T1D/5NW--42

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NR FUEL DEVELOPMENT TEST SPECIFICATION IIF-b

FUEL ELEMENT IMPREGNATION

(Title Unclassified)

Classification cancelled for change to
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Exempt from CCRP Re-review Requirement
(per 7/22/82 DOD/Caulle memorandum)
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9-27-61
Date

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Automatic Downgrading
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FUEL ELEMENT IMPREGNATION

TFST SPECIFICATION IIF-b

(U) 1.0 Purpose

To provide additional data concerning niobium metal resinate impregnation of high void elements for possible use in specification IV-B.

(U) 1.1 Primary Objectives

1.1.1 To determine niobium pick-up resulting from niobium metal resinate impregnation of high void elements of four different air-leak ranges.

1.1.2 To determine the corrosion characteristics of niobium metal resinate impregnated high void elements of four different air-leak ranges.

1.1.3 To study the mechanisms of beneficial effects produced by impregnation with niobium metal resinate.

1.1.4 To study the relationships between corrosion test behavior, air leak rate, and the distribution of niobium in the element.

(U) 1.2 Secondary Objectives

1.2.1 To determine the results of eliminating the regraphitization step of the resinate impregnation procedure,

AFF 2042.

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(U) 2.0 General Fabrication Information

(U) 2.1 High void fraction, Code 20 elements fabricated at WNCO for Phase IIA-2 will be used for further development in this specification.

(U) 2.1.1 All materials, and fabrication and inspection procedures will be standard as specified in specification IIA-2.

(U) 2.1.2 Elements for impregnation will be selected to exhibit whole-body air leakage (as leached) in four ranges as follows:

(U) 2.1.2.1 Low Range: 5 elements each with a leak rate between 10 and 25 cc/min - W.B. Air.

(U) 2.1.2.2 Medium range: 10 elements each with a leak rate between 40 and 60 cc/min - W.B. Air.

(U) 2.1.2.3 High range: 5 elements each with a leak rate between 80 and 100 cc/min - W.B. Air.

(U) 2.1.2.4 Very high range: 5 elements each with a leak rate between 200 and 450 cc/min - W.B. Air.

(U) 2.1.3 Standard elements shall exhibit leakage in the medium range.

(U) 2.2 Niobium metal resinate impregnant shall be used.

(U) 2.3 Niobium metal resinate impregnation shall be accomplished by following AFF procedure 2042, or by this procedure with the deletion of the re-graphitization step.

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(U) 3.0 Matrix

(U) 3.1 Raw Materials

(U) 3.1.1 All raw materials except impregnants are detailed in specification IIA-2.

(U) 3.1.2 Niobium metal resinate solution No. 41 from Englehard Industries.

(U) 3.2 Fabrication

(U) 3.2.1 Fabrication of elements has been detailed in Specification IIA-2.

(U) 3.3 Thermal Processing

(U) 3.3.1 All thermal processing details through leaching have been detailed in specification IIA-2.

(U) 4.0 Impregnation

~~(S)~~ 4.1 Twenty elements shall be impregnated with niobium metal resinate per AFF procedure 2042.

(U) 4.1.1 One element of each leak range in this group shall be impregnated, heat treated, physical properties determined as shown in Figure 2 and results studied before additional elements are impregnated.

~~(S)~~ 4.2 Five elements shall be impregnated with niobium metal resinate per AFF 2042 except with deletion of re-graphitization step.

(U) 4.2.1 One element of this group shall be impregnated,

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sectioned for physical properties as shown in Figure 2, and results studied before further impregnations are performed.

(U) 5.0 Standard Elements

(U) 5.1 Four high void elements of medium leak range shall be tested without impregnation as standards.

(U) 6.0 Heat Treatment After Impregnation

~~(U)~~ 6.1 All elements shall be given the heat-treatment designated in AFF procedure 2042 except as noted in 4.2.

~~(U)~~ 6.2 All applicable elements shall be weighed before impregnation and after the final heat-treatment to give the weight pick-up due to impregnation.

(U) 7.0 NbC Coating

~~(U)~~ 7.1 Diffusion coating process with gas flow from the hot end to produce a profile of 1.2 mils thickness at Station 20 and 2.0 mils at Station 50 shall be used.

(U) 7.2 Elements will be coated in one coating run.

