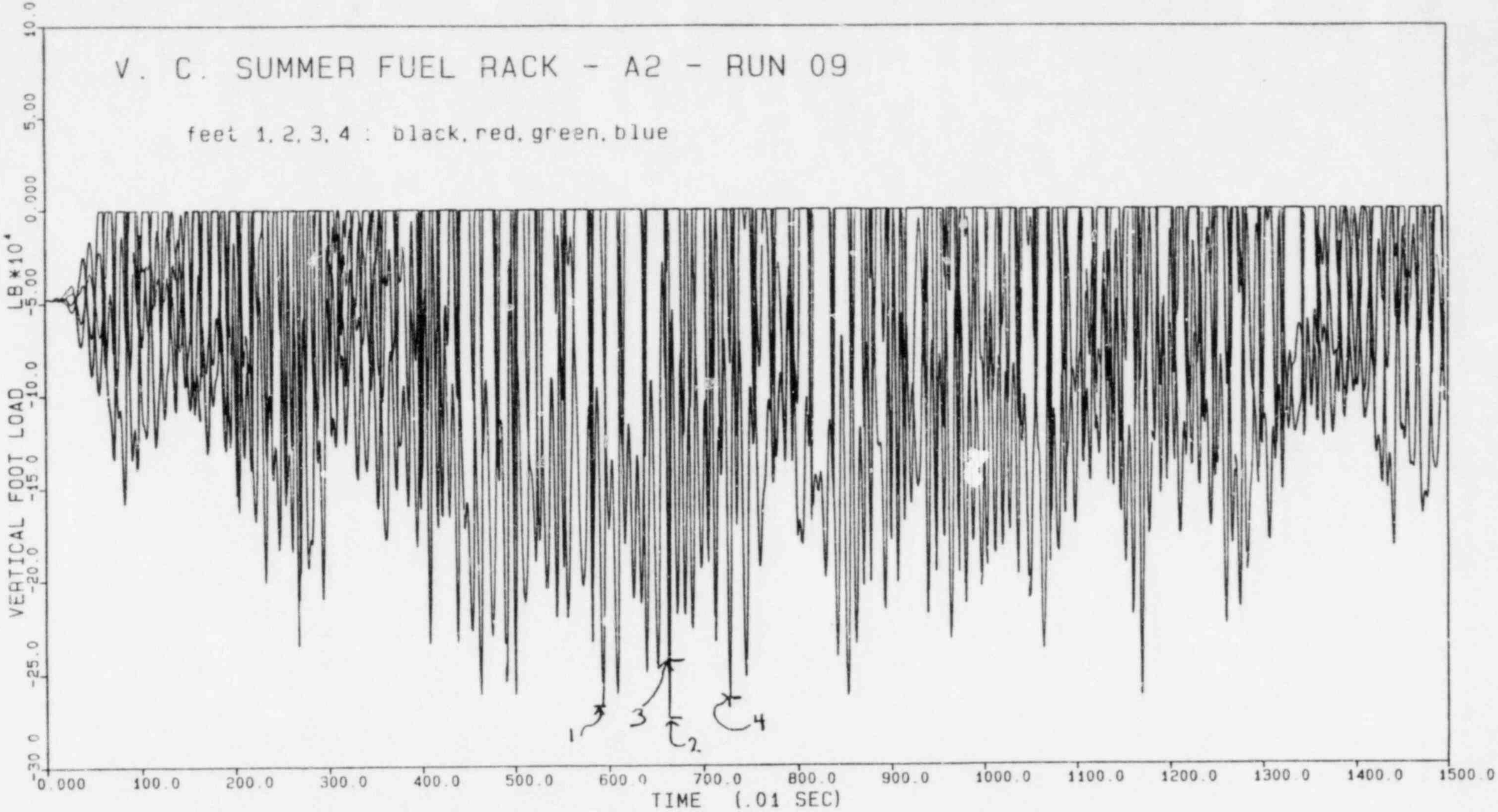


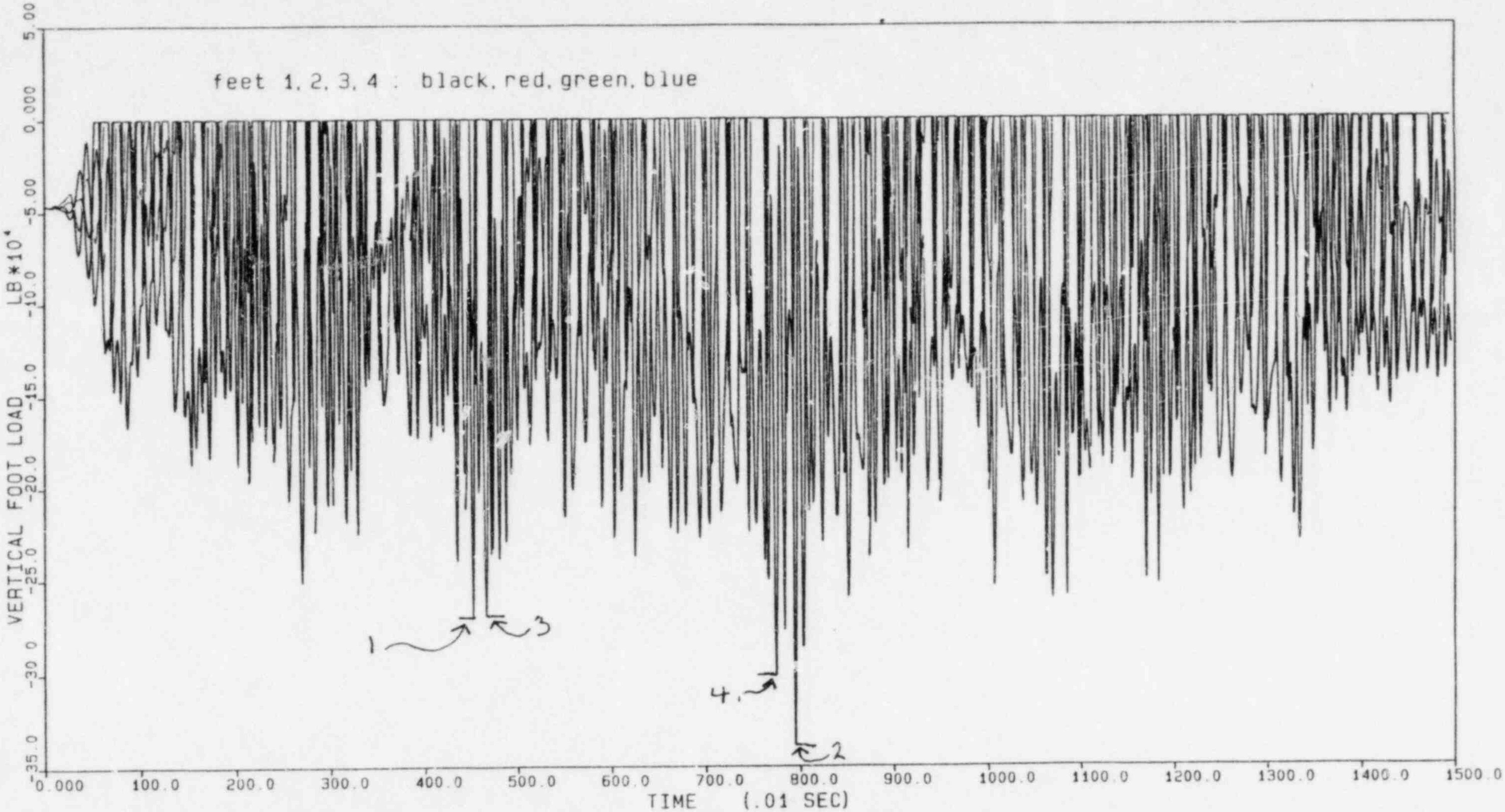
FIG. 2·1 MODULE LAYOUT

Attachment 2



Attachment 3

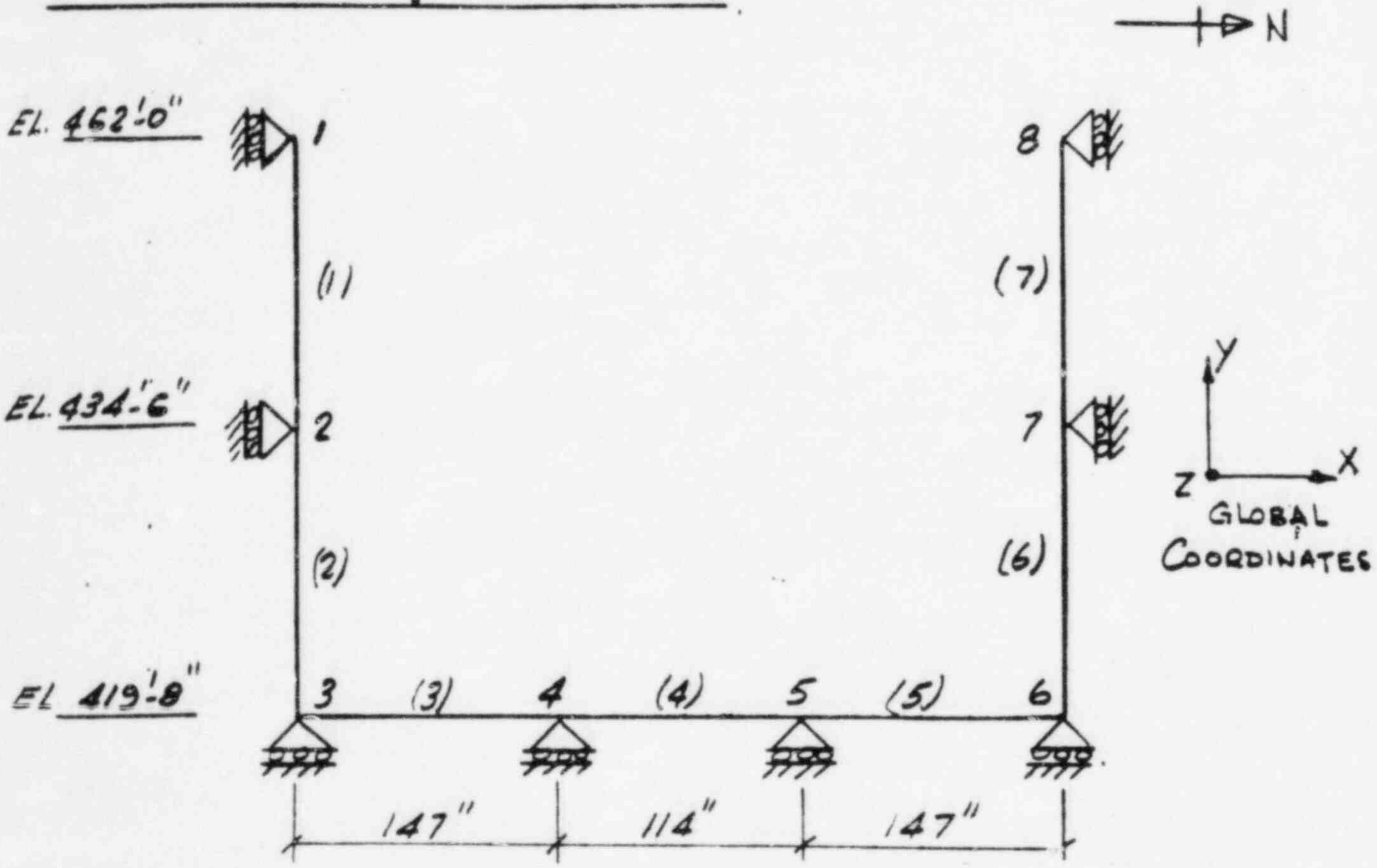
V. C. SUMMER FUEL RACK - C1 - RUN 20



Attachment 4

SUBJECT SPENT FUEL POOL STRUCTURE RE-EVALUATION. Q1		IDENTIFIER		PAGE ___ OF ___ PAGES
