BOOK34R

Notes:
"HFIR #1" on spine

Blank pages: inside cover page, inside cover page opposite page 1, 1, 6, 8, 20, 26, 28, 30, 32, 36, 38, 40, 42, 44, 50, 144, 145, 150-152, inside back covers

-2 pieces of paper clipped to page 114

Scanned by:
Sheila Finch
RSICC /Oak Ridge National Lab.
August 7, 1999
HFIR Log No.1

7/1/23 (South) → 6/5/24 (West)

The paper used in this book will give complete writing satisfaction. It was selected from many papers for its fine writing ledger surface.

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NEW YORK·N·Y
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No. 168 BLANK BOOK

Journal
Single Entry Ledger
Double Entry Ledger Record

Without Units

In 150 and 300 Pages

M A D E I N T H E U . S . A.

To reorder this book, specify number, ruling and thickness as indicated on backbone of book.
First Boron concentration

\[ 1.18 \text{ mg/gal} \]

\[ 6.178 \text{ mg/cc} \]
Instrument Check on 7-13-63 Source 100 K

<table>
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<tr>
<th>PM-1</th>
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<th>Alarm Trip OK</th>
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<td>PM-2</td>
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<td>IC-2</td>
<td>&gt;3 x 10^-4Meter Trip OK</td>
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<td>IC-3</td>
<td>Responds Calibration 5V</td>
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<td>CBK</td>
<td>Meter Trip</td>
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Preliminary Check on 7-13-64

Room 113 Pressure Differential 14°
Red Light On and Personnel Check SW C.C.
Scrams and Bldg, Alarm Reset OFF
Source Inserted C.C.
Safety Switch 1000
Controls Set 55cm 15°C 0°C 0.0
Reflector Water 6° above 86°
Moderator Water 25.5°

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<tr>
<th>Condition</th>
<th>Inner</th>
<th>Outer</th>
<th>Safety</th>
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3 PN-97
{ Brγ 8 } { sp 30 } { 145 keV }
{ Delay 14 } { Burst 10^3 } { 0.9 ma }
{ ch,ir 160 } { beam 7 ma }
Instrument Check on 7-4-64 Source Accept

PM-1 Low Trip OK Alarm Trip OK
PM-2
IC-1 \( > 3 \times 10^{-4} \) Water Trip OK Fast Trip OK
IC-2 \( > 3 \times 10^{-4} \) Water Trip OK
IC-3 Responds Calibration OK
IC-4 Responds Calibration OK
Cal Water Trip OK

Preliminary Check on 7-4-64

Room-115 Pressure Differential 1.4".
Red Light On and Personnel Check Jt c.e.
Screams and Bldg. Alarm Reset Jt
Source Inserted Jt
Safety Withdrawn 26:00
Controls Set Inner 19.62 Outer 10.00
Reflector Water 5" above Ro.
Moderator Water

Coalition Inner Outer Safety
\( K > 1 \) 19.42 19.85 26.0
\( K = 1 \) 19.42 19.60 26.0
\( K = 1 \) 19.41 19.61 26.0
\( K = 1 \) 19.43 19.43 20.77

Note: Shut Down to Repair Safety Drive
Cont Exp #131 (B)

12:30 Condition Inner Outer Safety
\( K > 1 \) 19.43 19.86 20.77
\( K = 1 \) 19.41 19.61 20.77
**Exp. 132**

**W/T**

**Instrument Check on 7-15-64**
Source: 10 mC

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**Preliminary Check on 7-15-64**

- Room 113 Pressure Differential: 4.75"
- Red Light On and Personnel Check: 70 cc
- Scrams and Bldg. Alarm Reset: 101°
- Source Inserted: 101°
- Safety Withdraw: 26.000
- Controls Set In: 18.00 Out: 18.00
- Reflector Water: 25.0 cc
- Moderator Water: 25.82 cc

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<thead>
<tr>
<th>Exp.</th>
<th>Condition</th>
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<th>BPM</th>
<th>see p. 146</th>
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### Preliminary Check on 7-16-64

Room 115 Pressure Differential 64"
Red Light On and Personnel Check OK c.c.
Scram and Bldg, Alarm Reset ON
Source Inserted ON
Safety Withdrawn 26-00
Controls Set In: 24-70 Out: 0.0
Reflector Water ON above 80
Moderator Water ON 35.74

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</table>
Foils:

Inner 5E-3E location: 37a

Outer 0E-96 location: 21b

No foil 5 of 5E-36 in #4 slot of 5E16F location: 12th slot from 32a

Target 1D of 5E-36 location 3û3" from 6

IC 5E-36 location on surface of target assembly

Begin exposure at 8:54AM, expose 30 min at 1 \( \times 10^{-8} \) IC-3

7 \( \times 10^{-8} \) IC-4

1.9 \( \times 10^{-5} \) IC-1

9.7 \( \times 10^{-8} \) IC-2
Foil Exposure Expt. 142 W.T.

Instrument Check on 7-17-64 Source 10 mc/s

| PM-1 | Low Trip | ok | Alarm Trip | ok |
| PM-2 |          |    | Alarm Trip | ok |
| IC-1 | 23x10"  | ok | Motor Trip | ok |
| IC-2 | 23x10"  |    | Fast Trip  | ok |
| IC-3 |         |    | Responds  | Calibration | III |
| IC-4 |         |    | Responds  | Calibration | III |
| CRM  |         |    | Meter Trip |            |    |

Preliminary Check on 7-17-64

Room 113 Pressure Differential 1.4" (sunk in)
Red Light On and Personnel Check III
Schramm and Blig, Alarm Reset III
Source Inserted III
Safety Withdrawn 21.00

Controls Set Inside 19.00 Outside 19

Neflector Water 6.80
Moderator Water 25.10

\[
k = 1 \quad 19.00 \quad 19.00 \quad \text{Read 14.7T}
\]

\[
k = 1 \quad 19.01 \quad 19.05
\]
foils

Inner 1E 15E location 37a
Outer 0E 4E 4E 786

Norm foil 4 8E 3E 4 Slot 12 from 37a

Begin Exposure at 8:30 a.m. Exposure 30 min. 6.4 x 10^6 IC 1

5.3 x 10^3 IC 2

2nd Exposure at 9:23 a.m.

.9 x 10^4 IC 3

5.5 x 10^3 IC 4
Instrument Check on 7-20-64 Source 10 mcY

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Preliminary Check on 7-20-64

Room 113 Pressure Differential 1.4"
Red Light On and Personnel Check SN OK
Screws and Clamps, Absent NONE
Source Inserted OK
Safety Withdrawn 24.00

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<th>Out</th>
<th>24.09</th>
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<td>Moderator Water</td>
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Condition Inner Outer
k=1
17.00 24.09 Grovelle (18.04) .125
k=1
17.22 24.09

Inter. may current
Have dissolved 704 gms of dried Na₂S₄O₆ in 3 liters H₂O.

Exp. 144 - add 500 cc of above solution.

Exp. 145 - 1000 cc - - - -

Exp. 147 - 500 cc - - -
<table>
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<th>Exp. 144</th>
<th>( k \geq 1 )</th>
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Exp. 145

| \( k = 1 \) | 21.00 | 21.15 |
| \( k = 1 \) | 22.00 | 20.97 |

Repeat:

Exp. 146

| \( k \geq 1 \) | 21.00 | 21.15 |
| \( k = 1 \) | 24.00 | 20.77 |

Test 500 cc.

Exp. 147

| \( k \geq 1 \) | 21.00 | 22.31 |
| \( k = 1 \) | 21.00 | 21.82 |
| \( k = 1 \) | 21.38 | 21.38 |
Exp 18

Dissolved 72.4 grams of dried Na₂S₄₀₃ in 2 liters of H₂O
Expt 148

K = 1  22.70  23.00

K = 1  22.68  22.68

Add 1000 cc.

Expt 149

R = 1  24.70  24.07

Removed 1 liter of moderator, added 1 liter of H₂O

R = 1  24.70  25.50

Expt 150

R = 1  24.27  24.27

Added 300 cc of H₂O, removed 1 liter of moderator (Expt 146)

R = 1  24.27  24.27

Expt 151

R = 1  24.29  24.29

Added 500 cc of H₂O, removed 1 liter of moderator (Expt 195)

R = 1  24.70  25.75

R = 1  24.30  24.30

Added 100 cc Betan Soln

Expt 152

24.70  26.085

K = 1  24.70  26.085  26.00

K = 1  24.70  25.05  24.00

\[ \text{g/Am} \]

Drain fuel H₂O

10 17

K = 1  24.70  24.085  26.00

K = 1  24.70  25.10
Instrument Check on 7-22-64 Source: JH

PM-1 Low Trip OK Alarm Trip OK
PM-2 Alarm Trip OK
IC-1 >3 × 10^5 Meter Trip OK Reset Trip OK
IC-2 >3 × 10^5 Meter Trip OK
IC-3 Responds Calibration JH
IC-4 Responds Calibration JH
6RM Meter Trip

Preliminary Check on 7-22-64

Room 113 Pressure Differential 1.9
Red Light On and Personnel Check JH CC
Screws and Bldg. Alarm Reset JH
Source Inserted JH
Safety Withdrawn 24.00
Controls Set JH 24.70 20

Condition: Furnace 0.5

K=1 24.70 24.00
K=1 24.52 24.52

Exp 152 Add 100 cc Baron Selan
K=1 24.70 26.085 26.0
K=1 24.70 25.05 26.0

9 AM Drain fuel H₂O

Exp 154 K=1 24.70 26.085 26.0
K=1 24.70 25.10 26.0

Add 100 cc H₂O

Exp 155 K=1 24.70 26.085 26.0
K=1 24.70 24.94 26.0

11/20 Add 100 cc H₂O
Foil
Inner: 613 A in 37a
Outer: 06 13F in 78 b
Normal 4F of IE 36 - slot 17 from 37a

target 1 2/32 from 4
18 edge

Reflector 4B on 6E
4c 2"
40 4"
46 6"

Begin Exposure at 94/68, Exposure 30 min

2.1 10^-10 Ic 1
4.5 3 x 10^-2 Ic 2
1.5 10^-2 Ic 4
Condition Inner Outer

Exp. 155

\[
\begin{align*}
\text{K} = 1 & \quad 24.67 & 24.97 \quad 7.2 \ \frac{\text{mCi}}{\text{hr}} \\
\text{K} > 1 & \quad 24.67 & 24.07 \quad 13.5 \ \frac{\text{mCi}}{\text{hr}} \\
\text{K} = 1 & \quad 23.47 & 24.07 \quad 13.7 \ \frac{\text{mCi}}{\text{hr}} \\
\text{K} < 1 & \quad 23.37 & 26.09
\end{align*}
\]

Foil Exposure Exp. 156 "T" Instrument Check on 7-23-64 Source

PM-1 Low Trip ok Alarm Trip ok

PM-2 Alarm Trip ok

IC-1 \( \geq 3 \times 10^{-7} \) Meter Trip ok Fast Trip ok

IC-2 \( \geq 3 \times 10^{-7} \) Meter Trip ok

IC-3 Responds Calibration OK

IC-4 Responds Calibration OK

CRM Meter Trip

Preliminary Check on 7-23-64

Room 113 Pressure Differential 1.9" Water Level 17.8" (cont)

Screws and Bldg. Alarm Reset on

Source Inserted

Safety Withdrawn 24:00 Controls Set 24:07 out 0:0

Reflector Water 6" above Ke.

Moderator Water ~ 24.5

Condition Inner Outer

\[
\begin{align*}
\text{K} = 1 & \quad 24.70 & 24.09 \quad 5.15 \ \frac{\text{mCi}}{\text{hr}} \rightarrow 12.9 \ \frac{\text{mc}}{\text{hr}} \rightarrow 8.279 \\
\text{K} < 1 & \quad 24.70 & 24.93 \quad 7.1 \ \frac{\text{mCi}}{\text{hr}}
\end{align*}
\]

Moderator water sampled

has 148 ppm.
Foil:

- Outer plates only
- OE 21 in 24b
- 6G in 155b
- 7F in 207b
- 15G in 257b
- 16F in 315b
- 16G in 1b

Norm. foil 257 IE-3G in slot 17 from 370v.

Begin Exposure 9:22am. Expose 30min. 1.9 10x10^8 IC1
- 51 3 x 10^6 IC2
- 1.5 10^5 IC3
- 1.5 10^5 IC4
Instrument Check on 7-24-64 Source 10 mil

PM-1 Low Trip OK Alarm Trip OK
PM-2 Alarm Trip OK
IC-1 $3 \times 10^{-4}$ Water Trip OK Fast Trip OK
IC-2 $3 \times 10^{-4}$ Water Trip OK
IC-3 Responds Calibration JH
IC-4 Responds Calibration ON

Preliminary Check on 7-24-64
Room 113 Pressure Differential 14
Red Light On and Personal Check JH OK
Scrams and Bldg, Alarm Reset JH
Source Inserted JH
Safety Withdraw OK 26.00
Controls Set Inner 24.70 Outer 20.00
Reflector Water 6" Above He
Moderator Water 26.5"

Condition Inner Outer
k=1 24.70 24.09
k=1 24.70 25.35

Expt 156 added 100cc H2O

$\bar{k}=1$ 24.70 24.09 w/Source

$\bar{k}=1$ 24.70 24.96
Instrument Check on 7-31-69/Source

PM-1 Low Trip OK Alarm Trip OK
PM-2
IC-1 2 P.M. Water Trip OK Fast Trip OK
IC-2 2:30 P.M. Water Trip OK
IC-3 Source Calibration OK
IC-4 Source Calibration OK
CRM Water Trip

Preliminary Check on 8-3-69

Room 113 Pressure Differential 4.9"
Red Light On and Personnel Check
Screams and Alarm—Source Inserted
Source Inserted
Source Inserted
Safety Withdrawn 0.2577
Controls Set Source 2.476
Reflector Water ~ 6" above 6E
Moderator Water ~ 2.76

Condition Inner Outer Safety
R=1 24.70 24.09 24.01
R=1 24.70 25.37 24.01
R=1 24.70 25.58 24.76
R=1 24.70 25.34 24.01
R=1 19.41 19.41 24.01 3PN-107
**Test 163**

**Instrument Check on 8-3-6/1**

<table>
<thead>
<tr>
<th>Test</th>
<th>Status</th>
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</thead>
<tbody>
<tr>
<td>NN-1</td>
<td>Low Trip</td>
</tr>
<tr>
<td>NN-2</td>
<td>Low Trip</td>
</tr>
<tr>
<td>NN-1</td>
<td>&gt; 3 x 10⁻¹¹ Meters</td>
</tr>
<tr>
<td>NN-2</td>
<td>&gt; 3 x 10⁻¹¹ Meters</td>
</tr>
</tbody>
</table>

**Preliminary Check on 8-3-6/1**

- Room 113 Pressure Differential: 14" Hg
- Red-Light On and Personnel Check: 1/2 - 1/2
- Source Inserted: C.C.
- Source Withdrawn: 24.00
- Controls Set Above: 24.70
- Reflect Water: 6" above C.C.
- Moderator Water: 12.71

**Condition Inner Outer Safety**

| k = 1 | 24.70 | 26.50 | 21.00 |
| k = 1 | 24.70 | 26.70 | 21.00 |
| k = 1 | 24.70 | 25.47 | 24.00 |

