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PRESENTATION TO THE ADVISORY COMMITTEE
ON REACTOR SAFEGUARDS
SEPTEMBER 10, 1965, AT HANFORD

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PRESENTATION TO THE ADVISORY COMMITTEE

ON REACTOR SAFEGUARDS

SEPTEMBER 10, 1965, AT HANFORD

Compiled by:

J. R. Spink
Process and Reactor Development Subsection
Research and Engineering Section

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PRESENTATION TO THE ADVISORY COMMITTEE
ON REACTOR SAFEGUARDS
SEPTEMBER 10, 1965, AT HANFORD

I. INTRODUCTION

This document records the chart materials and talk outlines used in presentations at the Advisory Committee on Reactor Safeguards meeting of September 10, 1965, on the Irradiation Processing Department, General Electric Company, operated production reactors. The general objectives of the meeting were to review administration of safety during contractor transition, the status of N-Reactor operation and conversion project progress, and progress on the confinement studies for the production reactors. Review of the proposal to raise the K-Reactor power level limit was the specific objective of the meeting. K and N Reactor Presentation Agenda is included. Presentation materials used by RLOO-AEC and N Reactor Department personnel are not included in this document. The list of meeting attendees and information used for the K-Reactor tour are included in the appendix.

[redacted]

II. AGENDA

Subject	Starting Time	Speaker
Welcome	1:45 p.m.	D.G. Williams, Mgr., RLO
A.[1] Management Actions to Assure Safety During Transition Period	1:50	A.B. Greninger, Gen.Mgr., IPD
Safety Under Segmented Operations	2:05	C.N. Zangar, Director, Health and Safety Division, RLO
B. Description of Hanford Reactor Design Features Which Help Prevent Accidents	2:20	Roy Nilson, Mgr., Process & Reactor Development, IPD T.W. Ambrose, Mgr., Research & Engineering, IPD
C. (Seismological Characteristics of Hanford Region)	3:10	R.E. Brown, Sr. Geologist, BNW
	3:20	R.E. Trumble, Mgr., Process Evaluation & Control, NRD
D. K-Reactor Power Level Limit	3:50	Roy Nilson TW Ambrose
(Ten-minute break)	4:20	
Status of N-Reactor Operation Conversion Project Progress	4:30	R.E. Hall, Supervisor, Process Engineering, NRD
E. Progress Report on Confinement Studies for the Production Reactors	4:45	Roy Nilson H.W. Heacock, Mgr., Development Engineering & Process Design, IPD
DECLASSIFIED	5:25	R.E. Trumble D.L. Condotta, Mgr., Process Design, NRD
F. Contamination of the Columbia River by Reactor Effluent Water	5:45	T.W. Ambrose
G. Future Plans for New Products	6:05	T.W. Ambrose M.C. Leverett, Mgr., Research & Engineering, NRD
Adjournment	6:20	

[1]Letters refer to IPD presentation subjects.

[redacted]

III. PRESENTATION CHARTS AND OUTLINES

A. Management Actions to Assure Safety During Transition Period

[redacted]

MANAGEMENT ACTIONS TO ENSURE SAFETY IN TRANSITION PERIOD
ACRS VISIT - SEPTEMBER 10, 1965

WELCOME:

INTRODUCTION: Late 1963 and early '64"

1. GE decided to withdraw
2. AEC announced production cutback - reactor shutdown
3. Since then 1-1/2 years activity getting ready. Labs to Battelle last January; next is Irradiation Process Department November 1 (Chemical Processing Department January 1, Support Services March 1, NRD July '67)

Briefly review management actions to ensure safety during this difficult transition period (which we have considered to include the early period of new contractor operation as well as the ending period of G.E. operation) - IPD hit hardest.

I. G. E. plan (+AEC) to complete reactors shutdown and layoffs before transfer

   1. Hiring Freeze
   2. IPD layoffs to date = 86
   3. NRD + CPD -- Stable

II. Plan to transfer "going concern"

   - Persuade competent people to stay - difficult position for GE
   - OH Greager loss (and Wally Frank); other top technical people remaining
   - Retain technical competence in oper. crews
   - Careful shifting of people with shutdowns to minimize upset and keep good crews.

III. Nuclear Safety Task Force established by WE Johnson August 20, 1964

   - First Chm. OHG, + NRD, CPD, & Lab'y. Now MC Leverett
   - Study Nuclear Safety problems in transition period and periodic reports to G. E. Transfer Council and GETHC (Recommended that AEC continue this integrating body with new contractors-- committee now being organized)

IV. Department Managers directed to increase frequency of unannounced inspection trips and submit reports

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IPD Items:

1. Eliminate all hot startups (mid'64)
2. R&E physicist present for every startup; weekend coverage by plant managers (also above Dept. Mgr. inspection)
3. R&E Supplementary Audit of Process Standards
4. Certification Program for Super. Spec & Operators) Both started
   Equipment Maintenance Standards) early '62

HAPO Items:

1. Nuclear Safety Letter to New Contractor (Nuclear Safety Clause) to DUN mid-September

   a. Summary of status
   b. Refers to use of G. E. Hazards review groups
   c. Refers to transfer of "going concern" and recommends no change in Org, functional assignments or procedures for plant opr. until DUN officials have operated under present system for some extended period of time so as to become familiar with present system and nuclear safety problems faced by operating organization. Has been discussed and DUN has agreed to follow this recommendation.

SUMMARY:

QUESTIONS:

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III. PRESENTATION CHARTS AND OUTLINES (Cont.)

B. Description of Hanford Reactor Design Features Which Help Prevent Accidents

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REACTOR FEATURES WHICH HELP PREVENT ACCIDENTS

- REACTOR AND PLANT DESCRIPTION
- PHYSICS
- ENGINEERING
- SAFETY PHILOSOPHY

REACTOR DESCRIPTIONS (IPD)

HANFORD REACTORS ARE

- GRAPHITE MODERATED
- LIGHT WATER, SINGLE-PASS COOLED
- LOW ENRICHMENT URANIUM FUELED
- THERMAL SPECTRUM
- CONVERTERS

[redacted]

REPRESENTATIVE PROPERTIES

	K	SMALL
• CORE SIZE (LXHXW)	33½'X41'X41'	28'X36'X36'
• NUMBER FUEL CHANNELS	3220	2004
• LATTICE SPACING	7½"	8⅜"
• BULK POWER	4400 Mw	2100-2400 Mw
• SPECIFIC POWER (avg-max)	50-90 kw/ft	44-84 kw/ft
• TONS FUEL	~450	~220
• TONS GRAPHITE	~1700	~1150
• OPERATING TEMPERATURES		
• FUEL (avg-max)	240-400C	210-400C
• COOLANT (bulk-max tube)	95-120 C	95-120C
• GRAPHITE (avg-max)	560-700	460-600
• COOLANT FLOW RATE	209,000gpm	89,000-103,000gpm

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PHYSICS PROPERTIES TENDING TO ACCIDENT PREVENTION

- LARGE CORE SIZE
  - LOW LEAKAGE , LOW BUCKLING , LOW K EXCESS
- NEAR OPTIMUM LATTICE
  - LOW ENRICHMENT, LOW K EXCESS
- LOW NET BURNUP
- MODERATE TEMPERATURE SWING
- SMALL NET TEMPERATURE COEFFICIENT
  - LOW K EXCESS , SMALL Δ K
- NEGATIVE PROMPT TEMPERATURE COEFFICIENT
- SLOW POSITIVE TEMPERATURE COEFFICIENT

PHYSICS PROPERTIES CONT'D

- TRANSIENTS
  - SLOW , $k_{op} < k_{cold}$
  - USUALLY 0.6% k IN RODS
- STABILITY
  - NO FAST FEEDBACK PATH
  - DOPPLER
  - XENON OSCILLATIONS CONTROLLABLE
- FLOODING - negative Δk
- VOIDING - positive Δk
  - DICTATES PRINCIPAL CONTROL PHILOSOPHY

PHYSICS PROPERTIES CONT'D

- OPERATING CONTROL SYSTEM
  - INDEPENDENT, HCR, 2% K, 20 RODS
  - NO SAFETY DEPENDENCE

- PRIMARY SAFETY CONTROL
  - 41 VSR'S - 2.6% K - AT READY
  - EACH ROD INDEPENDENT
  - GRAVITY DRIVEN - NO FALL OUT
  - RESPONSE (2 SEC.) FAST ENOUGH TO SATISFY ALL ACCIDENT REQUIREMENTS
  - MULTIPLE SCRAM SOURCES
    - EARTHQUAKE
    - OVER POWER
    - INDIVIDUAL TUBE COOLANT LOSS
    - GROSS COOLANT LOSS
    - ELECTRICAL POWER LOSS
    - PUMP FAILURE

    (HIGH TEMPERATURE)

    (POWER RATE)

PHYSICS PROPERTIES CONT'D

- SECONDARY SAFETY CONTROL
  - 41 BALL 3X CHANNELS 4.5 % k
  - INDEPENDENT FROM VSR'S
  - GRAVITY DRIVEN – AT READY
  - SEVERAL SECOND RESPONSE TIME
  - FEW-CHANNEL FALLOUT POSSIBLE
  - MULTIPLE SCRAM SOURCES
    - RAPID COOLANT LOSS
    - MAJOR COOLANT LOSS
    - EARTHQUAKE IN COINCIDENCE WITH VSR FAILURES

- LOW POSITIVE REACTIVITY INSERTION
  - RATES OTHER THAN RAPID COOLANT LOSS
  - MAX. Δk/SEC. = 3¢ (K REACTORS)
  - " " = 40¢ (SMALL REACTORS) (CORRECTIBLE TO 5¢)

MULTIPLICITY OF EVENTS ARE REQUIRED FOR MAJOR FUEL MELTING

- SUCH COMBINATIONS ARE JUDGED NOT CREDIBLE

- EXAMPLES OF SUCH EVENTS INITIATED BY REACTIVITY ERRORS

  1. CRITICALITY DURING REFUELING
     FOUR ERRORS OR FAILURES
  2. STARTUP EXCURSION
     FOUR ERRORS OR FAILURES
  3. POWER SURGE
     THREE ERRORS OR FAILURES

PROBABILITY OF MULTIPLE EVENTS FOR CRITICALITY DURING REFUELING

- **MINIMUM CRITICALITY**
  - VIOLATES REACTIVITY SHUTDOWN REQUIREMENTS.
  - MISTAKING ENRICHED FOR NATURAL FUEL.
  - > 95 TUBES MISCHARGED IN ONE REGION.
    - > 1½ HOURS TO CHARGE.
    - UNLIKELY CHARGE PATTERN.
    - ALL IN MOST REACTIVE REGION.
  - NO SCRAM OF RESERVE RODS
    - NO RECOGNITION OF HIGH FLUX SIGNAL OR NO SIGNAL RECEIVED.

REACTOR COOLING SYSTEMS

HEAT REMOVAL CHARACTERISTICS

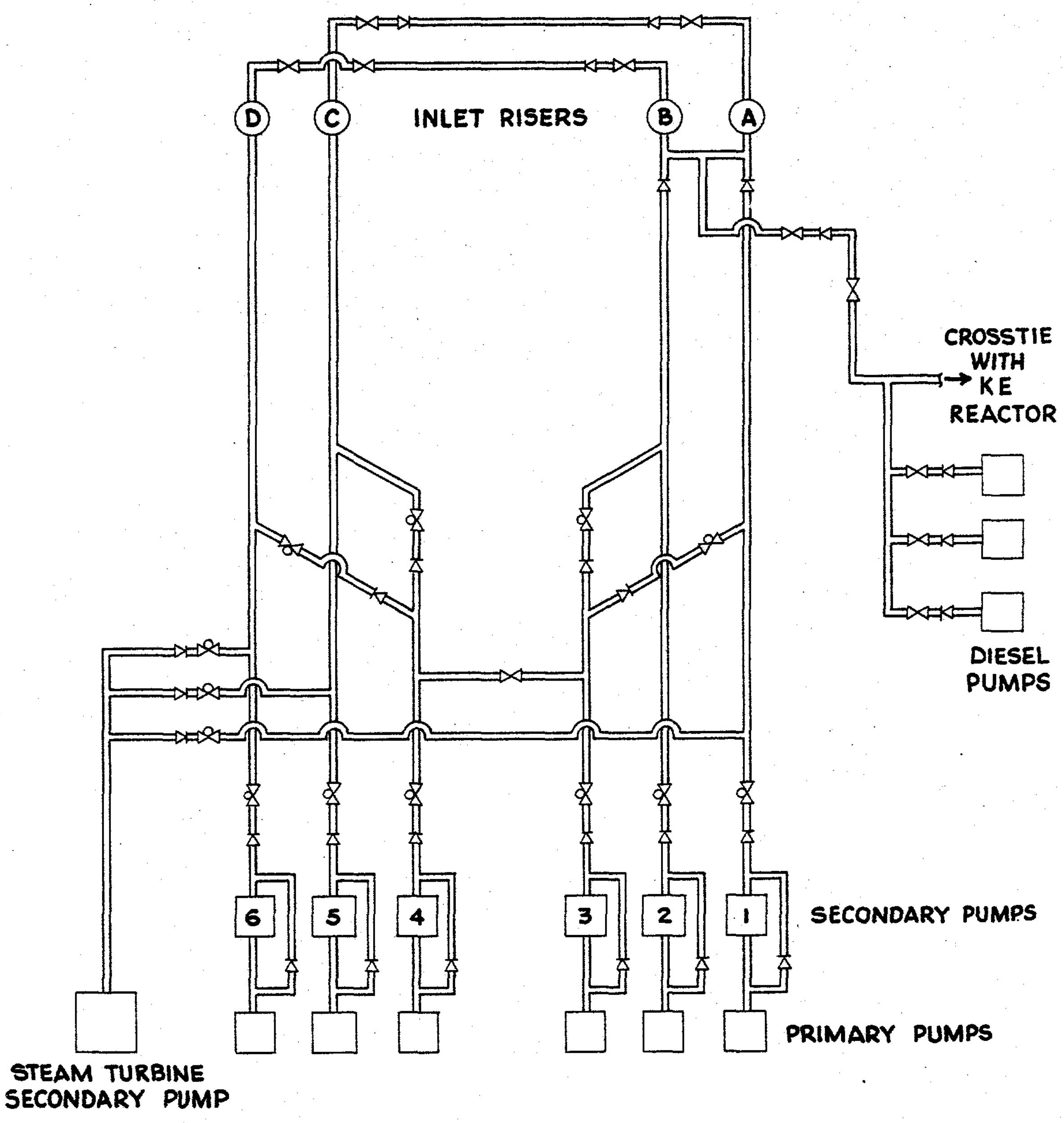
- LOCAL HEAT TRANSFER
- REMOVAL CAPABILITY
- REACTOR COMPONENT TEMPERATURE RESISTANCE
- MASSIVE GRAPHITE STACK
- SLOW INTERACTION BETWEEN TUBES

