April 17, 1979

# RECOMMENDATIONS OF THE NUCLEAR REGULATORY COMMISSION ADVISORY COMMITTEE ON REACTOR SAFEGUARDS REGARDING THE MARCH 28, 1979 ACCIDENT AT THE THREE MILE ISLAND NUCLEAR STATION UNIT 2

Presented orally to, and discussed with, the NRC Commissioners during the ACRS-Commissioners Meeting on April 17, 1979 - Washington, D. C.

Natural circulation is an important mode of reactor cooling, both as a planned process and as a process that may be used under abnormal circumstances. The Committee believes that greater understanding of this mode of cooling is required and that detailed analyses should be developed by licensees or their suppliers. The analyses should be supported, as necessary, by experiment. Procedures should be developed for initiating natural circulation in a safe manner and for providing the operator with assurance that circulation has, in fact, been established. This may require installation of instrumentation to measure or indicate flow at low water velocity.

The use of natural circulation for decay heat removal following a loss of offsite power sources requires the maintenance of a suitable overpressure on the reactor coolant system. This overpressure may be assured by placing the pressurizer heaters on a qualified onsite power source with a suitable arrangement of heaters and power distribution to provide redundant capability. Presently operating PWR plants should be surveyed expeditiously to determine whether such arrangements can be provided to assure this aspect of natural circulation capability.

The plant operator should be adequately informed at all times concerning the conditions of reactor coolant system operation which might affect the capability to place the system in the natural circulation mode of operation or to sustain such a mode. Of particular importance is that information which might indicate that the reactor coolant system is approaching the saturation pressure corresponding to the core exit temperature. This impending loss of system overpressure will signal to the operator a possible loss of natural circulation capability. Such a warning may be derived from pressurizer pressure instruments and hot leg temperatures in conjunction with conventional steam tables. A suitable display of this information should be provided to the plant operator at all times. In addition, consideration should be given to the use of the flow exit temperatures from the fuel subassemblies, where available, as an additional indication of natural circulation.

The exit temperature of coolant from the core is currently measured by thermocouples in many PWRs to determine core performance. The Committee recommends that these temperature measurements, as currently available, be used to guide the operator concerning core status. The range of the information displayed and recorded should include the full capability of the thermocouples. It is also recommended that other existing instrumentation be examined for its possible use in assisting operating action during a transient.

The ACRS recommends that operating power reactors be given priority with regard to the definition and implementation of instrumentation which provides additional information to help diagnose and follow the course of a serious accident. This should include improved sampling procedures under accident conditions and techniques to help provide improved guidance to offsite authorities, should this be needed. The Committee recommends that a phased implementation approach be employed so that techniques can be adopted shortly after they are judged to be appropriate.

The ACRS recommends that a high priority be placed on the development and implementation of safety research on the behavior of light water reactors during anomalous transients. The NRC may find it appropriate to develop a capability to simulate a wide range of postulated transient and accident conditions in order to gain increased insight into measures which can be taken to improve reactor safety. The ACRS wishes to reiterate its previous recommendations that a high priority be given to research to improve reactor safety.

Consideration should be given to the desirability of additional equipment status monitoring on various engineered safeguards features and their supporting services to help assure their availability at all times.

The ACRS is continuing its review of the implications of this accident and hope to provide further advice as it is developed.

EXTRACT OF B&W COMMUNICATION - RECEIVED BY NRC 4/20/79

Enclosure 1



TRODUCTION

IE CONTINUING REVIEW OF THE SEQUENCE OF EVENTS LEADING TO THE INCIDENT AT II-2 ON MARCH 28, 1979 SHOWS THAT ACTION CAN BE TAKEN TO PROVIDE ASSURANCE AT THE PILOT-OPERATED RELIEF VALVE (PORV) MOUNTED ON THE PRESSURIZER OF B&W NITS WILL NOT BE ACTUATED BY ANTICIPATED TRANSIENTS WHICH HAVE OCCURRED OR VE A SIGNIFICANT PROBABILITY OF OCCURRING IN THESE PLANTS. THIS ACTION MUST T DEGRADE THE SAFETY OF THE AFFECTED PLANTS WITH RESPECT TO THEIR RESPONSE NORMAL, UPSET OR ACCIDENT CONDITIONS NOR LEAD TO UNREVIEWED SAFETY CONCERNS. E ANTICIPATED TRANSIENTS OF CONCERN ARE:

1. LOSS OF EXTERNAL ELECTRICAL LOAD
2. TURBINE TRIP
3. LOSS OF MAIN FEEDWATER
4. LOSS OF CONDENSER VACUUM
5. INADVERTENT CLOSURE OF MAIN STEAM ISOLATION VALVES (MSIV).

UMBER OF ALTERNATIVES WERE CONSIDERED IN DEVELOPING THE ACTIONS PROPOSED ON INCLUDING:

RESTRICTING REACTOR POWER TO A VALUE WHICH WOULD ASSURE NO ACTUATION OF THE PORV. THE REACTOR PROTECTION SYSTEM, DESIGN PRESSURE AND PORV SET-POINTS REMAINED AT THEIR CURRENT VALUES.

