SNN FCN DT-SI	TIP DOCUMENT: SPECIFICAȚIE DE PROCURARE TITLUL: **SÂRMĂ RECTANGULARĂ DE ZY-4 PENTRU COMPONENTE NUCLEARE** APLICABIL LA/ÎN: FCN	COD: **S.P.-2.10** EDIȚIA: **3** PAG. 1 din 5 DATA INTRĂRII ÎN VIGOARE: 03.04.2017

CONȚINUT:

ELABORAT	ANALIZĂRI					APROBĂRI/ ACCEPTĂRI	
COMPARTIMENT: **S.I.-C.I.P**	**I.P.**	**S.A.**	**S.C.C.**	**S.M.C.**	**S.I**	**D.M.C.**	**D.T.**
NUME: **ANDREI TOMESCU**	**ANDREI MUȘETOIU**	**DUMITRU GIBAN**	**NICOLAE HOȚESCU**	**DANIELA COSTEA**	**ADRIAN ANGHENE**	**SORIN POPESCU**	**VASILE BĂILESCU**
SEMNĂTURA							
DATA 14.03.2017	14.03.2017	14-03-2017	14.03.2017	17.03.2017	31.03.2017	03.04.2017	05.04.2017

CONTROL DISTRIBUȚIE

Ex.nr.	Comp.	DIFUZAT PRIMIRE Marca	Semnătura	Data	RETRAS RETRAGERE Data	Marca	Semnătura
9	LCM-SDV	770		28.04.22			
2E	CIP	592		04.04.17			
5	SI	552		04.04.17			
24	IP	576		04.04.17			
2A	SMC	814		04.04.17			
65	SCC	365		04.04.17			
5A	SMC	397		04-04-17			
3C	SMC	337		04.04.17			
4G	SMC	607	103	04-04-17			

MODIFICĂRI 2 → 3 conf 145/29-05-2013

Secțiunea 2 Fișă de Modificare (FM) 044/03.04.2017

Pentru rubricile la care spațiul este insuficient, se continuă pe verso, pag. 1 bis.

BUN PENTRU DIFUZARE

EXEMPLAR NR. 49.2

1. **PRODUS:** Sarma rectangulara de Zy-4 pentru fabricarea combustibilului nuclear.

2. **STANDARDE SI SPECIFICATII**

2.1.	**TS-XX-37353-2**	Revision 2 and Amendment Notice no. 1/30.08.1996 AECL Technical Specification for Zirconium Alloy Bar, Rod, and Wire for Nuclear Fuel Applications
2.2.	**ASTM B350/B350M**	Standard Specification for Zirconium and Zirconium Alloy Ingots for Nuclear Applications
2.3.	**ASTM B351/B351M**	Standard Specification for Hot-Rolled and Cold-Finished Zirconium and Zirconium Alloy Bars, Rod, and Wire for Nuclear Application
2.4.	**CAN 3-Z299.3-85**	Quality Assurance Program – Category 3, a National Standard of Canada
2.5.	**10CFR50 Appendix B**	Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants.

3. **DIMENSIUNI**

3.1. Grosime:	**1,56 ± 0,04** mm	(0.0615 ± 0.0015")
3.2. Latime:	**2,87 ± 0,05** mm	(0.113 ± 0.0002")
3.3. Raza racordare:	**max. 0,25** mm	(0.010" max)

4. **CONDITII SI CERINTE TEHNICE**

4.1. Acceptarea documentelor

Furnizorul va pune la dispozitia FCN Pitesti, pentru acceptare, Fluxul de fabricatie si Planul de control.

Dupa acceptarea acestora de catre FCN Pitesti, nu este permisa abaterea de la aceasta documentatie, decat cu acordul scris dat de FCN Pitesti. Toata documentatia transmisa achizitorului va fi identificata prin editie si data.

Inainte de inceperea procesului sau inainte de implementarea oricarei modificari in procesul acceptat, furnizorul va pune la dispozitia FCN Pitesti, pentru acceptare, Fluxul de fabricatie.
Fluxul de fabricatie va cuprinde ca minim, fiecare proces de fabricatie, va indica secventa in traseul de fabricatie, va identifica parametrii ce urmeaza a fi monitorizati si controlati, precum si metoda utilizata pentru operatiile ce afecteaza calitatea produsului si/sau conformitatea cu specificatia. Unde este cazul, vor fi specificate conditiile sau cerintele de operare nominale, minime sau maxime.
Exemple de conditii de operare ce trebuie incluse: dimensiune, timp si temperatura, atmosfera, vid sau presiune, metoda.

Inaintea utilizarii procedurilor, furnizorul va inainta catre FCN Pitesti, pentru acceptare, procedurile standard si non-standard pentru refacere.

Inainte de inceperea fabricatiei sau inainte de implementarea oricarei modificari in planul acceptat, furnizorul va pune la dispozitia FCN Pitesti, pentru acceptare, planul de control.
Planul de control va cuprinde ca minim lista operatiilor de testare si control, va indica secventa in fluxul de fabricatie, va identifica parametrii ce urmeaza a fi controlati, precum si metoda utilizata pentru determinarea conformitatii, baza de prelevare a probelor si criteriile de acceptanta.