(U) 7.2.1 The coating run shall include the following elements:

(U) 7.2.1.1 Four elements of the highest leak rate range, group 1 of Figure 1.

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- (U) 7.2.1.2 Four elements of the lowest leak rate range, group 1 of Figure 1.
- (U) 7.2.1.3 Four elements of medium leak range, group 1 of Figure 1.
- (U) 7.2.1.4 Four elements of medium leak range, group 2 of Figure 1.
- (U) 7.2.1.5 Four elements of very high leak range, group 1 of Figure 1.
- (U) 7.2.1.6 Four standard high void Code 20 elements - not impregnated.
- (U) 7.2.1.7 One non-fuel element for metallographic determination of the coating profile - not impregnated.

~~(S)~~ 8.0 Molybdenum Overcoating

~~(S)~~ 8.1 Molybdenum overcoating may be used in conjunction with NbC coating. The procedure shall be specified when the NbC coating conditions are determined.

(U) 9.0 Inspection

(U) 9.1 As Impregnated

~~(S)~~ 9.1.1 One impregnated element from each leak range-group shall be sectioned for property measurements as detailed in Figure 2.

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(U) 9.2 As NbC Coated

(U) 9.2.1 Each element shall be weighed.

(U) 9.2.2 One element from each leak range-group and one standard element shall be sectioned for metallographic and radiographic study as detailed in Figure 3.

(U) 9.2.2.1 Metallography samples shall be split axially (as shown in Figure 3) and one section mounted and polished in axial and radial planes. The axial plane shall show both sides of 5 bores.

(U) 9.2.2.2 Radial radiography wafers shall be ground and polished to appropriate thickness (15-25 mils) for analysis.

(U) 9.2.3 Bore and OD coating profile by beta backscatter measurements shall be made on every element designated for corrosion testing, and by metallography on at least one element from the coating batch.

(U) 9.2.4 Across flats measurements shall be made on the three flats at the S/N end, middle, and hot end as well as at the following distances from the hot end: 1/2, 1-1/2, 2-1/2, and 4 inches.

(U) 9.2.5 Incremental electrical resistance shall be determined on every coated element.

(U) 9.2.6 Air impedance shall be determined on every element designated for molybdenum overcoating.

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9.3 As Molybdenum Overcoated

- (U) 9.3.1 All elements shall be weighed.
- (U) 9.3.2 The incremental electrical resistance shall be made on all elements.

(U) 10.0 Corrosion Testing

- (U) 10.1 Electrical corrosion testing shall be performed at the conditions specified in Table I.

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TABLE I

Power (Kw)	1280*
Flow (scfm)	850
Δ P at Station 20 (psig)	30
Temperature, station 48.6 ($^{\circ}$ R)	4950
Exit pressure (psig)	611
Test Time (minutes)	To be determined

*Power is to be controlled at this level.

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FIGURE 1

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PROCESS AND TEST FLOW SHEET, PHASE IIF-b

*This block must be completed before remaining impregnations are started.

- (1) Leak range 10-25 cc/min W.B. Air.
- (2) Leak range 40-60 cc/min W.B. Air.
- (3) Leak range 80-100 cc/min W.B. Air.
- (4) Leak range 200-450 cc/min W.B. Air.
- (5) Non-fuel element is for coating run profile determination.

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FIGURE 2

SAMPLING DIAGRAM - PHASE IIF-b

SAMPLE NO.

PURPOSE

4, 13, 21	Specific resistance and flexural strength
1, 9, 24	Porosity and bulk density
2, 11, 23	Chemical analysis
5, 10, 18	Compressive strength
6, 14, 19	Longitudinal CTE (Machine to 3 ± 0.005" - ends flat and parallel)
7, 15, 20	Transverse CTE (Group of 4, 1/4 inch long samples)
3, 12, 22	Radiography
8, 17	Metallography Axial Section
16	Metallography Radial Section

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IIF-b

[REDACTED]

FIGURE 3

SAMPLING PLAN FOR METALLOGRAPHY AND RADIOGRAPHY ANALYSIS

PHASF IIF-b

NOTES:

1. Lettered samples are for metallography (1 inch long)
  2. Numbered samples are for radiography (1/8 inch long)
- * 1 sample is taken across tip joint.

[REDACTED]