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Docket No. 50-245
B10347

Mr. Darrell G. Eisenhut, Director
Division of Licensing
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

References:
(1) W. G. Counsil letter to D. G. Eisenhut, dated October 24, 1980.
(2) W. G. Counsil letter to D. G. Eisenhut, dated January 21, 1981.
(3) W. G. Counsil letter to D. G. Eisenhut, dated March 20, 1981.
(4) D. G. Eisenhut letter to All Licensees of Operating BWR's and Applicants for BWR Operating Licenses (Generic Letter No. 81-18), dated March 30, 1981.
(5) W. G. Counsil letter to D. M. Crutchfield, dated April 10, 1981.
(6) D. M. Crutchfield letter to W. G. Counsil, dated March 13, 1981.
(7) W. G. Counsil letter to B. H. Grier, dated July 27, 1980.

Gentlemen:

Millstone Nuclear Power Station, Unit No. 1
BWR Scram Discharge System:
Diverse Instrumentation Requirement

The purpose of this submittal is to document the position of the Northeast Nuclear Energy Company (NNECO) regarding the NRC Staff's requirement for diverse scram level-sensing instrumentation in the scram discharge system.

Background

As indicated in Reference (1), NNECO participated fully in the development of the evaluation criteria for the scram discharge system by the BWR Owners' Group Ad-Hoc Committee on I&E Bulletin No. 80-17. These criteria were prepared in concert with the NRC Staff. It was the BWR Owners' Group's determination (and believed to also be the NRC Staff's determination) that compliance with such evaluation criteria would provide more than reasonable assurance of reliable and safe operation of the scram discharge system.

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As further indicated in Reference (1), NNECO committed to reevaluate the Millstone Unit No. 1 scram discharge system against such evaluation criteria, and to submit to the NRC Staff the results of this reevaluation along with a schedule for implementation of any required modifications, by December 15, 1980. However, based upon the fact that NNECO believed a NRC Generic Safety Evaluation Report (SER) regarding BWR scram discharge systems was being transmitted to all BWR licensees, NNECO concluded it would be more appropriate to perform the above-mentioned reevaluation after reviewing the NRC Staff's positions represented in the Generic SER. Therefore, in Reference (2), NNECO proposed to submit the results of the reevaluation, along with a schedule for implementation of any required modifications, within thirty (30) days after receipt from the NRC Staff of the Generic SER. NNECO submitted such information in Reference (3).

In the Generic SER, the NRC Staff indicated that the existing scram discharge volume (SDV) "level instrumentation has experienced some failures. These failures have demonstrated the potential for common-cause failures and therefore, common-cause failures may be the most significant contributor to the unreliability of the scram function. Although it is now believed that the common-cause failures (i.e., hydrodynamic forces) have been identified for the crushed floats, there are still concerns for other common-cause failures such as human error (particularly during testing), crud buildup or manufacturing errors. Therefore, it is the" NRC Staff's "position that each BWR licensee should address . . . common-cause failures with respect to the SDV level instrumentation provided for reactor scram." As a result of this position, a requirement for diverse SDV level instrumentation was added to the BWR Owners' Group evaluation criteria by the NRC Staff in their Generic SER, even though it was believed that the evaluation criteria adequately dispositioned all NRC Staff concerns.

For Millstone Unit No. 1, acceptable means of complying with this additional requirement would be to replace two (2) of the existing four (4) Magnetrol float level switches with either level-sensing instrumentation of a diverse type (i.e., different operating principle) or float level switches made by a different manufacturer. An additional option to meet the diverse instrumentation requirement regarding operator action in conjunction with an alarmed continuous SDV monitoring system, which was originally included in the Generic SER, was withdrawn by the NRC Staff in Reference (4). The NRC Staff further indicated in Reference (4) that they consider "diverse instrumentation for the automatic level sensing system on the Scram Discharge Volume to be a necessary and important provision that will enhance the overall reliability of the BWR Scram System." In Reference (3) as well as in Reference (5), which was submitted in response to Reference (6), NNECO informed the NRC Staff that since the requirement for diverse instrumentation had been added to the BWR Owners' Group evaluation criteria by the NRC Staff, further evaluation of common-cause failures of the scram level instrumentation would be required.

