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MINUTES OF THE
ACRS SUBCOMMITTEE MEETING ON
CLASS 9 ACCIDENTS
AUGUST 28, 1980
WASHINGTON, D.C.

The ACRS Subcommittee on Class 9 Accidents met on August 28, 1980 in Washington, D.C. to continue examination of the role of Class 9 Accidents in the licensing process and to consider hydrogen generation and control during degraded core accidents.

ACRS members present were W. Kerr - Subcommittee Chairman, S. Lawroski, C. Siess, J. C. Mark, and H. Etherington. ACRS consultants in attendance were R. Seale, S. Siegel, J. Lee, R. Strehlow, G. Schott, and D. Gregory.

Presentations were made by Bulter - NRC/NRR, Fleishman - NRC/OSD, Medeiros - NRC/OSD, Shapaker - NRC/NRR, Tinkler - NRC/NRR, Bowman - LLL, Hubbard - R&D Associates, Lau - TVA, and Miller - NSAC.

Attached are a list of documents provided to the Subcommittee and a copy of the meeting agenda.

Introductory Remarks by the Chairman

Dr. Kerr noted that a number of questions currently exist regarding NRC's treatment of hydrogen. For example, (1) will a design basis or a probabilistic approach be taken in dealing with the problem; (2) will treatment of the hydrogen problem be conservative or realistic; (3) will the Staff's suggested approach to Class 9 Accidents be published prior to rulemaking; (4) does the Staff have a safety goal for mitigation features; (5) how much have TMI-mandated changes reduced the probability of hydrogen-generating accidents; and (6) will single failure criteria be applied to mitigation features.

NRC Efforts on Hydrogen Generation and Control

Mr. Butler, NRC/NRR, summarized NRC actions on hydrogen generation and control. The Staff issued SECY 80-107, 80-107A, and 80-107B on hydrogen control. A draft

interim rule has been prepared (SECY 80-399), to become effective in 1981. The rule requires inerting BWR Mark I and Mark II containments (only two operating BWRs currently are not inerted - Vermont Yankee and Hatch-2). Requirements for Mark IIIs and Ice Condensers are still being studied. There will probably be no requirements for the "large dry" containments.

Short term programs on Ice Condenser containments were described, including: (1) efficacy of igniters - LLL; (2) MARCH calculations-BCL; (3) alternate hydrogen control measures-Sandia; (4) strength of containments-Ames; and (5) TVA/Westinghouse studies.

The Staff position on Sequoyah is that full power operation need not await the igniter system.

The Staff does not currently have a position on the specifics of hydrogen generation that must be dealt with, for example, the rate and amount of hydrogen generation, and the design approach (probabilistic or design basis). The Staff does not expect to formulate a position prior to rulemaking.

Interim Rule on Hydrogen Control

Mr. Fleischman, NRC/NRR, described the proposed interim rule on hydrogen, the intent of which is to insure protection up to 50% equivalent clad/water reaction with evolution expected to occur over several hours. The interim rule requires licensees to perform analyses of hydrogen up to 75% equivalent clad/water reaction with evolution over periods of from of 0 to 8 hours. Dr. Kerr noted the interim rule gives only vague guidance to the licensees on what they are supposed to analyze.

Rulemaking on Hydrogen Control

Mr. Medeiros, NRC/OSD, discussed long term rulemaking on degraded cores and the Advance Notice of Rulemaking (ANR), which will be released soon. The ANR solicits comments on hydrogen control measures and inerting.

Sequoyah Ignition System - TVA Experiments

Mr. Shapaker, NRC/NRR, discussed the Sequoyah containment ignition system. The system is currently installed. It is planned that it be manually activated upon actuation of engineered safety features. The system makes use of 30 glow plugs; 18 in the lower compartment; 5 in the lower plenum of ice condenser; 3 in the upper plenum of the ice condenser; and 8 in the upper compartment. It is powered by emergency power sources. Glow plug operating temperatures are ~1700 F, which is about 500 F above the hydrogen ignition point.

Tests are being performed to characterize hydrogen combustion in the presence of steam and to determine the reliability of glow plugs for ignition. A report on the initial test phase is due October 1, 1980. Longer-term work will study; (a) effect of hydrogen combustion on equipment, (b) effect of containment sprays; (c) possible installation of additional glow plugs; and (d) alternate hydrogen control measures. TVA will submit to NRC plans for determining effect of hydrogen burning on essential components. TVA expects their hydrogen control studies to continue for 1 year.

Hydrogen Control Experiments - NRC Sponsored Programs

Mr. Tinkler, NRC/NRR, described NRC programs on hydrogen control. LLL is testing the operation of the Sequoyah igniter systems in order to confirm TVA results. Also, LLL is surveying hydrogen monitors.

