BOOK67R

Notes:
"1970 Chem Tech Log  DWM"

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-pages 20 & 21 has 1 sheet glued each
-pages 28 & 29 has 1 sheet glued each
-page 47 has 1 small sheet taped
-page 66 has 1 small graph taped
-page 98 has 1 half sheet taped
-page 112 has 1 graph sheet

Scanned by:
Sheila Finch
RSICC /Oak Ridge National Lab.
August 23, 1999
Account Book

No. S 149

No Units

Journal
Ledger, Single Entry
Ledger, Double Entry
Record Ruled (27 Lines)

Made in 150, and 300 Pages

TO REORDER, SPECIFY NUMBER, RULING AND THICKNESS INDICATED ON BACKBONE OF THIS BOOK.

MADE IN U.S.A.

Summary of Discussion with J.P. Nichols on Nondestructive Assay of Fissile Material.

Chem Tech Div has responsibility for:

1) Waste Material Storage in Salt Mine
   Primary design for Federal Repository of Waste Matertial

2) LMFBR Fuel Reprocessing

3) HTGR

4) LWBR (235U)

Desirable to be able to analyze some data directly:

1) Irradiated Fuel Element

2) Process stream

3) Waste Materials

Waste Repository materials of 2 types:

a) High Level Waste which contain fission products, will be in sealed 6 x 24 in.
   diameter cylinders 1 ft long

b) Low Level Waste at present mostly
   a) contaminated water (from TPU)
   b) contaminated drums (from TPU)

Items under b) will be stored for the next few years until Salt Mine ready.
Barrels are limited only by heat generation and criticality problem — no maximum upper limit on $\frac{235}{93}$ or $\frac{235}{5}$. An upper limit of 5 kg of fissile material may be placed. 5 kg x 6.4 ft$^3$ = 400 g per ft$^3$.

potassium, sodium, or water $\approx 1$ ft$^3$ from hot line $\approx 1$ ft

or a reduction. This will protect Chernobyl paper and plastic; temperature limit here has been set to be $\approx 500^\circ$ (do not recall value). (I do not recall.)

Criticality problem —

RMX RR can fill with 500 mtr. unit:

$9 \times 9 \times 50$ ft$^3 = 4050$ ft$^3$

$3 \times 5 \times 22$ = 420 ft$^3$ per unit

Crush conditions for Train Wreck.

Storage Facility for 2 waste units; Rocky Flats

150, 000 ft$^3$ = must cut out!
The efforts of Keggin et al. at LAW and the work of GCA at San Diego on Fissilare Materials Safeguards was discussed at some length. The extension of these efforts to the nondestructive assay of irradiated fissionable materials may be a very difficult problem. JPN believes that if either group has the capability of assaying the waste barrels, we should duplicate their efforts and learn how to do similar tests can be installed at ORNL! JPN will support CEP -- 1 man year + 25 k$ to 50 k$ for year for next fiscal year. It was emphasized that this amount of money would not allow to buy the necessary electronics but only to study the problem and make a proposal for the next contract action.

From JTR array calculations:

1000 Bar units in 24" tube age
5.97 kg of $^{237}$ Pu metal
(6.16 x 10^6 units of 1.6 kg per unit from JTR)

From JTR Calculations on Barrels with foam glass or Uraninite + 10% safety factor:

5.7 kg for 1000 unit
6.3 kg for 100 units
leakage calculations showed the core to be 5 barrels

for optimum H/Pa and C/Pa ratios.

This could be done in spherical geometry which
has equal volume and fission thickness equal to
barel weight, assuming these calculations.

Jan 24, 73

Assume one has a 15% of some of the core.

assumed 10^10/100 sec = 4.27 cm

Assume dissolution time = 10 sec

5t = 1 x 10^10

Assume solid angle 0.1m = 1/1.256 x 10^-5 cm

Fast flux = 0.8 x 10^-6

Assume 10 g sample

\( \frac{5t}{2} \geq 2 t \)

Induced Fissions = \( g \times m \times \frac{5t}{2} \)

\( = 3.0 \times 10^5 \times 10 \times 0.6 \times 2 \)

\( = 4 \times 10^4 \)

Prompt Neutrons for 2 = 3

\( = 1.2 \times 10^5 \)

Total Delayed Neutrons (D/P = 0.004)

\( = 4.8 \times 10^2 \)

If counting eff = 0.05

Total Counts = 24

In order to collect same size core will have to be cycled
10 sec in 10 sec out perhaps 1000 times.
Assume "L" as LMFBR Fuel in Barrel
Source strength (Beq/yr) = $5 \times 10^2$ m/sec y

Assume 10 g J Pw, Total Background $5 \times 10^3$ m/sec

Assume 10 sec collection time
Total Background $5 \times 10^6$ m

If Signal to Background Ratio is 10
Delayed Neutrons = $5 \times 10^5$ m

Delayed to Prompt Ratio \( \approx 100 \%
\)
Prompt Neutrons = $1 \times 10^3$ m

Initial Fission \( \approx 3 \) = $3.3 \times 10^7$

Assume 14 MeV fission, \( f_f = 2.5 \) for \( ^{239} \)Pu and \( ^{240} \)Pu

\( t_f \) = fission time

Fissions = \( \phi t_f \times \frac{10^5 \times 6 \times 2.5 \times 8}{240} \)

\( \phi t_f = 3.3 \times 10^7 \times \frac{40}{2.5} = 5.2 \times 10^8 \) m/sec

Assume Solid Angle @ 1m \( \Rightarrow 1.25 \times 10^5 \) cm

\( \phi = \frac{S}{A} \Rightarrow S = \phi A \)

\( S_t = 5.2 \times 10^5 \times 1.25 \times 10^5 = 6.6 \times 10^{13} \)

\( \phi t_i = 10 \) sec

\( S = 6.6 \times 10^{12} \) m/sec
June 25, 1970

Method for making analyses of irradiated fuel element
from an I. M. E. R.

Use critical experiment with fuel element
in center - Nuclear Test Guy. Type I measurement.
Such an experiment would be calibrated with dummy
elements, permanent power limits and large
target. A large target would not be
large enough to overide source. Special gamma
compensation instrumentation is required. Multiplication
measurements may be sensitive enough.

Measurements of two types can be made.

1. In the center of a thermal column such
as target region of HTTR which will
impart reactivity thermal fission of $^{239}$Pu
and absorption in $^{238}$Pu.

2. In a mixed fission spectrum, perhaps
a fast reactor spectrum which may
then give a measure of $^{239}$Pu
rather than a difference of $^{239}$Pu and $^{238}$Pu

$\rho = \theta \times \frac{\text{thick} \times \text{fission}}{\text{thick} + \text{coolant}}$

In a fast reactor $^{239}$Pu acts with fission
and contributes to the reactivity.

