DOCKET NO. 50-237

ILLUSTRATIONS USED IN PRESENTATION BY
GENERAL ELECTRIC COMPANY AND
COMMONWEALTH EDISON COMPANY
TO ACRS/AEC
CONCERNING DRESDEN UNIT 2
ON SEPTEMBER 1, 1965

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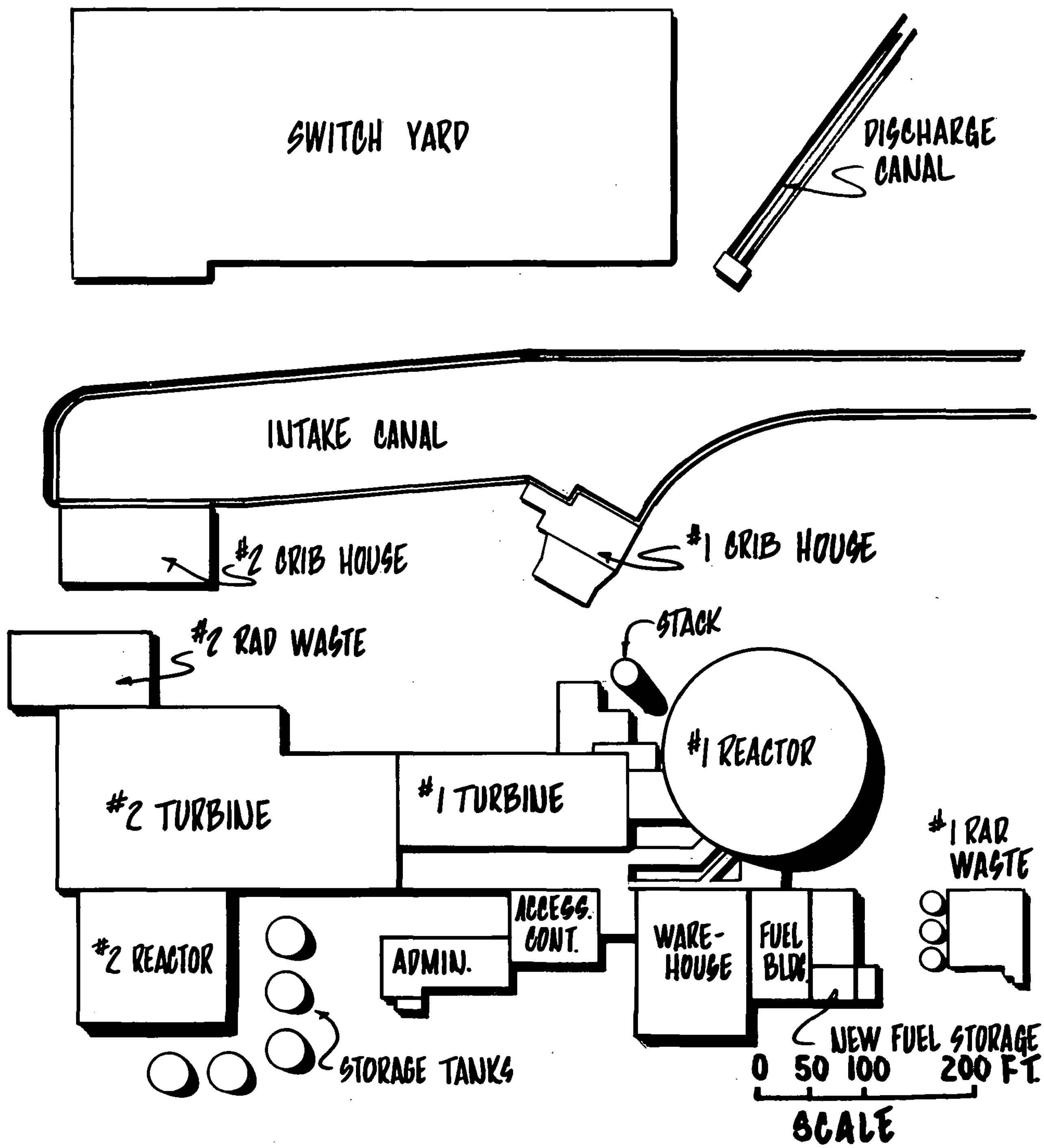
3146

DRESDEN NUCLEAR POWER STATION



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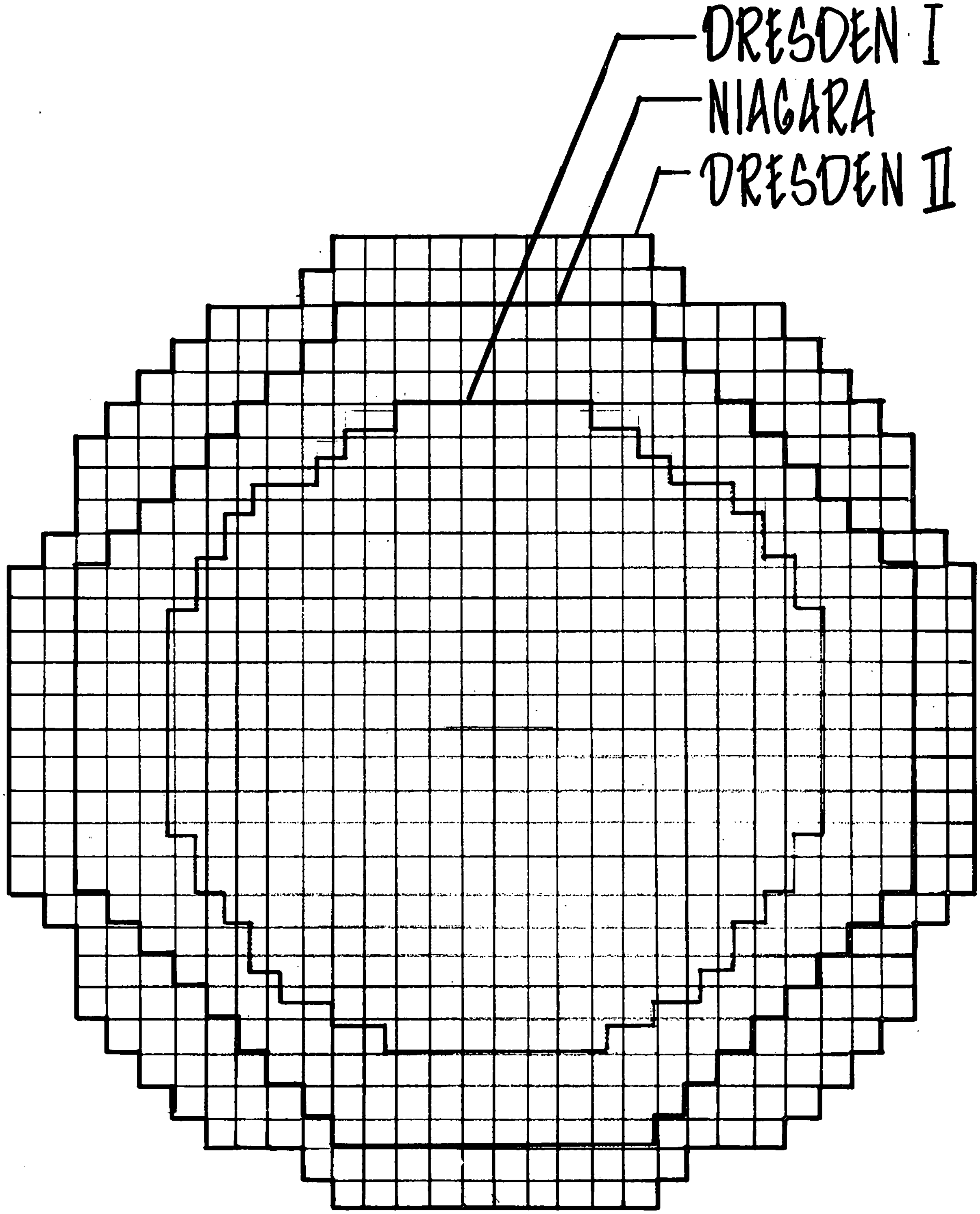
DRESDEN-2

DATA SUMMARY

PLANT OUTPUT	715 MWe
REACTOR OUTPUT	~2300 MWT
FUEL	UO_2
ENRICHMENT	2%
CLAD	ZIRCALOY-.036"
NO. FUEL ASSEMBLIES	724
AVG POWER DENSITY	36.7 KW/LITER
MAXIMUM HEAT FLUX	349,000 $Btu/hr\text{-}ft^2$
AVG CORE VOIDS	26.6%
EQUIVALENT CORE DIA.	182.2 INCHES
NO. CONTROL RODS	177
CONTROL ROD POISON	B_4C
REACTOR VESSEL	20'11" ID x 68' LONG
RECIRCULATION LOOPS	2
NO. JET PUMPS	20
CONTAINMENT TYPE	PRESSURE SUPPRESSION

