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September 20, 1984

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

Subject: Byron Station Units 1 and 2
Braidwood Station Units 1 and 2
Pipe Whip Restraints Utilizing
Crushable Energy Absorbing Material
NRC Docket Nos. 50-454/455 and 50-456/457

References (a). B. J. Youngblood letter to D. L. Farrar dated July 21, 1983

(b): E. D. Swartz letter to H. R. Denton dated September 8, 1983

(c): E. D. Swartz letter to H. R. Denton dated September 7, 1984

Dear Mr. Denton:

On August 29, 1984, a meeting was held in the NRC Region III offices between Region III, NRR, and Commonwealth Edison and our consultant (Sargent & Lundy) personnel to discuss the remaining NRC concerns with the use of energy absorbing material (EAM) in certain of the pipe whip restraints utilized at our Byron and Braidwood Stations. At this meeting, the NRC staff requested that we provide a list of all installed pipe whip restraints utilizing a design concept consisting of a single EAM compression member with a single tension member, an analysis showing the bounding installation(s), and the finite element analysis results which demonstrate the adequacy of design of the bounding installation(s).

The purpose of this letter is to provide this requested information including the list of all restraints utilizing the configuration discussed above, and the results of the detailed nonlinear finite element analysis of the three worst case restraints SI3R-640A, FWR-35 and FWR-16.

A typical restraint using the design concept consisting of a single compression member with energy absorption material (EAM) and a single tension member is shown in the enclosed Figure 1. In this conceptual design, the pipe whip energy can be absorbed either

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by crushing of the EAM or by yielding of the tension rod by adjusting the relative sizes of the EAM and the necked down area of the tension bar. When the pipe whip energy is to be absorbed in the EAM, the tension rod area is sized large enough not to yield at the load the EAM crushing starts. When the pipe whip energy is to be absorbed in the yielding tension rod, either the EAM is not provided or when provided (because of other pipe breaks), it is sized large enough not to crush at the load magnitude initiating the yielding of the tension rod.

The enclosed Table 1 lists all restraints utilizing the single compression member with EAM and a single tension member concept. In this table for each pipe whip restraint, the angle from the tension leg to the blow down force direction is listed. Also listed is the member (tension leg or compression leg) in which the pipe whip energy is being absorbed. Under the remarks column, the restraints which are no longer required based on final as built walk down and piping analysis are identified.

The table lists 27 total restraints, 10 of which have been deleted. In 8 of the remaining 17 restraints, the pipe whip energy is being absorbed by yielding of the tension rod without crushing of the EAM. Thus, the NRC staff's concerns on EAM energy absorption properties are not applicable to these restraints. In 10 of the 17 restraints, the pipe whip energy is being absorbed by the EAM crushing. Note restraint RH-R1 is governed by the tension leg for breaks 2 and 3, and by the compression leg for break 1.

In Reference (a), the NRC staff stated, "The staff believes that the tension member for two restraints (identified as FWR-35 and SI3R-640A) will be in compression (not tension) during the initial loading phase. Consequently, the EAM will be subjected to a load angularity and deformation not explicitly considered in the restraint design nor in the test plan. Furthermore, the EAM will be subjected to an additional bending moment (in conjunction with the compressive and lateral loadings) which is also not considered in the restraint design nor in the test plan." (Reference (b) stated the Commonwealth Edison position that it was not possible for Hexcel/MCI to perform a dynamic test to simulate the FWR-35 restraint design utilizing the existing test configuration.) This NRC staff observation was based on the fact that the angle between the tension leg and the blow down force direction for these two restraints was less than 90°.

In response to the NRC staff's concern, we have performed a detailed finite element nonlinear, large deflection analysis of pipe whip restraints FWR-35, SI3R-640A, and FWR-16. FWR-16 was added to the list of restraints because it is the third worst case restraint from the load angularity criteria as shown in the enclosed Table 1. As stated during the August 29, 1984 meeting, both FWR-35 and FWR-16 have been deleted and are no longer required.

The analysis model and resulting responses are summarized in the attached SAD Report 442 entitled, "Finite Element Analysis of Pipe Whip Restraints SI3R-640A, FWR-35 and FWR-16". In this analysis, possible buckling of the tension rod and the direct compression with shear and bending moment on the EAM is considered.

This analysis shows that the maximum strain in the EAM is less than 21% for the three cases. The deformed shape of the EAM is also bounded by the EAM deformation achieved in the Byron Station impact loading in angularity configuration tests. In addition, this analysis also shows that the tension leg is in tension at all levels of load and the question of buckling of the tension rod does not arise. Based on the results of the detailed nonlinear finite element analysis of the three worst case restraints, it is our conclusion that the Byron and Braidwood Station pipe whip restraint design is conservative and that these restraints will perform their intended function.

Reference (c) provided the simplified sketches for the 79 Sargent & Lundy and 23 Westinghouse designed pipe whip restraints as also requested during the August 29, 1984 meeting. Our response to the remaining open items identified and discussed during the meeting is currently undergoing our final review and will be provided early next week.

One signed original and fifteen copies of this letter with the Enclosure are provided for your use. Additionally, this information package is being sent directly to Region III.

