APR 2 1974

DOCKET NOS.: 50-438, 439, 452, 453 AND 460

APPLICANTS : TENNESSEE VALLEY AUTHORITY, DETROIT EDISON COMPANY AND WASHINGTON PUBLIC POWER SUPPLY SYSTEM

FACILITIES : BELLEFONTE NUCLEAR PLANT, UNITS 1 AND 2; GREENWOOD ENERGY CENTER, UNITS 2 & 3; WASHINGTON NUCLEAR PROJECT-1

SUMMARY OF GENERIC MEETING WITH BABCOCK & WILCOX (B&W) ON CONTAINMENT PEAK PRESSURE ANALYSIS

A generic meeting was held March 14, 1974 to discuss the methods B&W used to predict the mass and energy release to the containment as the result of a loss-of-coolant accident for all 205 fuel assembly plants. The affected applicants for these plants were invited to attend this meeting. A list of attendees is enclosed; the Detroit Edison Company was represented by Bechtel.

B&W presented information addressing concerns that the staff had raised regarding the conservatism of the CRAFT code to predict mass and energy to the containment following the initial blowdown. The slides given in these presentations are attached.

Significant points discussed are summarized below:

1. Comparison of CRAFT and REFLOOD

The REFLOOD code is used in B&W's ECCS analysis to compute the inlet flow rate to the core during the reflooding period. This code appears to be similar to the staff's FLOOD code that is used to predict mass and energy release to the containment during the reflooding period. B&W presented comparisons showing that CRAFT code predicted a greater mass and energy release than the REFLOOD code. The staff noted that the input assumptions used in the REFLOOD code were more typical of those for ECCS analysis and may not be conservative for containment analysis.

2. Quenching of Steam by the ECCS Water

The staff had stated that the assumption of complete steam-water mixing used by B&W reduced the steam flow into the containment and did not appear to be conservative. This assumption reduces the peak containment pressure by about 2 psi and reduces the containment decompression time. B&W presented data from the Combustion Engineering steam-water mixing

LB

Memo

tests which indicate complete mixing exists if the liquid flow rate is sufficiently high. These tests were for cold leg ECCS injection whereas B&W's ECCS (CFT and LPI) injects into the downcomer. B&W also presented mixing results for steam and feedwater in the B&W once-through steam generator. However, no data were available for the geometry of the B&W downcomer.

3. Carryout Rate Fraction (CRAFT vs. FLECHT Data)

The CRAFT code was stated to calculate a carryout rate fraction of steam and water leaving the core of about 90% compared to about 80% from an average core channel of the FLECHT data. The CRAFT analysis appears to be conservative in this calculation.

4. Effect of Nucleate Boiling Heat Transfer in CRAFT

The staff had stated that for heated surfaces exposed to the primary coolant such as the core piping and steam generator tubes, the assumption of nucleate boiling heat transfer would be more realistic and would maximize heat flow to the containment. B&W stated that they already considered nucleate boiling in the core and primary metal surfaces. They presented analysis showing that the heat transfer coefficient in the steam generator tubes was sufficiently high so that a further increase would not increase containment pressure.

5. Conclusions

It appears that either the CRAFT code or the REFLOOD code with proper input can provide conservative mass and energy release data to the containment. The staff stated that the assumption of complete steam-water mixing in the CRAFT code had yet not been fully justified and that the REFLOOD code should be used with assumptions conservative for containment analysis instead of ECCS analysis. For plants that have been analyzed during the reflood period using the CRAFT code the staff will review the results on a case-by-case basis and make comparisons with the results of our FLOOD code.

Original Signed by

Don K. Davis, Project Manager
Light Water Reactors Branch 2-3
Directorate of Licensing

Original Signed by

Walt Jensen, Project Manager
Containment Systems Branch
Directorate of Licensing

Enclosure:
1. List of Attendees
2. Slides Shown at Presentation

OFFICE ▶	x7886 LWR 2-3	L:CSB				
SURNAME ▶	DKDavis:cjb	WJensen				
DATE ▶	3/29/74	3/30/74				

MEETING HELD MARCH 14, 1974
TVA, DEC AND WPPSS
BELLEFONTE 1 & 2, GREENWOOD 2 & 3, WNP-1

LIST OF ATTENDEES

Atomic Energy Commission

D. Davis
*A. Schwencer
*G. Lainas
T. Cox
J. Shapaker
W. Jensen
T. Greene
C. Anderson

Babcock & Wilcox

J. McFarland
C. Parks
G. Brazill
R. Bybee
I. Putney
K. Shieh
B. Dunn
M. Oren
J. Mecca

Washington Public Power Supply System

J. Kemp

Tennessee Valley Authority

J. Carter, III
G. Curtis

Bechtel

R. Boles, Jr.
J. Thiesing

United Engineers & Constructors

J. Daniel
K. Niyogi
W. Stromguist

Portland General Electric

D. Herborn

*Denotes Part-Time Attendance

Meeting Summary - Tennessee Valley Authority, Detroit Edison Company and Washington Public Power Supply System

DISTRIBUTION:
AEC PDR
LPDR
Dockets (5)
L Reading
LWR 2-3 Reading
VAMoore
RDenise
DSkovholt
RCDeYoung
DRMuller
RIreland
RAClark
KKniel
JStolz
ASchwencer
KGoller
DVassallo
WButler
PCollins
RSchemel
DZiemann
GKnighton
GDicker
BYoungblood
WRegan
SVarga
DEisenhut
JHendrie
HDenton
RTedesco
RMaccary
VStello
BGrimes
WGammill
JKasnter
RBallard
MSpangler
CLong
GLainas
RVollmer
VBenaroya
JKnight
SPawlicki
LShao
TNovak
TIppolito
DRoss
WHouston
DDavis
TCox
LEngle
DKartalia
JCohen
WPaton
CDomeck
GDittman
RLoose
RO (3)
EGoulbourne
RFraley, ACRS (16)
JShapaker
WJensen
TGreene
CAnderson