- Added 100 cc H₂O
  - 24.70 25.12 21.00

- Added 100 cc H₂O

  - 24.70 24.85 21.00

  *Take sample 5A (B) moderator*  

  *Sample 5A: 1.89% B*
Instrument Check on 8-4-64 Source 10 mev

PM-1 Low Trip OK Alarm Trip OK
PM-2 Alarm Trip OK
IC-1 > 3 x 10^-7 Meter Trip OK Fast Trip OK
IC-2 > 3 x 10^-7 Meter Trip OK
IC-3 Calibration Alarm
IC-4 Physicist Calibration JIC
GIC Meter Trip

Preliminary Check on 8-4-64

Room 113 Pressure Differential 1.4" Red Light On and Personnel Check JIC
Scamps and Flags, Alarm Reset JIC Source Inserted JIC Safety Withdrawn 20.00 Controls Set Inner 24.70 Outer 25.00 Reflector Water 64.00 Water 28.00

Condition Inner Outer Rh A

k>1 24.70 26.07 6.48 ±
k=1 24.70 24.91
k<1 24.70 24.31 -7.23
k<1 24.70 25.09

Act of D^2
Expt 165 W/T

Instrument Check on 8-6-CY Source 20°C

PM-1 Low Trip OK Alarm Trip ✓
PM-2 Alarm Trip ✓
IC-1 > 3 x 10⁻⁸ Meter Trip ✓ Fast Trip ✓
IC-2 > 3 x 10⁻⁸ Meter Trip OK
IC-3 ✓ Calibration OK
IC-4 ✓ Calibration OK
CRM Meter Trip ✗

Preliminary Check on 8-5-CY

Room 115 Pressure Differential 1.6 psi
Red Light On and Personnel Check ✓
Screws and Hinges, Alarm Reset ✓
Source Inserted ✓
Safety Withdrawn

Controls Set
Refractor Water
Moderator Water

Condition Inner Outer Safety
k=1 24.70 25.45 26.00
k=1 24.70 25.59 26.76 3PN-111 see p.46
k=1 24.70 25.57 26.76

my point 126 div/sec 2738 sec = k x 8472.4
K = .6668
<table>
<thead>
<tr>
<th>Time</th>
<th>T</th>
<th>P</th>
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<tbody>
<tr>
<td>11:05</td>
<td>345.8</td>
<td>8.58</td>
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<tr>
<td>11:35</td>
<td>290.1</td>
<td>5.16</td>
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<td>10:59</td>
<td>236.8</td>
<td>4.81</td>
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<td>14:05</td>
<td>305.3</td>
<td>4.88</td>
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**Exp 166**

**Instrument Check on β - C-64 Source**

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<tr>
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<th>Alarm Trip</th>
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<tr>
<td>FM-2</td>
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<tr>
<td>IC-1</td>
<td>&gt; 3x10''</td>
<td>Meter Trip</td>
</tr>
<tr>
<td>IC-2</td>
<td>&gt; 3x10''</td>
<td>Meter Trip</td>
</tr>
<tr>
<td>IC-3</td>
<td>Response</td>
<td>Calibration</td>
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<td>IC-4</td>
<td>Response</td>
<td>Calibration</td>
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<tr>
<td>CRM</td>
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<td>Meter Trip</td>
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</tbody>
</table>

**Preliminary Check on β - C-64**

- Room 113 Pressure Differential: 1.4``
- Rod Light On and Personnel Check: III
- Scraps and Flas. Maint. React: III
- Source Inserted: III - Acc.
- Safety Withdraw: 24.00
- Controls Set: Inner 24.70, Outer 23.00
- Reflector Water: 6.0 above Ge
- Moderator Water: 0.26``

<table>
<thead>
<tr>
<th>Condition</th>
<th>Inner</th>
<th>Outer</th>
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<td>k&gt;1</td>
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Added 153 cc H₂O to Moderator - ρ - density
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<th>Condition</th>
<th>Inner</th>
<th>Outer</th>
<th>Safety</th>
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<tbody>
<tr>
<td>27.1</td>
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<td>K=1</td>
<td>24.09</td>
<td>23.65</td>
<td>26.00</td>
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</table>

Add 150 cc of Borated Water. Expt. 25.7

R=1 25.00 24.12 26.00
R=1 24.12 24.12

Add 200 cc of Borated Water Expt. 25.8
Exp 258

Instrument Check 88

<table>
<thead>
<tr>
<th>PM-1</th>
<th>Low Trip</th>
<th>OK</th>
<th>Alarm Trip</th>
<th>OK</th>
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<td>IC-1</td>
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<tr>
<td>IC-2</td>
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<td>IC-3</td>
<td>Response Calibration</td>
<td>III</td>
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<td>IC-4</td>
<td>Response Calibration</td>
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<td>CMA</td>
<td>Water Trip</td>
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Preliminary Check on 11-25-64

Room 113 Pressure Differential: 6.4" Hg
Red Light on and Personnel Check: III CC
Scarms and Bldg, Alarm Reset: III
Source Inserted: III
Safety Withdrawn: 2400
Controls Set In: 0.0, Out: 0.0
Reflector Water: 6" above 6c
Moderator Water: ~ 25"

<table>
<thead>
<tr>
<th>Exp</th>
<th>Condition</th>
<th>Inner</th>
<th>Outer</th>
<th>Safety</th>
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Add 200 cc of Boric Solution

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<th>Outer</th>
<th>Safety</th>
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<td>k &lt; 1</td>
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Add 200 cc of Boric Solution

<table>
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<th>Outer</th>
<th>Safety</th>
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<tbody>
<tr>
<td>260</td>
<td>k &gt; 1</td>
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<td>25.69</td>
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<tr>
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<td>25.43</td>
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12/26/64 → 1.385%
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<th>Outer</th>
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<th>SPV</th>
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<td>19.00</td>
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1.39 5%
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</tbody>
</table>

Preliminary Check on 11-27-64

Room 113 Pressure Differential 1.4"
Red Light On and Personnel Check 81A. cc.
Screws and Bldg, Alarm Reset 1A.
Source Inserted 1A.
Safety-Withdrawn 26.00
Controls Set Inn 25.16 Out 0.0
Reactor Water 6" above Be
Moderator Water ~ 25°

Exp. Condition Low Out High Safety 3 PN #
271 1>1 25.30 25.69 26.00
272 1>1 26.89 25.71 26.00
273 1>1 25.27 25.71 26.00
274 1>1 25.07 25.07 26.00
275 1<1 22.00 25.11 26.00 19.5°
276 1<1 21.00 25.11 26.00 19.6°

Add 100 cc of H2O
Add 400 cc of H2O
Add 10 cc of Borated Solution
Add 10 cc of Borated Solution

1.38 ± %
<table>
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<tr>
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<td>Add 200 cc</td>
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<tr>
<td></td>
<td>of H₂O</td>
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</tbody>
</table>

280 - 283 on page 148
12/14/64

10 am. Removed 18 liters of non-distilled H₂O
added 20 " " distilled H₂O.

Sample 8A taken 3:30 pm.

Result on 12/21/64 0.28%
Instrument Check on 12-14-67 Source

PM-1 Dow Trip OK Fast Trip OK
PM-2 Larm Trip OK
IC-1 $3 \times 10^{-11}$ Water Trip OK Fast Trip OK
IC-2 $1 \times 10^{-7}$ Water Trip OK
IC-3 legend Calibration SR
IC-4 Response 11
CRM Water Trip

Preliminary Check on 12-14-67

Room 113 Pressure Differential 14 psi
Red Light On and Personnel Check ✓ (Read)
Screams and Bldg, Alarm Reset
Source Inserted
Safety Withdrawn 26.00
Controls Set Inner 0.0 Outer 8.0
Reflector Water 6" above 8-
Moderator Water

Condition Inner Outer Safety
$k>1$ 20.05 20.17 26.00
$k>1$ 20.05 20.20 26.00
$k=1$ 20.05 20.00 26.00
$k=1$ 20.02 20.02 26.00
$k=1$ 20.045 20.045 20.88 3P-20
$k=1$ at end of 3P

Experi. 284 Stan. acc. p=14%

Drained, Filled with Deuter-43.2% and Reused.
Experiment 297

Instrument Check on 1/17/65 Source 100 vr

PM-1
Low Trip OK
Alarm Trip OK

PM-2

IC-1 5 - 3 x 10^{-5} Water Trip OK
Fast Trip OK

IC-2 3 x 10^{-11} Water Trip OK

IC-3 Response Calibration OK

IC-4 Response Calibration OK

CRM Water Trip

Preliminary Check on 1/17/65

Room 115 Pressure Differential 1.4

Red Light On and Personnel Check OK

Scrams and Blinds, Alarm Reset OK

Source Inserted OK

Safety Withdraw 2/100

Controls Set

NCE-0.0

Reflector Water 0.0 above Bc

Moderator Water 2.0

Condition Inner Outer Safety

k=1 26.60 22.50 23.00 2.5

k=1 22.00 20.15 26.00 26.00

k=1 24.00 20.81 24.00 23.17

k=1 20.00 20.81 26.00 21.92

NB. Linear plots show increase then decrease.

NB. Very slightly negative.

k=1 20.01 20.81 26.00 21.92

k=1 20.00 20.81 26.00 18.92

NB. All plots show decrease.

k=1 20.41 20.81 26.00 18.92

k=1 26.93 25.80 26.00 12.38

k=1 24.43 25.50 26.00 14.85

f			
\[ \text{Expt. 248} \]

- Added 100 cc of cone \( \text{B} \)-solution to moderator.
- Mixed in moderator storage tank for 8 min.
- Condition: \text{Tunnel Outer Safety Mod.} 1.0

| \( k \leq 1 \) | 20 | 21.20 | 26.00 | 26.81 |
| \( k = 1 \) | 20.00 | 21.20 | 26.00 | 26.81 |

\[ \text{N.B. (all shown only decrease)} \]

| \( k \leq 1 \) | 21.26 | 21.26 | 26.00 | 20.00 |
| \( k = 1 \) | 21.26 | 21.26 | 26.00 | 19.5 |

\[ \text{Expt. 249} \]

- Added 1 liter cone \( \text{B} \)-solution mixed to \( k \leq 1 \)
- Condition: \text{Tunnel Outer Safety Mod.} 1.0

| \( k \leq 1 \) | 21.39 | 26.00 | 26.00 | 27.0 |
| \( k = 1 \) | 20.80 | 20.80 | 26.00 | 27.0 |

Continued draining, showed no change in normal neutron decay for shutdown condition.
1-19-65  Put 0.333% moderator into system again.

---

N.B.
Comparison of results observed in Exp 297 with those of Exp 258 casts doubt on 297.

Since additional boron was small in quantity & effect the experimental conditions may be considered the same.

Seems to suggest moderator for Exp 297 may not have been well mixed.

May also suggest that effect would be more manifested in dilute boron solutions rather than more concentrated.
Sprint element D-24 centered in island of CE-3

Exp 518  Spent Plate D 3224 in slot 1 of D24
      DS 495  "  22  "  52  (N)
  1.78 l/hr  →  38.65 sec  →  19.40 $  →  36.47 %
          (16.47)

Exp 518  Spent Plate D 3242 in slot 2 of D24
      D 870  "  21  "  D24  (N)
  2.87 l/hr  →  62.31 sec  →  14.07 $  →  63.95 %
          (13.52)

Exp 520  Added spent plate D-3252 in slot 20 of D24
      D 3228 in slot 3 of D24
  3.52 l/hr  →  76.42 sec  →  12.13 $  →  75.37 %
          (11.79)
**Exps. 518**

**Instrument Check on 3-15-65 Source 10 mc/s**

<table>
<thead>
<tr>
<th>PM-1</th>
<th>Low Trip</th>
<th>Alarm Trip</th>
<th>OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM-2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IC-1</td>
<td>3x10&quot;</td>
<td>Water Trip</td>
<td>OK</td>
</tr>
<tr>
<td>IC-2</td>
<td>3x10&quot;</td>
<td>Water Trip</td>
<td>OK</td>
</tr>
<tr>
<td>IC-3</td>
<td>Responds</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IC-4</td>
<td>Responds</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CRM</td>
<td></td>
<td>Water Trip</td>
<td></td>
</tr>
</tbody>
</table>

**Preliminary Check on 3-15-65**

| Room 113 Pressure (inches) | 15 |
| Red Light On and Personnel Check | JW, AC |
| Screws and Bolts, unless Taped | JW |
| Source Inserted | JW |
| Safety Warden | O |
| Controls Set | |
| Reflectors Water | Combined |
| Moderator Water | |

---

<table>
<thead>
<tr>
<th>Exp.</th>
<th>Conditions</th>
<th>Safety</th>
<th>H₂O</th>
<th>Blending</th>
</tr>
</thead>
<tbody>
<tr>
<td>518</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>( k &gt; 1 )</td>
<td>16.75</td>
<td>26.26</td>
<td>2 spot plates</td>
</tr>
<tr>
<td></td>
<td>( k = 1 )</td>
<td>16.218</td>
<td>26.26</td>
<td></td>
</tr>
<tr>
<td>519</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>( k &gt; 1 )</td>
<td>13.63</td>
<td>26.26</td>
<td>4 &quot; &quot;</td>
</tr>
<tr>
<td></td>
<td>( k = 1 )</td>
<td>13.41</td>
<td>&quot;</td>
<td>&quot; &quot; &quot;</td>
</tr>
<tr>
<td>520</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>( h &gt; 1 )</td>
<td>11.87</td>
<td>26.32</td>
<td>6 &quot; &quot;</td>
</tr>
<tr>
<td></td>
<td>( h = 1 )</td>
<td>11.71</td>
<td>&quot;</td>
<td>&quot; &quot; &quot;</td>
</tr>
<tr>
<td>521</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>( k &gt; 1 )</td>
<td>14.61</td>
<td>26.07</td>
<td></td>
</tr>
</tbody>
</table>
Exp. 521  Spot plate D.324.3 in slot 19 of D.24
    D.326.1  "  4.7"  12.34
    1.76"/sec  → 36.91 sec  → 19.97 ft  → 85.37 ft/min  (10.58)

Exp. 522  Spot plate D.323.0 in slot 5 of D.24
    D.325.9  "  18.3"  13.74
    3.76"/sec  → 31.63 sec  → 11.54 ft  → 86.12 ft/min  (9.97)

Exp. 523  Spot plate D.321.9 in slot 6 of D.24
    D.322.3  "  17.9"  12.75
    2.88"/sec  → 62.53 sec  → 14.03 ft  → 93.53 ft/min  (8.64)

Exp. 524  Spot plate D.324.1 in slot 7 of D.24
    D.324.6  "  16.2"  12.57
    1.61"/sec  → 34.95 sec  → 20.67 ft  → 83.67 ft/min  (7.93)

Exp. 526  3 8° strips in E.A.; 2 8° strips in O.A.
    1.77"/sec  → 38.63 sec  → 19.40 ft  → 27.13 ft/min  (17.86)

Exp. 527  5 8° strips in E.A.; 2 8° strips in O.A.