REACTOR COOLING SYSTEMS

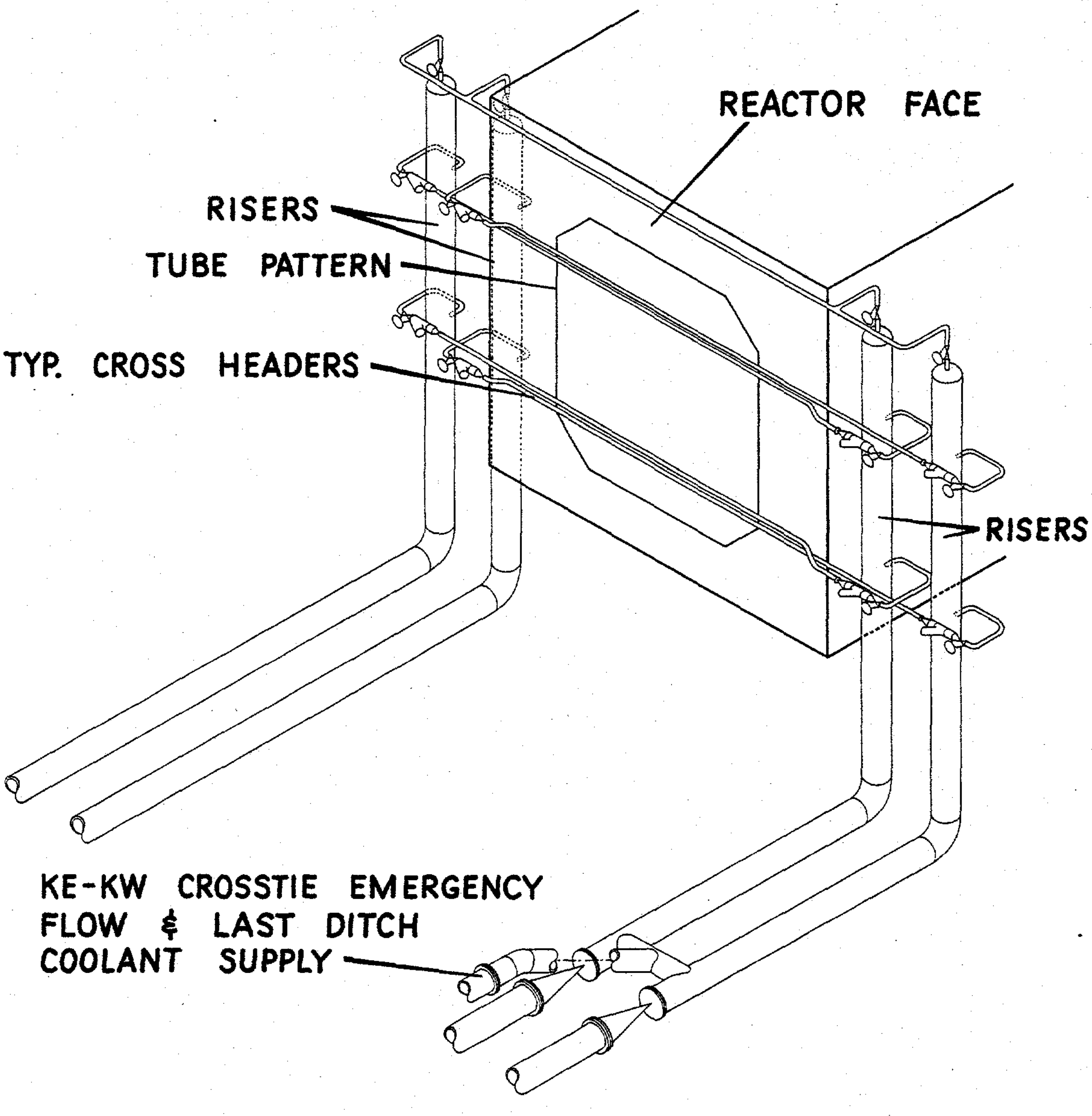
DESIGN FEATURES

- COOLANT SYSTEM SIMPLICITY
- COOLANT FLOW STABILITY
  - SINGLE PHASE FLOW
  - SWEEPS OUT VOIDS
  - SCRAM CAPABILITY
- COOLANT SYSTEMS
  - RIVER
  - PRIMARY
  - SECONDARY
  - LAST DITCH
  - SHUTDOWN COOLING
- MULTIPLE PIPING
  - PRIMARY PUMPS
  - PIPE LINES
  - RISERS
  - CROSSHEADERS
- COOLANT BACK FLOW
  - PIGTAILS
  - NOZZLE
  - CROSSHEADER
- COMPONENT RELIABILITY
  - PIPING AND HARDWARE DESIGN
  - MAINTENANCE AND INSPECTION
- FAILURE LIKELIHOOD
  - PIGTAIL
  - CROSSHEADER
  - RISER
  - PRIMARY PIPES

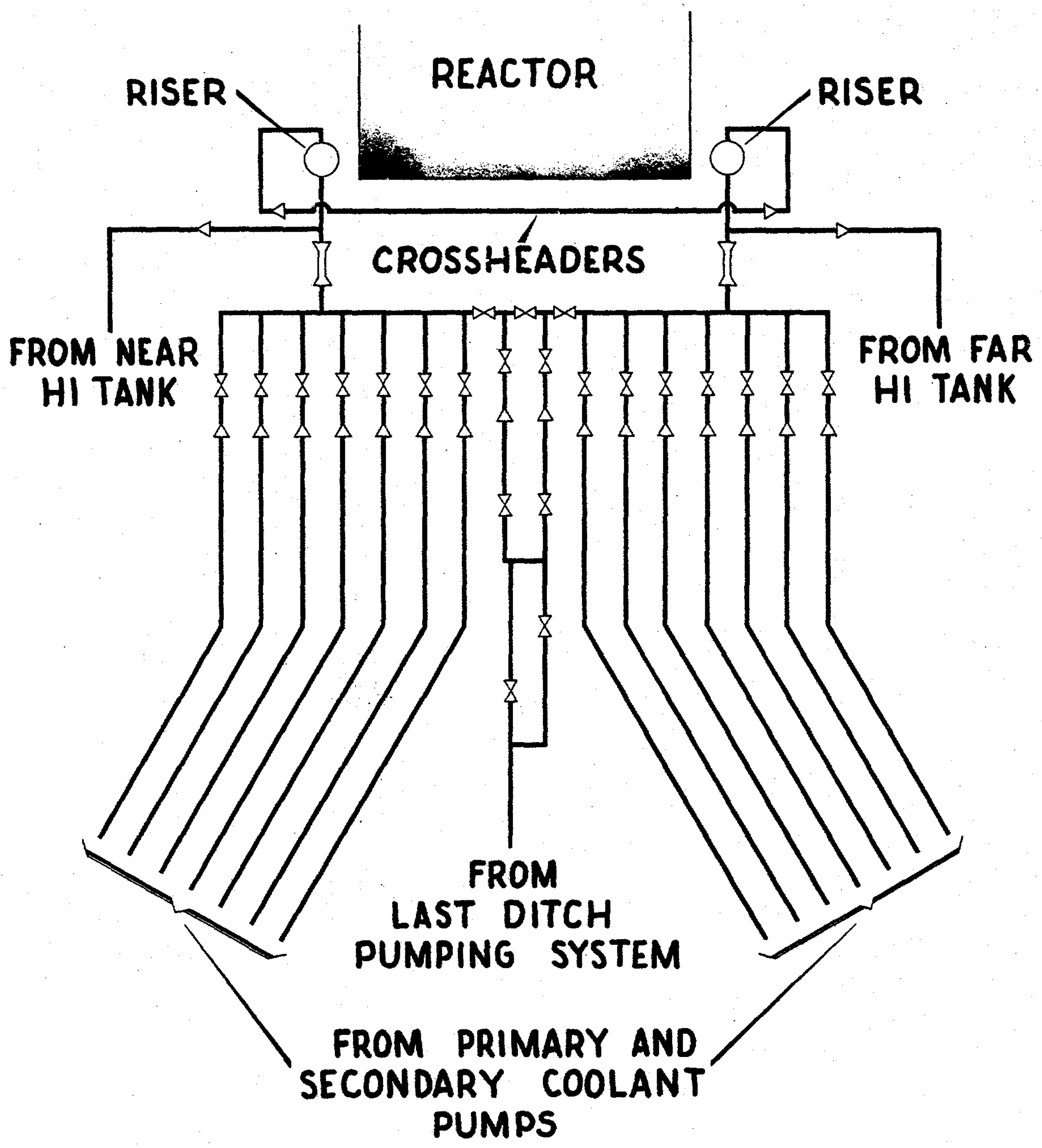
K COOLANT PIPING SCHEMATIC



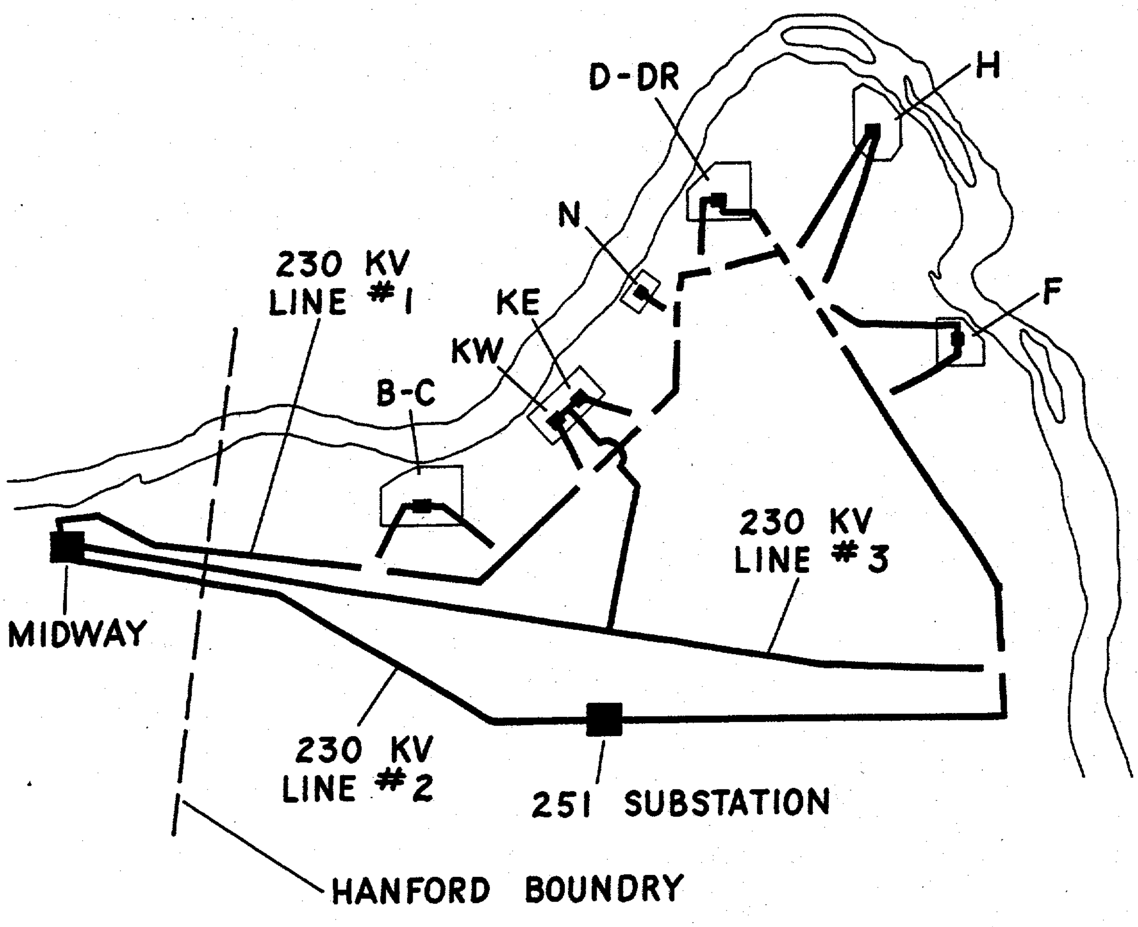
K REACTOR INLET COOLANT PIPING



B-D COOLANT PIPING SCHEMATIC



HANFORD ELECTRICAL DISTRIBUTION SYSTEM



ELECTRICAL DISTRIBUTION SYSTEM

MIDWAY SUBSTATION - 230 KV

- BUSES SUPPLYING HANFORD ARE SUPPLIED BY TWO GENERATION SOURCES

HANFORD LOOP - 230 KV

- THREE LINES IN SERVICE
- CLOSED LOOP OPERATION
- MINIMUM OF TWO BUS SECTIONS AT MIDWAY
- EACH SUBSTATION SUPPLIED BY TWO POWER SOURCES
- SINGLE FAILURE WILL NOT INTERRUPT ALL POWER TO 151 SUBSTATION
- FOLLOW CRITICAL POWER PROCEDURES
- REGULAR TESTING AND MAINTENANCE

HANFORD SUBSTATIONS - 13.8 KV
4.16 KV

- CRITICAL LOAD DIVIDED AMONG DISTRIBUTION FEEDERS FROM SEPARATE BUSES

REMOTE TYPES OF ACCIDENTS

- ACTS OF WAR OR SABOTAGE
- EXTENDED FLOW STOPPAGE OF THE COLUMBIA RIVER
- BREACH OF GRAND COULEE DAM
- FALLING OBJECT (airplane or meteor)
- SEVERE EARTHQUAKE

REACTOR SAFETY PHILOSOPHY

PREVENTION VS. CURE

- MULTIPLE SHUTDOWN SYSTEMS
- REDUNDANT COOLING SYSTEMS
- CONTAINMENT - CONFINEMENT

NUCLEAR CONTROL & REACTOR COOLING

- PREVENTION OF REVERSIBLE ACCIDENTS
- NO ESCALATION OF IRREVERSIBLE
- OPERATION WITHOUT DEPENDING ON AUTOMATIC CORRECTION
- PREVENT RELEASE OF FISSION PRODUCTS
- PREVENT FUEL MELTING
- PREVENT BULK BOILING

PERFORMANCE CRITERIA

NUCLEAR CONTROL

- SPEED OF CONTROL — REQUIRES SUFFICIENTLY FAST EMERGENCY NUCLEAR CONTROL SO THAT UNDER ANY CREDIBLE ACCIDENT CONDITION THERE WOULD BE NO ESCALATION OF CONSEQUENCES BEYOND THOSE INEVITABLE.
- TOTAL CONTROL — REQUIRES SUFFICIENT STRENGTH OF EMERGENCY NUCLEAR CONTROL SO THAT UNDER ANY CREDIBLE ACCIDENT CONDITION THERE WOULD BE NO SIGNIFICANT INCREASE OF CONSEQUENCES BEYOND THE INEVITABLE.