Slide 1

Containment Meeting
with Staff 3-14-74

PRESENTATION TOPICS

I CRAFT - REFLOOD COMPARISON

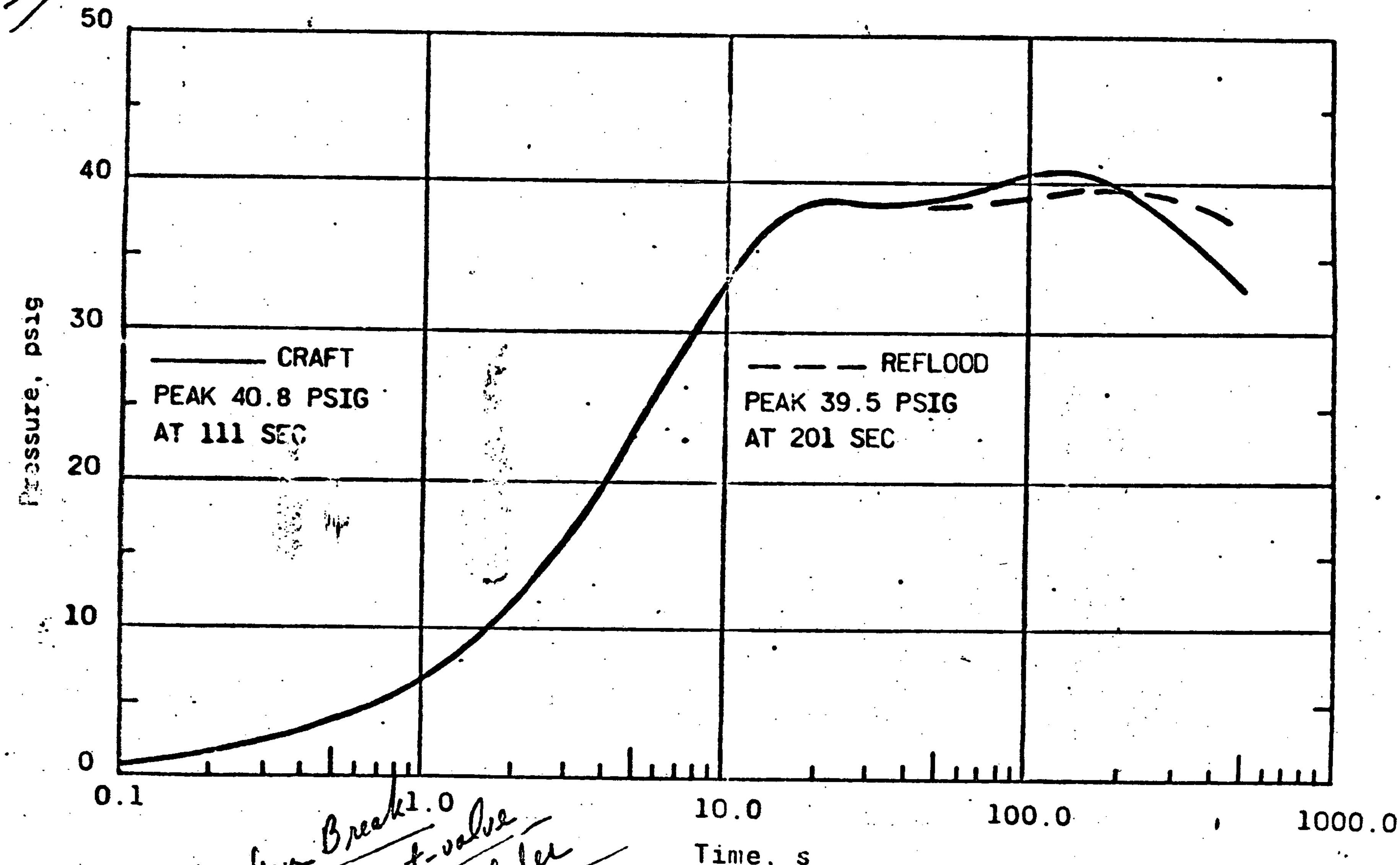
II JUSTIFICATION OF STEAM CONDENSATION

III CARRY-OUT RATE FRACTIONS

IV ENERGY SOURCES

Slide 2

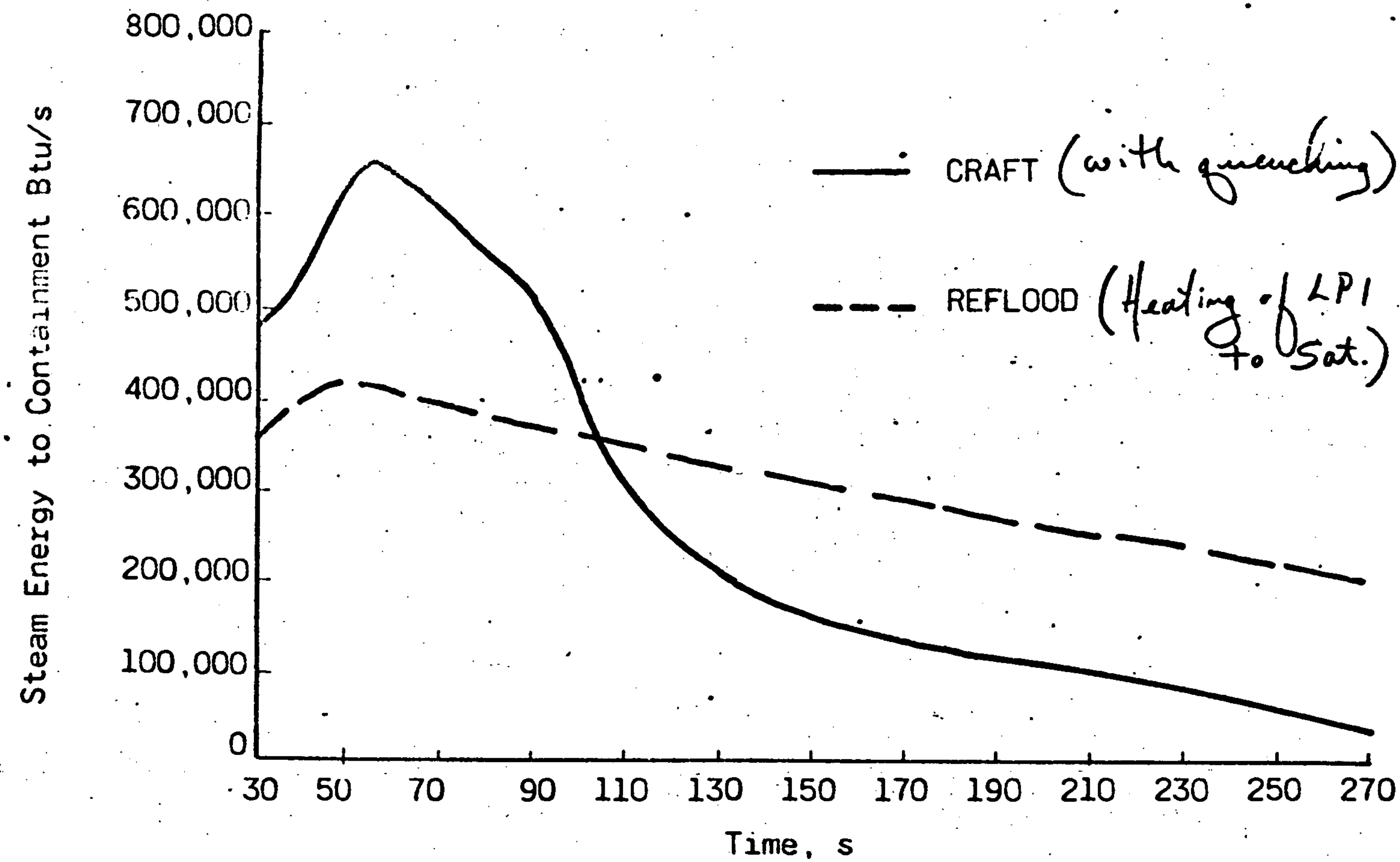
REACTOR BUILDING PRESSURE HISTORY FOR MASS X ENERGY RELEASE
DEVELOPED BY CRAFT AND REFLOOD



