



“Comparison of SAW and Tandem Electrode Gas Shielded Processes for Productivity, and Distortion in Thin Panel Butt Joints for Thin Panel Structures”

South Padre Island, Texas, April 7, 2010

NSRP Subcontract Agreement No. 2010-305

Prime Contractor: *Todd Pacific Shipyard*

Sub-Contractors: *NASSCO Shipbuilding, CD-adapco , Weaver Engineering, Dwight Laboratories, Machinists Inc.*

Contributing Team Members: *ESAB Welding and Cutting Products, Wolf robotics, Abicor Binzel Corporation, Parametrix, Inc., Northrop Grumman Ship Systems*





Project Status Report

First Quarter Tasks

The tasks for the first quarter of the project are:

- 1.1 Procure, fabricate, and set up weld cell, fixturing, and apparatus. **COMPLETE**
- 1.2 Interface the robot arm with the welding power supplies and controls. Synchronize the LIDAR, thermocouple data acquisition, and robot. **COMPLETE**
- 1.3 Program the robotic automation. **COMPLETE**
- 1.4 Validate the weld cell with test plates. **COMPLETE**
- 1.5 Establish and validate temperature measurement. **COMPLETE**
- 1.6 Set up thermal simulation model. **PARTIALLY COMPLETE**
- 1.7 Identify baseline SAW parameters currently in use at NASSCO and Northrup Grumman. **COMPLETE**





Project Status Report

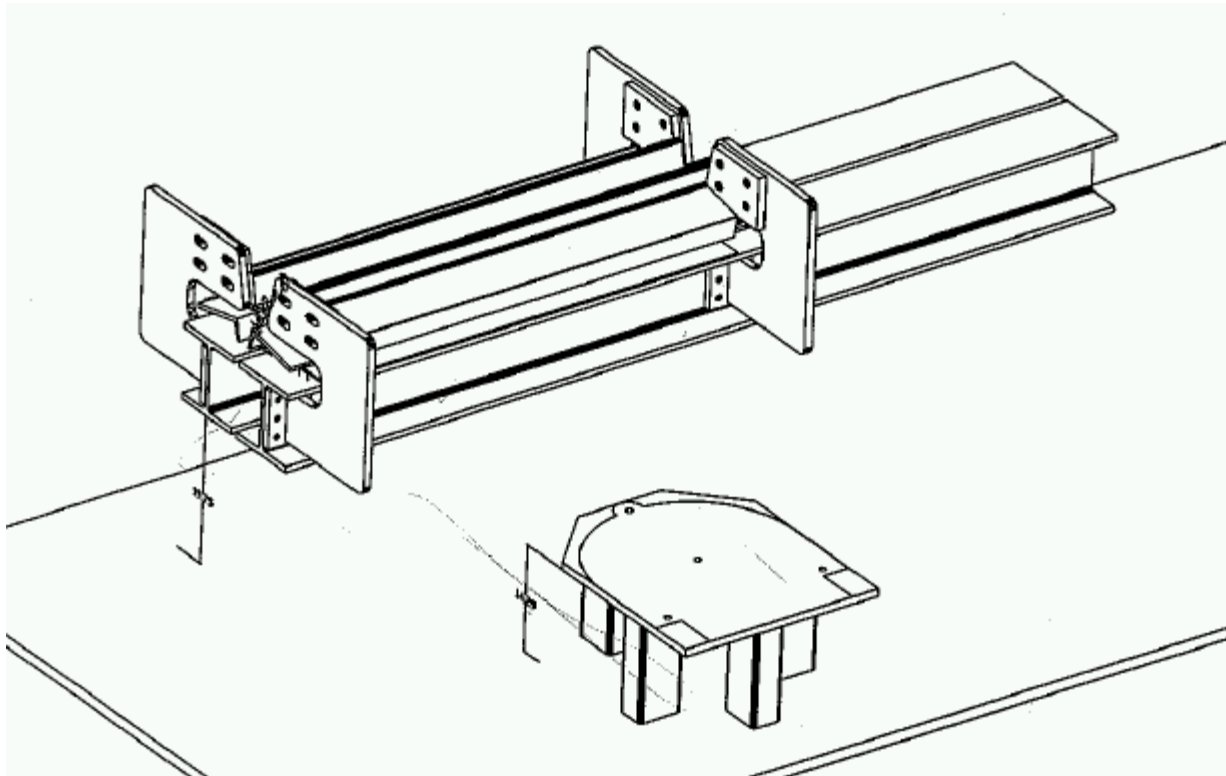
Second Quarter Tasks

The tasks for the first quarter of the project are:

