UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

June 6, 1990

REC'D 6/8/90

H.A.F.A. International, Inc.
ATTN: Ms. Fay Hess
7545 Central Industrial Drive
Riviera Beach, Florida 33404

Dear Ms. Hess:

SUBJECT: INSTRUMENTED INSPECTION TECHNIQUE (II.), H.A.F.A. LETTER DATED MARCH 22, 1990, HII-90-4201, HESS TO RICHARDSON

Based on allegations related to the testing performed by your company at several nuclear power plants, the NRC staff conducted inspections at the Davis-Besse and Palisades Nuclear Plants during the week of August 21, 1989, the Beaver Valley Nuclear Plant during the week of September 5, 1989, at your facility during the week of September 11, 1989, and at the St. Lucie Nuclear Plant during the week of October 10, 1989. The NRC staff, by letter dated December 21, 1989, transmitted its concerns to you and a meeting was held with you on February 1, 1990, to obtain information from you regarding our concerns. The staff has completed its review of your implementation of HAFA Topical Report 135 (P-A) and the safety evaluation is enclosed. The review considered the information contained in the transcript of the February 1, 1990 meeting, and in your letter dated March 22, 1990. For the reasons set forth in the attachment, the staff concludes that the testing performed by H.A.F.A. was invalid and approval to conduct testing under Topical Report HAFA 135 (P-A) dated December 1985 is rescinded.

H.A.F.A. has submitted a revision to the Topical Report, HAFA 135 (P), Revision 1, by letter dated March 23, 1990. The staff is currently reviewing this submittal.

In your March 22, 1990 letter, you expressed concern that the NRC staff conducted their inspections or visits and did not use the accepted Topical Report as the basis document. During the February 1, 1990 meeting, we informed you that we could not shed any light on the current location of the 23 copies of the Topical Report you transmitted to us on December 20, 1985. Since that time we have looked into the matter further. Topical Report HAFA 135 (P) was submitted to the NRC by your letter dated April 2, 1985. The staff reviewed the Topical Report based on the NRC policy and guidance provided in NUREG-0390, Volume 7, No. 2, "Topical Report Review Status", dated October 15, 1984. This Topical Report was approved by the staff in a letter dated November 7, 1985, which then permitted its use by reference in license applications to the extent specified and under the limitations delineated in the Topical Report and the associated NRC proprietary and nonproprietary safety evaluations. These safety evaluations necessitated that the Topical Report be

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amended. As you indicated in your letter dated December 20, 1985, you submitted 23 copies of the amended Topical Report for docketing. NRC procedures require that reports of this nature be microfilmed for future use and copies distributed to the reviewer's for use. Sometime thereafter, the remaining copies are to be destroyed. Our review disclosed that this report was microfilmed and that the remaining copies were destroyed. The reviewer's normally destroy their copies after a review is completed because of file space limitation.

A comparison between HAFA 135 (P) and HAFA 135 (P-A) was made by the NRC staff to identify any discrepancies between the two reports. The revisions you made prior to issuance of Topical Report 135 (P-A) were editorial in nature with two exceptions. One revision increased the number of types of pressure testing that could be performed using the HAFA leak test method. Secondly, the supportive VT-2 visual examination was characterized as a "may" requirement per Topical Report 135 (P) and mandatory per Topical Report 135 (P-A). Neither of the two revisions substantially affected the technical review.

Sincerely,

J E Richardson

James E. Richardson, Director
Division of Engineering Technology
Office of Nuclear Reactor Regulation

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Safety Evaluation

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ENCLOSURE

SAFETY EVALUATION

IMPLEMENTATION OF HAFA TOPICAL REPORT 135 (P-A)

1. Introduction

By letter to H.A.F.A. International, Inc. dated December 21, 1989, the NRC staff expressed its concerns with the implementation of HAFA Topical Report 135 (P) which was accepted by NRC letter dated November 7, 1985. The staff, as part of this evaluation, has reviewed the information contained in HAFA Topical Report 135 (P-A) dated December 1985 (reissued after staff acceptance), the findings of the NRC field inspections, the information in the transcript of our February 1, 1990 meeting, as well as the information in the H.A.F.A. letter dated March 22, 1990.

2. Evaluation

2.1 Scope of the IIT Technique

The staff approval of the IIT technique was based on its understanding that all flow into and out of the test boundary was to be monitored by flow meters supplemented by acoustic sensors to aid in locating leakage. This testing was to be supported by a VT-2 visual inspection to verify the IIT results with regard to leakage through the pressure boundary.

