HARPSTER FIELD NOTES

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initial information 9/26

① steam feedwater system control system logic failure apparently initiated the MSIV isolation

② cause of electromagnetic relief sticking open was pilot valve stuck open (K valve had been recently worked on, cooling relief with integral pilot valve assembly

9/27

max cooldown rate was 35° in 7 min but did not exceed 10°/hr

was boiling in core confirmed by source range spikes ; press-temp trajectories close relay (seal in relay) was missing from electrical relief cycled about 2255 psig

Noted 3-6 dry

minor insulation is off ~ 40%

around 56 & 8-10' big off

(1) B&W evaluating cooldown people coming in tonight

(2) cables to pressurizer heaters were wetted & some repaired low - are presently

(3) anticipate finishing insulation Wednesday Saturday & clean up in a couple of days

flow indicator
aux feed water
pot heaters

3/28 critique

- no indication of starting feed valve position at ICS ~~station~~ - only demand signal
- no positive indication of electromatic relief valve position
- reconstruction

starting feed valve shut
low level #2 SG
RCS press & temp increased
relief & spray cycling
~~RCS~~ pzr level ↑ ~ 290" — relief stuck open
Rx manually tripped
SFAS trip / HP injection
pzr level ↑
rupture disk blew

was there time when HP injection isolated due to mistaking

To 13W37

discrepancy between alarm logger & reactimeter data (~~[illegible]~~) on securing of RCP's
never got B-2 pump stopped alarm

pzr level ↑ & flat at 390"
(press decreasing)

#2 SG was dry
#1 SG ?

because level indication on SG is
DP cell indication flattened out
at low level

pzr (uncompensated level) appeared
not to be solid - also no spikes

worst observed temps 580°
Tc 505°

aux feed pump gov problem - #2 had
to be put in manual (~ 40 sec later)

was put back in auto later

it was ~ 20 (15-) min till block valve
in series with electro-relief was
closed

cause of starting aux feed valve
stuttering & initial half
trip still unknown

find aux feed turbine discharge disconnect when press < 600 psi
was low steam press trip blocked

? previous event may have
a/2 similar problem - tbl
alarm 1751 ?

letdown for long time when
PZR level up

FCR written for indicating lights on electric block (may affect life false indication)

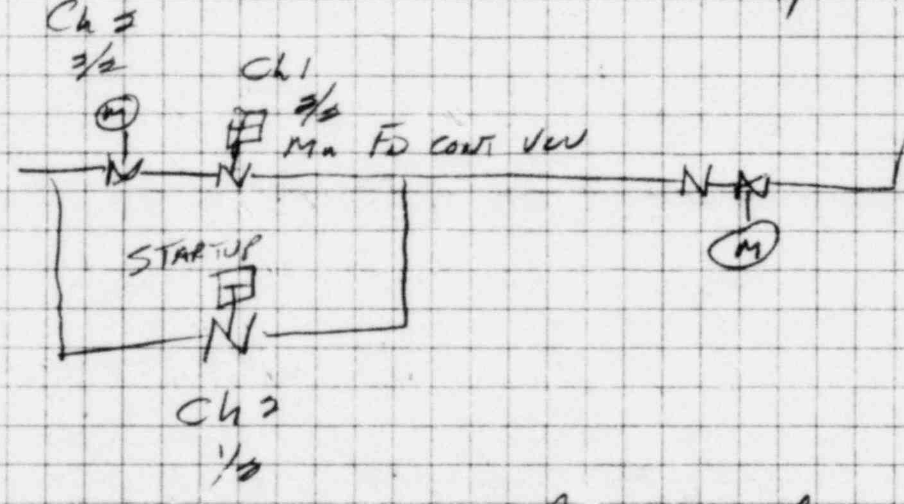
asked for ~~a~~ interlock on RC-11 below 2100# which would shut

asked for Rx trip following SFRCS trip

when on startup valves < 80% without block (main) open half trip (2) closes - can this logic be improved

appears one problem is operators are unclear how SFRCS system operates

appears would violate single fail criterion



note there is always this problem at < 55% power

there also is surveillance but where jumper is installed where slip with jumper would cause same transient

would steam gen. had gone dry if
AFP governor had worked - apparently
station was aware of governor problem
since January

B&W will provide evaluation
of press & temp excursion

B&W is evaluating core effects

B&W is evaluating SG dry

FCR has been written to replace
aux feed pump governors

also investigating shut down
procedure for AFP - pump will
not come up right if not
shut down exactly right

~~[illegible]~~ (problem with hydraulic
press (critical) when
shutting down)

checking on history relay for electro relief

Jack Herring

POOR ORIGINAL

may have been outside limit on
containment annulus diff press.
alarms may not seal in on charts
trip & computer may not pick up
if it comes & goes

9/30 Meeting

relief block valve closed at ~20 min

cont press reached 4 psia

SFRCS

- SFRCS 1/2 trip in 1/3 of channel 2 (want sealed in)

1/2 trip seals in on MS. ✓

other 1/3 trip on SG low level

two pressure trips 2/3 need

→ efforts to track down trips

all surveillance test ✓

all setpoints ✓

found 4 connections not tight (1 obvious) (was in channel 3 & did not cause this incident)

others were not as bad but could have caused trip (press switch on main steam line)

* tripped actuated device seals in but alarm does not so it must (signal) remain in for 1 full sec for computer scan to pick up

there were 2 other SFRCS initiation
9/15 real
7/2 event appears to have similar
½ trip initiation

both 9/2 & 9/24 events gave unexplained channel 2 ½ trips which closed start up control valve

lo press (steam)
lo level 56
ΔP across vlv
} all will close 50 valve & give up ½ trip