2

CORE SIZE COMPARISON



3

DRESDEN 2

NEW FEATURES

NUCLEAR BOILER

- JET PUMPS
- REFLOODING CAPABILITY
- MAINSTEAM FLOW RESTRICTOR

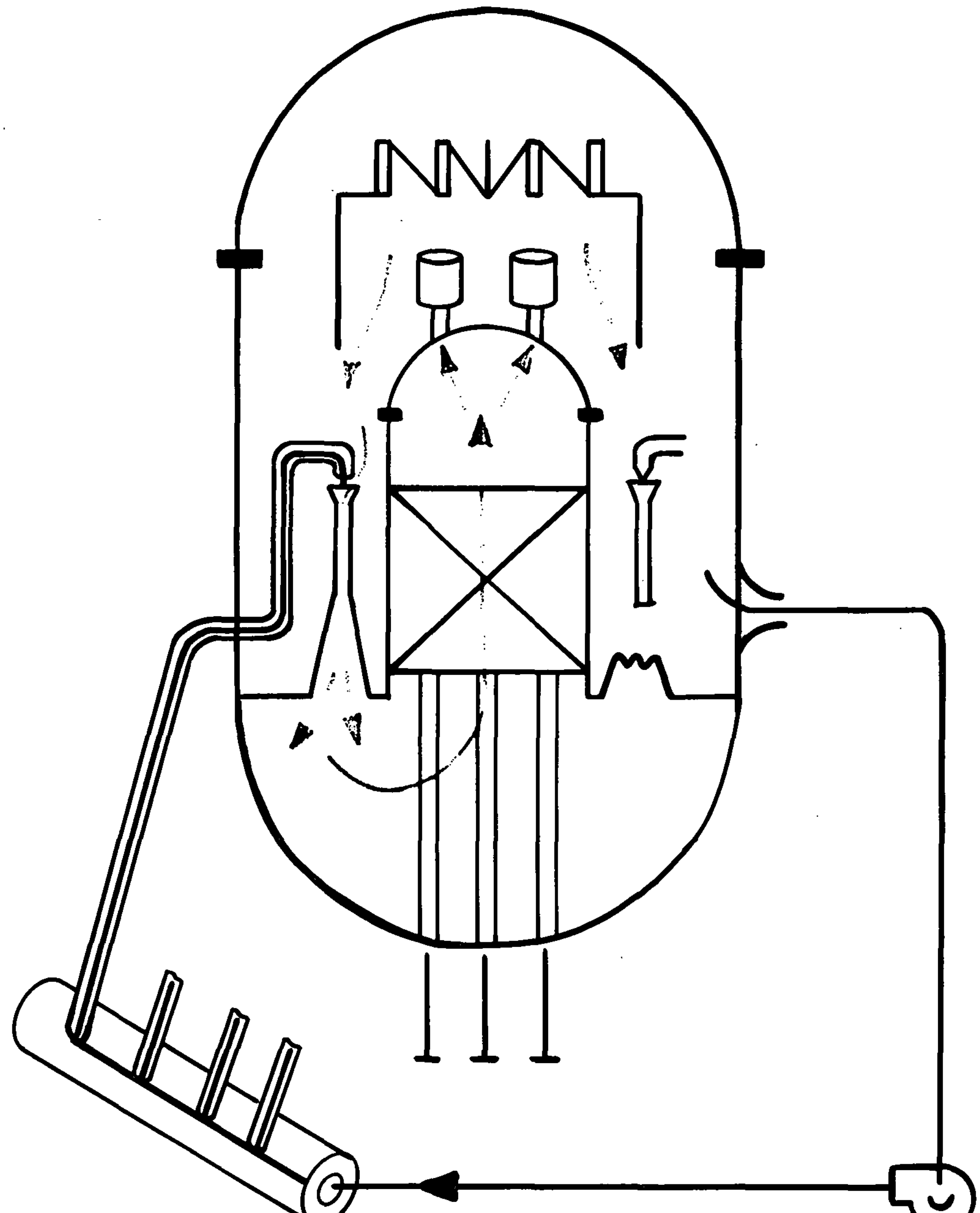
NEUTRON MONITORING SYSTEM

REACTIVITY EXCURSION SAFEGUARDS

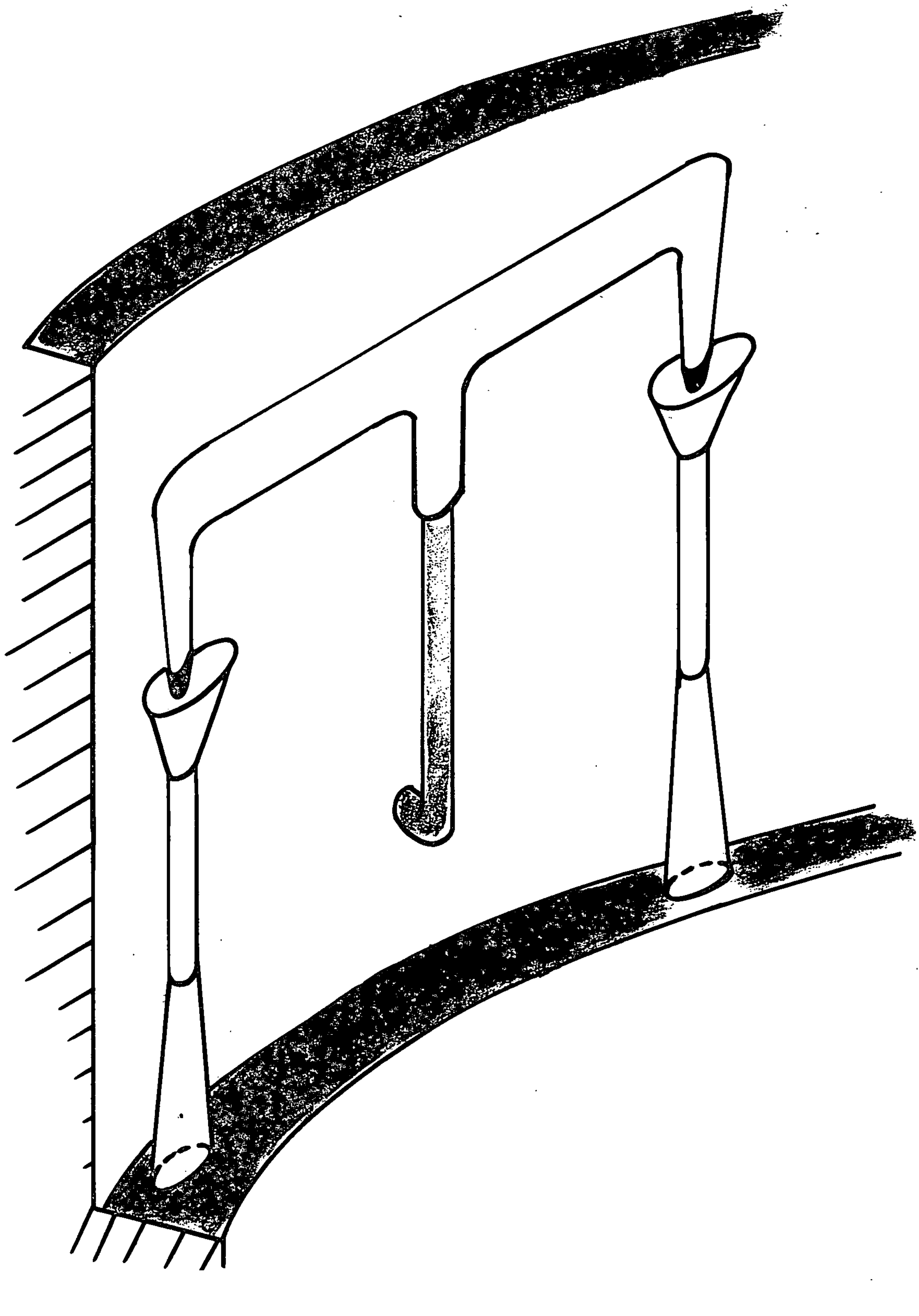
- ROD WORTH MINIMIZER
- CONTROL ROD DROP VELOCITY LIMITER
- CONTROL ROD DRIVE THIMBLE SUPPORT

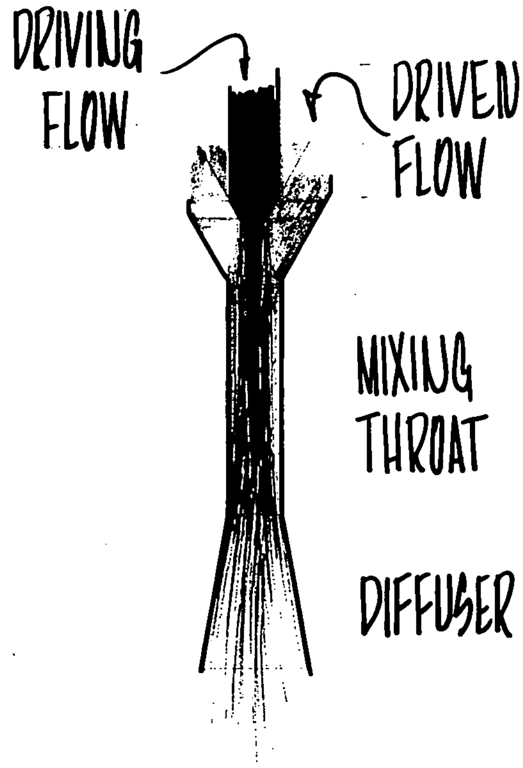
PROVISIONS FOR HANDLING METAL-WATER REACTION

RECIRCULATION SYSTEM



ANNULUS ARRANGEMENT

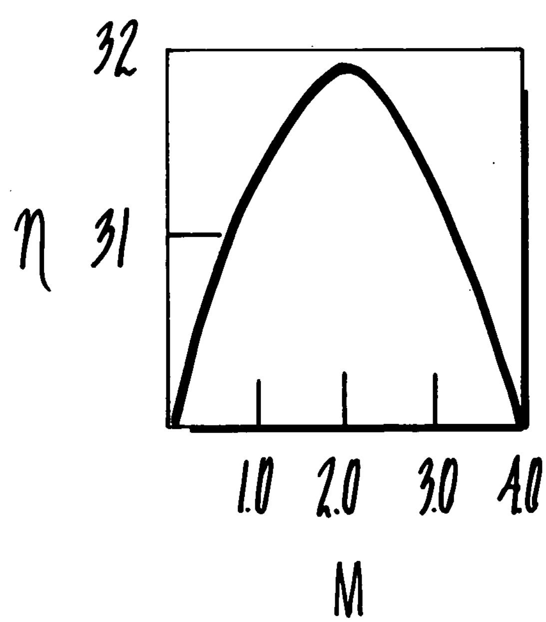


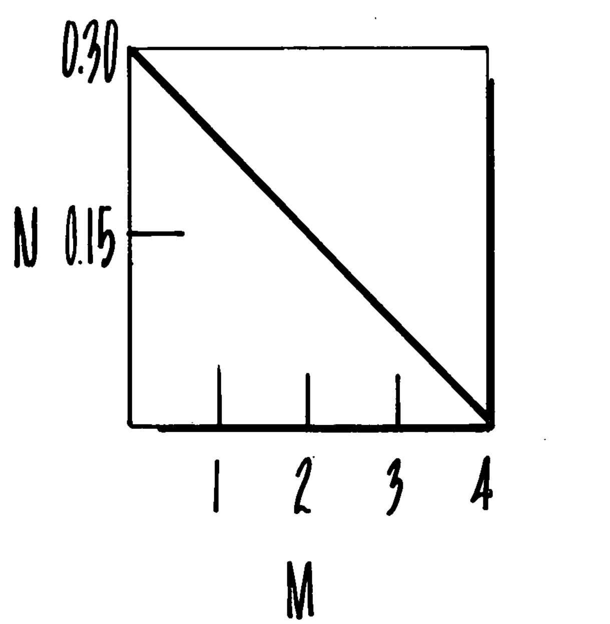


$$\text{FLOW RATIO} = \frac{\text{DRIVEN FLOW}}{\text{DRIVING FLOW}} = M$$

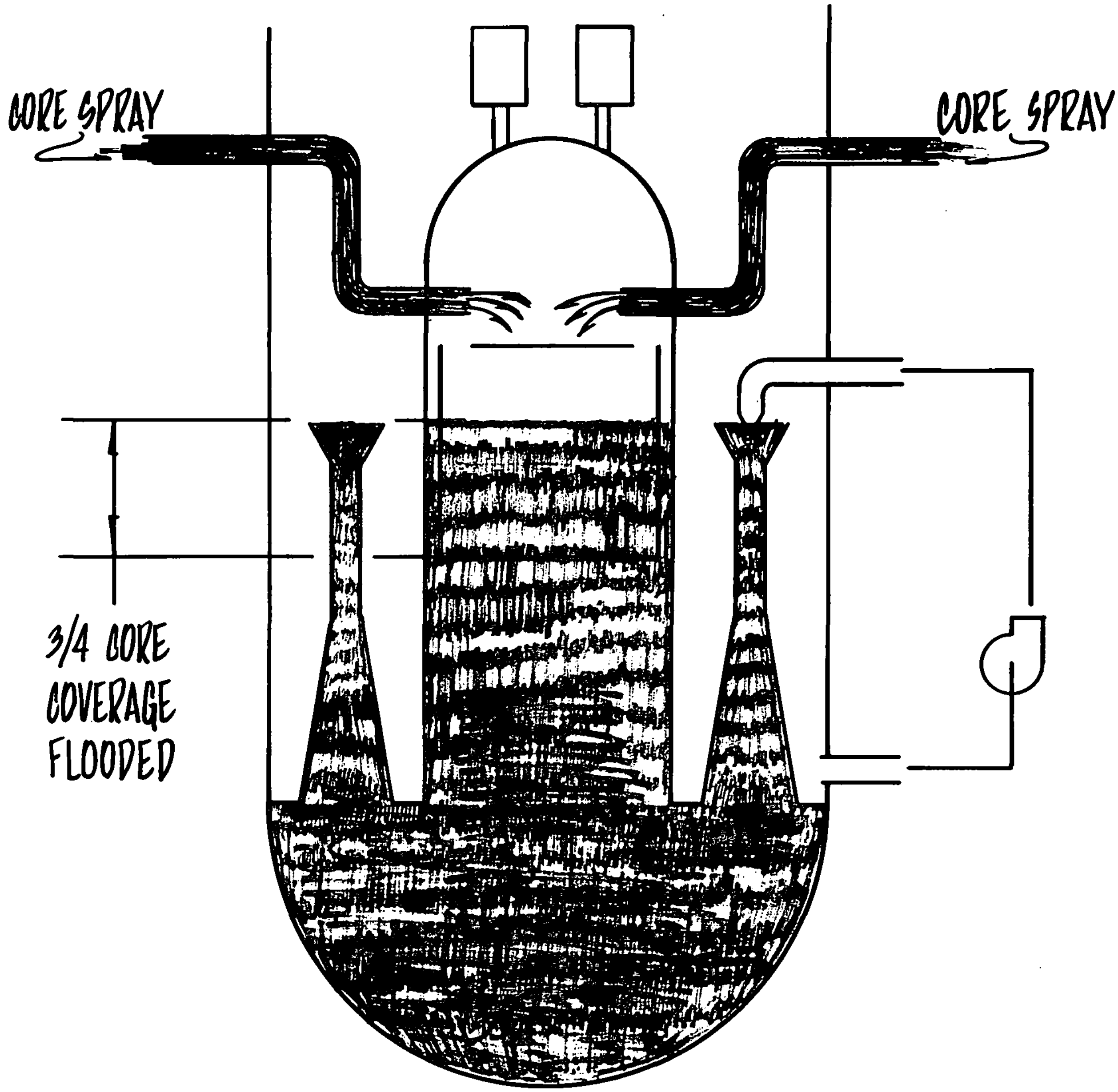
$$\text{HEAD RATIO} = \frac{\Delta P \text{ OUTPUT}}{\Delta P \text{ INPUT}} = N$$

