

LICENSEE: South Carolina Electric & Gas Company

FACILITY: Virgil C. Summer Nuclear Station, Unit No. 1

SUBJECT: SUMMARY OF JANUARY 11, 1993 MEETING

On January 11, 1993, the staff met with representatives of South Carolina Electric & Gas Company and Westinghouse Electric Corporation to discuss a proposed safety injection pump run-out test at the Virgil C. Summer Nuclear Station, Unit No 1. Data from the proposed test would be used to determine whether or not it is acceptable to increase the safety injection pump run-out limit by about 10 percent. The current pump run-out limit is 680 gallons per minute. An increased safety injection flow limit would be necessary to support a future power up-rate for the Summer Station. The test data may be submitted for staff review as part of a future license amendment application.

An attendance list is provided as Enclosure 1. A copy of the licensee's handout is provided as Enclosure 2.

ORIGINAL SIGNED BY:

George F. Wunder, Project Manager
Project Directorate II-1
Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

Enclosures:

- 1. Attendance list
- 2. Licensee's handout

cc w/enclosures: Licensee and Service List

DISTRIBUTION:

Docket File*

- NRC/Local PDRs*
- PD II-1 Reading File*
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- J. Partlow 12-G-18
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- G. C. Lainas 14-H-3
- J. A. Mitchell
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- P. D. Anderson
- E. Jordan MNBB 3701
- OGC
- ACRS (10)
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- P. Campbell 8-D-22
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*Only ones to receive Enclosure 2

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ATTENDANCE LIST

ENCLOSURE 1

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P. Campbell
M. Padovan
G. Wunder

LICENSEE

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WESTINGHOUSE

S. Swantner
J. Dudiak
D. Augustine

AGENDA
FOR NRC MEETING
ON SI PUMP RUNOUT TESTING
AT V. C. SUMMER NUCLEAR STATION

INTRODUCTION

- VCSNS's SIS
- RECENT DEVELOPMENTS AFFECTING SI PUMP RUNOUT
- RUNOUT TEST OBJECTIVES
- MEETING OBJECTIVES

GENERIC SI PUMP RUNOUT ISSUE

SI PUMP RUNOUT TESTING AT VCSNS

- SCOPE
- INITIAL CONDITIONS
- SYSTEM ALIGNMENT
- DATA ACQUISITION
- TEST TERMINATION CRITERIA
- TEST SEQUENCE & DURATION

