CONFIDENTIAL
RESTRICTED DATA

Atomic Energy Act - 1954

SNPO-C
Lovoff

MASTER

WANL-TME-1819
July 10, 1968

Westinghouse Astronuclear Laboratory

EXPERIMENT DESIGN FOR GTR-20

RADIATION EFFECTS TEST OF

SPOT WELDED TITANIUM BANDS, 15/W003
(U)

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

CONFIDENTIAL
RESTRICTED DATA

Atomic Energy Act - 1954

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, 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. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

CONFIDENTIAL
RESTRICTED DATA
Atomic Energy Act - 1954

MASTER

**Astronuclear
Laboratory**
WANL-TME-1819
July 10, 1968

EXPERIMENT DESIGN FOR GTR-20
RADIATION EFFECTS TEST OF
SPOT WELDED TITANIUM BANDS, 15/W003
(U)

NOTICE
This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Energy Research and Development Administration, nor any of their employees, nor any of their contractors, subcontractors, or 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.

~~INFORMATION CATEGORY~~
~~Confidential Restricted Data~~
~~7/2/68~~
~~Authorized Classifier~~ ~~Date~~

Prepared By:
D. L. Burwell
D. L. Burwell
Radiation Effects Test Planning & Analysis

Approved By:
J. R. Coombe
J. R. Coombe, Supervisor
Radiation Effects Test Planning & Analysis
D. C. Thompson
D. C. Thompson, Manager
NERVA Reactor Design
A. C. Sanderson
A. C. Sanderson, Manager
Test Systems & Operations

Classification cancelled (or changed to)
by authority of _____
by *H. F. C.* T.C. date *SEP 11 1970*

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

SPECIFICATION DETERMINATION Class: <u>U</u>	REVISIONS	Class	Date
	<u>DBW</u>	<u>U</u>	<u>4-8-62</u>

~~Group - 1~~
~~Excluded From Automatic Downgrading
And Declassification~~

CONFIDENTIAL
RESTRICTED DATA
Atomic Energy Act - 1954

CONFIDENTIAL
RESTRICTED DATA
Atomic Energy Act - 1954

Astronuclear
Laboratory
WANL-TME-1819
July 10, 1968

OUTLINE

- I. Experimental Purpose
- II. Experimental Objectives
- III. Requirements for Experimental Data
 - A. Accuracy Requirements
 - B. Prediction of Results
- IV. Experimental Procedures
 - A. Specimen Irradiation Fluence and Temperature
 - B. Load Testing
 - C. Pedigree Specimens

REFERENCES

FIGURES

CONFIDENTIAL
RESTRICTED DATA
Atomic Energy Act - 1954

I. Experimental Purpose

Spot welded titanium bands $3/4$ inches wide and approximately 18 inches long will be used in the proposed R-1 Reactor's control drum ganged drive system shown in Figure 1. These bands utilize loops (see Figure 2) in the ends. The loops are made by spot welding the band onto itself as shown in Figures 3 and 4 with parent (titanium) material as the weld. The welded region of the band is always flat against the cylindrical surface of a control drum pulley. It is necessary to demonstrate that these welds are adequate after irradiation equivalent to the R-1 environment.

The environment for gang drive bands in the R-1 reactor consists of fast neutron ($E > 1 \text{ MeV}$) fluences between 2×10^{16} and 1×10^{18} nvt (Reference 1) and a temperature of 271°R (Reference 2). The fluences are based on a ground test having 100 minutes of equivalent time at full power. The uncertainty in the neutron fluence as determined by the Thermal and Nuclear Design is $\pm 50\%$, while that in the temperature is $\pm 100^\circ\text{R}$.

CONFIDENTIAL
RESTRICTED DATA
Atomic Energy Act - 1954

**Astronuclear
Laboratory**
WANL-TME-1819
July 10, 1968

II. Experimental Objectives

The objectives of this radiation effects experiment is simply to demonstrate that the welded region is still stronger than the unwelded region, when bands are tensile tested with the welded region on a cylindrical surface with the same radius as R-1 control drum pulleys. In unirradiated tests the unwelded region has always failed (Figures 2-4) if the welded region is on the cylindrical surface with the lap joint (or 3/4" edge of band) toward the hub as shown in Figure 2. The ultimate load (lbs) will be determined.

CONFIDENTIAL
RESTRICTED DATA
Atomic Energy Act - 1954

III. Requirements for Experimental Data

A. Accuracy Requirements

The ultimate loads shall be recorded to within ± 10 lbs.

Thermocouple readings of the test fixture or of the bands shall be recorded to within $\pm 10^\circ\text{R}$ during load testing.

B. Prediction of Results

Figures 2-4 show that these three specimens had ultimate loads of 2400, 2100, and 1970 lbs. Specimens to be irradiated are not expected to break in the welded region.

IV. Experimental Procedures

A. Specimen Irradiation Fluence and Temperature

A total of four specimens will be irradiated in LN₂ (140°R) to a fast neutron ($E > 1$ MeV) fluence of 5×10^{18} nvt. The specimens shall be placed on a spherical surface (as shown in Figure 5) that is 5 inches North of the inner surface of the dewar on a horizontal line through the core center perpendicular to the core North face and intersects a 10 inch radius circle on the inner surface of the dewar. This surface may be modified slightly and its deviation from spherical defined as a result of further dosimetry analysis and calculation of the attenuation from the high fluence specimens.