REACTOR COOLANT SUPPLY

- THREE, INDEPENDENT, RELIABLE SOURCES OF COOLING.
- FAILURE IN ONE SYSTEM CANNOT INDUCE FAILURE IN AN ALTERNATE.
- SUPPLY ADEQUATE COOLING.
- SINGLE COMPONENT FAILURE CANNOT RENDER SYSTEM INADEQUATE.
- ENGINEERING, CONSTRUCTION, OPERATION AND MAINTENANCE MEET APPLICABLE CODES AND STANDARDS.

REACTOR SAFETY IMPLEMENTATION

ORGANIZATIONAL RESPONSIBILITY

- MANUFACTURING
- RESEARCH AND ENGINEERING

FORMAL REACTOR SAFETY CONTROLS

- PROCESS STANDARDS
- PROCESS CHANGE AUTHORIZATION
- PRODUCTION TESTS AUTHORIZATION
- PROCESS IMPROVEMENT TRANSITION AUTHORIZATION
- DEVELOPMENT TESTS
- DESIGN CHANGES
- EQUIPMENT MAINTENANCE STANDARDS
- STANDARDS OPERATING PROCEDURES

FORMAL AUDITS

- MANUFACTURING
- RESEARCH AND ENGINEERING

UNUSUAL EVENTS DURING THE PAST YEAR

- 7-10-64 H-REACTOR, FRONT FACE NOZZLE BROKEN OFF DURING CHARGE-DISCHARGE
- 10-25-64 C-REACTOR, FRONT FACE FITTING FAILURE DURING RISE OF WATER PRESSURE
- 10-25-64 KW-REACTOR, SHUTDOWN MANUALLY FROM 1 MW WHEN ENNUNCIATOR WOULDN'T CLEAR ON IN-CORE FLUX MONITOR TUBE. NO REAR PIGTAIL
- 10-28-64 C-REACTOR, TWO TUBES WITH HIGH PANELLIT PRESSURE-VENTURE INSERTS WERE MISSING
- 11-26-64 C-REACTOR, SHUTDOWN WITH TWO HALF-RODS CAUSING 210-300 MW POWER RISE IN 30 SEC.
- 2-26-65 D-REACTOR, SHORT IN 190-DR SUBSTATION. POWER DIP TO TWO 190-D PROCESS PUMPS. SCRAM
- 7-8-65 C-REACTOR OPERATED 12 HOURS WITH 25 OF 45 BALL 3X HOPPERS LOCKED OUT OF SERVICE
- 7-22-65 D-REACTOR, POWER INTERRUPTION TO 3 OF 4 BUSES. SCRAM-ALL SECONDARY EQUIPMENT FUNCTIONED
- 7-31-65 K-REACTOR, No 3 EMERGENCY BOILER FAILURE CAUSED MANUAL SHUTDOWN OF REACTOR

[redacted]

III. PRESENTATION CHARTS AND OUTLINES (Cont.)

C. Seismological Characteristics of Hanford Region

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SEISMOLOGICAL CHARACTERISTICS OF THE HANFORD REGION

I. INTRODUCTION

A. Seismology is an interpretive and historical science.

1. Earthquake records help tell of structures at depth that give rise to quakes.

2. Seismic characteristics of area are determined from long record of quakes.

II. SEISMOLOGICAL CHARACTERISTICS OF HANFORD REGION

A. Accumulating data from eight recording seismographs and Blue Mountain Observatory helping define characteristics.

1. Epicenters of recent quakes as close as 20 mils away,

B. Stability of area well established

1. Tectonically more active areas on all sides.

2. Thick series of high density basalts.

3. Stresses relieved by minor slippage as stress occurs.

C. Major threat from adjacent areas is minimized.

1. Thick sedimentary sequence filters and absorbs waves to minimize hazard.

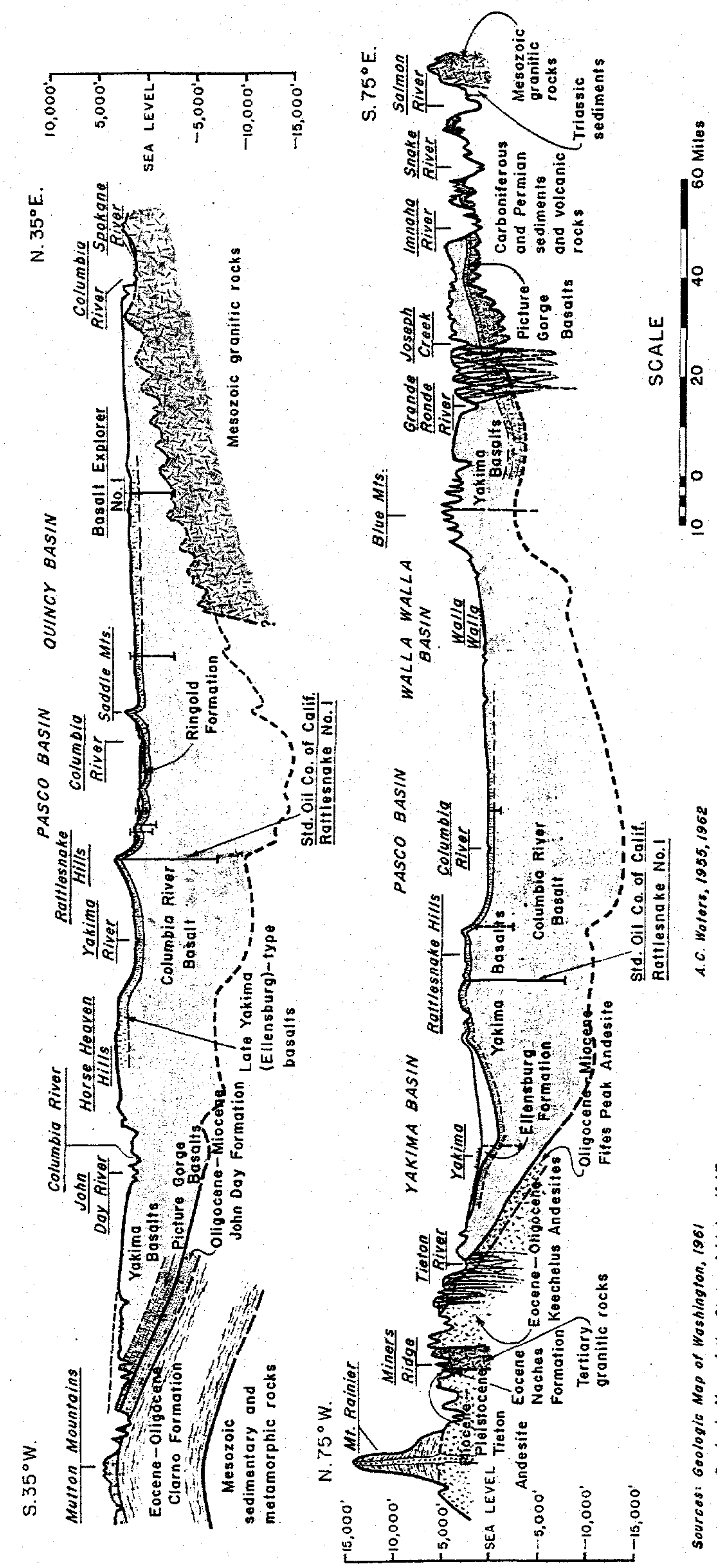
2. Waves of 0.2 sec. period about only hazard.

3. Quakes are lower in intensity at Hanford than at comparable distances elsewhere.

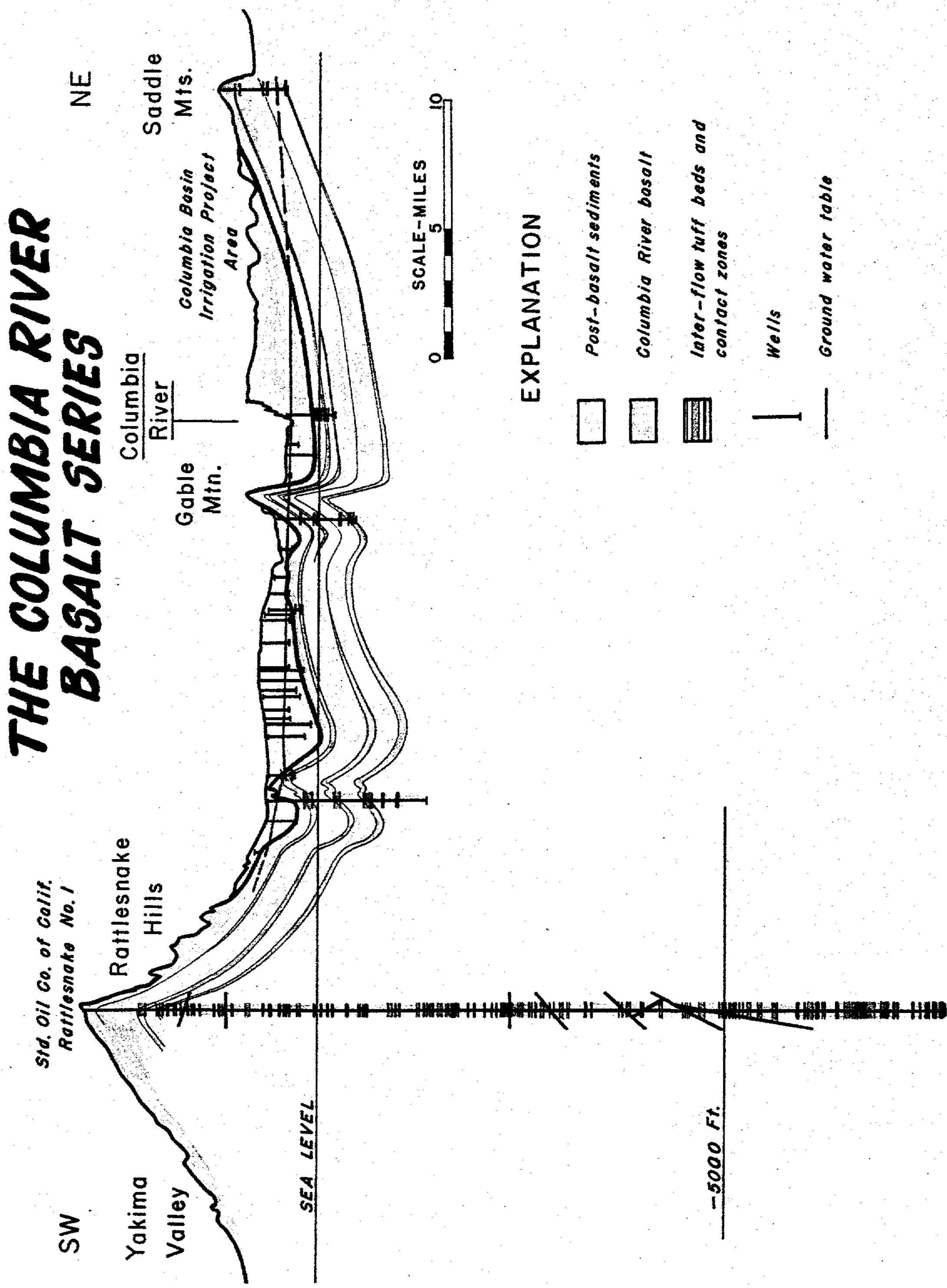
D. Plans

1. Strong motion seismographs (accelographs) to be installed to determine coupling factor and different response of reactors to same and different quakes.

GEOLOGIC CROSS SECTIONS
COLUMBIA RIVER BASALT PLATEAU



Sources: Geologic Map of Washington, 1961 A.C. Waters, 1955, 1962
Geologic Map of the State of Idaho, 1947 E.M. Baldwin, Geology of Oregon, 1959
Geologic Map of Oregon West of the 121st Meridian, 1961 Standard Oil Co. of California, 1958
Tectonic Map of the United States, 1962


THE COLUMBIA RIVER BASALT SERIES
SW
NE
Yakima Valley
Std. Oil Co. of Calif. Rattlesnake No. 1
Rattlesnake Hills
Gable Mtn.
Columbia River
Columbia Basin Irrigation Project Area
Saddle Mts.
SEA LEVEL
-5000 Ft.
SCALE-MILES
0
5
10
EXPLANATION
Post-basalt sediments
Columbia River basalt
Inter-flow tuff beds and contact zones
Wells
Ground water table

III. PRESENTATION CHARTS AND OUTLINES (Cont.)

D. K-Reactor Power Level Limit

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FACTORS AFFECTING REACTOR POWER LEVEL

TECHNICAL FACTORS

1. REACTOR SAFETY	NUCLEAR CONTROL	SPEED OF CONTROL
	HEAT REMOVAL	SUB-COOLED BURNOUT
		EMERGENCY TRANSIENT BURNOUT
		BACKUP SYSTEM CAPACITY
2. CONTINUITY OF OPERATION	EFFLUENT SYSTEM DAMAGE	BULK OUTLET TEMPERATURE
3. ECONOMICS AND REACTOR LIFE	FUEL RERFORMANCE	EXPOSURE & POWER
	TUBE PERFORMANCE	CORROSION
	MODERATOR DAMAGE	GRAPHITE OXIDATION
		GRAPHITE CONTRACTION

ADMINISTRATIVE FACTORS

1. ADMINISTRATIVE LIMITS	FISSION PRODUCT INVENTORY	POWER LEVEL

SPEED OF CONTROL

UNIQUE PHILOSOPHY

SOLE PURPOSE IS TO
ASSURE SUFFICIENTLY
FAST EMERGENCY NUCLEAR
CONTROL SO THAT UNDER
ANY CREDIBLE ACCIDENT
CONDITION THERE WOULD
BE NO ESCALATION BEYOND
THE CONSEQUENCES
INEVITABLE .

CRITERION ESTABLISHED IN
1956-7. REVIEWED BY ACRS

SPEED-OF-CONTROL CRITERION

THE OPERATION OF THE HANFORD REACTORS SHALL BE SUCH THAT IN THE EVENT OF A POWER EXCURSION RESULTING FROM ANY CREDIBLE COMBINATION OF EVENTS, AND INCLUDING COMPLETE AND PERMANENT LOSS OF COOLANT, THE RESPONSE OF THE REACTOR SAFETY CONTROL SYSTEM SHALL BE SUFFICIENT TO INSURE THAT NO ENERGY STATE WILL DEVELOP DURING THE EXCURSION WHICH WOULD SIGNIFICANTLY INCREASE THE CONSEQUENCES OF THE ACCIDENT.