A facility such as the RMF and/or ARMF
(Advanced Reactivity Measuring Facility may be required)
July 14, 1972
B Telephone J.P. Nichols

JPN is preparing a budget request for the development of a waste drum "interrogator" or "assay machine" to be built and operational by the end of 1974.

He is writing a somewhat lengthy proposal as well as a letter to Mr. Ackman (Kepco) on portable interrogation tunnel, cost estimates, etc. For FY 1971, he is suggesting $175,000 for Egypt. Whether or not his request will be approved is yet to be ascertained.

JPN does not want to involve either J.B.C. or the AEC.

He believes the United States will make procurement interpretations and delayed decisions but wants to give full responsibility to us here in 9213. (I don't understand)

Many questions still unanswered:

1. Can the samples be brought into 9213?

2. Specifications for monitron and complete, only generalized, what drum content, what fissile isotope, what gamma sources, what neutron sources.

3. Electronics support by whom?

4. Barrels per day?

5. By weight or per barrel? Upper limit?
\[
\frac{\Delta N}{\Delta t} = \frac{6.02 \times 10^{23}}{10} \frac{2.96 \times 10^{-8}}{7.13 \times 10^9} = 3.75 \times 10^{-3} \text{ c/pcc}
\]

\[
E^t = 6.25 \times 10^{-4} \times 6 = \frac{3.75 \times 10^{-3}}{2.96 \times 10^3} \text{ c/pcc}
\]

Assume \(3 \times 3 \times 7 = 63\) \(\text{c/ft}^2\) at distance of 1m

\[
\text{Solid angle} = \frac{\pi \times 3.81^2}{1 \times 10^7} = 3.62 \times 10^{-4}
\]
July 31, 1971

Neutron source strength monitor for spontaneous fission

\[
\begin{align*}
2^{39}\text{Pu} & \rightarrow t_{1/2}(SF) = 1.32 \times 10^7 \text{ yr} \\
\lambda & = 2.196 \times 10^{-8} \\
\frac{1}{\lambda} & = 4.61 \times 10^6 \\
2^{39} \text{Pu} & \rightarrow 2^{39} \text{Pu} \\
\text{Coincidence Detections} & \approx 50\% \\
\text{Eff} & \approx 10\%
\end{align*}
\]

10 g of Pu 5000 m/sec

Assume "Barrel" is sphere having 30 cm rad

Surface area = \(4\pi r^2 = 11.309.26 \text{ cm}^2\)

Spin Detections Area = \(2 \times 30 \times 30 = 1800 \text{ cm}^2\)

\[\text{Eff} \approx 10\%\]

Neutron counting rate

\[C.R. = 5 \times 10^3 \times 10^{-1} \times \frac{3.6 \times 10^9}{4\pi \times 2.436 \times 10^{-14}} = 5000 \times \frac{1.65^2}{4\pi \times 30^2} \times \frac{1}{1600} \times 0.000625 \times 6 \text{ detectors} \]

\[100.37 \times 10^{-2} \times 2.273 \times 10^9 = 3.522 \times 10^{-6}\]
Detector Response

Locations
\[
\begin{align*}
& (\pm 1, 0, 0) \\
& (0, \pm 1, 0) \\
& (0, 0, \pm 1)
\end{align*}
\]

Det Resp = \[ \sum \frac{1}{r_i^2} \]

\[
\begin{align*}
& r_i^2 = (x-1)^2 + y^2 + z^2 \quad 0 \leq x \leq 1 \\
& r_i^2 = (x+1)^2 + y^2 + z^2 \quad 0 = y = 1 \\
& r_i^2 = x^2 + (y-1)^2 + z^2 \quad 0 \leq z \leq 1 \\
& r_i^2 = x^2 + (y+1)^2 + z^2 \\
& r_i^2 = x^2 + y^2 + (z-1)^2 \\
& r_i^2 = x^2 + y^2 + (z+1)^2
\end{align*}
\]

Programmed on Wang Tape for \( x = 1.6 \)

\[
(1.8, 1.8, 1.8) \rightarrow 2.936 \quad y = 1.6
\]

\[
(1.8, 0, 0) \rightarrow 27.748 \quad z = 0.8
\]

Response tabulated on next pages 20-21.

Date: Aug 17, 70

The calculated response may be useful for a detector system surrounding a liquid barrel. If the detector were located a barrel diameter from the inner (4-D equilateral barrel) response \( +20\% \) increased and near the axis and far from the origin.

If the barrel is located in a different medium such as \( \text{CH}_2 \) or \( \text{H}_2\text{O} \), the calculated response will be much different and probably more linear.

If barrel radius and height are 0.4, then

\[
\begin{align*}
\text{range} & = 5.7 \pm 0.7 \quad \text{or} \quad (4.2 \pm 0.5) \pm 8.9 \quad \text{measured between 6.0 and 6.4 (28\% \pm 3.5)}
\end{align*}
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Average value for cube $(4.4 \pm 0.5) = 454.296 \pm 6.261$
Similarly, an irradiation facility can be constructed using six sources at $\pm x$, $\pm y$, and $\pm z$, and the beam would move between the sources.

Counting system must be remote from the 6 sources.

If system is in H2O, then the source - barrel distance should be optimized to produce the required spectrum.

If fast neutron calibration is preferred, then the sources and barrel should be in a large casing.

Distance between source & counting system should reduce the flux to less than 1 m/sr/sec.

Assume 6 sources each at 5 cm from the origin. Total strength = $10^7$ m/sr/sec or 4.27 mg
or 0.71 mg (710 µg) per source.

Central flux is $\frac{10^7}{\pi \times 5^2} = \frac{10}{\pi \times 10^{-4}} = 3.18 \times 10^6$ m/sr.
Assume fast flux = $3.15 \times 10^5$ n/sec cm$^2$

Assume $10^9$ fission, $\sigma_{f} = 1.5$.

Fission rate $= N \sigma_{f} = \frac{10^9 \times 0.022 \times 3.15 \times 3.15 \times 10^5}{25} = 1.223 \times 10^4$ fission/sec

Delayed neutron/flux $= 0.167$.

$= 1.95 \times 10^2$ delayed/sec

Assume 10 sec instead.

$= 1.95 \times 10^3$ delayed/100 sec

If counting is 100 sec

Counter efficiency accounting 10% bar half should be $\approx 10%$.

$= 19.5$ delayed neutron/sec

Isolation expected 100 x Cycles Total Count $= 1950$.