Initial NNECO Position

Subsequent to NRC Staff review of References (3) and (5), the basis for the diverse instrumentation requirement was discussed between our staffs on several occasions. Of particular interest to the NRC Staff was whether or not we intended to comply with this requirement. It was NNECO's position that no significant benefit (or even potentially an adverse effect) would be achieved by implementation of such a requirement at Millstone Unit No. 1. Our position was based upon the following:

- In more than ten years of operating experience at Millstone Unit No. 1, the six (6) Magnetrol float level switches in the scram discharge system have never experienced a failure. This was documented to the NRC Staff in Reference (7) in response to I&E Bulletin No. 80-14.

- Damage to Magnetrol float level switches experienced at other BWR's was due primarily to improper instrumentation piping configurations. Such configurations do not exist at Millstone Unit No. 1. Additionally, Magnetrol float level switches of the vertical acting type have experienced some minor problems. The Magnetrol float level switches utilized at Millstone Unit No. 1 are of the horizontal acting type. We are not cognizant of any failures of this type of Magnetrol switch in other BWR scram discharge systems.

- Our assertion that float level switches are the most appropriate level sensing switch for this application.

- Significant modifications to the scram discharge system were already planned to comply with the BWR Owners' Group evaluation criteria and the NRC Staff's Generic SER. NNECO maintained that these planned modifications will by themselves significantly increase the availability of the scram discharge system to function as required. The major improvements include:

  (i) incorporation of an instrumented volume tank (IVT) for each of the two (2) SDVs,

  (ii) augmentation of the SDVs to meet the 3.34 gallons per CRD requirement,

  (iii) replacement of all 2" piping in the scram discharge system with 6" piping, and

  (iv) incorporation of redundant vent and drain valves.

- As indicated in Reference (7), the IVT float level switches at Millstone Unit No. 1 are functionally tested monthly.

- Human errors due to differences in calibration and maintenance techniques for diverse instruments may negate any benefit achieved by diversity.

- Each of the two (2) planned IVTs would include a total of six (6) Magnetrol float level switches. Four (4) switches would be utilized for the scram function, one (1) for a rod block, and one (1) for alarm. The four (4) scram level switches for each IVT would possess a "1 out of 2 taken twice" logic. Detection of high water level in either IVT would scram all control rods. Therefore, if water was accumulating in one IVT, two (2) scram level switches would have to fail to preclude an automatic scram from occurring. Additionally, a total of six (6) level switches would have to fail such that the operator would not be knowledgeable of such water accumulation and subsequently take corrective action. Likewise, if water were building up in both IVTs, four (4) and twelve (12) level switches would have to fail to preclude an automatic scram and operator action, respectively. Such failures are highly improbable.

Based upon the above, NNECO had concluded that replacement of the existing Magnetrol horizontally acting float level switches, which have never experienced a failure at Millstone Unit No. 1, with either level sensing instrumentation of unknown reliability (i.e., diverse type) or float level switches of different manufacturers, which would still function essentially the same, was not justified.

Probabilistic Safety Evaluation

Due to residual differences between our staffs regarding the overall improvement in reliability of the IVT achieved by diverse instrumentation, NNECO decided to perform a probabilistic safety evaluation for the scram discharge instrumented volume tank, including associated piping, valving, and instrumentation. This evaluation was undertaken to identify those factors which present limitations on the net reliability of the IVT and to quantify the increase or reduction in overall reliability if the diverse instrumentation requirement was implemented at Millstone Unit No. 1.

As a starting point for the probabilistic safety evaluation, a base case was defined to study the impacts of various modifications. The configuration shown in Figure 1 was chosen for the base case. The base case does not represent either the existing or proposed design configuration, but rather is a composite of both. The use of this composite design allows fault tree evaluations for several different configurations by merely removing certain base events from the fault tree. Using the base case design, a Failure Mode and Effects Analysis (FMEA) was performed in accordance with IEEE-352-1975.

A fault tree was developed addressing (1) the unavailability to scram given high water level in the IVT and (2) the probability of spurious scrams. These fault trees were quantified by generating minimal cut sets and then inserting point estimates of unavailability determined from component failure rates, human error probabilities, testing intervals, maintenance downtimes, and testing downtimes. Component failure rates for process control level switches were obtained from IEEE-500-1977 and are twice as large as those assumed in the Bases to the Millstone Unit No. 1 Technical Specifications. Human error probabilities were obtained from Chapter 13 of NUREG/CR-1278, Handbook of Human Reliability Analysis. Testing intervals and testing and maintenance downtimes were obtained either from plant procedures or discussions with plant personnel responsible for performing such testing and maintenance.