SPEED OF CONTROL LIMIT

- RAPID COOLANT LOSS KEY ACCIDENT IN SETTING LIMIT.
- INTENT TO DELAY MELTING - NO VIOLENT RELEASE.
- AN EQUILIBRIUM POWER EXISTS WHERE CONTROL RESPONSE JUST FAST ENOUGH TO MEET CRITERIA.
- SIMULTANEOUS EVENTS - SOLUTION TRACTABLE BY SPATIAL KINETICS.
- SAFETY MARGIN ESTABLISHED BY COMBINATION OF CONSERVATIVE ASSUMPTIONS OF KEY PARAMETERS.

[redacted]

SPEED OF CONTROL SAFETY MARGIN K REACTOR

PARAMETER	CONSERVATIVE ASSUMPTION	EFFECT ON LIMIT
PRESSURE DECAY	ONE SECOND LOSS	NO CREDIT
PRESSURE GAUGE RESPONSE	0.1 SECOND TOO LONG	-500 Mw
SAFETY ROD STRENGTH	0.3 % k TOO WEAK	-150 Mw
SAFETY ROD RESPONSE	0.2 SECOND TOO LONG	-1000 Mw
VOID COEFFICIENT	0.25 % k ADDED	-600 Mw
POWER LIBERATED-GRAPHITE	ASSUMED LIBERATED IN FUEL	-5%
		2520 Mw

[redacted]

[redacted]

[redacted]

SPEED OF CONTROL MARGIN

- MINIMUM LIMIT - K REACTOR

CALCULATED VALUE	5400 MW
COMBINED MARGIN	2520 MW
"TRUE" LIMIT	7920 MW

THUS MARGIN IS 50% - REACTOR IS CONTROLLED BY CALCULATED LIMIT

ADMINISTRATION OF LIMIT

- PROCESS STANDARDS - VARIABLES
- GRAPHITE TEMPERATURE AND FUEL EXPOSURE MONITORED CONTINUOUSLY
- ROD SPEEDS AND CIRCUIT DELAYS MEASURED FREQUENTLY
- NO CONSEQUENCES OF THEMSELVES OF EXCEEDING LIMIT

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INTERPRETATION OF THE SPEED-OF-CONTROL CRITERION

THE ENERGY GENERATED IN AN EXCURSION ACCOMPANYING LOSS OF COOLANT SHALL NOT BE SUFFICIENT TO CAUSE THE SURFACE TEMPERATURE OF ANY FUEL ELEMENT IN THE REACTOR TO REACH THE MELTING POINT OF URANIUM UNTIL THE POWER GENERATION OF THAT HOTTEST FUEL ELEMENT RETURNS TO ITS PRE-ACCIDENT VALUE.

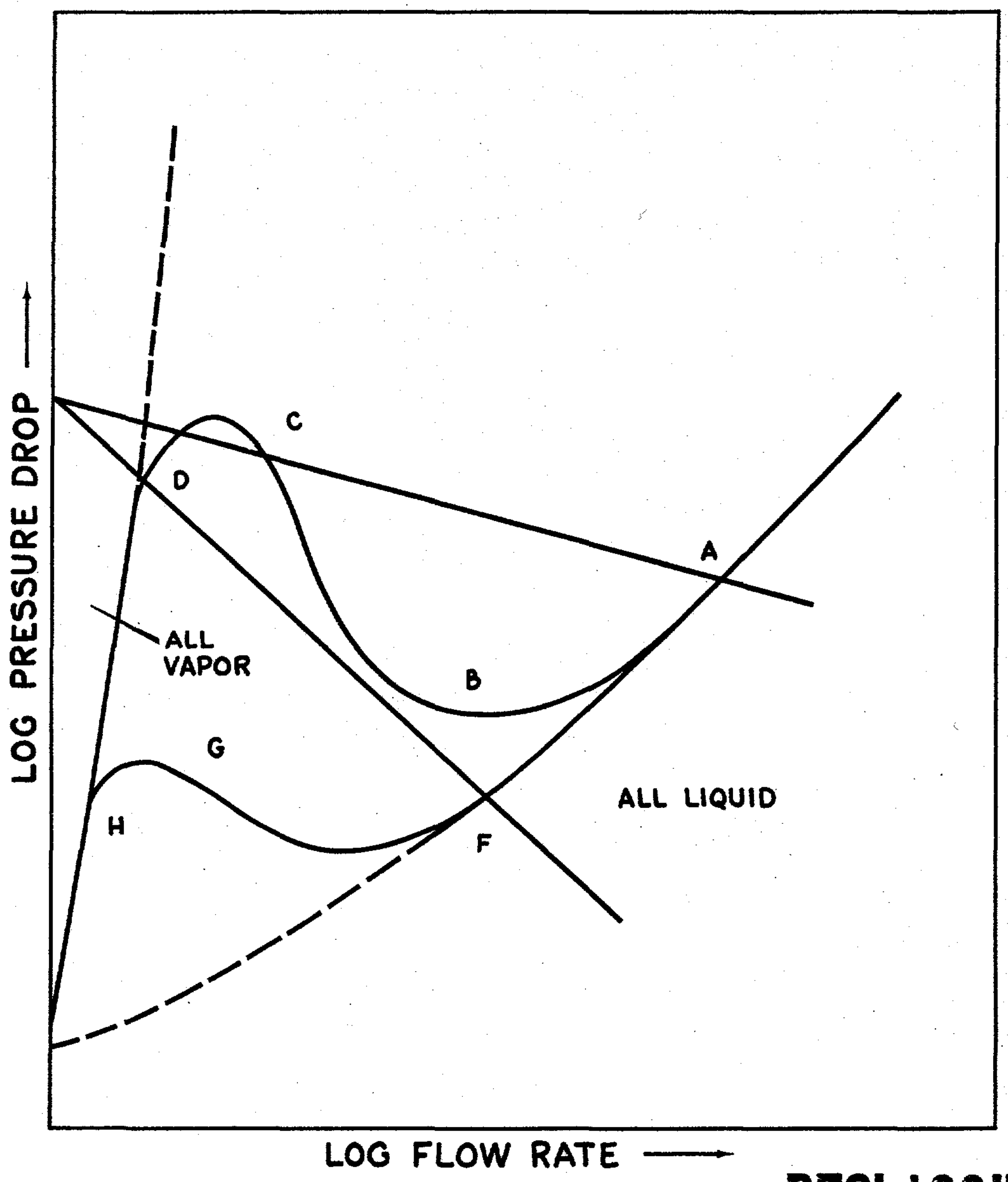
[redacted]

EMERGENCY REACTOR COOLING

- PHILOSOPHY AND SAFETY MARGINS
  - PREVENT BOILING
  - HEAT REMOVAL DEMAND
  - 15% CONSERVATISM
- SECONDARY COOLANT SYSTEM ADEQUACY
  - SUPPORT 7500 OPERATION
  - NO DETAILED ERROR ANALYSIS
- LAST-DITCH COOLANT SYSTEM
  - FLOW MEASUREMENT
  - 6% FACTOR
- ADEQUACY DURING UNEXPECTED POWER LEVEL SERGES

[redacted]

INSTABILITY CURVES



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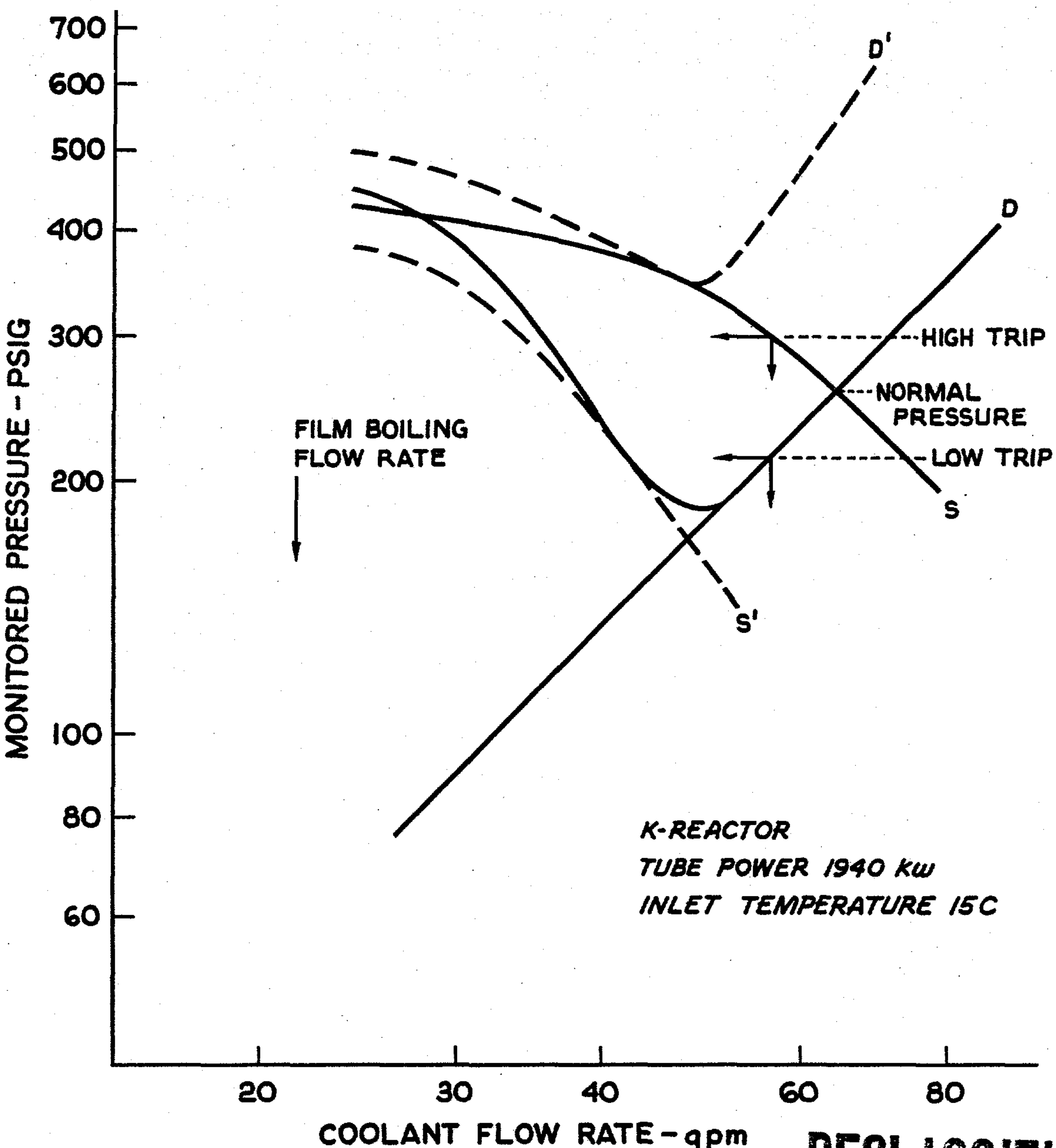
INSTABILITY TRIPS



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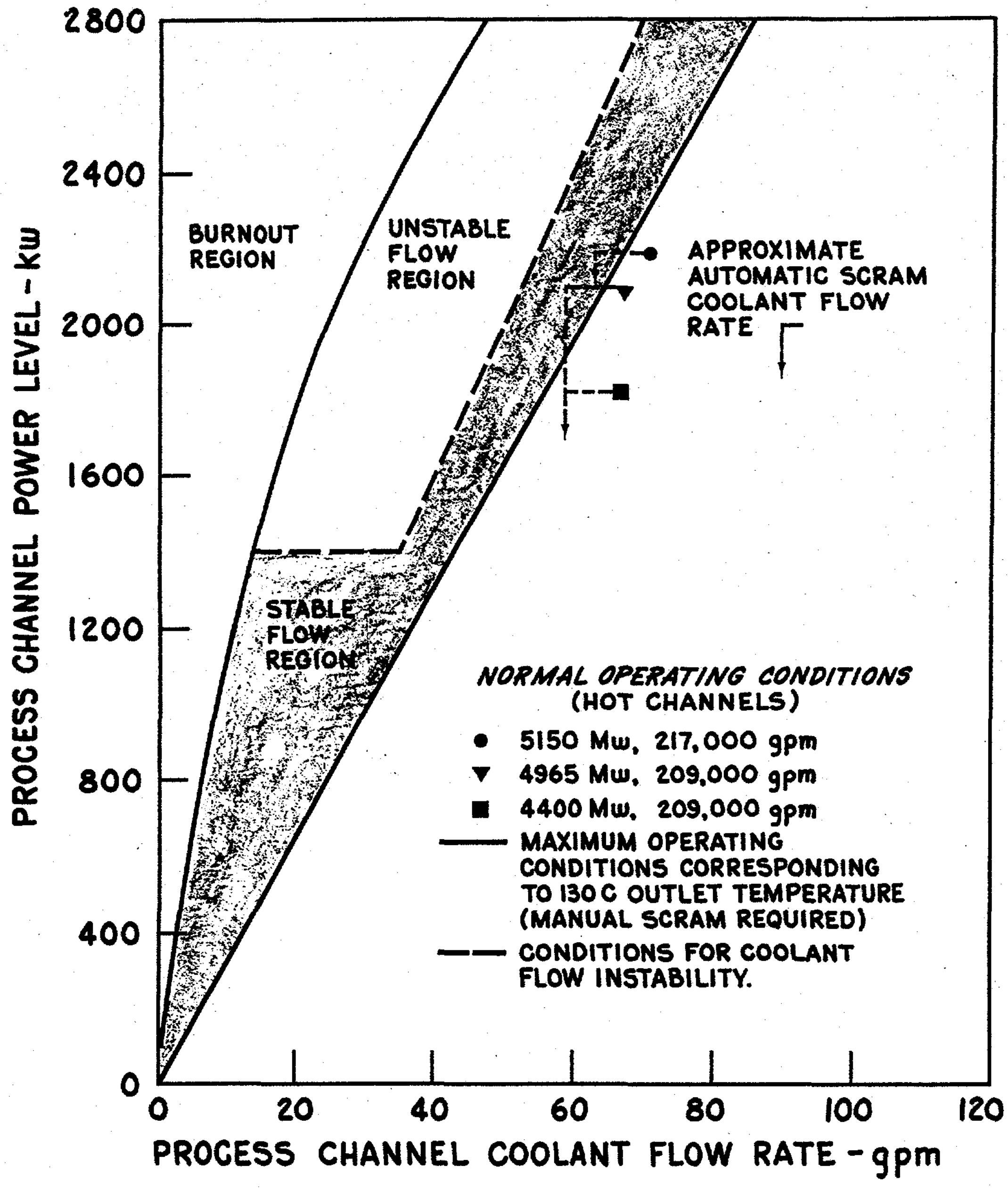
INSTABILITY LIMITS



