AIM

Association for Information and Image Management

1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910

301/587-8202

Centimeter

Inches

MANUFACTURED TO AIM STANDARDS
BY APPLIED IMAGE, INC.

1 of 1

**Cover Sheet for a Hanford
Historical Document
Released for Public Availability**

Released 1994

**Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830**

**Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
by Battelle Memorial Institute**

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

This is a historical document that is being released for public availability. This was made from the best available copy. Neither the United States Government nor any agency thereof, nor Battelle Memorial Institute, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

(CLASSIFICATION)

MANFORD ATOMIC PRODUCTS OPERATION - RICHLAND, WASHINGTON

HW-43464

COPY NO. AND SERIES

23 _____ A

COPY 1 OF 1, ~~SERIAL~~

LAND, WASHINGTON

~~FILE DESIGNATION~~ 1656

RETURN TO

~~TECHNICAL INFORMATION FILES~~

PRODUCTION TEST NO. 105-634-A

IN-PILE COCKED SLUG TESTS

AUTHOR

P. B. McCarthy
F. W. VanWormer

☐ OTHER OFFICIAL CLASSIFIED INFORMATION
THIS MATERIAL CONTAINS INFORMATION AFFECTING
THE NATIONAL DEFENSE OF THE UNITED STATES
WITHIN THE MEANING OF THE ESPIONAGE LAWS,
TITLE 18, U.S.C., SECS. 793 AND 794, THE TRANS-
MISSION OR REVELATION OF WHICH IN ANY MANNER
TO AN UNAUTHORIZED PERSON IS PROHIBITED BY
LAW.

THIS DOCUMENT MUST NOT BE LEFT UNATTENDED OR WHERE AN UNAUTHORIZED PERSON MAY HAVE ACCESS TO IT. WHEN NOT IN USE, IT MUST BE STORED IN AN APPROVED LOCKED REPOSITORY WITHIN AN APPROVED GUARDED AREA. WHILE IT IS IN YOUR POSSESSION AND UNTIL YOU HAVE OBTAINED A SIGNED RECEIPT FROM CLASSIFIED FILES, IT IS YOUR RESPONSIBILITY TO KEEP IT AND ITS CONTENTS WITHIN THE LIMITS OF THIS PROJECT AND FROM ANY UNAUTHORIZED PERSON. ITS TRANSMITTAL TO, AND STORAGE AT YOUR PLACE OF RESIDENCE IS PROHIBITED. IT IS NOT TO BE DUPLICATED. IF ADDITIONAL COPIES ARE REQUIRED, OBTAIN THEM FROM THE RELATED ISSUING FILE. ALL PERSONS READING THIS DOCUMENT ARE REQUESTED TO SIGN IN THE SPACE PROVIDED BELOW.

	DATE

[illegible]

THIS DOCUMENT IS PUBLICLY
AVAILABLE

C-3195-MB (11-94) DEC 22 01 11 00 -Q

(CLASSIFICATION)

~~DECLASSIFIED~~ *48*

~~MASTER~~

DECLASSIFIED

156-43464

1. AEC:HOO: Attn: HH Schipper
2. AEC:HOO: Attn: AT Gifford
3. JA Ayres
4. RS Bell
5. JA Berberet
6. CW Botsford
7. LP Bupp
8. RL Call
9. PA Carlson
10. VR Cooper
11. ES Day - WA Richards
12. RL Dickeman
13. MJ Fouts
14. RM Fryar
15. GC Fullmer
16. JH Gerety
17. CG Lewis
18. WK MacCready
19. AR Maguire
20. PB McCarthy
21. LH McEwen
22. JF Music
23. PH Reinker
24. WC Riley
25. OC Schroeder - RE McGrath
26. CD Shadinger
27. JT Stringer
28. JW Talbott
29. FW Van Wormer
30. NG Wittenbrock
31. EC Wood
32. Extra
33. File Copy
34. 300 Files

Classification Cancelled and Changed To

DECLASSIFIED

By Authority of CG-PR-2

RM Ilen 10-6-92

By PM Eick 4-26-94

Verified By JH. Wells 4-26-94

May 29, 1956

This document consists of
6 pages No. 23 of
34 copies Series A

PRODUCTION TEST NO. 105-634-A

COPY 1 OF 1, ~~SECRET~~

IN-PILE COCKED SLUG TESTS

~~RESTRICTED DATA~~

~~This document contains restricted data identified in the Atomic Energy Act of 1946. Its transmission or the disclosure of its contents in any manner to an unauthorized person is prohibited.~~