Instrument Check on 3-16-65 Source JOY

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Condition</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM-1</td>
<td>Low Trip</td>
<td>OK</td>
</tr>
<tr>
<td>PM-2</td>
<td>Alarm Trip</td>
<td>OK</td>
</tr>
<tr>
<td>IC-1</td>
<td>&gt;3 x 10^-4&quot;</td>
<td>Water Trip</td>
</tr>
<tr>
<td>IC-2</td>
<td>&gt;3 x 10^-4&quot;</td>
<td>Valve</td>
</tr>
<tr>
<td>IC-3</td>
<td>Responds</td>
<td>75</td>
</tr>
<tr>
<td>IC-4</td>
<td>Responds</td>
<td>Calibration</td>
</tr>
<tr>
<td>CRM</td>
<td>Valve Trip</td>
<td></td>
</tr>
</tbody>
</table>

Preliminary Check on 3-16-65

Room 113 Pressure Differential 1/5``
Red Light On and Personnel Check (Exit) UN
Scram and Bldg, Alarm Reset UN, all alc
Source Inserted UN
Safety Withdrawn UN
Controls Set
Reflector Water 26.26
Moderator Water

<table>
<thead>
<tr>
<th>Expno</th>
<th>Condition</th>
<th>Safety</th>
<th>H2O</th>
<th>Island</th>
</tr>
</thead>
<tbody>
<tr>
<td>521</td>
<td>k = 1</td>
<td>10.70&quot;</td>
<td>26.26</td>
<td>8 plates</td>
</tr>
<tr>
<td></td>
<td>k = 1</td>
<td>11.10&quot;</td>
<td>26.26</td>
<td>8 plates</td>
</tr>
<tr>
<td>522</td>
<td>k &gt; 1</td>
<td>9.56&quot;</td>
<td>26.26</td>
<td>10 plates</td>
</tr>
<tr>
<td></td>
<td>k = 1</td>
<td>9.43&quot;</td>
<td>26.26</td>
<td>10 plates</td>
</tr>
<tr>
<td>523</td>
<td>k &gt; 1</td>
<td>8.72&quot;</td>
<td>26.26</td>
<td>12 plates</td>
</tr>
<tr>
<td></td>
<td>k = 1</td>
<td>8.57&quot;</td>
<td>26.26</td>
<td>12 plates</td>
</tr>
<tr>
<td>524</td>
<td>k &gt; 1</td>
<td>8.36&quot;</td>
<td>24.27</td>
<td>14 plates</td>
</tr>
<tr>
<td></td>
<td>k = 1</td>
<td>2.31&quot;</td>
<td>26.29</td>
<td>14 plates</td>
</tr>
<tr>
<td>525</td>
<td>k &gt; 1</td>
<td>21.00&quot;</td>
<td>24.29</td>
<td>14 plates</td>
</tr>
<tr>
<td>526</td>
<td>k &gt; 1</td>
<td>18.47&quot;</td>
<td>26.29</td>
<td>14 plates</td>
</tr>
<tr>
<td></td>
<td>k = 1</td>
<td>17.70&quot;</td>
<td>26.29</td>
<td>14 plates</td>
</tr>
<tr>
<td>527</td>
<td>k &gt; 1</td>
<td>26.00&quot;</td>
<td>24.29</td>
<td>14 plates</td>
</tr>
</tbody>
</table>

68° strips inner annulus
22.8° " outer "
38° " inner "
22.8° " outer "
58° strips inner annulus
52.2\textsuperscript{9} 30\textsuperscript{0} I.A. + 23\textsuperscript{0} O.A.

\begin{align*}
52.2 & \ 
2.83 \text{ dir.} \rightarrow 61.44 \text{ arc} \rightarrow 19.21 \phi \rightarrow 23.57 \% \quad (17.53) \\
53.0 & \ 
6.53 \text{ dir.} \rightarrow 141.77 \text{ arc} \rightarrow 7.46 \phi \rightarrow 38.26 \% \quad (16.763)
\end{align*}

53.1 \ 
18\textsuperscript{0} I.A. + 23\textsuperscript{0} O.A.

\begin{align*}
53.1 & \ 
4.36 \text{ dir.} \rightarrow 94.66 \text{ arc} \rightarrow 10.31 \phi \rightarrow 19.81 \% \quad (15.337)
\end{align*}

53.2 \ 
23\textsuperscript{0} O.A.

\begin{align*}
53.2 & \ 
2.6 \text{ dir.} \rightarrow 56.45 \text{ arc} \rightarrow 15.08 \phi \rightarrow 59.14 \% \quad (14.785)
\end{align*}

53.3 \ 
29\textsuperscript{0} O.A.

\begin{align*}
53.3 & \ 
0.94 \text{ dir.} \rightarrow 20.41 \text{ arc} \rightarrow 23.20 \phi \rightarrow 30.04 \% \quad (17.77)
\end{align*}

53.4 \ 
33\textsuperscript{0} O.A.

\begin{align*}
53.4 & \ 
48 \text{ dir.} \rightarrow 1042 \text{ arc} \rightarrow 1.21 \phi
\end{align*}

53.5 \ 
31\textsuperscript{0} O.A.

\begin{align*}
53.5 & \ 
2.09 \text{ dir.} \rightarrow 44.27 \text{ arc} \rightarrow 17.79 \phi \rightarrow 17.77 \% \quad (17.32)
\end{align*}
<table>
<thead>
<tr>
<th>Type</th>
<th>Condition</th>
<th>Safety</th>
<th>H.O.</th>
<th>Island</th>
<th>48° Strips inner annulus</th>
</tr>
</thead>
<tbody>
<tr>
<td>528</td>
<td></td>
<td>24.00</td>
<td>2630</td>
<td>14 plates</td>
<td>23.6°</td>
</tr>
<tr>
<td>529</td>
<td>l&gt;1</td>
<td>18.88</td>
<td>&quot;</td>
<td>&quot;</td>
<td>20° I.A. + 20° O.A.</td>
</tr>
<tr>
<td></td>
<td>l=1</td>
<td>19.27</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>530</td>
<td>l&gt;1</td>
<td>16.96</td>
<td>&quot;</td>
<td>&quot;</td>
<td>20° I.A. + 23° O.A.</td>
</tr>
<tr>
<td></td>
<td>l=1</td>
<td>16.76</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>531</td>
<td>l&gt;1</td>
<td>15.74</td>
<td>&quot;</td>
<td>&quot;</td>
<td>18° I.A. + 23° O.A.</td>
</tr>
<tr>
<td></td>
<td>l=1</td>
<td>15.57</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>532</td>
<td>l&gt;1</td>
<td>14.88</td>
<td>&quot;</td>
<td>&quot;</td>
<td>23° O.A.</td>
</tr>
<tr>
<td></td>
<td>l=1</td>
<td>14.62</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>533</td>
<td>l&gt;1</td>
<td>18.35</td>
<td>&quot;</td>
<td>&quot;</td>
<td>29° O.A.</td>
</tr>
<tr>
<td></td>
<td>l=1</td>
<td>17.41</td>
<td>&quot;</td>
<td>&quot;</td>
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<tr>
<td>534</td>
<td>l≈1</td>
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<td>&quot;</td>
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<tr>
<td>535</td>
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<td>&quot;</td>
<td>31° O.A.</td>
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<tr>
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<td>l=1</td>
<td>18.89</td>
<td>&quot;</td>
<td>&quot;</td>
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</table>

Instrument Check on 17 Jan 65
Source 10 mC

<table>
<thead>
<tr>
<th>PM-1</th>
<th>Low Trip</th>
<th>OK</th>
<th>Alarm Trip</th>
<th>OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM-2</td>
<td>Alarm Trip</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IC-1</td>
<td>7 X 10^-2&quot; Meter Trip</td>
<td>OK</td>
<td>Fast Trip</td>
<td>OK</td>
</tr>
<tr>
<td>IC-2</td>
<td>7 X 10^-2&quot; Meter Trip</td>
<td>OK</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IC-3</td>
<td>Respond Calibration</td>
<td>F.T.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IC-4</td>
<td>Respond Calibration</td>
<td>F.T.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CRM</td>
<td>Meter Trip</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Preliminary Check on 3-17-65

Room 113 Pressure Differential 1.5"
Red Light On and Personnel Check SLA F.T.
Scraps and Blinds, Alarm Reset SLT.
Source Inserted SLT.
Safety Withdrawn SLR.
Controls Set SLT.
Reflectors Water Combined
<table>
<thead>
<tr>
<th>Page</th>
<th>33</th>
<th>(8^\circ) Ship</th>
<th>O.A.</th>
<th>2.03</th>
</tr>
</thead>
<tbody>
<tr>
<td>537</td>
<td>32</td>
<td>(8^\circ) Ship</td>
<td>O.A.</td>
<td>1.37</td>
</tr>
<tr>
<td>538</td>
<td>28</td>
<td>(8^\circ) Ship</td>
<td>O.A.</td>
<td>1.75</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>17.08</td>
</tr>
<tr>
<td>539</td>
<td>24</td>
<td>(8^\circ) Ship</td>
<td>O.A.</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td>15.11</td>
</tr>
<tr>
<td>540</td>
<td>20</td>
<td>(8^\circ) Ship</td>
<td>O.A.</td>
<td>1.35</td>
</tr>
<tr>
<td>541</td>
<td>16</td>
<td>(8^\circ) Strips</td>
<td>O.A.</td>
<td>0.84</td>
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<tr>
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<td>16.94</td>
</tr>
<tr>
<td>542</td>
<td>12</td>
<td>(8^\circ) Strips</td>
<td>O.A.</td>
<td>1.02</td>
</tr>
<tr>
<td>543</td>
<td>8</td>
<td>(8^\circ) Strips</td>
<td>O.A.</td>
<td>2.24</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td>9.18</td>
</tr>
<tr>
<td>544</td>
<td>4</td>
<td>(8^\circ) Strips</td>
<td>O.A.</td>
<td>1.21</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9.00</td>
</tr>
<tr>
<td>545</td>
<td></td>
<td>Removed Spurt plate: 3241 from slot 7 and 3246 from slot 16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>546</td>
<td>12</td>
<td>(8^\circ) Strips</td>
<td>O.A.</td>
<td>2.64</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12.19</td>
</tr>
<tr>
<td>547</td>
<td>20</td>
<td>(8^\circ) Strips</td>
<td>O.A.</td>
<td>1.74</td>
</tr>
<tr>
<td>548</td>
<td>28</td>
<td>(8^\circ) Strips</td>
<td>O.A.</td>
<td>5.91</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<td>22.06</td>
</tr>
<tr>
<td>549</td>
<td></td>
<td>Removed Spurt plate 3217 and 3223</td>
<td>5.53</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td>(22.37)</td>
</tr>
<tr>
<td>Exp</td>
<td>Condition</td>
<td>Safety</td>
<td>H2O</td>
<td>Island</td>
</tr>
<tr>
<td>-----</td>
<td>-----------</td>
<td>--------</td>
<td>-----</td>
<td>--------</td>
</tr>
</tbody>
</table>
| 536 | k = 1     | 26.00  | 24.28| 14 plates | 32 B° strips in O.A. |}
|     |           | 62.77  | 54.28|        |          |
| 537 | k > 1     | 21.33  | 26.28|        | 32 B° strips |}
|     |           | 71.76  | 76.7 |        |          |
| 538 | k = 1     | 17.22  | 28 B° strips |          |}
| b = 1 | 16.77  |        |          |          |
| 539 | h > 1     | 15.24  |        | 24 B° strips O.A. |}
| b = 1 | 14.99  |        |          |          |
| 540 | h > 1     | 13.91  |        | 20 B° strips |}
| b = 1 | 13.54  |        |          |          |
| 541 | k = 1     | 12.54  |        | 16 B° |          |}
|     |           | 12.38  |        |        |          |
| 542 | k > 1     | 11.23  |        | 12 B° |          |}
| k = 1 | 11.15  |        |          |          |
| 543 | k >= 1    | 10.22  |        | 8 B°  |          |}
|     |           | 10.01  |        |        |          |
| 544 | k = 1     | 9.26   |        | 4 8°  |          |}
| k = 1 | 8.93   |        |          |          |
| 545 | k = 1     | 9.24   | 26.25 | 12 plates | 4 8° |}
| k = 1 | 9.69   |        |          |          |
| 546 | k = 1     | 12.63  | 26.27 | 12 B° |          |}
| k = 1 | 12.13  |        |          |          |
| 547 | k > 1     | 15.28  |        | 20 B° |          |}
| k = 1 | 14.81  |        |          |          |
| 548 | h > 1     | 26.00  |        | 28 |          |}
| b = 1 | 20.99  |        |          |          |
| 549 | h > 1     | 26.00  | 10 plates | 24 |          |}
| b = 1 | 20.96  |        |          |          |
55-0  20 B° Strips 0A

\[
2.34 \text{ in/sec} \to 50.80 \text{ sec} \to 16.21 \text{ f} \to 37.70 \%\text{in}
\] 16.385

55-1  12 B° Strips 0A

\[
2.52 \text{ in/sec} \to 54.71 \text{ sec} \to 15.41 \text{ f} \to 70.05 \%\text{in}
\] 13.31

55-2  4 B° Strips 0A

\[
3.25 \text{ in/sec} \to 70.56 \text{ sec} \to 12.86 \text{ f} \to 82.97 \%\text{in}
\] 10.672

Expn 553  4 B° Sprites; 10 Sport plates

\[
10.1 \text{ in/sec} \to 219.28 \text{ sec} \to 5.15 \text{ f} \to 88.64 \%\text{in}
\]
12.394

\[
2.08 \text{ in/sec} \to 45.16 \text{ sec} \to 12.54 \text{ f} \to 85.83 \%\text{in}
\]
(10.63)

17.54 \% = 94.40 \%\text{in}
(10.702)

Expn 554  9° B° Stripes; 10 Sport plates

\[
2.48 \text{ in/sec} \to 53.84 \text{ sec} \to 15.58 \text{ f} \to 89.19 \%\text{in}
\]
(7.551)

\[
7.47 \text{ in/sec} \to 162.18 \text{ sec} \to 6.67 \text{ f}
\]

Removed startups 32.30 from slot 5 and 32.57 from slot 18

Expn 555  9° B° Stripes; 7 Sport plates

\[
2.96 \text{ in/sec} \to 64.26 \text{ sec} \to 13.76 \text{ f} \to 87.16 \%\text{in}
\]
10.539
<table>
<thead>
<tr>
<th>Exp.</th>
<th>Condition</th>
<th>Safety</th>
<th>$H_2O$</th>
<th>Island</th>
<th>Coment</th>
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### Instrument Check on 3-18-65 Source 10 mi

- **PM-1** Low Trip OK Alarm Trip OK
- **PM-2** Alarm Trip
- **IC-1 $\geq 3 \times 10^{-4}$** Meter Trip OK Fast Trip OK
- **IC-2 $\geq 3 \times 10^{-4}$** Meter Trip J.T.T. OK
- **IC-3** Responds Calibration J.T.T.
- **IC-4** Responds Calibration J.T.T.
- **CRM** Meter Trip

### Preliminary Check on 3-18-65

- Noise II3 Pressure-Differential 1.5"
- Red Light On and Personnel Check S/R J.T.T.
- Screams and Bldg, Alarm Reset OK J.T.T.
- Source Inserted 6" K.
- Safety Withdrawn 6
- Controls Set
- Reflector Water Combined
- Moderator Water
556 2.28 deg. → 49.50 sec → 16.50 ft 10.32% → 79.46 ft
8.19 deg. → 177.81 sec → 61.17 ft