DE Pump Suction Break
7 sq ft with vent-valve
out all slides

Slide 3

STEAM ENERGY TO CONTAINMENT
CRAFT VS REFLOOD

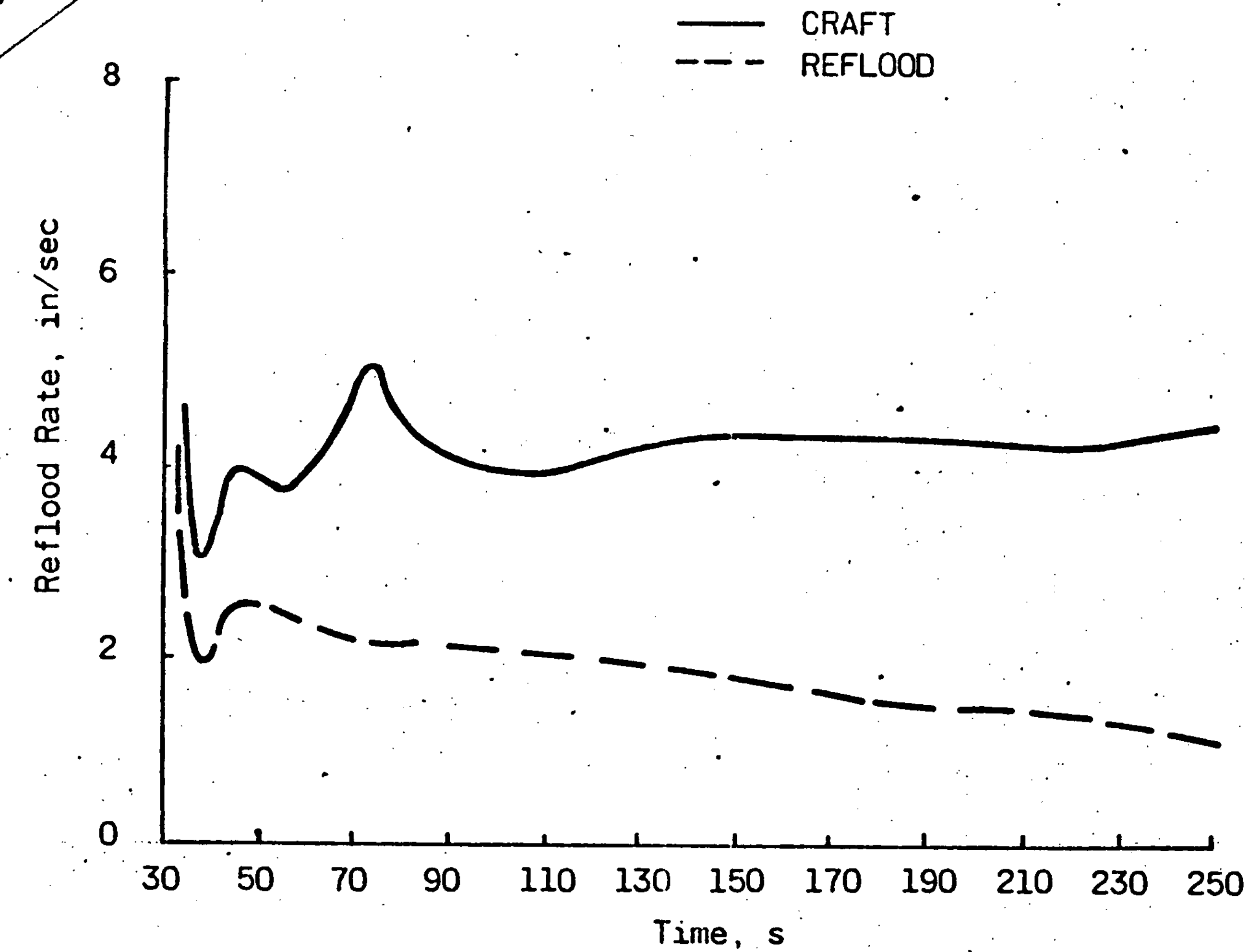


Slide 4

Dual HPI one LPI

COMPARISON OF REFLOOD RATES

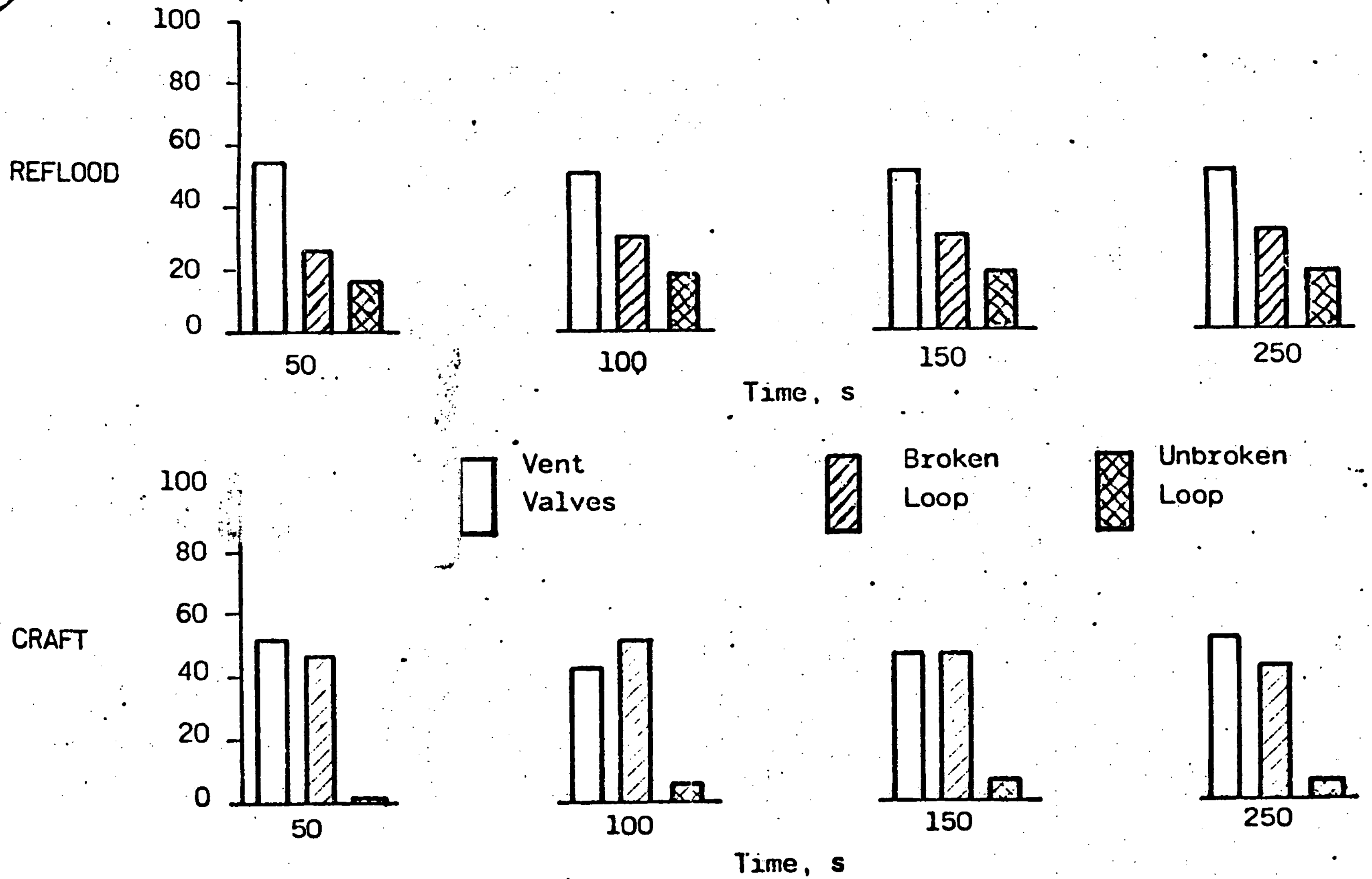
CRAFT VS REFLOOD



Back press ~ 50 psia

Slide 5