POST TEST DATA EVALUATION

OPEN DISCUSSION

ECCS-HIGH HEAD INJECTION

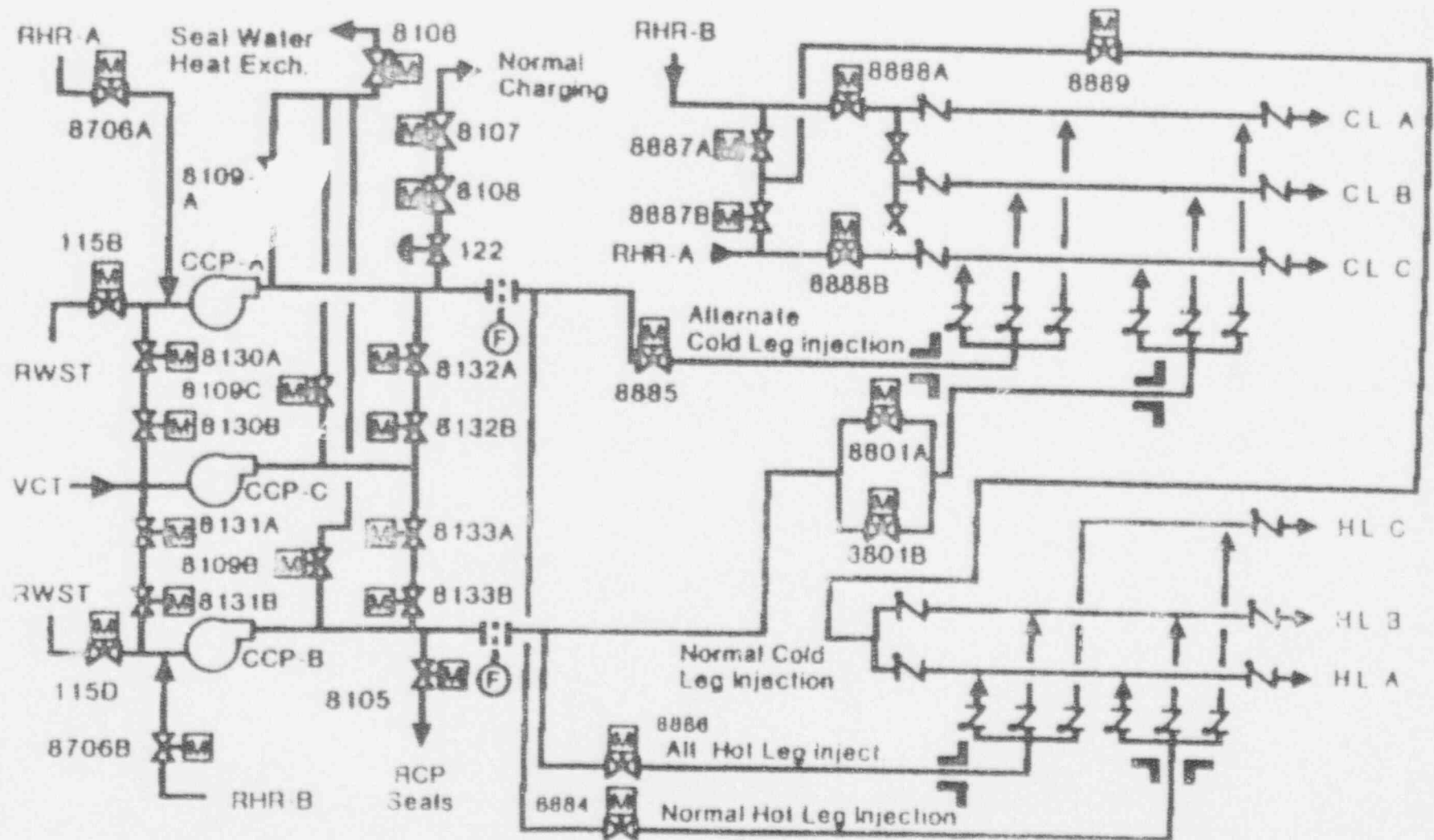


FIGURE AB 10.5

JAN-07-1992 15:16 FROM O. C. SUMNER NULEPAP 2. TO

CHARGING PUMP PERFORMANCE CURVE

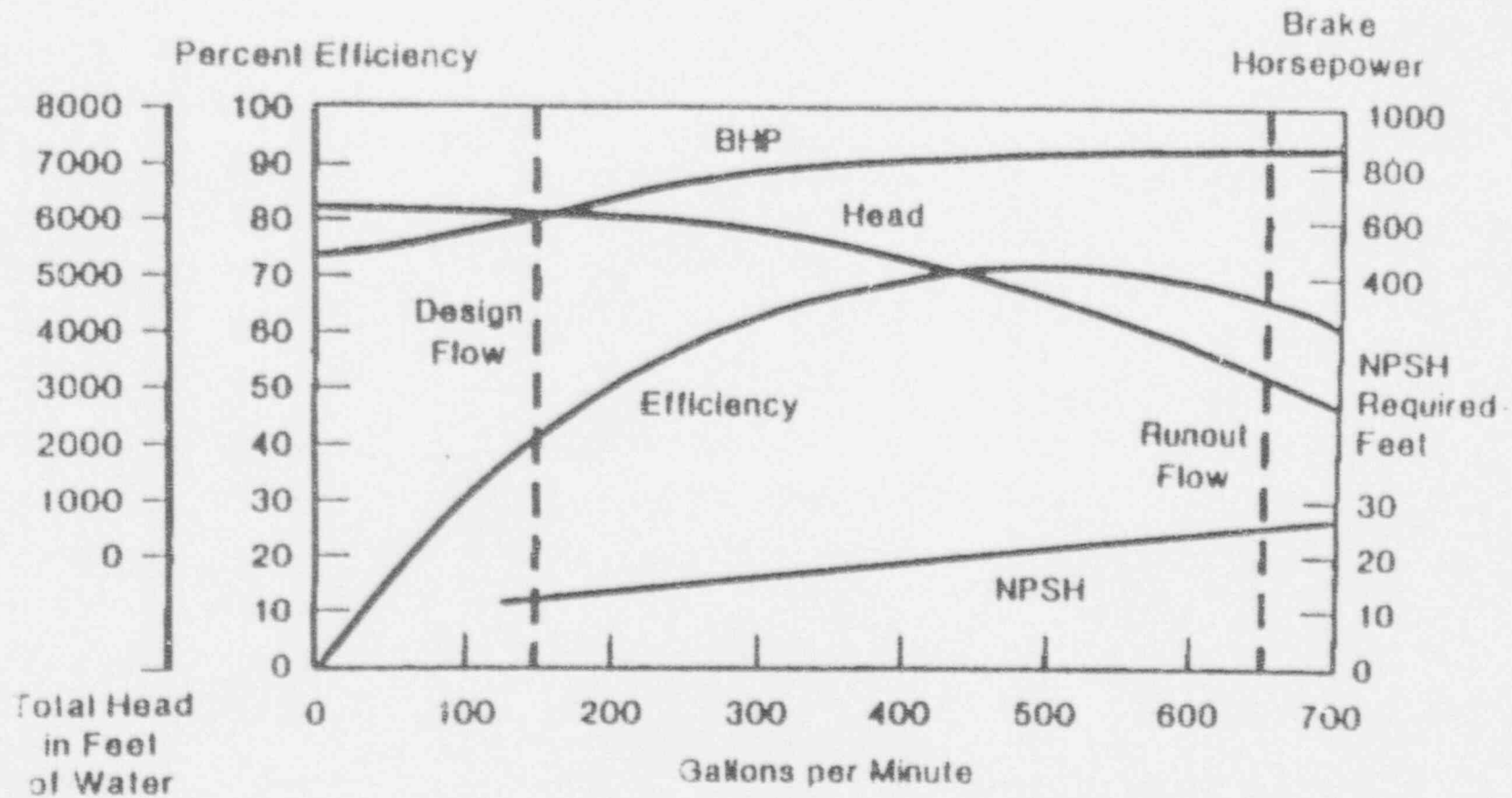


FIGURE AB 10.4

1041-07-1-993 15:16 FROM U. C. SUMNER NUCLEAR 2: 10

RECENT DEVELOPMENTS AFFECTING SI PUMP RUNOUT

POTENTIAL ISSUE ON SI PUMP RUNOUT

- NOTIFIED OF ISSUE IN FALL OF 1991 JUST PRIOR TO RF-6.
- W/DRESSER RECOMMENDED THAT THE SI PUMP MAXIMUM FLOW BE LIMITED TO < 675 GPM UNLESS ADDITIONAL TESTING IS CONDUCTED.
- DURING RF-6, THE SIS WAS REBALANCED AND THE BRANCH LINE THROTTLE VALVES WERE SET TO LIMIT TOTAL PUMP FLOW TO LESS THAN 675 GPM.
- USE OF LOWER RUNOUT LIMIT MADE IT MORE DIFFICULT TO BALANCE THE SIS WITHIN MIN/MAX FLOW LIMITS.

SG REPLACEMENT/POWER UPRATE

- SG's ARE BEING REPLACED AT VCSNS IN RF-8.