557 2.36 deg. → 51.02 sec → 16.16 ft → 60.52% (14.67)

558 3.00 deg. → 65.15 sec → 13.63 ft
5.07 deg. → 110.29 sec → 7.15 ft

559 20 B° Strip; 8 infant plates
18.7 deg. → 405.99 sec → 2.91 ft → 0.78 ft/min

560 Removed infant plates 3261 from slot 4 and 3243 from slot 15.
6 infant plates + 16 B° strips

561 11 B° strips; 6 infant plates
2.33 deg. → 50.57 sec → 16.34 ft → 37.99% (14.67)

562 1.96 deg. → 41.25 sec → 18.61 ft
4.00 deg. → 86.84 sec → 16.02 ft

565 90 B° strips; 4 infant plates
1.81 deg. → 37.30 sec → 19.20 ft → 62.95% (13.53)

566 3 B° strips; 4 infant plates
2.04 deg. → 44.29 sec → 17.77 ft → 50.20% (14.91)

567 7 B° strips; 4 infant plates
3.82 deg. → 82.94 sec → 11.41 ft → 31.09 ft/min (17.37)
<table>
<thead>
<tr>
<th>Exp.</th>
<th>Condition</th>
<th>Safety</th>
<th>% O.</th>
<th>Island</th>
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<tr>
<td>562</td>
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<td>7</td>
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<td>564</td>
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</table>
568. 10 B° Strip in OA. j 4 Spent Plate. 4.00
18.38 div. 399.00 ac. 3.01 $ 10.75 yrs (23.83)

570. Have removed Spent plate 2870 from set 21 and 3242 from set 2.
4 B° Strip. j 2 Spent Plate. 4.82
7.25 div. 157.40 ac. 6.84 $ 1.42 yrs (22.79)

571. 2 B° Strip. 2 Spent Plate. 6.69
2.25 div. 48.85 ac. 16.65 $ 24.89 yrs (18.07)

572. Fr. B° Strip. 2 Spent Plate. 5.4
1.69 div. 36.69 ac. 20.05 $ 37.13 yrs (18.07)

573. Have removed Spent plate D-3224 and D-5495 T. 45 $ 2.421.
3.98 div. 76.41 ac. 11.06 $ 40.96 yrs (16.07)

574. Have removed Spent plate D-3224 and D-5495 T. 40 $ 3.20.
2.26 div. 49.07 ac. 16.60 $ 39.65 yrs (15.95)
Instrument Check on 3-19-45 Source: "".

<table>
<thead>
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<th>Material</th>
<th>Condition</th>
<th>Test Trip</th>
<th>Other Trip</th>
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<td>Alarm Trip OK</td>
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<td>PM-2</td>
<td>Alarm Trip</td>
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<td></td>
</tr>
<tr>
<td>IC-1</td>
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<td>Meter Trip OK</td>
<td>Fast Trip OK</td>
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<tr>
<td>IC-2</td>
<td>&gt; 3 x 10^-10</td>
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<tr>
<td>IC-3</td>
<td>Response</td>
<td>Calibration OK</td>
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</tr>
<tr>
<td>IC-4</td>
<td>Response</td>
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<tr>
<td>CRM</td>
<td>Meter Trip</td>
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</table>

Preliminary Check on 3-19-45

Room 113 Pressure Differential: 1.5".
Red Light On-and-Off Check: After 1-4-45.
Serious and Bldg. Alarm Reset: After 1-4-45.
Source Inserted: After.
Safety Withdrawn: After.
Control Set: After.
Reflector Water: Combine.
Moderator Water: After.

<table>
<thead>
<tr>
<th>Expr.</th>
<th>Cooling</th>
<th>Safety</th>
<th>Water</th>
<th>Island</th>
<th>Comments</th>
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<td>5.74</td>
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<td>5.75</td>
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<td>15.75</td>
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</table>
575  Mould Plate 0.3224 + D.5795  in slot 4 + 19.
     1.98 lb/ft² -> 42.99 mpa -> 18.12 ft -> 42.64 ft/m

576  Mould Plate 0.3224 + D.5795  in slot 5 + 18.
     1.92 lb/ft² -> 41.68 mpa -> 18.09 ft -> 43.20 ft/m

577  Mould Plate 0.3224 + D.5795  in slot 6 + 17.
     2.5 lb/ft² -> 54.27 mpa -> 15.49 ft -> 44.90 ft/m

578  Mould Plate 0.3224 + D.5795  in slot 7 + 16.
     1.84 lb/ft² -> 39.95 mpa -> 19.00 ft -> 43.75 ft/m

579  Replaced all 16 spent plates in original slot.
     2.04 lb/ft² -> 44.27 mpa -> 17.77 ft -> 43.87 ft/m

580  Removed spent element, tube cleaning and put replaced and
     replaced element in reactor, side that was on nuc mat.
     2.22 lb/ft² -> 48.20 mpa -> 16.20 ft -> 72.92 ft/m

581  Removed spent plate 0.3241 + D.3246  from slot 7 + 16.
     7.53 lb/ft² -> 54.93 mpa -> 15.37 ft -> 100.47 ft/m

582  Cleared spent plate 0.3241 in slot 7, D.3246 = 16, D.3260 = 8, D.3259 = 1.
     2.27 lb/ft² -> 49.28 mpa -> 16.85 ft -> 94.57 ft/m

583  3 B'" Strip in 0.4; 16 spent Plates
     2.59 lb/ft² -> 56.23 mpa -> 15.12 ft -> 77.55 ft/m

584  6 B'" Strip in 0.4; 16 spent Plates
     2.66 lb/ft² -> 79.46 mpa -> 11.78 ft -> 102.93 ft/m

585  36 B'" Strip in 0.4; 16 spent Plates
     4 lb/ft² -> 755.27 mpa -> 1.42 ft
<table>
<thead>
<tr>
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<th>Condition</th>
<th>Safety</th>
<th>H_2O</th>
<th>Langle</th>
<th>Connect</th>
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<td>26.36</td>
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<td>16 Plt</td>
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<td>6 B^10</td>
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<tr>
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<td>3 B^10</td>
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</tbody>
</table>
Have removed CE-3 and placed CE-2 on pedestal in tank.

586  Spent plates D-3224 and D-5495 in slft 7 4/16

587  Added spent plate D-3242 in slft 2

4 B" strip in QA

588  4 spent plates 3 B" strip 5.81

4.82 lb/ft → 93.79 lb → 10.39 ft → 1.76 %

(22.46)

589  6 spent plates 9 B" strip 328

1.76 lb/ft → 40.38 lb → 17.37 ft → 57.53 %

(14.449)
Instrument Check on 22Mar 65 Source 10mcV

<table>
<thead>
<tr>
<th>PM-1</th>
<th>Low Trip</th>
<th>OK</th>
<th>Alarm Trip</th>
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<tr>
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<td>OK</td>
<td>Fast Trip</td>
</tr>
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<td>IC-3</td>
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<td>IC-4</td>
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<td>CRM</td>
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</tr>
</tbody>
</table>

Preliminary Check on 3-22-65

- Room 113 Pressure Differential: 1.5"
- Red Light On and Personnel Check: 90°, 2.4 K
- Sirens and Bldg. Alarm Reset: OK, 1/2
- Source Inserted: 1/2
- Safety Withdrawn: 0.0
- Controls Set
- Reflector Water: Combined
- Moderator Water

<table>
<thead>
<tr>
<th>Exp.</th>
<th>Condition</th>
<th>Safety</th>
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</tbody>
</table>

1/2
590 4 Spect Plates in Island
   2.9" dia. → 52.11 sq. in. → 15.93 $\rightarrow$ 33.97 $^\prime$  \( (17.07) \)

591 4 Spect Plates ; 3 8" Strips = 0.16
   6.17 sq. → 133.96 sq. → 7.82 $\rightarrow$ 9.63 $^\prime$ \( (21.90) \)

592 Have moved Spect element off center ~ 9/16"
   Had to raise it 1/4" by placing a 3/4" plywood spacer
   under it.
   20" Strips
   3.1 dia. → 67.30 sq. → 13.31 $\rightarrow$ 13.05 $^\prime$ \( (19.85) \)

593 Spect element same as 592. 4 8" Strips
   3.67 dia. → 79.03 → 11.83 $\rightarrow$ 31.97 $^\prime$ \( (17.32) \)

594 Replaced Spect element in center of Island at PA
   3/4" Plywood spacer on bottom.
   2.43 dia. → 52.76 sq. → 15.70 $\rightarrow$ 33.55 \( (17.16) \)

595 Same as 594 ; 2 8" Strips at 0 A
   1.67 dia. → 35.40 sq. → 20.43 $\rightarrow$ 14.29 $^\prime$ \( (19.63) \)
Instrument Check on 3-26-65 Source 10 mcY

<table>
<thead>
<tr>
<th>PM-1</th>
<th>Low Trip</th>
<th>OK</th>
<th>Alarm Trip</th>
<th>OK</th>
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<tbody>
<tr>
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<tr>
<td>IC-1</td>
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<tr>
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<tr>
<td>IC-3</td>
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<tr>
<td>IC-4</td>
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<tr>
<td>CRM</td>
<td></td>
<td></td>
<td>Meter Trip</td>
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</table>

Preliminary Check on 3-26-65

Room 113 Pressure Differential 1.5"  
Red Light On and Personnel Check 1/8 R.  2/8 R.
Source Inserted 1/8 R.
Safety Withdrawal 0.0
Controls Set 0
Reflector Water 3
Moderator Water

<table>
<thead>
<tr>
<th>Exp.</th>
<th>Condition</th>
<th>Safety</th>
<th>H2O</th>
<th>Lead</th>
<th>Container</th>
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<tbody>
<tr>
<td>590</td>
<td>1 &gt; 1</td>
<td>17.33</td>
<td>25.97</td>
<td>Y-Spade</td>
<td></td>
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<tr>
<td></td>
<td>1 = 1</td>
<td>16.56</td>
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<tr>
<td>591</td>
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<td>22.50</td>
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<td>&quot;</td>
<td>30°C Ship 0.4 A</td>
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<tr>
<td>592</td>
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<td>593</td>
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<tr>
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<td>1 = 1</td>
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<td>&quot;</td>
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<td>595</td>
<td>1 &gt; 1</td>
<td>20.36</td>
<td>&quot;</td>
<td>&quot;</td>
<td>25°C Ship 0.4 A</td>
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<td>1 = 1</td>
<td>18.93</td>
<td>&quot;</td>
<td>&quot;</td>
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</tbody>
</table>

Mass of Inner HFIR fuel element = 9.611 kg 0.205
Mass of Outer HFIR fuel element = 6.816 kg 0.205
Total 9.427 kg 0.005

\[ 1 = 9.45 \text{ SS Net} = 10.119 \text{ kg} \text{ inner} \]
[autor co] [R.K.P.]
<table>
<thead>
<tr>
<th>INSTRUMENT</th>
<th>RANGE</th>
<th>TRIP</th>
<th>SOURCE</th>
<th>SET</th>
<th>START-UP</th>
</tr>
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<tbody>
<tr>
<td>K-1 3/10 12</td>
<td>Meter</td>
<td>11'</td>
<td>1'</td>
<td>10 x 10' 12</td>
<td></td>
</tr>
<tr>
<td>K-2</td>
<td>11'</td>
<td>Meter</td>
<td>24</td>
<td>1'</td>
<td>1'</td>
</tr>
<tr>
<td>R-1</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>R-2</td>
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</tr>
<tr>
<td>PM-1</td>
<td>700 V</td>
<td>Alarm</td>
<td>120'</td>
<td>5002</td>
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</tr>
<tr>
<td>PM-2</td>
<td>1200 V</td>
<td>Low</td>
<td>120'</td>
<td>9000</td>
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</tr>
</tbody>
</table>

LOG & CALIBRATE OPERATE SOURCE No. 8-60

DUMP WELL, FREE LIGHT

HEIR, four and outer fuel element only.

START-UP CHECK-LIST

Equipment checked by [signature] Personnel check by [name]

Instruments and safety checked and reset by [signature]

Source in checked by [signature] Source No. M-13

Emergency equipment in control room checked by [signature]

Instruments in trip circuit: K-1 -2 PM-2

Red light on by [signature] Time 1005

Start-up OK'd by [signature] E. & D.C. 7-27-65

When H-0 at top of table, scale reads 0.0 cm.

Fuel rate = 5.75 cm min. Fuel rate reset at 3.3 cm

Dump rate = 7.9 cm min. 1.25 cm

1600 Water level = 13.4 ft. 3.5 cm.

System outlet critical. Prog.
74  7-27-65

1230  added first fuel element in inner core fire.
      Element box & fuel plate. (more of 2 fuel plates = 28.12
      0235).

1344  Water hgt = 117.90 cm. System very sub-critical.
      Drain: Tag n = .005

1402  added two more spent fuel plates to element. (more
      of 2 fuel plates = 27.52 cm + 0235). Total mass of
      spent fuel now = 55.9 gm. 0235

1438  Water hgt = 107.00 cm. System sub-critical.
      Drain: Tag n = .012.

1454  added two more spent fuel plates to element. (more
      of 2 fuel plates = 28.3 gm. 0235). Total mass of spent
      fuel now = 84.2 gm. 0235. Total mass of 2H 1.913 kg.
      0235.

1527  + Hot Water hgt = 96.00 cm. 0.5 55 cm
      t = 145.5°C = 748° = 1232°F.

1535  Water hgt = 95.95 cm. System just critical.
      Drain: 1 cu. in. above top of fuel x 1.3.
<table>
<thead>
<tr>
<th>INSTRUMENT</th>
<th>RANGE</th>
<th>TRIP</th>
<th>SOURCE</th>
<th>SET</th>
<th>START-UP</th>
</tr>
</thead>
<tbody>
<tr>
<td>K-1</td>
<td>3 x 10^-2</td>
<td>Meter</td>
<td>✔️</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Feet</td>
<td>✔️</td>
<td></td>
<td></td>
</tr>
<tr>
<td>K-3</td>
<td></td>
<td>Meter</td>
<td>✔️</td>
<td></td>
<td></td>
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<td></td>
<td>Feet</td>
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<td></td>
</tr>
<tr>
<td>R-3</td>
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<td></td>
</tr>
<tr>
<td>PM-1</td>
<td>700 V</td>
<td>Alarm</td>
<td>✔️</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PM-2</td>
<td>1200 V</td>
<td>Low</td>
<td>✔️</td>
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<td></td>
</tr>
</tbody>
</table>

LOG N CALIBRATE: OPERATE: SOURCE No.: B-80

DUMP WELL FROSE LIGHT: 

**START-UP CHECK LIST**

- Equipment checked by: AM
- Personnel check by: AM
- Instruments and safeties checked and reset by: AM
- Source in checked by: AM
- Source No.: M-43
- Emergency equipment in control room checked by: AM
- Instruments in trip circuit: K-1-2 PM-1-2
- Red light on by: ORT
- Time 07:50
- Start-up OK'd by: ORT AM
- Date: 7-28-65

added 4.031" x 7/8 x 2 1/4" Naturalboro Stainless Steel strip, 0.92 weight per unit length. (Horiz.)
Water ht. = 107.00 cm. System slightly sub critical.