4.2. Material

Sarma va fi produsa din lingouri ce au fost topite in cuptoare cu arc electric, in vid, utilizate in mod conventional pentru metale reactive, sau prin alte procese acceptate de catre FCN Pitesti. Sarma va fi produsa din lingouri a caror compozitie chimica este conforma cu ASTM B350. Numarul de topiri va fi specificat.

4.3. Identitate

Identitatea tuturor materialelor, cu respectarea numarului de topiri ale lingoului si numarul lotului de furnizor se va pastra in toate etapele de fabricatie. Tot materialul ce se supune acestei specificatii va fi separat si identificat prin numarul lingoului, numarul lotului de furnizor si numarul bobinei.

4.4. Definirea lotului

Un lot se constituie din sarma de aceeasi dimensiune nominala, forma, structura si finisare, va fi produsa dintr-un singur lingou, fabricata in acelasi mod, urmand acelasi program de tratare termica si operatii de finisare cu tratamentul termic final, in aceeasi sarja a cuptorului.

4.5. Specificatia de material

Sarma va fi confectionata din zircaloy-4, in conformitate cu TS-XX-37353-2, Editia 2 și fișa de modificare nr. 1/30.08.1996.

Planul de prelevare a probelor va fi conform cu ASTM E55.

4.6. Conditii de material

a) Sarma de Zy-4 furnizata conform acestei specificatii va fi recoapta.
b) Furnizorul va asigura furnizarea unui numar minim de bobine pentru fiecare lot de sarma.
c) Nu este permisa nervurarea sarmei.

4.7. Marcarea sudurilor

Orice sudura efectuata va fi clar marcata pe sarma. De asemenea, numarul de suduri pentru fiecare bobina, va fi mentionat clar pe suprafata exterioara a bobinei.

4.8. Ambalarea si identificarea

4.8.1. Diametrul nominal al bobinei cu sarma va fi de 0,3 m, cu o latime de 0,1 m (12" D x 4" W). Nu este permisa utilizarea aluminiului.

4.8.2. Un esantion in lungime de 0,6 ÷ 1,0 m de sarma reprezentativa va fi atasat pe exteriorul bobinei.

4.8.3. Orice sudura va fi marcata clar pe sarma. Numarul de suduri pentru fiecare bobina, va fi marcat clar pe exteriorul bobinei.

4.8.4. Pe o bobina se va infasura un singur lot de sarma.

4.8.5. Greutatea maxima a sarmei pe o bobina va fi 14,5 Kg (32 lbs).

4.8.6. Materialul va fi ambalat in asa fel incat sa se previna pierderea, deteriorarea sau contaminarea in timpul transportului.

4.8.7. In fiecare container va fi ambalat un singur lot de material.

4.8.8. Fiecare container va include o copie a certificatului de material.

4.8.9. Containerul de transport va fi identificat cu urmatoarele informatii:

a) Numele si adresa Furnizorului;

b) Numele si adresa FCN Pitesti;
c) Numarul contractului de achizitie;
d) Tipul materialului si dimensiunea nominala;
e) Numarul lotului/lingoului si gradul de aliere;
f) Cantitatea;
g) Greutatea bruta si neta si tara.

5. INSTRUCTIUNI SPECIALE

5.1. ASIGURAREA CALITATII

5.1.1. Acces

Furnizorul va permite accesul rezonabil la instalatiile sale pentru reprezentantul FCN Pitesti, in scopul evaluarii stadiului, conformitatii cu cerintele comenzii de achizitie si evaluarea programului de calitate al furnizorului. Se va aduce la cunostinta FCN Pitesti faptul ca unele detalii ale proceselor furnizorului pot fi considerate informatii private si nu vor fi dezvaluite; in orice caz, acest lucru nu va influenta negativ evaluarile prezentate anterior.

Furnizorul va extinde autorizatia de acces acordata pentru FCN Pitesti, oferind acces acestuia si la instalatiile subcontractorilor si ofertantilor furnizorului, atunci cand este insotit de un reprezentant al furnizorului, cu scopul evaluarii programului de calitate al furnizorului/subcontractorilor.

5.1.2. Programul de asigurarea calitatii

Programul de asigurarea calitatii al Furnizorului va fi conform CAN 3-Z299.3-85 sau 10CFR50 Anexa B, sau echivalent. Furnizorul va impune subcontractorilor si furnizorilor sai un program de asigurarea calitatii corespunzator nivelului serviciului/produsului furnizat.

5.1.3. Calificarea personalului pentru teste nedistructive

Tehnicile si procedurile de instruire a personalului furnizorului si subcontractorilor/ofertantilor angajat in teste nedistructive ale materialelor vor fi calificate dupa CGSB 48.9712 in Canada, sau se vor conforma nivelelor de calificare prezentate in ASNT SNT-TC-1A in SUA, sau altui standard international acceptat de FCN Pitesti.

5.1.4. Controlul, testarea si receptia

Furnizorul va efectua suficiente teste si inspectii pentru a asigura conformitatea cu specificatia. Daca vreunul din rezultate nu indeplineste cerintele specificate, se poate efectua o retestare pe un numar dublu de probe fata de testarea originala. Un singur set de retestari pe o caracteristica este permis fara refacere. Toate retestarile trebuie sa indeplineasca criteriile de acceptanta pentru caracteristica retestata. Atat rezultatul original, cat si cel din retestare vor fi certificate, iar rezultatele retestate vor fi indicate prin sufixul „R". Furnizorul are optiunea de a face inspectie 100% pentru orice caracteristica.