$$\text{EFFICIENCY} = M \times N = \eta$$





REFILL CAPABILITES AFTER LOSS OF COOLANT

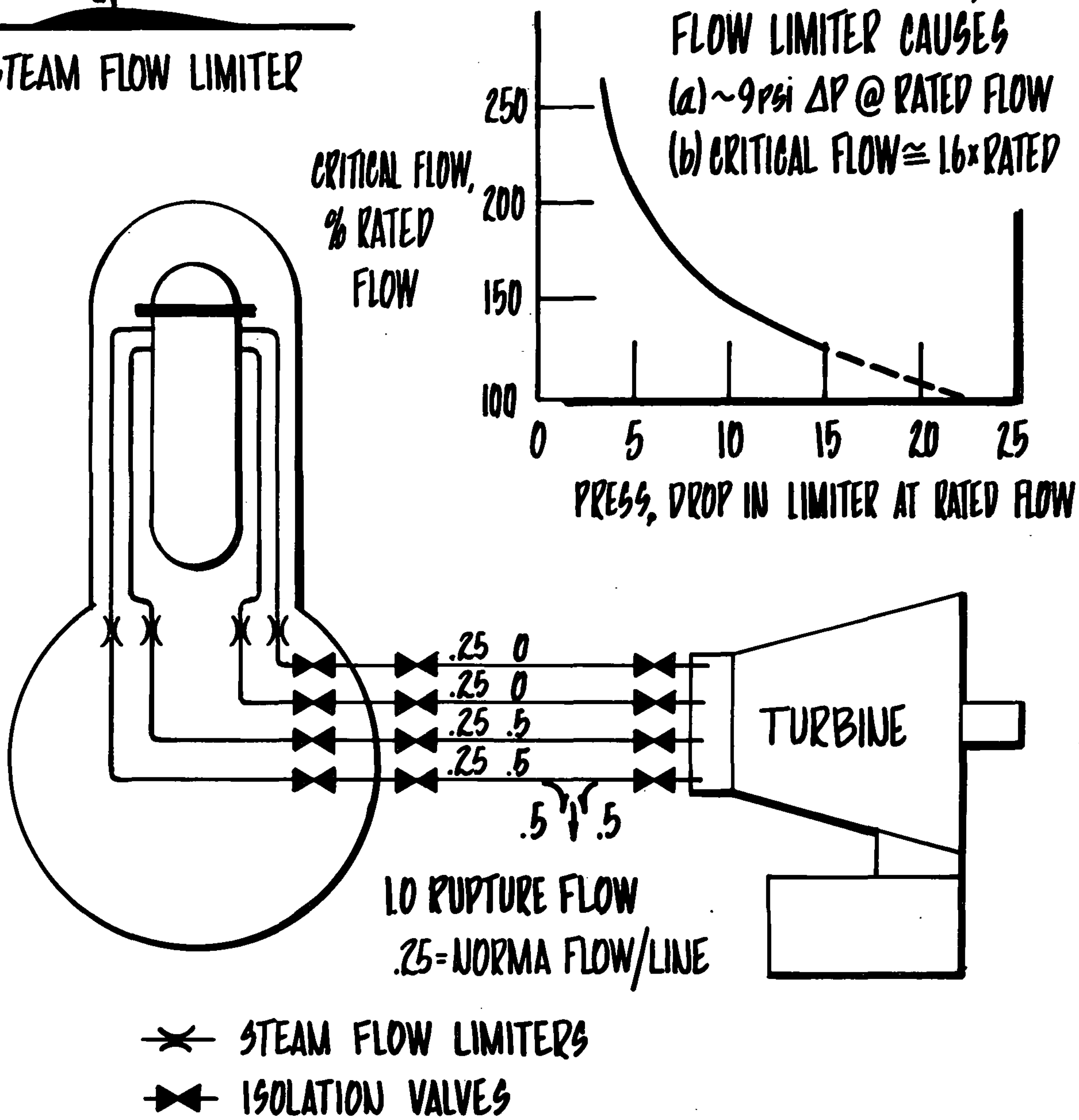


DRESDEN II STEAM LINE SCHEMATIC & STEAM FLOW LIMITER

STEAM FLOW LIMITER

EXAMPLE

FOR β RATIO d/D = 0.5,
FLOW LIMITER CAUSES
(a) ~9 psi ΔP @ RATED FLOW
(b) CRITICAL FLOW ≅ 1.6 × RATED



CONTROL SYSTEM

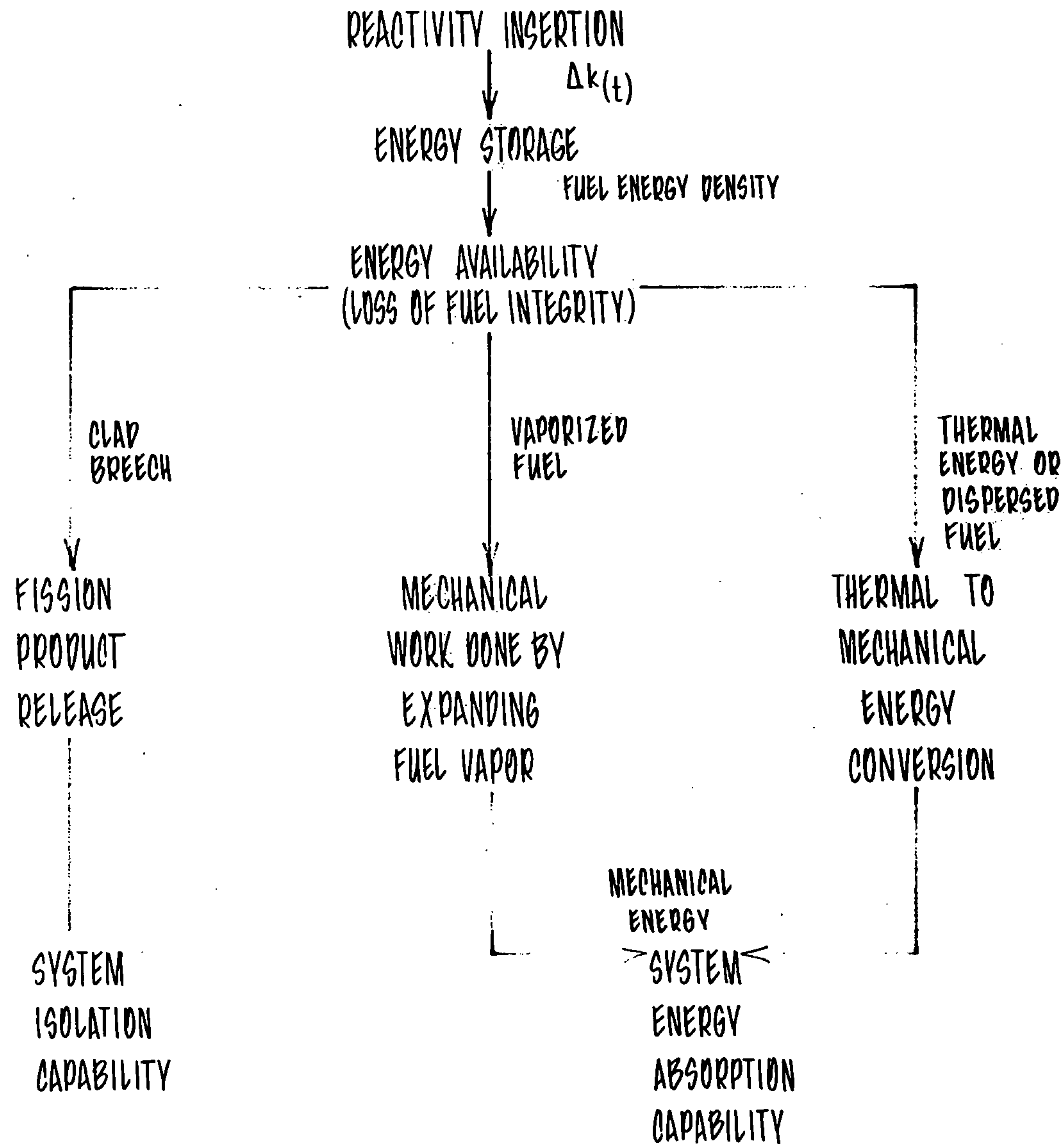
PERFORMANCE OBJECTIVE

BY PROCEDURAL CONTROL, ENGINEERED SAFEGUARDS AND INHERENT SAFETY FEATURES, PRECLUDE THE POSSIBILITY OF DAMAGE BY MOTION OR RUPTURE TO THE REACTOR PRIMARY COOLANT SYSTEM

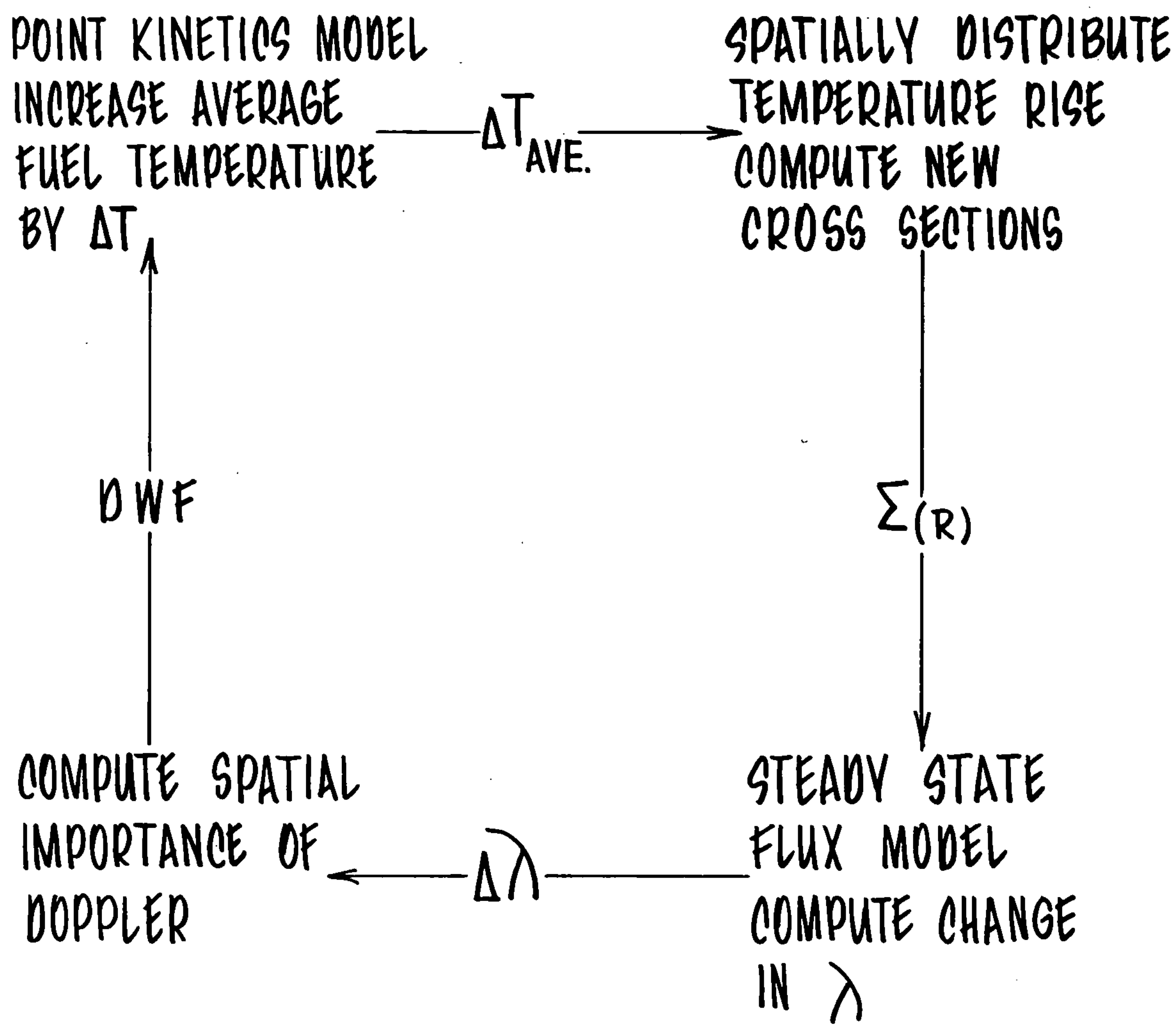
BASIS

COMPOUNDING OF OPERATOR ERRORS, INDEPENDENT EQUIPMENT MALFUNCTIONS OR A COMBINATION OF THESE WILL NOT CAUSE REACTOR PRIMARY COOLANT SYSTEM DAMAGE

PHENOMENOLOGICAL DESCRIPTION



NUCLEAR KINETICS MODEL

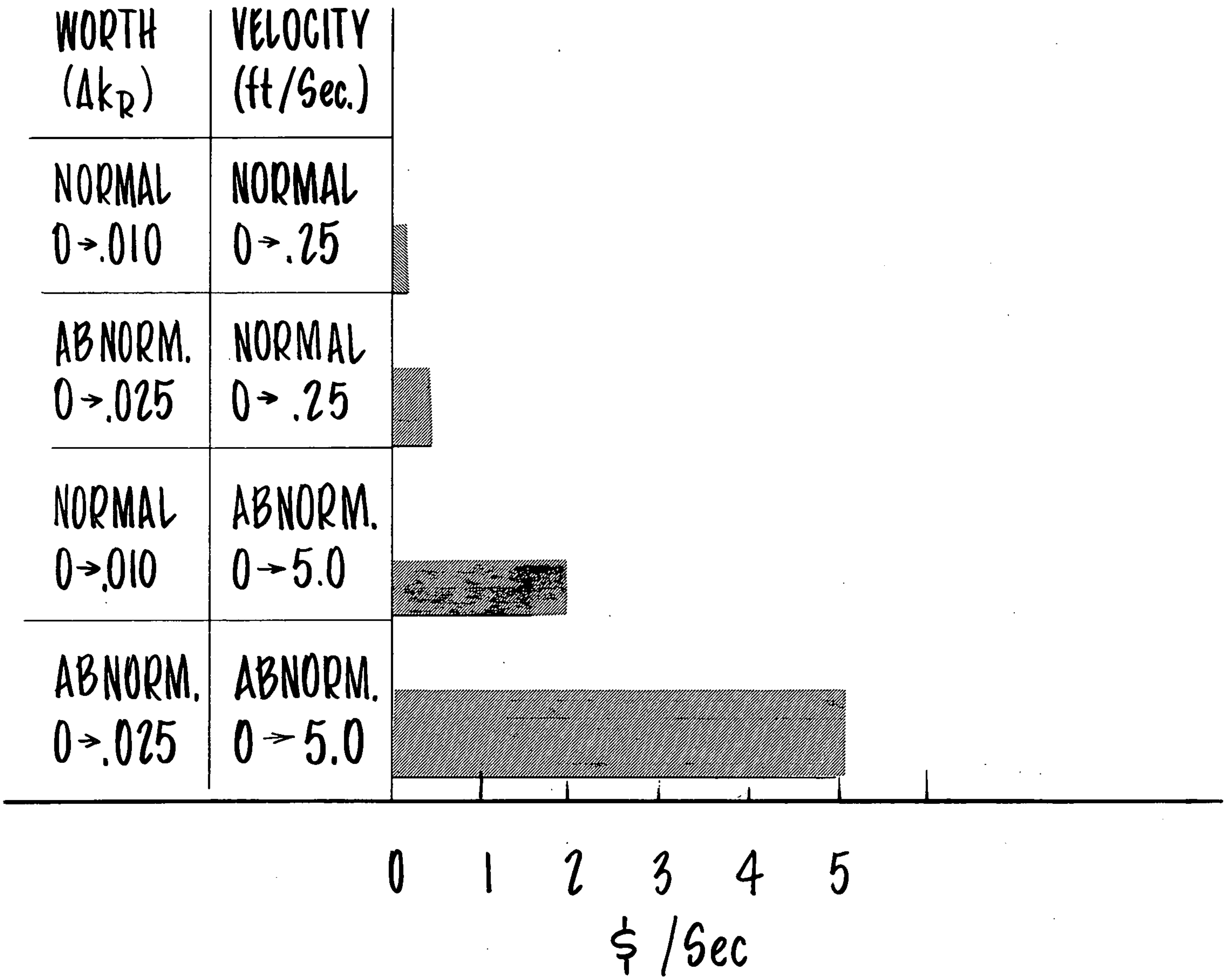


CHARACTERISTICS OF NUCLEAR EXCURSION

OXIDE CORES

RANGE	REACTIVITY INSERTION RATE	MINIMUM PERIOD	PEAK ENERGY DENSITY	PRINCIPAL SHUTDOWN MECHANISMS
	$/SEC	MS	CAL/GM	
LOW	< 2.5	> 4	< 120	DOPPLER EFFECT NEG. MODERATOR COEFFICIENT
MEDIUM	2 - 25	5 - 2	100 - 425	DOPPLER EFFECT
HIGH	> 20	< 1.5	> 380	DOPPLER EFFECT CORE DISASSEMBLY