- 2.1 Develop welding procedure with weld joint design for TGS. Essential welding parameters, electrode, shielding gas, joint fit and preparation will be established for the 6mm and 12mm plate thickness'
WORK CURRENTLY UNDERWAY
- 2.2 Measure distortion with the LIDAR system and temperature history.
WORK CURRENTLY UNDERWAY, PENDING ITEM 1
- 2.3 Perform Inspection on selected test plates: NDT per MIL-STD-2035A (SH); Destructive Testing per Technical Manual S9074-AQ-GIB-010/248.
PENDING ITEM 1
- 2.4 Continued development of thermal and distortion simulation.
WORK CURRENTLY UNDERWAY, PENDING ITEM 1

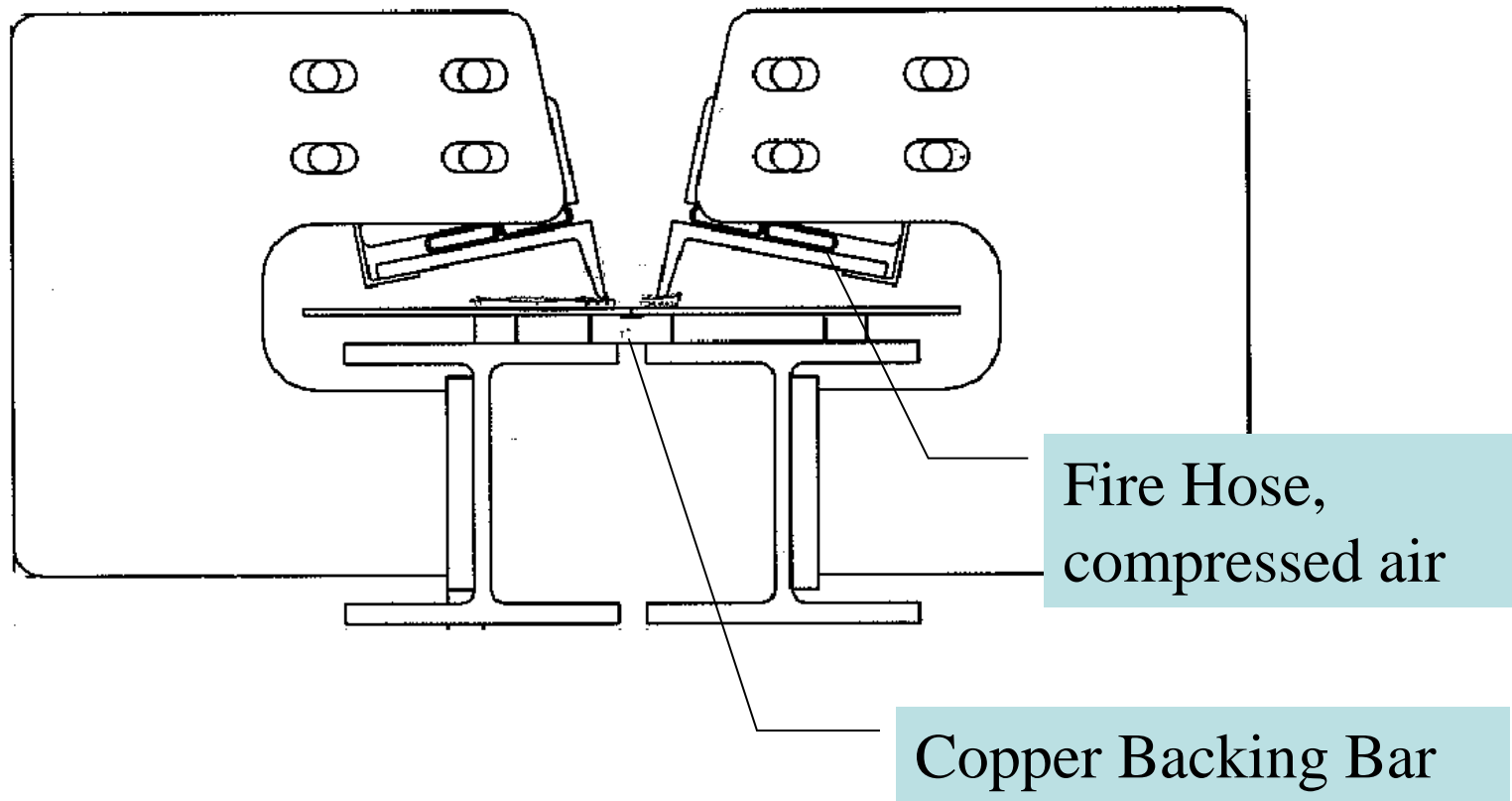


Task 1.1: Procure, fabricate, and set up weld cell, fixturing, and apparatus.



Welding Fixture Layout

Task 1.1: Procure, fabricate, and set up weld cell, fixturing, and apparatus.



Welding Fixture Clamp System, End View

Task 1.1: Procure, fabricate, and set up weld cell, fixturing, and apparatus.



Weld Lab at Todd Pacific Shipyard with Weld Cell and Fixture



Task 1.2: Interface the robot arm with the welding power supplies and controls. Synchronize the LIDAR, thermocouple data acquisition, and robot.

