REPORT

August 2, 2006
EWI Project No. 46996GTH

Advanced Welding Repair and Remediation Methods for In-Service Pipelines

Other Transaction Agreement No. DTRS56-03-T-0009

Quarterly Status and Progress Report

April 2006 through June 2006

Submitted to:

U.S. Department of Transportation
Research and Special Programs Administration
Washington, DC

EWI

MATERIALS JOINING TECHNOLOGY

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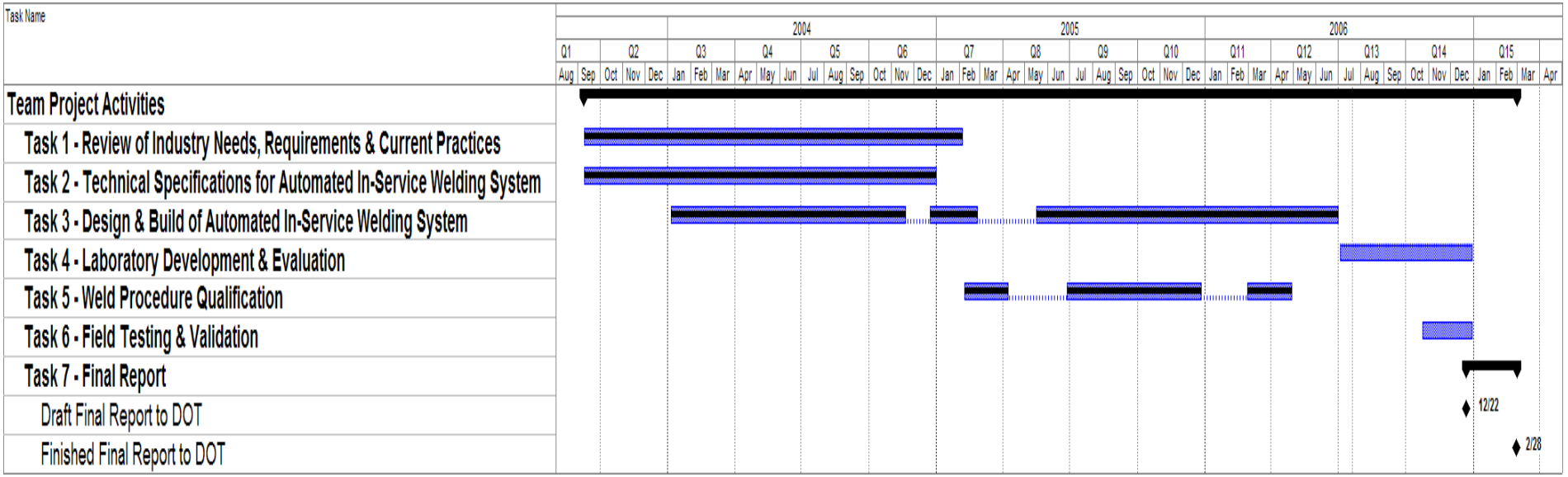

Figure 1 - Project Gantt Chart

1.2 Major Developments

- Equipment design finalized; remaining equipment ordered.

1.3 Technical Issues

- None

1.4 Problem Areas

- None

2.0 Business Status

2.1 Status of Team Participant Contributions

- DOT agreement #DTRS56-03-T-0009 fully executed on September 9, 2003.
- EWI/Cranfield cost-share (tracked via EWI project number 46256CSP) is complete for Task 3. Total cost-share from this project is $191,089.
- Pipeline Research Council International (PRCI) cost-share (tracked via EWI project number 47451CAP) for this quarter is $4,552; PRCI cost-share total to-date is $30,284.
- Cranfield University subcontract for $195K fully executed on July 17, 2004. Cranfield University expenses were $91,127 for July through December 2004 (Tasks 1, 2 & 3) when subcontract was terminated. EWI is completing this work in-house. Per the no-cost extension through December 31, 2006, task budgets in Table 1 (under government funding) were realigned.
- For DOT award DTRS56-05-T-0001, "Innovative Welding Processes for Small to Medium Diameter Gas Transmission Pipelines," EWI developed a graphical user interface (GUI) and a communication protocol to control the motion control software of the Serimer DASA welding system via EWI project no. 47961GTH, Task 4. EWI plans to use this same GUI and communication protocol for the Serimer DASA welding system being developed for DTRS56-03-T-0009 and will count the labor for software development for DTRS56-05-T-0001 as cost-share for DTRS56-03-T-0009 (46996GTH, Task 3). Total cost-share labor for GUI and communication protocol development was $26,599.
- $50K cost-share from TransCanada Pipeline (TCPL) scheduled to support Task 6 activities; not initiated yet.