- SUPPORTING ANALYSIS ARE BEING PERFORMED AT A CORE POWER OF 2900 MWt TO SUPPORT A FUTURE POTENTIAL UPRATE FROM OUR CURRENT LICENSED LIMIT OF 2775 MWt.
- 10% MORE SI FLOW IS REQUIRED TO ACQUIRE ACCEPTABLE SBLOCA RESULTS AT UPDATED CONDITIONS.
- ONE WAY TO OBTAIN THE REQUIRED SI FLOW INCREASE IS BY INCREASING THE SI PUMP RUNOUT LIMIT.

TEST OBJECTIVES

- DEMONSTRATE THAT VCSNS'S CURRENT TECHNICAL SPECIFICATION LIMIT (680 GPM) FOR MAXIMUM SI PUMP FLOW IS ACCEPTABLE FOR MAXIMUM CONTINUOUS RUNOUT.
- DETERMINE SI PUMP'S ABILITY TO OPERATE AT FLOWS $>$ 680 GPM.
- GENERATE ADEQUATE DATA SET TO SUPPORT AN INCREASE IN THE TECHNICAL SPECIFICATION MAXIMUM PUMP FLOW LIMIT.

MEETING OBJECTIVES

- INFORM THE NRC OF OUR PLANS AND OBJECTIVES.
- SOLICIT NRC FEEDBACK.
- IDENTIFY ADDITIONAL ITEMS, IF ANY, NEEDED TO SUPPORT A TECHNICAL SPECIFICATION CHANGE REQUEST.

