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

MAR 2 8 1978

MEMORANDUM FOR: R. Mattson, Director, Division of Systems Safety, NRR

FROM: D. F. Ross, Jr., Assistant Director for Reactor Safety, DSS

SUBJECT: KEY DECISIONS IN ATWS REPORT

As agreed in the 3-27-78 meeting, enclosed is a list by DSS branch of key decisions in ATWS report to be verified by DSS management. Also there is a list of "General" and DSE/DOR. What is needed by April 3, 1978 is for each A/D to collect advice, confirmatory or otherwise, of the support of these statements. The format should be by A/D to you, copies to A. Thadani and D. Ross. It is strongly urged that each reader consult, in addition to main report, the draft rule in Appendix IV.

D. F. Ross, Jr., Assistant Director
for Reactor Safety
Division of Systems Safety

Enclosure:
As stated

cc: A. Thadani
DSS B/Cs, A/Ds
G. Arlotto
S. Hanauer
M. Ernst
V. Stello
D. Eisenhut
R. Boyd
H. Denton
A. Buhl
M. Malsch

8104170531

PLANT SYSTEMS

ICSB

1. (p. 26) $U_{RPS} \sim 3x10^{-5}$/demand, @ 50% level.

2. (p. 69-70) Improvements in present RPS not now necessary (as contrasted with 1975 status reports) due to role of rods and drives unreliability; goal instead is reliable mitigating systems.

ASB

See RSB list, numbers 3, 4, 5, 6

CSB

1. (p. 60) ATWS not limiting for design pressure and temperature

2. (p. 61) Suppression pool temperature limit must be set to preclude destructive vibration

PSB

1. (p. 66): LOOP as initiating event ($\sim.2$/year) convoluted with U_{RPS} ($\sim 3x10^{-5}$) results in acceptance of onsite AC power unreliability of $\sim 5.10^{-2}$, since this path is then sufficiently low (see also Appendix IV).

2. See RSB list #3, 4, 5, 6

ENGINEERING

MEB

1. (p. 26, p 40): CRD system unreliability is approximately equal to electrical portion of unreliability (~1.5×10^{-5}).

2. (p. 39) Old Class A (WASH-1270) fix no longer acceptable; diverse rods would be needed.

3. (p. 52): Steam generator tube leakage is to be considered in dose calculation; two leakage categories are to be used, dependent on relative s.g. integrity

4. (p. 53): Service Condition C is appropriate, except for S.G. tubes.

5. (p. 68): Failure of safety valve to open is not a design basis.

MTEB

None seen

SEB

None seen

REACTOR SAFETY

RSB

1. (p. 13): Arrival rate of transients of significance is 7/RY.

2. (p. 50) ATWS is a DBA and specific plant calculations must be provided and reviewed.

3. (p. 62-63) Mitigating systems:

   i) automatically initiated

   ii) justify any operator action

   iii) high availability

   iv) independent, separate, diverse from RPS

   v) meet natural phenomena expected to occur <u>during plant lifetime</u>

   Note: ASB, ICSB also involved.

4. p. 63: Operator action >10 min if justified

5. p. 64: Single failure criterion <u>not</u> mandatory (Other systems branches also involved)

6. p. 66: At 50% C. L., a mitigating system must have unavailability approximately 10^{-3} per demand unless safety grade.

7. p. 73: Initial and boundary conditions generally best-estimate, although conservative where experience limited, or range large.

   Note: AB, CPB also affected.

AB

1. (p. 72) Vendor models generally acceptable, except impact of new GE transient, ODYN, yet to be confirmed (thought to be minimal)

CPB

1. (p. 60) PCI fuel failure probably enveloped by rods in deficient cooling for BWRs; probably not a problem for PWRs.

2. (p. 74-75) MTC should be at 99 percentile value.

General

1. (p. 34) Frequency of ATWS event resulting in core melt or exceeding part 100 should be reduced to 10^{-6} per R.Y. per plant, in order to maintain nuclear risk nationwide, low with respect to other societal risks.

2. (p. 32-33) RSS insights may be used to develop licensing criteria for ATWS

3. (p. 51) Rulemaking should be initiated

4. Reducing core melt probability ascribable to ATWS does not provide a directly proportional decrease in events that exceed part 100, as not all core melts exceed part 100. In addition, some ATWS events, that do not go to melt would exceed part 100. This argument is important in assessing whether ATWS C.M.P. should a low contributor on its own, or relative to other CMP sequences.

DSE/DOR

1. (p. 52) Acceptable dose model - should it be 5% or 50%?