Robot and Power supplies were integrated by Wolf Robotics at Wolf's facility in Colorado.

With weld fixture, LIDAR distortion measurements will be before and after, not during welding.

Thermocouple measurement is triggered at the initiation of the robotic weld by manual intervention.

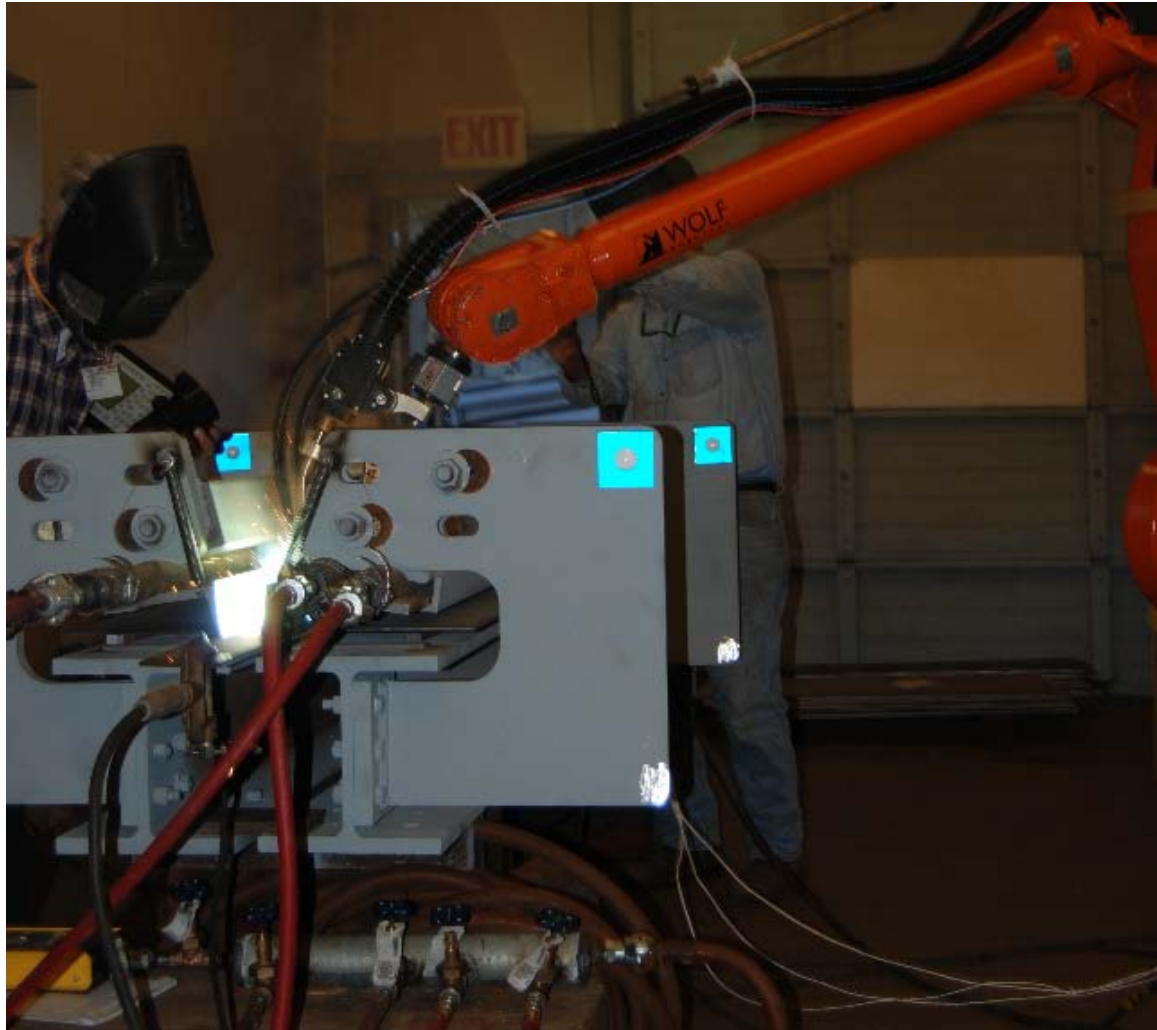


Task 1.3: Program the robotic automation.



Programmer at Work

Task 1.4: Validate the weld cell with test plates.



Fully Configured Weld Cell Welding a Butt Joint

Task 1.4: Validate the weld cell with test plates.

Completed Weld, still sitting in fixture.