VIRGIL SUMMER CHARGING/SI PUMP RUNOUT FLOW

BACKGROUND OF GENERIC RUNOUT FLOW ISSUE

■ WESTINGHOUSE ISSUED NOTIFICATION LETTER TO NUCLEAR INDUSTRY

- RUNOUT FLOW RATES OFTEN EXCEED ORIGINAL DESIGN LIMITS
- PUMP VENDOR PROVIDED INCORRECT MARGIN IN SEVERAL CASES
 - CORRECTED ON A PLANT SPECIFIC BASIS
- AVAILABLE RUNOUT FLOW MARGIN IS DEPENDENT ON:
 - PLANT SPECIFIC PUMP CONFIGURATIONS
 - PLANT SPECIFIC SYSTEM CONDITIONS
- ORIGINAL VENDOR TEST CURVES MAY BE MISLEADING
 - HIGHER RUNOUT FLOWS SOMETIMES TESTED
 - ACCEPTABLE FOR SHORT-TERM HYDRAULIC PERFORMANCE
 - MAY NOT BE ACCEPTABLE FOR CONTINUOUS OPERATION

■ CONCERNS WITH INCREASED RUNOUT FLOW

- MOTOR HORSEPOWER LIMITATIONS
- PUMP CAVITATION DAMAGE
- MECHANICAL EFFECTS OF CAVITATION
 - WEAR AND AGING

VIRGIL SUMMER CHARGING/SI PUMP RUNOUT FLOW

MOTOR HORSEPOWER CONSIDERATIONS

- MOTOR HORSEPOWER ISSUES WITH INCREASED RUNOUT FLOW
 - HORSEPOWER COULD EXCEED NAMEPLATE RATING
 - STATOR TEMPERATURE RISE WILL INCREASE
 - MOTOR QUALIFIED LIFE COULD BE REDUCED

- MOTOR HORSEPOWER IS GENERALLY NOT A LIMITING FACTOR
 - MARGIN IN MOTOR DESIGNS
 - STEEP SLOPE ON HEAD-CAPACITY CURVE
 - FLAT BRAKE HORSEPOWER CURVE

