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August 9, 1988

U.S. Nuclear Regulatory Commission
ATTENTION: Document Control Desk
Washington, DC 20555

Subject: McGuire Nuclear Station
Docket No's: 50-369 and 50-370

Dear Sir:

Flow balance testing performed on the Unit 2 Hydrogen Skimmer System (VX) during the recently completed refueling outage determined that individual compartment ventilation flow rates stated in the FSAR could not be achieved. The purpose of this letter is to document Duke's conclusion that the VX System remains capable of performing its design basis function and to describe planned actions to improve the performance of this system.

Background

The VX System has a single header that draws air from each of the containment subcompartments by the use of redundant fans located on either end of the header as shown on the attached schematic. Either fan is capable of drawing the total design basis flows from the areas served. However, the physical arrangement of the system (i.e. a fan on each end) is such that balance of the individual compartment flow rates is difficult to achieve when operating each fan independently.

Unit 2 Testing

Near the end of the Unit 2 EOC 4 refueling outage, a flow balance test was performed in an attempt to verify distribution and balance as needed while running either 2A or 2B fan. Flow measurements were performed using a hand held velometer (air velocity meter), scanned across the intake. When the FSAR values for individual compartment flow could not be achieved, Duke's Design Engineering Department was consulted to assist in evaluating the test results. On their recommendations, a more accurate flow hood was brought in to repeat the tests. When test results did not demonstrate uniformly acceptable results and because the planned justification for continued operation (JCO) did not rely on flow numbers, the flow measurement tests were terminated This decision was based, in part, on the evaluation of the operability of the VX System (see Attachment). In the JCO it was recognized that the maximum hydrogen concentration assumption used in the design of the VX System was more conservative than required by NUREG-0800, that the hydrogen generation source term had been decreased by 10CFR50.46 and subsequent ECCS analyses and that a Hydrogen Mitigation System had been added and was operable per Technical Specification.

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The method used for flow balancing VX was to first take "as found" flow measurements while running one fan, then the other. Data was then evaluated to determine optimum damper positions. It was observed that the "as left" damper positions were essentially the same as the pre-operational positions as evidenced by paint shadows on the damper actuators. Two dampers (both serving the reactor head area) were initially found closed but were left in a throttled (approximately 50% open) position.

Unit 1 Testing

The Unit 1 VX System flow distribution was verified prior to fuel loading (Jan - FEB '81). The test method was different from the one used most recently on the Unit 2 System. On Unit 1, both fans were run at the same time and dampers adjusted to provide approximately twice the FSAR flows for each compartment. Each manual actuator was then secured in the "as left" position. At some later time (assumed to be prior to initial criticality), painting on each valve body and actuator handle left a shadow mark on the valve position indicator. Each valve was verified to be in the same painted mark position during the Fall '87 refueling outage.

Current Operability

As discussed above, the current design of the VX System does not lend itself to flow balancing on an individual fan basis. Attempts to balance the system on both units have demonstrated that even though the total fan flow is higher than the minimum FSAR value, it is not possible to achieve the current minimum FSAR flow for each compartment for each fan. For both units there is reasonable assurance that all dampers are currently throttled to a near-optimum position. Flow measured on Unit 2 established that only a few compartments have less than the currently analyzed minimum flows rates. Duke considers that the additional analyses now being performed using a lower metal-water reaction 1.5%, (0.3% times a factor of 5 for conservatism) and a higher allowable concentration, 4% versus 3.5%, will demonstrate that the current flow rates are acceptable.

Although it is recognized that the Hydrogen Mitigation (EHM) System cannot be relied upon as a substitute for the VX System, the EHM does provide added assurance that in the unlikely event of a design basis accident, the concentration of hydrogen gas would not build up to detonatable concentrations. A recent operability test verified the EHM was fully operable on both units.

Planned Corrective Actions

Analysis

Analysis using revised hydrogen source term and allowable concentration will be completed by August 15, 1988. Results of the analysis will be made available to the NRC.