FLOW SPLIT COMPARISON BETWEEN CRAFT AND REFLOOD

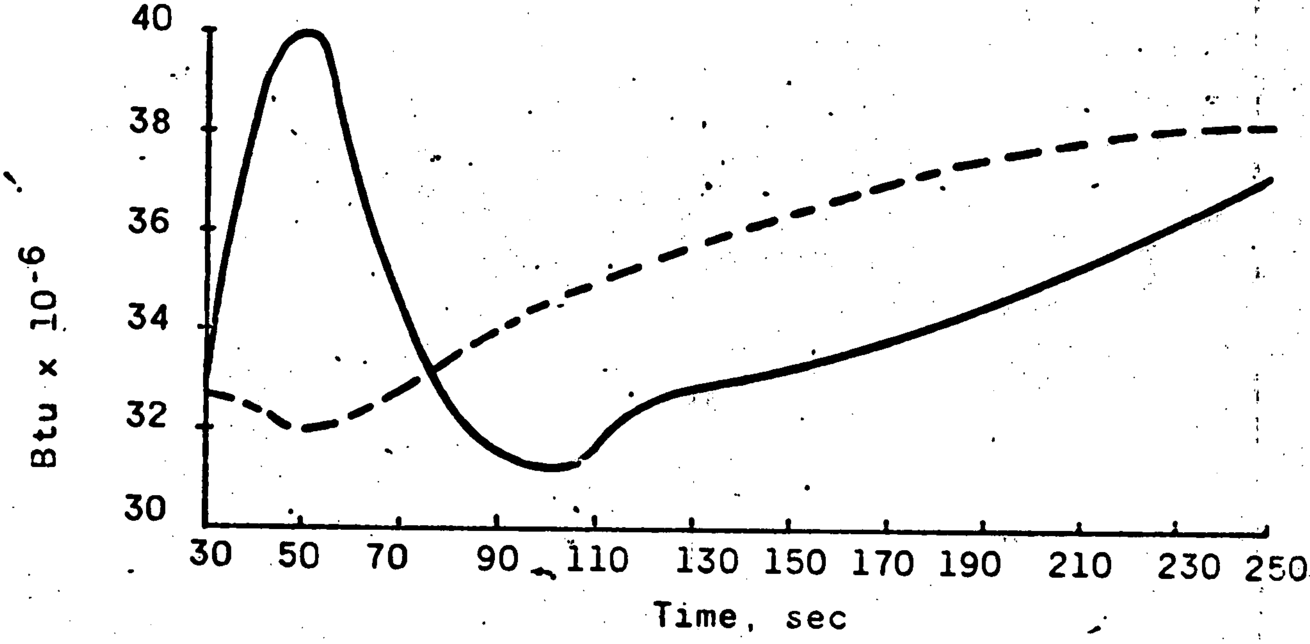


Slide 6

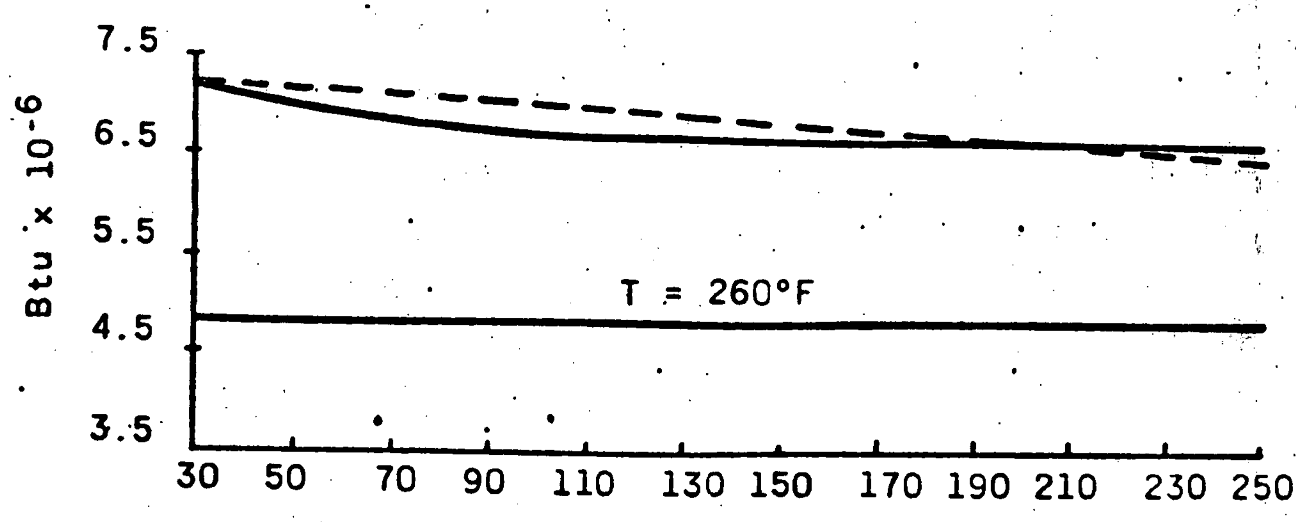
STORED ENERGY VERSES TIME FOR VARIOUS ENERGY SOURCES

——— CRAFT   - - - - REFLOOD

REACTOR COOLANT ENERGY

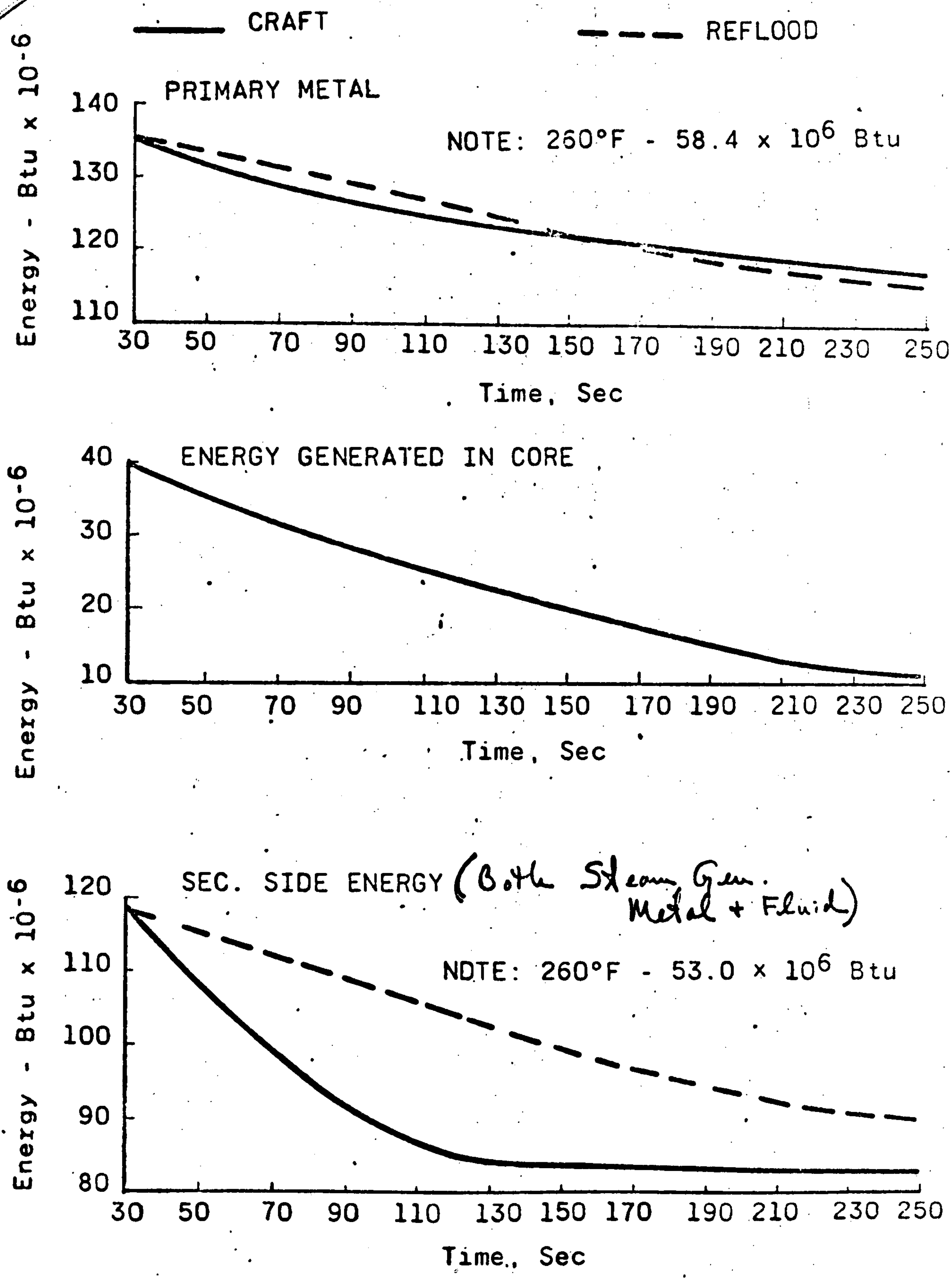


ENERGY STORED IN CORE

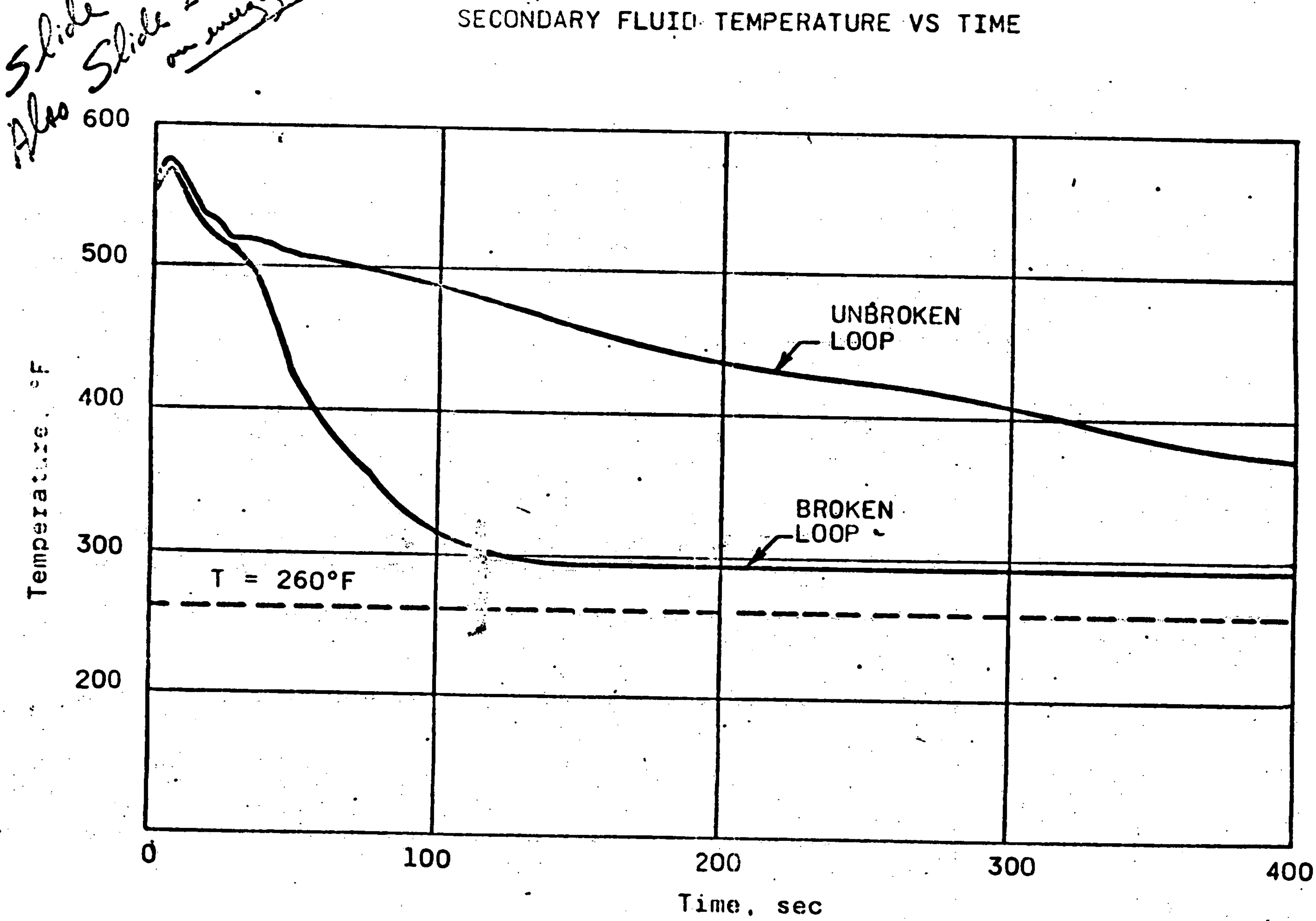