VIRGIL SUMMER CHARGING/SI PUMP RUNOUT FLOW

CAVITATION CONSIDERATIONS

■ PUMP CHARACTERISTICS THAT AFFECT CAVITATION ONSET

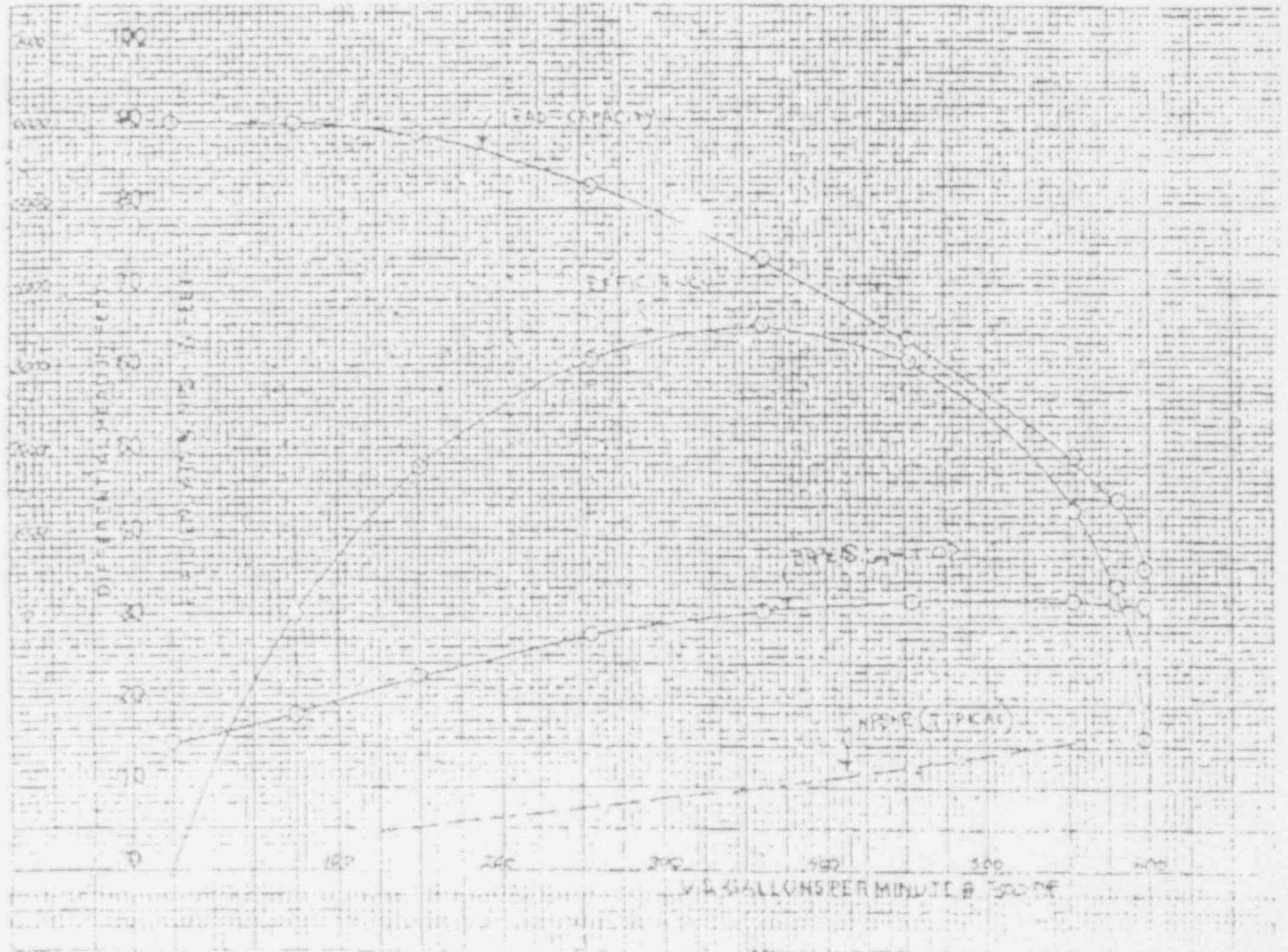
- NPSH REQUIRED VERSUS FLOW RATE
 - ASYMPTOTIC INCREASE WITH CH/SI PUMP DESIGNS
- IMPELLER CONFIGURATIONS
 - SAND-CAST VS. INVESTMENT CAST COMPONENTS
- IMPELLER EYE DIAMETER

■ CAVITATION CHARACTERISTICS

- PUMP HEAD WILL DEGRADE DURING CAVITATION
- SHORT-TERM DEGRADATION MECHANISMS - SEVERE CAVITATION
 - WEAR RING RUBBING
 - MECHANICAL SEAL DAMAGE
 - BEARING DAMAGE
- LONG-TERM DEGRADATION MECHANISMS - LOW-LEVEL CAVITATION
 - EROSION OF PUMP INTERNAL COMPONENTS
 - REDUCTION IN EXPECTED MECHANICAL SEAL LIFE
 - REDUCTION IN EXPECTED BEARING LIFE
 - PUMPS CAN RUN ACCEPTABLY FOR FINITE PERIODS

VIRGIL SUMMER CHARGING/SI PUMP RUNOUT FLOW

TYPICAL EXAMPLE OF DROOPING HEAD-CAPACITY CURVE



VIRGIL SUMMER CHARGING/SI PUMP RUNOUT FLOW

GENERIC RUNOUT FLOW LIMITATIONS AND WESTINGHOUSE RECOMMENDATIONS

■ GENERIC RUNOUT FLOW LIMITATIONS

- DEPENDENT ON PUMP-SPECIFIC DESIGN DETAILS
- CONSERVATIVE TO BOUND ALL PUMP SPECIFIC VARIATIONS
- VALUES SHOWN IN ATTACHED TABLE
- BASED ON DATA FROM VENDOR TESTING

■ GENERIC RECOMMENDATIONS TO RESOLVE RUNOUT FLOW DISCREPANCIES

- MODIFY SYSTEM ALIGNMENT TO REDUCE RUNOUT FLOW
- EMERGENCY RESPONSE GUIDELINES TO MANUALLY REDUCE FLOW
- JUSTIFY INCREASED FLOW BY REVIEW OF PUMP TEST RESULTS
 - ACTUAL PUMP OPERATION AT MAXIMUM RUNOUT CONDITION
 - DATA AVAILABLE FOR ALL CRITICAL PUMP PARAMETERS