Current Working Parameters:

Gas	90/10 Ar/CO2
Joint Prep	Square Groove, Plasma Cut
Material	6 mm, ASTM A36
Root Opening	0 - 1 mm
Electrode Spacing	15 mm
Cup to work distance	15 mm
Travel Speed	60 ipm

	Lead Electrode	Trailing Electrode
Electrode	ER-70S2 Spool Arc 65, .045"	CW-70 E-70C- 6M Core Weld,
Voltage	29.8	33.3
Wire Feed Speed (ipm)	488	602
Transfer Mode	Spray	Spray
Amperage	260	380





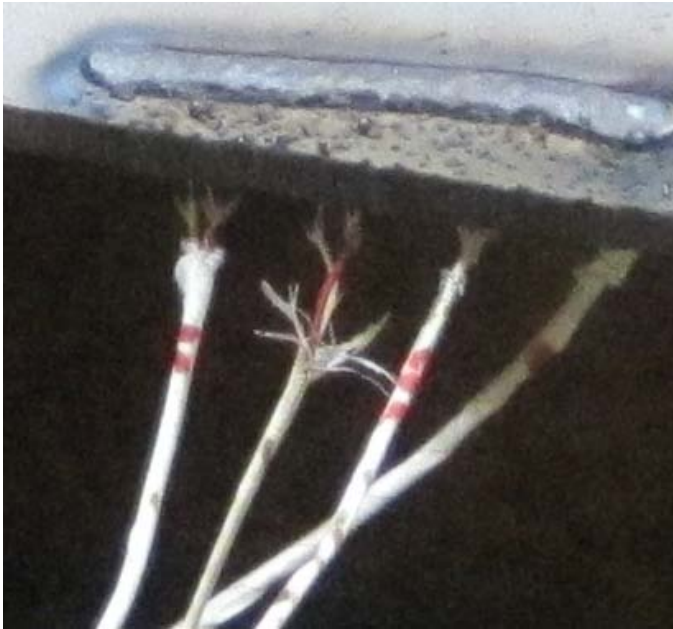
Task 1.5: Establish and Validate Temperature Measurement.

Objectives of Temperature Measurements

- Calibrate and Validate Simulation
- Combined with Simulation, Identify how much heat is delivered into the metal, and how much goes into torch cooling, radiation, convected away in shielding gas, etc.
- Identify how much heat is conducted into fixture: The copper backing bar and aluminum clamp angles - similar to one sides SAW stations in the shipbuilding industry.

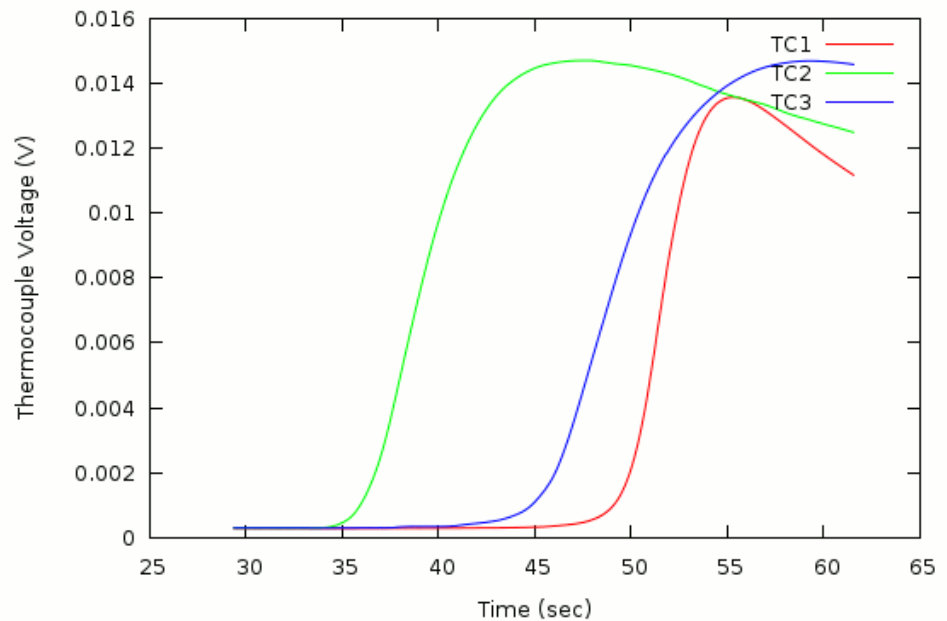


Task 1.5: Establish and Validate Temperature Measurement.



