

Proposed Protocol for the Establishment of Critical Mechanical Properties of Metamic-HT

(USNRC Docket No. 71-9325)
A Presentation to the SFST

by
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Objective of Presentation

- To present a plan to quantify the physical characteristics of Metamic-HT to resolve the issues raised by the USNRC. This plan presented herein represents the well considered technical position of this presenter in this matter.
- To demonstrate that the proposed test plan is sufficiently comprehensive to support an ASTM level of standardization of the material.
- To obtain the regulators concurrence with the proposed test plan.

Test Conditions

- When conducting dynamic modulus tests for isotropy, should the results indicate that condition prevails, subsequent mechanical testing shall not be required.
- When a data base is established for a property measurement, reduced sampling may be imposed if results are consistently within limits; conversely, sampling shall be increased should test results indicate.
- Sampling protocol and samples size shall be based on MIL-STD 105.
- Approximately 460 samples may be required for the full test program.
- Recognized algorithms for accelerated aging shall be acceptable for predicting long term performance.

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Objectives of the Proposed Test Plan

- Develop Testing and Sampling Requirements in Support of Metamic-HT Based on Report 06911 by Metamic LLC
- Satisfy Inquiry For Further Information For TAC No. L24076 Through Specific Testing
- Establish Baseline Performance Database Through Statistically Valid Sampling
- Test to Internationally Recognized Recommended Practices and Appropriately Certified Testing Laboratories

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Test Program Requirements

- Test coupons must be produced using controlled specifications and procedures so that they emulate the production material in all respects. To achieve this:
 - Approved powder specification required.
 - Approved manufacturing specification required.
 - Samples are to be obtained from product made to approved specifications.

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Critical Properties

- Test the base metal coupons and welded coupons for the following critical properties:
 - Minimum Yield Strength @ ambient temperature, 300°C, and -40°C
 - Minimum Young's Modulus @ ambient temperature, 300°C, and -40°C
 - Minimum Elongation @ ambient temperature, 300°C, and -40°C
 - Minimum Thermal Conductivity @ ambient temperature, 300°C, and -40°C
- Test for the change in neutron attenuation characteristics due to thermal aging of coupons

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Secondary Properties at Reduced Sampling

- Minimum Tensile Stress
- Charpy Impact Test
- Maximum Coefficient of Expansion
- Hardness (Orthogonal)
- Metallographic Evaluation (Orthogonal)

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Emissivity (OTI 3-8)

- Emissivity at room and elevated temperature has been measured and reported in Metamic Report 06911 Rev. 3 (Section 3.8).
- Emissivity is repeatable and will be controlled by maintaining a minimum required coating thickness.
- No further testing warranted.

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Isotropy Determination Protocol

- Isotropy is the influence of processing direction on physical properties.
- The presence of isotropic behavior will be determined by measuring a minimum of 10 specimens for Dynamic Young's Modulus in the longitudinal, long transverse and short transverse directions of representative samples of Metamic HT.
- Modulus values which differ by 15% or less shall verify isotropic behavior.

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Testing Protocol

- Sample representative of production material
- Sample size of 29 specimens for critical properties
- All testing to nationally recognized standard, *i.e.* ASTM
- Use only accredited testing facilities
- Reduced testing of non-critical properties, minimum of 10 specimens

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Material Test Condition

- As extruded
- Elevated Temperature Testing As Specified
- Accelerated Temperature Testing 440°C, 15 Days*
- Irradiated
- Irradiated and Accelerated Temp. Testing 440°C, 15 Days
- Welded

* Equivalent to Five Year Exposure

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Process Qualification

- Samples to represent final product performance
 - * 17:1 Extrusion Ratio
 - * Cross Sectional Thickness
 - * Production Extrusion Parameters
 - * Sample Size of 29 for Initial Critical Qualification of Process
 - * Reduced Sample Size (10 Min.) for Subsequent Qualification Based on Experience
 - * Qualify Powder Sources

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Irradiated Specimen Testing

Samples Tested Before and After Exposure

- Mechanical Property Degradation
- ¹⁰Boron Degradation As Measured by Neutron Attenuation
- Metallographic Determination of B₄C Distribution Stability

No additional elevated temperature creep testing with irradiation warranted for isotropic material

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Sample Sizes

Test	Number Specimens
Tensile Tests	348
Charpy Impact Tests	58
Thermal Conductivity Measurement	3
Thermal Expansion Measurement	9
Welding Trials	12
Dynamic Young's Modulus	30
Metallography will use residuals	-
	Total 460 specimens

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Test Schedule

- All data shall be completed and quality validated report submitted 14-Sept-08.