VIRGIL SUMMER CHARGING/SI PUMP RUNOUT FLOW**CHARGING/SI PUMP
GENERIC RUNOUT FLOW LIMITATIONS**

PUMP TYPE	IMPELLER CASTING TYPE	DESIGN RUNOUT (GPM)	MAXIMUM CONTINUOUS RUNOUT (GPM)	NPSH REQ'D (FT)
4-LOOP CH/SI 2-1/2 RL-IJ	SAND	550	560	30
4-LOOP CH/SI 2-1/2 RL-IJ	INVESTMENT	550	580	30
3-LOOP CH/SI 2-1/2 RL-IJ	SAND	650	675	30
3-LOOP CH/SI 2-1/2 RL-IJ	INVESTMENT	650	675	30

VIRGIL SUMMER CHARGING/SI PUMP RUNOUT FLOW

VIRGIL SUMMER CHARGING PUMP SPECIFICS

■ PUMP CONFIGURATION (INCLUDING SPARES)

- PACIFIC PUMPS MODEL 2-1/2" RL-IJ
- 11 STAGE CENTRIFUGAL PUMP
- SAND-CAST IMPELLERS
- JOHN-CRANE BELLOWS TYPE MECHANICAL SEAL
- KINGSBURY TYPE THRUST BEARING
- SLEEVE BEARINGS

■ ORIGINAL PUMP PERFORMANCE CONDITIONS

- DESIGN RUNOUT FLOW 650 GPM
- TECH SPEC FLOW LIMIT OF 680 GPM
- REQUIRED NPSH OF APPROX. 25 FEET @ 650 GPM

■ RUNOUT GUIDELINES PER WESTINGHOUSE NOTIFICATION LETTER

- 675 GPM FOR CONTINUOUS ACCEPTABLE OPERATION

SI PUMP RUNOUT TESTS

- WILL BE PERFORMED DURING REFUEL 7 WHICH IS SCHEDULED TO BEGIN 3/5/93.
- WILL BE INTEGRATED WITH NORMAL TESTING (I.E., INSERVICE PUMP TESTING, FULL FLOW CHECK VALVE TESTING, ETC.)
- WILL TEST ALL THREE SI PUMPS
- WILL TAKE DATA AT PUMP FLOWS UP TO 710 GPM OR UNTIL ANY TEST TERMINATION CRITERION IS REACHED.

SI PUMP RUNOUT TESTING INITIAL CONDITIONS

- REFUELING CAVITY IS FLOODED.
- REACTOR VESSEL HEAD IS REMOVED.
- CORE IS OFFLOADED TO SPENT FUEL POOL.
- SPENT FUEL POOL GATE IS INSTALLED OR FUEL TRANSFER TUBE GATE VALVE IS CLOSED.
- RWST HAS SUFFICIENT WATER TO SUPPORT THE TEST
- RECIRCULATION PATH FROM REFUELING CAVITY TO RWST IS AVAILABLE.
- SI/CVCS AND SUPPORT SYSTEMS ARE FUNCTIONAL.