DECLASSIFIED

DECLASSIFIED

- 2 -

HW-43454

INTRODUCTION

Slug ruptures characterized by intergranular corrosion failure of the aluminum can (Hot Spot Ruptures) have been a major cause for loss of reactor production, particularly during the past year. Although the cause for these failures is not definitely known, it is suspected that fuel elements when cocked in the process tube will sufficiently distort the neutron flux and the heat transfer characteristics in a localized area that very high local temperatures will exist and the corrosion rate of the aluminum can in these areas will be accelerated. It is the purpose of this test to introduce slugs that are known to be cocked and compare their resistance to rupture with slugs that are known to be uncocked when initially charged.

BASIS

- Cut-of-pile testing of the causes and effects of cocked slugs has been conducted for the past six months. It has been found that under normal flow conditions the cocked slug and several adjacent slugs will rise off the tube ribs, materially decreasing the water annulus at the top of the slug⁽¹⁾. A possible cause for cocking under present operating conditions was discovered and a test is currently underway to evaluate an appropriate remedy for that particular cause⁽²⁾.

Other tests have shown that nozzle misalignment and flush charging of slugs⁽³⁾ will cause extreme cocking of slugs. It is to be expected that more extensive investigation will reveal that there are other contributing factors. Not yet answered is the question "Are cocked slugs a cause for slug failures?" It seems unlikely that this question can be answered in other than an in-pile test.

Should slug cocking be a problem it is expected that solutions can be found. The tru-line slug may prevent cocking, also, it may introduce other problems. In any event, it would seem appropriate to define the problem before proposing solutions.

Out-of-pile tests employing flush charging as proposed for Project CG-642 have revealed that in nearly all instances at least one slug in the column has been cocked⁽³⁾. The prevalence of cocking is most frequent near the rear of the charge and to a lesser extent near the center of the charge. Two types of cocking has been observed; i.e., the upstream end of the slug cocked up against the top of the tube, and the entire slug against the tube wall as though it were riding on only one rib.

If cocked slugs influence rupture rates it would be expected that other factors that must be considered would be the nature of the cocking and the location of the slug in the tube because of the effect of mean local water temperatures and the specific power of the slug. It is likely that the effect of specific power is more significant than the effect of mean local water temperature.

- (1) HW-41661, "Slug Cocking & Column Bowing Experiments", S. O. Arneson.
- (2) HW-41400, "Development Test 105-623A - Relations Between Hand And Flow Seating of Slug Charges As They Affect Slug Rupture Rates", 2-13-56, S. O. Arneson, F. W. Van Wormer.
- (3) HW-43456, "Interim Report, Cocked Slug-Flush Charging Relations For 'CW' Pile Conditions", P. B. McCarthy, 6-1-56, (To be published).

DECLASSIFIED

DECLASSIFIED

-3-

HW-43464

In order to have a permanently cocked slug in a process tube, the slug will have collapsible aluminum projections welded to the can well. These projections will hold the slug cocked in the desired position and will collapse in case a rupture does occur. The method of welding these projections on the slug can was developed by Fuel Technology for use on slugs that were to be used in ribless tubes. Although the welded projections have not been given in-pile tests, out-of-pile corrosion and metalurgical tests⁽⁴⁾ have indicated that welding did not injure the uranium, Al-Si bond or aluminum can.

PROCEDURE

Introduction of a Cocked Slug

The particular slugs to be cocked, number 17 and 28 counting from the front, will have 3/32 inch dia. bent aluminum wire projections on the lower side. These projections will fit between the ribs of the process tube and hold the slug cocked, as shown in Figure 1.

Before charging the cocked slug the tube must be emptied and the rear nozzle removed, as a safety precaution against damaging the wire. A stinger or plug will be inserted in the front of the tube to stop water flow while slugs are being charged from the rear. All slugs will be lubricated with Calol Solubleoil and inserted from the rear. After charging the tube and replacing the rear nozzle and cap, the charge will be hand seated from the front. Numbers and locations of all slugs will be recorded and after completing the tests all slugs will be examined in the viewing basin.