REACTIVITY INSERTION RATES

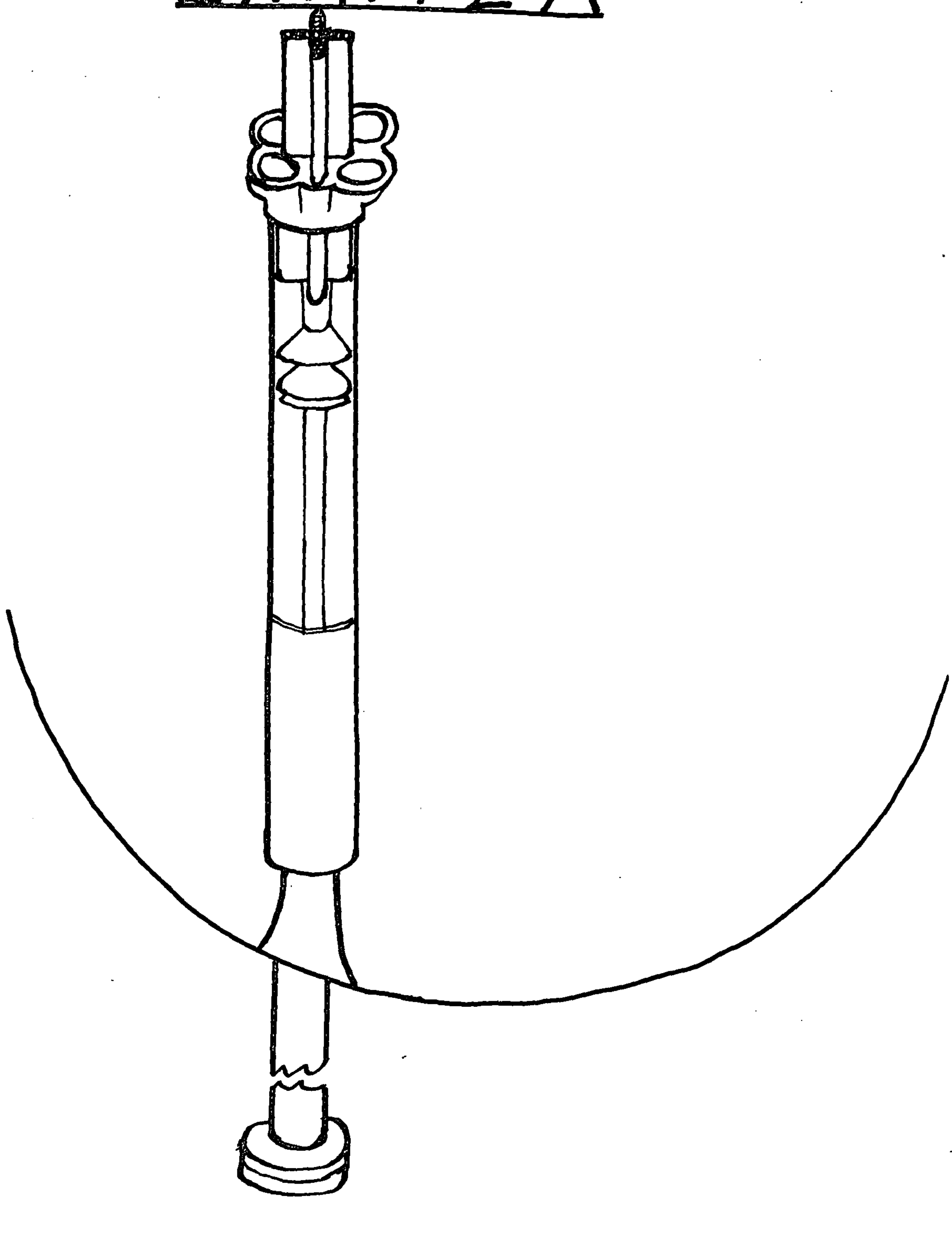


CONTROL SYSTEM SAFEGUARDS DEVICES

1. ROD WORTH MINIMIZER
2. VELOCITY LIMITER
3. DRIVE THIMBLE SUPPORTS

15

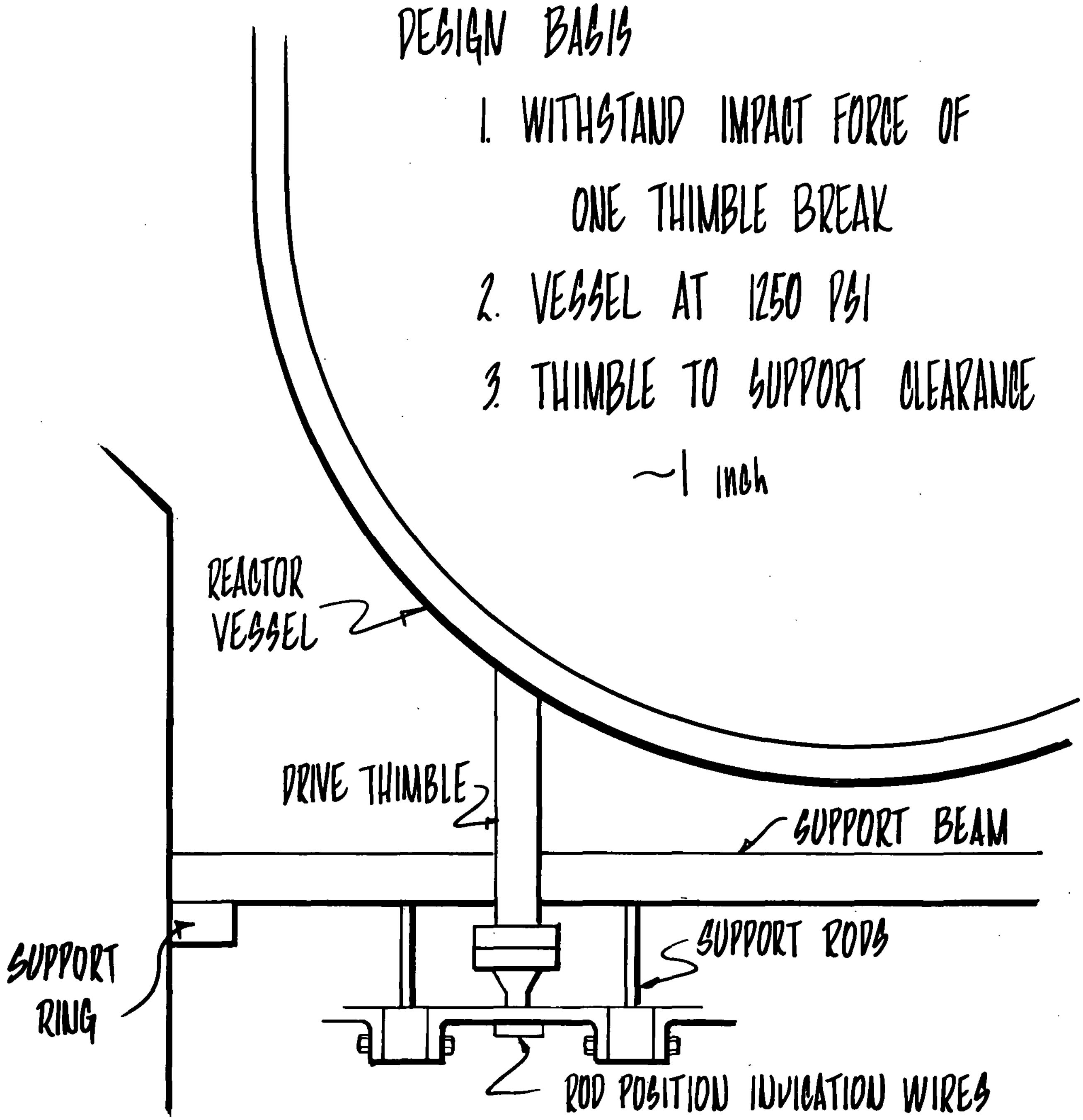
ROD VELOCITY LIMITER



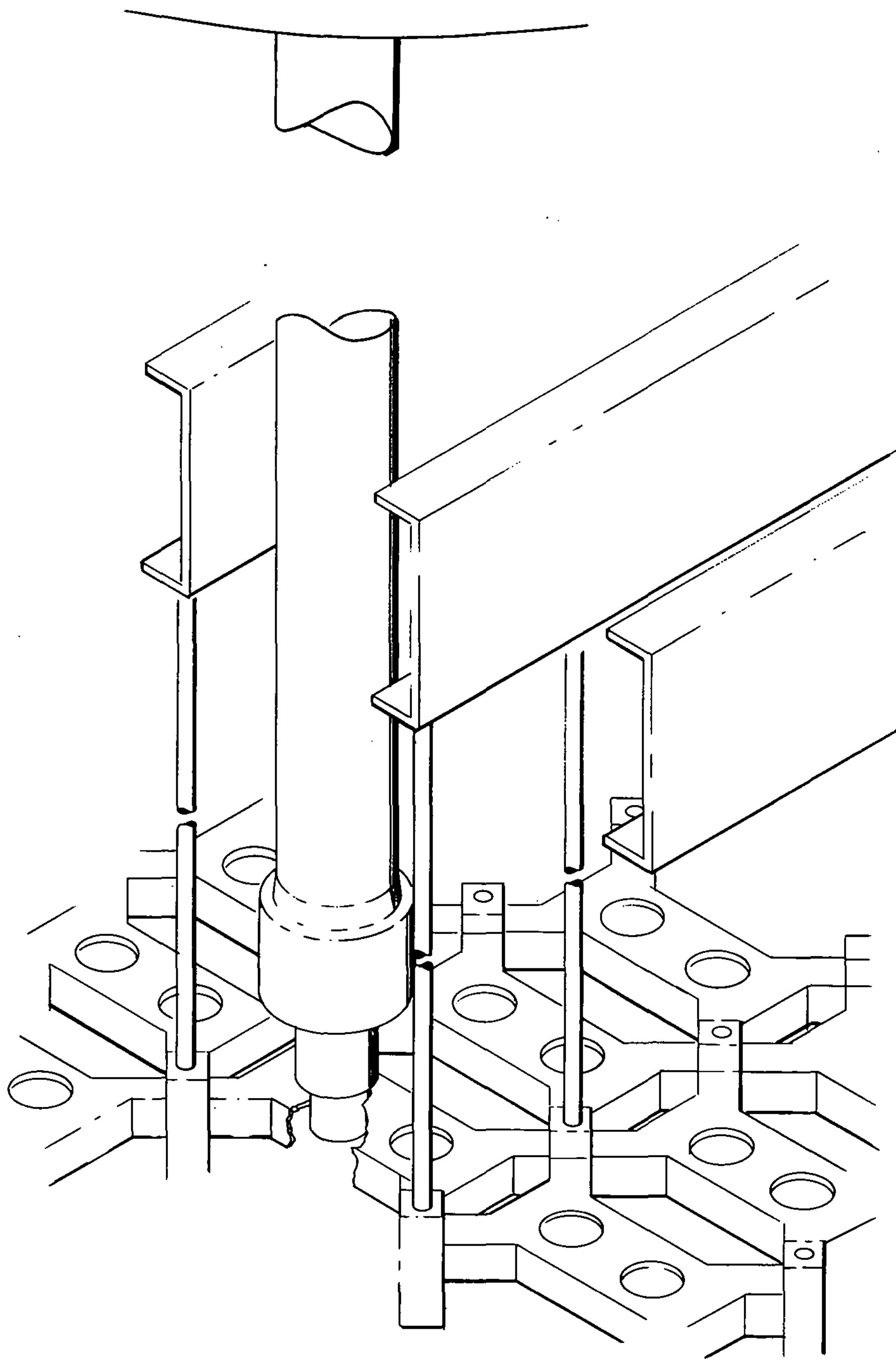
CONTROL ROD DRIVE THIMBLE SUPPORT

DESIGN BASIS

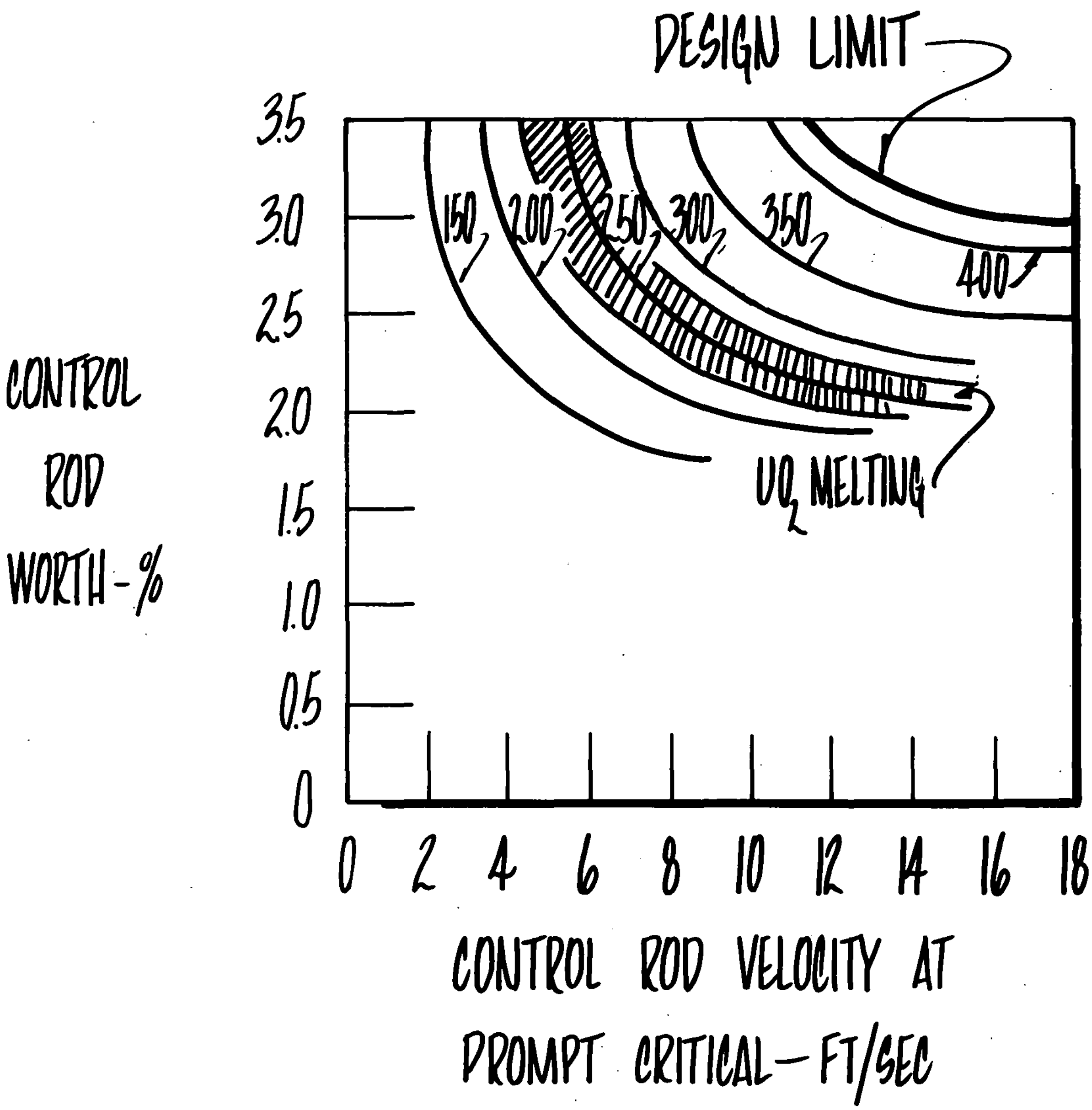
1. WITHSTAND IMPACT FORCE OF ONE THIMBLE BREAK
2. VESSEL AT 1250 PSI
3. THIMBLE TO SUPPORT CLEARANCE ~1 inch



