(2)

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RELATIVE SAFETY

Safety: Avoid H_2 explosion
Criteria: Avoid release of fission products to public
Cool the core (avoid melting)
Process parameters should be available by measurement

1. R.C. Pump (greatest degree of safety)

Advantages
- a. Effective cooling
- b. Has the most back up options
- c. Probably gives most core flow
- d. Involves items normally used
- e. We know its working

Disadvantages
- a. Adds to System as much heat as the core (or more)
- b. Requires off-site power
- c. Requires higher pressure
- d. Requires make-up pump

2. Natural circulation with solid primary and solid secondary systems.

Advantages
- a. Probably better heat transfer than HPIS will give
- b. Still has quite a few options left
- c. Gas evolution is less than with boiling natural circulation
- d. Permits colder shut down at lower pressure than with R. C. Pumps

Disadvantages
- a. Effectiveness not verified either by analysis or test
- b. Requires off-site power or jury-rig
- c. Can't have bad leaks in primary system or needs considerable make up
- d. Off-design mode

3. National Circulation with Nucleate boiling with secondary system solid.

Advantages
- a. Probably gives better heat transfer than solid natural circulation in primary system.
- b. May permit jury-rigging to rely only on on-site power.
- c. Is a logical sequence if solid primary system natural circulation doesn't work well.

Disadvantages
- a. Gas evolution could be a problem, and could lead to blocking candy cane.
- b. May disturb core more than solid natural circulation
- c. Pressure maintenance required in P S
- d. Requires off-site power
- e. Has not been verified by analysis on test

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4. HPIS

Advantages
a. In principle, provides forced flow through core
b. Doesn't require secondary system.
c. Requires only on-site power

Disadvantages
a. Potential for by-passing core (via S.G.'s) needs to be studied
b. Keeps system at higher press than RHR
c. Vent, to the containment and adds to water volume in the containment

5. RHR

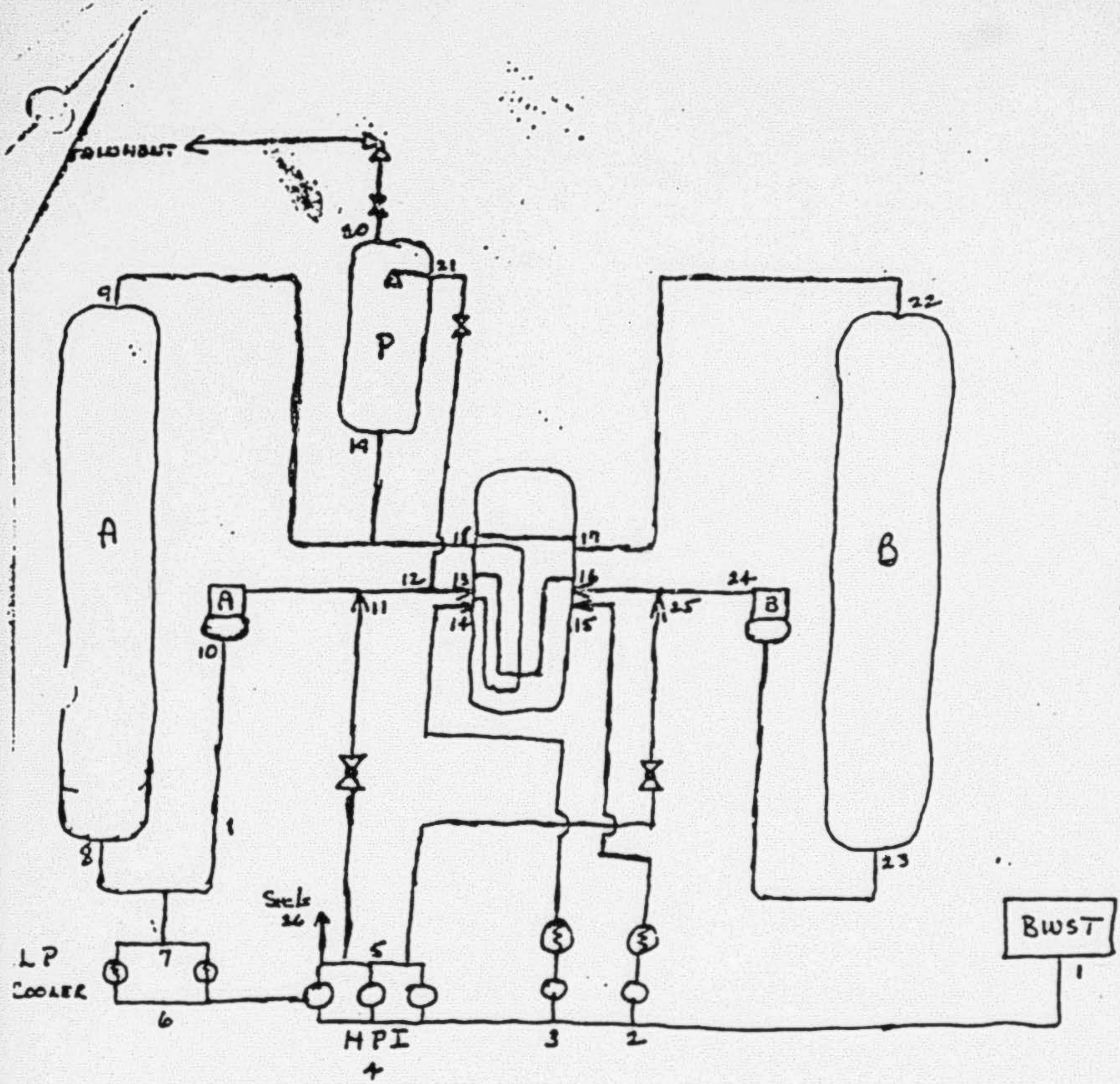
Advantages
a. Was designed to cool core for long term
b. Requires on site power only
c. It operates at relatively low pressure