If counter efficiency can be increased $\times 10$% then total count $= 19500$

Cycles reduced to 50

Total count $= 7000$

Fast neutron irradiation is feasible but slow

Calculations should be made for the flux inside a cavity for various moderator and heavy reflector arrangements to maximize the thermal flux at the target location.
Assume $8 \text{ mg} \frac{\text{Cf}}{\text{sec}} = 8 \times 10^{-5} \times 2.34 \times 10^{-6}$

$= 1.872 \times 10^{-10} \text{ m/sec}$
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<td>24</td>
<td>3.0569</td>
<td>2.48</td>
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</tbody>
</table>
August 20, 1970

Discussed with J. Thomas the feasibility of using an array of easily contained units (intertidal) to obtain single unit critical mass, size, etc. Information, confidence in single unit calculations is markedly increased if calculations can "replicate" or simulate an experimental array of the same material.

Materials of interest.

1. Fully enriched

   Oxides of various densities and low moderation values, e.g., of UO₂ (NG) that could also be used

2. Low enrichment and determinate enrichment Oxides

UNH

Such a scheme would reduce fabrication and preparation costs if a process stream can be tapped. Technique would be to make 27 reactors in a size which 8 could be most natural with very small spacing. Both bare and reflected 8 and 27 unit critical spacings would be determined. If materials can be compacted, multiplier in precisely, it would be preferred. However, loose powder would also be used.
August 24, 1970

Telephone conversation with Rod Weston.

Los Alamos Passive Neutron Analysis System.

1. Attenuation - Rotation for Pu.

2 NaI Detectors - 8 barrel segments

100 µc H.E. attenuation measurement

in Transmission.

Results: 1 gram ± 10%.

With everything ganged, measurement and
segmented 1 gram ± 10% in 2013 Min.

2. Calibration - Rotation Method for Pu.

for attenuation factors up to 100
across barrels.

Los Alamos Passive Neutron Analysis

for 240Pu Spontaneous Fission

Lower limit: 1 - 10 grams of Pu

(240Pu content possibly 5 to 10%) only.

DeMagnuson
Signal Clearance for Los Alamos suggested
Tori @ 8:15 TA-35 (Teraite) 06/27
Los Alamos

Brandon - Photo Fission 88-744-293-5000 P300 motor
Gogami 602 453-1000
Costello Brandon Ext 484
Uchiki 1676
E. Anderson Spectrum Analysis Cell
Lube - Art-Valle Analytic

AI - Shuret Country Squin
7401 Popanga Grogan Rd
5212 Susana
White Thorne

Passive Analysis Detection: $^{239}$Pu 385 - 414

55 gal. drums

$^{15}I$% rotate

a) correcting for $^{15}I$ b) " for $^{15}I$

One modification

Barrel assay $\sim 1$ per 10'

Use Collimators

Use 8 detector

for detecting

region

Change angle

diff. atten.

as a function of atten

with attenuation map $\sim 20$

Use Source to measure atten. factors

Certi. less resolution - and
SF. vaults, must know \( \text{Pu} \) assay

1. 2 gal drums
2.

\( \text{Acc} = \text{Source} t \) 4-year period

\( \pm 5\% \) fn

Tride method --- for motion officials

Add a menu from ? 250 \( \mu \text{g} \)

Trace Detection

UCRL-50007

Joe Temple from Livermore

-69-1 \( 20 \text{ keV X-rays from Pu} \) 239 \( \mu \text{A} \) 60 kV

-69-2

-69-3

\( 5" \) + \( \frac{1}{2} " \) NaI xT

Used on waste water discharge to sewage. will detect 0.1 \( \mu \text{A} \) tolerance for \( \text{Pu} \)

TA-18 I. 30 Badly Off
None work in high radiation field.
25% MTR maximal @ 20000 R lead stuck.

Fissile content of high.

Pulse 50% Count 50% to maximize 1/2/1/2.

Yield Technique
14 MeV

Then separate to different is: 236, 232 Th from 235, 233, 232.

Kritics Response
Short Pulse vs Long Count.

He counter not gated off
Keeping gated off during beam pulse.

Her first mention: Interrogation for 2-32.

Use 238U and 235U

I gram main detection in pure filtered beam
+15%.

For 235U only, using tailoring assembly
for neutron flux.

2½ MA KAMAN 200keV.

DC model ~17K.

Acceler 2.5 x 10^10 m/s
1000 hrs tube life, $1300 replacement.


1. $^11_O (np)^*n$ reactions to give delayed neutrons
   above activity threshold at 11 MeV

   4-6 inches of lead releases neutron energy below 14 MeV

2. Decoupling shielding from cavity
   
   PVC + boron = 1/4" thick
   
   Transformer oil 6-8 inches
   
   30 in water

3. Oxygen in sample may interfere

   $^16O (np)^*N$ with 7 MeV gamma ray

   a 5" NaI XTL can monitor O$_2$ content of sample.
Data measurements

\[ \text{delayed motion escaped \&} \]

\[ \text{effect compensated.} \]

\[ 0.3 \text{ Hz, vol fraction or line} \]
Robby Weston

RED

Prototype Development

Specked mobile lab. Field

LASS House keeping

D.O. design for coincident counter

30 gallon drum for plutonium fuel

Non destructive Verification Lab.

U-Al mixture

1,001 MeV 1 cm 327.2 can be used for prompt


Actinides

Neutron Activation

Fissile vs Fertile threshold energy

Materials independent by having a fissile monitor
discrimination ratios for energy

Photon Activation
Pu \sim 7 \times 10^4 \, \text{Bq/gm} \text{sec} \text{ in } 380 - 415 \, \text{group}

Pu \sim 500 \, \text{Bq/gm} \text{ sec}

Speck Scanning for Fission Fragment Track

in Plastic Foils

Neil L. Larkin

(U. S. Army Res. Lab., Univ. of California, San Diego, Calif.)

On leave from Raymond College

Union, Calif.

25 weeks with Brookhaven Accelerator, Inc.
Slee Detectors
2 Banks
Fusion Detectors

Low Dose Rocky Flats
Standard Barrels
containing various
S.F.  Barrell Counter
'91 Budget: 1 x 10^6
Total: 65-70
Blandquist, David
Naliboff, Darius

Dear Crouse,

- Get on ESA Dist.

1. Photon-induced reactions for different gages
2. Various Neutron Sources
   $\frac{S(r)}{B(r)} \approx \rho \cdot g(r)$
   Percent
   Gel!