The results of three different cases are shown in Table 1. Case I is the base case configuration and consists of four (4) float level switches for the scram function. Case II utilizes the configuration shown in Figure 2, which is essentially the proposed design (prior to the completion of this evaluation) for the yet to be installed IVTs and consists of less valves than Case I. Case II also utilizes four (4) float level switches. Case III consists of the same configuration as in Case II but simulates diversity by utilizing two (2) float level switches and two (2) heated junction thermocouples. Heated junction thermocouples were chosen for diversity since from an engineering viewpoint they appeared to be the most feasible of the choices for diverse type of instrumentation. Based upon the results of the evaluation, additional cases utilizing other types of diverse level switches were deemed unnecessary.

The significant findings of the probabilistic safety evaluation are contrary to the above quoted statements from the NRC Staff's Generic SER and Reference (4), and are summarized below:

- The unavailability to scram on high water level in the IVT is dominated <u>in all cases</u> by human error to restore instrument isolation valves to their correct position following monthly periodic tests, and failure to restore cut off valves following flushing of instrument lines. These results are quite conservative in light of the fact that <u>no coupling</u> was assumed for human errors. If common-cause coupling of human errors in testing instrument isolation valves is assumed (as it should be), the unavailability contribution from valve misalignments would significantly increase, thus making common-cause instrument failures even less significant. Since no single valve misalignment can preclude the IVT from causing a scram on high water level, <u>two (2) totally independent</u> human errors are required to render the IVT unavailable to scram.

- The impacts of common-cause sensor failures <u>will not dominate unavailability</u> even if common-cause coupling is assumed to be <u>53%</u> of all sensor failures. This is highly conservative due to double counting redundant sensor failures caused by multiple operator errors in restoring instrument isolation valves. The common-cause Beta-factor used in the evaluation is roughly <u>20 times larger</u> than would have been predicted by WASH-1400 using the square root bounding approximation for common-cause coupling.

- The unavailability to scram on high water level in the IVT is decreased substantially by minimizing the number of manual valves.

- The use of diverse type level sensors will eliminate the common-cause coupling which is the smallest contributor to unavailability and thus slightly reduce the overall unavailability of the IVT. However, use of such diverse type level sensors will dramatically increase the spurious scram probability due to the replacement of instrumentation based upon a relatively simple operating principle with instrumentation of a more complex nature.

As can be seen from Table 1, only 18.6% of the total unavailability of the IVT to cause a scram on high water level can be attributed to common-cause sensor failures for Case II. This is insignificant compared to 77.6% of unavailability due to double valve failures. Of particular significance is a comparison between the results of Case I with Case II since Case II involved removing eight (8) valves, nearly one-half of the total, from the base case. Even with this substantial reduction in valves from the base case, the unavailability of the IVT to cause a scram on high water level for Case II is still clearly dominated by double valve failures.

Conclusions

Regarding compliance with the diverse instrumentation requirement utilizing float level switches of different manufacturers, the largest reduction in unavailability that could be hypothesized, yet certainly not believed to be realistic, would be a mere 18.6% of the overall unavailability and would not even address the dominant contributor to the unavailability to scram. Since the failure data for the float level switches used in Case II represent all types of float level switches and since float level switches of different manufacturers would still operate on the same principal, a noticeable reduction of the 18.6% number would not be realistically expected. However, we would expect the 18.6% to be reduced if sufficient failure data for Magnetrol horizontally acting float level switches were available and were utilized in the probabilistic safety evaluation. Therefore, NNECO asserts that replacement of two (2) Magnetrol float level switches with float level switches of a different manufacturer would produce a negligible, if any, decrease in overall unavailability to scram, and that implementation of this option for diversity cannot be justified.