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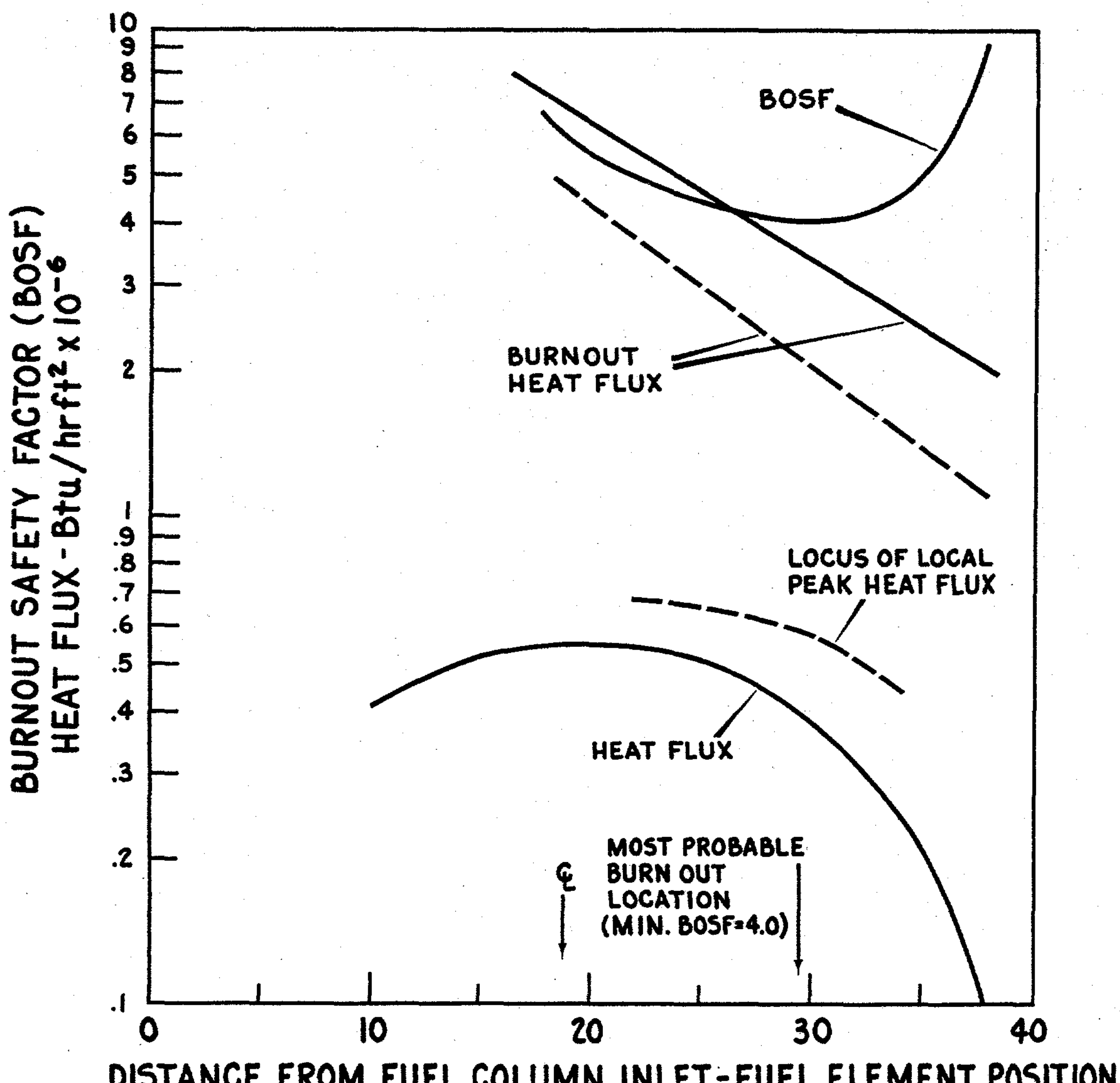
K REACTOR NATURAL URANIUM COLUMN HOT CHANNEL 4965 MW - 209,000 gpm



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K REACTOR POWER LEVEL LIMITS-MW

-REACTOR LIFE & OPERATING CONTINUITY-

	PREVIOUS	NATURAL LOADING	E-Q LOADING	PROJECTED 65-66
BULK OUTLET TEMPERATURE	4870	4965*	4965*	5150**
GRAPHITE TEMPERATURE	4400	4700	4700	5150
SPECIFIC FUEL TEMPERATURE	9000	9000	8100	9000

**REACTOR FLOW-209,000 gpm- INLET WATER TEMPERATURE 5°C*

***REACTOR FLOW-217,000 gpm- INLET WATER TEMPERATURE 5°C*

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K REACTOR POWER LEVEL
LIMITS-MW
"NUCLEAR SAFETY"

	PREVIOUS	NATURAL LOADING	E-Q LOADING	PROJECTED 65-66
SPEED OF CONTROL (COOLANT LOSS)	6000	5400	8500	5400
EMERGENCY COOLING CAPABILITY				
SECONDARY SYSTEM	7500	7500	7500	7500
LAST-DITCH SYSTEM	5100	5100-6000	5100-6000	6000
INDIVIDUAL TUBE COOLANT INSTABILITY	5170	5600	5530	5750
FUEL BURNOUT	6800	6800	6800	6800

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B, D, & C REACTOR POWER LEVEL LIMITS MW

LIMITS	B & D REACTORS	C REACTOR
NUCLEAR SAFETY		
SPEED OF CONTROL	2,760	2,600
EMERGENCY COOLING CAPABILITY		
SECONDARY SYSTEM	3,945	6,260
LAST DITCH SYSTEM	2,300	3,550
INDIVIDUAL TUBE COOLANT INSTABILITY	2,550	2,920
FUEL BURNOUT	4,400	3,400
REACTOR LIFE & OPERATING CONTINUITY		
BULK OUTLET TEMPERATURES		
WITH CURRENT FLOW RATE	2,110	2,425
WITH INCREASED FLOW RATE	2,305	2,540
SPECIFIC FUEL TEMPERATURES	4,950	5,100
OLD ADMINISTRATIVE LIMIT	2,090	2,310

ASSUMPTIONS

COLD WATER INLET - 5°C

ORIFICING EFFICIENCY - B & D - 81% C - 85%

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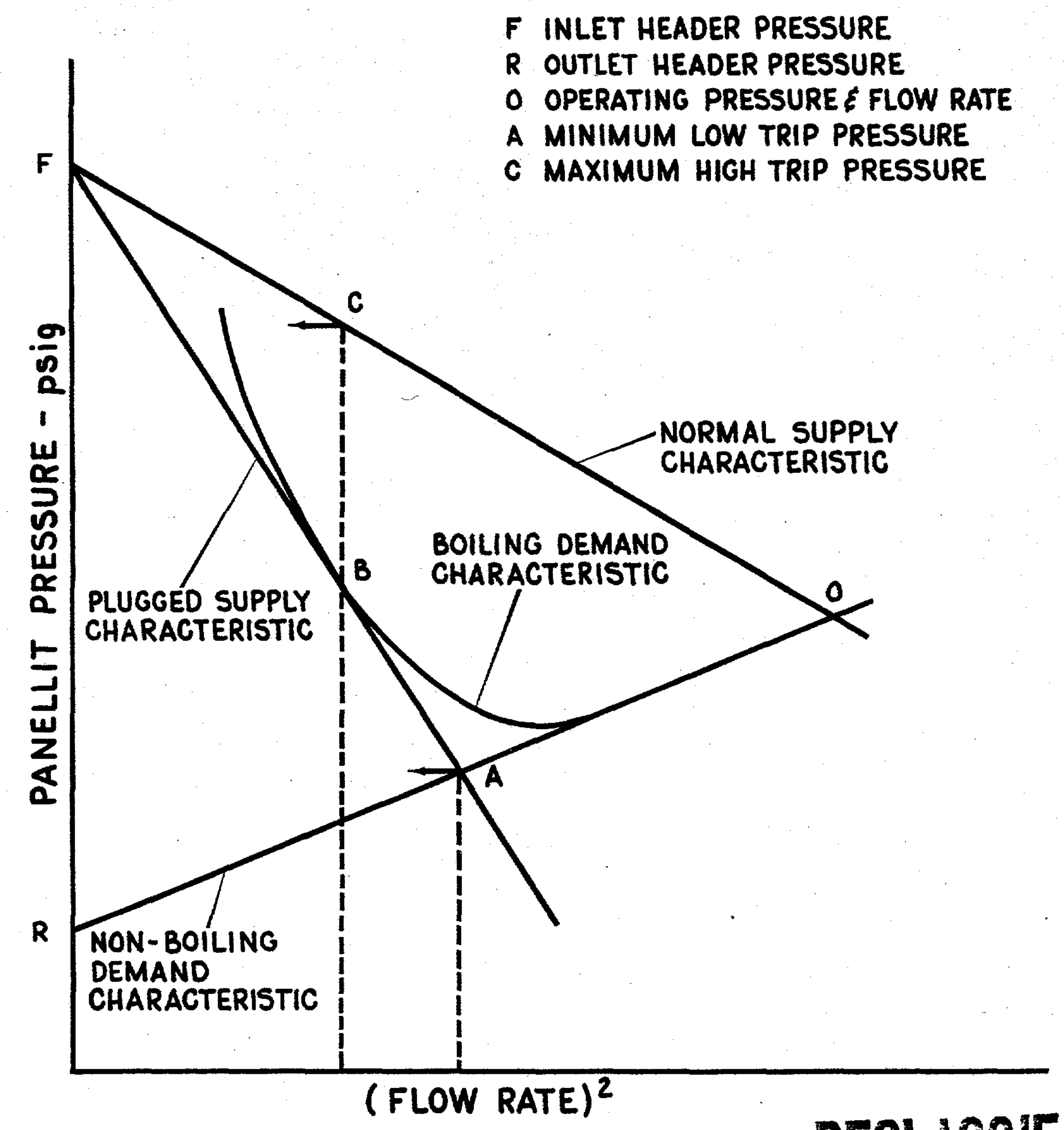
ILLUSTRATION OF INSTABILITY LIMITS



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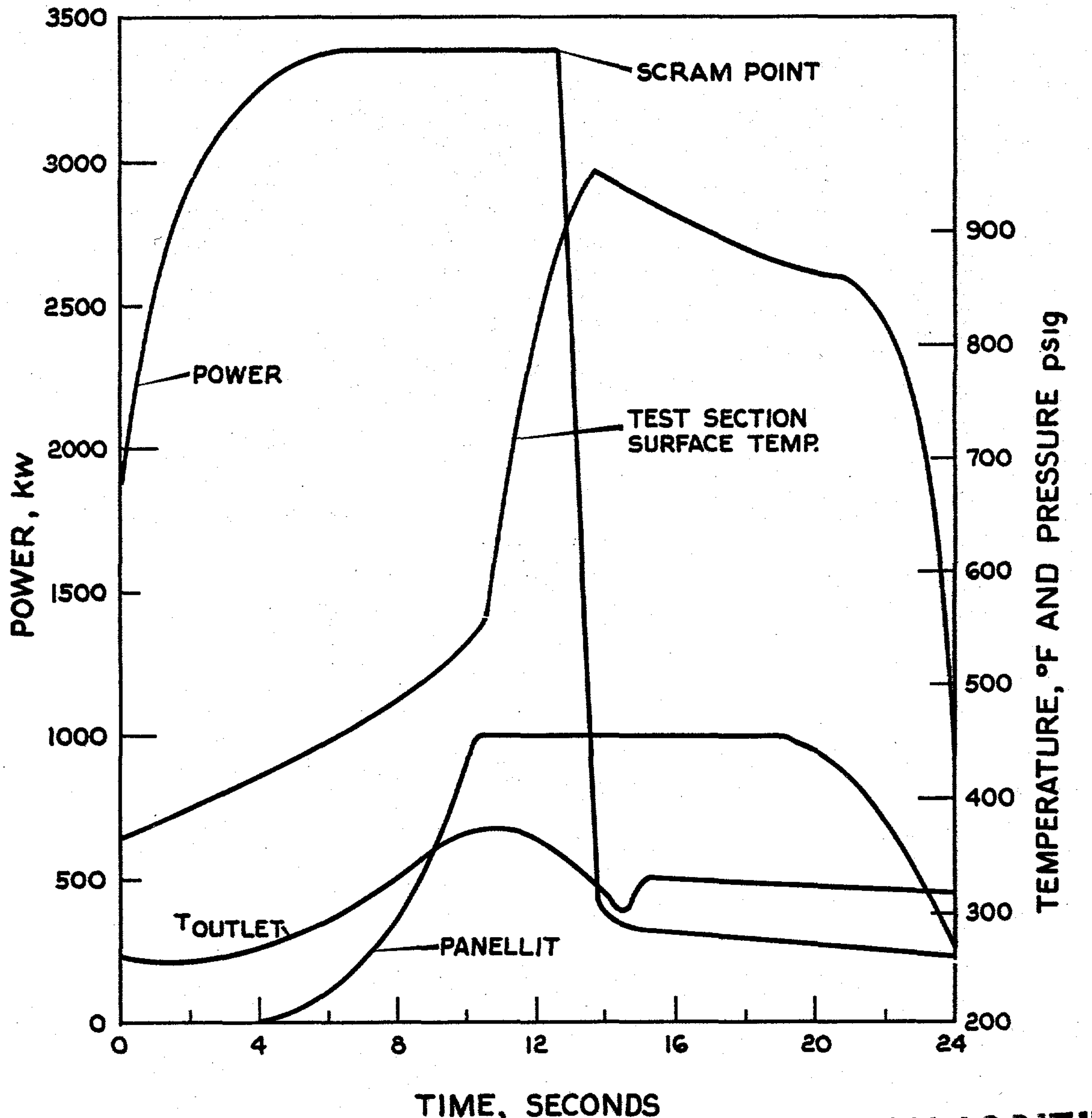
PLOT OF DATA FROM POWER SURGE TEST



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III. PRESENTATION CHARTS AND OUTLINES (Cont.)