2.2 Quarterly Accounting

	Government Funding			Contractor Cost-Share		
Task	**Budget**	**Current**	**Cumulative**	**Budget**	**Current**	**Cumulative**
1	$28,008	$0	$28,008	$0	$0	N/A
2	$14,326	$0	$14,326	$0	$0	N/A
3	$85,216	$35,958	$103,253	$400,000	$4,552	$247,972
4	$49,856	$0	$0	$0	$0	N/A
5	$22,666	$3,150	$30,978	$0	$0	N/A
6	$36,140	$0	$0	$50,000	$0	$0
7	$14,440	$0	$0	$0	$0	N/A
Sub-CU	$91,127	$0	$91,127	$0	$0	N/A
PM	$67,894	$2,387	$60,726	N/A	N/A	N/A
Totals	$409,673	$41,495	$328,420	$450,000	$4,552	$247,972

Table 1 - Quarterly Accounting Chart

2.3 Deviations

- None.

2.4 Proposed Adjustment Actions

- None.

3.0 Payable Milestones

3.1 - Payable Milestone Status

Item No.	Task No.	Activity / Deliverable	Qtr No.	Expected Completion Date	Payable Milestone Title	Projected Federal Payment	Project Partner Cost Sharing	Total	Status
1	1	Review of Industry Needs, Requirements, and Current Practices	0	Ongoing	Initial Review of Industry Needs, Requirements, and Current Practices	$909.96	$0	$909.96	Ongoing
2	3	Design and Build of Automated In-Service Welding System	0	Ongoing	Develop Computer Control Algorithms	$0	$178,436.00	$178,436.00	Ongoing
3	PM	Project Management	0	Ongoing	Initiate Federal Project in EWI System	$349.27	$0	$349.27	Complete 09/18/03
					SUBTOTAL	$1,259.23	$178,436.00	$179,695.23	
4	1	Review of Industry Needs, Reqmts, and Current Practices	I	Ongoing	Continue Review of Industry Needs, Requirements, and Current Practices	$6,069.50	$0	$6,069.50	Ongoing
5	2	Technical Specification for Automated In-Service Welding System	I	Ongoing	Initiate Draft of Technical Specification	$10,258.12	$0	$10,258.12	Ongoing
6	3	Design and Build of Automated In-Service Welding System	I	Ongoing	Continue to Develop Computer Control Algorithms	$0-	$1,244.00	$1,244.00	Ongoing
7	PM	Quarterly Status Report	I	12/08/03	Submit Quarterly Report (July 03 - Sept 03: Qtr. No.= 0)	$3,541.00	$0	$3,541.00	Complete 12/8/03
		First Payable Milestone	I		SUBTOTAL	$21,127.85	$179,680.00	$200,807.85	
8	1	Review of Industry Needs, Reqmts, and Current Practices	II	Ongoing	Continue Review of Industry Needs, Requirements, and Current Practices	$3,072.89	$0	$3,072.89	Ongoing
9	2	Technical Specifications for Automated In-Service Welding System	II	Ongoing	Continued Work on Technical Specification	$112.20	$0	$112.20	Ongoing
10	3	Design and Build of Automated In-Service Welding System	II	Ongoing	Continue to Develop Computer Control Algorithms and Complete Initial Design	$2,217.74	$320.00	$2,537.74	Ongoing
11	PM	Quarterly Status Report	II	03/07/04	Submit Quarterly Report (Oct 03 - Dec 03: Qtr. No.= I)	$7,686.72	$0	$7,686.72	Complete 03/7/04
		Second Payable Milestone	II		SUBTOTAL	$13,089.55	$320.00	$13,409.55	