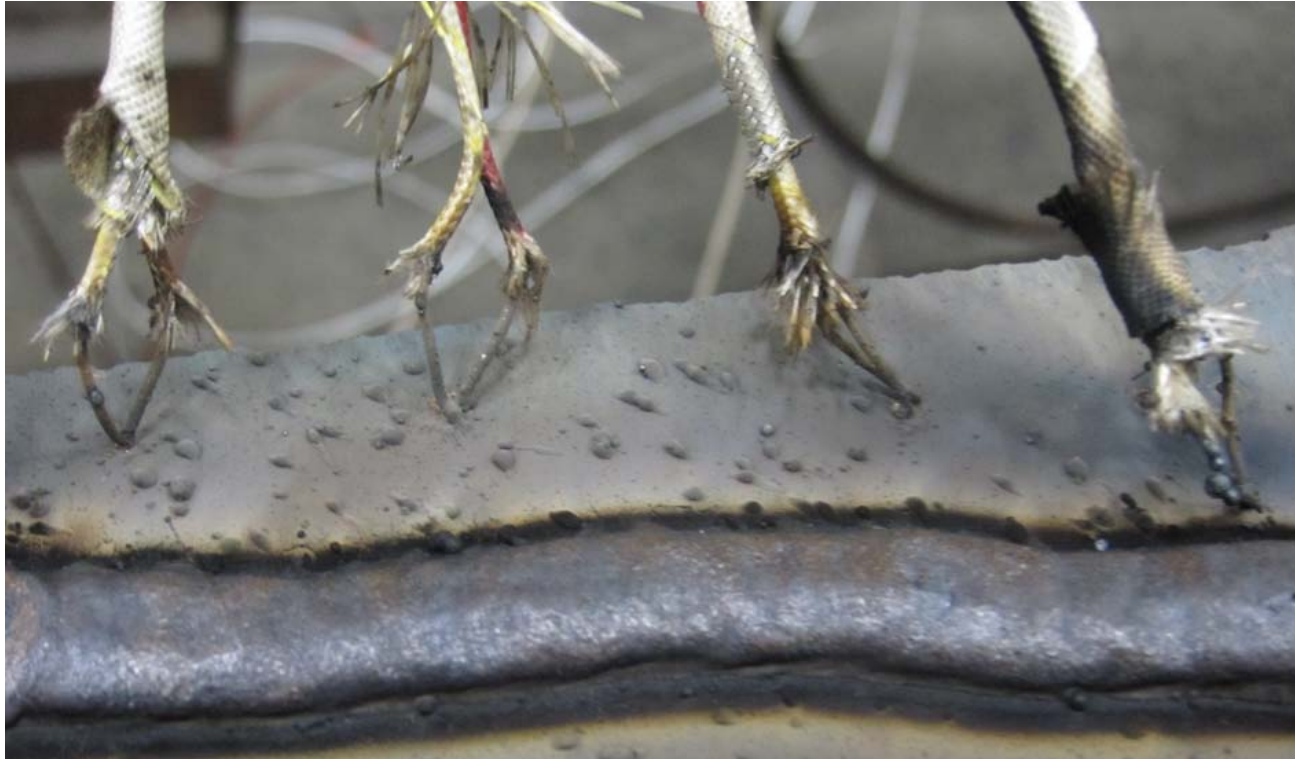
Thermocouple Parameters:	
Style	K, 22 Gauge, Shielded
Recording Rate	20 readings/second, each TC
Averaging	200 Samples per reading

Thermocouple Test, Weaver Engineering at Machinist's Inc, Jan 05, 2010



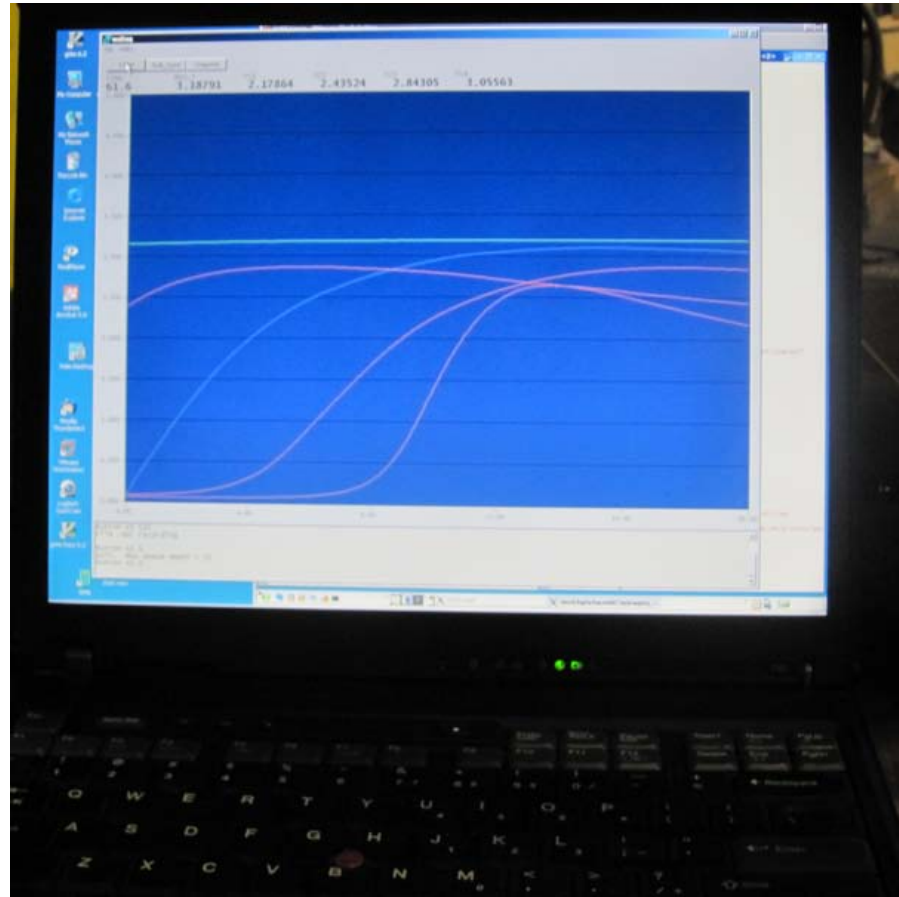
Thermocouples Readings on Bottom (other side) of plate.

