

## Weld Qualification Program for Metamic HT

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*A Presentation to the SFST*

by

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## Weldability Study of Metamic HT

- ASME Code Compliance for Unassigned Materials
- Verification of Weld Metal and HAZ Properties
- Verification of Weld Deposit Quality
- Verification of Weld Quality Repeatability
- Demonstrate Manufacturing Reliability
  - Process selection
  - Process application

## ASME Qualification

- Section IX accepts unassigned material in accordance with paragraph QW-424
- The *Essential Variables* for each welding process will be applied as required by the ASME Section IX Code
- Testing per the Section IX Code will assure that the minimum specified Weld Metal and HAZ Properties will be achieved.
- Specific Welding Procedure Qualifications will be performed in accordance with ASME Section IX
- Specific Welding Personnel Qualification will be completed in accordance with ASME Section IX

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## Initial Testing of Unrepresentative Material

- Typical practice for HMD is to qualify welding procedures for manufacturing after the material has been specified and the order released. In this case, NPD requested that HMD initiate the testing program well in advance of the manufacturing release to establish the reliability of welds made in the Metamic Material.
  - Observed Weldability
    - Similar to 6061 extruded bar
      - Slower puddle formation
      - Observed faint material expulsion from weld pool.
    - Acceptable Visual Inspection in accordance with the ASME Code Section V and Section III acceptance criteria.

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## Physical Test Results

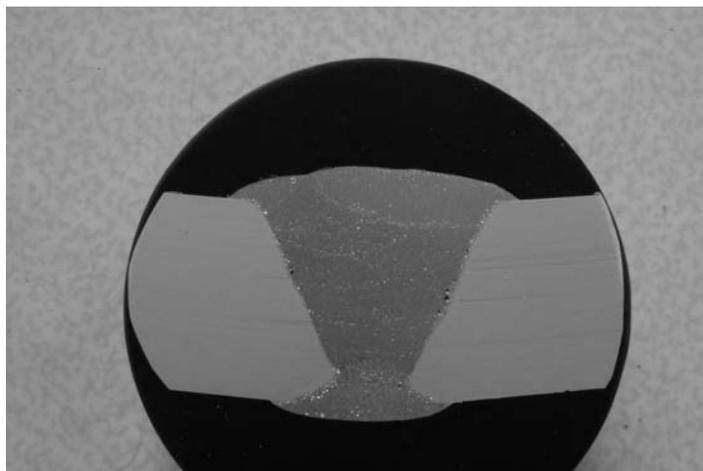
Sample	T 1	T 2	T 3	Base
Process	GTAW	GMAW	GMAW	
Filler	4043	4043	5356	
TENSILE (psi)				
Room Temp	14,300	16,380	20,490	26,312
% Reduction	45.7	37.7	22.1	
150 C.	9,520	11,180	16,590	
300 C.	5,020	6,090	9,290	11,718
% Reduction	57.2	48.0	20.7	

- Sample results indicate best results with the GMAW process using 5356 filler material. This material will be used initially with additional testing using the GTAW process.

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## Metallographic Typical Results



- T3 Macrograph shows multi-pass weld in 0.680 inch thick Metamic with backing weld. Bead profile and fusion are acceptable in accordance with ASME visual inspection criteria. Porosity along the fusion line will be evaluated for its effect on mechanical properties.

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## Initial Conclusions

- Initial results support development on representative Metamic HT material
- Standard welding processes limit the strength reduction to no more than 25% of the base metal value.
- ASME Code compliance to Section III and Section IX can be achieved.

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## Initial Test Group

- Repeat weld testing using GTAW and GMAW
- Use 5356 and 1100 filler materials
- Perform NDE to evaluate inspection methods
- Repeat tensile testing
- Bend tests to verify 6% minimum ductility

The results from this testing will meet the ASME code requirements for procedure and welder qualification. Additional testing in accordance with Dr. Phillip Blue's Test Plan may be performed.

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## Property and Quality Improvement Options

- Cleaning to minimize fusion zone porosity
  - Reduce through chemical or mechanical means
- Filler metal development for deoxidizers and improved properties
  - Specific alloy additions may scavenge oxides in the weld metal.
- Include EBW and LBW with and without filler.
  - Processes would minimize HAZ.

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## Additional Evaluations as Part of Development

- Tensile testing at room and elevated temperatures
- Effect of aging and irradiation on weld metal and HAZ
- Relate NDE results to actual performance
- Establish manufacturing practices

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## Development Schedule

- July 21 to 28 – Receive test material.
- July 28 to August 4 – Complete 12 welded test specimens.
- August 25 – Complete long-term thermal and irradiation Tests.
- August 25 – Complete testing for tensile, bend, and micrographic evaluation.
- August 25 – Select processes and test protocol for ASME procedure qualification and support for the approved material test plan.

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## Conclusions

- The weldability of Metamic based on initial testing is acceptable for fabrications using groove and fillet welds.
- The specific welding requirements for compliance to the ASME code are defined and can be met with established welding processes and materials.

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