Item No.	Task No.	Activity / Deliverable	Qtr No.	Expected Completion Date	Payable Milestone Title	Projected Federal Payment	Project Partner Cost Sharing	Total	Status
12	1	Review of Industry Needs, Reqmts, and Current Practices	III	Ongoing	Continue Review of Industry Needs, Requirements, and Current Practices	$5,412.14	$0	$5,412.14	Ongoing
13	2	Technical Specifications for Automated In-Service Welding System	III	Ongoing	Continued Work on Technical Specification	$1,132.96	$0	$1,132.96	Ongoing
14	3	Design and Build of Automated In-Service Welding System	III	Ongoing	Continue to Design Old System	$0	$0	$0	Ongoing
15	PM	Quarterly Status Report	III	06/05/04	Submit Quarterly Report (Jan 04 - Mar 04: Qtr.. No = II)	$3,500.00	$0	$3,500.00	Complete 06/5/05
		Third Payable Milestone	III		SUBTOTAL	$10,045.10	$0	$10,045.10	
16	1	Review of Industry Needs, Reqmts, and Current Practices	IV	Ongoing	Continue Review of Industry Needs, Requirements, and Current Practices	$10,183.00	$0	$10,183.00	Ongoing
17	2	Technical Specifications for Automated In-Service Welding System	IV	Ongoing	Continued Work on Technical Specification	$7,347.00	$0	$7,347.00	Ongoing
18	3	Design and Build of Automated In-Service Welding System	IV	Ongoing	Continue to Design Old System	$52,164.50	$4,673.00	$56,837.50	Ongoing
19	PM	Quarterly Status Report	IV	09/03/04	Submit Quarterly Report (Apr 04 - Jun 04: Qtr. No.= III)	$1,817.00	$0	$1,817.00	Complete 09/02/04
		Fourth Payable Milestone	IV		SUBTOTAL	$71,511.50	$4,673.00	$76,184.50	
20	1	Review of Industry Needs, Reqmts, and Current Practices	V	Ongoing	Continue Review of Industry Needs, Requirements, and Current Practices	$3,987.00	$0	$3,987.00	Complete
21	2	Technical Specifications for Automated In-Service Welding System	V	Dec 04	Completed Technical Specification	$4,524.00	$0	$4,524.00	Complete
22	3	Design and Build of Automated In-Service Welding System	V	Ongoing	Continue to Design Old System	$36,669.50	$6,041.00	$42,710.50	Ongoing
23	PM	Quarterly Status Report	V	12/02/04	Submit Quarterly Report (July 04 - Sept 04: Qtr. No.= IV)	$10,475.00	$0	$10,475.00	Complete 12/02/04
		Fifth Payable Milestone	V		SUBTOTAL	$55,655.50	$6,041.00	$61,696.50	

Item No.	Task No.	Activity / Deliverable	Qtr No.	Expected Completion Date	Payable Milestone Title	Projected Federal Payment	Project Partner Cost Sharing	Total	Status
24	1	Review of Industry Needs, Reqmts, and Current Practices	VI	Feb 05	Complete Review of Industry Needs, Requirements, and Current Practices	$5,615.91	$0	$5,615.91	Complete
25	3	Design and Build of Automated In-Service Welding System	VI	Ongoing	Continue to Design Old System	$16,788.61	$119,765.00	$136,553.61	Ongoing
26	5	Weld Procedure Qualification	VI	Initiated	Initiated Weld Procedure Qualification	$2,180.36	$0	$2,180.36	Initiated
27	PM	Quarterly Status Report	VI	03/02/05	Submit Quarterly Report (Oct 04 - Dec 04: Qtr. No.= V)	$14,004.85	$0	$14,004.85	Complete 02/26/05
		Sixth Payable Milestone	VI		SUBTOTAL	$38,589.73	$119,765.00	$158,354.73	
28	3	Design and Build of Automated In-Service Welding System	VII	Ongoing	Continue to Design Old System	$7,764.00	($55,281.00)	($47,517.00)	Ongoing
29	5	Weld Procedure Qualification	VII	Ongoing	Continue Weld Procedure Qualification	$3,178.00	$0	$3,178.00	Ongoing
30	PM	Quarterly Status Report	VII	05/31/05	Submit Quarterly Report (Jan 05 - Mar 05: Qtr. No. = VI)	$2,320.00	$0	$2,320.00	Complete 05/27/05
		Seventh Payable Milestone	VII		SUBTOTAL	$13,262.00	($55,281.00)	($42,019.00)	
31	3	Design and Build of Automated In-Service Welding System	VIII	Ongoing	Complete Preliminary Design of New System	$11,727.15	$5,000.00	$16,727.15	Ongoing
32	5	Weld Procedure Qualification	VIII	Ongoing	Continue Weld Procedure Qualification	$2,023.69	$0	$2,023.69	Ongoing
33	PM	Quarterly Progress Report	VIII	08/29/05	Submit Quarterly Report (Apr 05 - June 05: Qtr. No. = VII)	$6,700.00	$0	$6,700.00	Complete 08/12/05
		Eight Payable Milestone	VIII		SUBTOTAL	$20,450.85	$5,000.00	$25,450.85	
34	3	Design and Build of Automated In-Service Welding System	IX	Ongoing	Order Parts and Start Building New System Design	$8,181.46	$31,508.00	$39,689.46	Ongoing
35	5	Weld Procedure Qualification	IX	Ongoing	Continue Weld Procedure Qualification	$3,821.08	$0	$3,821.08	Ongoing
36	PM	Quarterly Progress Report	IX	11/25/05	Submit Quarterly Report (Jul 05 - Sep 05: Qtr. No. = VIII)	$2,495.00	$0	$2,495.00	Complete 10/12/05
		Ninth Payable Milestone	IX		SUBTOTAL	$14,497.54	$31,508.00	$46,005.54	