Aux feed

saw 5600 RPM
switched to manual & turbine ↑ 3600 RPM

normal shutdown procedure requires gov to be required to be full open

torque at shutdown causes binding of ~~the~~ linkage & gov may not be full open

a special procedure had been worked out in past to try to preclude this problem

in trying to reconstruct pump was started 4 of 5 times & once binding problem reoccurred

Terry turbine & Woodward Governor

3 potential fixes
put on slow speed stops at shutdown
put on slower motor
put on limit switch to stop travel

power relief valve

2255 ↑ open
2205 ↓ close

close relay missing which provides seal in to keep valve open till 2205

this caused power relief to cycle ~9 times about 2255

relay was scheme checked & in place during preop & tested with simulated pressures

cause of removal unknown now

stem on Crosby pilot valve was bent - replaced pilot
Crosby man said rapid actuation caused failure & subsequent failure open of relief

plan to simulate ~~the~~ signals to verify proper operation - relay has been replaced

Pressure excursion & transient

~~2 times during excursion~~

- reconstruction of data - feel steam formation for ~6 min in RCS

most likely in RCP suction (downstream of system)

heat input from decay heat, metal or heating, & RCP.

pump problems ~6 min & ~16 min

(steam formation also likely along heated surfaces)

seal return line was isolated putting full system press on upper seal (designed to handle this)

may be concern with loss of head on hydrostatic bearing

3 pumps have operated since transient with no problems during

Comp. JS

Fuel

max ΔP across fuel clad - 300 psid
about 6 min into transient
preliminary evaluation shows no concerns

Stresses

does not appear to have caused problems
are presently evaluating cycle contributions
against code limitations to see if fatigue
life shortened
this transient did exceed analyzed
transient 3200-800 15 min
this transient greater

Physical damage in containment

quench tank rupture disk 18"
ventilation duct vent & louvers blown
(replaced)
~10 steel changing
~20 on floor
minor insulation removed ~ 1/3 way
around SG & paint removal
39 new pieces were installed

press heater cables wetted (13 or 14)
- were dried out (originally measured low)

4 cables had some physical damage which probably occurred before the replacement
- were returned for repair to mfg.

2 Cl motors were measured

five detectors above 2Cl were damaged by steam & replaced

1 lighting fixture dislodged

Chemistry

Chromium 51
Zinc 97
Cobalt 58
Sodium 37

core samples indicated almost no spalling & mostly corrosion products

some → ~ 10^{-6} uc/cc iodine is normal from surface contamination

no cesium was detected before entry

surface contamination ~ 40,000 DPM / 100 cm²

boric acid crystallization under
minor on SG - evaluated to be
no problem

HP injection - no indication

.98 on 2 makeup pumps were on operating
140 GPM which exceeded flow from
HP pumps

discharge press of makeup pumps were
higher than HPI pumps

Aux feed, with cross connect - performed
properly operator had throttled

Thermal shock SG - within P/T
envelope previously analyzed
(Feedwater temp was considerably
higher) (analyzed temp is
43°)

Containment annulus ΔT
not out of spec

there are no safety related cables
affected by general tank rupture
(previously reviewed for FSAR by B&W)

10/5/77 Closeout visit

SG dry - if AFW work properly

(1) on dbl ended steam line break - safety analysis indicates both SG would go dry & reflood

(2) on feed rupture - SG would not go dry

→ on small break affected SG would go dry

relay

no work orders issued for relay

relay is held in place by 2 screws (plug in type)

subsequent review has shown 5 other empty sockets & 11 empty fuse holders - are still reviewing to determine if these are spares

relay was tested on prev & AFT also was schem checked

Tech spec violations

none - all action statements were met

Dry SG

B&W defines dry SG as (lower instrument taps) - 8" above tubesheet 6"

B & W evaluation

Immed action letter

(1) actual cause of ⅓ trips not known
(loose connections . . .)

plan to connect ~10 brush recorders
to various points in SFRCS system
to provide continuous monitoring of
selected parameters (temporary fix)
if nothing is found would conclude
(tightening) connections was fix

evaluating time delays for
SFRCS alarms

presently annunciators only on low
steam press trips

are planning to provide annunciator
windows for ⅓ trips

(existing)	windows	trips
	1	full SFRCS
	1	RCP's
	2	lo stm pres
	2	lo level
	3	56 ΔP

only cable calls would be within control room - info already available in computers with exception of full BFRCS trips

(2) B&W has verbally confirmed these as result of cooldown were within acceptable limits - will follow with hard copy

(3) same as (2) will follow in ltr

(4) SG was isolated because AFP did not come up to speed (consider definition of dup)

(5) AFP not up to speed because of procedure for testing gov at high speed stop

both governors are at Woodward in Colorado - are installing position switch which alerts operators if not on low speed stop

Lowell Roe is submitting Jan 31 report

signal to Bodine is level error
{ above setpt drives down
{ below setpt drives up

electro relief - seal in relay → 2305 ↓ 2255 ↑
missing
rapid cycling deformed pilot vlv stem
which caused pilot to stick open
plan to test with simulated ress sig
position indicating switch is being
installed

SFRCS causing initial half trip

Training

lesson plans have been prepared to
initiate training for operators on
SFRCS
starting training next Wednesday
all operators will be through
in (3-5 weeks)
probably 2-4 hour sessions
& probably complete by 10/30