Pentru determinarea conformitatilor cu valorile limita, se poate utiliza metoda de rotunjire ASTM E29.

Materialul furnizat conform specificatiei poate fi supus controlului de receptie de catre FCN Pitesti.

5.1.5. Standarde vizuale

Acolo unde se folosesc mostre vizuale pentru acceptanta produsului, se vor stabili doua seturi de mostre care vor fi acceptate atat de furnizor cat si de FCN Pitesti. Un set se va pastra de furnizor, iar altul de FCN Pitesti.

5.1.6. Inregistrari si certificari

Inregistrarile proceselor, testarilor si controalelor vor fi disponibile pentru verificare de catre FCN Pitesti. Inregistrarile de calitate vor fi pastrate o perioada de 10 ani de la data livrarii materialului. Mostrele arhivate vor fi retinute o perioada de 5 ani de la data livrarii materialului.

Pentru asigurarea conformitatii cu specificatia si certificarea lingoului, rezultatele testelor furnizorului vor fi certificate de un reprezentatnt de la asigurarea calitatii furnizorului si transmise catre FCN Pitesti odata cu transportul materialelor. Certificatul de conformitate si certificatul lingoului vor fi identificate cu numarul contractului de achizitie, numarul lingoului si numarul lotului.
Codul si editia fluxului de fabricatie si al planului de control si testare va fi inregistrat pe certificatul fiecarui lot.

5.2. **NECONFORMITATI**

Furnizorul nu va expedia catre FCN Pitesti nici un material neconform. Furnizorul nu va intreprinde nici o reparare asupra materialului de livrat, fara acceptul prealabil al FCN.

Cerintele descrise in aceasta sectiune vor fi aplicate si subcontractorilor furnizorului.

5.3. **RESPINGEREA MATERIALULUI**

FCN Pitesti isi rezerva dreptul de a respinge o parte sau tot materialul ce prezinta neconformitati la receptie. Materialul care a fost deja procesat de FCN Pitesti poate fi respins daca acesta demonstreaza furnizorului ca defectul pentru care a fost respins exista deja in materialul receptionat.

5.4. **DOCUMENTE ANEXATE**

Aceasta specificatie de procurare este insotita de urmatoarele documente:

1° Specificatia Tehnica AECL: TS-XX-37353-2 Rev. 2 si Fisa de Modificare AECL nr. 1/ 30.08.1996.

NOTA: Documentele de mai sus si prezenta specificatie de procurare trebuie folosite numai in relatia dintre FCN si furnizor. Furnizorul este responsabil pentru pastrarea confidentialitatii documentelor si nu va permite instrainarea partiala sau totala a acestora, respectand totodata si drepturile de proprietate asupra documentelor.

EXEMPLAR NR. 49.2

PENTRU DISTRIBUIRE

SNN FCN DT-SI	DOCUMENT TYPE: PURCHASE SPECIFICATION TITLE: **ZY-4 RECTANGULAR WIRE FOR NUCLEAR COMPONENTS** APPLICABLE TO/IN: FCN	CODE: **S.P.-2.10** ISSUE: **3** PAGE 1 of 5 APPROVAL DATE: 03.04.2017

CONTENT:

1. **PRODUCT**
2. **STANDARDS AND SPECIFICATIONS**
3. **DIMENSIONS**
4. **TECHNICAL CONDITIONS**
5. **SPECIAL INSTRUCTIONS**

PREPARED	REVIEW					ACCEPTANCE/ APPROVAL	
DEPARTMENT: S.I.-C.I.P	I.P.	S.A.	S.C.C.	S.M.C.	S.I	D.M.C.	D.T.
NAME: **ANDREI TOMESCU**	**ANDREI MUȘETOIU**	**DUMITRU GIBAN**	**NICOLAE HOȚESCU**	**DANIELA COSTEA**	**ADRIAN ANGHENE**	**SORIN POPESCU**	**VASILE BĂILESCU**
SIGNATURE [signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]
DATE 14.03.2017	14.03.2017	14.03.2017	14.03.2017	14.03.2017	31.03.2017	03.04.2017	03.04.2017

RELEASING CONTROL

RELEASED | WITHDRAWN

Copy.no.	Dept..	RECEIVING				WITHDRAWAL		
		Mark	Signature	Date		Date	Mark	Signature
46	SACH	107	103	04.04.17				
6	Arhivă	100	[signature]	04.04.17				
49 cop. inf. SACH aferent CS-ST-04 ed. 1, cf. ref. 1790/30.03.17								
49-1 copie informativă SACH aferent CS-ST-4 ed. 1/01.01.2021 conform referat ad: ST-30/22.01.2021								

CHANGES 2

Section 2 Change Notice (CN) 145/29.05.2013; 044/05.04.2017

EXEMPLAR NR. 49.2

If the space is exceeded, additions shall be made on the other side, page 1 bis.