Item No.	Task No.	Activity / Deliverable	Qtr No.	Expected Completion Date	Payable Milestone Title	Projected Federal Payment	Project Partner Cost Sharing	Total	Status
37	3	Design and Build of Automated In-Service Welding System	X	Ongoing	Order Parts and Start Building New System Design	$8,181.46	$32,262.00	$40,443.46	Ongoing
38	5	Weld Procedure Qualification	X	Ongoing	Continue Weld Procedure Qualification	$3,821.08	$0	$3,821.08	Ongoing
39	PM	Quarterly Progress Report	X	02/24/06	Submit Quarterly Report (Oct 05 - Dec 05: Qtr. No. = IX)	$2,500.00	$0	$2,500.00	Complete 2/10/06
		Tenth Payable Milestone	X		SUBTOTAL	$14,502.54	$32,262.00	$46,764.54	
40	3	Design and Build of Automated In-Service Welding System	XI	Ongoing	Continue to Build New System Design	$8,181.46	$32,262.00	$40,443.46	Ongoing
41	5	Weld Procedure Qualification	XI	Ongoing	Continue Weld Procedure Qualification	$3,821.08	$0	$3,821.08	Ongoing
42	PM	Quarterly Progress Report	XI	05/26/06	Submit Quarterly Report (Jan 06 - Mar 06: Qtr. No. = X)	$2,500.00	$0	$2,500.00	Complete 05/01/06
		Eleventh Payable Milestone	XI		SUBTOTAL	$14,502.54	$32,262.00	$46,764.54	
43	3	Design and Build of Automated In-Service Welding System	XII	Ongoing	Continue to Build New System Design	$8,181.46	$32,262.00	$40,443.46	Design Complete
44	4	Laboratory Development and Evaluation	XII	Initiate	Initiate Laboratory Development and Evaluation	$24,928.00	$0	$24,928.00	Initiated
45	5	Weld Procedure Qualification	XII	Ongoing	Continue Weld Procedure Qualification	$3,821.08	$0	$3,821.08	Complete 04/27/06
46	PM	Quarterly Progress Report	XII	08/24/06	Submit Quarterly Report (Apr 06 - June 06: Qtr. No. = XI)	$2,500.00	$0	$2,500.00	Complete 08/02/06
		Twelfth Payable Milestone	XII		SUBTOTAL	$39,430.54	$32,262.00	$71,692.54	
47	3	Design and Build of Automated In-Service Welding System	XIII	10/01/06	Complete System Build	$0	$11,508.00	$11,508.00	
48	4	Laboratory Development and Evaluation	XIII	12/31/06	Complete Laboratory Development and Evaluation	$24,928.00	$0	$24,928.00	
49	5	Weld Procedure Qualification	XIII	10/01/06	Complete Weld Procedure Qualification	$0	$0	$0	Complete 04/27/06
50	6	Field Testing and Validation	XIII	12/31/06	Complete Field Testing and Analysis	$36,140.00	$50,000.00	$86,140.00	
51	7	Final Project Report	XIII	12/31/06	Complete Draft of Final Project Report	$14,440.00	$0	$14,440.00	
52	PM	Quarterly Progress Report	XIII	11/22/06	Submit Quarterly Report (July 06 - Sep 06: Qtr. No. = XII)	$7,500.00	$	$7,500.00	