CONTROL ROD DRIVE THIMBLE SUPPORT



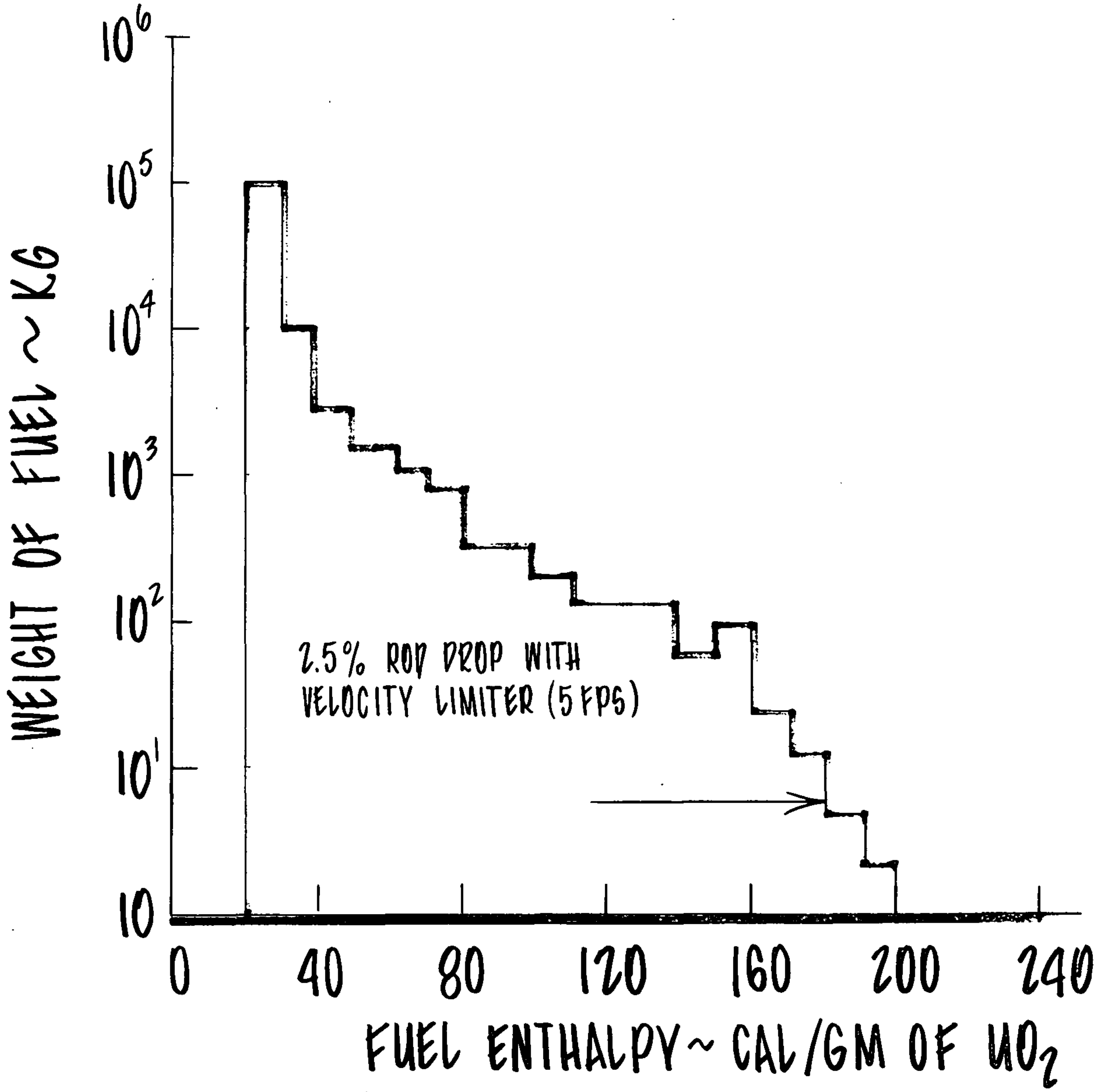
RELATIONSHIP BETWEEN ROD WORTH AND WITHDRAWAL VELOCITY AT CONSTANT PEAK FUEL ENTHALPY



SUMMARY OF 0.025 ΔK ROD DROP

1. PEAK POWER (MW)	1×10^5
2. E_T (MW-SEC)	4000
3. PEAK ENTHALPY (CAL/gm)	200
4. E_T > 425 (CAL/gm) MW-SEC.	0
5. # UO_2 > 425 (CAL/gm)	0
6. E_T > 220 (CAL/gm) MW-SEC.	0
7. # UO_2 > 220 (CAL/gm)	0
8. # UO_2 > 170 (CAL/gm)	50
9. # OF RODS, UO_2 > 170	330
10. E_T FROM $Zr-H_2O$ REACTION (MW-SEC)	30

FUEL ENERGY DISTRIBUTION



SAFEGUARDS FEATURES

OPERATIONAL OR ACCIDENT PREVENTION

CORE

- LOW ENRICHMENT UO_2 FUEL
- HIGH INTEGRITY FUEL CLADDING
- MODEST THERMAL CONDITIONS
- NEGATIVE REACTIVITY COEFFICIENTS FOR MODERATOR, FUEL, VOID
- MODULAR FUEL & CONTROL ROD ARRANGEMENTS

MECHANICAL

- RIGID STANDARDS FOR DESIGN

  VESSEL AND PIPING CODES

  QUALITY CONTROL

- AUXILIARY POWER AVAILABILITY
- ISOLATION CONDENSER
- CONSERVATIVE STRUCTURAL DESIGN
- CONSERVATIVE DESIGN OF SHIELDING & WASTE DISPOSAL SYSTEMS

CONTROL

- HYDRAULIC CONTROL DRIVES
- VARIABLE FLOW CONTROL
- IN-CORE NEUTRON MONITORING
- ROD WORTH MINIMIZER
- AUTOMATIC INTERLOCKS
- INTEGRATED PLANT CONTROL
- SHUTDOWN OVERRIDE
    - AUTOMATIC
    - OPERATOR

SAFEGUARDS FEATURES

ACCIDENT MITIGATION AND CONTAINMENT

PRIMARY CONTAINMENT

- 2 CORE SPRAY SYSTEMS
- REFLOODING CAPABILITY
- 2 CONTAINMENT COOLING SYSTEMS
- PRIMARY CONTAINMENT DESIGN
    - 62 PSIG
    - PRESSURE SUPPRESSION
    - LOW DESIGN LEAKAGE RATE
    - TESTABLE PENETRATIONS
    - ISOLATION VALVES
- PROVISIONS FOR INERTING
- ACCOMODATE FULL CORE MELT

REACTOR BUILDING

- SECONDARY CONTAINMENT BARRIER
- LOW INLEAKAGE RATE
- TREATMENT OF EXHAUST
- ELEVATED RELEASE OF TREATED EXHAUSTS

ELECTRICAL POWER BACKUP

OTHER MECHANICAL FEATURES

- ROD VELOCITY LIMITER

- CONTROL ROD THIMBLE SUPPORT

- FLOW RESTRICTORS IN STEAM LINES

TESTABILITY

SUMMARY OF ACCIDENT CONSEQUENCES

ACCIDENT	MAXIMUM TOTAL OFF-SITE EXPOSURE - RADS	
	WHOLE BODY	THYROID
STEAM LINE RUPTURE	3×10^{-7}	4×10^{-4}
ROD DROP	1.6×10^{-6}	4.8×10^{-3}
FUEL LOADING	1.9×10^{-2}	7.0×10^{-2}
LOSS OF COOLANT		
1% CORE MELT	3.1×10^{-3}	1.1×10^{-2}
100% CORE MELT	1.2×10^{-1}	3.8×10^{-1}