Electron Anneal Technique

- Electron
- Target
- Stacking
- Must be accurate
- Recoil
- Inhomogeneity
- Shielded
- Look for prompt and delayed
  @ 5.5 MeV

Elron Electronics, for PM Tubs and pulse shaping disk.
Barrel Rotate: electron transceivers

- 6" Pb
- 200000
- 4 channel

Monitor

- 1 inch target
- Cesium 137

- Brain 3x3 NaI

24 ea 2 in. BF3 for linear operation in polyethylene

Used only for delayed neutrons

Gate off electronics 75 microsec

with gamma-flash cancellation

Gateoff 10-15 microsec

100 microsec decay or die away

Beam Pulse 2 microsec 180 ppm

Nahloff

Dave Kunkquist
Sept 18, 1976 - V Decarie.
Telephone call from Ronny Walton  Sept 23 11:40

L.A. is going to build a large pentomine barrel test that will detect and pump quantities of (E=2" Pa)
(Pa=95) (For Muni man Pa Raising Opns)

a) For 30 gal drums
b) 78 unters in hexagon away

and a Top & Bottom (same 6 x 2" of)
similar to previous assembly for catring 200 Pa.
c) Polyethylene Shakes - gravel and
then assembled around container.
d) Will have engineering drawing
in a few weeks.
e) Shifting not discussed.

20-13
Drum Counting System

b. Rotation of drum

c. No collimation to reduce efficiency.

Solution of thermoelastic problem for rotation

\[ s^2 = x^2 + y^2 + z^2 \]

\[ z = R \sin \theta \]

\[ y = R \sin \phi \]

\[ x = R \cos \phi \]

\[ s^2 = (x^2 + R^2 \sin^2 \theta + R^2 \cos^2 \phi) \]

\[ s^2 = (x^2 + R^2(1 + \frac{x}{x^2 + R^2} \cos \phi)) \]

\[ \phi = \int_0^{2\pi} \frac{d\phi}{s^2} \]

\[ = \frac{1}{2\pi b} \int_0^{2\pi} \frac{d\phi}{(1 + a \cos \phi)} = \frac{1}{2\pi b} \left( \frac{2\pi}{\sqrt{1 - a^2}} \right) \]

Case 1: \( R = 1 \), \( x = \phi \), \( z = \theta \) with original drum

<table>
<thead>
<tr>
<th>( R \times 10^3 )</th>
<th>( B \times 10^3 )</th>
<th>( Hz )</th>
<th>Response</th>
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<td>1.0000</td>
<td>0.622</td>
<td>1.0000</td>
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<tr>
<td>0 4 1.5 2.5</td>
<td>0.997 35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 4 1 3</td>
<td>0.989 24</td>
<td>0.613</td>
<td>0.9850</td>
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<tr>
<td>0 4 0.5 3.5</td>
<td>0.969 37</td>
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<tr>
<td>0.5 4 2 2</td>
<td>1.007 50</td>
<td>0.562 22</td>
<td>1.000</td>
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<tr>
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<td>1.005 22</td>
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<tr>
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<td>0.997 06</td>
<td>0.501 13</td>
<td>0.991 11</td>
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<tr>
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<td>0.979 08</td>
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<td></td>
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<tr>
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<tr>
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<tr>
<td>1 4 0.5 3.5</td>
<td>1.009 77</td>
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</table>
\[ \frac{272}{235} \frac{U}{U} \approx 7 \times 10^{-6}, \quad \frac{\tau_{\beta}}{\tau} \approx 7.4 \text{ years.} \]

\[ \frac{235}{231} \frac{U}{U} \approx 97, \quad \frac{\tau_{\beta}}{\tau} \approx 16.2 \times 10^5 \text{ years.} \]

\[ \frac{235}{231} \frac{V}{V} \approx \frac{1}{7.13 \times 10^7} \text{ years.} \]

\[ \frac{dN}{dt} (235) = \left( \frac{7.13 \times 10^7}{2.3} \right) \times 7 \times 10^{-6} = 62.4 \]

\[ \frac{dN}{dt} (233) = \left( \frac{7.43 \times 10^7}{2.3} \right) \times 7 \times 10^{-6} = 62.4 \]

Assume 95% branching ratio for \( \beta \)

Reduction detector efficiency for 2.6 MeV vs. 1.85 MeV,

\[ 6.7 \times 10^{-3} \approx 23.6 \]

Assume \( 1.5 \frac{B}{T} \), \( \frac{233}{231} \frac{U}{U} \)

\[ \frac{dN}{dt} (232) = \frac{dN}{dt} (232) \times 7 \times 10^{-6} \times \frac{7.43 \times 10^7}{2.32} \times 7 \times 10^{-6} \]

\[ = 5.29 \times 10^6 \]

\[ \frac{dN}{dt} (230) = 1.99 \times 10^6 \]

Detector solid angle:

\[ \begin{array}{c}
14 \text{ cm}^2 \\
35 \text{ cm}^2 \\
150 \text{ cm}^2
\end{array} \]

\[ \begin{align*}
\pi \times r^2 &= 2.26 \times 10^5 \\
\pi \times r^2 &= \frac{\pi \times (3.5)^2}{4 \times 1.8 \times 10^4} = \frac{19.516}{7.2 \times 10^{-7}} = 2.7016 \times 10^{-4} \\
\sin \theta \cdot \cos \theta &= 5 \text{ mils} \times 5 \text{ mils}
\end{align*} \]

\[ = 4.032 \times 10^{-7} \]
Assume Detection Efficiency for 3X3 @ 2.6 MeV = 0.23 (Peak/Total Ratio)

\[ 1.89 \times 10^6 \times 4.0 \times 10^{-4} \times 0.23 \]

Estimated Count Rate = \( 1.75 \times 10^4 \) counts/sec

10 min counts \( \rightarrow 1.05 \times 10^5 \) counts

This is adequate statistics for 100% decay equilibrium of decay.

For 10% of equilibrium 0.3 min after

\[ 1.05 \times 10^4 \text{ counts} \rightarrow 10 \text{ min} \]

It remains to be seen how other gamma emission interfere with this analysis.

Probably sum of \( ^{233} \text{U} \) standard having same \( ^{238} \text{U} \) content and processed at same time to follow the equilibrium.
Oct 30, 1979

Set up TAC-2X-40 25 x 4 V with 3 x 3 NE T, N1 E PS @ 100 V, linear sweep input at gain 64 and 22. To look at and record spectrum from 235U, 233U, and 239Pu at 1 meter.

Check out with 137Cs and 60Co., spectrum OK. Don Open.

Isotope Peak Energy Count - Bkg (10 min) Count/g

239Pu (3.0g) ~ 385 126 293 15 560

HfR 015127 235U (19.8g) ~ 185 73 087 3 691

Calutron 233U (101g) ~ 105 277 235 109 800

@ 20" = 2.55 @ 1 m

Smaller peak @ 240

335

475

1450

No detectable peak @ 2.615 MeV in 50 min counting time.