As Table 1 illustrates, utilization of a diverse type of level sensors (i.e., Case III) deletes in its entirety the unavailability factor due to common-cause sensor failures. However, since this failure mechanism is such a small percentage of the overall unavailability, the overall unavailability to scram on high water level in the IVT only decreases from $3.61 \times 10^{-3*}$ per demand to $3.24 \times 10^{-3*}$ per demand. The dominant contributor to the unavailability to scram, which is due to independent double valve failures (2.8×10^{-3}), still remains and represents 86.4% of the overall unavailability to scram. Additionally, the probability of a spurious scram increases by a factor greater than four (4). Spurious scrams are undesirable since they unnecessarily challenge safety systems and operators. The cyclic thermal/mechanical stresses placed on reactor system components by spurious trips are known to reduce the useful lifetime of these components. Therefore, NNECO has concluded that the decrease in unavailability to scram (only about 10%) is insignificant compared to the increase in spurious scrams that would occur, and that implementation of this option for diversity cannot be justified.

*It is cautioned that these unavailability numbers are very conservative and extremely biased for common-cause sensor failures. These numbers should only be used on a relative basis for comparisons among the various cases. The absolute values are less meaningful outside the scope of this letter. Also, these numbers do not represent the unavailability of the scram discharge system (SDS) to function properly, but only the unavailability to scram given high water level in the IVT. The unavailability of the SDS to preclude water accumulation in the SDS beyond the point at which this system could still accept the total amount of water discharged during a scram would have to be computed to determine the overall unavailability of the SDS to function properly. This as yet undetermined number will be significantly reduced due to the planned modifications to SDS.

The lack of justification for the diverse instrumentation requirement dictates that individual licensees should be allowed to use IVT level-sensing instrumentation of their choice. Therefore, NNECO hereby informs the NRC Staff that four (4) Magnetrol horizontally acting float level switches are planned for use for the scram function on both IVTs which will be installed at Millstone Unit No. 1.

In Appendix A to 10CFR50, General Design Criterion 22 requires that "design techniques, such as functional diversity or diversity in component design and principles of operation, shall be used to the extent practical to prevent loss of the protection function." Additionally, the Introduction to Appendix A states that "there may be water-cooled nuclear power units for which fulfillment of some of the General Design Criteria may not be necessary or appropriate. For plants such as these, departures from the General Design Criteria must be identified and justified." NNECO has concluded that based upon the information in this submittal, functional diversity or diversity in component design and principles of operation for the scram level instrumentation on the IVTs is clearly not practical and that departure from GDC 22 is more than adequately justified. It is also noted that utilization of float level switches of diverse manufacturers would not meet the intent of GDC 22.

Since it is intended that the existing IVT will be replaced by two new IVTs (one for each SDV), we plan to take advantage of the results of the probabilistic safety evaluation in the design of the new IVTs and associated piping. This evaluation, and other evaluation criteria and Generic SER requirements, as well as engineering, ALARA, surveillance, and maintenance considerations, will be used to obtain an optimum IVT design. We have determined that our efforts should more appropriately be expended on reducing the dominant contributor to the unavailability of the IVT to cause a reactor scram on high water level (i.e., valve misalignment due to human error), in lieu of implementing the diverse instrumentation requirement.

NNECO highly endorses the concept of evaluating all aspects of a proposed modification to determine if overall plant safety is enhanced and whether the proposed modification will significantly address the safety concern. NRC Staff requirements should address authentic safety concerns based upon sound technical justification, not those concerns "believed" to be a problem. It is our understanding that the recently formed Generic

Requirements Review Committee (GRRC) has the responsibility of assuring adequate NRC Staff review of newly proposed requirements prior to their imposition upon licensees. Unfortunately, the diverse instrumentation requirement was formulated prior to the existence of the GRRC and did not receive such NRC Staff review. We recommend that the NRC Staff reevaluate its position on diverse instrumentation in light of the above information and in the spirit of the GRRC Charter. We believe such a reevaluation would result in concurrence with NNECO's position.

If desired by the NRC Staff, NNECO is willing to meet with you to present a conservative and rigorously thorough technical defense of our probabilistic safety evaluation.