H.A.F.A. now contends that the IIT technique, as described in HAFA Topical Report 135 (P-A), requires only the following activities: (a) measurement of inlet flow only, and not outlet flow; (b) instrumentation of "selected" boundary valves with acoustic sensors as an "aid" to locating leaks; and (c) a visual inspection (VT-2) to verify IIT results on leakage through the pressure boundary. See transcript of February 1, 1990 meeting, between NRC staff and H.A.F.A., p. 77.

The staff disagrees with H.A.F.A.'s position with respect to each of these activities. In HAFA Topical Report 135 (P-A), H.A.F.A. stated:

> " . . . it was demonstrated (Section V and Appendix I) that leakage areas important to safety may be difficult or impossible to find as per the visual examination (VT-2) method even during test periods, which last as long as nine hours. Since small leakages may not penetrate the insulation or be designed to be conducted away, the IWA-5213 hold time gives only a minimal validity to a test.
>
> IIT utilizes a two-fold approach to quantify and locate system leakage in a manner generally non-intrusive to plant operations. The replacement volume of flow measurement is utilized to determine total system leakage, exit flow measurement is utilized to determine individual component leaks through selected boundary valves, especially in the case of potential intersystem leakage. Acoustic leak detection techniques are utilized to identify the component or the position in the piping system which is the source of the leakage . . ." (See HAFA Topical Report 135 (P-A), p. 4)

H.A.F.A. contended in HAFA Topical Report 135 (P-A) that it might be difficult to find small leaks by visual inspection and that the IIT will not only detect but locate leaks. In order to achieve the flow or mass balance stated in the topical report, accurate measurement of the replacement volume, necessary to maintain test pressure and leakage volume through all test boundary valves would be required for any flow measurement technique to detect external leakage. Theoretically, if no external leakage is present, the algebraic sum of the inlet flow and all outlet flows will be zero.

Further, in order to implement the claim in the topical report that acoustic leak detection techniques are utilized to identify the component or the position in the piping system which is the source of leakage, the piping system would have to be adequately instrumented with acoustic sensors to aid in locating leakage along the entire length of the pressure boundary.

> "The techniques employed measure the total system leakage at NOP using flow measuring devices on air and water systems. The acoustic leak detection method is an aid to identifying leak locations. For steam systems, acoustic leak sensing equipment is utilized. A supporting ASME VT-2 type examination will be performed in conjunction with the IIT, with a two hour hold time imposed on insulated piping." (See Topical Report 135 (P-A), p. 8)

> " . . . The techniques used require a preliminary system analysis and the use of special equipment in applying optimum operational, technical and economical methods to locate external and intersystem boundary leaks . . ." (See Topical Report 135 (P-A), p. 32)

The topical report also stated that the visual inspection was to be performed in conjunction with the IIT; however, this does not mean that the results of the visual examination in and by itself is to be used as the acceptance criterion for the IIT test. H.A.F.A. stated that the IIT techniques would use analysis and special equipment to locate external and intersystem boundary leaks without reliance on the VT-2 examination. In fact, in the P version of the topical report, the visual inspection was not proposed as a mandatory requirement by H.A.F.A.

H.A.F.A. characterizes the test of the Component Cooling Water System as follows:

> "Davis-Besse Unit 1 -- Component Cooling Water System (Full system demonstration leakage and AE) . . ." (See Topical Report 135 (P-A), p. 17)

This is the only test so characterized. The test included measurement of inlet and outlet flow and a demonstration that the installed acoustic system could locate leaks equally as well at two different pressures.

The "Purpose" paragraph 1., of Test No. 3 (included in the Topical Report) clearly states that acoustic readings will be taken at intervals along the length of the system and that the capability of acoustic leak sensing equipment to detect and locate leaks will be demonstrated.

Further, H.A.F.A. stated that only measurement of inlet flow, acoustic techniques as an aid to location of that leakage, and a visual inspection (VT-2) to verify system integrity were necessary to comply with their commitments in the approved Topical Report. Further, "acoustic techniques" were defined by H.A.F.A. as only instrumenting selected boundary valves with acoustic sensors.