Nov 3 11:00 233U (9.551 g) 2.615 MeV 8096 847.7

233U from Hanford Shipment #4. (Arrived Nov 2)

Batch Lot No. Drum 61 2-2-5 815-5019

347.5 mg U/ml Sp gr = 1.492

98.333% Fissile Ud 0.02295 g > 9.712 5 1

Cmsf 54.5

M 12.7

Net 71.79

(60)
A comparison of the spectra from the Celutran sample and the standard "shipment sample."
Nov 10, 1970

\[ 9.55 \text{ g} \quad ^{233}\text{U} \quad (171-210) \quad 12.9 \pm 7.7 = 12.897 \]

\[ ^{233}\text{U} \text{ (1.75 MeV) at } \theta = 18 \text{, Baseline } = 20.0 \]

\[ ^{233}\text{U} \text{ counting } + \text{ Baseline set to } 2.00 \pm 0.67 \text{ ch} \]

\[ 2.5 \text{ peaks } \theta \quad 187 + 57 = 2.54 \quad \text{(Nominal)} \]

\[ (21-210) \quad 131275 - 767 = 130468 \times 1366/10 \text{ min} \]

\[ 1366 \quad 1.61 \quad 22 \text{ days} \quad 65 \]

\[ 39 = 1.66 \]

\[ 23 \quad 16 \quad 69 \quad 43 = 1.60 \]

\[ \text{Therefore, the age on Nov 3 was } \sim \text{ 16 days} \]

\[ \text{0 days on Oct 18.} \]

**Oak Ridge Orcoate has } 1.03 \times 10^{-5} \text{ atoms/cm}^2 \]

\[ \lambda = 2.196 \times 10^{-6} \quad \text{1.687} \times 10^{-17} \quad \text{K}^{-1} \text{cm}^{-1} \]

\[ \text{K}^{-1} \text{cm}^{-1} \]

\[ N = 4.03 \times 10^{17} \]

\[ \Delta N = 6.847 \times 10^{2} \quad \text{X} \quad (4.68 \times 10^{-5})/10 \text{ min} \]

\[ \text{Solid Angle} = 3.8^2 \times \pi \]

\[ \text{Ceiling area } \times \text{10 cm thick } = (5 \times 3.5)^2 \times 10 \]

\[ \times 1 \text{ cm thick } = 2.32 \times 10^5 \]

\[ \text{Count Rate } = 4.68 \times 10^{5} \times 6.25 \times 10^{-4} \times 2.32 \times 10^4 = 6.916 \times 10^{6} \text{ ch / min} \]

\[ \times 1.18 \times 10^{-7} = 0.98 \]
Observed 3400 counts in peak 14s
60 x 100 min
340 counts/10 min, expected 1400!

Portland Cement concrete has 0.0029 g 40K/cm

\[ \times \frac{6.0 \times 10^{-3} \times 1.04 \times 10^{10}}{1.0 \times 10^9} = 9.32 \times 10^{-7} \, \text{g} \text{K/cm}^2 \]

\[ \lambda = \frac{2.190 \times 10^{-2}}{1.3 \times 10^{-9}} = 1.69 \times 10^{-17} \]

\[ \lambda N = 0.2372 \text{ dis/sec/cm}^3 \]

Nov 17, 1970 235 U 9.551 g Plutonium

Total area in peak (111-210) 180.381 100%

179.3614

18.81 cts/g (10 min)

Extraction to zero on 23 Oct

5 day delay (Calculation time to Superintendency)

Nov 24, 1970 Plutonium (111-210) 228.755 100%

767

228 018

18 Oct 69380, 69400

Nov 23, 1970 2387.5 cts/g (10 min)

Dec 1, 1970 237.009

2.87240 \to 2.977, 60/9/60 min
Dec 8  267 264  171-210  
\[ \frac{267}{326.5} \text{ cfm/min} = 381.85 \text{ cfm/min/g} \]

Dec 15  391 000  
\[ \frac{391 000}{767} = 511 \text{ cfm/min/g} \]

Dec 31  165-210  529 903  100 min  (4.34 Bgl 50 min)  
\[ \text{Bgl} \approx 868 \]  
\[ \frac{529 903}{868} = 614.3 \text{ cfm/min/g} \]

Jan 6  168-210  275 180  50'  
\[ \text{pk 186.5} \]  
\[ \frac{420}{374750} = 5.695 \text{ cfm/min} = 575.3 \text{ cfm/min} \]

Jan 9  168-210  319 559  51  
\[ \text{pk 186.5} \]  
\[ \frac{480}{319.5 \times 2 \times 9.551} = 668.2 \text{ cfm/min} \]

Feb 9  168-210  407 955  
\[ \frac{480}{407 520 \times 2 \times 815.040} = 853 \text{ cfm/min} \]

Feb 17  Combine 3 gain x32  92-69  
\[ 10' - 83 245 - 101 = 83194 \approx 871.05 \text{ cfm/min} \]
February 16, 1971

On Friday Feb 12, 1971 discussed with JF. Nicholas and Victor di Carlo the development of a beta monitor for \( \mu \) source at Equin. It was assumed that the emphasis is on barrels.

My proposal was to use 2 detectors and a Landauer.

Need sample having \( ^{232}U \) et al. and age equal to Erwin scrap for calibrating standard.

Need barrel rotator.

Ann
Feb 17, 1971

Set up 3 x 3 x 3 Multichannel Analyzer with 40 Mm and that with Born liner at 3.00 (100) peak for 60Co.

0.133 MeV was in channel 33. Charge gain from x-ray to x-ray 2.614 MeV 248Th was at channel 40.

Gamma Counts 10 Min (29-64)

Air 93424 - 101

1" of Plexiglass 74880 - 101

1/4" of Plexiglass

2" of Plexiglass 66915 - 101

1" of Pb 26808 - 101

7.2 cm Wood 75386 - 101

37/6" of Plexiglass 50317 - 101

Air 83167 - 101

Background 101

Arrangement for simulated barrel at end

38 in. Source outside

30 in. Source on 38 in.

