

# Overview of Two Panel Projects: Determination of Mn Risk Factors Integrated Design Manual for Fabricated Shapes

Presented to:

Ship Design and Material Technology Panel  
National Shipbuilding Research Program



Paul Blomquist  
Applied Thermal Sciences, Inc.

April 13, 2011



# Determination of Mn Fume Risk Factors



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April 13, 2011



# Determination of Mn Fume Risk Factors

## Project Overview

### Goal:

- Conduct particle-size air sampling for Mn
- During representative shipyard welding processes
- Measurements of total, inhalable and respirable size fractions of Mn
- Prior to the effective date of a newly proposed occupational exposure limit
- Allow shipyards to evaluate compliance impact
- Prepare a practical and focused response





# Determination of Mn Fume Risk Factors

**Project Team:**

**Atrium Environmental Health & Safety  
Services, Inc.**

**Applied Thermal Sciences, Inc.**





# Determination of Mn Fume Risk Factors

**Factors:**

**Welding Power supply brand & model**

**Welding wire Feeder brand & model**

**Welding torch brand & model**

**Voltage - Amperage - Wire feed speed**

**Wire nomenclature: Brand, AWS type, Diameter**

**Shield Gas Data: Mix,**

**Distance of wire feeder from welding power supply**

**Torch tip-to-work distance,**

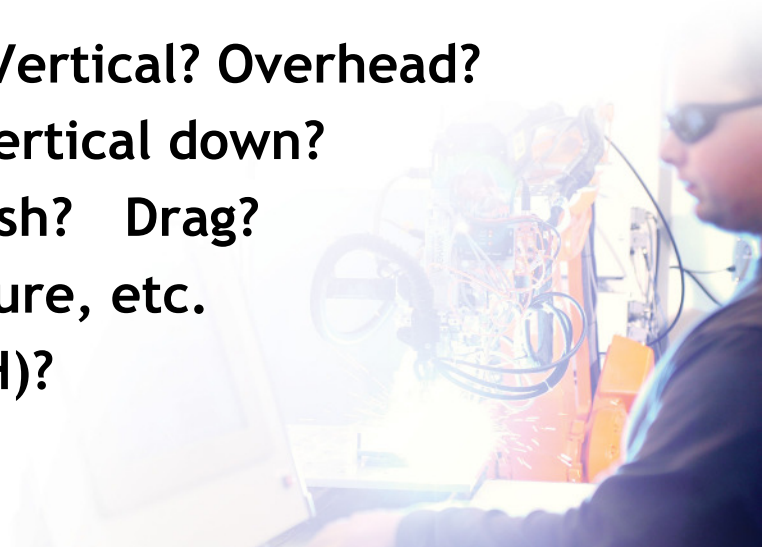
**Welding position: Flat? Horizontal? Vertical? Overhead?**

**Welding Progression: Vertical up? Vertical down?**

**Torch position relative to welder: Push? Drag?**

**Ambient conditions - wind, temperature, etc.**

**Open area? Enclosed space (L x W x H)?**





## Determination of Mn Fume Risk Factors

- Reviewed Navy's historical data for exposure to Mn during "hot work"
- Review of 3866 air sample entries collected between 1982 and 2007
- No particle-size data for Manganese in welding was found
- Reviewed OSHA's historical air monitoring data for occupational exposure to Mn
- Review of 1248 air sample results for Manganese fume collected between 1984 and 2009
- No particle-size data for Manganese in welding was found





## Determination of Mn Fume Risk Factors

- Reviewed technical reports and held discussions with National Institute for Occupational Safety and Health (NIOSH)
- Drs. Antonini & Harper: Each involved with multi-year studies on welding fume and particle-size measurements
- ACGIH: No side-by-side air monitoring data comparing total, inhalable and respirable size fractions on Mn





## Determination of Mn Fume Risk Factors

### Test Sites:

- Bath Iron Works
- BAE Systems Southeast Shipyards
- Navy and Marine Corps Public Health Center and
- Norfolk Naval Shipyard
- All sites agreed to testing
- Testing on-going, completes by mid-May



# Integrated Design Manual for Fabricated Shapes

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Ship Design and Material Technology Panel  
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**The Shape You *Need*  
For  
The Ship You *Want***



**The Ship You *Get*  
with  
The Shape They *Got***

Larry Thompson and Paul Blomquist  
Applied Thermal Sciences, Inc.