Task 1.5: Establish and Validate Temperature Measurement.



Protection is required for Top Side Temperature measurements.

Task 1.5: Establish and Validate Temperature Measurement.

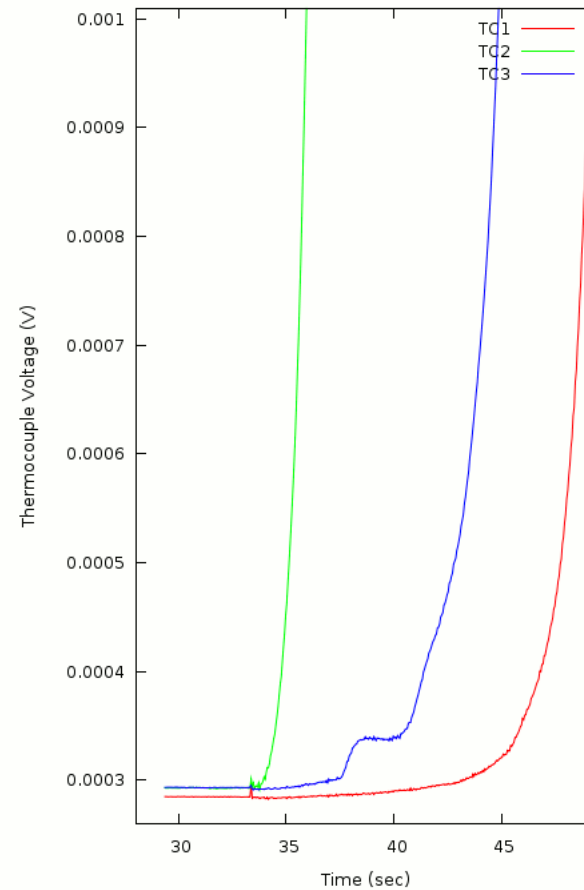


Task 1.5: Establish and Validate Temperature Measurement.



Thermocouple Configuration is important for a clean signal.

Thermocouple Test, Weaver Engineering at Machinist's Inc, Jan 05, 2

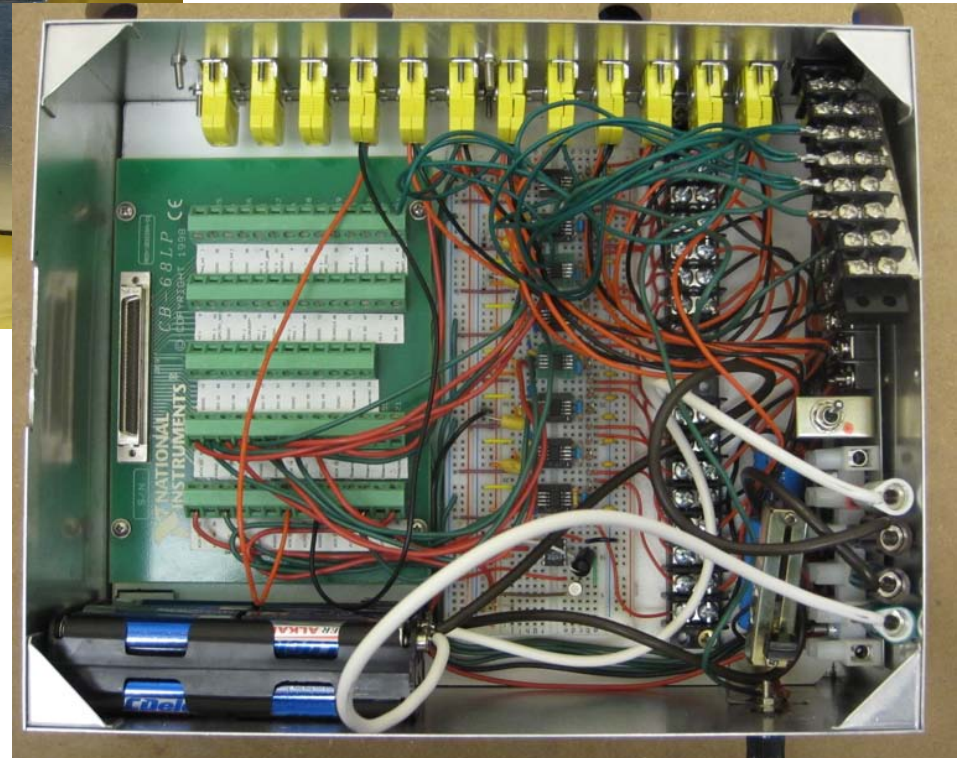


High resolution graph showing the low noise observed at the start of welding (34 sec)

Task 1.5: Establish and Validate Temperature Measurement.