REV.	0	1	2	3
MICROFILMED				
ORIGINATOR				
DATE				

STRUDL MODEL (NORTH - SOUTH)



JOINT RELEASES

1 2 7 8 FORCE Y, MOM. Z
3 4 5 6 FORCE X, MOM Z

MEMBER RELEASES

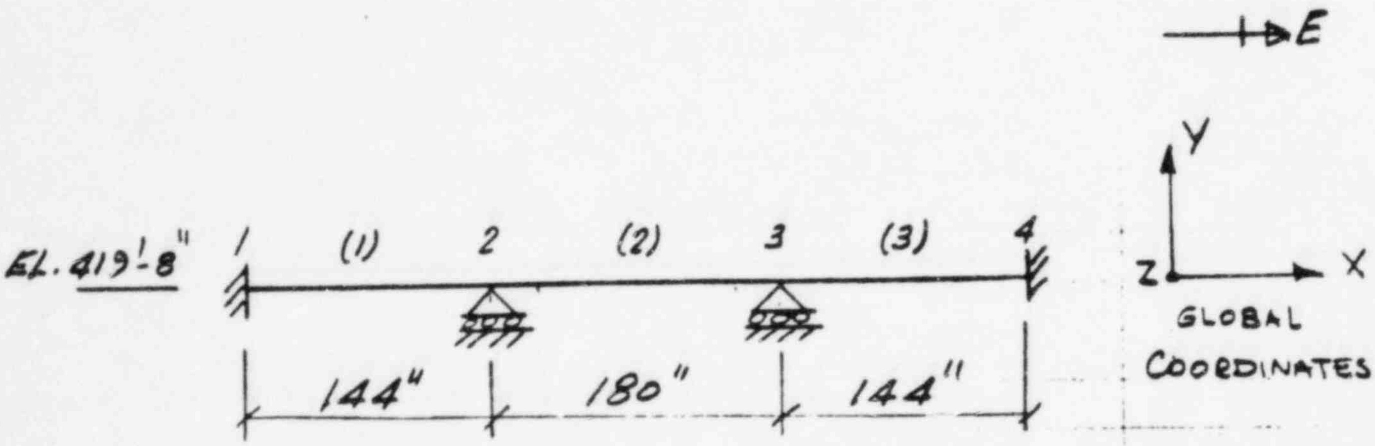
NONE

ALL MEMBERS 12" WIDE X 72" THK.

Attachment 5

SUBJECT SPENT FUEL POOL STRUCTURE RE-EVALUATION Q1		IDENTIFIER		PAGE ___ OF ___ PAGES
REV.	0	1	2	3
MICROFILMED				
ORIGINATOR				
DATE				

STRUDL MODEL (EAST-WEST)



JOINT RELEASES

2 3 FORCE X, MOM Z

MEMBER RELEASES

NONE

ALL MEMBERS 12" WIDE x 72" THK.