30 in. Source outside

D

BBL

Simulation B and D simulate absorption around source in BBL
<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>Count in 10 Min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>1''</td>
<td>1''</td>
<td>84452 - 101 = 84351</td>
<td></td>
</tr>
<tr>
<td>Source</td>
<td>1''</td>
<td>2''</td>
<td>67372 - 101 = 66370</td>
<td></td>
</tr>
<tr>
<td>Source</td>
<td>2''</td>
<td>2''</td>
<td>53641 - 101 = 52640</td>
<td></td>
</tr>
</tbody>
</table>

\[
E = \frac{N \cdot e^{-\mu X}}{2} = \frac{N}{2} \mu X e^{-\mu X} \\

\begin{align*}
1'' & : 1.254 \, 189 & 0.247 \, 2 & 1.135 \, 6 & 1.120 \, 3 \\
2'' & : 1.576 \, 238 & 0.435 \, 04 & 0.275 \, 2 & 1.255 \, 5
\end{align*}

Source at 30 in.

\begin{align*}
1'' & : N \cdot e^{\frac{-\mu X}{2}} = 131 \, 803 \text{ compared to } 132 \, 722 \\
2'' & : N \cdot e^{\frac{-\mu X}{2}} = 132 \, 870 \text{ compared to } 132 \, 723
\end{align*}

This simulated barrel attenuation is accurate to evaluation by putting the sources inside the barrel. For inhomogeneous conditions, the accuracy will probably be affected and barrel rotation may not average properly.

\[
\frac{dV}{V} = \frac{\left[ e^{\mu (X-x)} - e^{\mu (X+x)} \right]}{D - X} = \frac{\left[ e^{\mu X} - e^{-\mu X} \right]}{D + X}
\]

\[
= \frac{D^2 e^{-\mu X}}{D^2 + e^{\mu X} + D^2 e^{-\mu X}}
\]

For \( X = 0, \mu = 2 \)
Average value of the attenuation length for linear homogeneously distributed in a barrel

\[
\overline{z} = \frac{\int \text{d}x \, \text{d}y \, z}{\int \text{d}x \, \text{d}y}
\]

\[
= \frac{\int_{\Omega} \text{d}y \int_{-\sqrt{R^2-y^2}}^{\sqrt{R^2-y^2}} \text{d}x \left( \sqrt{R^2-y^2} - x \right)}{\int_{\Omega} \text{d}y \int_{-\sqrt{R^2-y^2}}^{\sqrt{R^2-y^2}} \text{d}x}
\]

\[
= \frac{1}{\pi R^2} \int_{-R}^{R} \text{d}y \left( \frac{R^2-y^2}{2} \right)^{\frac{3}{2}} \left[ \frac{2}{\left( R^2-y^2 \right)^{\frac{1}{2}}} \right] - \frac{1}{2} \left[ \frac{R^2}{R^2-y^2} \right]^{\frac{3}{2}}
\]

\[
= \frac{1}{\pi R^2} \int_{-R}^{R} \text{d}y \left[ \frac{2}{\left( R^2-y^2 \right)^{\frac{1}{2}}} \left( R^2-y^2 \right)^{\frac{3}{2}} \right]
\]

\[
= \frac{2}{\pi R^2} \left[ \frac{R^3}{3} - \frac{R^3}{3} \right] - \frac{R^3}{3}
\]

\[
= \frac{8}{3\pi} R - 0.8488 R
\]

\[
\overline{z} = 0.4244 \, D
\]
Feb 25, 1971

Additional thoughts and work 235U - cost to monitor

1. Checked out 2 well counters - from V. DeCar
   1. Not good

2. Poor resolution - can't use either

3. Presq OK with \( 3 \times 3 \) in Domax 6363 tube.

2. Proposed to J.R. Carruth that we set up one in 3019 and make measurements on anything we can to see what he has. Essentially a dry tube field method.

3. V. DeCarlo will run 2 samples
   one for 20 cm, thin wire, 1 RPM
   one 300 lbs, 12 cm thin wire, 3 RPM

4. The spectrum of \( { }^{208}Tl \) from 2.6 MeV MeV gamma includes a single peak at 3.103 MeV and a broad peak at 7.592 MeV

With the \( 3 \times 3 \times 7 \), integrating over all three one includes 3X as many counts.

5. Using a \( 1 \times 1 \times 7 \) is not satisfactory at all - too small efficiency for the peak.
6. Adjusted gain and baseline for only 1/4 memory so that
Channel 4 at energy 0.255 below double escape and channel 47 at 2.164 + 0.255.

Spectrum looks like below

\[ \text{Baseline @ 1.80} \]

\[ \text{Peak @ Ch 47.5} \]

Advantage of above set up is not as sensitive to PM drifts as previous
and includes \( 3 \times \) more counts.
Background is larger, but less than 1% for \( 9.55 \) g @ 38 cm.

March 1, 1971

On comparison of \( ^{60} \text{Co} \) spectrum, - 2.50 MeV
sum peak occurs within a channel of the
supposedly high peak of \( ^{208} \text{Te} \) @ 2.64 in \( ^{233} \text{U} \) sample,
\( \approx 21.5 \) (100 keV per channel), whereas it should have been \( > 50 \) channels
higher.
March 3, 1971

Set up Multichannel Analyzer at 3019
Peaked 2 Baseline 1.86 2370 peak at ch 58

Distance 10 x 1.414 x 9 + 8 + 8
1D + 12.76 + 8 = 143.26 in.
5
144.96 in. = 369.69 cm

1st Bird
1st + 2nd Bird
2nd + 1st Bird
2nd Bird

Cannot find 2nd Birdage

Work terminated

0.5 m
98812 x 13.52 = 133570 ft, 1.3357 x 10^6 @/m
0.5
1.33 x 10^7 @/m

x 100g sample 2.66 x 10^3 @/min @/m
Distance to face of XTC
6 3/4 in.
Total 6 5/8 in.
Distance to point beyond
Grid case
78.6 in.
Total 80 in.

Liveline Beeline 1.80

Cutting 2.6/14 m, plak
Sag Em 2.1
Dock sag 1.5

[Diagram: Line chart or graph]
March 8, 1931

<table>
<thead>
<tr>
<th>Date</th>
<th>Count</th>
<th>Time</th>
<th>Dist</th>
<th>Page No</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.52g</td>
<td>5</td>
<td>5108</td>
<td>6</td>
<td>65&quot;</td>
</tr>
<tr>
<td>3.899</td>
<td>5</td>
<td>2639</td>
<td>7</td>
<td>65&quot;</td>
</tr>
<tr>
<td>18.95</td>
<td>5</td>
<td>10623</td>
<td>8</td>
<td>65&quot;</td>
</tr>
<tr>
<td>18.60</td>
<td>5</td>
<td>10638</td>
<td>9</td>
<td>65&quot;</td>
</tr>
<tr>
<td>18.20</td>
<td>5</td>
<td>10683</td>
<td>10</td>
<td>65&quot;</td>
</tr>
<tr>
<td>18.70</td>
<td>5</td>
<td>10652</td>
<td>11</td>
<td>65&quot;</td>
</tr>
<tr>
<td>18.77</td>
<td>5</td>
<td>10615</td>
<td>12</td>
<td>65&quot;</td>
</tr>
<tr>
<td>P7</td>
<td>5</td>
<td>54800</td>
<td>13</td>
<td>80&quot;</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>54632</td>
<td>14</td>
<td>&quot;</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>50200</td>
<td>15</td>
<td>&quot;</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>59272</td>
<td>16</td>
<td>&quot;</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>59814</td>
<td>17</td>
<td>&quot;</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>X</td>
<td>18</td>
<td>&quot;</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>X</td>
<td>19</td>
<td>&quot;</td>
</tr>
</tbody>
</table>

