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TO : Marvin M. Mann, Assistant Director
Compliance Division of Inspection, AEC Headquarters

DATE: April 27, 1960

FROM : V. A. Walker, Inspection Specialist
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SUBJECT: PERSONAL IMPRESSIONS OF WTR INCIDENT INVESTIGATION

SYMBOL: IL:VAW

In a recent conversation you asked that I submit my personal impressions of the investigation of the WTR incident; the date of this incident was April 3, 1960.

This memorandum summarizes these impressions.

General

It was expected that more than the recital of the events preceding, during and following the incident would be made. It is realized that the WTR staff has been working primarily on the aftermath but, even so, a larger effort into the cause was indicated certainly. The recital of the events itself was not well organized and the explanations of the different actions of both the machine and the people were obtained only in response to questions by the investigators. It appeared to me that the WTR staff made the initial assumption that the AEC people knew as much about their reactor as they did; in my case this is certainly not true, and the duration of the meeting was increased through my ignorance -- my apologies, sir. The WTR staff took a defensive position and only offered technical information when precisely queried and these data were only very rough estimates, some of which were made during the course of the meeting. I would expect that the staff would desire to advise the investigators of the "why" of the incident as well as the "how" and "when" thereof; in this regard the WTR people made a minor effort only.

In general, I would judge that the men in the supervisory positions were inexperienced and exercised poor judgment in the execution of their primary responsibilities. For example, the Reactor Manager had a good knowledge of reactor physics and kinetics but did not include directions in the event of abnormal conditions in the operating procedures manual. In addition, an unlicensed operator with only three months of informal nuclear training was given the primary responsibility for the machine during this test. These two examples

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definitely show the lack of experience and good judgment on the part of the Reactor Manager. I would expect that the Manager, Scientific Support, would be one of the most knowledgeable men in the business on the subject of boiling in pressurized water reactors; in my opinion, he is not.

Organization

It was evident that the basic organization for the establishment and maintenance of an acceptable risk level has been instituted. However, there must have been different interpretations of the various functions. The Safeguard Committee considered the general testing philosophy and procedures but had not considered in detail the test which resulted in the incident. I cannot agree that the general test description submitted by the Manager, Scientific Support, to the investigators would have provided sufficient information for a Safeguard Committee member to make a reasonable judgment of the risk involved in the boiling detector calibration.

When considering the lack of knowledge regarding the behaviour of parallel channels at low pressures when in boiling, it appears that the instrumentation installed on the test fuel element was inadequate notwithstanding the fact that the ORR had executed a test program in the same manner as the WTR program. The lack of thermocouples measuring the wall temperatures is the responsibility of the Safeguard Committee. The unfortunate aspect of the exhibited ineptitude of the Safeguard Committee is that reactor test programs are probably less severe than the experimental irradiation programs which will be operated in the future.

The Manager, Reactor Operations, admitted that the reason he was present during this test was that the Shift Supervisor had been working at the WTR since early January 1960, that the Supervisor was not licensed, and that the Supervisor was inexperienced. But the Manager did not, in fact, provide direction to the Supervisor and, following the loss of a large amount of reactivity, the Supervisor directed an increase in power. Apparently the "maintain conditions" philosophy had been instilled adequately for the Supervisor to try to regain the initial conditions even though an abnormal situation existed. Unfortunately, this philosophy is not uncommon among reactor operators. The Shift Supervisor cannot be held entirely culpable since the written test procedure he was using as a guide did not state the action to be taken if an abnormal situation arose; all of the following men approved the detailed procedure:

Manager, Reactor Operations; Manager, Scientific Support; Operations Superintendent, and Senior Shift Supervisor.

The instructions that the Shift Supervisor had were clearly inadequate. During the investigation the Manager, Reactor Operations, recognized the need for more complete written operating instructions but it remains to be seen if he will have the additional instructions written, approved, and included in the operating manual. It can be said that this Manager will be more conscious of the need for a good, sound nuclear safety philosophy but he may not include this philosophy in the administration of this reactor complex.

It appeared to me that the fuel assembly inspection performed by the fabricator was considered adequate by the WTR staff since they did not perform additional inspections nor did they check the fabricator's data. This notion is additional evidence of the attitude taken toward nuclear safety.

I think that the WTR could be made a safe as well as an efficient reactor but that it is not now safe. In this regard the duty of the Division of Inspection is clear, particularly when major, engineered experiments are installed.

License Provision

In my opinion, the license amendment which allows one (1) percent of the total core volume to be voids is at least an order of magnitude greater than should be permitted. Roughly, one percent of the total core volume amounts to the volume occupied by one fuel assembly. The present state of the art regarding the effect of boiling on pressure drop and burnout through "flow-disease" is not developed sufficiently to make knowledgeable predictions. I know of only one report - of which, by the way, I advised Merson Booth in October 1959 - on the subject; it is: ANL-5178, Local Boiling Pressure Drop by J. B. Reynolds, March 1954.

The maximum heat flux used in this study was only 304,200 BTU/hr, sq. ft. as compared to about 600,000 in the WTR. Using the data cited in ANL-5178 and those given us by the Manager, Scientific Support, the local boiling pressure drop per unit length is roughly ten times the isothermal pressure drop per unit length; therefore, it is not surprising to me that burnout occurred, probably during the time that the reactor power was being increased from about 28 MW

to 35 MW with the flow at 5200 gpm, total. I must reiterate that Reynolds data should not be used since the geometry he used is different, the heat flux is much lower and the test piece was uniformly heated along its length but I do think that failure through the "flow-disease" mechanism is a very good candidate for the cause. Someone, somewhere, and sometime, should make a careful and thorough experimental study of this mechanism at all ranges of variables as well as the detection of the different boiling regimes in nuclear reactors. Until this study is complete I consider it unwise to permit operation of pressurized water reactors beyond the point of the initial detection by conventional nuclear instrumentation (including the reactor period) during steady state operations and calculated nucleate boiling using hot spot-hot channel techniques during transients.

Technical Data

In my opinion the following information in the WTR is not adequately known:

(a) neutron flux distribution, both radially and axially, during this particular fuel loading:

(b) the velocity distribution among the three channels and within each channel;

(c) the amount of reactivity that was added at 2034, April 3, 1960 to override the large negative reactivity insertion that was experienced;

(d) velocity re-distribution at the lower total flow rate;

(e) the gaseous activity released to the environment.

While metal or fuel temperatures are difficult to measure in nuclear reactors, experience has developed techniques by which such measurements can be made with some degree of success. Therefore, I cannot condone the attitude taken in this case. The comment was made by Manager, Scientific Support, "We talked to the people at Bettis Field and they said it couldn't be done." In fact, the Bettis people are using thermocouples inside nuclear reactors to determine the thermal conductivity of assembled fuel elements; it would appear that the Bettis people think that it is possible to make such measurements.

Summary

In general, I think the WTR is not well-managed and that the agressiveness they have exhibited in developing reactor technology has been misdirected. The latter condition can be attributed in part to the tests that have been performed elsewhere.