1. PRODUCT

1.1. Zircaloy – 4 rectangular wire to be used for the manufacture of nuclear fuel element assemblies.

2. STANDARDS AND SPECIFICATIONS

2.1.	**TS-XX-37353-2**	Revision 2 and Amendment Notice no. 1/96.08.30 AECL Technical Specification for Zirconium Alloy Bar, Rod, and Wire for Nuclear Fuel Applications
2.2.	**ASTM B350/B350M**	Standard Specification for Zirconium and Zirconium Alloy Ingots for Nuclear Applications
2.3.	**ASTM B351/B351M**	Standard Specification for Hot-Rolled and Cold-Finished Zirconium and Zirconium Alloy Bars, Rod, and Wire for Nuclear Application
2.4.	**CAN 3-Z299.3-85**	Quality Assurance Program – Category 3, a National Standard of Canada
2.5.	**10CFR50 Appendix B**	Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants.

3. DIMENSIONS

3.1 Thickness:	1.56 ± 0.04 mm	(0.0615 ± 0.0015″)
3.2 Width:	2.87 ± 0.05 mm	(0.113 ± 0.0002″)
3.3 Corner radii:	0.25 mm max.	(0.010″ max)

4. TECHNICAL CONDITIONS

4.1 Document acceptance

The Supplier is required to submit manufacturing flow, inspection and test plan, to FCN Pitesti, for acceptance.
Once purchaser acceptance is granted, deviation from accepted documentation is not permitted without prior written acceptance of FCN Pitesti.
All documentation submitted to FCN Pitesti shall be identified with an issue number and date.

The Supplier shall submit their manufacturing flow to FCN Pitesti for acceptance prior to start processing or prior to implementing any changes to an accepted process.
As a minimum, the manufacturing flow shall list each manufacturing or production operation, indicating the sequence within the manufacturing route, and identify the parameters to be monitored or controlled and the method used for operations affecting product quality and/or conformance to the specification. Nominal, minimum, or maximum operating conditions or requirements shall be specified where appropriate. Examples of operating conditions to be included are: size, time and temperature, atmosphere, vacuum or pressure, and method.

The Supplier shall submit their standard and non standard rework procedures to FCN Pitesti, for acceptance, prior to use of the procedures.

The Supplier shall submit their inspection and test plan to FCN Pitesti for acceptance prior to the start of processing or prior to implementing any changes to an accepted plan.
As a minimum, the inspection and test plan shall list inspections or test operations, indicating the sequence within the manufacturing route, and shall identify the parameters to be inspected, the method to be used to determine compliance, the sampling basis, and the acceptance criteria.

4.2. Material

Wire shall be made from ingots that have been vacuum consumable arc melted in furnaces conventionally used for reactive metals, or other processes accepted by FCN Pitesti.
Wire shall be also be made from ingots conforming to the chemical composition specified herein.
The number of melts is to be specified on the certification.

4.3. Identity

The identity of all material with respect to ingot melt number and Supplier lot number shall be maintained at all stages of manufacture. All material supplied to this specification shall be segregated and identified by ingot number, Supplier lot number, and spool number.

4.4. Definition

A lot shall consist of all wire of the same nominal size, shape, condition, and finish that is produced from the same ingot and processed through the same fabrication, heat treatment schedules, and finishing operations with the final heat treatment in the same furnance run.

4.5. Material Specification

The wire shall be Zircaloy-4 conforming to the requirements of TS-XX-37353-2, Revision 2 and Amendment Notice no. 1/96.08.30.
The sampling plan shall be in accordance with ASTM E55.

4.6. Material condition

a) Zircaloy-4 wire supplied under this Specification shall be in the annealed condition.
b) The Supplier shall ensure that the minimum number of spools is used to supply each lot of wire.
c) No finning of the wire is permitted.

4.7. Welding of Wire

Any welds made shall be clearly marked on the wire. Also, the number of welds for each spool shall be clearly stated on the outside of the spool.

4.8. Packaging and identification

4.8.1. The wire shall be layer wound on nominal 0.3 m diameter x 0,1 m wide (12" D x 4" W) spools. The use of aluminum spools is NOT permitted.

4.8.2. A 0.6 – 1.0 m (2' – 3') length or wire representative of the inner coils shall be attached to the outside of each spool.

4.8.3. Any weld shall be clearly marked on the wire. The number of welds for each spool shall be clearly stated on the outside of each spool.

4.8.4. Only one lot of wire shall be wound on each spool.

4.8.5. The maximum weight of wire on a spool shall be 14,5 kg (32 lbs.)

4.8.6. The material shall be packaged so as to prevent loss, damage, or contamination during shipment.

4.8.7. Only one lot of material shall be packed in each container.

4.8.8. A copy of the material certification shall be included in each container.

4.8.9. The shipping container shall be identified with the following information:

a) Supplier's name and address
b) FCN Pitesti name and address
c) Purchase Order Number
d) Type of material and nominal size
e) Ingot/Lot Number and Alloy Grade
f) Quantity
g) Gross, net, and tare weights

5. SPECIAL INSTRUCTIONS

5.1. QUALITY ASSURANCE

5.1.1. Access

The Supplier shall allow reasonable access to his facilities to FCN representative, for the purposes evaluation of progress, evaluation of compliance with the purchase order requirements and evaluation of the Supplier's quality program. It is recognized by the Purchaser that some details of some of the Supplier's processes may be considered to be proprietary and may not be revealed, however this shall not unreasonably interfere with the above evaluations.