E. Progress Report on Confinement Studies for the Production Reactors

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1965 HANFORD CONFINEMENT STUDIES ANALYTICAL WORK

PURPOSE

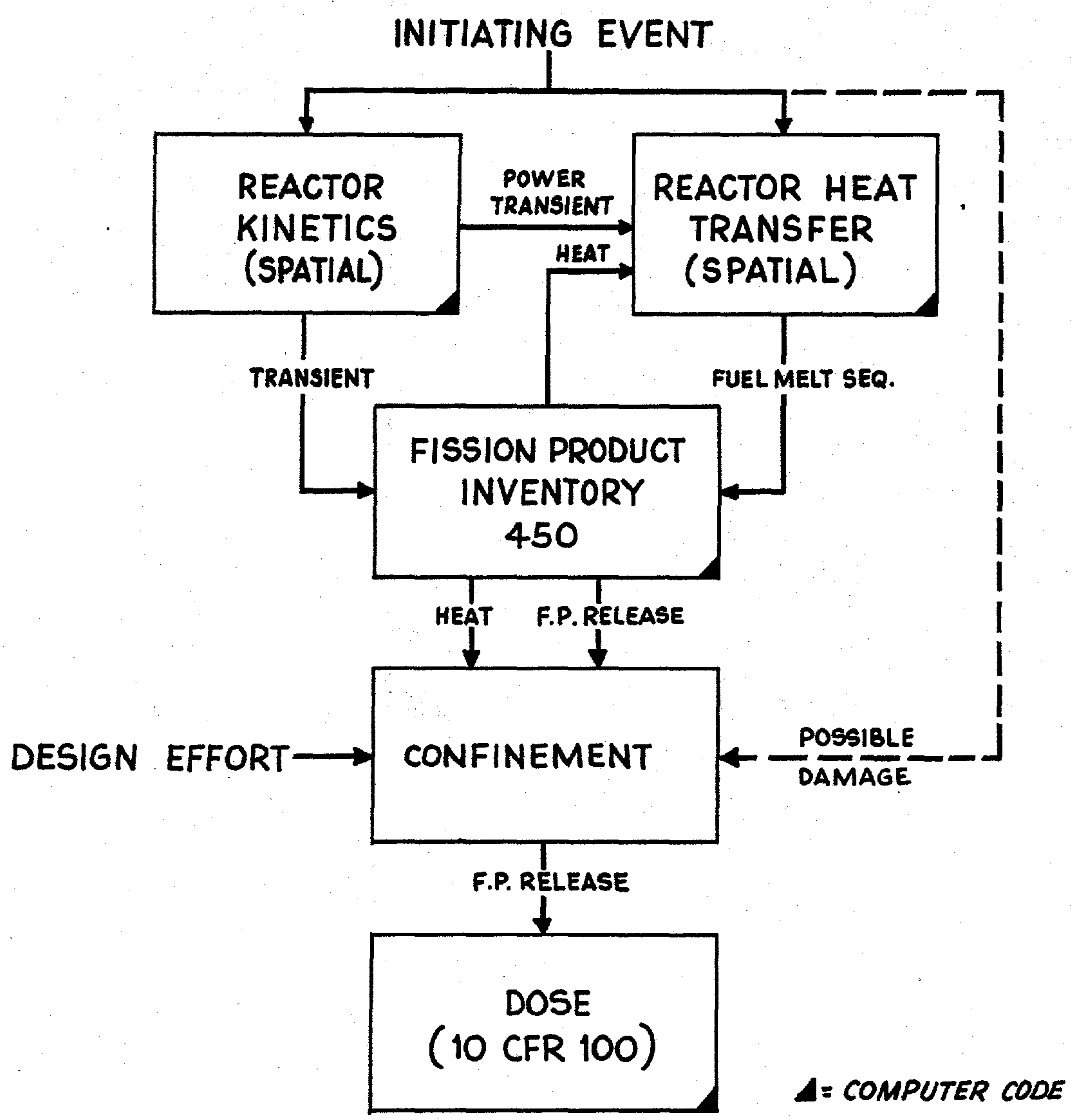
- CHARACTERIZATION OF LARGE ACCIDENTS
- REDUCTION IN CONSERVATISM
- IMPROVED SOPHISTICATING AND UPDATING
- TESTING AGAINST 10-CFR-100

ACCIDENTS UNDER STUDY

- FAILURE OF A SINGLE CROSSHEADER (MCA)
- FAILURE SO AS TO CAUSE LOSS OF COOLANT TO HALF OF TUBES
- FAILURE SO AS TO CAUSE LOSS OF COOLANT TO ENTIRE REACTOR

1965 HANFORD CONFINEMENT STUDY

ELEMENTS OF MODEL



HANFORD CONFINEMENT EXPERIMENTAL PROGRAM

F-REACTOR TESTS (COMPLETED)

- FILTER EFFICIENCY
- NEW TESTING METHODS
- IODINE PLATEOUT
- FOG SPRAY EFFECT
- FOAM EFFECT

FIVE YEAR R/D PROGRAM ELEMENTS

- FISSION PRODUCT RELEASE UPON CLAD MELT
- METHYL-IODIDE - FORMATION AND ABSORPTION
- COOLANT BOILOUT RATES
- PLATEOUT
- NOBLE GAS RETENTION
- ALTERNATE RELEASE PATHS
- FUEL TUBE MELTDOWN CHARACTERISTICS
- HEAT SINK FOR INTERMEDIATE COOLANT LOSS
- CONFINEMENT AIDS
- IN-PLACE FILTER TESTING

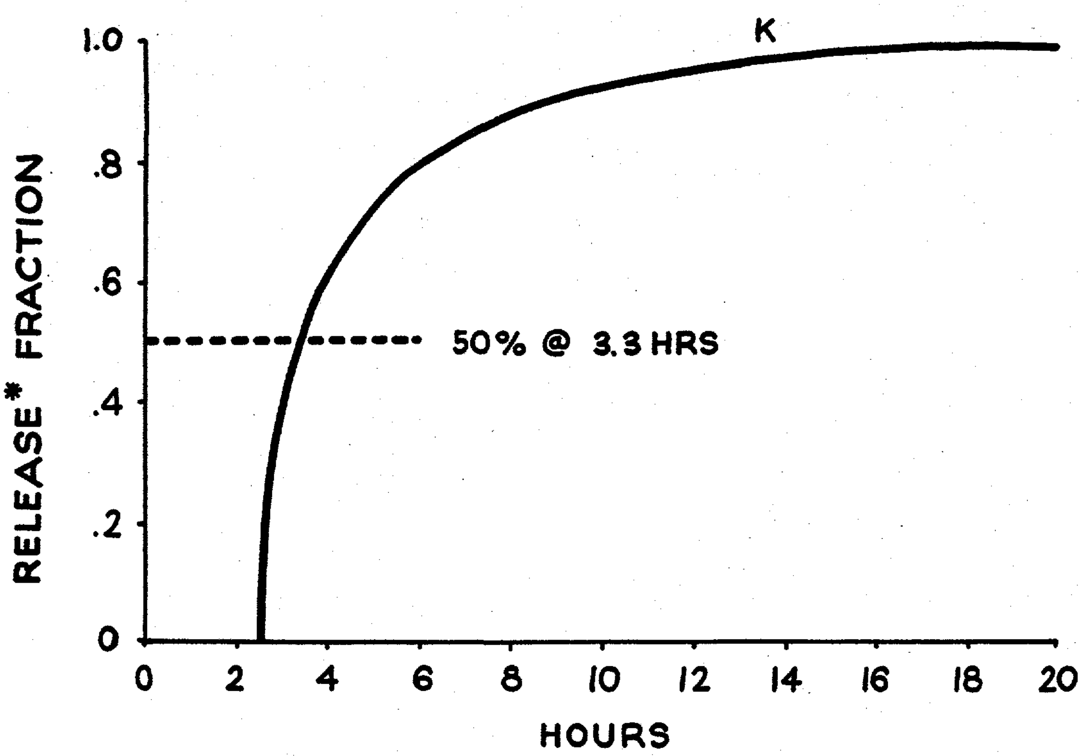
1965 HANFORD CONFINEMENT STUDY STATUS AND RESULTS

ANALYTICAL WORK

- NO FUEL MELTING IN SINGLE-HEADER LOSS
- FUEL MELTING MAY NOT OCCUR IN LOSS OF EVERY OTHER HEADER
- ALL FUEL MELTS IN CASE OF TOTAL COOLANT LOSS. K REACTOR - FIRST MELTING IN 2.7 HOURS. (SEE CURVE)
- FISSION PRODUCT INVENTORY COMPILED
- EXCURSION ACCOMPANYING COOLANT LOSS HAS LITTLE EFFECT ON CONSEQUENCES IF PROMPTLY TURNED AROUND BY SCRAM
- NEW METEROLOGY MODEL GIVES FIVEFOLD DOSE REDUCTION (FROM CLOUD) DUE TO WIND VARIABILITY FOR 8 HOUR RELEASE COMPARED TO 10 MINUTE RELEASE.

ACCUMULATIVE FRACTION OF ORIGINAL INVENTORY RELEASED* FOLLOWING COOLANT LOSS

(DECAY NEGLECTED)



* RELEASE ≡ MELTING

1965 HANFORD CONFINEMENT STUDY
STATUS & RESULTS
CONT'D

F CONFINEMENT TESTS

- IMPROVEMENTS NEEDED IN FILTER TESTING
- NEW TEST METHODS ENCOURAGING
- 75 % IODINE PLATEOUT
- FOG SPRAY EFFECTIVE ON HALOGENS
- FOG SPRAY NOT EFFECTIVE ON NOBLES
- FOAM WILL TRAP AND BRING TO GROUND FISSION GASES PERMITTING EXTENDED RELEASE AS FOAM EVAPORATES

PRESENT CONFINEMENT STANDARDS & TESTING

EFFICIENCY

UNIT	DESIGN	STANDARDS*
ABSOLUTE	99.99%	99.90%
CHARCOAL	99.0 %	95.0 %

* REJECTION ON SINGLE FILTER

TESTING

METHOD	FREQUENCY
VISUAL	QUARTERLY
DOP	ANNUALLY
IODINE RETENTION	ANNUALLY

F-REACTOR CONFINEMENT TESTS

ABSOLUTE FILTERS

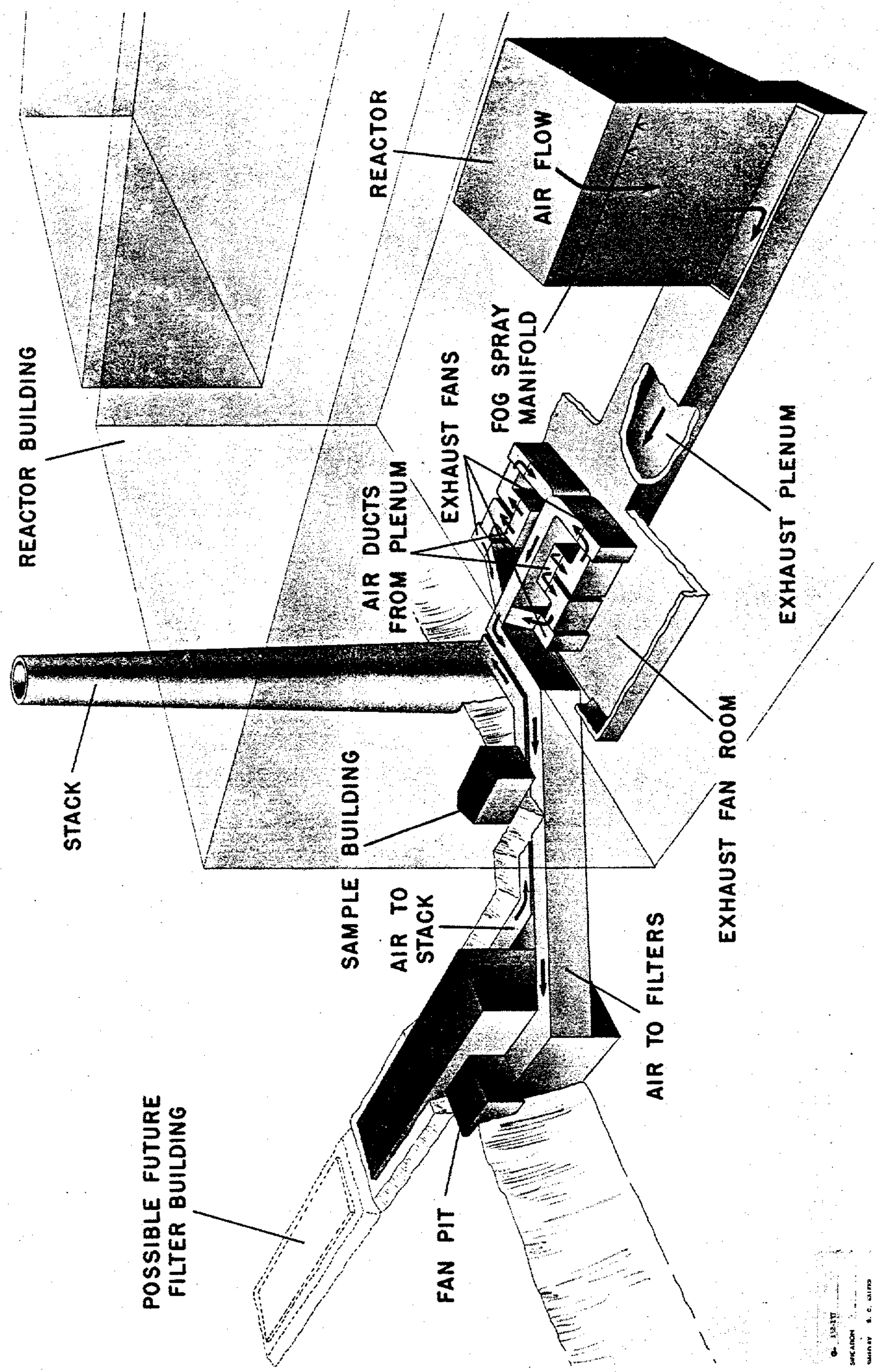
METHOD	DETECTABLE PENETRATION		
	STDS.*	LAB.	FIELD
• DOP(DIOCTAL PHTHALATE)	0.1%	0.01%±0.01%	—
• URANINE DYE	0.1%	0.05%±0.01%	0.1%±0.05%
• CONDENSATION NUCLEI(NaCL)	0.1%	0.05%-0.5%	0.05%-0.05%