Additional Flow Balancing

Unit 1 is scheduled to begin its EOC-5 refueling outage on October 14, 1988. Prior to restart, a flow balance will be conducted using one fan, then the other. Flow measurements will be conducted using the more accurate flow-hood technique.

Flow measurements will be done for Unit 2's B train during the next outage involving cold shutdown conditions.

A hardware modification is under evaluation that would address the current difficulty of individual train flow balancing. As envisioned, such a modification would cross-connect the suction piping to each fan. If possible, this modification will be implemented on each unit during its next refueling outage.

Summary

It is Duke Power's conclusion that the VX System for each unit is currently balanced in a near-optimum position and that revised analysis will demonstrate that currently measured flows are sufficient to prevent the buildup of excess quantities of hydrogen. Therefore, the VX System can be considered operable.

Very truly yours,

Hal B. Tucker

RLC/600/bhp

Attachment

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Mr. W. T. Orders
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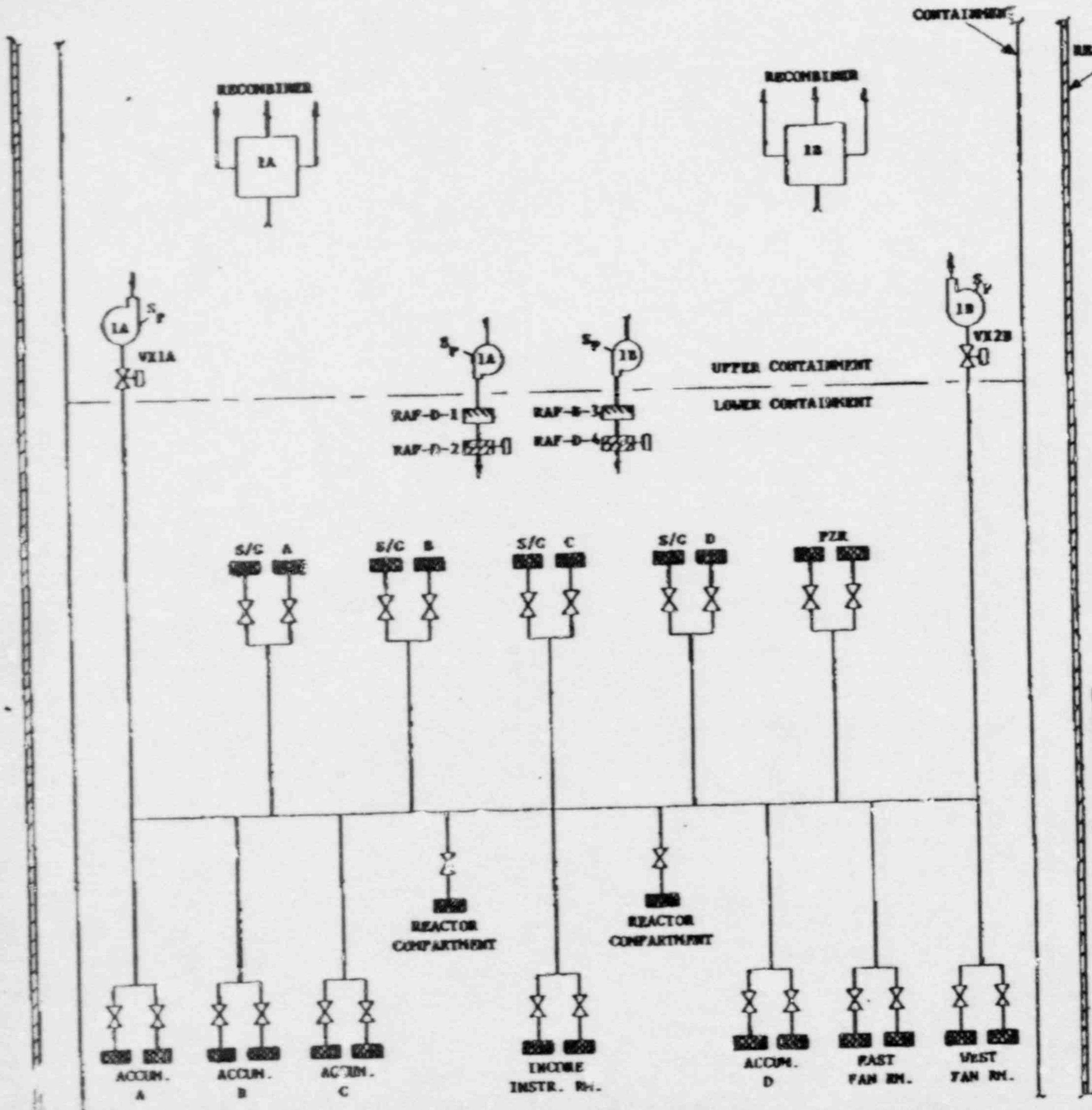