The staff, in its Safety Evaluation (SE) that approved HAFA Topical Report 135 (P) states in Paragraph 5.1: ". . . The major difference between IIT and conventional pressure testing is that the additional equipment enables testing personnel to locate leaks faster, detect smaller leaks, and detect in ersystem . ." The staff, in Paragraph 5.2.1 of the SE, states: "Sufficient data on small leaks in water-filled systems have been taken and the results analyzed to demonstrate that small leaks can be detected by IIT and that the changes in the leakage rates can be detected by IIT and that the changes in the leakage rates between normal operating pressures and the Code required pressures are relatively small. Based on the leak detection capabilities of IIT, the staff finds that its application in situations where the Code required test pressures are impractical to attain and hold, and the tests are performed at normal operating pressure, will provide added assurance that small leaks at lower pressures will be detected." The staff, in Paragraph 5.2.2 states: ". . . the Code requirement for pressure hold time of four (4) hours prior to visual examination of insulated systems is based on allowing sufficient time to elapse for a leaking fluid to penetrate the insulation and be detected by the VT-2 (visual) inspection. Since small leaks can be detected by the IIT, it is not necessary to require the four hour hold time . . ." The staff, in the SE, concluded in (3) that: ". . . the four-hour hold time requirement for insulated systems may be reduced to two-hours because of the small leak detection and location capabilities of IIT. Visual (VT-2) examination of the systems as required by Section XI should be performed after the two-hour hold time."

The position of the staff in accepting the Topical Report was clearly demonstrated in the SE. The staff relied on the leak detection capability of the IIT instrumentation to detect small leaks, and, therefore, allow for a reduction of the test hold time and pressure. The visual examination was to be performed after the hold time and was supportive.

In a paper that H.A.F.A. recently authored ("Materials Evaluation," December 1989, pgs. 1378-1381) the IIT is again described as an inventory flow balance where inlet flow is balanced against leakage through the boundary valves with the difference in inventory assumed to be through-wall leakage. Also, the paper states that acoustic leak detection techniques are used to identify the component or position in the piping system where leakage occurs. This further supports the staff position that IIT must use outlet flow measurements and acoustic leak detection at all boundary valves and intervals along the full length of the piping system that is being tested.

In summary, the position of the staff is that both HAFA Topical Report 135 (P) and HAFA Topical Report 135 (P-A) and later publications by H.A.F.A. represent the IIT as an instrumented flow method that detects leakage by inventory balance with acoustic leak detection used to aid in locating the position of the leakage. This position was reiterated by the staff in the SE approving the method. The VT-2 visual examination was characterized as a supportive examination in both the (P) and (P-A) reports.

2.2 Specific Field Implementation Problems

Based on the manner in which H.A.F.A. implemented the IIT, the instrumentation could not detect or aid in the location of any through-wall leakage if any system boundary valves were leaking and, therefore, the reduction of system pressures and test hold times are without basis.

2.2.1 Acoustic Leak-Sensing Equipment

2.2.1.1 Spacing of Sensors on Long Pipe Runs

In inspection reports (50-334/89-15, 50-346/89021 and 50-255/89026) the staff indicated that long runs of piping were not adequately instrumented to detect external leakage. The staff's basis for approval of IIT leak testing as discussed in Paragraph 2.1 above was that small leaks in the piping system would be detected and located by acoustic sensors placed at appropriate intervals along the length of the piping. Statements by A. Wehrmeister (Open Session, Pg. 102) at the February 1, 1990 meeting, indicated that acoustic sensors were not used on piping, other than on selected valves, for IIT leak testing. Further, R. Milke (Closed Session, Pg. 71) in response to the question of sensor spacing stated that, "Eighty percent of tests described in the topical had no acoustic test records."; and "acoustics are repeatedly described as an aid to location." These statements form the HAFA position that it was not intended that acoustics monitor pipe runs between valves during IIT leak testing.

As discussed in Section 2.2.1.1 above, the staff believes that long piping runs must be instrumented along the full length of systems being tested. H.A.F.A. did not present any information that adequately explains how leaks could be located with the sensor spacing observed in the field, or otherwise address the representations made by H.A.F.A. in Topical Report 135 (P-A) for the purpose and use of acoustic leak sensors.

For these reasons, the staff concludes, that in the absence of acoustic monitors along the length of the piping, the IIT method as implemented, did not function as an aid in locating small external leaks along the piping.

2.2.1.2 Background Noise

The staff's position is that acoustic background noise must be checked prior to performing leak testing. Our inspections identified that written guidance was not provided regarding the acceptable background noise, the number of measurements, or the interval of time between measurements. H.A.F.A.'s practice was essentially to record only baseline data.

H.A.F.A.'s position as stated in their March 22, 1990 letter, regarding acoustic background noise is as follows:

> "Relative to item (a) 2. on acoustic background noise. Acoustic background noise is checked prior to performing the test. This is accomplished at the time of mounting the sensors, and it additionally verifies the system's operability and responsiveness. It is our experience that, in a typical IIT Leak Measuring Device (LMD) test, background noise is generally low relative to the signal emitted by a leak. Baseline acoustic data is also acquired immediately prior to the pressurizat[illegible] of the test subsystem. Standard practice for these operat[illegible]idered to be part of the training required for certification of an individual's qualification to Level I, IIT Leak Testing. In summary, we reject the staff's position."