Slide 7

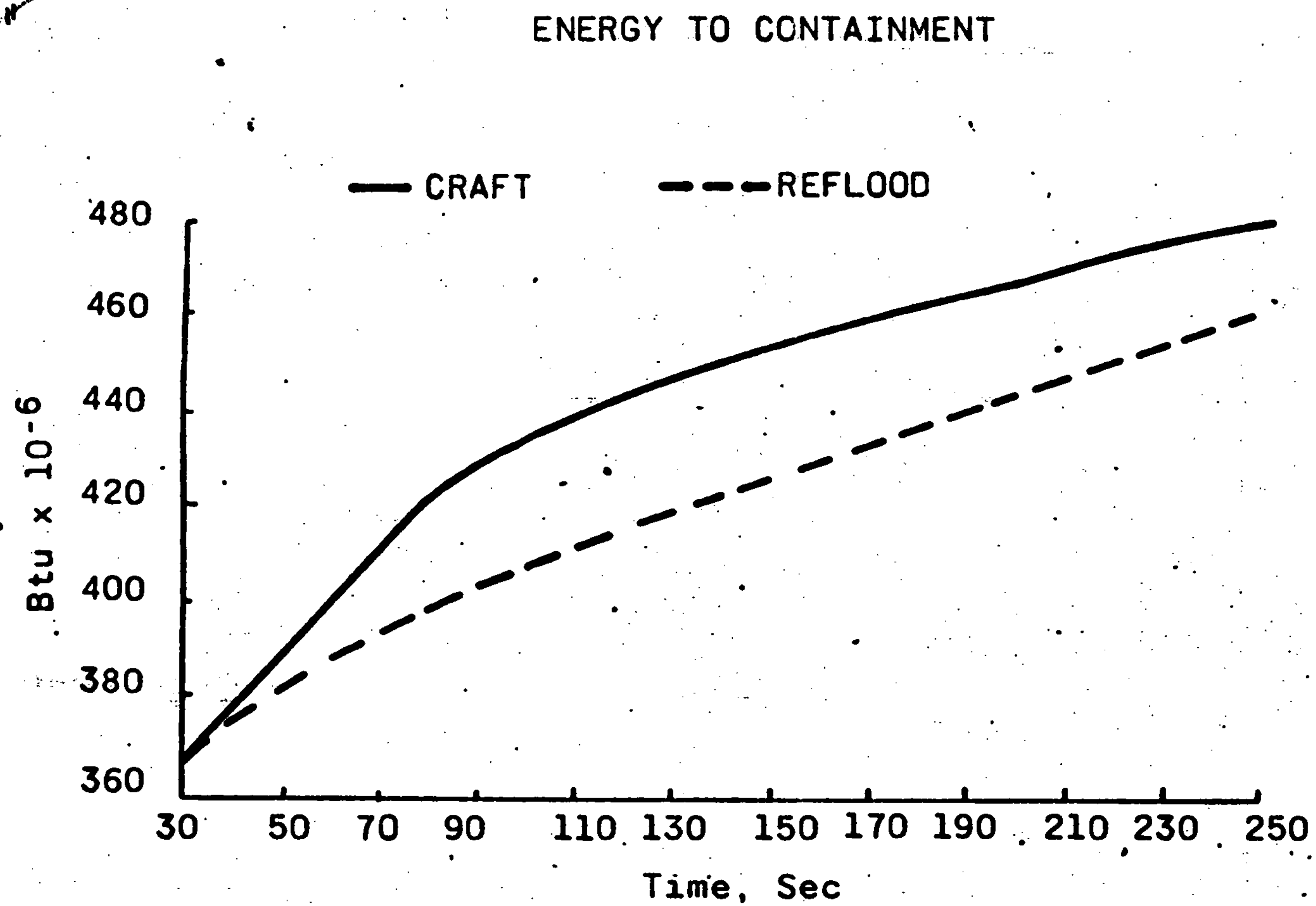
STORED ENERGY VERSES TIME FOR VARIOUS ENERGY SOURCES



Slide 8
Also Slide 22 on energy source

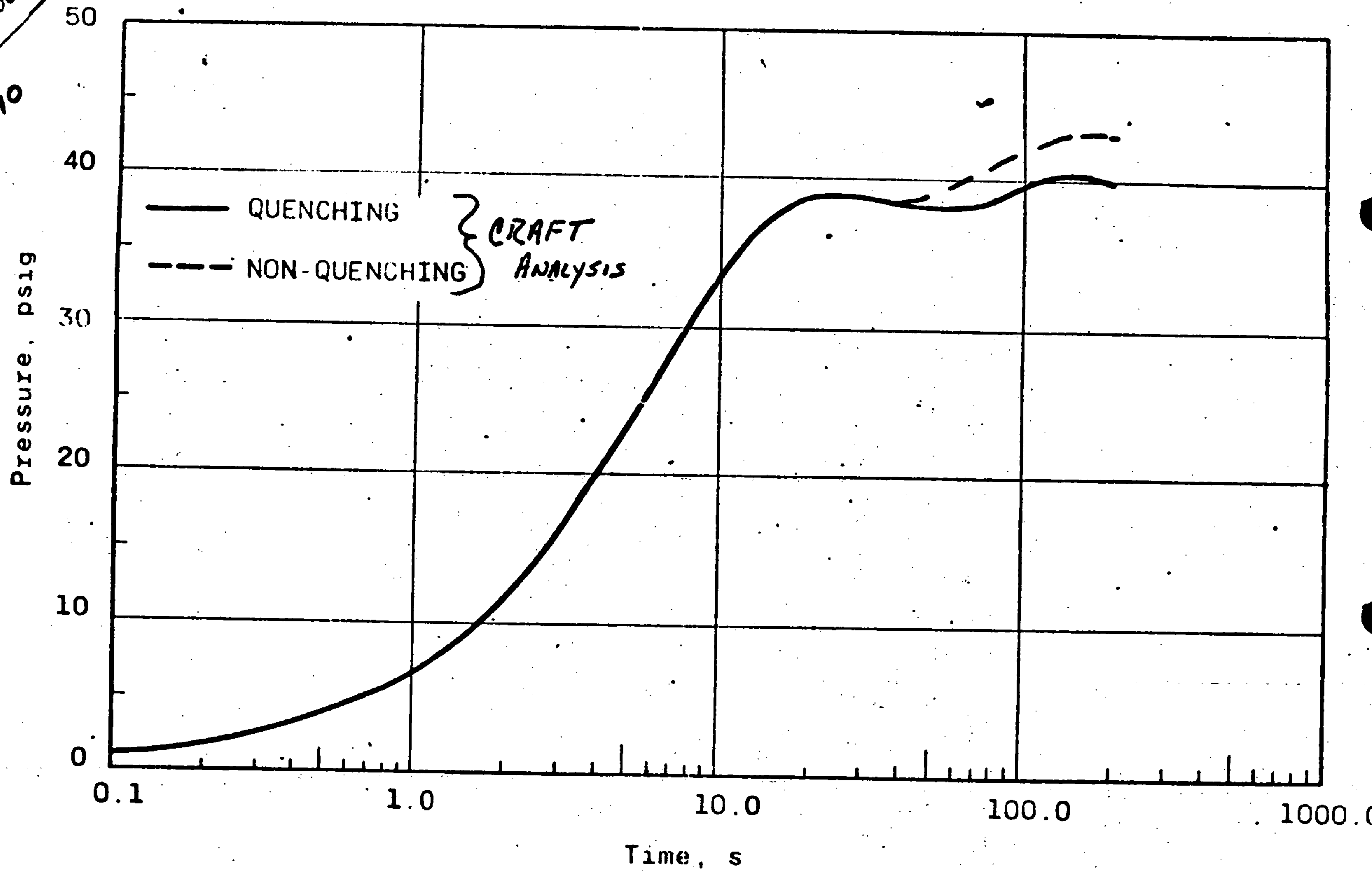


Slide 9


ENERGY TO CONTAINMENT
CRAFT
REFLOOD
Btu x 10-6
480
460
440
420
400
380
360
30
50
70
90
110
130
150
170
190
210
230
250
Time, Sec