B. Load Testing

The four specimens will be tested at GD/FW with the test fixture provided by WANL shown in Figures 6-8. They will be pulled with a Tinius-Olsen tensile testing machine or equivalent. Two specimens will be tested at LN₂ temperature, and two will be tested at room temperature. Thermocouples will be attached to the specimens and/or the half cylinder block.

C. Pedigree Specimens

Eighteen pedigree specimens will be tested at WANL. Nine will be tested at room temperature, while the other 9 will be tested at LN₂ (140°R) temperature. These 18 pedigree specimens will be from the same batch as the

CONFIDENTIAL
RESTRICTED DATA

Atomic Energy Act - 1954

Astronuclear
Laboratory

WANL-TME-1819

July 10, 1968

IV. (Continued)

four specimens to be irradiated. The three specimens shown in Figures 2-4 are not from the same batch, but were made from non-reactor grade titanium bands.

The spot welding of these bands is done in accordance with military specification MIL-W-6858B (Reference 3). The chemical composition of the weld material is the same as the band, i.e., the weld is parent material. The chemical composition of this titanium satisfies the purchase specification PDS-30067-B (Reference 4). This chemical composition is given below.

	Analysis (%)	Permissible Variation on Check Analysis (%)	
		Under Min.	Over Max.
Aluminum	4.75-5.75	0.20	0.20
Tin	2.20-2.80	0.15	0.15
Hydrogen, Max.	0.015	---	---
Iron, Max.	0.25	---	---
Oxygen, Max.	0.12	---	0.02
Carbon, Max.	0.05	---	---
Nitrogen, Max.	0.04	---	---
Titanium	Remainder	(Need not be determined)	

CONFIDENTIAL
RESTRICTED DATA

Atomic Energy Act - 1954

CONFIDENTIAL
RESTRICTED DATA
Atomic Energy Act - 1954

**Astronuclear
Laboratory**
WANL-TME-1819
July 10, 1968

REFERENCES

1. M. A. Capo, "R-1 Radiation Environment," DRM-1005, May 17, 1968
(A CRD Document).
2. "Engineering Data and Design Concepts," WANL-TME-1798, Volume 3,
June, 1968.
3. "Welding, Resistance: Aluminum, Magnesium, Non-Hardening Steels
of Alloys, Nickel Alloys, Heat-Resisting Alloys, and Titanium
Alloys; Spot and Seam," Military Specification MIL-W-6858B,
Amendment --1, March 22, 1962.
4. Westinghouse Astronuclear Laboratory, "Titanium Alloy Plate
Sheet and Strip," Purchasing Department Specification 30067-B,
December 14, 1965.

CONFIDENTIAL
RESTRICTED DATA
Atomic Energy Act - 1954

612531-5B

FIGURE 1 R-1 Reactor Assembly

ENGINEERING MECHANICS LABORATORY

DATE 3-26-68 EML NO A.4.01
TEST NO 1 RUN NO 1
SPECIMEN TITANIUM GANG DRIVE BAND
TEST TENSILE-WITH R-1 DRUM DIA. FIXTURE
ULTIMATE LOAD - 2400 lbs.

DATE 3-27-68 EML NO A.4.01
TEST NO 2 RUN NO 1
SPECIMEN TITANIUM GANG DRIVE BAND
TEST TENSILE-WITH R-1 DRUM DIA. FIXTURE
ULTIMATE LOAD - 2100 lbs.

DATE 3-27-68 EML NO A.4.01
TEST NO 3 RUN NO 1
SPECIMEN TITANIUM GANG DRIVE BAND
TEST TENSILE-WITH R-1 DRUM DIA. FIXTURE
ULTIMATE LOAD - 1970 lbs.

FIGURE 2 Broken Band Specimens and Cylindrical Surface

CONFIDENTIAL
RESTRICTED DATA

F-3

FIGURE 3 Broken Band Specimens Showing Spot Welds

CONFIDENTIAL
RESTRICTED DATA
Atomic Energy Act - 1954 Astronuclear
Laboratory

FIGURE 4 Broken Band Specimens Showing Spot Welds

CONFIDENTIAL
RESTRICTED DATA

Atomic Energy Act - 1954

612531-7B

FIGURE 5 Loading of Low Fluence Specimens

CONFIDENTIAL
RESTRICTED DATA

Atomic Energy Act - 1954

CONFIDENTIAL

RESTRICTED DATA

Atomic Energy Act - 1954

Astronuclear
Laboratory

FIGURE 6 Specimen Test Fixture

View 1

CONFIDENTIAL

RESTRICTED DATA

Atomic Energy Act - 1954

F-6

CONFIDENTIAL
RESTRICTED DATA
Atomic Energy Act - 1954

Astronuclear
Laboratory

FIGURE 7 Specimen Test Fixture

View 2

CONFIDENTIAL
RESTRICTED DATA
Atomic Energy Act - 1954

F-7

FIGURE 8 Specimen Test Fixture with Broken Specimen