BCL is performing analyses of some aspects of the igniter system using MARCH. MARCH does not treat details of hydrogen burning, rather, the burn parameters must be input to the code. Homogeneous mixtures are assumed. Mr. Tinkler characterized the MARCH code as a significant improvement over previous ways of doing containment analyses, and said the code gives reasonably good results.

Sandia will perform longer-term work on hydrogen control systems such as water fog, hydride converters, Halon-1301, and ignition systems.

There were some general comments made:

- Dr. Strehlow indicated that turbulent flow in long air ducts could cause transition to detonation in hydrogen concentrations as low as 8%, which may be a serious concern.
- Dr. Gregory indicated that hydride converters are not likely to be feasible because they oxidize in air, thus losing their effectiveness.
- System pressure has little effect on flammability limits of hydrogen mixtures.

NRC-Sponsored LLL Program on Hydrogen

Mr. Bowman, LLL, described the igniter test program. The program objectives are to (a) test Sequoyah igniters in various air/steam/hydrogen mixtures, (b) survey hydrogen detection devices; and (c) perform a literature survey on hydrogen combustion. A quick-look report is due October 30, 1980, with a final report in January 1981.

There are 4 types of hydrogen monitors: (1) catalytic, which measures increasing temperature of the catalyst; (2) semi-conductor, which measures change in current; (3) volume expansion, which changes size with hydrogen absorbtion; and, (4) electrochemical, which measures the output of a battery. The volume expansion device is slow-response (~5 minutes) whereas the other three types are faster (3 to 30 seconds). The first two types function only up to ~4% hydrogen, whereas the latter two are not so limited.

MARCH Calculations on Sequoyah

Mr. Cybulskis, BCL, summarized MARCH calculations on Sequoyah. The particular accident sequence examined was a small break LOCA with no ECCS. The results indicate the igniter system would prevent overpressurization of containment during the meltdown phase of this sequence. For example, with a hydrogen concentration of 10 v/o and 1 sec. adiabatic burn, and with the burn occuring throughout the entire containment, the peak pressure is 43 psig. (As a reference, 27% equivalent clad reaction results in a hydrogen concentration of ~10% in containment.) The code predicts containment failure upon melt-through of the pressure vessel.

CLASIX Calculations on Sequoyah

Mr. Tinkler summarized analyses performed using CLASIX, a Westinghouse containment code. A second code (LOTIC) is used to provide initial conditions to CLASIX. The calculations indicate the igniter systems would prevent overpressurization for 70% clad oxidation. Assuming a small break LOCA w/o ECCS scenario and 70% equivalent clad reaction, about 300,000 lbs of ice remain following completion of all hydrogen burns. Analyses, however, indicate pressure remains within acceptable levels even with early loss of ice. The analyses also indicate that peak pressure is sensitive to operability of the air circulation fans.

Comments by R&D Associates

Mr. Hubbard, R&D Associates (RDA), described the RDA assessment of the igniter system. He indicated (a) there is a concern with detonable pockets of hydrogen near the containment wall and (b) the uncertainties in hydrogen production and burning analyses are too large for him to have confidence in use of igniters.

Comments by TVA on Igniter System

Mr. Lau, TVA, summarized work on igniters. The locations of the 30 igniters were influenced by the pre-existing emergency lighting circuits to which they are attached. A question was raised as to whether igniters should be located near points of likely release of hydrogen from the coolant system.

TVA is performing tests to determine glow plug reliability and to characterize hydrogen combustion. A 7 foot diameter vessel is being used. It was said that detonable mixtures are not expected in ice condenser containments if the air circulation fans are on. There are two air circulation fans, each with 40,000 cfm capacity.

Mr. Lau indicated that for concentrations of interest, steam has only a small effect on hydrogen ignition temperature.

Comments by EPRI on Hydrogen

Mr. Miller, NSAC, described analyses of the TMI-2 hydrogen burn, which indicated 25% to 50% clad/water reaction.

EPRI plans hydrogen tests in a 50-foot diameter (65,000 cu ft) vessel to investigate scale effects on combustion. Initial tests will begin in the summer, 1981.

Summary Comments

The following summary remarks were made:

- Optimized placement of glow plugs is important. Igniters should probably be placed close to likely release points.
- Dr. Strehlow, ACRS consultant, expressed concern with flame propagation through the air circulation ducts.
- Effects of high temperatures on components and potential fires in foam insulation should be evaluated.
- The consultants felt, in general, that the igniter system is a good idea and that it should prove effective. Dr. Lee, however, indicated that consequences of hydrogen burning in containment should be carefully studied since this is a new matter.

Future Meetings

There are no meetings currently scheduled.

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NOTE: For additional details, a complete transcript of the meeting is available in the NRC Public Document Room, 1717 H St., NW, Washington, DC 20555 or from Alderson Reporting Company, Inc., 300 7th Street, S.W., Reporters Building, Washington, D.C. 20024 (202) 554-2345.