REASONS FOR ALL IN-CORE INSTRUMENTATION

- CORE SIZE INCREASES
- INCREASED WATER ANNULUS
- IMPROVED INSTRUMENT PERFORMANCE CAPABILITY

SOURCE RANGE MONITORING SYSTEM

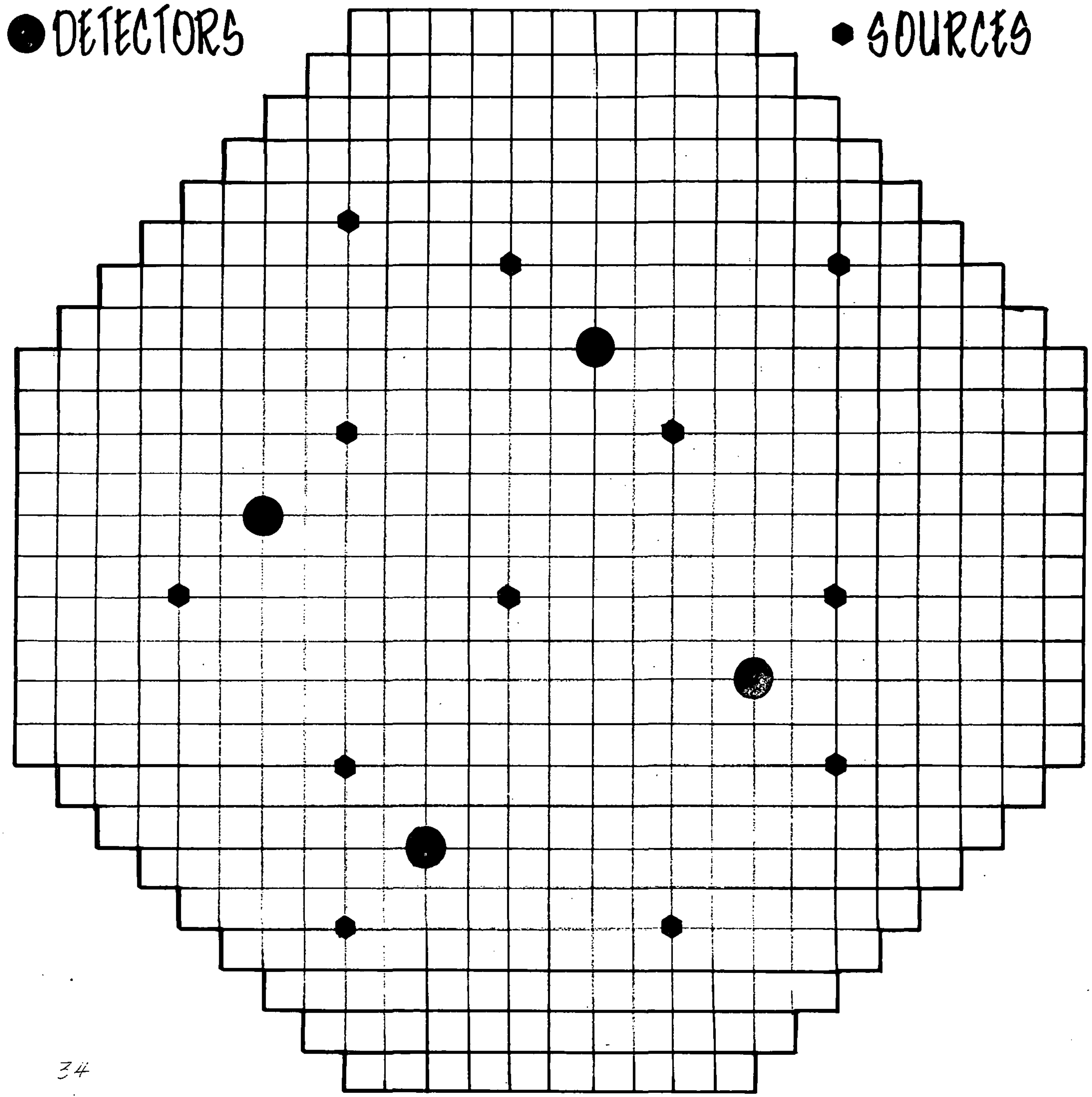
DESIGN OBJECTIVES

1. PROVIDE > 3 COUNTS/SEC.
   (ALL RODS IN, START)

2. MONITOR APPROACH TO CRITICAL

3. OVERLAP IRM

SOURCE RANGE MONITORING SYSTEMS
TYPICAL ARRANGEMENT



INTERMEDIATE RANGE SAFETY SYSTEM

DESIGN OBJECTIVES

1. LOW LEVEL SCRAM PROTECTION

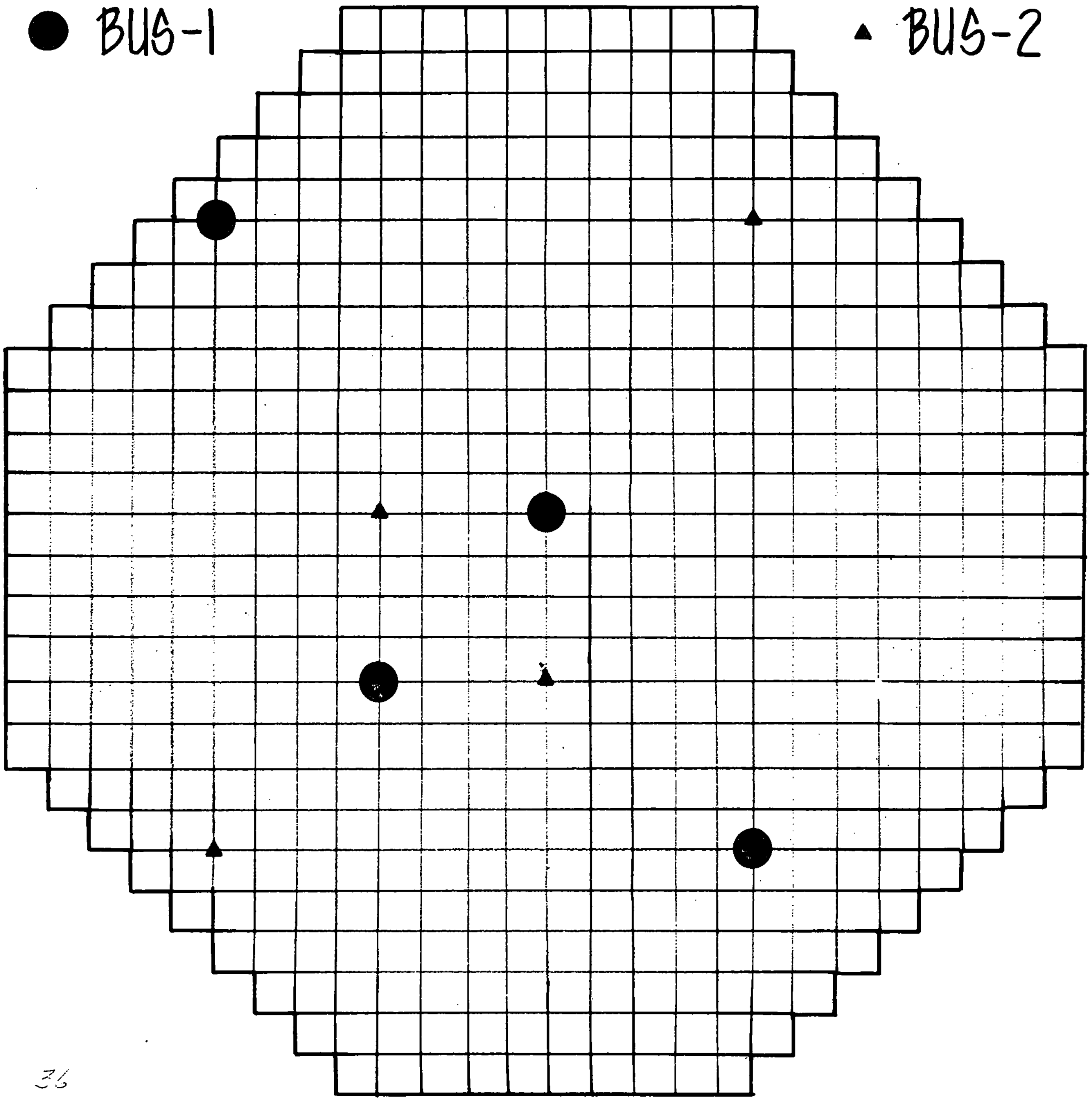
2. OPERATOR INFORMATION

   A. LEVEL

   B. OVERLAP

INTERMEDIATE RANGE SAFETY SYSTEM
TYPICAL DETECTOR ARRANGEMENT

● BUS-1 ▲ BUS-2

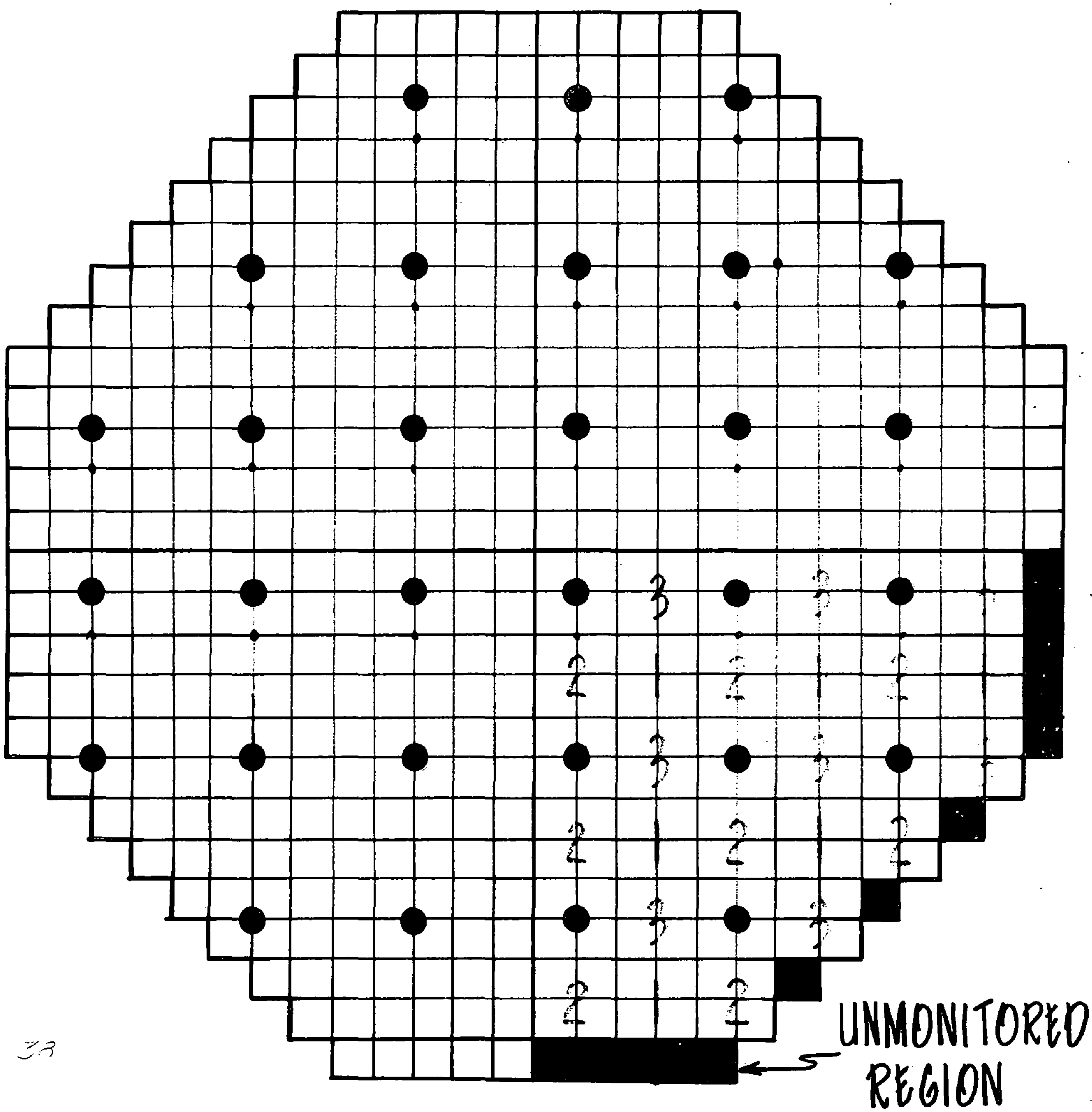


POWER DISTRIBUTION MONITORING SYSTEM

DESIGN OBJECTIVES

1. MONITOR LOCAL HEAT FLUX
2. EVALUATE CORE CRITICAL PARAMETERS
3. DEMONSTRATE COMPLIANCE WITH LIMITS
4. ALARM ON EXCESSIVE LOCAL HEAT FLUX

POWER DISTRIBUTION MONITORING SYSTEM



38

POWER RANGE SAFETY SYSTEM

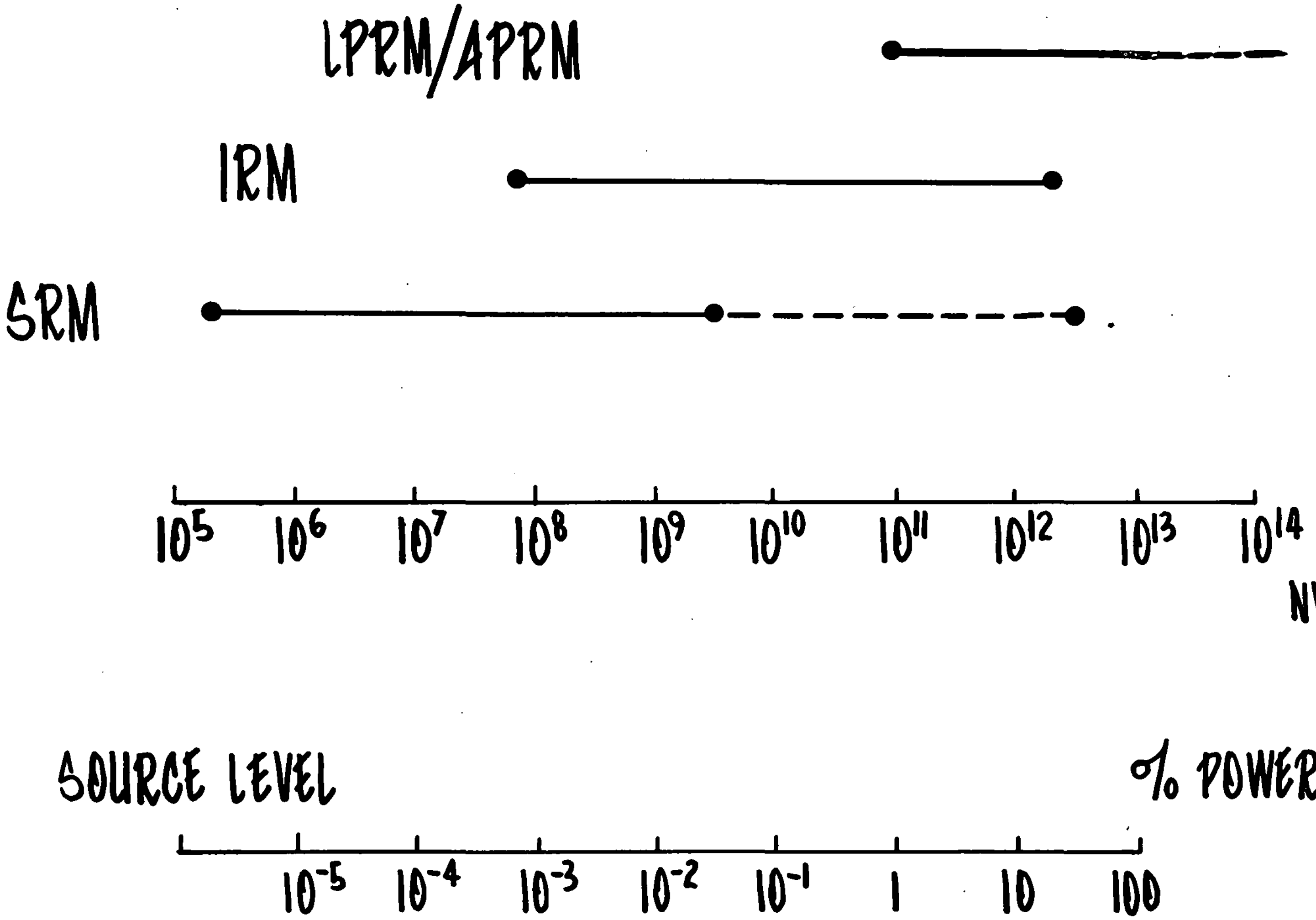
DESIGN

1. PREVENT CORE DAMAGE FROM SINGLE OPERATOR ERRORS OR EQUIP. MALFUNCTION
2. PREVENT CORE DAMAGE FROM BULK TRANSIENTS

DEFINITION OF DAMAGE USED FOR SYSTEM DESIGN

1. HEAT FLUX
2. MCHFR < 1.0

THERMAL NEUTRON FLUX
RANGES OF OVERLAP



STARTUP RANGE

1. MODE SWITCH – "STARTUP"
2. SRM & IRM CHAMBERS INSERTED
3. IRM LOWEST SCALE
4. ALL INSTRUMENTS OPERATIVE
5. APRM DNSC BYPASS

INTERMEDIATE RANGE

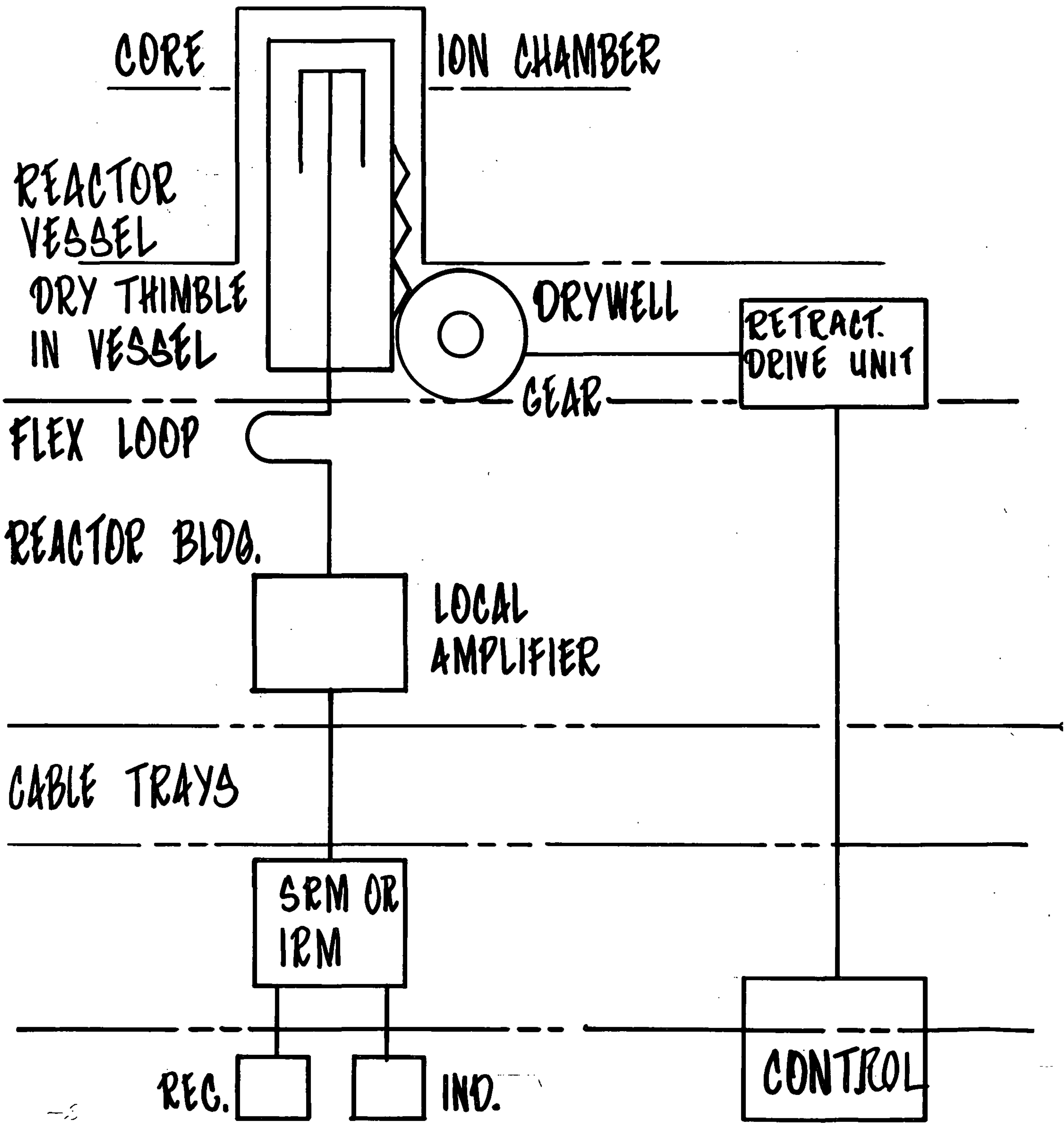
1. IRM UPSCALE
2. SRM – 10^3 TO 10^5 – CHAMBER RETRACT