SI PUMP RUNOUT TESTING

INITIAL SYSTEM ALIGNMENT

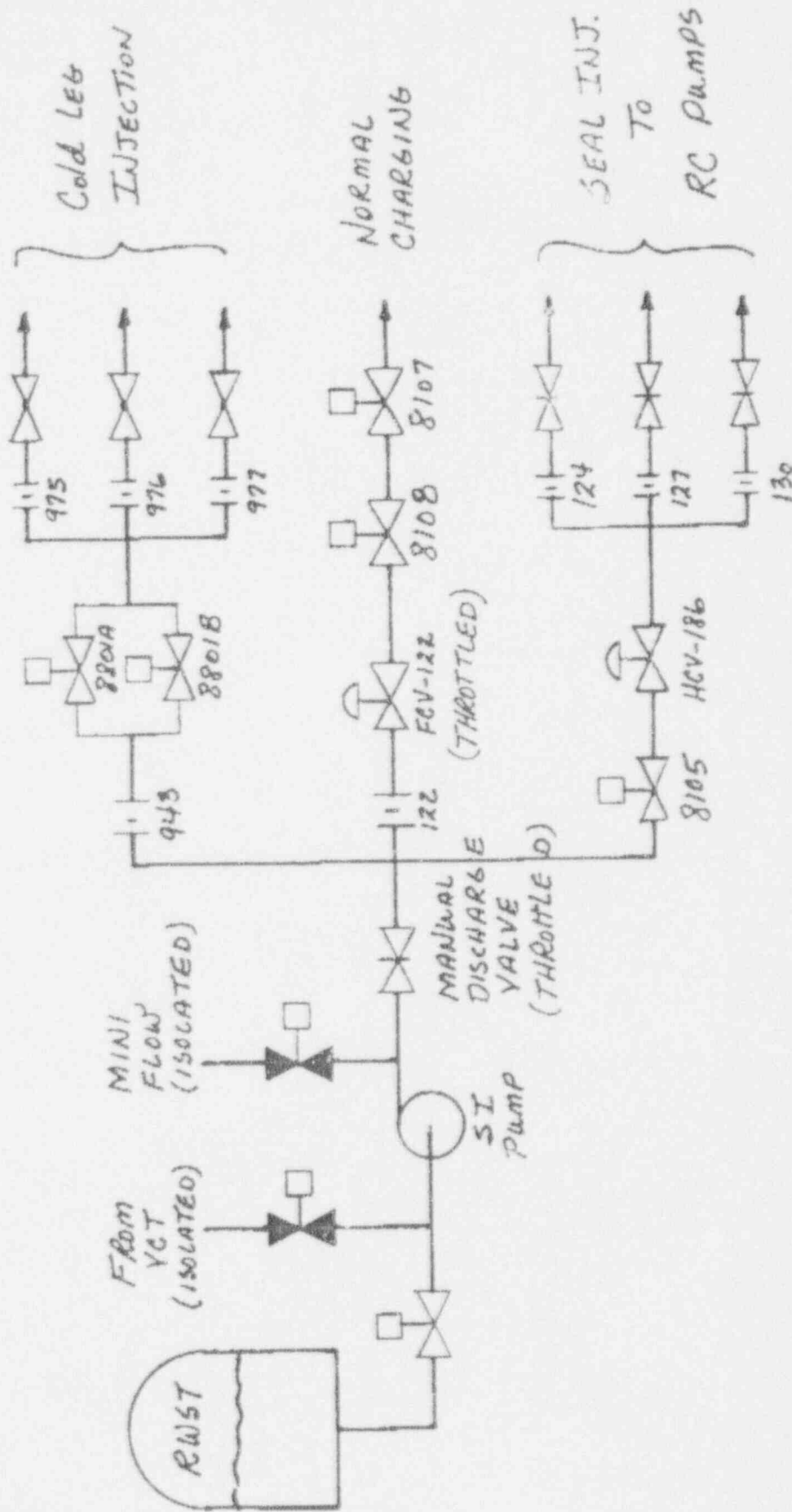
- SINGLE SI PUMP OPERATING
- SUCTION FROM RWST
- VCT ISOLATED
- MINI-FLOW PATH ISOLATED
- SEAL INJECTION AVAILABLE TO RCPs VIA FE- 122, 127, & 130 WITH FLOW THROTTLED
- NORMAL CHARGING PATH VIA FE-122 AVAILABLE WITH FLOW THROTTLED USING FCV-122
- NORMAL INJECTION PATH VIA FE-943 AND XVG-8801A&B IS AVAILABLE
- SI PUMP FLOW THROTTLED USING THE MANUAL PUMP DISCHARGE VALVE

ANTICIPATED FLOW CONDITIONS

AT START OF RUNOUT TESTING

- | | |
|-------------------------|---------------|
| • MINI-FLOW | 0.0 GPM |
| • SEAL INJECTION | 24 - 27 GPM |
| • NORMAL CHARGING | 65 GPM |
| • INJECTION PATH TO RCS | 503 - 511 GPM |
| • TOTAL PUMP FLOW | 595 - 600 GPM |