March 17, 2011

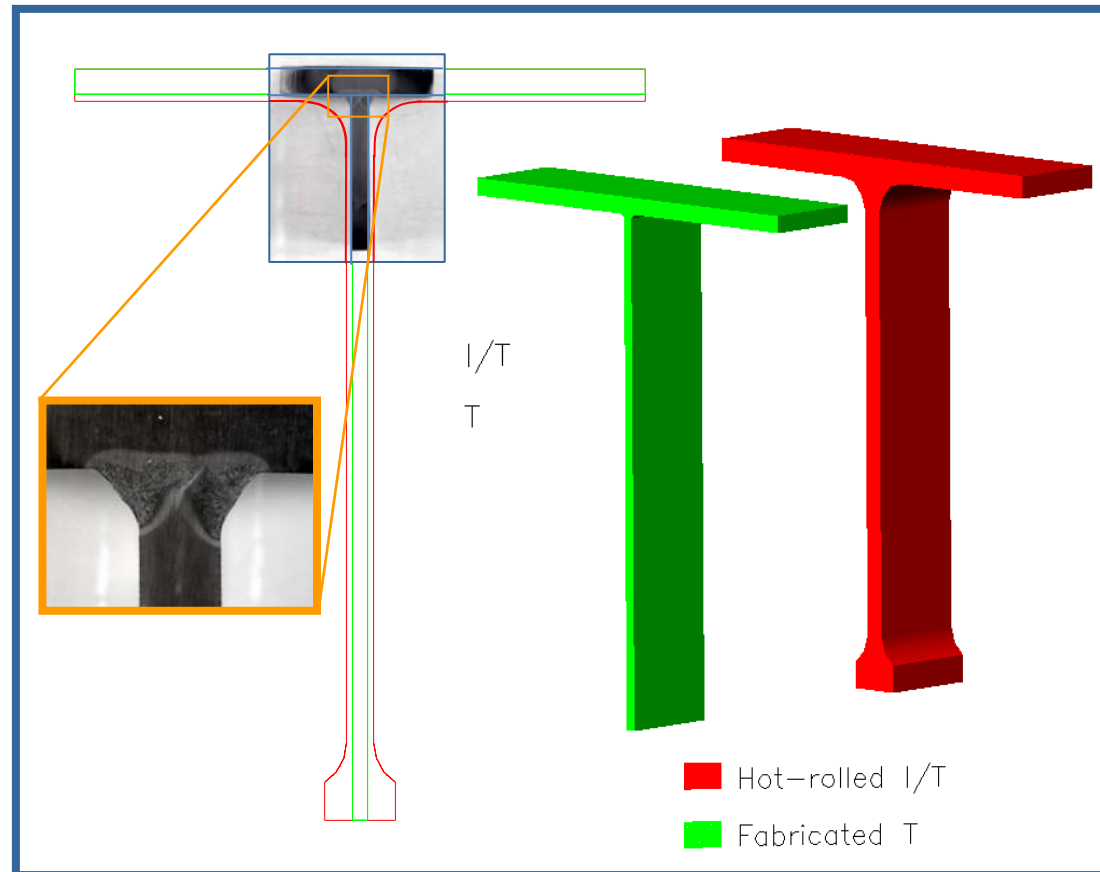


# Outline

- **Programmatic Overview**
- **Historical Perspective**
- **Technical Approach**
  - “Substitutional Design”
    - Replacement of existing T-beams in existing design
  - “Optimal Design”
    - “Clean sheet of paper” - no prior design
- **Design Tool Development Overview**
- **Future Work**



# Why Do This?



**9.0# DH-36 I/T Replaced by 6.3# DH-36 Fabricated Tee (33% wt. savings)  
Entirely within DD-51 Ship Specification Design Rules; Still Over-Strength**