CHARCOAL FILTERS

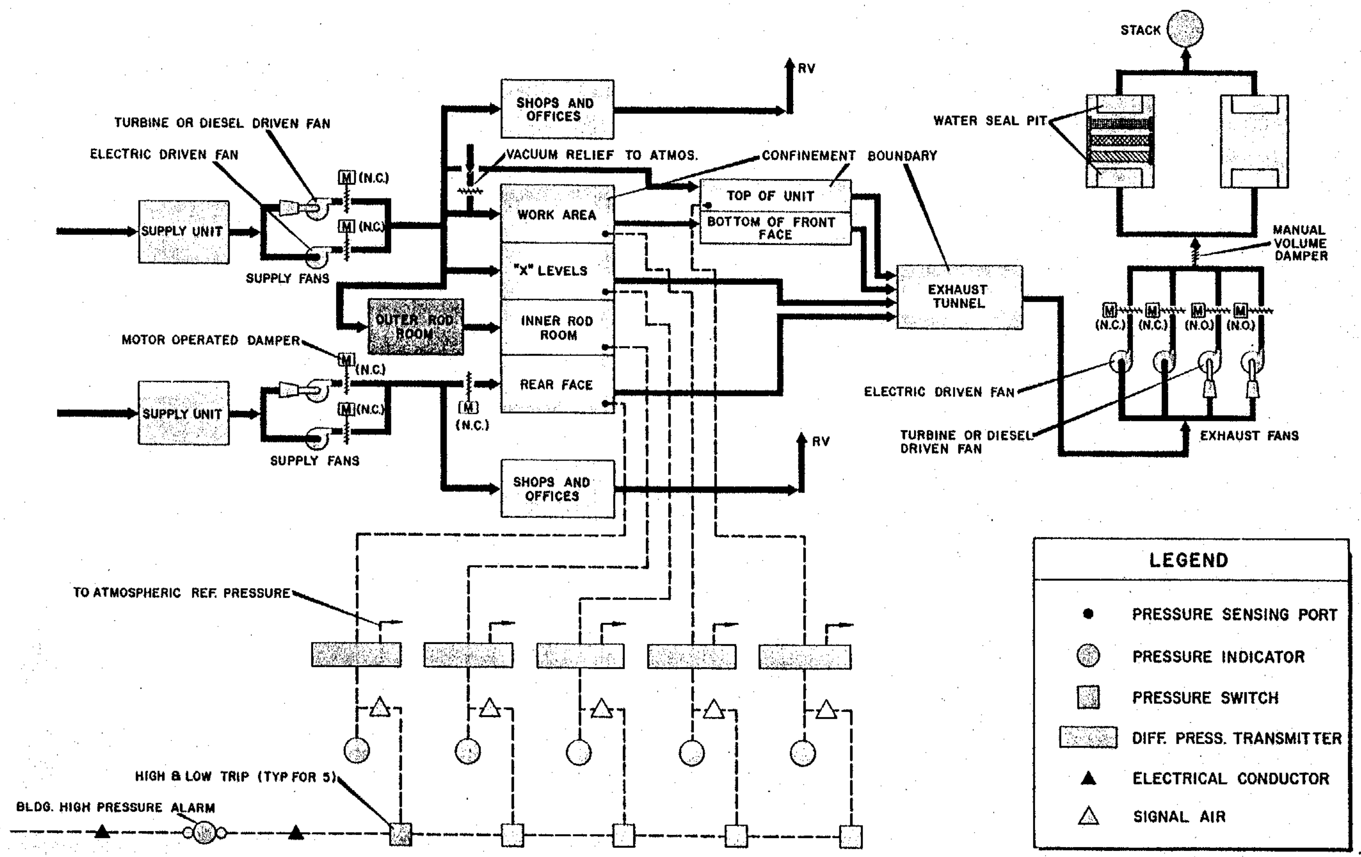
• IODINE	5%*	0.1% I-131	? I-128
• CONDENSATION NUCLEI	(UNDER DETERMINATION)		

* FOR REJECTION ON SINGLE FILTER

PROJECT CGI-791 REACTOR CONFINEMENT
FACILITY LAYOUT



CGI-791 TYPICAL FLOW DIAGRAM



REACTOR CONFINEMENT SYSTEM POTENTIAL IMPROVEMENTS

1. FOG SPRAY SYSTEM
2. WASTE DISPOSAL SYSTEM
3. EFFLUENT SYSTEM TRAPPING & VENTING
4. EXHAUST FAN DRIVE & AIR CONTROL IMPROVEMENTS
5. FOAM GENERATORS
6. FILTRATION SYSTEM IMPROVEMENTS
7. LOW PRESSURE GAS STORAGE
8. LAST DITCH COOLANT SYSTEM IMPROVEMENTS

REACTOR CONFINEMENT SYSTEM
ALTERNATE CONCEPTS

1. NOBLE GAS RETENTION

2. HIGH PRESSURE GAS STORAGE

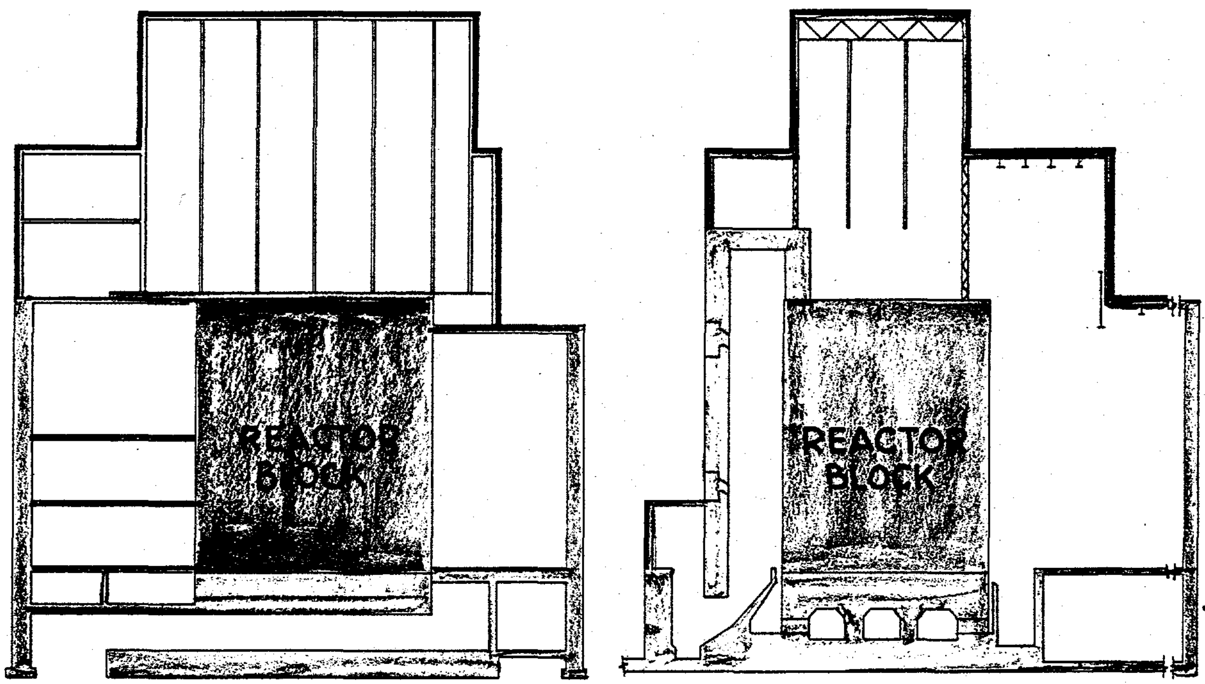
3. 0.3 PSI BUILDING SEAL

4. 1.0 PSI BUILDING SEAL

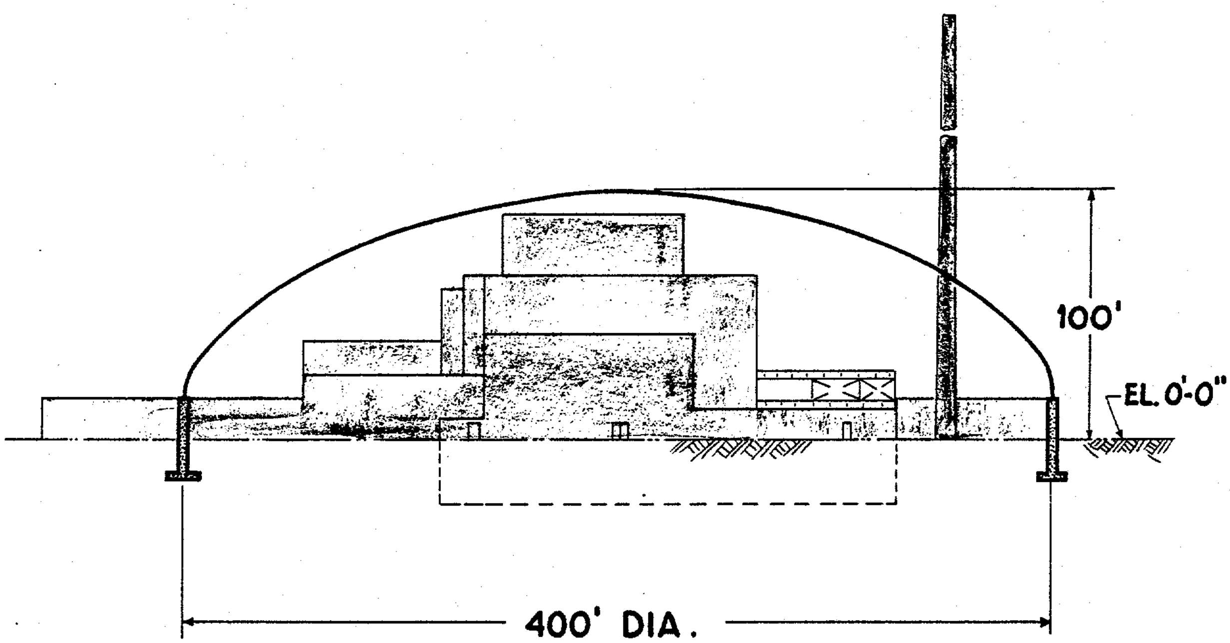
5. 2.0 PSI CONTAINMENT DOME

6. HIGH STACK

REACTOR CONFINEMENT SYSTEM 1.0 PSI BUILDING SEAL



REACTOR CONFINEMENT SYSTEM
2.0 PSI REACTOR CONTAINMENT DOME



III. PRESENTATION CHARTS AND OUTLINES (Cont.)

F. Contamination of the Columbia River by Reactor Effluent Water

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SOURCE OF REACTOR EFFLUENT RADIOISOTOPES

I IMPURITIES IN RIVER WATER.

II CHEMICALS ADDED IN WATER TREATMENT.

III CORROSION OF REACTOR COMPONENTS.

IV FOREIGN MATERIAL ON OR IMBEDDED IN FUEL ELEMENT SURFACE.

RADIOISOTOPE CONCENTRATION IN REACTOR EFFLUENT AND COLUMBIA RIVER

ISOTOPE	REACTOR EFFLUENT CONCENTRATION pc/ml	CALCULATED CONCENTRATION F AREA pc/ml	10 CFR 20 LIMITS pc/ml	HALF LIFE DAYS
Na-24	500	10	200	0.6
P-32	10	0.2	20	14
Sc-46	1	0.02	50	84
Cr-51	300	5	2000	28
Mn-56	5000	30	100	0.1
Cu-64	500	10	300	0.5
Zn-65	10	0.2	200	245
As-76	70	1	20	1.1
La-140	20	0.3	20	42
Np-239	100	2	100	2.4

RADIOISOTOPE RELEASE TO THE COLUMBIA RIVER

	RELEASE RATE CURIES PER DAY		
	1960	1963	1964
P-32	50	33	35
As-76	620	320	350
Np-239	730	470	550
Cr-51	1700	1600	1500
Zn-65	100	40	40

FISSION PRODUCTS FROM RUPTURED FUEL RELEASED TO THE RIVER

- FISSION PRODUCT ACTIVITY FROM RUPTURED FUEL DURING '56-'59 WAS LESS THAN 5% OF THAT GENERATED IN THE COOLANT
- TODAY ACTIVITY FROM RUPTURED FUEL IS LESS THAN 1% OF THAT GENERATED IN THE COOLANT
- REASONS FOR REDUCED RELEASE
  - BETTER RUPTURE DETECTION
  - IMPROVED FUEL PERFORMANCE
  - NO SPLIT TYPE FAILURES
- IODINE IS THE ELEMENT OF MAJOR CONCERN
- REQUIREMENTS OF 10-CFR-20 AND THE FRC

III. PRESENTATION CHARTS AND OUTLINES (Cont.)

G. Future Plans for New Products

FUTURE PLANS FOR IPD REACTORS

- DEFENSE PLUTONIUM
- NON REPRESENTATIVE PLUTONIUM
- CO PRODUCT – TRITIUM
- REACTOR LATTICE MODIFICATION
  - INHERENT SHUTDOWN ON VOIDING
  - INCREASED NEUTRON ECONOMY
  - VERSATILITY
- HIGH POWER DENSITY FUEL
  - INCREASED ENRICHMENT
  - LARGER TARGET TO FUEL RATIO
- TARGETS AND PRODUCTS
  - ThO_2 — U-233
  - Np-237 — Pu-238
  - Bi-209 — Po-210
  - Co-59 — Co-60
- PLUTONIUM BURNING

IV. APPENDIX

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LIST OF ATTENDEES, ACRS MEETING 9/9-11/65

ACRS

W. D. Manly, Chairman
Harold Etherington, Member
S. H. Hanauer, Member
David Okrent, Member
N. J. Palladino, Member
D. A. Rogers, Member
Leslie Silverman, Member
R. C. Stratton, Member
T. J. Thompson, Member
C. W. Zabel, Member
J. E. McKeee, Consultant
Dick Duffey, Technical Secretary
R. F. Fraley, Executive Secretary
R. H. Wilcox, Ass't to Executive Secretary
Leona S. Blische, Admin. Officer

Regulatory Staff

Clifford K. Beck, Deputy Director of Regulation
Marvin M. Mann, Ass't. Director of Regulation for Nuclear Safety
Richard L. Doan, Director, Division of Reactor Licensing
Lester Kornblith, Ass't. Director of Compliance for Reactors
Saul Levine, Chief, Test & Power Reactor Safety Branch
Roger Boyd, Chief, Research & Power Reactor Safety Branch
Robert Carlson, Division of Compliance
James Shea, Division of Reactor Licensing
Karl Goller, Division of Reactor Licensing
Richard DeYoung, Division of Safety Standards
M. G. Gaske, Divsion of Reactor Licensing
Robert Waterfield, Division of Reactor Licensing
Jack McEwen, Division of Reactor Licensing

Office of the General Manager

G. F. Quinn, Ass't. General Manager for Plans & Production
F. P. Baranowski, Director of Production
J. L. Schwennesen, Ass't Director of Production
W. J. Lindsey, Chief, Production Reactors Branch
F. P. Self, Division of Production

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RLO

D. G. Williams, Manager
H. H. Schipper, Ass't. Manager for Technical Operations
C. N. Zangar, Director, Health & Safety Division
A. T. Gifford, Director, Production Reactor Division
P. M. Midkiff, Deputy Director, Production Reactor Division
R. L. Plum, Chief, Production Reactor Operations Branch
Arthur Brunstad, Chief, Nuclear Safety Branch
G. R. Gallagher, Health & Safety Division
C. L. Robinson, Deputy Director, Research & Development Division
G. W. Albright, Research & Development Division
H. A. House, Research & Development Division

[redacted]

IPD-GE

Contractor personnel attending the meeting were the following:

O. C. Schroeder, Manager, Manufacturing Section,
G. C. Fullmer, Manager, Operation Physics
R. W. Reid, Manager, Process Technology
R. G. Geier, Specialist
G. F. Owsley, Supervisor, Reactor Physics
P. A. Carlson, Supervisor, Reactor Engineering
J. R. Spink, Senior Engineer
F. J. Mollerus, Principal Engineer - Electrical
R. Nilson, Manager, Process and Reactor Development
H. W. Heacock, Manager, Development Engineering and Process Design
T. W. Ambrose, Manager, Research and Engineering
A. B. Greninger, General Manager