HYDROGEN SKIMMER AND CONTAINMENT AIR RETURN SYSTEM (VX)

1. SAFETY RELATED
2. FANS ARE STARTED WITH THE FOLLOWING SIGNALS:
   - S_P (3 PSIG)
   - CPCS (.25 PSIG)
   - 10 MIN. TIME DELAY

MC-SYS-VX-1	DATE: 11-8-76
REF. 1557-1	TP7613
DRAWN: DOB	APP. CEM
TRAINING USE ONLY	

MCGUIRE NUCLEAR STATION UNITS 1&2

Hydrogen Skimmer System -- VX Flow Balance

JUSTIFICATION FOR CONTINUED OPERATION

Summary

Flow balance testing performed on individual trains of the Unit 2 hydrogen skimmer system determined that compartment ventilation flow rates stated in the FSAR cannot be achieved. Even with the system in a degraded condition, adequate design basis features are in place to mitigate the consequences of hydrogen produced during a design basis accident.

Although the hydrogen skimmer system was designed to reduce hydrogen concentration in the dead-ended compartments during a design basis event, several developments concerning hydrogen have occurred since that time which permit safe station operation with a degraded hydrogen skimmer system. These developments include installation of a hydrogen mitigation system, which is redundant to the skimmer system. This mitigation system will prevent accumulation of hydrogen, thereby providing adequate protection for continued safe operation of both station units.

References

1) Problem Investigation Report PIR 2-M88-0186
2) Test Procedure TT/2/A/9100/217
3) FSAR Section 6.6
4) SER Supplement 2
5) Regulatory Guide 1.7
6) Calculation MCC 1211.00-00-0027

Evaluation of Flow Requirements

Testing of the Unit 2 hydrogen skimmer system for flow balance determined several compartment flow rates to be less than values stated in Table 6.6.2-1 of the FSAR. The problem was documented on reference 1, and a design evaluation was initiated.

Reference 6 contains the original design basis requirements and calculations for the skimmer system. The values for compartment ventilation flow rates were determined from a conservative analysis based on AEC Safety Guide 7, dated March 10, 1971.

The original calculations of hydrogen evolution were based on a five(5) percent zirconium-water reaction, while current regulatory guidance (ref. 5), in conjunction with plant-specific ECCS analyses, prescribes a much lower clad reaction of only 1.5 percent. The prescribed value contains the required margin of safety of five(5) for added conservatism.

The values of compartment flow rates presented in the FSAR are also based on a dead-ended compartment hydrogen concentration upper limit of 3.5 volume percent. AEC Safety Guide 7 considered 4.0 volume percent as an acceptable upper limit, but 3.5 volume percent was used in the original design for a margin of safety. Based on use of the hydrogen recombiners to limit the upper containment hydrogen concentration to 3.0 volume percent, minimum compartment steady state ventilation flow rates were determined for maintaining an upper limit of 4.0 volume percent in the compartments. The 4.0 volume percent criterion is also consistent with current regulatory guidance contained in reference 5. Revised values do not take credit for reduction of the hydrogen source terms, and therefore remain conservative. Minimum flow rates have been revised only to increase the allowable compartment concentration from 3.5 to 4.0 volume percent.