*Source: NSRP N7-91-4*



# Historical Perspective

- **Legacy Stiffeners**
  - I/T's, W/T's, Angles, Bulb Flats, Flats
- **First NSRP-Funded Analysis**
  - N7-91-4 Tee-Beam Manufacturing Analysis (I/T's)
- **Extended Analysis**
  - DDG-51 Shapes - included W/T's as well as I/T'S
- **Implementation on CVN-78**
  - Shift to HSLA-65; Saves >480 Tons; Saves Assembly Costs
- **ATS Completes Sandwich Panel Design Tool**
  - Fast Iteration of Potential Designs
  - Less Than One Minute 30 Combinations of 16 design attributes
- **Implementation on DDG-1000**
  - Shift to HSLA-80
- **Inquiry Regarding LCS**
  - Issues with Mill Schedules, Interested in Potential





# Programmatic Update

- Project Team: ATS - Ingalls - Marinette Marine - CTC
- Contracts / Subcontracts in Place: February 2011
- Conference Call with Marinette Marine 2/22/11
- Using Recommended Reference Material for Guidance
- “Alpha” Design Tool Development Completed
  - Inputs / Outputs / Constraints / User Interface
- Uses Optimal Approach
- Developing User’s Manual
- Preparing for Beta-Level Review
- Determination of Next Steps
- Project Status - Nearly 80% Complete
- Funding Status - Nearly 40% Remaining
- Completion well before 1/31/2012





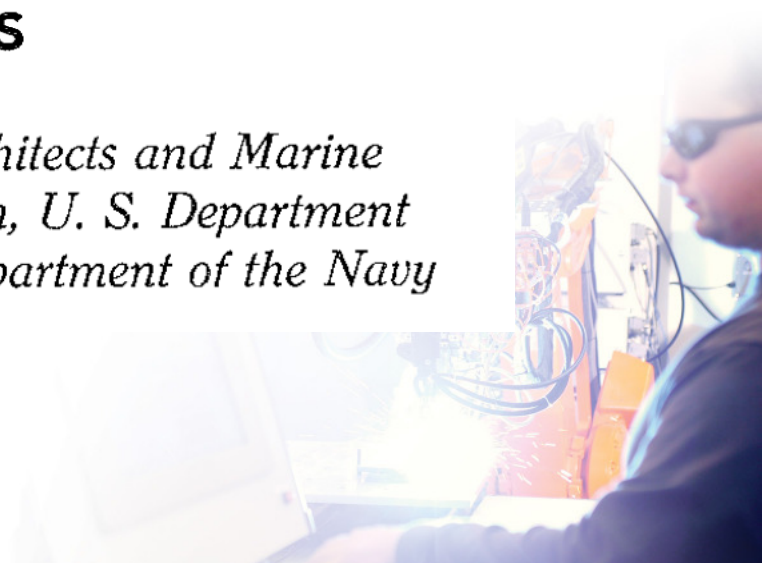
# Referential Guidelines

## MANUAL OF PROPERTIES OF COMBINED BEAM AND PLATE

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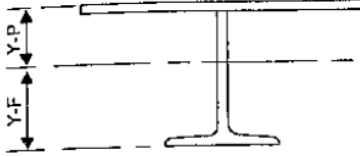
### *PART I* **TEES AND ANGLES**

*Coordinated by the Society of Naval Architects and Marine Engineers for the Maritime Administration, U. S. Department of Commerce, and the Bureau of Ships, Department of the Navy*