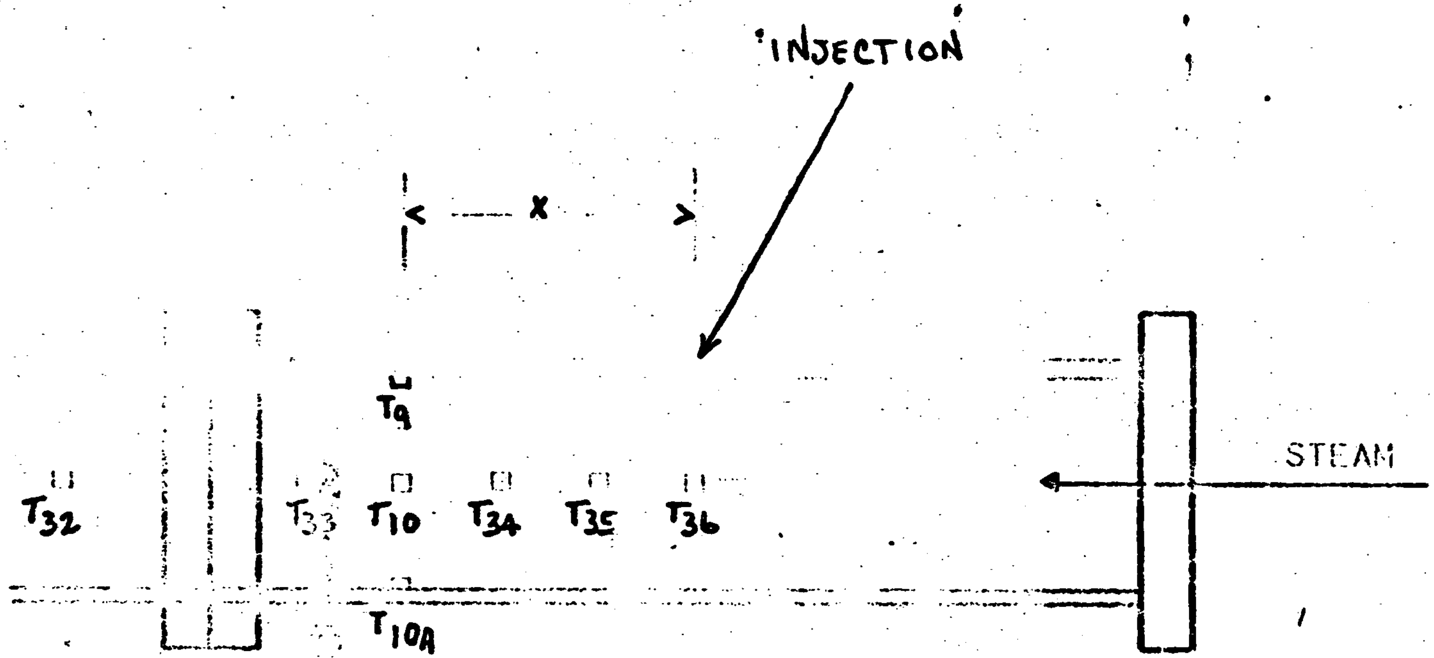
3/14/74
Afternoon Session
Slide 10

COMPARISON OF QUENCHING AND NON-QUENCHING IN CRAFT



Slide 11

TEST SECTION THERMOCOUPLES



X = 22 INCHES FOR 1/3 SCALE TESTS

= 14 INCHES FOR 1/5 SCALE TESTS

THERMOCOUPLES 32 36 NOT PRESENT IN 1/5 SCALE TESTS

Slide 12

SCALING OF FLOWS

TYPICAL COLD LEG FLOWS — STEAM 50 LBM/SEC

HPI 50 LBM/SEC

SCALING FACTORS — 1/3 TEST $= \left(\frac{10}{28}\right)^2 = .13$

1/5 TEST $= \left(\frac{6}{28}\right)^2 = .05$

TYPICAL FLOWS SCALED

	1/3	1/5
STEAM	**6.5** LBM/SEC	2.5 LBM/SEC
HPI	47 GPM	28 GPM

TEST DATA AVAILABLE

DATE	RUN #	SCALE	INJECTION (GPM	STEAM FLOW (LBM/SEC)
4/24/72	3	1/5	116	3.9
8/8/72	4	1/5	110	2.0
8/8/72	5	1/5	90	4.0
4/25/72	4	1/5	120	4.0
4/27/72	1	1/5	116	4.0
5/2/73	7	1/3	473	7.5
4/23/73	5	1/3	436	7.5

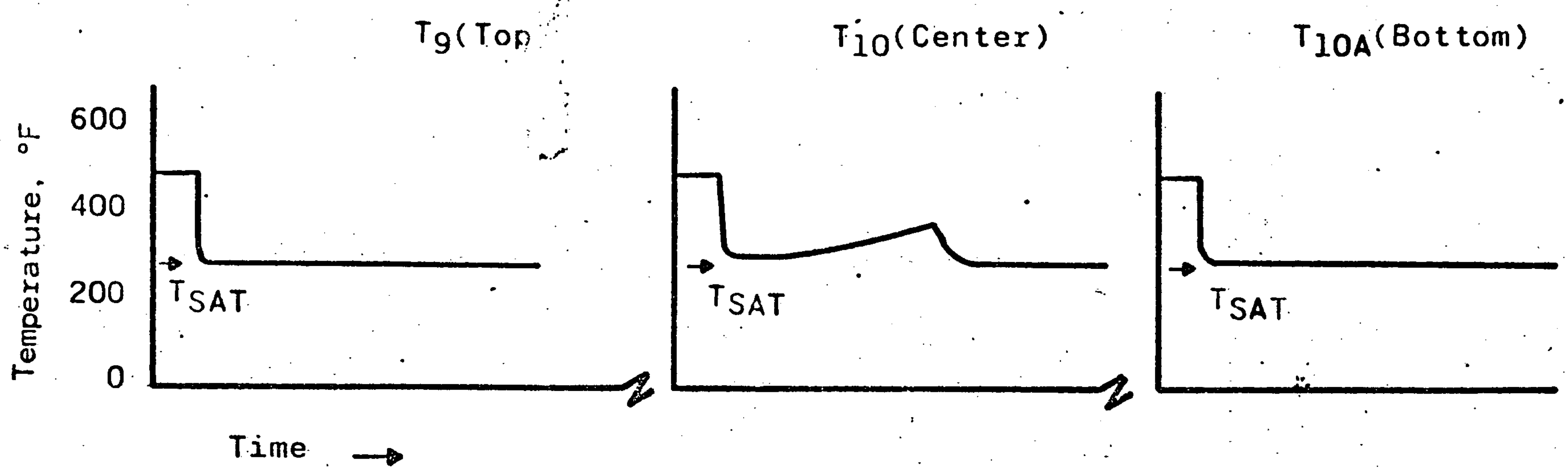
4A-394-3

Slide 13

4/24/72 RUN 3 SCALE 1/5

INJECTION	116 GPM	STEAM FLOW	3.9 LBM/SEC
	117°F		517°F
PRESSURE	59 PSIA,	T_{SAT} 292	

ENERGY TO REMOVE SUPERHEAT	444 BTU/SEC
ENERGY TO QUENCH STEAM	4014 BTU/SEC
ENERGY SINK IN INJECTION	3000 BTU/SEC
PERCENT FULL SINK	75%



GA-399-6

Slide 14

DATA SUMMARY

DATE	RUN #	SCALE	INJECTION GPM, °F		STEAM FLOW LBM/SEC, °F		T_{SAT}	THERMOCOUPLE READINGS °F T_9	T_{10}	T_{10A}
4/24/72	3	1/5	116	117	3.9	517	292	280	290	280
8/8/72	4	1/5	110	120	2.0	510	274	280	270	270
8/8/72	5	1/5	90	120	4.0	510	274	290	500	280
4/25/72	4	1/5	120	125	4.0	513	293	290	290	290
4/27/73	1	1/5	116	126	4.0	515	289	290	290	290
5/2/73	7*	1/3	473	117	7.5	410	289	240	220	220
4/23/73	5**	1/3	436	117	7.5	517	287	240	240	NF

* PERCENT TOTAL SINK 160%

** PERCENT TOTAL SINK 140%

GA-394-2

Slide 15

8/8/72 RUN 5 SCALE 1/5

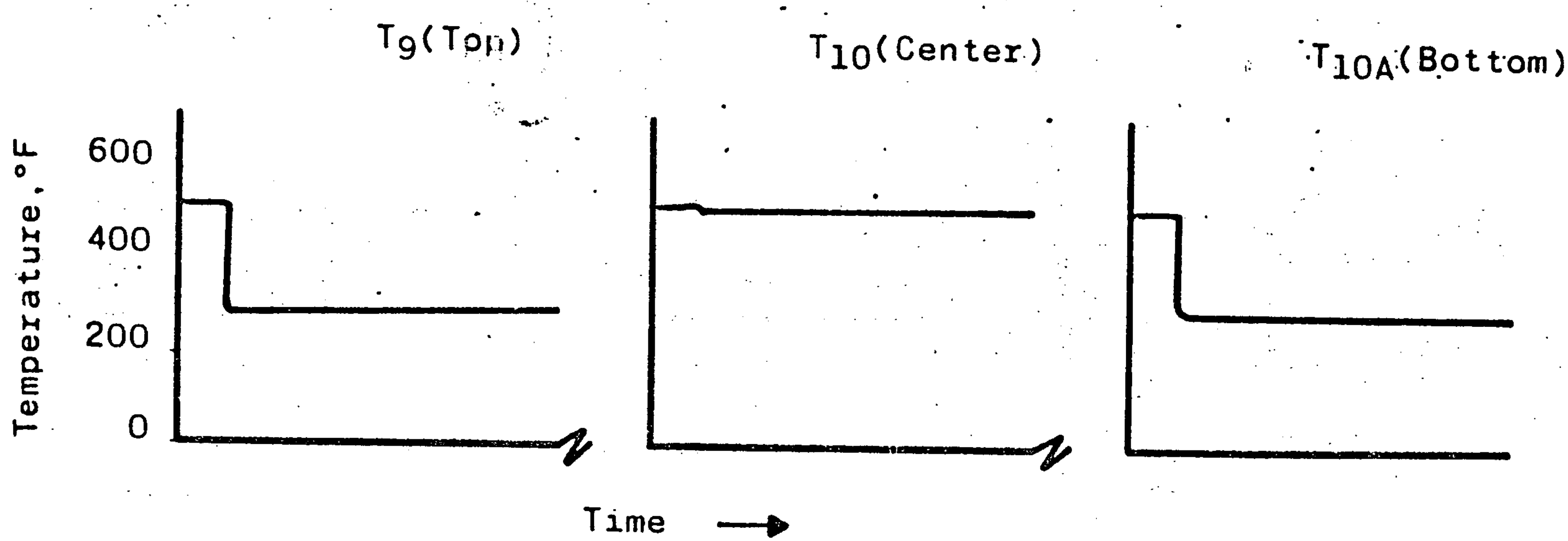
INJECTION	116 GPM	STEAM FLOW	4.0 LBM/SEC
	120°F		517°F
PRESSURE	45 PSIA	T_{SAT} 274	