Disadvantages
a. High radioactivity in the coolant
b. Should be upgraded by providing more redundancy for long term cooling
c. Operability of containment valves in system not confirmed

6. Containment Flooding

Advantages
a. It is the last available resort to cool core.
b. It is better than letting core melt in dry containment

Disadvantages
a. Heat transfer capability is unconfirmed
b. Makes eventual clean up difficult because of large volume of water and because water will carry debris to points otherwise cleaner
c. Endangers process monitoring capability
d. Potential thermal shock problem if there are significant hot spots
e. Loses sump valve, sump pump, reactor system drain tank pump, etc.
f. This is most severe off-design use of component
g. If there is containment liner damage, there is possible leak path to public
h. It puts positive pressure on containment



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BLEED AND FEED OR FEED AND BLEED

1, 4, 5, 11, 13, 18, 19, 20

TABLE I

Forms of Degeneration	Sequence	Importance	Probability
Loss of offsite power	I	A	B
Loss of instrumentation T_h, T_c, Core T/C's, Pressure, core flow, pressurizer level	I	A	A
Loss of RC pumps	I	B	A
Loss of RC pump seals	II	A	A
Can't close pressurizer valve	III	B	B
Can't open pressurizer valve	I	B	A
Loss of pressurizer heaters	I	C	A
Loss of secondary circulation	IV	B	B
Let down valve stuck open	I	B	B
Loss of letdown system	V	B	A
Nitrogen from accumulator	I	B	C
Accumulators stuck closed	I	C	C
Containment breach	VI	A	C
Personnel mislocation		A	A
Human error possibility	I	A	A
H_2 explosion	I	B	B
Flooding containment	VI	A	B
Failure of barrel check valves	I	C	C
Failure of R.V. head seals	III	C	C
Loss of incore instrumentation seal	III	B	C
Fire in containment*	VI	A	B
Fire in auxiliary *	I	A	B
Fire in other areas*	I	A	B
Air crash into plant	I	A	C
Flooding	I	A	C

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Forms of Degeneration	Sequence	Importance	Probability
Core coolability degradation	I	A	C
Leaking S/G. primary and secondary	VII	B	A
Formation of H_2 & O_2	I	C	A
Failure of containment penetration	VI	A	B
Evacuation of control room *		A	C
Breach of waste system (Site evac.)*		A	B
Valve alignment errors	I	A	A
Loss of all A/C power	I	A	B
Instrument/Sampling line leak	III	B	B
Boron dilution	I	A	C
Loss of key personnel	I	B	B
Short term power interruption	I	A	B

*Requires further study

PRIMARY SYSTEM COOLING
(Hamilton, Thrising, Pope, Palladino)

I. **Scope**

Study cooling modes that use primary components as a heat sink.

II. **Brief Description**

Conceive alternate cooling modes and analyze. These modes are:

A. Feed and Bleed
B. Primary Reactor Cooling System Letdown
C. Recirculate and Bleed

III. **Schematics**

A. Feed and Bleed - see next page

B. PRCS Letdown reverts to Mode A

C. Recirculate and Bleed - has limited value and is counter to the premise that loss of off-site power is the reason for Feed and Bleed in the first place. At this point, the scenario is RHR

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D. Reduced speed operation of recirc pump via an MG Set requires further study.

IV PREREQUISITES (ASSUMPTIONS)

- Identify current decay heat load 6.33 MW
- Loss of primary recirculation pumps
- Need BWST capacity
- Containment can accept bleed
- Controls are operable
- Calculate feed and steaming rates – not if system solid
- Provide emergency backup for electromatic relief and guard valve
- Determine present status of electromatic relief valve

V ADVANTAGES

- Does not circulate primary coolant outside containment
- Uses emergency safety grade equipment
- Does not require shift to natural circulation

VI DISADVANTAGES

- Additional containment flooding
- Adds heat to containment
- Electromatic relief and guard valve are not on diesel

VII RECOMMENDATION

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- Back up electromatic relief and guard valve with emergency power

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DEGRADATION SEQUENCE STUDY

OBJECTIVE

Identify revisions to the planned cooling degradation sequence in the event of plant/system failures.

RESULTS

A list of possible plant/system failures is provided in Table I. Additionally, each failure has been annotated to indicate probability and consequence (importance). These probability and importance designations range from A to C in descending order and are based on engineering judgement of the group.

Each failure event has been considered relative to the need for revision of the reference sequence (Sequence I). Sequences are identified by number in Table II.

IMPORTANT

Four identified plant/system failure events deserve detailed and urgent consideration. These are identified by * in Table I.

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