The Supplier shall extend FCN Pitesti privilege of access also to the facilities of the Supplier's subcontractors and suppliers, when accompanied by the Supplier's representative, for the purpose of evaluation of the subcontractor's/supplier's quality program.

5.1.2. Quality Assurance Program

The Supplier's quality assurance program shall comply with CAN 3-Z299.3-85 or 10CFR50 Appendix B, or accepted equivalent, to the extent required by this product.
The Supplier shall impose a quality assurance program, appropriate to the level of service/product, upon his subcontractors and suppliers.

5.1.3. Non-destructive Testing Personnel Qualifications

The Supplier's and the Supplier's subcontractor's/ supplier's personnel establishing techniques and procedures and engaged in non-destructive testing of the material shall be qualified to CGSB 48.9712 in Canada of comply with the levels of qualification stated in ASNT- SNT-TC-1A in the U.S.A. or other international standard accepted by FCN Pitesti.

5.1.4. Inspection, Testing and Source Inspection

The Supplier shall perform sufficient testing and inspection to ensure compliance with the specification. If any of the results fail to meet the specified requirements, a retest may be performed on twice as many new samples as originally tested.
One set of retests per characteristic is permitted without reworking. All the retests shall meet the acceptance criteria for the characteristic retested. Both the original and retest results shall be certified and the retest results shall be indicated with suffix "R". The supplier has the option to do 100% inspection for any given attribute.
The Rounding – Off Method of ASTM E29 may be used to determine conformance to limiting values.
The material supplied to this specification may be subject to source inspection by FCN Pitesti.

5.1.5. Visual Standards

Where visual standards are used for product acceptance, duplicate sets of the visual standards shall be established and be accepted by both the Supplier and FCN Pitesti. One set shall be retained by Supplier and one by FCN Pitesti.

5.1.6. Records and Certification

Records of processing, testing and inspection shall be available for review by FCN Pitesti. Quality Records shall be maintained for 10 years from the date of release of the material. Archive samples shall be retained for 5 years from the date of release of the material.

Results of Supplier's tests to ensure compliance with the specification and ingot certification shall be certified by a Quality Assurance representative of the Supplier and submitted to FCN Pitesti with the material shipment. The certificate of compliance and the ingot certification shall be identified with the applicable Purchaser Order Number, Ingot Number and Lot Number.

The identification and issue number of the Process Flow Outline and the Inspection and Test Plan shall be recorded of the certification for each lot.

5.2. NONCONFORMANCES

The supplier shall not ship to FCN Pitesti any nonconforming material. The supplier shall also not perform any repair unless prior authorization has been received from FCN.
The requirements contained in this section shall be applied to the supplier's subcontractors.

5.3. REJECTION OF MATERIAL

FCN Pitesti reserves the right to reject any and all material shown to be nonconforming as received.
Material that has been further processed by FCN Pitesti can only be rejected if it can be demonstrated to the satisfaction of the Supplier that the reject condition existed in the as-received material.

5.4. ANNEXED DOCUMENTS

This Purchase Specification is accompanied by the following documents:

1° AECL Technical Specification:: TS-XX-37353-2 Rev. 2 and AECL Amendment Notice no. 1/ 96.08.30.

NOTE: The above document and present Purchase Specification shall be used only in the relation between the Supplier and FCN. The Supplier has the responsibility of maintaining the confidentiality of documents, shall respect information ownership and licensing requirements related to these specification and shall not permit total or partial alienation of these documents.

AECL EACL

mendment notice Avis de modification

IENDMENT/MODIFICATION				TO: (Enter Doc. Ident. No.) DU N° (n° du Doc.)	DOC. REV. NO.: N° RÉV. DU DOC.:	DOC. REV. DATE: DATE RÉV. DU DOC.:
/N°:	1	Date:	96-08-30	TS-XX-37353-2	2	March 78

SCRIPTION OF AMENDMENT / DESCRIPTION DE LA MODIFICATION:

his Amendment No. 1 to the existing Technical Specification TS-XX-37353-2 Revision 2 is comprised of the ollowing: updated Release and Revision History Sheet, and amended Page 5.

lease remove and destroy the existing Release and Revision History Sheet, Page 5 and replace with the ttached Release and Revision History Sheet and amended Page 5.

Note: This amendment was necessitated to correct the Ultimate Tensile Strength for Zircaloy 4 Alloy identified on amended Page 5 in Bold Type.

EXEMPLAR NR 491C

EPARED BY / RÉDIGÉ PAR:	CLEARED BY / AUTORISÉ PAR:	APPROVED BY / APPROUVÉ PAR:
P. Chan	R. Sejnoha	J.H.K. Lau

Alloy	Metallurgical Condition	Ultimate Tensile Strength	0.2% Yield Strength	Elongation in 50 mm (2 inches)
Zircaloy-2 & Zircaloy-4	Annealed	414 MPa (60 ksi) 380 MPa (55 ksi) for thickness <1.27mm (0.05")	241 MPa (35 ksi)	14%
Zircaloy-2 & Zircaloy-4	Cold Worked & stress relieved	517 MPa (75 ksi)	448 MPa (65 ksi)	10%
Zirconium-2½ wt% Niobium	Cold Worked & stress relieved (Section 6.2)	587 MPa (85 ksi)	414 MPa (60 ksi)	15%

A1

7.2.2 Bend Test

The mechanical test requirement for wire is that it shall withstand a bend test as described in Section 8.3 without fracture.