2. (p. 85) V/I analysis supports ATWS decision

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MAY 03 1978

NOTE TO: D. Ross

FROM: A. Thadani

SUBJECT: ATWS MITIGATING SYSTEM RELIABILITY

The enclosure provides my attempt to elucidate our reliability criterion for ATWS mitigating systems. I hope I have not further confused the matter.

A. Thadani

Ashok C. Thadani

Enclosure:
As Stated

cc: S. Hanauer
R. Mattson
T. Novak
T. Ippolito

[illegible]

DUPE OF

8104170210

MITIGATING SYSTEMS RELIABILITY REQUIREMENTS

For licensing purposes we assume that the probability of an ATWS which could potentially exceed acceptance limits is approximately 2×10^{-4} per reactor year. The only exception is a loss of offsite power ATWS event The frequency of this event is believed to be approximately 6×10^{-6} per reactor year.

In general, following systems are used to mitigate consequences of ATWS events.

Short Term (less than 10 minutes)

PWRs	BWRs
Turbine Trip	Recirculation Pump Trip
Auxiliary Feedwater System	Relief and Safety Valves
Power Operated Relief Valves	HPCI(s) or RCIC
Steam Generator Safety Valves	Auto. Boron System
Pressurizer Safety Valves	Feed Pump Trip
Offsite or Onsite Power	Offsite or Onsite Power

Long Term (10 or more minutes)

PWRs	BWRs
Service Water System	Service Water System
RHR	RHR
Component Cooling System	Closed Loop Cooling Water System
Steam Dump Valves	

Definition of a Mitigating System

~~Clearly~~, several systems are relied on to mitigate the consequences of ATWS events. Each system relied on ~~in this manner~~ is called a mitigating system. If the system consists of three trains, and only two trains of this system are ~~relied on~~ to mitigate ATWS events, then the mitigating system reliability criterion requires that the ~~probability~~ of two trains out of three trains to function on demand be ~~shown to be~~ .999 at 50 percent confidence level for all ATWS events except loss of offsite power.

Example:

Auxiliary Feedwater System

One Turbine Driven Pump Train

Capacity 50%, Unreliability $\sim 4 \times 10^{-2}$

First Motor Driven Pump Train

Capacity 25%, Unreliability $\sim 10^{-2}$

Second Motor Driven Pump Train

Capacity 25%, Unreliability $\sim 10^{-2}$

Assuming no significant contribution from common mode failures.

Probability of losing more than 50 percent auxiliary feedwater flow is approximately 8×10^{-4}.

Probability of losing 50 percent auxiliary feedwater flow is approximately 4×10^{-2}.

Unreliability Criterion: Mitigating system must have an unreliability of $\sim 10^{-3}$/demand at 50 percent confidence (except for LOOP ATWS).

If credit is taken in the analyses for only 50 percent capacity of auxiliary feedwater system, then this system (one-half of total aux. feed system) would be the mitigating system and would also satisfy the reliability criterion.

Thus, this reliability criterion can be generalized as follows:

(a) Mitigating system with only one train: Credit can be taken for this system if it meets the 10^{-3} criterion (except for LOOP ATWS).

(b) Mitigating system with n identical trains where $n \geq 2$ and common mode failures are not significant.

Let u be unreliability of single train.

(i) If $n \times u$ meets 10^{-3} criterion credit may be taken for all trains.

(ii) If $n \times u > 10^{-3}$ unreliability, then credit may be taken for (n-1) trains if $n(n-1)u^2$ meets 10^{-3} criterion.

If $n(n-1)u^2 > 10^{-3}$ unreliability, then credit may be taken for (n-2) trains if $n(n-1)(n-2)u^3$ meets 10^{-3} criterion.

This, of course, can be extended for large n.

Comment:

In view of the difficulties with terminology and for completeness, I recommend that we add the following criterion if safety-grade equipment is not provided.

The sum of the probabilities of failure of each mitigating system shall be approximately 5×10^{-3} at 50 percent confidence level (except for LOOP).

Mathematically:

$$\left[\text{ATWS Probability}\right] \times \left[u_{s_1} + u_{s_2} + \ldots + U_{s_n}\right] \sim 10^{-6}$$

ATWS Probability $\sim 2 \times 10^{-4}$

$u_{s_1} \ldots u_{s_n}$ - Represent unreliabilities of mitigating systems $s_1 \ldots s_n$

$$u_{s_1} + u_{s_2} + \ldots + u_{s_n} = \sum_{i=1}^{n} u_{s_i}$$

$$\sum_{i=1}^{n} u_{s_i} \sim \frac{10^{-6}}{2 \times 10^{-4}} \sim 5 \times 10^{-3}$$