POWER RANGE – CHANGE TO "RUN"

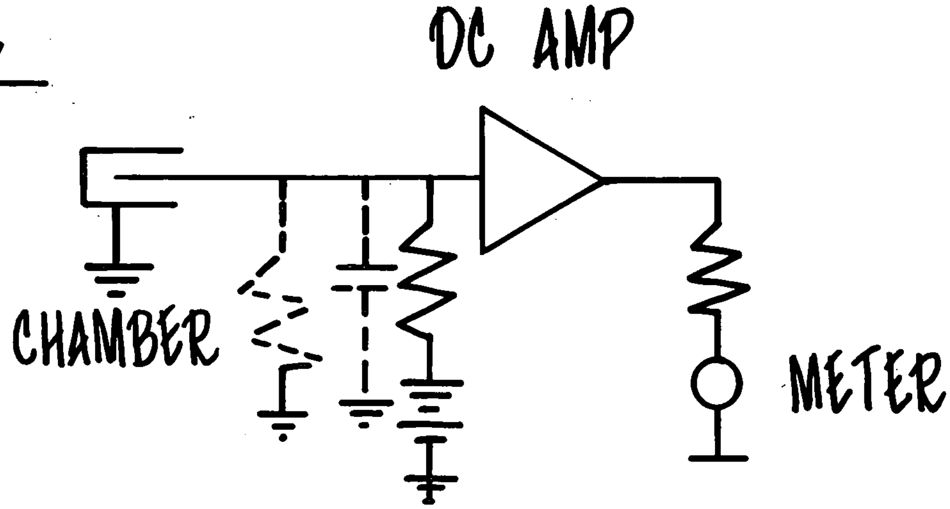
1. APRM UPSCALE
2. IRM CHAMBER RETRACT
3. IRM SCRAM BYPASSED – APRM UPSCALE

TYPICAL SRM & IRM CHANNELS

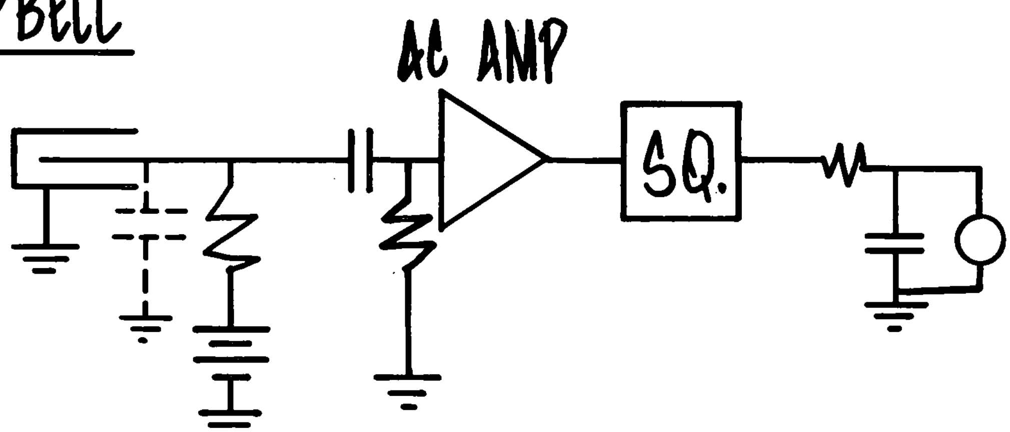
SOURCE OR INTERMEDIATE RANGE

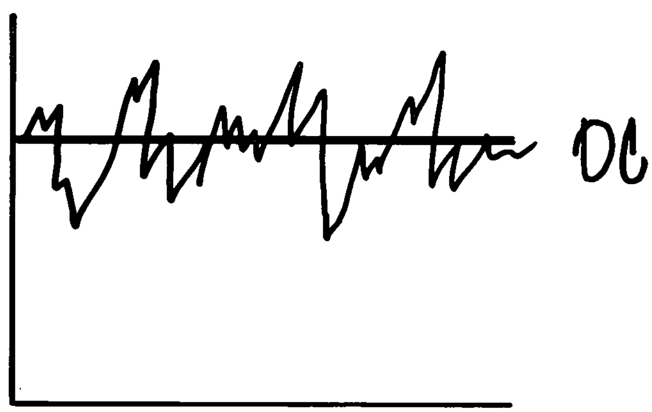


DC



CAMPBELL

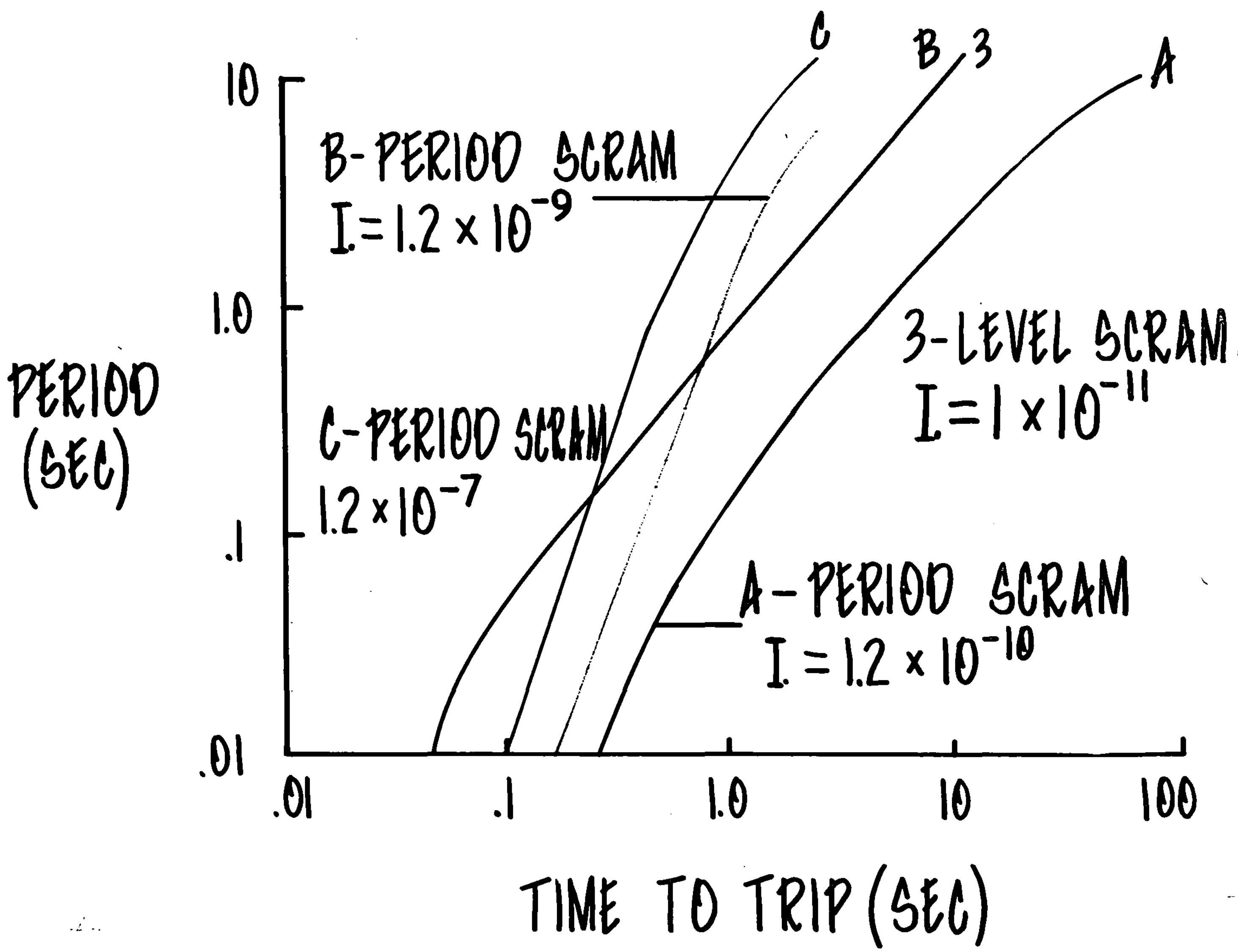




CHAMBER OUTPUT

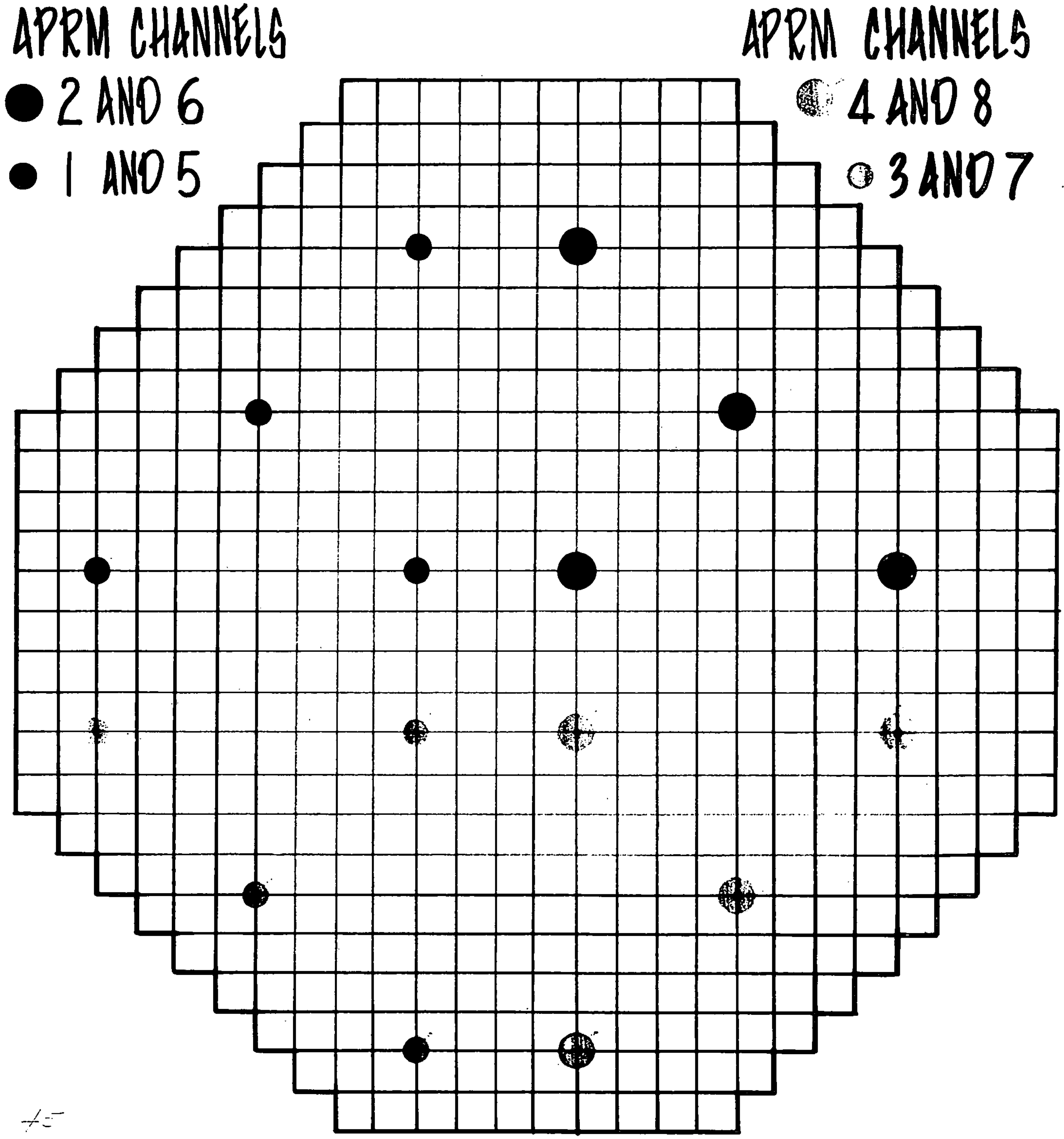