-Pr: T = 136.9°C cc = 14.1 f

0900. Remove two of the 0.01" x 0.76" x 2.4" natural boron strips and added 10 0.01" x 0.76" x 2.4" stainless steel strips.

0920. Water ht = 104.70 cm. System slightly sub critical

-Pr: 367.23°C cc = 2.4 f

0925. Adder H2O to ~ 111.0 cm no change in -Pr:

0929. Drain H2O to ~ 75.0 cm.

0943. Removed three 0.01" x 0.76" x 2.4" stainless steel strips.

1001. Drain to 20.0 cm.

1101. Water ht = 103.65 cm. System just critical.

1215. Removed remaining (natural boron + stainless steel) brass boronanton factor one + spent fuel element with 6 fuel plates. Moved the BF3 chamber to closer to fissioner. (BF3 chamber supplied by Dr. Ito)"
<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>13:11</td>
<td>Water at 100.55 cm. syphon just critical, η = 41</td>
</tr>
<tr>
<td>14:46</td>
<td>Water at 105.00 cm.</td>
</tr>
<tr>
<td></td>
<td>T = 25.84° C, P = 4564</td>
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<tr>
<td>14:27</td>
<td>Water at 100.30 cm. syphon very very slightly +1%</td>
</tr>
<tr>
<td></td>
<td>η = 3.5, start of power run for D.H. Ray's B.P. charger, B.F. Chambers &amp; Co. - 37%</td>
</tr>
<tr>
<td>14:31</td>
<td>Water at 100.70 cm. syphon very very slightly -1%</td>
</tr>
<tr>
<td></td>
<td>η = 3.5, PM - 17 at 740 pm</td>
</tr>
<tr>
<td>15:02</td>
<td>Water at 100.70 cm. syphon just critical, η = 3.5</td>
</tr>
<tr>
<td></td>
<td>PM - 2 = 17 at 740 pm</td>
</tr>
<tr>
<td>15:05</td>
<td>Drain</td>
</tr>
<tr>
<td>15:10</td>
<td>Drain at 7.90 cm, low reading - 6.0% away</td>
</tr>
<tr>
<td></td>
<td>Specific weight = 840 kg/m³ at center of water</td>
</tr>
<tr>
<td></td>
<td>area at center = 1374</td>
</tr>
<tr>
<td></td>
<td>Drain</td>
</tr>
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</table>
INSTRUMENT CHECK

<table>
<thead>
<tr>
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<th>RANGE</th>
<th>TRIP</th>
<th>SOURCE DISTANCE</th>
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<th>START-UP RANGE</th>
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<td>3 x 10</td>
<td>Meter</td>
<td>1''</td>
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<td></td>
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<tr>
<td>K-2</td>
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<td>Meter</td>
<td>2''</td>
<td></td>
<td></td>
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<tr>
<td>PM-1</td>
<td>700</td>
<td>Alarm</td>
<td>cont.</td>
<td>5000</td>
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<tr>
<td>PM-2</td>
<td>1200</td>
<td>Low</td>
<td>14''</td>
<td>5000</td>
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</table>

LOG N CALIBRATE OPERATE SOURCE No. B-80
DUMP WELL PROBE LIGHT

START-UP CHECK LIST

Equipment checked by [Signature]
Instruments and safety checked and reset by [Signature]
Source in checked by [Signature] Source No. M-43
Emergency equipment in control room checked by [Signature]
Instruments in trip circuit: K-1-2 PM-1-2
Red light on by [Signature] Time 0800
Start-up OK'd by [Signature] Date 7-29-65

0750 Outer core reading at center of core = 18 MW
0920 Water at 100.70 cm³ system and continual. Log H - 0.12

Added same # M-227 will M-43. Log H = 0.75
K = 1 = 57.5 \times 10^{-5}. PM - 2 = 1.5 - 9000V. For 20 min.
mean D.M. Fig.

1023 Renamed both sources: From now for D.M. Fig.

1248 Added 8\² 0.031" X 29" Stainless Steel Strip.
S = 2 = 10.7 J. Also same M-43 and M-227.
For min: for D.M. Fig. Total position added = 50.299.
Water at 100.70 cm³ temp = 24.5°C
Log H = 0.75. K = 54.5 \times 10^{-11}. PM - 2 = 0.5 - 0.9000V

1420 Added two more Enriched Boron Stainless Steel (Type 304) Strip 0.031" X 29" End 5 Natural Boron Stainless Steel (0.031" X 29") Strip to outer element. Water at 100.70 cm³. Total
power now = \frac{5.41}{5.09} \text{ cm}³ Run for D.M. Fig.
Log H = 0.25 K = 3.21 \times 10^{-11}. PM - 2 = 1.0 - 8000V.
7-29-65

14:54  Drain H2O to ~50.9. Removed all steps added except 4 Camphor Boro. $	ext{HNO}_3$ in coils.

New in coil ~50:

---

15:20  Water, ft = 100,70 cm$^2$. Swirl M-43, M-227 in.

Same gas with suction on above. Run for ~6 minutes:

Log $\omega = 1.15$  $K = \frac{3}{3} \times 10^{-7}$  PM 203 3-700u

16:00  Drain:

No: Since (core + spent plants + BE chamber) was critical flooded, the amount of poison inserted represents the subcriticality of the flooded core.
INSTRUMENT CHECK

<table>
<thead>
<tr>
<th>INSTRUMENT</th>
<th>RANGE</th>
<th>TRIP</th>
<th>SOURCE DISTANCE</th>
<th>SET</th>
<th>START-UP RANGE</th>
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<td>0 x 10⁻¹²</td>
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<td>K-2</td>
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<td>R-2</td>
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<tr>
<td>PM-1</td>
<td>700 V</td>
<td>Alarm</td>
<td>C</td>
<td>500 V</td>
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<td>PM-2</td>
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<td>1 1/4&quot;</td>
<td>900 V</td>
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LOG N' CALIBRATE OPERATE SOURCE NO. B-50
DUMP WELL PROBE LIGHT

START-UP CHECK LIST

Equipment checked by AKIN Personnel check by E.D.C

Instruments and safety checked and reset by AKIN

Source in checked by AKIN Source No. M-43

Emergency equipment in control room checked by E.D.C

Instruments in trip circuit: K-1 - L PM-1 - L

Red light on by AKIN Time 0855

Start-up OK'd by E.D.C AKIN Date 7-30-65

Removal Heat fuel element + the Heron stainless steel strip + added the strip face to inner fuel element. Diameter of strip face = 4.1875". Also removed 0.19" Enyke instrument and edc.
1011  Water ht = 106.00 cm. Lyten sub critical.

Drain.

1100  Remark inner core: Put in optimum styrofoam need in outer core: Styrofoam is 10.500” O.D. x 25.9375” long.

1217  Water ht = 100.00 cm. Lyten sub critical. tz = 0.005

Drain.

1300  Reduce the O.D. of styrofoam to 10.125.”

1334  Water ht = 106.30 cm. Lyten sub critical. tz = 0.005

Drain.

1425  Now have inner fuel element as close as possible (1/2”) to outer fuel element. Fuel plate must be within 1/8”. Both elements have styrofoam inside. Outer element width = 10.125.”

Inner element width = 4.1875.”

1500  Water ht = 107.60 cm. Lyten sub critical. tz = 0.005

Drain.
Production Cap ii

(INSTRUMENT CHECK)

<table>
<thead>
<tr>
<th>INSTRUMENT</th>
<th>RANGE</th>
<th>TRIP</th>
<th>SOURCE DISTANCE</th>
<th>SET</th>
<th>START-UP RANGE</th>
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<tbody>
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<td>3.16</td>
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<td>8 x 10 x 12</td>
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<td>&quot;</td>
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<tr>
<td>R-1</td>
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<tr>
<td>PM-1-700V</td>
<td>Alm</td>
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<td>9.000</td>
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</table>

LOG N CALIBRATE OPERATE SOURCE No. E-80

DUMP WELI PROBE LIGHT

START-UP CHECK LIST

Equipment checked by AKL Personnel check by F.D. C

Instruments and safety checked and reset by AKL

Source in checked by AKL Source No. M-43

Emergency equipment in control room checked by F.D. C

Instruments in trip circuit: K-1-2 PK-1-2

Red light on by AKL Time 1500

Start-up OK'd by F.D. C AKL Date 1-6-66

New seal static & Inner H E J R Core assembled.

(Handwritten Notes)
When water hit 21.05 cm on gauge scale, we have 6.5" stop reflection.

Feed rate = 2.9 cm/min.
3/4" Steam rate = 3.3 cm/min.
3" Pump rate = 38 cm/min.

When water hit 9.20 cm on gauge scale, water hit stop of fuel elements (log of plates)

An eighth-in. spread was placed in the outer annulus to support the inner annulus at its correct height. This was necessary because we are supporting only the bottom 15.45 inches of the system subcritical. Log = 0.003

This element is the second production core and the first made by Metals & Controls. It contains 9.762 kg of U3Si4, of which 8.562 kg is in the inner annulus and 1.200 kg is in the outer annulus. The inner annulus contains 8.62 g of 235U. These numbers from technician W. H. Card, who quoted inspection certificate reports from MEC; they do not agree with the transfer weights because of work made by MEC in the 121 form. Fig. 44.
### INSTRUMENT CHECK

<table>
<thead>
<tr>
<th>INSTRUMENT</th>
<th>RANGE</th>
<th>TRIP</th>
<th>SOURCE</th>
<th>DISTANCE</th>
<th>SET</th>
<th>START-UP</th>
<th>RANGE</th>
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<tbody>
<tr>
<td>K-1</td>
<td>3 x 10^{-12}</td>
<td>Meter</td>
<td>1&quot;</td>
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<td>3 x 10^{-12}</td>
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<tr>
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<td>Meter</td>
<td>1&quot;</td>
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<tr>
<td>PM-1</td>
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</tbody>
</table>

LOG N CALIBRATE OPERATE SOURCE No. B-80

DUMP WELL PROBE LIGHT

### START-UP CHECK LIST

Equipment checked by **AKM** Personnel check by **F. LC**

Instruments and safeties checked and reset by **AKM**

Source in checked by **AKM** Source No. M-93

Emergency equipment in control room checked by **F. LC**

Instruments in trip circuit: **K-1-2 PM-1-2**

Red light on by **AKM** Time 12:15

Start-up OK'd by **F. LC AKM** Date 1-7-66

---

added: Spent fuel element in center of core. Spent element has 4 fuel plates, #5 0-322, 6-5495, 0-3242, 0-2870, breeder in core = 55 9 2 0235
1255  Water h<sub>t</sub> = 6.30 cm

1304  Water h<sub>t</sub> = 6.10 cm

1330  added 2 0.031" x 0.25" x 29.0" stainless steel strips in outer element = 53.32 ft.

1413  Water h<sub>t</sub> = 9.20 cm

1425  Water h<sub>t</sub> = 8.40 cm

1435  added 2 0.031" x 0.25" x 29.0" natural iron strips in outer element = 27.50 ft.

1508  Water h<sub>t</sub> = 10.60 cm

1520  Water h<sub>t</sub> = 10.25 cm

1546  Water h<sub>t</sub> = 10.85 cm
Drain H20 below center of cone.

1525

Removed the two (2) natural boron strips and
added two (2) 0.031" x 1.25" x 29.0" enriched
boron strips. 53.32 f. Now have 1 enriched strip.

1540

Water Ht = 12.30 cm

f

5.1321.53 sec. = 6.0 f. = 9.9 ft/cm.

1548

Water Ht = 11.70 cm

f

System just critical

1608

Water Ht = 13.10 cm  

5.4 = 14 cm

f

5 = 81.49 sec. = 11.6 f. = 8.3 ft/cm.

1613

Water Ht = 11.70 cm

f

System just critical

Drain.
### INSTRUMENT CHECK

<table>
<thead>
<tr>
<th>INSTRUMENT</th>
<th>RANGE</th>
<th>TRIP</th>
<th>SOURCE</th>
<th>DETECT</th>
<th>SET</th>
<th>START-UP RANGE</th>
</tr>
</thead>
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<td>10-12</td>
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<td>&quot;</td>
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<td>3 ( \times ) 10^-&quot;1</td>
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<td>&quot;</td>
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<td>&quot;</td>
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<td>P-1</td>
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<tr>
<td>P-2</td>
<td>700 V</td>
<td>Alarm</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
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<td>PM-1</td>
<td>1200 V</td>
<td>Low</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>900 V</td>
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</table>

**LOG N CALIBRATE**

**OPERATE**

**SOURCE NO.** B-80

**DUMP WELL PROBE LIGHT**

---

### START-UP CHECK LIST

Equipment checked by [AKAF](#) Personnel check by [E105](#)

Instruments and safeties checked and reset by [AKAF](#)

Source in checked by [AKAF](#) Source No. [1M-03](#)

Emergency equipment in control room checked by [E105](#)

Instruments in trip circuit: [K-1-1](#) PM-1-1-3

Red light on by [AKAF](#) Time 0905

Start-up OK'd by [E105](#) Date 1-10-66

---

added two (2) natural horn strips! Now have four (4) embroidered strips and two (2) natural strips! Total of six (6). Total worth = 134.14¢
0839

Water ht = 21.05 cm
+ Per,
\[ T = 151.02 ^\circ C = 71.4 ^\circ C = \frac{.694}{cm}. \]

0900

Water ht = 18.00 cm

Hydrom just critical
Drain.

0950

Remove tube 2 (enriched boron strip).
Now have 2) natural and tube 2 (enriched boron strip). Purpose is to repeat + Per 4 3 and critical ht on page 16.

1015

Water ht = 11.30 cm
+ Per,
\[ T = 151.02 ^\circ C = 71.4 ^\circ C = \frac{.694}{cm}. \]

1023

Water ht = 10.80 cm

Hydrom just critical
Drain 0.0 cm in order to reject critical ht.

1032

Water ht = 11.40 cm
+ Per
\[ T = 89.09 ^\circ C = 10.8 ^\circ C = \frac{13.5}{9/\text{cm}} = 23.8 ^\circ C. \]

Water ht = 10.80 cm

Hydrom just critical.
1:55  Removed spent fuel elements. Took sample and enriched boron strips. Installed the 4.18 x 2.50" optically-styphosured void in lower element. Top of void is 0.750" above top of fuel plate.
void = (-6%)  

13:29  Water ht = 7.10 cm  \[ \Delta w = 0.50\text{ cm} \]  
\[ \Delta w \times 100\% = 7.0\% \]  
\[ E = 150.45\text{ cm} \times 0.97 = 13.8\% \]  

13:30  Water ht = 6.60 cm  
System just critical  
Drain.

14:30  Removed the 4.18" x 2.5" styphosured void and replaced it with the 3.975" x 2.50" void styphosured void. (-31.5% void). Top of styphosured is even with top of fuel plate.