Comparison Standards

At the same time the cocked slugs are being inserted from the rear, eight tubes of control slugs will be loaded from the front. These slugs will be charged by hand to be sure no slugs are cocked as they were pushed through the nozzle.

TESTING DATA

Tube loading and conditions will be as follows:

GROUP NUMBER	COCKED NUMBER	SLUG NUMBER	<u>COLUMNS DISCHARGED AT EXPOSURE LIMITS</u>		
			<u>200 MWD</u>	<u>400 MWD</u>	<u>600 MWD</u>
1	17	Can end up	2	2	4
2	28	Can end up	2	2	4
3	28	Rolled on Rib	2	2	4
4	None	Normal	2	2	4

(4) HW-43076, "Status of Projection Fuel Elements as of May, 1956", J. W. Lingafelt and E. A. Smith, 5-16-56.

DECLASSIFIED

DECLASSIFIED

- 4 -

HW-43464

If any two tubes in a group have confirmed ruptures, the remaining tubes in the group may be discharged.

The tubes selected for tests will be in the central zone and, if possible, should be fitted with individual sampling lines for rupture detection.

HAZARDS

This test has a high rupture potential. Recent rupture rate analysis reveal that, for normal charges in C pile, about one charge in ten might be expected to fail at an exposures of 600 MWD/T.

Two failures could normally be expected out of the 16 high exposure charges. However, since the effect of cocked slugs upon failure rates is not known, a maximum of eight possible failures (two in each of four groups) are specified.

RESPONSIBILITY

Reactor Section personnel will be responsible for scheduling and for operational safety and production continuity of the reactor. Reactor personnel will also be requested to assist in charging and discharging the tubes. Pile Technology Section personnel will be responsible for the supply of special slugs, inserting the slugs from the front and rear, inspection of slugs, interpretation of the data, and preparing all reports. Primary responsibility rests with F. W. Van Wormer, and P. B. McCarthy.

AREA

"C" Pile has been selected for this test since tube powers are high and most of the cocked slug x-ray test work has been done in a "C" tube flow mock up.

STARTING TIME

The test will be started at the first scheduled outage after the approvals for this test have been received.

COSTS

Costs above those incurred during normal charging will be due to the additional time required to completely discharge the tube, remove and replace the rear nozzle, and load the slugs by hand.

Remove and replace 24 rear nozzles.	48 man hours.
Charge 24 tubes from the rear.	8 man hours.
Charge 8 tubes by hand from the front face.	2 man hours.
Hand seat all charges	1 man hour.

DECLASSIFIED

DECLASSIFIED

- 5 -

HW-43464

Estimated front elevator time

4 man hours.

Rear elevator time.

8 man hours.

Cost code

5740 253.62

FW Van Wormer
Process Technology Unit
Pile Technology Section
ENGINEERING DEPARTMENT

P.B. McCarthy
Mechanical Equipment Development Unit
Pile Technology Section
ENGINEERING DEPARTMENT

FW VanWormer/PB McCarthy:rdp

APPROVALS

L. P. Bupp

L. P. Bupp
Acting Manager, Pile Engineering Sub-Section
ENGINEERING DEPARTMENT

O. C. Schroeder

O. C. Schroeder
Superintendent, Process Sub-Section
REACTOR SECTION

R. Maguire

R. Maguire
Superintendent, Operations Sub-Section
REACTOR SECTION

R. S. Bell

R. S. Bell
Manager, REACTOR SECTION
MANUFACTURING DEPARTMENT

P. H. Reinker

P. H. Reinker
Acting Manager, Pile Technology Section
ENGINEERING DEPARTMENT

W. K. MacCready

W. K. MacCready
Manager,
MANUFACTURING DEPARTMENT

Date of Issue Aug. 27, 1956

DECLASSIFIED

DECLASSIFIED

FIGURE I

COCKED SLUGS
IN PROCESS TYPES

A. Slug Cocked Up at Can on Upstream End.

B. Slug Rolled Up on One Rib.

-6-

HM-43464

DECLASSIFIED

DATE

FILMED

9 / 30 / 94

END