ENERGY TO REMOVE SUPERHEAT 484 BTU/SEC

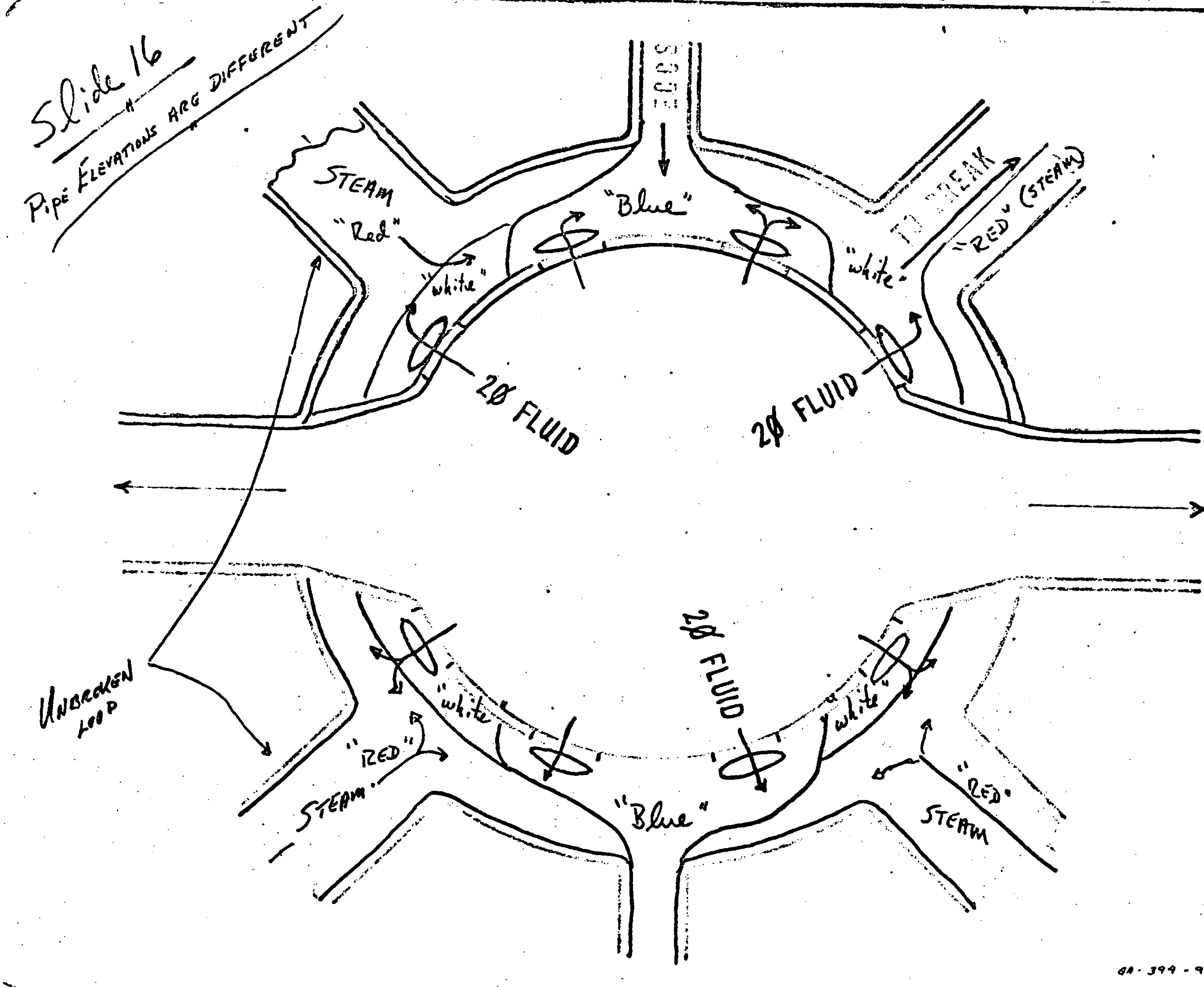
ENERGY TO QUENCH STEAM 4200 BTU/SEC

ENERGY SINK IN INJECTION 2540 BTU/SEC

PERCENT FULL SINK 60%

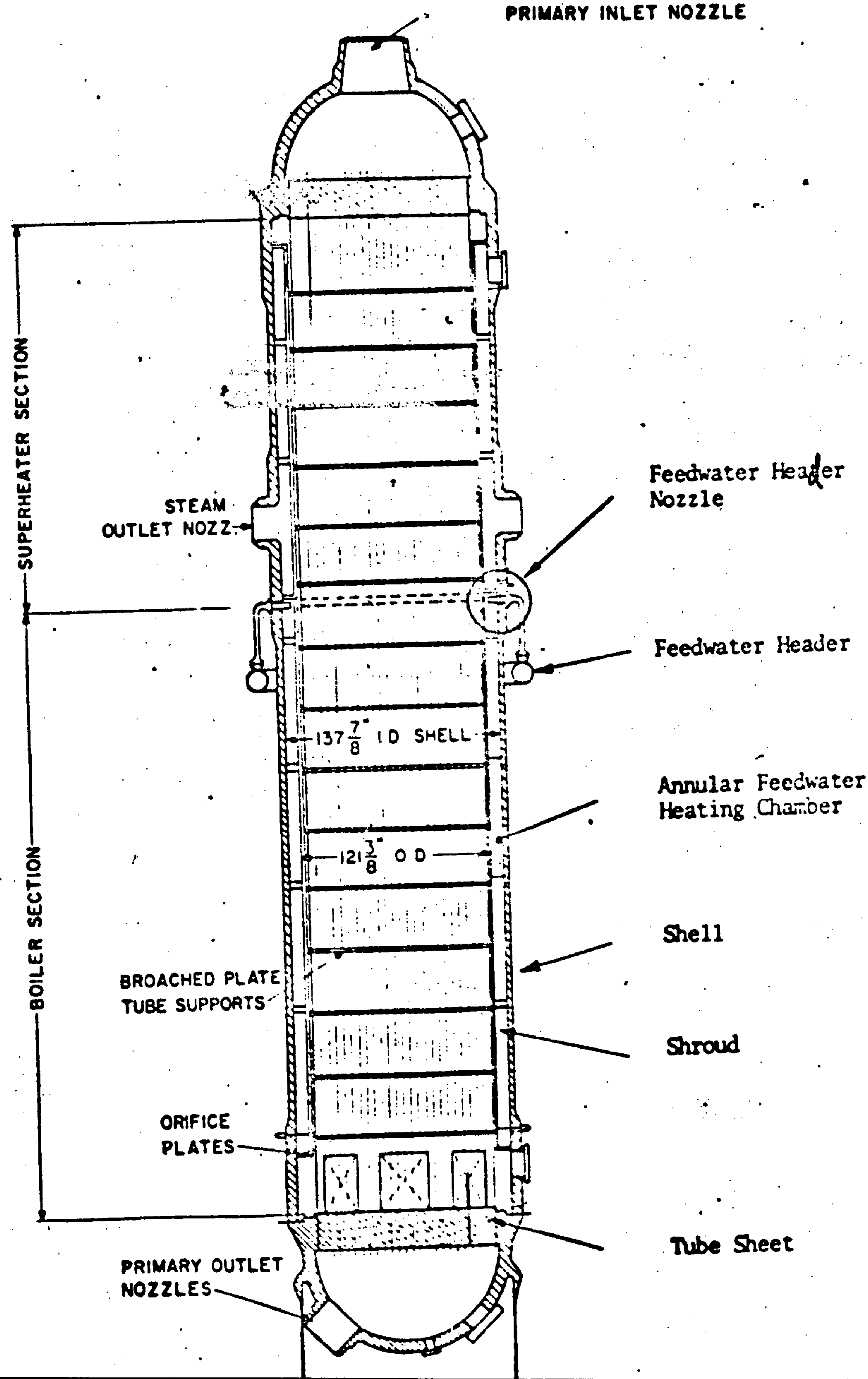


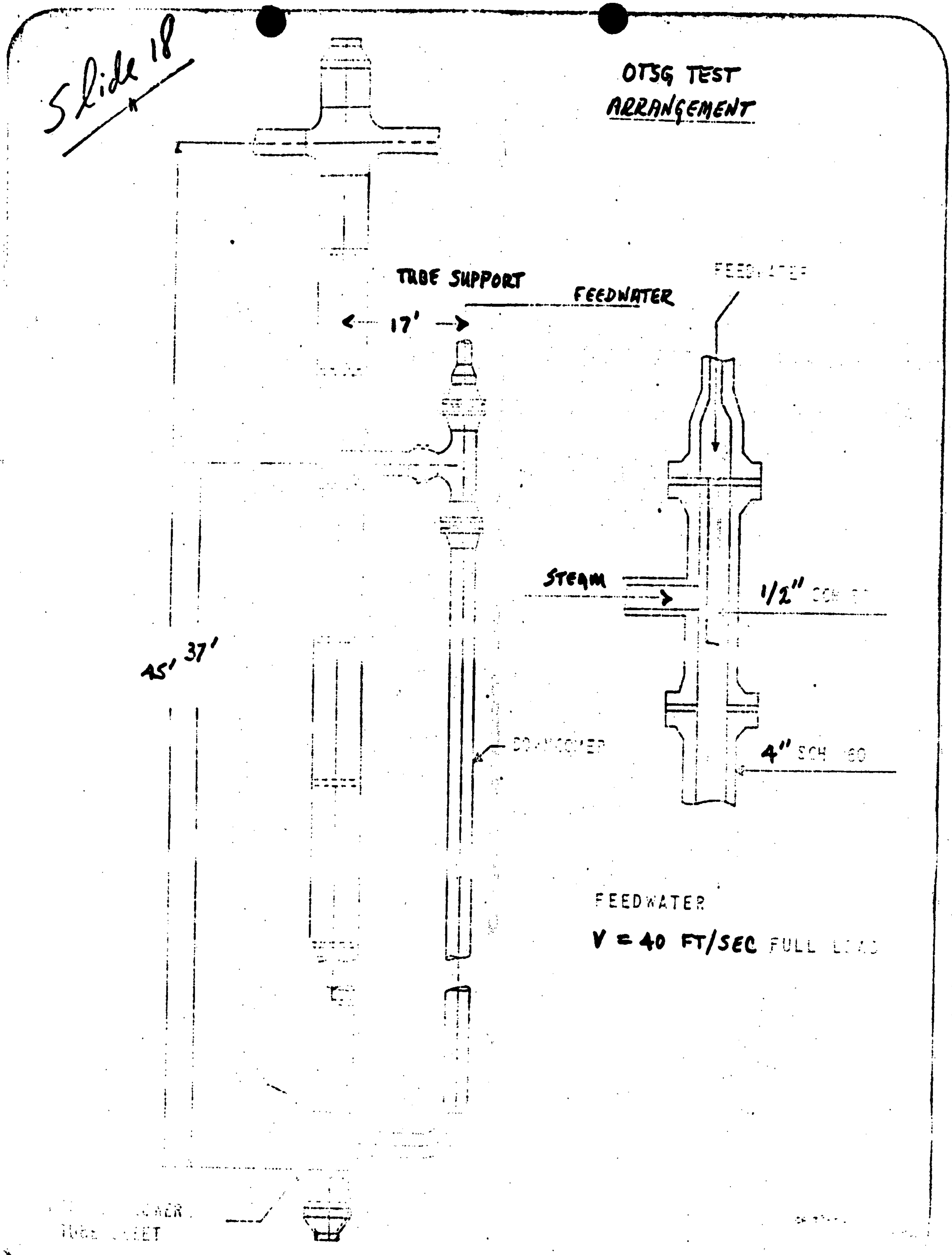
GA-399-4


Slide 16
Pipe Elevations are different
STEAM
"Red"
"white"
"Blue"
"white"
TO BREAK
"RED" (STEAM)
2Ø FLUID
2Ø FLUID
2Ø FLUID
Unbroken loop
"white"
"RED"
STEAM
"Blue"
"white"
"RED"
STEAM
8A-394-9

Slide 17

CROSS SECTION OF NUCLEAR ONCE-THROUGH STEAM GENERATOR




Slide 18
OTSG TEST
ARRANGEMENT
TUBE SUPPORT
FEEDWATER
17'
STEAM
1/2"
45' 37'
4"
FEEDWATER
V = 40 FT/SEC FULL

Slide 19

CORRESPONDENCE AND SCALING

TEST $\overline{W_{st}}$ = 880 LBM/HR

$\overline{Q_{fw}}$ = 17 GPM

LOOP +2 VENT VALVES MIGHT HAVE A FLOW OF 460,000 LBM/HR

SCALING FACTOR IS 520

GIVING NEEDED INJECTION OF 8840 GPM