Thermocouple Data Acquisition Box





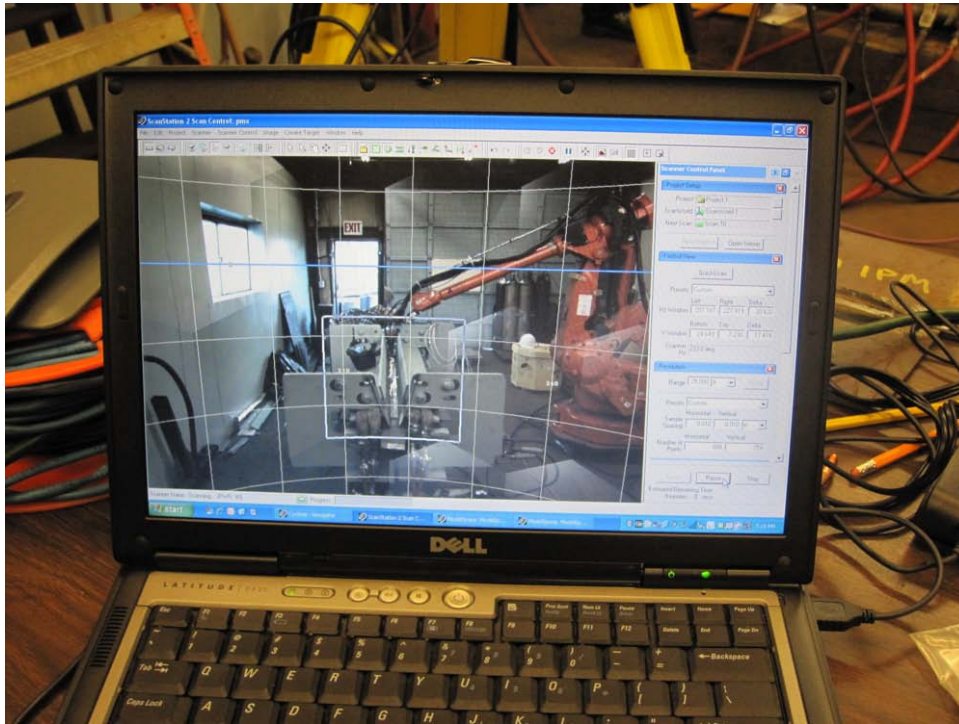
Task 2.1: Procedure Development

- Double sided welding procedure established to get started
- Current work on development of one sided welding procedure.