15:12  Water ht = 17.20 cm  
System just critical  
Drain.
## Instrument Check

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Range</th>
<th>Trip</th>
<th>Source Distance</th>
<th>Set</th>
<th>Start-Up Range</th>
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</thead>
<tbody>
<tr>
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<td>1&quot;</td>
<td>3 x 10⁻¹²</td>
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</tr>
<tr>
<td></td>
<td>1&quot;</td>
<td>Foot</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K2</td>
<td>Meter</td>
<td>1&quot;</td>
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<td></td>
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<tr>
<td></td>
<td>Foot</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>R.T.</td>
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<tr>
<td>PM-1</td>
<td>700 V</td>
<td>Alarm</td>
<td>cont</td>
<td>500 V</td>
<td></td>
</tr>
<tr>
<td>PM-2</td>
<td>1200 V</td>
<td>Low</td>
<td>10&quot;</td>
<td>900 V</td>
<td></td>
</tr>
</tbody>
</table>

Log: "N CALIBRATE" Operate: "SOURCE No. B-80"

Dump well probe light

---

## Start-Up Check List

- Equipment checked by AKLF Personnel checked by FIDC
- Instruments and safety checked and reset by AKLF
- Source in checked by AKLF Source No. M-23
- Emergency equipment in control room checked by FIDC
- Instruments in trip circuit: K-1-2 PM-1-2
- Red light on by AKLF Time 0812
- Start-up OK'd by FIDC AKLF Date 1-11-66

Purpose: To repeat experiment with the 2.875" x 29.0" styrofoam vessel (see bottom of page 90). The vessel now is centered with a 50" (5.0") fiberglass club at top of vessel.
1-11-66

0911 Water ht = 21.10 cm

\[ \Delta h = 3.80 \text{ cm} \]  

Water Temp:

\[ T_3 = 25.5^\circ \text{C} \]  

Recorder:

\[ \frac{T_3}{T_4} = 1.1 \]

0937 Water ht = 17.80 cm

Heater just critical

\( T_{\text{in}} \)

Influence of .00 cm in critical ht (page 91)

Installed: tile 3.250" x 24.437" styrofoam walk

= 41% void

10.33

Water ht = 10.90 cm

\[ \Delta h = 1.5 \text{ cm} \]  

Temp measured with thermometer

\[ T_{\text{in}} = 24.0^\circ \text{C} \]

10.43 Water ht = 10.25 cm

Heater just critical

\( T_{\text{in}} \)

10.50 added 2 enriched boron strips = 53.32 ft

Water ht = 16.00 cm

\[ \Delta h = 1.85 \text{ cm} \]  

Water Temp:

\[ T_{\text{in}} = 24.0^\circ \text{C} \]
12-25 Removed enriched boron trip #3 & 2, and replaced them with enriched boron trip #5 & 10, in same position in outer core.

12-49 Water: Bo = 16.00 cm  
        D = 1.8 cm  
        \( t = \frac{172.75 \text{ sec}}{6.3} = 27.5 \text{ sec} \)  

1300 Water: Bo = 14.20 cm  
              Water temp.  
              = 240°C  

Lytet just critical  
Drain.  
added natural boron trip #3. Now have 2  
enriched and 1 natural boron trip. Total amount  
= 67.10 ft

1330 Water: Bo = 21.00 cm. Lyteter very slightly - Neg.  
              - Per.  
              \( t = \frac{1412.45 \text{ sec}}{2.9} = -0.09 \) ft

1345 Increased Bo to 22.00 cm. No change in  
reactivity.  
Drain.
INSTRUMENT CHECK

<table>
<thead>
<tr>
<th>INSTRUMENT</th>
<th>RANGE</th>
<th>TRIP</th>
<th>SOURCE</th>
<th>SET</th>
<th>START-UP RANGE</th>
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<td>&quot;</td>
<td>&quot;</td>
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<td>&quot;</td>
<td>&quot;</td>
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<td>&quot;</td>
<td>Cont</td>
<td>1/2&quot;</td>
<td>500 V</td>
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<tr>
<td>PM2</td>
<td>1200 V</td>
<td>&quot;</td>
<td>1/2&quot;</td>
<td>1/2&quot;</td>
<td>900 V</td>
</tr>
</tbody>
</table>

LOG N CALIBRATE: OPERATE: SOURCE NO: R-50

START-UP CHECK LIST

Equipment checked by A.K.I. Personnel check by R.C.

Instruments and safety checked and reset by A.K.I.

Source in checked by A.K.I. Source No. M-93

Emergency equipment in correct test condition by R.C.

Instruments in trip circuit: K-1-2 PM-1-2

Red light on by A.K.I. Time: 09:15

Start-up OK'd by F.D.C. R.K. Date 1-12-66
New box on the 6.16 x 2.95" Tygon tube, plus
2 natural boron strips and 2 enriched boron
strip (all strip in outer element)

\[ \text{void} = 400.00 \text{ ft}^3, \; \text{strip} = 134.00 \text{ ft} \]

\[ \text{Water ht} = 12.65 \text{ cm}, \; D_2 = 15 \]

(1)

\[ \text{5 m} = 136.90 \text{ cm} = 7.75 \text{ ft} \]

Water Str,

29.12

\[ \text{Water ht} = 11.90 \text{ cm} \]

\[ \text{System just critical} \]

\[ \text{Drain...} \]

1005

\[ \text{added 2 more enriched strips. Now have} \]

\[ \text{6 enriched strips and 2 natural boron strips} \]

\[ \text{void} = 400.00 \text{ ft}^3, \; \text{strip} = 137.52 \text{ ft} \]

1030

\[ \text{Water ht} = 21.10 \text{ cm}, \; \text{system just critical} \]

\[ \frac{5}{7} = 137.73 \text{ cm} = -14.5 \text{ ft} \]

\[ \text{Water Str}, \; = 29.2 \]

1043

\[ \text{Remove 1 enriched boron strip, and added 1 natural} \]

\[ \text{boron strip. Now have 5 enriched boron strips} \]

\[ \text{and 3 natural strips.} \]

\[ \text{void} = 400.00 \text{ ft}^3, \; \text{strip} = 174.64 \text{ ft} \]
11:04 Water ht = 21.10 cm: System slightly sub-critical.

\[ T = -484.58 \text{ cm} = -2.9^\circ C \]

\[ \text{Water temp} = 24.2^\circ C \]

12:25 New Core start fuel element in. Well, 2 fuel plate, # 0-3229, & 0-5495, all position strips removed. Top of first fuel plate even with top of core fuel plate.

\[ \text{Fuel plate (2)} = 2.50 \text{ cm long} \]

1300 Water ht = 21.10 cm: System sub-critical.

\[ T = -118.8 \text{ cm} = -7.7^\circ C \]

13:30 New core to fuel plate in front element.

\# 0-3229, 0-5495, 0-3292, 0-2870, 0-3228, and 0-3252. Also have 3 enriched boron strips and 2 normal boron strips.

\[ \text{Fuel plate} = 515.00 \text{ cm} \quad \text{roof} = 240.82 \text{ cm} \]

14:03 Water ht = 12.00 cm

\[ T = 145.59 \text{ cm} = 7.3^\circ C = 10.4^\circ F/\text{cm} \]
14.50 Water ht = 21.10 cm, system sub-critical

52 - 275.97 cm = -53.9 cm

Water temp = 29.0°C

15.00 Now have 4 fuel plates in first element: 0.3225
0.5495, 0.3242, and 0.2870. Also have 2 enriched
boron strips and 2 natural boron strips. Repeat of
exp on page 88 and top of 89.

15.00 Water ht = 21.10 cm

15.50 Water ht = 15.20 cm

15.00 Water ht = 15.20 cm

System just critical.

Drain.

Sodium initial h' (page 73 - 80)

= 26 cm.
INSTRUMENT CHECK

<table>
<thead>
<tr>
<th>INSTRUMENT</th>
<th>RANGE</th>
<th>TRIP</th>
<th>SOURCE DISTANCE</th>
<th>SET</th>
<th>START-UP RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>K-1</td>
<td>3 x10 - 12</td>
<td>Meter</td>
<td>Y&quot;</td>
<td>1/2&quot;</td>
<td>3 x10 - 12</td>
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<td>K-2</td>
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<td>R-1</td>
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<tr>
<td>R-2</td>
<td></td>
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</tbody>
</table>

PM-1: 700 V

PM-2: 1200 V

LOG N CALIBRATE: OPERATE: SOURCE No. 8-80

DUMP WELL PROBE LIGHT

START-UP CHECK LIST

Equipment checked by Akil

Personnel check by E.I.C

Instruments and safeties checked and reset by Akil

Source in checked by Akil: Source No. 12-63

Emergency equipment in control room checked by E.I.C

Instruments in trip circuit: K-1-2

Red light on by Akil: Time 08:10

Start-up OK'd by E.I.C. Akil: Date 1-13-66

Register is to be kept at described on location of page 97.
0845 Water h.t. = 21.19 cm.

0854 Water h.t. = 15.20

0856 System just critical

0915 Removed 1.25" plexiglass spacer from inner core. Inner core now 1.25" below outer core. Other conditions same as above. 4 fuel plates, 4 fuel grids, and 2 natural grids.

0933 Water h.t. = 21.30 cm. - 1.25"

0934 System very sub-critical. > 0.5

0938 Installed 2.50" plexiglass spacer in inner core. Other conditions the same as above.

1005 Water h.t. = 17.40 cm.

1010 Water h.t. = 15.10 cm.

System just critical
10.75 Installed 0.50" plexible grease on skin in excess core. After condition the same. + 0.25"

10.46 Water ht = 22.90 cm. D 2 = 6.60 cm

+ Pre

5 = 178.19 cm = 0.24 = 0.82 ft

Water Temp 29.00

11.57 Water ht = 15.80 cm
System just critical

Drain

11.16 Installed 1.00" plexible grease on skin in excess core. Also removed 1 natural born strip.
Other conditions the same. + 0.75"

11.34 Water ht = 14.90 cm

+ Pre

5 = 201.35 cm = 5.94 = 4.88 ft

Water Temp 29.00

11.47 Water ht = 13.75 cm
System just critical

Drain

Date: 1-13-60

Water Temp. 7.90°C

130.5 Water ht = 19.40 cm

Water Temp. 7.90°C

131.5 Water ht = 15.90 cm

Suppose just critical

Drain.

Installed 1.75" plexiglass "gaper or skin in inner core. Conditions same as above.

1.352 Water ht = 29.60 cm

Water Temp. 24.2°C

1.403 Water ht = 17.40 cm

Suppose just critical

Drain.

14.30 "Removed the 1.75" plexiglass gaper or skin in inner core. Inner core now 12.5" below outer core. Half fuel plates, enriched boron strip and 1 natural strip, -11.5"

151.5 Water ht = 21.10 cm

Water Temp. 5.70°C
**102**

15:30

15:35 Water Hc = 15.90 cm

Ly. to 24.2°C

System just critical

**INSTRUMENT-CHECK**

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Range</th>
<th>Trip</th>
<th>Source Distance</th>
<th>Set</th>
<th>Start-Up Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>3x10⁻²</td>
<td>Meter</td>
<td>½&quot;</td>
<td>3x10⁻²</td>
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<tr>
<td></td>
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<td>Jets</td>
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</tr>
<tr>
<td>A2</td>
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<td>Meter</td>
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<td>1&quot;</td>
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<td>Jets</td>
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<tr>
<td>B1</td>
<td>700 V</td>
<td>Alarm</td>
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<td>B2</td>
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</table>

Log in calibrate Operate Source No. B-80

Dumb well purge light
START-UP CHECK LIST

Equipment checked by AA
Personnel check by E125
Instruments and safety checks and reset by AA
Source checked by AA
Source No. M-43
Emergency equipment in control room checked by E125
Instruments in trip circuit: K-1-2 P19-1-2
Red light on by AA
Time 0605
Start-up OK'd by E125
Date 1-14-66

Note: First fuel element and the fuel plate envelope is to see if any air is trapped between inner and outer core.

Water Ht. = 21,50 cm

Liptis sub-entrail

Raised the inner core, and did not find any sufficient amount of air trapped between core.
1-10-66

Now have inner core raised 2.0" above outer core, also raised the first fuel element 1.875" (limit). System has 4 fuel plates & enriched boron strip, and 1 natural boron strip.

1010 Water ht = 24.90 cm

System just critical

Water temp = 24.2°C
1-14-66  H.F.I.R. CE-2
West End

1320  Now have CE-2 installed in test tank,
      same conditions as with production core	
      #2

When water HT = 8.35 cm on glow scale outer
cone plate was just covered. When water HT
= 7.10 cm inner cone plate was just covered.

1345  Water HT = 22.00 cm. CE-2 shielded.
      System sub-critical

1500  Now have 3.25" fiberglass void in place.
      1. natural boron strip
      1. void after 11.8"
      above top of fuel plate.

1550  Water HT = 21.00 cm
      System sub-critical

+Pen
  $c = 543.25 \text{ cm} = 2.3 \text{ ft}$
  Water temp. = 29.5$^\circ$C

1603  Water HT = 16.60 cm
      System just critical
      +Pen
### INSTRUMENT CHECK

<table>
<thead>
<tr>
<th>INSTRUMENT</th>
<th>RANGE</th>
<th>TRIP</th>
<th>SOURCE DISTANCE</th>
<th>SET</th>
<th>START-UP RANGE</th>
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<td>PM-1200 V</td>
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</table>

LOG N CALIBRATE ✔ OPERATE ✔ SOURCE No. B-80

DUMP WELL PROBE LIGHT

### START-UP CHECK LIST

- Equipment checked by AKLL
- Personnel check by AKLL
- Instruments and safety checked and reset by EA FT
- Source in checked by AKLL
- Source No. M-93
- Emergency equipment in control room checked by AKLL
- Instruments in trip circuit: K-1 2 PM-1 2
- Red-light on by AKLL
- Time 0830
- Start-up OK’d by EA FT AKLL Date 1-17-66
0830  Now have spent fuel element in, with fuel plates # 0-3229, # 0-5995, # 0-3232, # 0-2870. The spent fuel plates are 12.5" below H.E.I.R. fuel plate. Also had 3 enriched boren strips in.

0907  (1) Water ht = 12.20 cm, \( T = 0.15 \)

(2) \( T = 166.45 \text{ sec} = 0.5 \text{ sec} \), \( T = 6.7 \text{ ft} \)

0918  Water ht = 11.95 cm
Lepton just critical

0923  added 1 more enriched boren strip. Now have 4 spent plates and 4 enriched strips.

0944  (2) Water ht = 21.05 cm; Lepton just critical

\( T = -225.99 \text{ sec} = -7.0 \text{ sec} \)

1004  Removed 1 enriched boren strip, and replaced it with 1 natural boren strip. Now have 3 enriched + 1 natural strip + 4 spent fuel plates.