TYPICAL ALIGNMENT FOR SI PUMP RUNOUT TEST



PARAMETERS TO BE RECORDED DURING TESTING

PARAMETER	COMMENT
FLOW	RECORD TOTAL PUMP DISCHARGE FLOW FOR EACH TEST POINT.
SUCTION PRESSURE	RECORD TO CALCULATE DEVELOPED HEAD AND AVAILABLE NPSH.
DISCHARGE PRESSURE	RECORD TO CALCULATE DEVELOPED HEAD. FLUCTUATIONS TO BE NOTED.
SUCTION TEMPERATURE	RECORD TO CALCULATE AVAILABLE NPSH.
THRUST BEARING TEMPERATURE	RECORD LUBE OIL TEMPERATURE.
BEARING HOUSING VIBRATION	RECORD (SPECTRAL PLOTS) THRUST BEARING HOUSING AND RADIAL BEARING HOUSING DISPLACEMENTS AND VELOCITIES IN 3 PLANES; FREQUENCY RANGE OF INTEREST IS 1000 TO 20000 HZ.
PUMP CASING VIBRATION	RECORD CASING DISPLACEMENTS AND VELOCITIES NEAR THE SUCTION NOZZLE; FREQUENCY RANGE OF INTEREST IS 1000 TO 20000 HZ.
POWER SUPPLY VOLTAGE	RECORD TO DETERMINE TOTAL HORSEPOWER.
MOTOR AMPERAGE	RECORD AND MONITOR FOR FLUCTUATIONS WHILE HOLDING CONSTANT FLOW.

TEST TERMINATION CRITERIA

FLOW	TOTAL PUMP FLOW > 710 GPM
DEVELOPED HEAD	FLUCTUATIONS GREATER THAN 5 % WHILE OPERATING AT FIXED SYSTEM RESISTANCE.
THRUST BEARING TEMPERATURE	LUBE OIL TEMPERATURE > 165F AT THE BEARING HOUSING OUTLET.
BEARING HOUSING VIBRATION	DISPLACEMENT > 1.5 MILS PEAK TO PEAK - OR - VELOCITIES > 0.4 IN/SEC. ALL VALUES FILTERED TO RUNNING SPEED.
MOTOR CURRENT	MOTOR CURRENT IN EXCESS OF <ul style="list-style-type: none">· 75 AMPS @ BUS VOLTAGE OF 6900 V· 72 AMPS @ BUS VOLTAGE OF 7200 V· 69.5 AMPS @ BUS VOLTAGE OF 7450 V WHILE HOLDING CONSTANT FLOW.
SOUND	DISCERNABLE "MARBLE" NOISES.

SI PUMP RUNOUT TESTING TEST SEQUENCE AND DURATION

- ESTABLISH INITIAL SYSTEM ALIGNMENT
- RUN PUMP UNTIL PUMP BEARING TEMPERATURES STABILIZE.
- ESTABLISH BASELINE DATA
 - INCREASE TOTAL PUMP FLOW TO APPROXIMATELY 620, 640, 660 AND 675 GPM BY THROTTLING OPEN THE MANUAL PUMP DISCHARGE VALVE UNTIL FULL OPEN AND THEN BY ADJUSTING FCV-122.
 - AT EACH FLOW POINT, THE PUMP WILL BE RUN FOR SEVERAL MINUTES TO ESTABLISH A STABLE FLOW CONDITION.
 - AT EACH FLOW POINT, DATA WILL BE TAKEN ONCE FLOW IS STABILIZED.
- COLLECT DATA AT PUMP FLOWS AT OR ABOVE CURRENT TESTS LIMIT WITH FLOW LIMITED TO NO GREATER THAN 710 GPM.
 - INCREASE TOTAL PUMP FLOW IN INCREMENTS OF 5 GPM (i.e., 680 GPM, 685 GPM, 690 GPM, etc.) BY ADJUSTING FCV-122.
 - AT EACH FLOW POINT, THE PUMP WILL BE RUN FOR SEVERAL MINUTES TO ESTABLISH A STABLE FLOW CONDITION.
 - AT EACH FLOW POINT, DATA WILL BE TAKEN ONCE FLOW IS STABILIZED.
- STOP TESTING IMMEDIATELY IF ANY TERMINATION CRITERION IS REACHED.
- PERFORM POST TEST DATA EVALUATION.

VIRGIL SUMMER CHARGING/SI PUMP RUNOUT FLOW

POST-TEST REVIEW OF DATA

- GOAL IS TO DEMONSTRATE ACCEPTABILITY FOR CONTINUOUS OPERATION
 - TRENDING PARAMETERS VERSUS INCREASING FLOW RATES
 - EVALUATION AGAINST ACCEPTANCE CRITERIA
 - REVIEW OF OTHER TEST DATA FOR SIMILAR PUMPS

- REVIEW KEY PARAMETERS
 - VIBRATION LEVELS
 - DEVELOPED HEAD VERSUS CAPACITY
 - MOTOR AMPERAGE

- BASIS OF ACCEPTANCE CRITERIA
 - HYDRAULIC INSTITUTE STANDARDS
 - PUMP VENDOR REQUIREMENTS
 - MOTOR VENDOR REQUIREMENTS