LOWERING THE HIGH PRESSURE REACTOR TRIP SETPOINT TO A VALUE WHICH WOULD ASSURE NO ACTUATION OF THE PORV. THE DESIGN PRESSURE OF THE REACTOR AND THE SETPOINT FOR PORV ACTUATION REMAINED AT THEIR CURRENT VALUES.

LOWERING THE HIGH PRESSURE REACTOR TRIP SETPOINT AND ADJUSTING THE OPERATING PRESSURE (AND TEMPERATURE) OF THE REACTOR TO ASSURE NO PORV ACTUATION AND TO PROVIDE ADEQUATE MARGIN TO ACCOMMODATE VARIATIONS IN OPERATING PRESSURE. THE SETPOINT FOR PORV ACTUATION REMAINED AT ITS CURRENT VALUE. THIS ALTERNATIVE WOULD REDUCE NET ELECTRICAL OUTPUT.

ADJUSTING THE HIGH PRESSURE TRIP AND THE PORV SETPOINTS TO ASSURE NO PORV ACTUATION FOR THE CLASS OF ANTICIPATED EVENTS OF CONCERN. THE DESIGN PRESSURE OF THE REACTOR REMAINED AT ITS CURRENT VALUE.

NALYSIS OF THE IMPACT OF THESE VARIOUS ALTERNATIVES AND THEIR CONTRIBUTION SSURING THAT THE PORV WILL NOT ACTUATE FOR THE CLASS OF ANTICIPATED TRANSIENTS ONCERN HAS BEEN COMPLETED. THE RESULTS SHOW THAT:

LOWERING THE HIGH PRESSURE REACTOR TRIP SETPOINT FROM
2355 PSIG TO 2300 PSIG

AND

RAISING THE SETPOINT FOR THE PILOT OPERATED RELIEF VALVE
FROM 2255 PSIG TO 2450 PSIG

IDES THE REQUIRED ASSURANCE. THIS ACTION HAS THE FURTHER ADVANTAGES OF:

- REDUCING THE PROBABILITY OF PORV AND ASME CODE PRESSURIZER SAFETY VALVE ACTUATION FOR OTHER INCREASING PRESSURE TRANSIENTS.
- PRESERVING PRESSURE RELIEF CAPACITY FOR ALL HIGH PRESSURE TRANSIENTS.
- ELIMINATING THE POSSIBILITY OF INTRODUCING UNREVIEWED SAFETY CONCERNS.
- REDUCING THE TIME AT WHICH THE STEAM SYSTEM HEAT SINK WOULD BE LOST IN THE EVENT EMERGENCY FEEDWATER FLOW WERE DELAYED.

SUMMARY OF THE IMPACT OF THE PROPOSED SETPOINT CHANGES ON ALL ANTICIPATED ANSIENTS IS GIVEN IN TABLE 1.

M PLANTS ARE CURRENTLY CAPABLE OF RUNBACK TO 15% OF FULL POWER UPON LOSS OF AD OR TRIP OF THE TURBINE. THIS CAPABILITY REQUIRES ACTUATION OF THE PILOT-ERATED RELIEF VALVES. THE CAPABILITY INCREASES THE RELIABILITY OF POWER PPLY TO THE SYSTEM BY RETURNING THE UNITS TO POWER GENERATION MORE QUICKLY TER THESE TRANSIENTS. THE ACTION PROPOSED ABOVE WILL REQUIRE THAT THE ACTOR BE TRIPPED FOR THESE EVENTS.

E NOTE:

The effect of changing the reactor coolant system pressure trip setpoint upon peak pressurizer pressure is typified by the attached figure 1. which was developed by B&W for a loss of feedwater transient.

# TABLE 1

## SUMMARY OF PROTECTION AGAINST PORV ACTUATION PROVIDED BY PROPOSED SETPOINT CHANGES FOR ALL ANTICIPATED TRANSIENTS

EXTRACT OF B&W COMMUNICATION - RECEIVED BY NRC 4/20/78

ANTICIPATED TRANSIENTS WHICH HAVE OCCURRED AT B&W PLANTS AND WHICH WOULD NORMALLY ACTIVATE PORV AT THE CURRENT SETPOINT (2255 PSIG):

A. TURBINE TRIP
B. LOSS OF EXTERNAL ELECTRICAL LOAD
C. LOSS OF MAIN FEEDWATER
D. LOSS OF CONDENSER VACUUM
E. INADVERTENT CLOSURE OF MSIV

ANTICIPATED TRANSIENTS WHICH HAVE OCCURRED AT B&W PLANTS AND WHICH WOULD NORMALLY ACTUATE PORV AT THE PROPOSED SETPOINT (2450 PSIG):

NONE

ANTICIPATED TRANSIENTS WHICH HAVE NOT OCCURRED AT B&W PLANTS (LOW PROBABILITY EVENTS) AND WHICH WOULD NORMALLY ACTUATE PORV AT THE CURRENT SETPOINT (2255 PSIG):

A. SOME CONTROL ROD GROUP WITHDRAWALS (MODERATE TO HIGH REACTIVITY WORTH GROUPS NOT OTHERWISE PROTECTED BY HIGH FLUX TRIP).
B. MODERATOR DILUTION.