Item No.	Task No.	Activity / Deliverable	Qtr No.	Expected Completion Date	Payable Milestone Title	Projected Federal Payment	Project Partner Cost Sharing	Total	Status
		Thirteenth Payable Milestone	XIII		SUBTOTAL	$83,008.00	$61,508.00	$144,516.00	
53	7	Final Project Report	XIV	02/28/07	Submit Final Project Report	$0	$0	$0	
54	PM	Final Quarterly Progress Report	XIV	02/28/07	Submit Final Quarterly Report (Oct 06 - Dec 06: Qtr. No.= XIII)	$0	$0	$0	
					GRAND TOTALS	$409,673.23	$450,000.00	$859,673.23	

Table 2 - Payable Milestone Status Chart

3.2 - Payable Milestone Activity

Table 3 - Task Status Chart

Milestone	Description	Status
Task 1	Review of Industry Needs, Requirements, and Current Practices	Complete
Task 2	Technical Specifications for Automated In-Service Welding System	Complete
Task 3	Design and Build of Automated In-Service Welding System	Design Complete
Task 4	Laboratory Development and Evaluation	Initiated
Task 5	Weld Procedure Qualification	Complete
Task 6	Field Testing and Validation	Not Started
Task 7	Final Report	Not Started

Task 1 - Review of Industry Needs, Requirements, and Current Practices

- No activity this quarter as Task 1 is complete.

Task 2 - Technical Specifications for Automated In-Service Welding System

- No activity this quarter as Task 2 is complete.
- As part of the final report, the project team will revisit the technical specifications to ensure that they fully capture the final system configuration.

Task 3 - Design and Build of Automated In-Service Welding System

- Received all outstanding equipment from Serimer DASA. We now have the two welding bugs, controllers and tracks as shown in Figure 2.
- The second set of Serimer DASA equipment (bug, controller and track) was wired up and connected to the first set of Serimer equipment. Continued work on motion control; added second bug to software. Figure 3 shows the interface for both bugs. In this particular mode, both bugs can be controlled independently (*i.e.*, both interfaces are live).
- In Figure 4, the motion of both bugs are synched and are controlled by the BUG 1 interface (on the left).