64-7 & 7 inside 6 behind

7 60817 13A 80" Behind Vent

6 60901 14A 80" Behind Vent
**UNH Solution from U-6 for Testing by D. W. Magnuson**

_B.C. - 102-5204_

<table>
<thead>
<tr>
<th>Bottle No.</th>
<th>Brown. g.</th>
<th>Trace. g.</th>
<th>net. g.</th>
<th>$^{233}U$ (%)</th>
<th>Vol. (l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>36.55</td>
<td>33.55</td>
<td>3.00</td>
<td>0.54</td>
<td>0.0022</td>
</tr>
<tr>
<td>2</td>
<td>55.00</td>
<td>33.70</td>
<td>21.30</td>
<td>3.89</td>
<td>0.01572</td>
</tr>
<tr>
<td>3</td>
<td>137.70</td>
<td>33.95</td>
<td>103.75</td>
<td>18.95</td>
<td>0.2485</td>
</tr>
<tr>
<td>4</td>
<td>135.60</td>
<td>33.70</td>
<td>101.90</td>
<td>18.60</td>
<td>0.07548</td>
</tr>
<tr>
<td>5</td>
<td>136.55</td>
<td>34.10</td>
<td>102.45</td>
<td>18.70</td>
<td>0.07588</td>
</tr>
<tr>
<td>6</td>
<td>136.45</td>
<td>33.70</td>
<td>102.75</td>
<td>18.76</td>
<td>0.07411</td>
</tr>
<tr>
<td>7</td>
<td>144.50</td>
<td>41.70</td>
<td>102.80</td>
<td>18.77</td>
<td>0.07614</td>
</tr>
</tbody>
</table>

**5 P.G. 1.3501**

Total: 99.78 l / 98.21 l
<table>
<thead>
<tr>
<th>Sample</th>
<th>Count</th>
<th>Time</th>
<th>Printout Dist No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>80&quot;</td>
<td>No Bird cage</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>83580</td>
<td>24 80&quot; No Bird</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>82719</td>
<td>25 &quot;</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>82547</td>
<td>26 &quot;</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>82663</td>
<td>27 &quot;</td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td>84014</td>
<td>28 &quot;</td>
</tr>
</tbody>
</table>

6+7 5 206848 18 65" 1st Bird over
5+6+7 5 307120 19 " 1 20 x 2
4+5+6+7 5 409481 20 " 1st Bird at plane 1
3+4+5+6+7 5 515509 21 " 1
1+2+3+4+5+6+7 5 546744 22 "

5+6+7 5 294043 19 A 65" 1st Bird in line with 76
1+(2+3 5+6) 5 516587 22 A 65" Close pack in Bird

# (65") +7(6) 5 165546 23 65" 1st Bird

<table>
<thead>
<tr>
<th>Sample</th>
<th>Tin Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>127024 29 65&quot; No Bird Ch 8-7</td>
</tr>
<tr>
<td>6</td>
<td>129 9 33 30 &quot;</td>
</tr>
<tr>
<td>5</td>
<td>124 3 31 &quot;</td>
</tr>
<tr>
<td>4</td>
<td>125 2 32 &quot;</td>
</tr>
<tr>
<td>3</td>
<td>125 5 33 &quot;</td>
</tr>
<tr>
<td>weighted HO in TMC cu-110 0K</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>127 145 33A 11</td>
</tr>
</tbody>
</table>

3. 5' 127.191 33B 6.5'' No Band
   Adjust Hi Voltage (now 12v)
   3 5' 127.681 33C

<table>
<thead>
<tr>
<th>Date</th>
<th>Distance</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-15-71</td>
<td>3, 4, 5, 6, 7, 8</td>
<td>7923</td>
</tr>
<tr>
<td>for 5th 93.28 g/21.1</td>
<td>7557</td>
<td></td>
</tr>
<tr>
<td>8.5 ppm agw</td>
<td>1/8.5 cm</td>
<td>133.713</td>
</tr>
<tr>
<td>Std</td>
<td>325.924</td>
<td>318.486</td>
</tr>
<tr>
<td>Unknown + Std</td>
<td>136.0 cm</td>
<td>251.112</td>
</tr>
<tr>
<td>(12.9 g) 3.9 ppm</td>
<td>Stopped FRN, Returned</td>
<td></td>
</tr>
<tr>
<td>Age ~ 20000 d</td>
<td>Calibration factor = 1200.78</td>
<td></td>
</tr>
<tr>
<td>Alt. factor = (0.5925) ^ 1/2 = 0.7697</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age Factor = 328 / 52 = 6.31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>232 U content 39/5 = 4.59</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28.96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(243.672) / 1200.2 x 28.96 = 7.01 g</td>
<td></td>
<td></td>
</tr>
<tr>
<td>~ 3.12.9 g</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
April 8, 1971

It was decided to drill a ½" hole in a 4x4x4 lead brick
and a 1" holder another ""

to make collimators. The 10mCi Co source
was placed 98' 4" from the surface of the 3x3
NaI detector. Integrate over both peaks at 1179.1 eV

Net Rate (Kv)

No. Coll. 215.635 - 916 = 214.119 cts/min
1" Coll 304.83 - 876 = 29.807 "
½" Coll 090.82 - 845 = 8.237 "

There was no apparent loss in resolution
or shift in peak heights. Conclude that
collimators and/or distance can be used
to decrease sensitivity of the 3x3 NaI detector

Areas of x 14

<table>
<thead>
<tr>
<th></th>
<th>3.6</th>
<th>9</th>
<th>26.0</th>
<th>7.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&quot;</td>
<td>4</td>
<td>3.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>½&quot;</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Dwight
April 8, 1971

Glass

- 2" lead - 4 1/2"

North

- 2" lead - 1/4" lead

PM XTC

- ½ x 1"

Lead

Colli meter

Co 60

some
Linear Abs coeff for head @ 2.4 MeV = 0.48 cm⁻¹

Nn 4.5 in = 10.6 cm

\( \mu X = 4.88 \) e⁻μX = 0.00762
June 1, 1971

Nord Country Analysis System to Bldg 3019

for demonstration I met with Bertke on June 2, 71

Beverly 180

Gain (HV) adjusted so that upper edge of 26 MeV line
in channel 64, peak channel > 60. (57)
but all others 1.6, 2.1, 2.6 lines are accepted in
64 channel.