7.3 CORROSION RESISTANCE

Each lot shall have the capability of satisfying the corrosion test described in Section 8.4.

7.4 GRAIN SIZE

The grain size of the bar, rod, or wire shall have the capability of satisfying the requirements of Section 8.5.

7.5 SURFACE FINISH

7.5.1 Unless otherwise specified in the purchase order, the bar, rod, or wire shall be supplied with a surface finish of 1.5 μm (60 microinch) AA or better.

7.5.2 The surface shall be visibly free from contaminants such as oxide, dirt, oil, grease, lubricants, or other extraneous materials.

Atomic Energy of Canada Limited
Power Projects

L'Énergie Atomique du Canada, Limitée
Groupe Électronucléaire

AECL PROPRIETARY

Branch/Serv	WP/Lot	RC/CD	CL	Dist.	Rev.	Date	Page	of/de	Proj.	SI	Sect.	Ser.
7741	0000	999	001	999	02	78/03/01	1	12	XX	37353	TS	002

TECHNICAL SPECIFICATION

TS-XX-37353-2

ZIRCONIUM ALLOY BAR, ROD AND WIRE
FOR NUCLEAR FUEL APPLICATIONS

REGISTERED PROFESSIONAL ENGINEER
A. R. KNIGHT
PROVINCE OF ONTARIO

EXEMPLAIRE 49.16

Prepared by: A.R. Knight

Date: February 1978

Approved by: R D P

Date: 78.04.10.

Revision No.: 2

Date: March 1978

ISSUED FOR PROJ.	REV.
29,59 87	2
22	2
18	0
22,29,59 21,87	1

Atomic Energy of Canada Limited
Power Projects

L'Énergie Atomique du Canada, Limitée
Groupe Électronucléaire

ENGINEERING DOCUMENT ISSUE AND REVISION HISTORY

ZIRCONIUM ALLOY BAR, ROD AND WIRE FOR NUCLEAR FUEL APPLICATIONS

NUMBER 7741-0000-XX-37353-2 alc

SHEET NO.

ISSUE	DATE	REV.	DATE	DETAILS	PREPARED BY	CLEARED BY	APPROVED BY
1		0	Jan. 75	Original Issue. Issued for Proj. 18: 76-04-05.	L.G. Bell		R.D. Page
2		1	Apr. 77	Changes in 2 (p.1), 7.1.1 (p.3), 7.1.2.	A.R. Knight		R.D. Page
				(p.4 and 5), 8.25 (p.6), 8.5.2 and 9 (p.8).			
				Distributed for Projects 21, 22, 29, ~~30~~, ~~38~~, ~~44~~,			
				59, and 87, For Comments.			
3	78-04-17	2	Mar. 78	Sections 3, 4.1, 6.2, 7.1.1, 7.1.2, 7.2.1,	A.R. Knight alc		R.D. Page
				7.5.2, 8.2.1, 8.2.5, 8.4.1, 8.4.2, 8.4.3,			
				8.5.1, 8.5.3 revised. (Issued for same as above)			
				TS-XX-37353-2(F) issued for Projects 61			
				and 66 and TS-XX-37353-2(S) for Project 18			

TABLE OF CONTENTS

ZIRCONIUM ALLOY BAR, ROD AND WIRE FOR NUCLEAR FUEL APPLICATIONS

1. SCOPE

This Specification covers hot and cold finished zirconium alloy bar, rod and wire manufactured from Zircaloy-2, Zircaloy-4, or zirconium 2.5 wt% niobium, for nuclear fuel applications.

2. CONTENTS

3. APPLICABLE SPECIFICATIONS AND DOCUMENTS

The following specifications in effect at the date of issue of the pertinent purchase order shall form part of this Specification:

ASTM E8	Tension Testing of Metallic Materials
ASTM E29	Recommended Practice for Indicating which Places of Figures are to be Considered Significant in Specified Limiting Values
ASTM E55	Sampling Wrought Non-ferrous Metals and Alloys for Determination of Chemical Composition
ASTM G2	Aqueous Corrosion Testing of Samples of Zirconium and Zirconium Alloys

In the event of conflict Specification TS-XX-37353-2 shall override.

4. DEFINITION OF TERMS

4.1 LOT

A lot shall consist of all material of the same size, shape and condition produced from the same ingot by the same reduction schedules and heat treatments and given final heat treatment in the same furnace charge.

4.2 PURCHASER

Where used in this Specification the term "Purchaser" shall be defined as the purchaser of zirconium alloy bar, rod, or wire.

4.3 SUPPLIER

When used in this Specification the term "Supplier" shall be defined as the supplier of zirconium alloy bar, rod, or wire.

4.4 BAR AND WIRE

Since the specification for these products is quite different, the form of a particular order shall be as defined by the Purchaser.