INTERMEDIATE RANGE SAFETY SYSTEM

MEASURED RESPONSE TIMES OF SAFETY INSTRUMENTATION

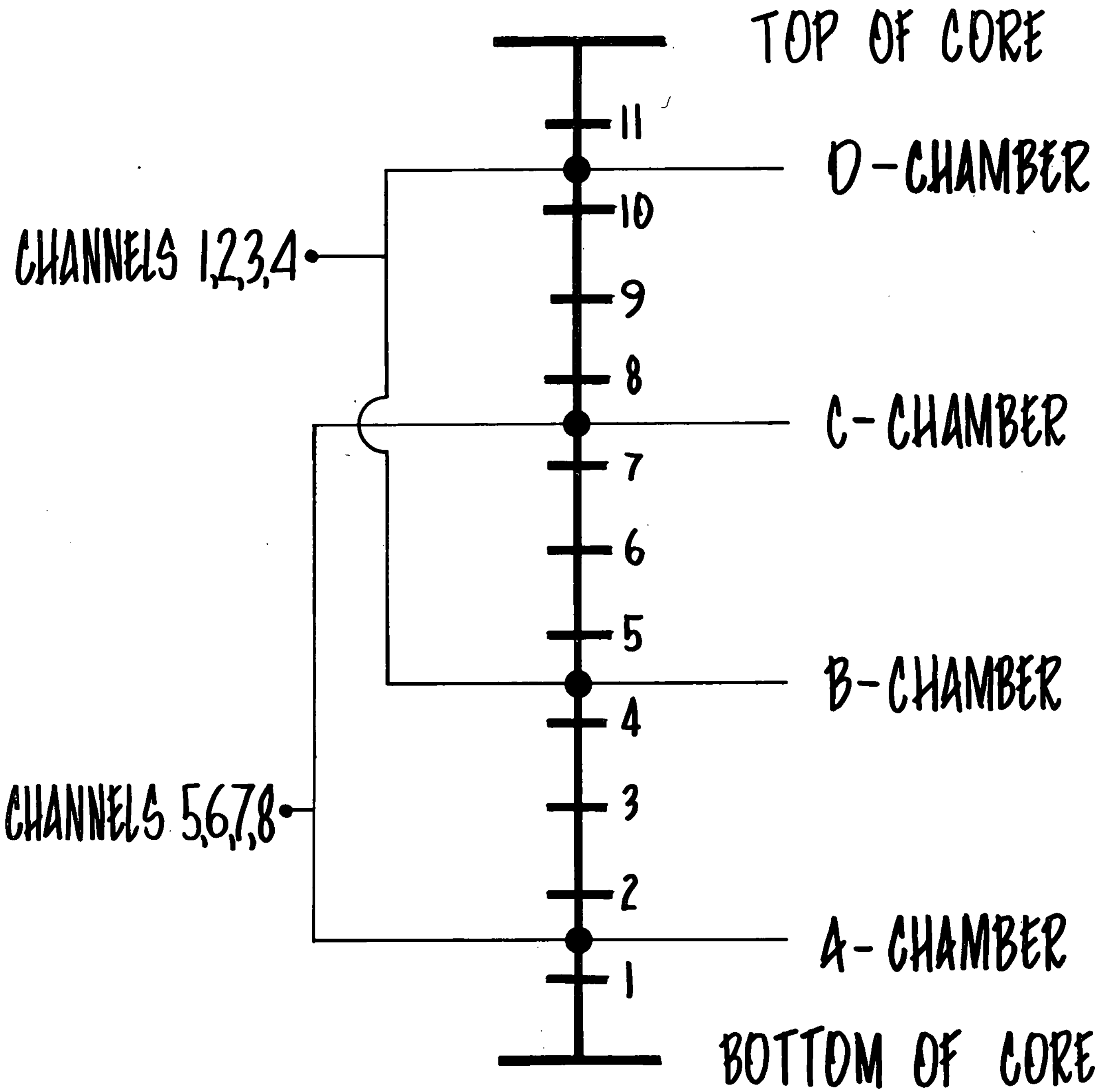


POWER RANGE SAFETY SYSTEM

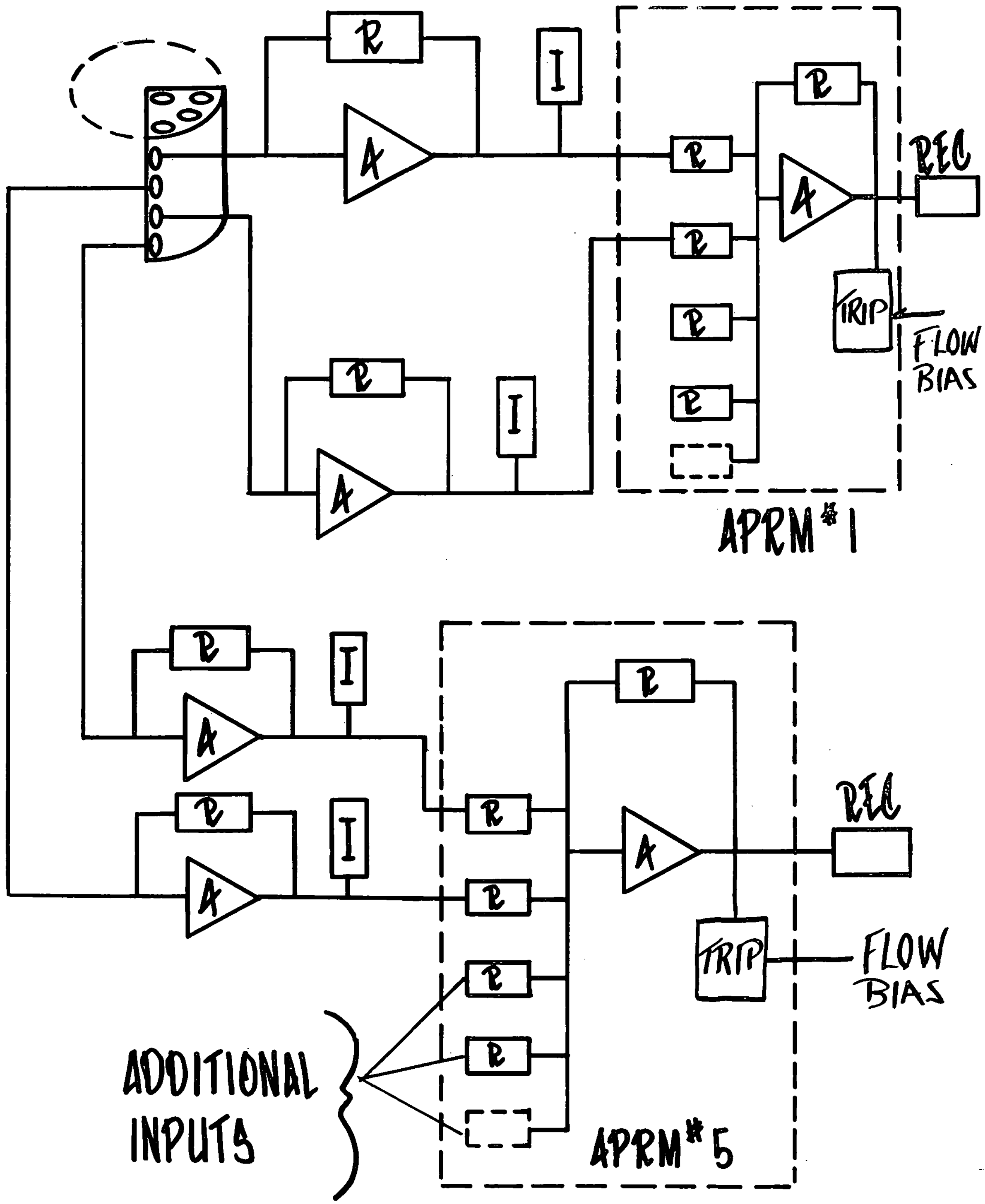
(CALIBRATION % OF RATED POWER)



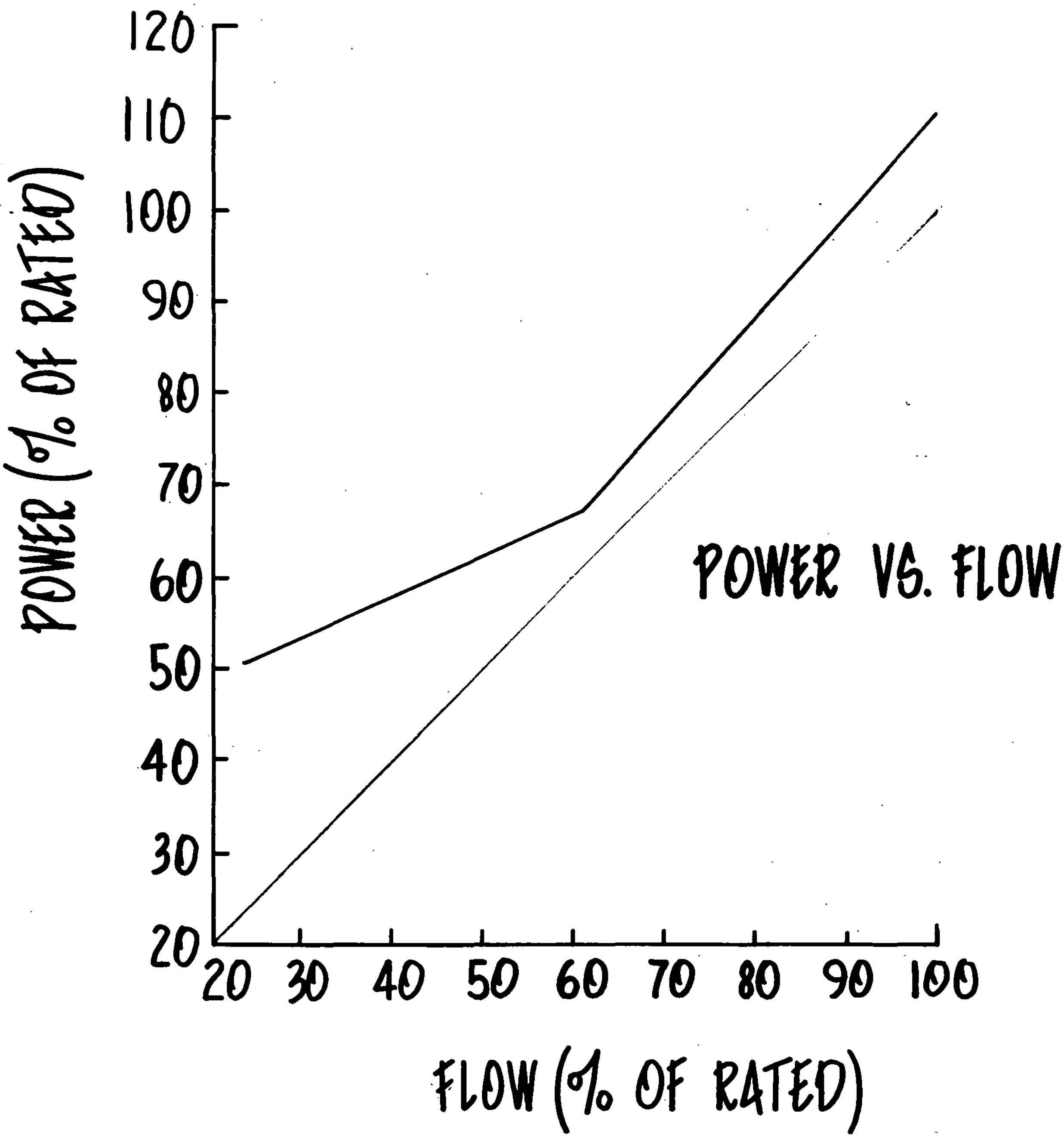
POWER RANGE SAFETY SYSTEM



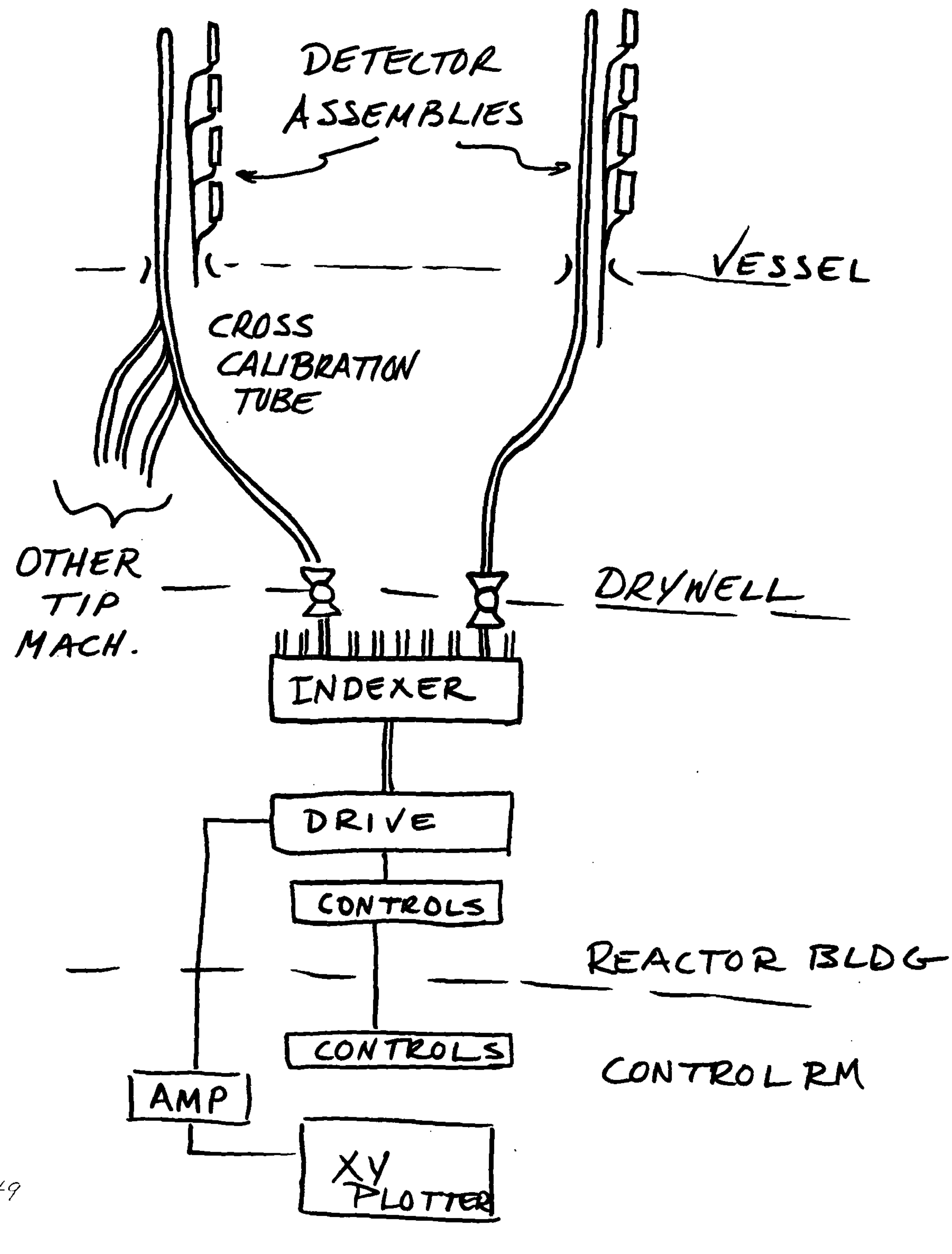
TYPICAL APRM CHANNELS



ILLUSTRATIVE APRM SET POINTS



LPRM CALIBRATION SYST 'TIP'



49