Comparison of Test and Design Data

System flow balance data for Unit 2 does not meet the required minimum flow rates for an upper limit hydrogen concentration of 4.0 volume percent. Although in a slightly degraded condition, the system will perform its fundamental safety function, and in conjunction with the hydrogen mitigation system, will limit hydrogen concentration in the dead-ended compartments following a design basis loss-of-coolant accident.

The attached tabulation compares compartment flow rates for four(4) cases: 1) the nominal system design values, 2)minimum flow rates for 3.5 volume percent, 3) minimum flow rates for 4.0 volume percent, and 4) measured flow rates for system 2A.

The compartment numbers correspond to FSAR Table 6.6.2-1.

Compartment Ventilation Flow Rates

Compartment	Design	3.5 v/o	4.0 v/o	Train 2A
1	85	85	43	171
2	85	85	43	60
3	64	64	32	206
4	14	14	7	83
5	14	14	7	65
6	64	64	32	68
7	52	52	26	60
8	*	*	*	*
9	564	477	239	278
10A	441	355	178	223
10B	441	355	178	763
10C	442	355	178	1112
10D	442	355	178	167
11	442	355	178	160
Total	3150	2630	1319	3416

* The flow requirement for compartment number 8 was evenly distributed among compartments 9, 10A-D, and 11 in the original design due to the physical configuration. A specific value cannot be measured.

Evaluation of Safety Significance

10CFR50.46 requires that the amount of fuel element cladding that chemically reacts with water or steam shall not exceed one(1) percent of the total amount of zirconium alloy in the reactor. In accordance with this requirement, the McGuire design basis analysis indicates that the total metal/water reaction is less than 0.3 percent for all breaks. Standard Review Plan(NUREG-800), Section 6.2.5, requires that the hydrogen control and mitigation system be designed for five times the amount of hydrogen released in the FSAR analysis of a DBA assuming at least one train of ECCS operable. For an accident of this type, virtually no radioactivity would be released from the fuel.

As stated in NUREG-800, a lower flammability limit of 4.0 volume percent hydrogen in air or air-steam atmospheres is well established and is adequately conservative. Research has shown that relatively low levels of turbulence in containment promote sufficient mixing such that stratification of hydrogen will be minimized(EPRI NP-2669). Based on the FSAR analysis of hydrogen production in a postulated DBA, with no hydrogen control measures at all, it would be approximately eight days before the lower flammability limit was exceeded.

The McGuire hydrogen skimmer system was included as part of the original plant desgn basis due to a concern that hydrogen created in containment by accident conditions would tend to accumulate at the high points in lower containment. There have been several developments concerning containment hydrogen which occurred since that time:

1) The containment hydrogen mitigation system was installed at McGuire. This system consists of redundant sets of hydrogen igniters located throughout containment, including the tops of the steam generator and pressurizer enclosures. These igniters prevent accumulation of hydrogen by causing it to burn at low concentrations. Because the igniters in the pressurizer and steam generator enclosures are located close to the hydrogen skimmer fan suction, the presence of the igniters eliminates concerns over hydrogen skimmer fan operability by performing the same function.

2) Sensitivity analyses of containment response to hydrogen burning performed using the CLASIX code showed that the presence of the hydrogen skimmer fan had no effect on containment response.

Conclusion

The hydrogen mitigation system, consisting of hydrogen igniters and the hydrogen skimmer system in its current condition, are sufficient to insure that the design basis for applicable hydrogen producing events are met and therefore the hydrogen skimmer system is considered operable.

Prepared By: G.A. Richardson Date: 7/22/88

Reviewed By: [signature] Date: 7-22-88

Approved By: R R Weidler Date: 7-22-88