ALSO ACCOUNT FOR DIFFERENCE IN ENTHALPY

TEST Δh = 93 LPI Δh = 181

GIVING FACTOR OF .51

RESULTING INJECTION FLOW NEEDED IS 4500 GPM

GA-[illegible]

Slide 20

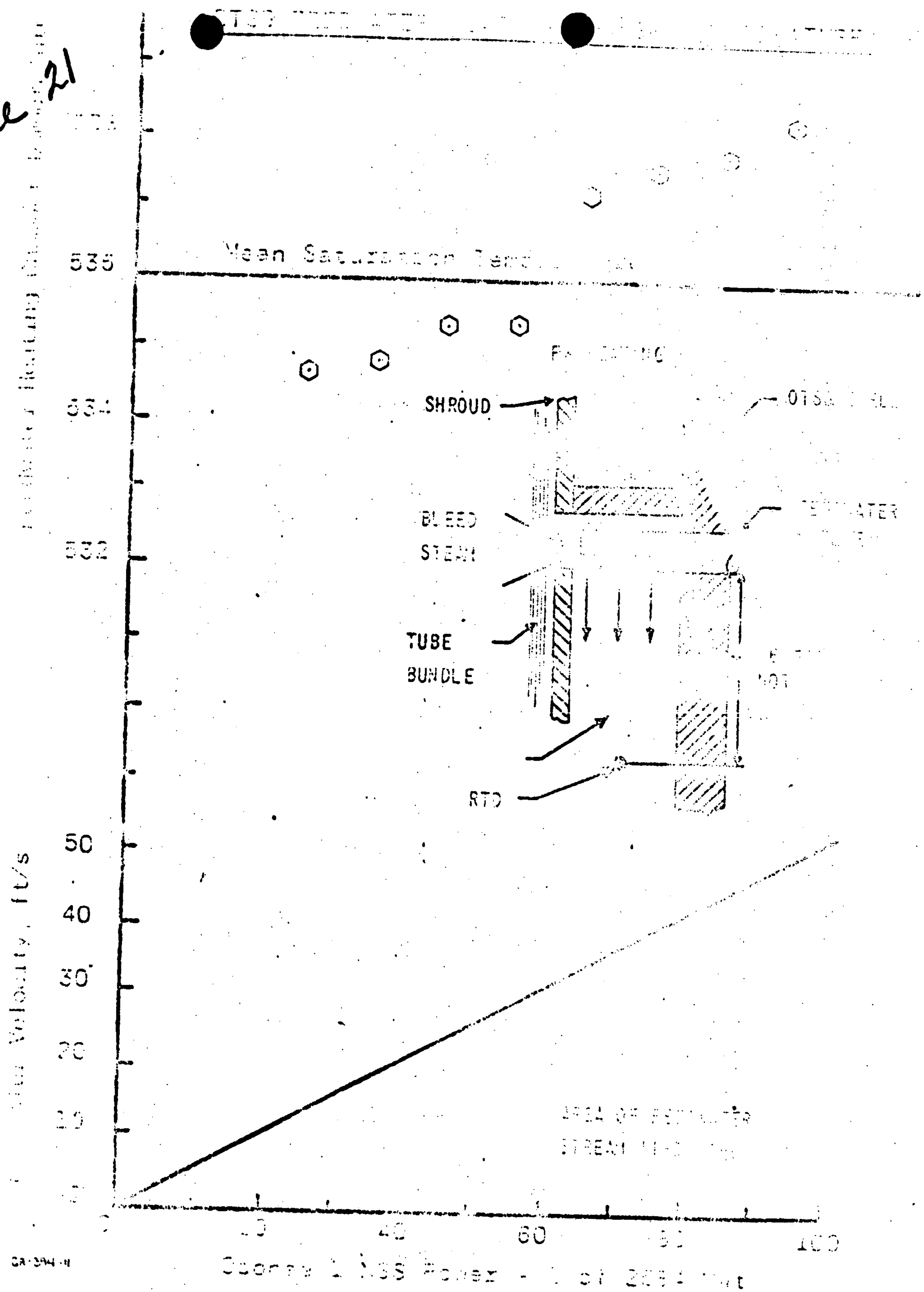
19 TUBE OTSG TEST RANGE

steam or feedwater flow	5000 – 9000 LBM/HR
Feedwater temperature	400 – 460 °F
Pressure	500 – 900 PSIA
Feedwater subcooling	30-150 BTU/LBM
Steam velocity	8-20 FT/SEC
Feedwater volumetric flow	13-23 GPM

IN ALL CASES FEEDWATER IS SATURATED AFTER MIXING CHAMBER

[illegible] TUBE OTSG TEST CONFIRMED THAT FEEDWATER WOULD SATURATE FOR 27% AND 50% LOAD WITH FLOW RATES AS 10 FT/SEC.

Slide 21



535
534
532
SHROUD
BLEED
STEAM
TUBE
BUNDLE
RTD
50
40
30
20
ft/s
60
100

Slide 23

COMPARISON OF TREATMENT OF SECONDARY SIDE ENERGY TRANSFER AND MODELING OF STEAM GENERATOR TUBES - CRAFT

Review Slide 8 to initiate En Source Discussion