Very truly yours,

NORTHEAST NUCLEAR ENERGY COMPANY

W. G. Counsil

W. G. Counsil
Senior Vice President

Table 1

Case No.	IVT Trip Unavailability (Q NET)	Common-Cause Sensor Failures Qcc/%	Double Value Failures Q/%	Cross Term Doubles Q/%	Spurious Scram Probability (Pscram)
I	5.24×10^{-3}	6.69×10^{-4}/12.8%	4.4×10^{-3}/84.0%	1.71×10^{-4}/3.0%	4.14×10^{-6}
II	3.61×10^{-3}	6.69×10^{-4}/18.6%	2.8×10^{-3}/77.6%	1.41×10^{-4}/3.8%	4.14×10^{-6}
III	3.24×10^{-3}	0/0%	2.8×10^{-3}/86.4%	4.4×10^{-4}/13.6%	1.67×10^{-5}

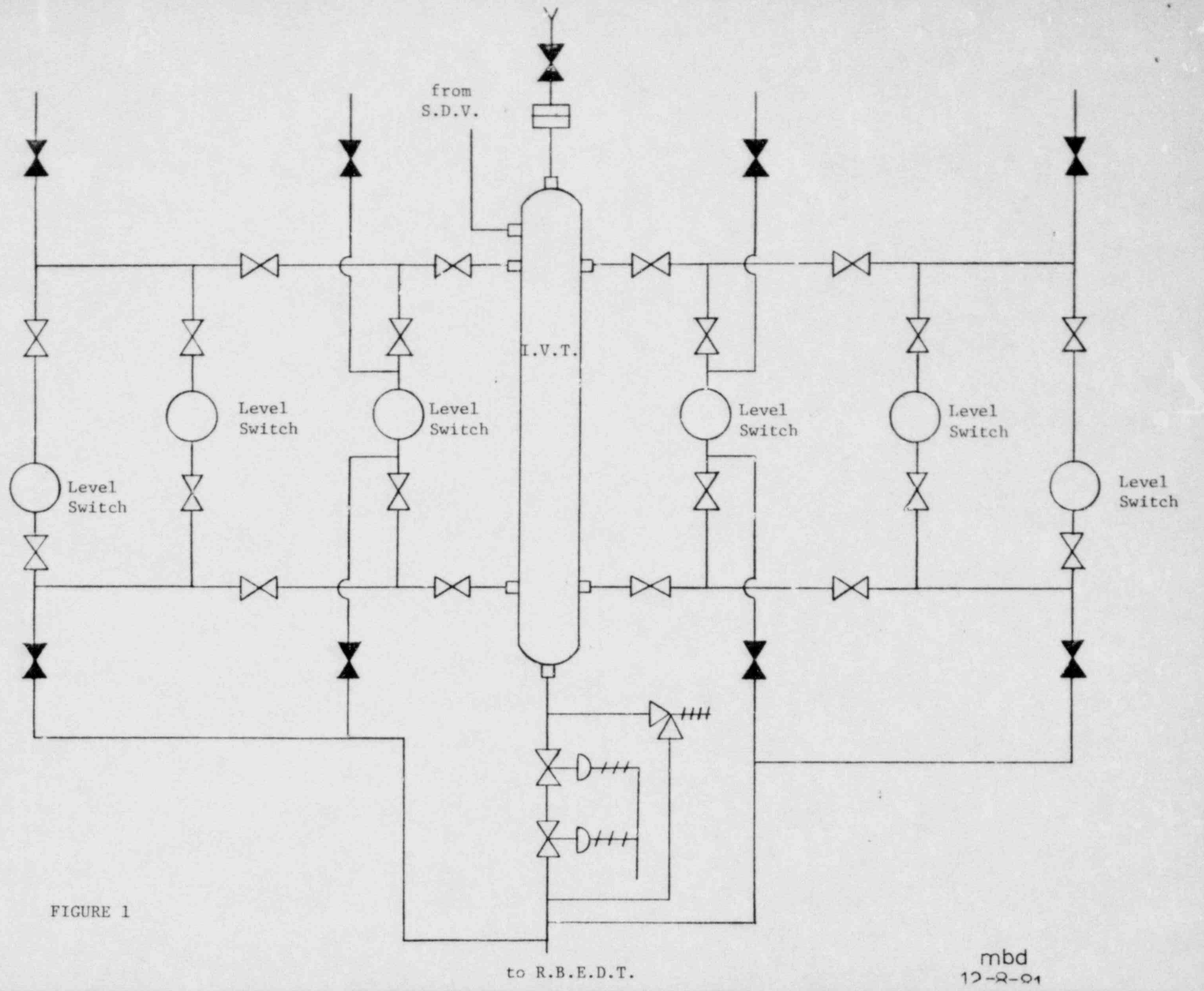
from
S.D.V.
I.V.T.
Level
Switch
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FIGURE 1