Task 2: LIDAR Part

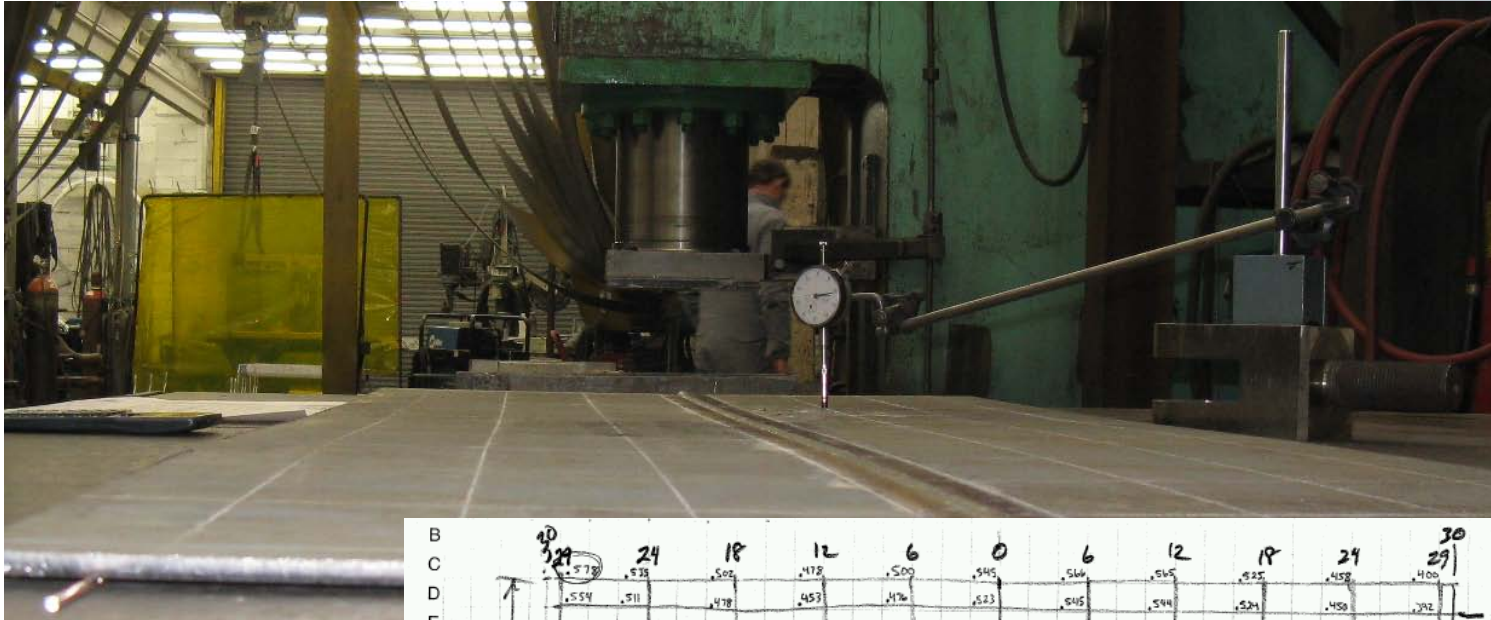
Assessment of in fixture



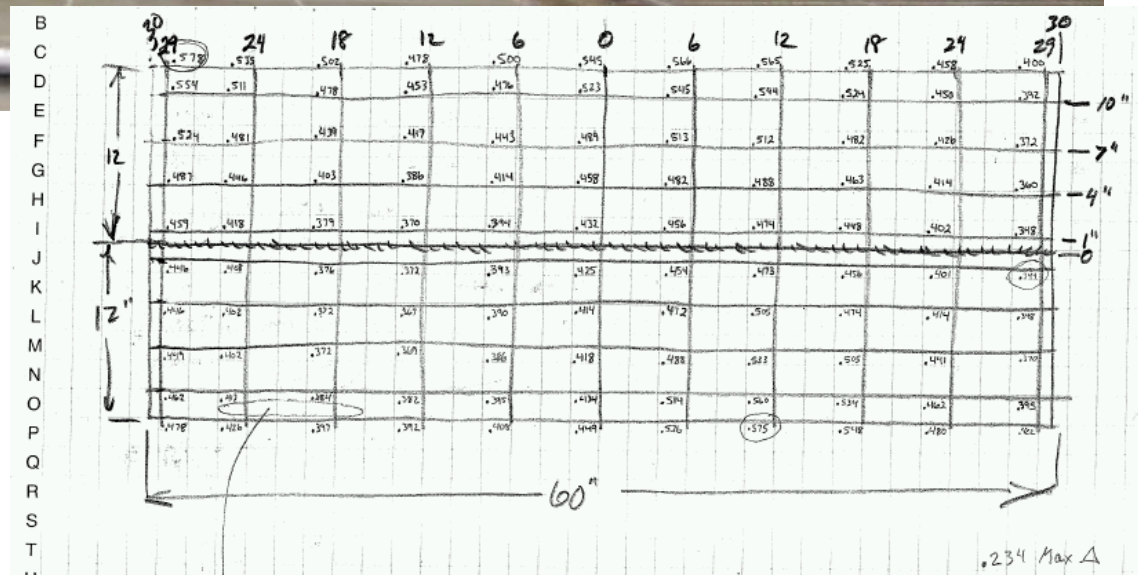
Initial assessment of LIDAR during welding, with plate in fixture. Next step, build a separate fixture for LIDAR scanning.



Task 2: Distortion Measurement - LIDAR Validation



Baseline measurements to validate LIDAR readings.





Conclusion

- Weld Cell in place and working
- Double Sided Weld Procedure Developed, Single Sided Procedure Current effort.
- Thermocouple Apparatus validated and ready for simulation.
- Distortion Measurement System process development and validation well under way.



Conclusion

Path Forward:

- Complete Single Sided Welding Procedure on 6 mm and 12 mm, 36 ksi material.
- Inspect NDT per MIL-STD-2035A, Destructive Testing per Technical Manual S9074-AQ-GIB-101/248.
- Measure and simulate temperature and distortion.
- Assess SAW procedures on like test joints for heat, distortion, and Micro-hardness profiles.





Conclusion

This project at Todd Pacific Shipyard would not be possible without the significant equipment and support of the contributing team members: ESAB, Wolf Robotics, Northrup Grumman Ship Systems, Abicore Binzel, and Parametrix;

Especially -

Wolf Robotics and ESAB Welding and Cutting Equipment.

Also the effort and support of the subcontractors:
NASSCO Shipbuilding, CD-adapco , Weaver Engineering,
Dwight Laboratories, and Machinists Inc.