5. BASIS OF PURCHASE

The relevent purchase order shall form a part of this Specification and all include the following information:

5.1 Quantity
5.2 Alloy
5.3 Condition
5.4 Surface Finish
5.5 Cross-section
5.6 Form (bar, rod, wire)
5.7 Applicable Dimensions
5.8 Additional Test Requirements

6. CONDITIONS

6.1 Zircaloy-2 or Zircaloy-4 wire furnished under this Specification shall be in the annealed condition, but with enough cold work, a few percent, to prevent kinking when uncoiled. Zircaloy-2 and Zircaloy-4 bar and rod shall be furnished in one of two conditions as designated in the purchase order.

6.1.1 Annealed.

6.1.2 Cold worked and stress relieved.

6.2 Zirconium-2½ wt% niobium bar, rod, or wire shall be cold worked with 15 to 40% reduction, then stress relieved at 840K ± 28K (1053°F ± 50°F) for 6 hours ± 1/2 hour.

7. MATERIAL REQUIREMENTS

7.1 CHEMICAL COMPOSITION

7.1.1 Alloying Elements

	Zircaloy-2	Zircaloy-4	Zr-2½ wt% Nb
Tin	1.20-1.70 wt%	1.20-1.70 wt%	-
Iron	0.07-0.20 wt%	0.18-0.24 wt%	-
Chromium	0.05-0.15 wt%	0.07-0.13 wt%	-
Nickel	0.03-0.08 wt%	-	-
Total Fe+Cr+Ni	0.18-0.38 wt%	0.28-0.37 wt%	-
Niobium	-	-	2.40-2.80 wt%
Oxygen	900-1500 ppm	900-1500 ppm	900-1500 ppm

7.1.2 Impurities

	Zircaloy-2 ppm max.	Zircaloy-4 ppm max.	Zr-2½ wt% Nb ppm max.
Aluminum	75	75	75
Boron	0.5	0.5	0.5
Cadmium	0.5	0.5	0.5
Carbon	400	400	400
Chromium	-	-	200
Cobalt	20	20	20
Copper	50	50	50
Hafnium	100	100	100
Hydrogen	35	35	35
Iron	-	-	1500
Lead	130	130	130
Magnesium	20	20	20
Manganese	50	50	50
Molybdenum	50	50	50
Nickel	-	70	70
Niobium	100	100	-
Nitrogen	80	80	80
Silicon	120	120	120
Tantalum	200	200	200
Tin	-	-	100
Titanium	50	50	50
Tungsten	100	100	100
Uranium	3.5	3.5	3.5
Vanadium	50	50	50

7.2 MECHANICAL PROPERTIES

7.2.1 Tensile Properties

Each lot of bar and rod shall have not less than the following minimum room temperature tensile properties as determined by the mechanical property tests described in Section 8.3.

Alloy	Metallurgical Condition	Ultimate Tensile Strength	0.2% Yield Strength	Elongation in 50 mm (2 inches)
Zircaloy-2 & Zircaloy-4	Annealed	414 MPa (60 ksi) 380 MPa (55 ksi) for size < 0.127mm (.050")	241 MPa (35 ksi)	14%
Zircaloy-2 & Zircaloy-4	Cold Worked & stress relieved	517 MPa (75 ksi)	448 MPa (65 ksi)	10%
Zirconium-2½ wt% Niobium	Cold Worked & stress relieved (Section 6.2)	587 MPa (85 ksi)	414 MPa (60 ksi)	15%

7.2.2 Bend Test

The mechanical test requirement for wire is that it shall withstand a bend test as described in Section 8.3 without fracture.

7.3 CORROSION RESISTANCE

Each lot shall have the capability of satisfying the corrosion test described in Section 8.4.

7.4 GRAIN SIZE

The grain size of the bar, rod, or wire shall have the capability of satisfying the requirements of Section 8.5.

7.5 SURFACE FINISH

7.5.1 Unless otherwise specified in the purchase order, the bar, rod, or wire shall be supplied with a surface finish of 1.5 μm (60 microinch) AA or better.

7.5.2 The surface shall be visibly free from contaminants such as oxide, dirt, oil, grease, lubricants, or other extraneous materials.

7.6 SIGNIFICANCE OF NUMERICAL LIMITS

For the purpose of determining compliance with the specified limits for requirements of the properties listed in the following table, an observed value or a calculated value shall be rounded as indicated in accordance with the rounding methods of Recommended Practice E29.

Property	Rounded Unit for Observed or Calculated Value
Chemical composition, hardness and tolerances (when expressed as decimals)	nearest unit in the last righthand place of figures of the specified limit
Tensile strength and yield strength	nearest 10 MPa (1000 psi)
Elongation	nearest 1%

8. INSPECTION, TESTS AND REPORTS

8.1 GENERAL

8.1.1 The Supplier shall be responsible for and shall perform all the tests required to demonstrate compliance with the requirements of this Specification for each lot.

8.1.2 The Supplier shall afford the inspector representing the Purchaser all reasonable facilities to satisfy him that the bar, rod, or wire is being furnished in accordance with this Specification.