# Referential Guidelines



STEEL

**PROPERTIES OF  
COMBINED BEAM AND PLATE  
I-T AND T**

**60t**

5.1# PLATE WEIGHT

NOMINAL SIZE IN. x IN. x LBS./FT.	WEIGHT PER FOOT LBS.	SECTION MODULUS		I IN. <sup>4</sup>	r IN.	YF IN.	YP IN.	BEAM DIMENSIONS				
		LESSER IN. <sup>3</sup>	GREATER IN. <sup>3</sup>					AREA IN. <sup>2</sup>	DEPTH IN.	FLANGE		SHEAR AREA IN. <sup>2</sup>
										WIDTH IN.	THICK IN.	
18 x 11 3/4 x 105 I-T	71.22	70.6	161.4	905.8	6.43	5.6	12.8	20.95	18.32	11.79	0.911	10.14
96 I-T	65.10	65.2	148.0	827.6	6.42	5.6	12.7	19.15	18.16	11.75	0.831	9.29
18 x 8 3/4 x 85 I-T	60.34	66.1	128.7	805.3	6.56	6.3	12.2	17.75	18.32	8.84	0.911	9.63
77 I-T	54.46	60.4	117.4	728.9	6.56	6.2	12.1	16.02	18.16	8.79	0.831	8.62
70 I-T	49.48	55.6	106.9	663.0	6.54	6.2	11.9	14.55	18.00	8.75	0.751	7.88
64 I-T	45.19	51.7	98.3	609.4	6.54	6.2	11.8	13.29	17.86	8.71	0.686	7.20





# Tool Development Overview

- **Design and develop:**
  - BEAM-stiffened plate optimization tool
    - MS Excel / Visual Basic
    - Run as a macro within MS Excel.
- **User Manual:**
  - Guide for the using the tool
  - Section on fundamental theory





# Input Parameters

- **Load Case**
  - Simply supported with uniform pressure distribution
- **Span or Frame Spacing**
  - Input parameters (Substitutional)
  - Output values (Optimal design)
- **Safety Factor**
- **Deflection Criteria**

Example of an Input Dialog Box\*

Sandwich Panel Design Constraints	
Uniform Pressure (lb/ft <sup>2</sup> )	500
InPlane Load (lb/ft)	0
Span (ft)	5.0
Safety Factor	2.0
Buckling Knockdown	0.55
Deflection Criteria (Span over)	300
Relaxation Factor	1.1
Core angle (Deg)	70.0

NEXT QUIT

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\* Taken from ATS' sandwich panel design optimization tool



# Input Parameters (continued)

- Material Selection Dialog box, thicknesses will start at 1/8" and go to 3/4" in 1/16" increments
- List of standard ship construction materials to pick from
  - HSLA 80
  - DH 36
  - EH 36
  - Others (??)
  - User Defined Material

Example of a user defined material Input Dialog Box\*

Material Properties	
Material Description	AL 2003 Stainless Steel
Modulus of Elasticity (PSI)	30.5e6
Poisson Ratio(0.0 - 0.49)	0.3
Yield Stress (PSI)	65.0e3
Weight Density (lb/in <sup>3</sup> )	0.279

BACK NEXT QUIT

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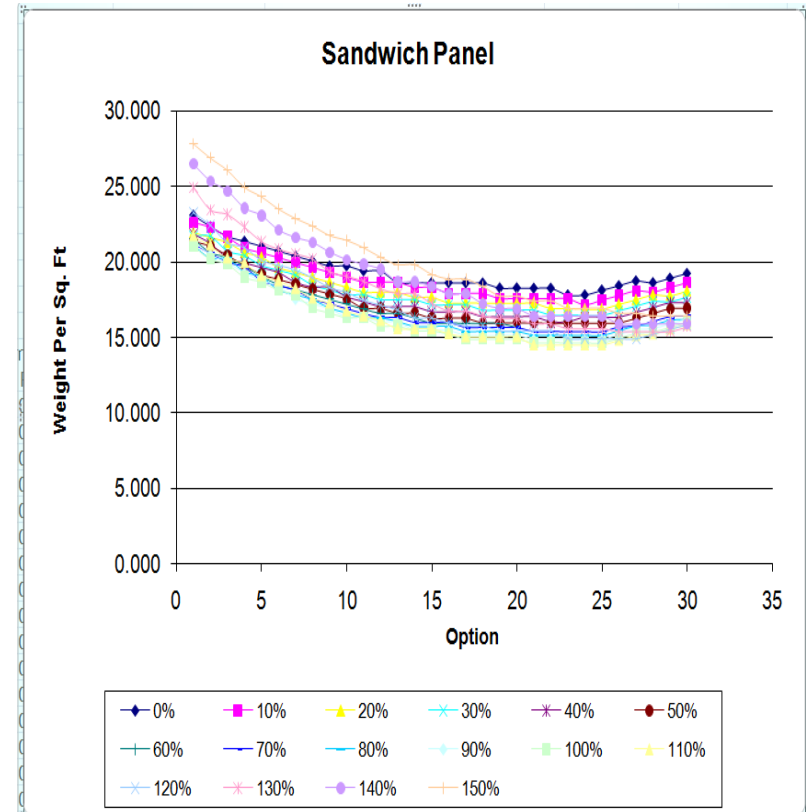
\*