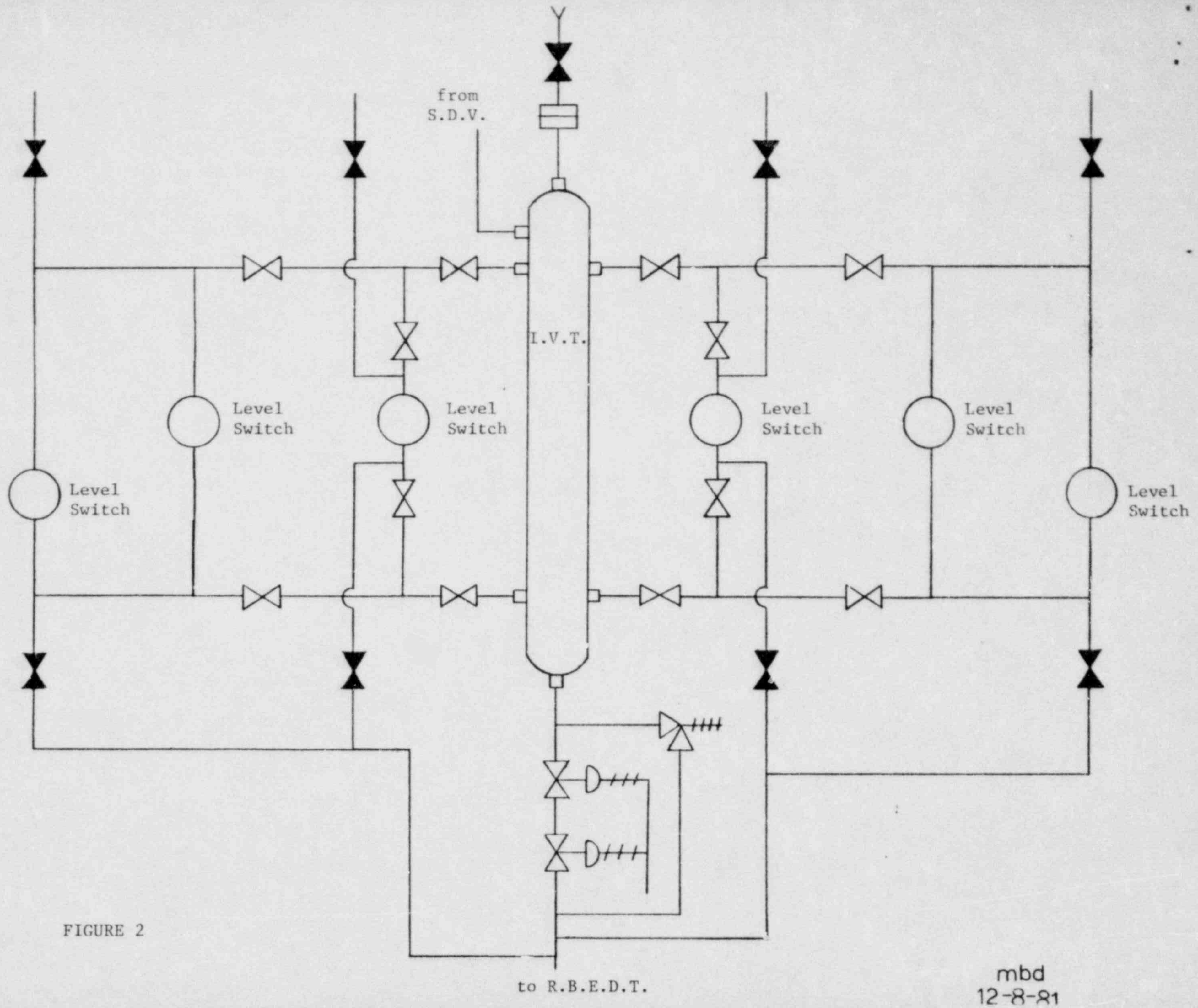

FIGURE 2

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