According to ASTM E 1211-87, Paragraph 5, interferences caused by external or internal noise sources can effect the sensitivity of an acoustic emission leak detection system. Further, Paragraph 5.2 states that stability of backgroud noise can also effect leak detection sensitivity since fluctuation in background noise determines the smallest change in acoustic level that can be detected.

Since systems tested by IIT leak testing typically require some make-up flow, it is proper to assume the presence of variable background noise due to increasing flow turbulence and leakage as pressure increased. Furthermore, plant noise levels caused by nearby equipment, operations, and other activities is most certainly not constant.

The baseline data recorded by H.A.F.A. is necessary but not sufficient. H.A.F.A.'s stated procedure (letter dated March 22, 1990) does not provide the continuity of data required to evaluate variable background noise. Therefore, the necessity for written guidance regarding the acceptable background noise, the number of measurements, and the time interval between measurements has not been met. In the absence of this information, the leak detection sensitivity of the IIT tests performed to date cannot be evaluated.

2.2.2 Inadequate Replacement of Flow Instrumentation

In its letter of December 21, 1989, the staff expressed its position with regard to the lack of flow instrumentation at some test boundary valves. H.A.F.A.'s written response and comments provided during the February 1, 1990 meeting, indicates that H.A.F.A.'s position is that they did not intend to provide instrumentation at all test boundary valves. H.A.F.A. further stated that "total system leakage" is measured by the inlet LMD.

The purpose of the ASME Code hydrostatic test is to ensure that the integrity of the pressure boundary is maintained, i.e., no external leaks. The Code defines the pressure boundary as pressure retaining components excluding such things as gaskets, valve packing, and valve seats. By excluding valve seats, the Code has established a position that valve internal leakage is beyond the scope of the hydrostatic test. H.A.F.A.'s measurement of "total system leakage" with an inlet LMD may provide some information as to collective test boundary valve performance; however, this is not in concert with the objective of the hydrostatic test. Valves that require testing because of their safety function are tested under separate programs in accordance with appropriate Technical Specifications, ASME Section XI or 10CFR50, Appendix J requirements.

From a conceptual standpoint, accurate quantification of leakage through all test boundary valves as well as measurement of inlet volume would be required for the IIT system to detect any leakage of interest (i.e., external leakage as defined above).

In conclusion, H.A.F.A.'s implementation of the IIT precluded it's ability to detect or quantify external leakage and was contrary to the concept approved by the staff.

2.2.3 Lack of Acceptance Criteria for Tests

The staff expressed its position regarding the lack of a quantifiable acceptance criteria for the data from IIT testing. H.A.F.A.'s written response indicates that data evaluation is the responsibility of the Level II test person but you provide no acceptance criteria or guidance for evaluations of the IIT test data.

The basis of NRC relief from ASME Code pressure and hold time requirements was the expected benefit of the IIT evaluation to quickly detect small leaks not readily detected by visual means.

It is the staff's position that a lack of specific criteria for the IIT data interpretation and acceptance contributes to the ineffectiveness of the IIT in finding external leakage in the pressure boundary.

3. Leak Testing Demonstration at the H.A.F.A. Facility

With regard to the IIT demonstration at the H.A.F.A. facility, the staff expressed concerns pertaining to the sensitivity of the test method. During the demonstration, the acoustic sensor detected an external leak rate of approximately 0.03 gpm while the instantaneous flow LMD reading required a substantially greater external leak before detection.

In H.A.F.A.'s written response, they referenced portions of the February 1, 1990 meeting, and state that the NRC inspection team was not certified on H.A.F.A. equipment and should have read the totalizer, not the instantaneous flows. H.A.F.A. offered to perform an IIT leak testing demonstration as part of NRC's inspection at the H.A.F.A. facility. H.A.F.A. certified test personnel were intimately involved in the demonstration and did not offer this information. Furthermore, test records included in H.A.F.A.'s Topical Report, which were used to support qualification and demonstrate H.A.F.A.'s process, utilize instantaneous flow rates exclusively.

While the staff recognizes the fact that H.A.F.A.'s instruments may not have been of current calibration and that the addition to the demonstration by the NRC was not part of the usual test procedure, the observations of relative flow differentials at various rates of external leakage nonetheless raise concerns as to the level of overall test method sensitivity.

4. Conclusion

The staff concludes that the testing performed by H.A.F.A. was invalid and approval to conduct testing under HAFA Topical Report 135 (P-A) dated December 1985, should be rescinded.