Very truly yours,

E. Douglas Swartz

E. Douglas Swartz
Nuclear Licensing Administrator

Enclosure

EDS/rap

cc: J. A. Stevens - LB1
J. Streeter - RIII

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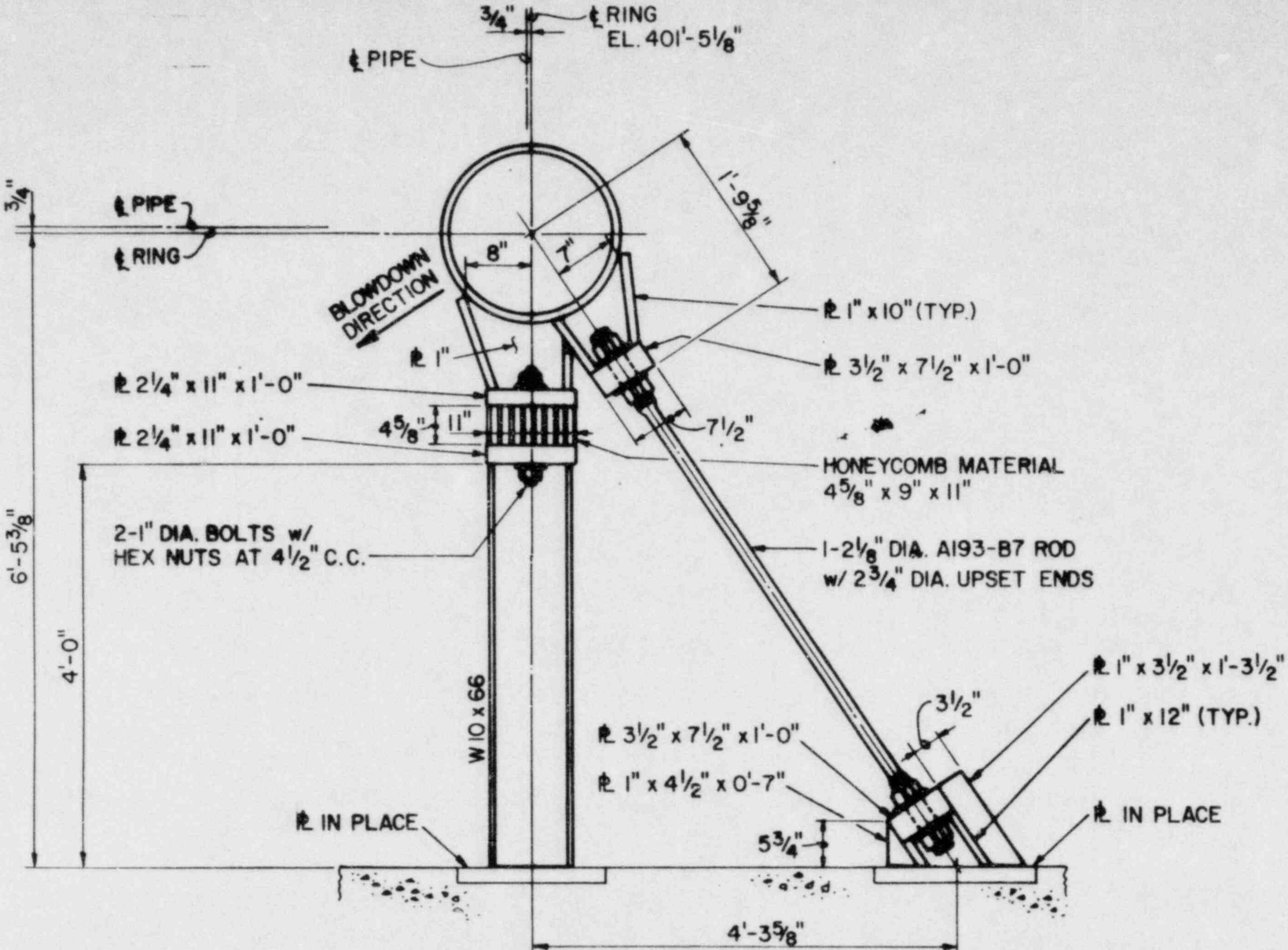
TABLE 1: LIST OF PIPE WHIP RESTRAINTS WITH A SINGLE EAM COMPRESSION MEMBER AND WITH A SINGLE TENSION MEMBER

PIPE WHIP RESTRAINT NO.	ANGLE FROM TENSION LEG TO BLOW DOWN DIRECTION	YIELD IN COMPRESSION OR TENSION LEG (*)	REMARKS
FWR-3	107°	C	
FWR-4	109°	C	DELETED
FWR-6	90°	C	DELETED
FWR-12	110°	T	
FWR-13	121°	T	DELETED
FWR-16	91°	T	DELETED
FWR-25	102°	T	DELETED
FWR-27	109°	T	DELETED
FWR-30	112°	T	DELETED
FWR-31	135°	T	
FWR-35	78°	C	DELETED
FWR-36	106°	T	DELETED
FWR-38	107°	C	DELETED
FWR-39	111°	T	
MS-P10	164°	T	
MS-P25	168°	T	
MS-R1	133°	C	
MS-R2	135°	C	
MS-R9	135°	C	
MS-R10	131°	C	
MS-R11	135°	T	
MS-R49	135°	T	
SI1R-10B	122°	C	
SI3R-640A	84°	C	
SI4R-15B	92°	C	
RH-R1 (BRK-2, 3)	135°	T	
RH-R1 (BRK-1)	113°	C	
RH-R3	116°	C	

* T = Tension Leg
  C = Compression Leg



TYPICAL WHIP RESTRAINT UTILIZING TENSION-COMPRESSION MEMBER CONCEPT

FIGURE 1