

MASTER

ATOMIC ENERGY OF CANADA LIMITED

Engineering Design Branch

Specification Number - MET - 55

Issue 2 - 15 July 1960

ZIRCALOY-4 WIRE MATERIAL

RESEARCH METALLURGY

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ZIRCALLOY-4 WIRE MATERIAL

TABLE OF CONTENTS

	<u>Page</u>
1. SCOPE .....	1
2. DEFINITION OF TERMS .....	1
2.1 Lot .....	1
3. MATERIALS AND MANUFACTURE .....	1
4. CHEMICAL COMPOSITION .....	1
4.1 Alloying Elements .....	2
4.2 Impurities .....	2
4.3 Chemical Analysis .....	3
5. MECHANICAL PROPERTIES .....	3
5.1 Bend Testing .....	3
5.2 Fracture Testing .....	3
5.3 Frequency of Testing .....	4
6. CORROSION TEST .....	4
7. METALLOGRAPHIC EXAMINATION .....	4
8. IDENTIFICATION .....	4
9. INSPECTION .....	5
10. SHIPPING .....	5
11. CERTIFICATION .....	6

ZIRCALOY-4 WIRE MATERIAL

1. SCOPE

This specification covers Zircaloy-4 wire material for reactor use where high integrity and satisfactory corrosion resistance at elevated temperatures are required.

2. DEFINITION OF TERMS

2.1 Lot

In this specification, a lot shall consist of all material of the same size, shape, condition and finish on an order produced from the same ingot and annealed in the same charge.

3. MATERIALS AND MANUFACTURE

3.1 The ingot from which the wire is produced shall be made by double vacuum arc melting.

3.2 Unless otherwise specified on the purchase order, wire shall be furnished in the cold worked condition. The amount of cold work shall not exceed that necessary to produce wire which on uncoiling remains unkinked.

3.3 All annealing subsequent to the initial hot working operation shall be performed at an equilibrium absolute pressure not to exceed one micron of mercury unless prior agreement has been reached with the Purchaser to use air annealing.

4. CHEMICAL COMPOSITION

The composition of the wire shall conform to the requirements set out in 4.1 and 4.2.

ZIRCALOY-4 WIRE MATERIAL

4.1 Alloying Elements

Tin	1.20 - 1.70 weight per cent
Iron	0.12 - 0.18 weight per cent
Chromium	0.05 - 0.15 weight per cent
Oxygen	1000 - 1400 ppm
Zirconium	Balance (including impurities)

4.2 Impurities

Aluminum	75	ppm maximum
Boron	0.5	ppm maximum
Cadmium	0.5	ppm maximum
Carbon	500	ppm maximum
Cobalt	20	ppm maximum
Copper	50	ppm maximum
Hafnium	200	ppm maximum
Hydrogen	30	ppm maximum
Lead	130	ppm maximum
Magnesium	20	ppm maximum
Manganese	50	ppm maximum
Molybdenum	50	ppm maximum
Nickel	40	ppm maximum
Nitrogen	100	ppm maximum
Silicon	120	ppm maximum
Titanium	50	ppm maximum
Tungsten	100	ppm maximum

ZIRCALOY-4 WIRE MATERIAL

4.2 Impurities (Cont'd)

Uranium	3.5 ppm maximum
Vanadium	50 ppm maximum

Any other impurities measured shall be reported.

4.3 Chemical Analysis

4.3.1 Whilst ingot analysis may be accepted as defining the chemical composition of the wire as specified in 4.1 and 4.2 with the exceptions set out in 4.3.2, the Purchaser reserves the right to reject wire in the event of a check analysis showing departure from this specification.

4.3.2 Check analysis for Copper, Hydrogen, Nitrogen and Nickel shall be made on representative samples from each lot of wire. The content of these elements shall be as specified in 4.1 and 4.2.

5. MECHANICAL PROPERTIES

5.1 Bend Testing

Samples shall be bent 180° round a radius of 1.T without signs of cracking when examined at a magnification of X10 (where 1.T is equal to the wire diameter).

5.2 Fracture Testing

Samples shall be fractured by reverse bending without revealing defects visible to the naked eye.

ZIRCALOY-4 WIRE MATERIAL

5.3 Frequency of Testing

The tests described in 5.1 and 5.2 shall be performed on at least two samples from each lot of wire.

6. CORROSION TEST

At least two samples, not less than 4 inches long, from each lot of wire shall be etched to remove 0.001 inch of surface and tested in 750°F steam for 3 days at a minimum pressure of 100 psi. After test the specimens shall show a uniform black, lustrous oxide finish and have a weight gain of no more than 22 milligrams per square decimeter of surface. If the corrosion tested samples fail to meet the above requirements, two additional specimens may be selected from the lot of wire and tested for 14 days in 1500 psi steam at 750°F. After test the specimens shall show a uniform black, lustrous finish and have a weight gain of no more than 38 milligrams per square decimeter of surface. If either of these specimens fails to meet the above requirements the lot shall be rejected.

7. METALLOGRAPHIC EXAMINATION

Two transverse and two longitudinal samples from each lot of wire are to be microscopically examined after suitable chemical or electrolytic polishing. These samples are to be examined for stringers, surface cracks, seams and any sub-surface defects. Any abnormal result should be immediately reported to the Purchaser.

8. IDENTIFICATION

Ingot number and lot number shall be maintained through

ZIRCALOY-4 WIRE MATERIAL

8. IDENTIFICATION (Cont'd)

all stages of fabrication and delivery.

9. INSPECTION

9.1 Unless otherwise agreed between Purchaser and Contractor the tests called for in this specification shall be made at the Contractor's works and at his expense.

9.2 The Contractor shall afford the inspector representing the Purchaser all reasonable facilities to satisfy him that the wire is being furnished in accordance with this specification.

10. SHIPPING

10.1 The Contractor shall make adequate provisions to protect the material supplied to this specification to ensure that on arrival at the destination specified in the pertinent tendering or purchasing documents and after storage as stated therein it will not have suffered corrosion or damage of any sort. The material shall be wrapped or packaged sufficiently to prevent damage by weather, dirt or other foreign matter. It is desired that the packaging and shipping practices adhere as closely as possible to the Contractor's standard, but they shall nevertheless comply with the requirements stated herein.

10.2 Each package or container shall be marked with the purchase order number, lot number, quantity, size and name of the manufacturer.

ZIRCALOY-4 WIRE MATERIAL

11. CERTIFICATION

The Contractor shall perform all tests and certify that the wire supplied meets all the requirements of this specification and relevant purchase order. This certification shall include test results, analyses, fabrication history including source of ingot. All reports shall be signed by a responsible technical representative of the Contractor.

**END**