Taken from ATS' sandwich panel design optimization tool



# Output Parameters

- Table of output parameters
  - T-Beam
    - Elastic properties:  $I_{xx}$ ,  $I_{yy}$ ,  $S_x$ ,  $S_y$ ,  $r_x$ , and  $r_y$
    - Area
    - Web details
    - Flange details
    - Stiffener Spacing
  - Potential for application to composite properties



Example of a weight optimization curve\*

\* Taken from ATS' sandwich panel design optimization tool

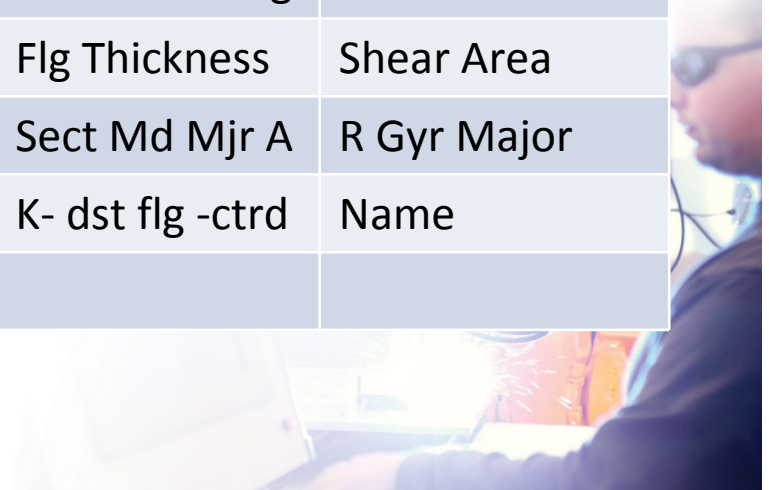


# Technical Approach

## Optimal Design

Input Parameters				
Load	Span	Dfl Crit -Global	Dfl Crit-Local	Min Pltg Crit
Mat'l (Catlg)	Mat'l Usr-Def	Modulus	Poisson's Ratio	Yield Stress
Density	Safety Factor	Min Pltg "C" Fctr		

Output Values				
"Option"	Weight/Sq Ft	Ctr Defl Ratio	Local Defl UF	Local Strs UF
Web Shr Strs UF	Norml Strs UF	Lmtg Elmnt P? F?	Pl Thk Min	Lsr Sect Mod
Grtr Sect Mod	Effective I	R Gyr – Eff Sect	YF –ctrd to Flg	YP-Ctrd to Pl
Area – Full Sect	Sect Depth	Flg Width	Flg Thickness	Shear Area
Sect Wgt/ft	Web Thickns	I –Major Axis	Sect Md Mjr A	R Gyr Major
I Minor Axis	S Minor Axis	R Gyr - Minor	K- dst flg -ctrd	Name
Eff. Breadth				





# Future Work

- **Complete Beta Version of Design Tool**
  - Review, Test and Validate Internally
  - Review, Test and Validate Externally
- **Depending on Resources:**
  - Evaluate “In-Plane” Loading Scenarios
  - “Publish” - Release to NSRP Community
  - Develop Design Tool for Alternate Strategy
  - Hold a Workshop for Potential Users
  - Evaluate other materials