ANTICIPATED TRANSIENTS WHICH HAVE NOT OCCURRED AT B&W PLANTS (LOW PROBABILITY EVENTS) AND WHICH WOULD ACTUATE THE PORV AT THE PROPOSED SETPOINT (2450 PSIG):

A. SOME CONTROL ROD GROUP WITHDRAWALS (HIGH REACTIVITY WORTH NOT OTHERWISE PROTECTED BY HIGH FLUX TRIP).

EXTRACT OF B&W COMMUNICATION - RECEIVED BY NRC
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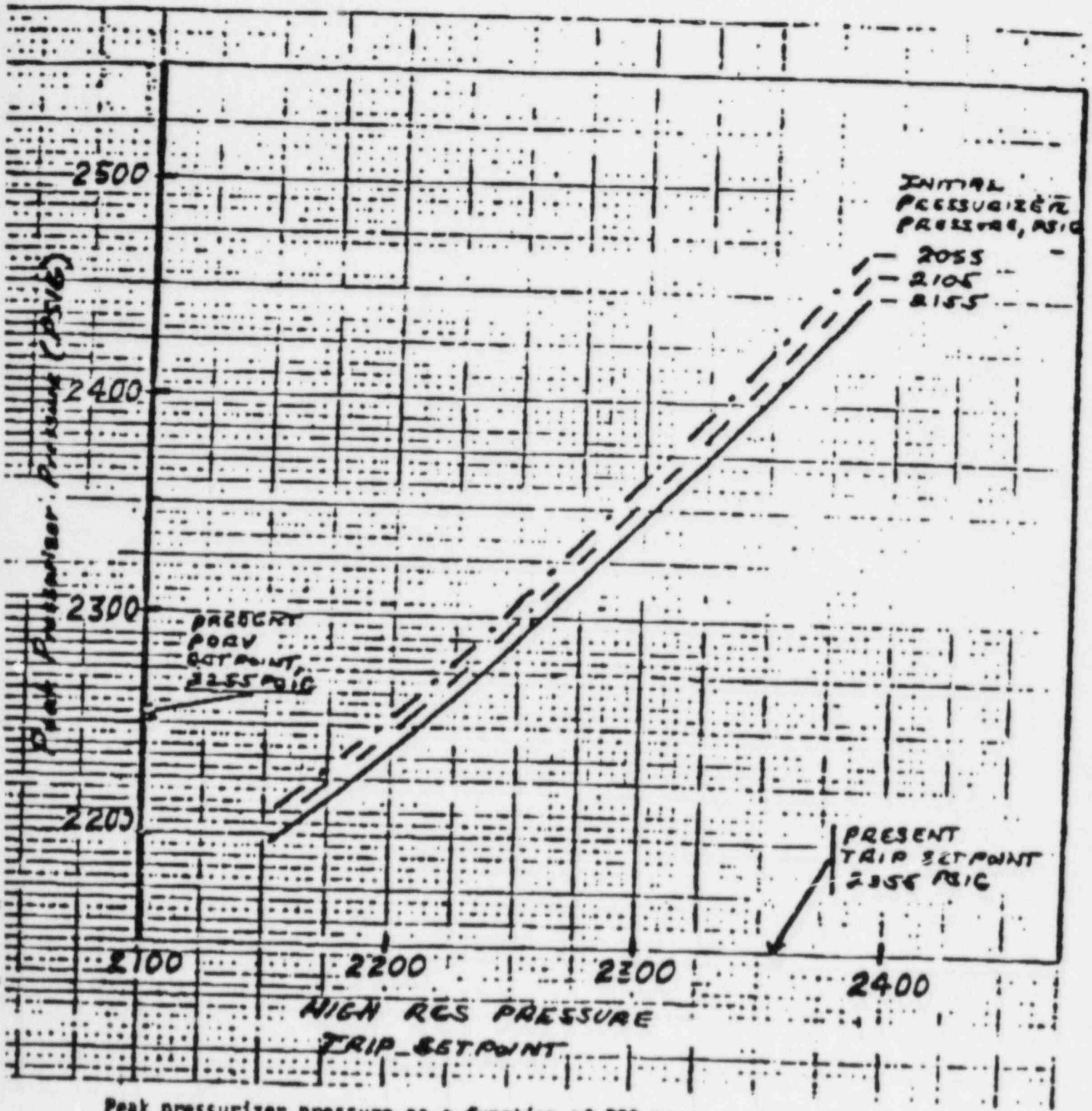


Peak pressurizer pressure as a function of RCS pressure trip setpoint for a loss of feedwater transient for expected conditions and various initial pressures.

Figure 1