1031  (3) Water ht = 21.05 cm

\( T = 321.60 \text{ sec} = 3.7 \text{ sec} \)

\( KH = 6.35 \)
10.49 \text{ Water height } = 14.70 \text{ cm.} \\
\text{System just critical.} \\
\text{Drain.}

\begin{align*}
\text{Flow rate} & = 25.41 \\
\text{Strain rate} & = 2.54 \text{ in./min} \times 13.28 = 53.26 \\
\text{Excess} & = 2.78 \\
\text{Core} & = 3.51 + 0.04 + 0.54 + 2.93 + 12 \times 0.04 = 9.46
\end{align*}

\begin{align*}
\text{3-14-66} & \\
\text{M + C "No.2"}
\end{align*}

Outer element \# 2-0 \\
5.5, net = 7305.01 \text{ lb}

Inner element \# 3-1 \\
5.5, net = 7507.18 \text{ lb}

+ 2.805 \text{ sq in inner element.}

The inner core was 1.25" below the outer core fuel. \\

Feed rate = 2.7 \text{ gpm} \\

\frac{3/4" \text{ main rate}}{30" \text{ main rate}} = 4.80 \text{ gpm} / 30\text{"}

\frac{30" \text{ rate}}{38.1 \text{"}} = 0.78 	ext{ gpm/"}
### Instrument Check

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Range</th>
<th>Trip</th>
<th>Source Distance</th>
<th>Set</th>
<th>Start-Up Range</th>
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<td>3 $\times 10^{-2}$</td>
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<td>K-2</td>
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<td>Meter</td>
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<td>K-3</td>
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<td>600</td>
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Log. N. Calibrations - Operate - Source No. 8-82

Dump Well Probe Light

### Start-Up Check List

- Equipment checked by **MKL** Personnel check by **E10C**
- Instruments and safeties checked and reset by **MKL**
- Source in checked by **MKL** Source No. 19-13
- Emergency equipment in control room checked by **E10C**
- Instruments in trip circuit: **K-1-2 PM-1-2**
- Red light on by **MKL** Time 10:23
- Start-up OK'd by **E10C** Date 3-12-66

9:24 am 16-pole scale water shewn with stopple 10:30

Your last book Section 1.1 R. Core assembly.

11:20 Water lit at 21.50 cm.

System sub critical.
3-14-66

1355 Added spent fuel elements in center of core. 
Element has & fuel plates: #5 D-3224, D-3495, D-3242 & D-2870. 
Mass incstr = 65.4 lb.
Top of spent fuel plate on even with top of water element fuel plate.

1426 Water hT = ?
1438 Water hT = 4.50 cm 
1445 Water hT = 4.90 cm

System just critical

1515 Added 4 enriched boro. strips #s 7, 8, 9, & 10. 
2 natural boro. strips #8 364. mass = 720.28 lb.
All strips one place = equal distance in water core.

1537 Water hT = 10.10 cm
Water temp. 

hT = 23.7

1812.95 cm. = 5.34 = 17.7 ft.
2 = 24.0
Water \( \Delta T = 9.80 \text{cm} \)

Lyman just critical.

Drain

\[
\text{Conv} = 258.5 \times \exp \left( \frac{137.2}{(273 + 40)} \right) - 15 \times 30 = 2.187
\]

\[3 - 15 - 66\]

### INSTRUMENT CHECK

<table>
<thead>
<tr>
<th>INSTRUMENT</th>
<th>RANGE</th>
<th>TRIP</th>
<th>SOURCE DISTANCE</th>
<th>SET</th>
<th>START-UP RANGE</th>
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LOG N CALIBRATE OPERATE SOURCE No. B-80

DUMP WELL PROBE LIGHT

### START-UP CHECK LIST

Equipment checked by AKIP Personnel check by JDC

Instruments and safeties checked and reset by AKIP

Source in checked by AKIP Source No. M-43

Emergency equipment in control room checked by JDC

Instruments in trip circuit: K-1-2 PM-1-2

Red light on by AKIP Time 0800

Start-up OK'd by JDC AKIP Date 3-15-66
Purposes is to report last experiment.

0541 Water ht = 10.30 cm, Water temp. °C

\[ T = 24.0 \]

\[ c = 0.7 \text{ ft} \]

0851 Water ht = 9.90 cm
System just critical.

Drain.

0900 added two more enriched boron strips. \( \#5 \)
Now have 5 enriched boron strips \( \#5 \), 5, 7, 9, 10,
and 2 natural boron strips \( \#5 \) 344. Total of 8 strips. Total work = -187.5 ft

0933 Water ht = 13.35 cm
System just critical.

Drain.

0945 added 125" plastic spacers to raise minor core even with outer core. Other conditions the same as above.
10:30 Water Ht = 18.25 cm  Water Temp. °C 1 = 24.2

Lyten first critical

Drain

391.00 cal/18.75 cal - 1.8 cal 18.4 cal

= 201.65 cal sub critical (fuel plate in target region)

11:05 Removed fuel plates #5 D - 32.42, E - 28.70 from spent fuel elements. Also removed 4 enriched boron strips. #s 4, 5, 8, 10. #s 3, 7, 9.

Now have 2 enriched boron strips and 2 natural boron strips. Also fuel plates #5 D - 32.42,

+ 0 - 5995.

11:25 Water Ht = 21.40 cm  Water Temp. °C 1 = 24.5

Lyten sub critical

Drain

12:30 Removed 1 enriched boron strip and 1 natural boron strip. Now have two fuel plates and 1 enriched strip and 1 natural strip. 

Water Ht = 21.40 cm  Temp °C

Drain slightly - NE.

- Perc. 5 = 543.3 mV = -2.6 - 3

1 = 24.3

2 = 24.5
Added drained brine, Trip #9, and added natural brine strips #4 in its place. Also added 16 stainless steel strips.

Now have 2 spent fuel plates. 2 natural brine strips #5, 3 at #3, and 6 stainless steel strips. Total weight of strip = 35.60 ft.

134lbs
4 Water dt = 21.90 cmm

+ Few
T = 505.2 sec = 1.2 ft

1605 Water dt = 18.90 cmm Water temp. °C

LAVA = 29.5

Drain 1

240.55 - 35.60 - 1.2 ft
= 203.20 ft sub emulsion (7 + fuel + 7+ in toy + 24 cmm)

Average: (203.20 + 8.5) + (22.16 + 8) + (201.24 + 8.2) = 202.25 + 12.6

Reflected water sample taken after run.

Reg # 68 + 490.

Add for:
1. Total solids
2. Alum.
<table>
<thead>
<tr>
<th>INSTRUMENT</th>
<th>RANGE</th>
<th>TRIP</th>
<th>SOURCE RANGE</th>
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</table>

LOG N CALIBRATE Operate SOURCE No. 6-50
DUMP WELL PROBE LIGHT

---

**START-UP CHECK LIST**

Equipment checked by [Name]
Personnel check by [Name]

Instruments and safeties checked and reset by [Name]

Source in checked by [Name], Source No. M-3

Emergency equipment in control room checked by [Name]

Instruments in trip circuit: K-1 - 2, PM-1 - 2

Red light on by [Name], Time 14:10

Start-up OK'd by [Name], Date 5-26-61

---

[Signature]
5-26-66
Repeat of critical conditions with C E-2 cone. (See page 105, 106, 107, 108.)

Now have C E-2 cone in reflector tank; booster and auto-core only.

1456
Water ht = 20.9 cm.
System sub critical.

INSTRUMENT CHECK

<table>
<thead>
<tr>
<th>INSTRUMENT</th>
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<th>TMD</th>
<th>SOURCE</th>
<th>START-UP</th>
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<td>PM-1</td>
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<tr>
<td>PM-2</td>
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<td>Low</td>
<td>18&quot;</td>
<td>900 V</td>
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</table>

LOG N CALIBRATE - OPERATE - SOURCE No. 8-80

DUMP WELL PROBE LIGHT
START-UP CHECK LIST

Equipment checked by AK77 Personnel check by E.P.E.

Instruments and safety checked and reset by AK77

Source in checked by AK77 Source No. M-423

Emergency equipment in control room checked by E.P.E.

Instruments in trip circuit: K-1-2 P-7-1-2

Red light on by AK77 Time 0505

Start-up OK'd by E.P.E. AK77 Date 5-27-66

Now have spent fuel element installed.
4 fuel plate, #0 D-322.9, D-5025, D-3242,
D-2870. Also have three (3) uninstalled.
Ideal strip at 10.8 ft. and one natural
strip #2.

Water Exp.

0855 Water Ht = 21.00 cm 07 = 25.7 cm 61 = 25.5
2 = 23.7

1 = 4 95.4 t = 2.49 = 4.1/cm

0917 Water Ht = 15.30 cm

Limiter just Critical

Drain.

C1 = 290.7 V

Production Core: P# 3-00H 2-1

1025 New low production core is # 3-0 (outer element)
and # 2-1 (inner element) assembly. Inner
element fuel plate 12.5" in below top of outer
element fuel plate.
When water hT = 9.76 cm on mirror scale: Water even with top of fuel plate in outer element.

10:45 Water hT = 31.10 cm, \( \text{Temp}^0 \text{C} \)

System sub-critical

\( \# \) 1 = 23.7

\( \# \) 2 = 24.0

12:30 Added spent fuel element with 2 fuel plates #5 0-5495 and 0-3229. Also added 2 natural boron strips #5 3 & 4, plus 6 stainless steel strips.

2 fuel plates = 240.0$  

2 boron strips = 35.6$

13:45 Water hT = 21.10 cm, \( \text{Temp}^0 \text{C} \)

System sub-critical

\( \# \) 1 = 24.2

\( \# \) 2 = 24.2

13:50 Removed the 2 natural boron strips #5 3 & 4.

Now have 2 fuel plates plus 6 stainless steel strips.

2 fuel plates = 240.0$

2 boron strips = 35.6$

14:27 Water hT = 21.00 cm, \( \text{Temp}^0 \text{C} \)

System sub-critical

\( \# \) 1 = 24.2

\( \# \) 2 = 24.3
14:50 added 2 more fuel plates.
Now have 4 fuel plates in first element.
Plus 4 enriched boron strips @ 847,85,86,87.

fuel plate = 291,029

parin strip = 104,823

15:15 Water HT = 21.00 cm, \( \Delta H = 7.2 \text{ cm} \), \( T = 250 \)°

\( \Delta = 5.62 \text{ cm} \) = 7.2 \% \( \frac{\Delta}{\Delta} = 7.2 \% \)

15:29 Water HT = 13.50 cm.

Let's just enrich
Drain
INSTRUMENT CHECK

<table>
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<tr>
<th>INSTRUMENT</th>
<th>RANGE</th>
<th>TRIP</th>
<th>SOURCE DISTANCE</th>
<th>SET</th>
<th>START-UP RANGE</th>
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<td>11</td>
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<td></td>
<td>11</td>
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LOG N-CALIBRATE  V  OPERATE  V  SOURCE No. B-80

START-UP CHECK LIST

Equipment checked by E. Personnel check by E.

Instruments and safeties checked and reset by E.

Source in-checked by E. Source No. M-43

Emergency equipment in control room checked by E.

Instruments in trip circuit: K-1-2, PM-1-2

Red light on by E. Time 08:20

Start up OK'd by E. Date 5/31/66

Log K blew fuses: 2nd rectifier tube replaced.

Report of last run of 5/25/66

0524 H-0 at 8.40 cm. Temp 7.64 C. RH 79.88% Time 01:24:22.3 C 0530 H-0 at 7.50 cm. Temp 7.64 C.

Dm= 136.81 = 7.74
1837  H_2O at 848 am, + power 4%  $1: 24.5^oC
   C = 14.5 50 am = 7.3 $  $2: 24.5^oC
1949  H_2O at 7.63 am, Level.

Dizon

Added 1 ft & enriched boron, 2 natural boron.
Note: boron & enriched boron and 1 natural boron,
+ 1 SPERT plates. Feb -3509, strio -173.7.
   C = 16.8 60 am = 6.6 $  $1: 24.5^oC
1947  H_2O at 12.73 am, + power 6%  $2: 24.5^oC
   $1: 24.5^oC
1952  H_2O at 11.8 am, Level.

Drain  Core = -350 + 173.7 + 29.5 = -261.8 $  

Gord 3 enriched boron strips. Load boron 7 enriched
strips, and 1 natural strip. Strips = 2025 K, fuel 3524.
   Core 186.5 K.
1035  H_2O at 11.7 am, slightly subcritical
Put source boron in to increase power level.
1413  Removed source for 15 min, period 24.

Dz = In - Pr = - 671.46 am = -2.1 $  $1: 24.5^oC

Core + fuel + poisons = Key
Core + 391 = 2005 = 241
Core = 391 - 2005 = -124
Core = 350.5 - 2005 = 140.6 $  

Removed 2 plates from SPERT element. Now have
2 fuel plates, enriched strip #7, natural strip #8, and
4 stainless steel strips. Total 45,000 in poison, 243 in fuel.
1522  H_2O at 21.5 am, subcritical.

Dizon
**INSTRUMENT CHECK**

<table>
<thead>
<tr>
<th>INSTRUMENT</th>
<th>RANGE</th>
<th>TRIP</th>
<th>SOURCE</th>
<th>SET</th>
<th>START UP</th>
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LOG CALIBRATE OPERATE SOURCE No. 123

DUMP WELL PROBE LIGHT

Removal of all straps. Now known only in final plates.
START-UP CHECK LIST

Equipment checked by AKMY Personnel check by JVEC

Instruments and safety checked and reset by AKMY

Source in checked by AKMY Source No. M-93

Emergency equipment in control room checked by EVEC

Instruments in trip circuit: K-1-2 PM-1-2

Red light on by AKMY Time 09:20

Start-up OK'd by JVEC AKMY Date 6-1-66

09:20

All main strips removed. Have 2 feed plate in spent element. E 0-3229 and 0-5495.

Plate = 240.0 ft.

09:11 Water ht = 11,60 cm. Δh = 1.2 cm. Temp °C

+ P Carey

T = 58.63 °F = 14.7 °F

E = 24.5

09:11 Water ht = 110.40 cm.

lysin first critical

09:45 added 12.5" plastic spacers to raise inner core even with outer core. Other conditions same as above.
10:50 Water ht = 10.30 cm  dh = 4.75  Water temp °C

-110.0  + 7.69 = 17.90 m/s

110.1 Water ht = +10.35

System just critical.

110.5 Drain to = 0.0 cm on narrow scale.

111.2 Water ht = 11.30 cm  dh = 1.75 cm  Water temp °C

-120  + 13.37 = 15.94 m/s

120 Water ht = -10.30  atm = 10.25

System just critical

13:40 Now have 2 spent fuel plates. & titanium shell strips and 4 natural boron strips #2.

14:10 Water ht = 12.25 cm  dh = 5.55 cm  temp °C

-140  + 2.40.04 = 8.00 m/s

#1 = 24.7

2 = 25.0
14:28 Water: Ht = 11.70 cm. Feed = 240, steps: 19.1

System just critical: \( C_0 = 240 + 19.1 + 30.5^2 - 150.0^2 \)

Drain.

1500-

Removal agent agent: Flooded core to check for air. Could not find any air bubbles on core fuel plate. Raisin core up, and found some small air bubbles. Drain water. Replaced, 12.5" space and flooded core again.

When inner core was moved, had a large number of air bubbles.

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### Instrument Check

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Range</th>
<th>Trip</th>
<th>Source</th>
<th>Start-Up</th>
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<tr>
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<td>Alarm</td>
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<tr>
<td>PM-2</td>
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<td>12&quot;</td>
<td>900 V</td>
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Log: N Calibrate: Operate Source No. B-80

Dump Well Probe Light
START-UP CHECK LIST

Equipment checked by AKLF Personnel check by FDC
Instruments and safeties checked and reset by AKLF
Source in checked by AKLF Source No. MA-23
Emergency equipment in control room checked by FDC
Instruments in trip circuit: \( K = 1 \), \( 1ə = 1 \), \( 1ə = 2 \)
Red light on by AKLF Time 0505
Start-up OK'd by FDC AKLF Date 6-2-66

0.800 Have inner cone raised 1.25" with plastic spools.
Also have 2 items full plate as D-3224 and D-54.95. Will stainless steel strip plus
natural lower strip no. 2. (See bottom of page 125)

0.840 Water \( h = 13.00 \) cm. \( \Delta h = 0.30 \) cm. Water temp \( c \)
(1) / Len
\( c = 706.23 \) sec = 1.68 = 5.34°F/cm
\( \pi = 2.97 \)

0.925 Water \( h = 12.70 \) cm
System just critical
Drain 1/2 way down with 3° dump valve

0.945 Water \( h = 12.90 \) cm \( \Delta h = 0.10 \) cm. Water temp \( c \)
(2) / Len
\( c = 123.86 \) sec = 8.37 = 7.54°F/cm
\( \pi = 2.45 \)
\( \pi = 2.47 \)

0.955 Water \( h = 11.90 \) cm
System just critical
Drain,
In order to vent air trapped between outer and inner core.

10:30
Now have inner core reamed .375". Inner core fuel plate now .250" above top of outer core fuel plate. Top of inner core fuel plate also .250" above top of spent fuel plate.
Same fuel and fission loading as described on page 127.
Fuel = 240.0 ft,
Poison = 17.14 ft.