8.2 CHEMICAL ANALYSIS

8.2.1 The ingot analysis may be submitted as defining the chemical composition for the material produced to this Specification, with the exception of hydrogen and nitrogen. However, the Purchaser reserves the right to reject material which departs from the specified composition. Where ingot analysis is not available to Section 8.2.5, product chemical analyses shall be performed on each lot. All ingot and product analyses shall be submitted and shall meet the chemical composition requirements.

Chemical analysis tolerances shall be as follows and shall not broaden the specified variations in composition requirements but shall reflect variation between laboratories in the measurement of chemical composition.

Permissible Variations in Product Analysis

Element	Permissible Variations from Specified Range
(Alloy)	
Tin	0.050 wt%
Iron	0.020 wt%
Chromium	0.010 wt%
Nickel	0.010 wt%
Fe+Cn+Ni	0.020 wt%
Oxygen	70 ppm
Niobium	0.040 wt%
(Impurities)	20 ppm or 20%, whichever is smaller

8.2.2 Product analysis shall be done to determine hydrogen and nitrogen concentration on one or more samples representative of each lot. The results shall comply with the requirements of Section 7.1.2 with the exception of hydrogen in wire which shall be less than 50 ppm.

8.2.3 Analysis shall be made using standard methods. In the event of disagreement as to the chemical composition of the metal, methods of chemical analysis for reference purposes shall be determined by a mutually acceptable laboratory.

8.2.4 Sampling for chemical composition shall be conducted in accordance with ASTM E55.

8.2.5 Sampling of Ingot - where ingot analysis is done, the ingot shall be sampled at least once for every 820 to 1000 kg (1800 to 2200 lb) of ingot weight. These samples shall be taken uniformly along the length of the ingot so as to sample the top, bottom and points in between. Additional samples shall be taken in areas where segregation is suspected.

8.3 MECHANICAL PROPERTY TESTS

8.3.1 Two specimens for tensile test shall be made each from a different piece from each lot of finished bar and rod and the tensile, yield, and elongation properties reported. The specimens shall be cut in the logitudinal direction. The test shall be performed in accordance with ASTM E8 and the strain rate shall be 0.003 to 0.007 per minute through the yield strength. After the yield strength has been exceeded, the crosshead speed may be increased to produce a specimen strain of approximately 0.05 per minute to failure.

8.3.2 Because it is impractical to conduct a tensile test on wire a bend test is substituted. Two specimens shall be selected and bent on a mandrel of diameter 3T through a minimum angle of 180°, where T is the minor dimension on a transverse section through the wire.

8.4 CORROSION TEST

8.4.1 When corrosion resistance is evaluated, two specimens shall be autoclaved in 673K ± 5K (752°F ± 9°F) steam in accordance with the procedures defined by ASTM G2.

8.4.2 After autoclaving, Zircaloy-2 and Zircaloy-4 specimens shall show a uniform, black lustrous oxide film and a weight gain of not more than 22 milligrams per square decimetre of surface after 3 days (72 plus 8, minus 0 hours) or not more than 38 milligrams per square decimetre of surface after 14 days (336 plus 8, minus 0 hours).

8.4.3 After autoclaving, zirconium-2½ wt% niobium specimens shall show a uniform dark gray oxide film and a weight gain of not more than 35 milligrams per square decimetre of surface after 3 days (72 plus 8, minus 0 hours) or not more than 60 milligrams per square decimetre of surface after 14 days (336 plus 8, minus 0 hours).

8.5 METALLOGRAPHIC EXAMINATION

8.5.1 Two transverse and two longitudinal cross-sections from each lot of finished bar, rod, or wire shall be examined metallographically. The samples shall be examined for stringers, surface cracks, seams, blisters, porosity, pipe and grain size and the results reported to the Purchaser.

8.5.2 A microsection transverse to the direction of cold work shall be used to determine the grain size along any line normal to the surface of the finished bar, rod, or wire.

8.5.3 The average grain size shall not exceed 35 μm AA and no grain shall be larger than 80 μm.

8.6 NON-DESTRUCTIVE TESTING

The material shall be examined for physical defects. The equipment, test procedure, test standards and sampling procedure used shall be subject to approval by the Purchaser.

9. WORKMANSHIP

The bar, rod or wire shall be free from scabs, cracks, seams, slivers, blisters, laps, folds, burrs, foreign material and other injurious imperfections in accordance with standards of acceptability agreed upon by the Supplier and the Purchaser.

10. CERTIFICATION

The results of all tests on the finished bar, rod or wire shall be reported to the Purchaser. The test reports and inspection reports, including ingot analysis (two copies of each) signed by a responsible technical representative of the Supplier and covering all tests and analyses shall be submitted to the Purchaser. When inspection or testing is sub-contracted to an outside agency, the reports shall be signed by a responsible technical representative of such agency and countersigned by the Supplier.

11. PACKAGING AND SHIPPING

11.1 The material shall be packaged so as to prevent loss, damage, or contamination during transit.

11.2 Each package or container shall be legibly and conspicuously marked with the following information:

(1) Purchase Order Number
(2) Name of Supplier
(3) Alloy
(4) Type of Product
(5) Number of Pieces
(6) Size
(7) Ingot and Lot Number
(8) Gross, Net and Tare Weights

ANEXA C – Schita suport bobina