C.C.

June 2, 1971

Letter to Brooks back on Thorium interferences
with 237 U - 205 Tl Analyses.
July 21, 1971

Discussion with S.O. Snyder in Texas indicated that the NDT section of NRC Div. was interested in developing a neutron scanning device similar to the ray inspection machines that have been developed. The HFIR fuel plate scanner is an example of the latter, and it is believed that no neutron inspection machines have been conceived. The interest of NRC in neutron radiography is mainly to have available a facility but not to do much development work.

My suggestion for using critical assemblies and fission fission for neutron sources was appealing to him because they could be made very easy. We could not breed the critical neutron fluxes in a C.A. that a reactor could produce just having a source only for neutron radiographs that has many advantages.

Consideration of the fluxes that could be produced by fission sources.

Assume 10 mg of $^{252}$ Cf a $2.34 \times 10^{10}$ n/sec.

Measured flux per $^{252}$ Cf source = 0.013 n/cm$^2$ sec

Source strength at 3 ft. collimator = $3 \times 10^8$ n/sec cm$^2$

$\gamma_{\text{out}} = 7 \text{ cm}^2$ = $3 \times 10^8$ n/sec

Assume collimator = 100 cm, $r = 10^{-2}$

Flux at 3 ft. collimator = $3 \times 10^4$ n/sec

Statistics for pulse counting timing = 0.6%
For an area of 1 mm$^2$ for the collimator

the count rate = 300 n/sec

and for an integration time of 10 sec., the statistic would be 1.87%. Such an inspection device would appear to be technically feasible.

Detectors such as Be, BeF$_2$, BiF$_3$, and the proportional counters or the scintillation detectors can be obtained showing efficiencies

of 70%. A preliminary experiment has been designed to measure the flux in a neutron count rate at the end of a 16 in. long 1 in. o.d. collimator which is lined with Cd. The Pu-Be source which was used to measure the neutron flux at a rate of 1,000 n/sec per square inch will be placed at 4-5 cm away.

The source will be placed near the center of a 30 x 30 x 32 assembly of C$_2$H$_4$ blocks in which a 16 in. hole penetrates to the vicinity of the source. A 2 in. o.d. BeF$_3$

counter will be used to detect the emergent neutrons. The diameter of collimator of 22 in. Cd is 0.021 in.

area = 6.262 in$^2$ = 4.1 cm$^2$
BF₃ + PRE AMP + HV @ 300 + A/D AMP @ 165 x, PHS = 30 V (pulses > 500)
+ Torne & Davis Scaler PHS @ 10 (PHS @ 5 for 600 check) - No pulses with HV 0 volts.
Count rate expected to be
\[ 8.3 \times 10^6 \times 0.069 \times 4.1 \times \frac{1}{18^2} \times 90\% = 3.7 \times 10^2 \]
\[ = 57.4 \text{ c/sec on } 3 \times 50 \text{ c/min} \]
\[ = 0.45 \text{ c/m}^2 \text{ sec} \]

July 22, 1971

Observed count rate BF3 coaxial with Beck.

240 c/min
220 "
210 "
200 "
200 "

with Counten Offset from Atlantic

16,180 c/HR
BF3 10,870 c/HR

Net 5,310 c/HR or 1.5 c/sec. 181 c/1 min

BF3 coaxial Counten with Cadmium 160/10 m = 160 c/min
Counten in front of collimator 910/10 m = 91 c/min
Withdraw Cd Sheet 2", moved detector 2 in each
Net Collimator 18", penetrates 4" from (Ch2) 14700/10 min
131 c/min

With new Cd Sheet 6.4" 1290 c/10 m = 113 c/min
3" 1460 \[\rightarrow 130 \]
1" 1260 \[\rightarrow 110 \]

Change BF3 Counten part 1941 to 1938
1" 1250 \[\rightarrow 111 \]

1938 Cha, With 2 "slits in iron containing source, hole 18" deep now

1" 1820 \[\rightarrow 166 \]
Repeat 3.4" 770 + 490 = 166 + 153
3" 1840 \[\rightarrow 168 \]
0" 1740 \[\rightarrow 153 \]
July 23, 1974

Turned around on p. 117 to date.

New

Previous

Previous installed 1" od stainless RSN: 7 400 cm/kg Bf

Source 1600 V PHS max 10 @ 2.80 mGy pulsed

Portion 220V, peak B field ~ 50-70 volt.

Used 0" 10'

0" (16" in holder) 2700

Bkg 80 = 262 min

0" 2790 = 271
1" 2910 + 283
2" 2920 + 284
3" 2940 + 286
4" 2700 = 262
Counter Efficiencies

2.678 x 10^19 atoms/cm³ std atm oxygen

\[(10^8) \frac{N_e}{N_o} = 0.0982 \times 10^{-28} \times 30.48 \times \frac{1}{0.18} = 0.4751 \quad e^{-N_e} = 0.622 \quad 1-e^{-N_e} = 0.378\]

For 2 in. copper, 12 in. long, 12 cm H₂

\[\frac{12}{76} \times 30.48 \times 0.4751 = 0.4751 \quad e^{-N_e} = 0.622 \quad 1-e^{-N_e} = 0.378\]

For 1 in. copper, 8 in. 40 cm

\[\frac{40}{76} \times 20.32 \times 0.018 = 1.0558 \quad e^{-N_e} = 0.348 \quad 1-e^{-N_e} = 0.652\]

Count rate ratio = 0.652

for beam on \[\frac{.378}{.1800} = 1.725\]
Turned Source around as described on p 115

4"
2"
1"
0"

\[
\text{Counts/sec cm}^2 = \frac{286}{6.0 \times 10^4} = 1.64 \times 10^{-7} / \text{cm}^2
\]

\[
\text{Counts/sec m} / \text{sec} = \frac{1.83 \times 10^9}{1.7 \times 10^{-7}}
\]

\[
22"\]

\[
\text{Counts} = 3.36 \times 10^3 / \text{cm}^2 = 33.6 / \text{mm}^2
\]

Width being efficiency constant and smaller beam tubes (which restrict the flux much less), this can be increased to \(336 / \text{mm}^2\)

\[
\text{and } 3360 / \text{cm}^2 = 3.16 \times 3.16 \text{mm}
\]

Using a cone shaped collimator, the source area can be increased and the collimator length increased to \(3 \text{ cm}\).

\[
\text{area} = 3.14 \times 100 \times 2 = 628 \text{ mm}^2
\]

3He
\[
\text{pur. cont.}\n\]

\[
\text{eff.} \approx 100\%
\]
South to desert crossing
West to Tepary Canyon