11:18 Water HT = 13.10 cm $\Delta H = 1.02$ Water temp $\circ C$
\[ (3) \frac{\rho}{\rho} \]
\[ 7 = 7.32 \text{ sec} \times 7.94 = 7.74 \text{ ft/sec} \]
\[ \# 1 = 24.5 \]

$\Delta H = 1.02$ = 12.07 cm

11:30 Water HT = 12.05 cm
System just critical
Drain.

12:30 Repeat of above:

12:35 Water HT = 13.10 cm $\Delta H = 1.05$ Water temp $\circ C$
\[ (4) \frac{\rho}{\rho} \]
\[ 7 = 13.58 \text{ sec} \times 7.94 = 7.54 \text{ ft/sec} \]
\[ \# 2 = 24.7 \]

12:40 Water HT = 12.05 cm
System just critical
Drain.
13:30 added natural boron trip #3. Hour 2
spent fuel element with 2 fuel plates #80-3229
and 0-5995. Two (2) natural boron strips #5 2
and 3. and 4 stainless steel strips.
Fuel = 210.0°F
power trip = 32.92 ft

19:00 Water hgt = 13.70 cm  \( \Delta h = 4.70\, \text{cm} \)  Water Temp
\( T = 99.96 \, \text{sec} = 9.04 \, \text{cm} \) \( \#1 = 28.7 \)
\(+14.10 \, \text{cm} = 14.00 \, \text{cm} \) \( 2 = 25.0 \)

19:10 Water hgt = 13.90 cm
System just initiated
Drain to \( 0.0 \) cm on maneuver scale: repeat
+ 10°.

19:20 Water hgt = 21.20 cm  \( \Delta h = 1.20 \, \text{cm} \)  Water Temp

\( C = 83.66 \, \text{sec} = 11.34 \, \text{cm} \) \( \#1 = 25.0 \)
\( D = 22 \) 25.1

19:27 Water hgt = 14.00 cm
System just initiated.

Core + fuel + strips + key
Core + Key + fuel + strips
- 113 + 242 + 22.5 = 355.0
New core. 4 fuel plates in front element. #0-3224, D-5495, D-3242, and D-2870. Also have 4 enriched boron strips, #s 7, 8, 9, and 10, evenly spaced in outer fuel elements.

1.515 Water ht = 8.70 cm, D-l, 7.90 cm, Water temp.

7.37

1.530 Water ht = 7.80, -7.80 = 7.80

System just critical.

Drain to 0.0 cm on mirror scale, input + Pw.

1.338 Water ht = 8.60 cm, D-l, 8.85 cm, Water temp.

6.37

T = 97.17 = 10.8 = 12.6 ft/sec

2 = 25.0

1.545 Water ht = 7.80 cm

System just critical

Drain.
### INSTRUMENT CHECK

| Instrument | Source | Coach | S.T. | Start-up | Log
|------------|--------|------|-----|----------|-----
| R-1        |        |      |     |          |     
| R-2        |        |      |     |          |     
| PM-1       | 500 V  | Alarm| cont| 500 V    |     
| PM-2       | 1200 V | Low  | 18 V| 900 V    |     

### START-UP CHECK LIST

- Equipment checked by AKH. Personnel check by F.D.C.
- Instruments and safeties checked and reset by AKH.
- Source in checked by AKH, Source No. M-43.
- Emergency equipment in control room checked by F.D.C.
- Instruments in trip circuit: 14-12  PM-1-2
- Red light on by AKH, time 0615
- Start-up OK'd by F.E.C. AKH, date 6-3-66

Some conditions as described on top of page 180:
- 4 fuel plates in spent element 24-0-322, 24-0-5495, 24-0-3212 and 24-0-2870. 4 enriched core elev. 25-7, 8, 9, 10.
09:35 Water hT = 8.60 cm
\[ \text{Water Temp} \]
\[ \frac{\Delta T}{\Delta P} \]
\[ 5.2 = 180 \text{ cm} \]
\[ \#1 = 29.7 \]
\[ \#2 = 29.7 \]

09:47 Water hT = 7.80 cm
System just critical

10:00 Now have 4 fuel plates in front element, plus 7 enriched boron strips. #6, 1, 2, 3, 7, 8, 9 & 10. Plus natural boron strip #2. Total of 9 fuel plates plus 1 strip.

10:38 Water hT = 21.10 cm
\[ \text{Water Temp} \]
\[ \frac{\Delta T}{\Delta P} \]
\[ 5.2 = 540.93 \text{ cm} = -1.6 \]
\[ \#1 = 29.5 \]
\[ \#2 = 25.0 \]

10:48 added water: hT = 23.40 cm, no change

Onset.
1100  Remaind natural boron trip # 2: Added 5
     stainless steel strips

     Now have:
     4 fuel plate
     7 enriched strips (1.23.75 9+10)
     5 stainless steel strips

     fuel = 391.00
     poison = 193.32
     391.0 - 193.32 - 3.9 = 193.78 ± 15.2

1130  Water ht = 21.10 cm

     \( \frac{2.4}{3.80} \text{ cm, Water Trip } ^{0} \text{C} \)

     \( T = 29.77 \text{ cm} \)

     \( t = 28.7 \text{ cm} \)

1145  Water ht = 16.30 cm

     Reactor just critical

1240  Now have:
     2 fuel plates (0-32.29 + 0-5492)
     2 natural boron strips = 2 x 3
     5 stainless steel strips

     See page 129

     fuel = 24.0 00
     poison = 329.27
     114 - 240.0 + 329.9 = 195.68 ± 27.8

1315  Water ht = 21.10 cm

     \( E = 7.1 \text{ cm, Water Trip } ^{0} \text{C} \)

     \( T = 23.0 \text{ cm} \)

     \( t = 83.23 \text{ cm} \)

     - 6.2 4/hr, cm

     \( 2 \times 2.52 \)
1322 Water ht = 14.00 cm.

Leakage just critical
Dries.

Outer core #3.0 Inner core # 9-1

Now have inner core 4-1 in place of 2-1.
Outer core #3.0 No plastic found or
pocene strips.

1420 Water ht = 22.00 cm.

Leakage still critical.

1423 Inner core tank found large release of
air bubbles. Could also see air shifting
up and down from at the
injecting joint. Leakage still still critical.
Dries.

1445 Now have inner core raised 3.75"
2 fuel plates (3-0 to 322.4 + 0.5992)
2 natural boron strips (2 + 23)
4 stainless steel strips.
Fuel = 240.00 %
poison = 3 + 92.2 %

1520 (Water ht = 16.80 cm. \( \Delta H = 3.10 \) cm

\( \delta \) = 144.08 \( \tau = 8.94 = 2.94 \) /cm

\( \beta = 25.5 \)
15:30. Water Ht = 13.70 cm.

System just initiated

Drain

$\text{me} = 13.3 \pm 2.5 - 2x.3 + 19.8 \pm 9.5$

**INSTRUMENT CHECK**

<table>
<thead>
<tr>
<th>INSTRUMENT</th>
<th>RANGE</th>
<th>TRIP</th>
<th>SOURCE DISTANCE</th>
<th>SET</th>
<th>START-UP RANGE</th>
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<td>$3 \times 10^{-12}$</td>
<td>Meter</td>
<td>4''</td>
<td>2''</td>
<td>$3 \times 10^{-12}$</td>
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<tr>
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<tr>
<td>FM-1</td>
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<td>FM-2</td>
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<td>900 V</td>
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LOG N CALIBRATE \(\checkmark\) OPERATE \(\checkmark\) SOURCE No. B-80

DUMP WELL PROBE LIGHT

**START-UP CHECK LIST**

Equipment checked by D.E. Personnel check by M.E.

Instruments and subflock checked and reset by M.E.

Source in checked by D.E. Source No. M-43

Emergency equipment in control room checked by M.E.

Instruments in trip circuit: $K1 \cdot 2 PM1 \cdot 2$

Red light on by D.E. Time 0810

Start-up OK'd by D.E. D.E. Date 6/6/66

Report of last experiment 6/3/66 (OVER)
10/4/14

0900 H₂O at 15.7 cm. + Press. 96

Tem. 148°C

0940 H₂O at 19.3 cm. Critical. Level

Draain, putting back to bottom of manometer.

0945 H₂O at 17.1 cm. + Press. 96

T = 157.5°C - 6.5°C

0955 H₂O at 14.3 cm. Level

Drain

Clean 240 + 32.9 + 10 - 152.1°F ± 8.5°F

Replaced 3-D and 4-F, replaced with 4-D and 4-F

and element of various strips. Threw under current 0.35 A.

1226 H₂O at 16.1 cm. Subcritical

Installed 5/8% element with fuel plates,

2 for 1 1/2 strips and 4 5/8 strips

Fuel 240°F, Pois. 32.9°F

1305 Apparently critical at low burnout. 9.274°C

Level. 6 V source brings it to rise. 9.274°C

Power. H₂O at 21.2 cm.

1320 Removed source

1345 H₂O at 17.1 cm. Level

Core = -x² + 32.5 + 3.2² - 250.9°F ± 8.5°F
4/10/60

Removal of 55 strips. New lines in SPERT plan and Venture 6060 strips.
Fuel: 740 lb., Post. 47.3 kg.

1404

H₂O at 721.2 cm. + Period #3

T: 129.1°C, 15.7 F

1410

H₂O at 146.6 cm. Read.

Draw Cave = -241 + 17.6 + 5.1 = -203.2 F

Added weak H₂O to SPERT column, have enriched 8°C strips 2, 3, 4, 5, 12 (total 6) and Venture strip #3.

Fuel: 351, Post. = 175.2 kg.

1515

H₂O at 153.0 cm. + Period #4

T: 126.4°C, 221.5 F

1525

H₂O at 12.95 cm. Read

Draw

Cave = -391 + 173.7 + 18.3 = -198.3 kg + 16.4 F
### Instrument Check

<table>
<thead>
<tr>
<th>INSTRUMENT</th>
<th>RANGE</th>
<th>SOURCE</th>
<th>START-UP</th>
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<td>K-1</td>
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<td>P-1</td>
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<td>PA-1</td>
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<td>Contact</td>
<td>500 V</td>
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<td>PA-2</td>
<td>1000 V</td>
<td>Low</td>
<td>900 V</td>
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LOG IN CALIBRAT    OPERATE  SOURCE No.  B-83

DUMP WELL PROBE LIGHT

### Start-Up Check List

- Equipment checked by EJ, IOC. Personnel check by IAC.
- Instruments and safeties checked and reset by EJ.
- Source-in checked by IOC. Source No. M-63.
- Emergency equipment in control room checked by IOC.
- Instruments in trip circuit: K-1, K-2, P1, P2, P3.
- Red light on by DC. Take 12/10.
- Start-up grid by DC, IAC. Date 4/7/66.

Installed 3" I in 40" with 0.375 in. space
1240 H. @ 22.9 cm. identical.
4/7/00

Added 3 PERT element with fuel plates and 1 # & 2 # natural born strips and 4 55 strips.
Fuels: 24.8% Vol = 22.5% 

1330 H2 at 21.25 cm. Source back in 2 raise.

1341 Source went way period 1.
T = 171.5 cm = 0.16 F
Cov = 248 - 32.7 + 28 = 207.9 F = 8.39

Removed 4 55 strips. Now have 2 fuel plates and 2 natural born strips. Pois. = 27.5 F.

1414 H2 at 11.5 cm. + raised Day
T = 215.2 cm = -5.1 F
Cov = 240 - 27.56 - 5.1 = 207.36 F = -3.4 F

1420 H2 at 15.95 cm. Critical.

Pres. 25 F.

Installed 0.7 and 0.0 with 0.375 in greases.

1430 H2 at 21.25. Delivered.

Drain

Added 2 fuel plates and 2 # natural born strips.
Pois = 27.5 F.
INSTRUMENT CHECK

<table>
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<tr>
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<th>RANGE</th>
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<th>SOURCE</th>
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<td>PM-1</td>
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<td>Operate</td>
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<td>Dump Well-Probe Light</td>
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START-UP CHECK LIST

Equipment checked by EJ
Personnel check by TDC

Instruments and safeties checked and reset by EJ

Source in checked by EJ
Source No: M-43

Emergency equipment in control room checked by TDC

Instruments in trip circuit: K-1, K-2 PM-1, PM-2

Red light on by 04:30E Time: 08:15

Start-up Co'd by EJ TDC Date: 1/1/66

Condition as of end of p. 135.

05:00
HyO at 16.0 cm. + Period

05:10
HyO at 15.0 cm. Critical

05:20
HyO at 15.0 cm. Critical
1305  
H₂O at 15.65 cm. + period 12
T = 141.9°C  72°F
2:14.7°C

1316  
H₂O at 13.45 cm. Critical
Cm² = -391 + 123.7X + 15.4X² 2017 ft² 18.7°F
Drain parts of tanks.

1347  
H₂O at 16.5 cm. Period 3
T = 134.5°C  73°F
2:25.0°C

1355  
H₂O at 13.30 cm. Critical
Drain

Installed 6:1 over 3:0 with 0.375-in. spacers.
Emissivity above: 0.95, glass: 0.85, and natural strip: 0.45, and 4 perforated plates.

1505  
H₂O at 14.5 cm. + period 4
T = 145.3°C  75°F
2:14.7°C

1515  
H₂O at 12.5 cm. Critical
Drain
Cm² = -391 + 123.7X + 15.4X² 2017 ft² 18.7°F
Drain 4 plates in 8th and 9th perforated.
Lime: chips *2 *3.
4/8/66

1623  H2O 27.212 mm  + Revert 5°
      To 87.3°  10.5°

1619  H2O at 17.90 cm  Criticel

   Drain

Calc = 247 + 27.5 + 10.9 = 286.1° ± 8.4°
### INSTRUMENT CHECK

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- LOG N CALIBRATE: ✓
- OPERATE: ✓
- SOURCE No.: B-80
- DUMP WELL PROBE LIGHT: ✓

### START-UP CHECK LIST

- Equipment checked by O.C.
- Personnel check by O.C.
- Instruments and safeties checked and reset by O.C.
- Source in checked by O.C.
- Source No.: M-43
- Emergency equipment in control room checked by O.C.
- Instruments in trip circuit: K1-2 PM1-2
- Red light on by O.C.
- Start-up OK'd by O.C.
- Date: 6/9/66

Repeat of last experiment on 6/8.
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