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IN NUCLEAR SCIENCE ABSTRACTS

SNAP 8

**FUEL ELEMENT
FABRICATION AND
PERFORMANCE TESTING**

ATOMICS INTERNATIONAL

a division of North American Aviation, Inc. AEC Contract: AT(11-1)-GEN-8

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The production processes for the third generation of SNAP 8 fuel elements have been established and pilot production runs completed. The photographs in this document show the sequence used in fabricating fuel elements from the raw material to the finished product. The non-nuclear performance testing sequence for fuel elements is also shown.

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SNAP FUEL ELEMENT FABRICATION

FUEL ROD FABRICATION

Raw fuel rod materials are weighed and compacted into arc melt sections.

Arc-melt compacts are welded together to form full-length arc-melt electrode.

As-welded arc-melt electrode.

Electrode being loaded into arc-melt furnace.

Starting vacuum arc-melter

As-melted billet being removed from copper crucible.

Billet being machined to extrusion billet shape.

Recording of primary billet weight prior to extrusion.

Secondary billets being loaded into extrusion preheat furnace.

Extrusion lubricant is sprayed on heated billet.

Extrusion billet being loaded into extrusion press.

Billets extruded to rough fuel rod diameter.

After fuel rod extrusions are cut to length and rough machined they are loaded into ceramic boats.

Ceramic boats containing fuel rods are combined with heat shield and loaded into furnace retort for hydriding.

Weight comparison is made before and after hydriding to determine amount of hydrogen added.

Hydried rods are rough machined, and

Then final machined.

Fuel rods are final inspected, including a scintillation scan to determine uranium distribution, and released for fuel element assembly.

HYDROGEN BARRIER COATING PREPARATION

Raw materials for hydrogen barrier coating being inserted in smelting furnace.

Compaction of hydrogen barrier coating frit for flow button test.

Comparison of flow of frit batch with reference frit.

Weighing and recording of frit prior to ball melting.

Recording of frit after ball milling.

Mill additions are combined with the basic hydrogen barrier frit.

Mixture is ball milled to combine additions.

Ball milled mixture is screened to remove large particles.

Slip batch is rescreened and recorded in container ready for use on cladding tubes or cups.

CLADDING TUBE AND SEAL CUP FABRICATION

Machining of fuel element components.

Top cap being assembled over internal chill block prior to welding tube to cap.

External chill blocks in position over tubing and top cap prior to welding.

Helium leak inspection of welded tube.

Cladding tubes being loaded into boats prior to outgassing.

Outgassing of cladding tubes and seal cups.

Ultrasonic cleaning of seal cups after sandblasting.

Sandblasting internal surfaces of cladding tube.

Ultrasonic cleaning of cladding tube after sandblasting.

Spray coating of seal cups.

Hydrogen barrier coating slip being poured into cladding tube. Machine used to distribute coating to tube walls.

Low-temperature dip drying.

Second drying operation at higher temperature

Firing of coating to cladding tubes.

Air gauging of coated cladding tube to measure as-coated inside diameter.

Visual inspection of coated cladding tube.

FINAL FUEL ELEMENT ASSEMBLY

Fuel rod being inserted in coated cladding tube.

Shrink fitting of end seal inside cladding tube.

Vapor cleaning of external surfaces to remove oxides.

Ultrasonic cleaning of weld joint prior to welding.

Fuel elements being positioned in five element electron beam welding fixture.

Electron beam welding of final closure seal

Fusion of final hydrogen barrier seal.

Hydrogen permeation testing of assembled fuel elements.

Final dimensional inspection of fuel elements.

SEQUENCE OF NON-NUCLEAR PERFORMANCE TESTS FOR SNAP 8 FUEL ELEMENTS

PERMEATION TEST SYSTEM

16-ELEMENT CAPACITY

Fuel elements tested at $1400 \pm 10^\circ\text{F}$ isothermally to establish base permeation rate and check for changes during test sequence. Permeation rate determined by measuring hydrogen with modified mass spectrometers calibrated with hydrogen leak standards.

THERMAL SOAK SYSTEM

16-ELEMENT CAPACITY FOR EACH OF 3 FURNACES

Fuel elements are subjected to 5 to 10 thermal soak cycles to simulate reactor and system thermal check-out prior to launch.

Fuel element temperatures during thermal soak.

NINETEEN-FUEL-ELEMENT TEST FIXTURE FOR SHOCK, VIBRATION, AND ACCELERATION TESTING

Some fuel elements are vibrated and shocked during system tests, such as the S8DRM-1, to evaluate effects of full 211-element core response.

ACCELEROMETER

Fuel element test fixture mounted for acceleration test.

TYPICAL SHOCK AND VIBRATION TEST SYSTEM

Tests are performed in the Environmental Test Laboratory at Santa Susana. The NASA-417-2 specification is used as a basis for the test inputs to the system.

Fuel element temperatures during ramp heating and thermal cycling.

RAMP HEAT AND THERMAL CYCLE SYSTEM

SINGLE-ELEMENT CAPACITY IN EACH OF FIVE SYSTEMS

Ramp heating of fuel elements to simulate reactor startup and thermal cycling to simulate reactor dead-band operation is accomplished by programmed induction heating of the fuel elements. Ramp heating rates as high as 750°F/min have been obtained with these systems.

THERMAL ENDURANCE SYSTEM

Mass spectrometers.

Endurance furnaces.

MAXIMUM CAPACITY 144 FUEL ELEMENTS
IN EACH OF TWO SYSTEMS

Fuel elements are tested at $1400 \pm 10^\circ\text{F}$ for 10,000 hours with hydrogen permeation rates measured during the test period.

Fuel element test fixture mounted for acceleration test.

FUEL ELEMENT PERMEATION SCANNING SYSTEM

SINGLE ELEMENT CAPACITY

System used to nondestructively scan fuel elements to locate high-leak-rate areas.

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