NRD-GE

W.S. Nechodom, Manager, Reactor Physics
N. R. Miller, Supervisor, Process Evaluation and Control
R. L. Dickeman, General Manager
M. C. Leverett, Manager, Research and Engineering
R. E. Trumble, Manager, Process Evaluation and Control
D. L. Condotta, Manager, Process Design
R. E. Hall, Supervisor, Process Engineering

DUN

C. D. Harrington, General Manager
S. P. Smith, Deputy General Manager

BNW

R. L. Junkins, Senior Representative for Nuclear Health & Safety
C. L. Simpson, Senior Meteorologist
R. E. Brown, Senior Geologist
D. O. Lanning, Manager, Heavy Moderator Physics

[redacted]

ACRS TOUR OF A K REACTOR

Reactor Building

1. Model Room

   A. Reactor Moderator
   B. Shielding Arrangement
   C. Process Tubes
   D. Coolant Piping
   E. Control Equipment
   F. Safety Equipment
   G. Discussion of Water Plant Arrangement and What Will be Seen on Area Tour

2. Control Room

   A. Operating Controls
   B. Safety Controls, Primary and Backup
   C. Safety Instruments, Primary and Backup

      1. ~~Flow~~ Monitors
      2. Flux Monitors
      3. Temperature Monitors

3. Front Face

   A. Riser and Header Arrangement
   B. Tube to Header Equipment
   C. Supplemental Control

4. Valve Pit

   A. Separation of Lines
   B. Backup Diesel Pump Tie-In Point
   C. Ventilation Exhaust Fans

5. Fuel Pickup Chutes

   A. Fuel Discharge Path

6. Fuel Storage Basin

   A. Monorail System
   B. Storage Time

7. Fuel Shipping

8. Supply Fans

   A. Confinement Operation

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Coolant Supply Building

1. Electric Equipment Room

   A. Connection of Pumps to Separate Bus Bars
   B. Switchgear

2. Power Transformer Substation

   A. Sources of Electric Power

3. Pump Room

   A. Primary Coolant System

      1. Low Lift Pumps - Clearwells to high lift pump suction
      2. High Lift Pump
         (a) Flywheel
      3. Divided Coolant Supply System

   B. Secondary System

      1. Low Lift Pumps
      2. Turbine Pump

4. Control Room

   A. Piping Arrangement
   B. Isolation of Two Sides
   C. Electrical Bus Arrangement

5. Boiler and Turbine Generator Room

   A. Backup on Loss of BPA Power for Low Lift Pumps
   B. Turbine Pump

6. Valve Pit

   A. Isolation Valves
   B. Check Valves
   C. Area Tour

      1. Confinement Filter Structure
      2. Retention Basins
      3. River Pumps
      4. Diesel Pumps
         (a) Third Pump System
         (b) How Operated and Tested
      5. Water Treatment Plant

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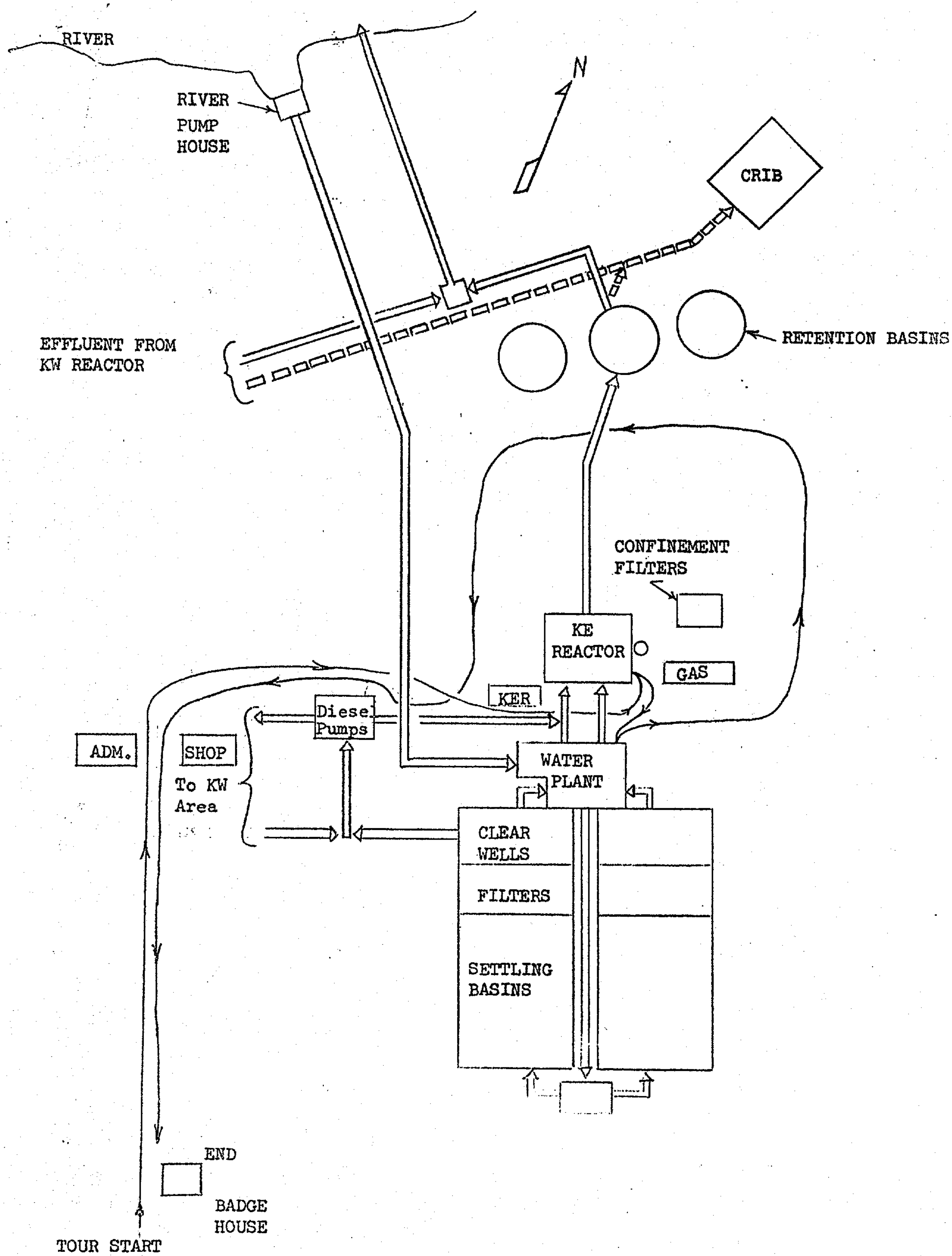
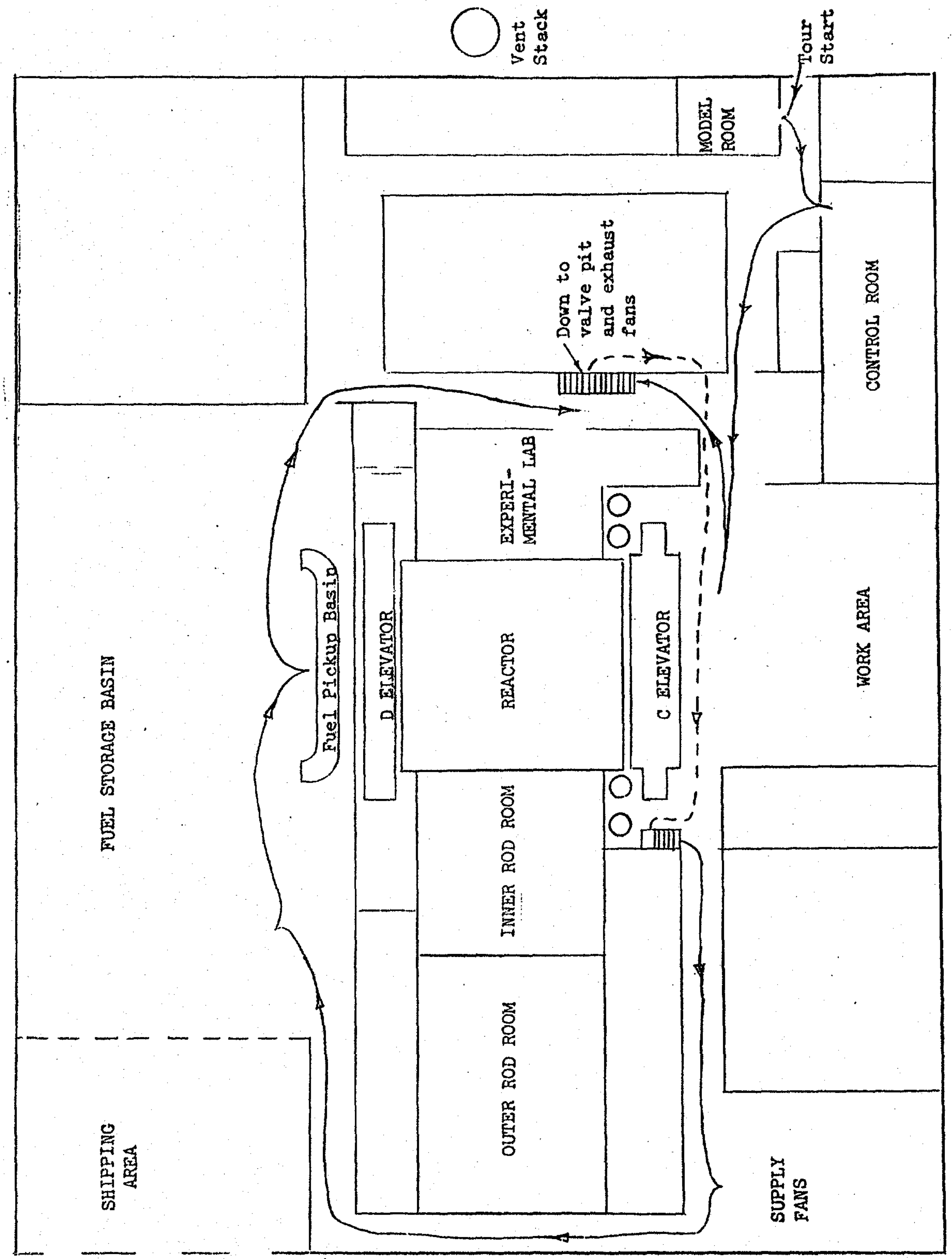
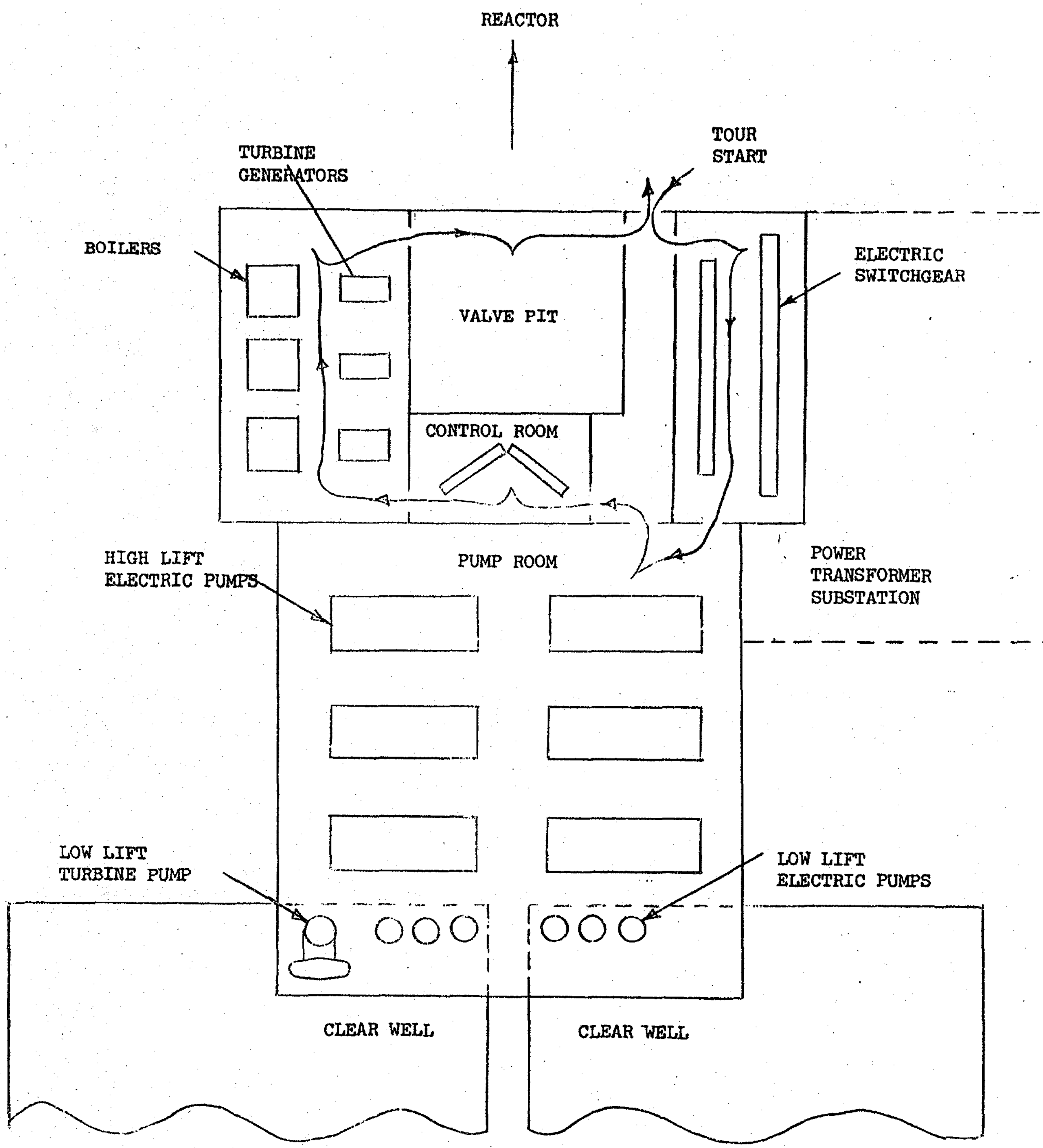

RIVER
RIVER
PUMP
HOUSE
N
CRIB
EFFLUENT FROM
KW REACTOR
RETENTION BASINS
CONFINEMENT
FILTERS
KE
REACTOR
GAS
KER
Diesel
Pumps
ADM.
SHOP
To KW
Area
WATER
PLANT
CLEAR
WELLS
FILTERS
SETTLING
BASINS
END
BADGE
HOUSE
TOUR START

100-KE AREA



KE REACTOR BUILDING



185-KE AND 190-KE
COOLANT SUPPLY BUILDINGS