Figure 2. Serimer DASA Equipment

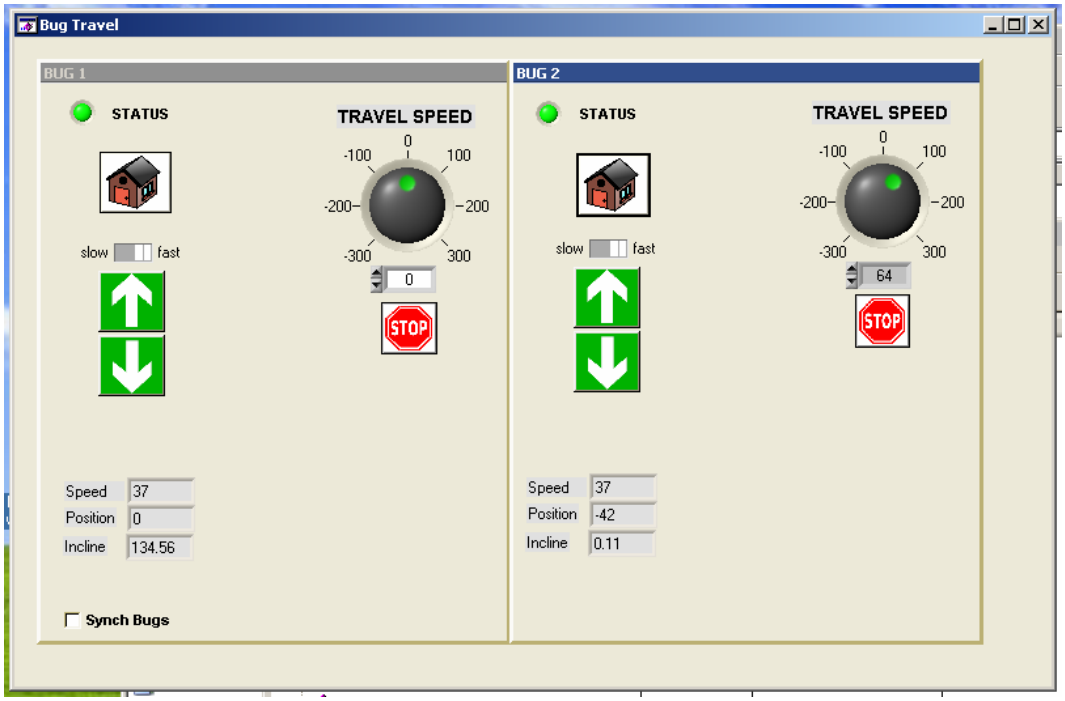

Figure 3. Motion Control Interface for Both Bugs - Controlled Independently

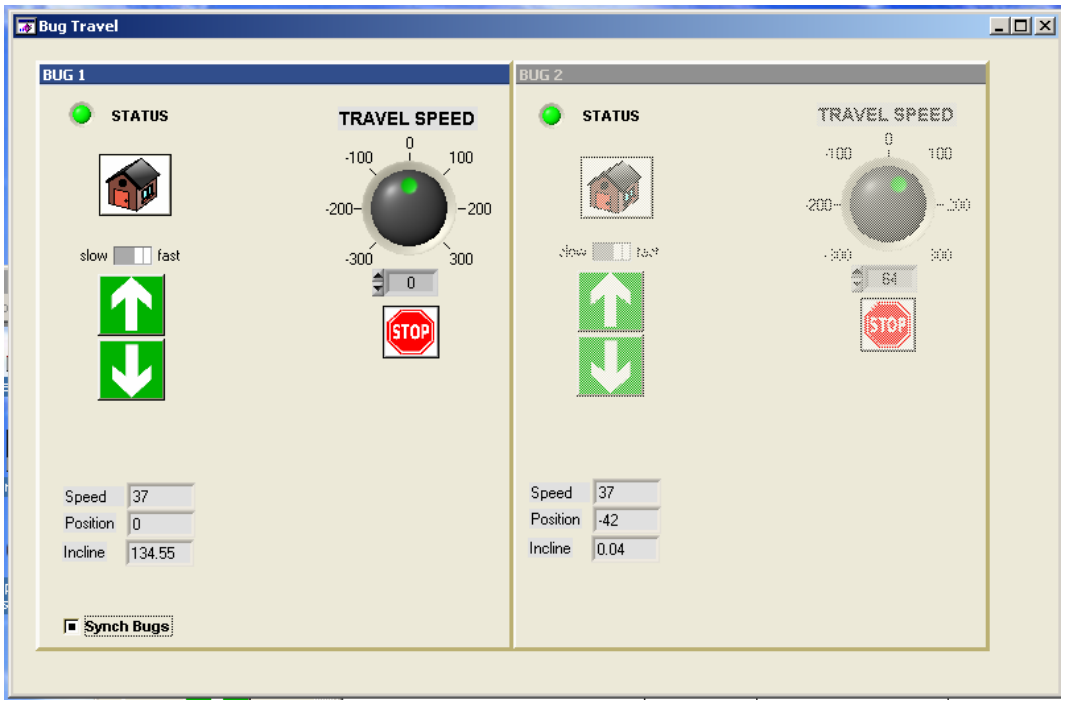

Figure 4. Motion Control Interface for Both Bugs - Synched

- Tests were conducted on the Serimer bugs to characterize their individual performance at a travel speed of 100 cm/min, which is the travel speed the bugs are programmed to return to the home position. This is the maximum travel speed that will be experienced in service. These tests were conducted without any additional weight. There was a slight variation in bug speed as shown in Table 4.

Table 4. Independent Bug Travel Performance Without Added Weight

	Travel Speed	Forward 360° (sec)	Backward 360° (sec)
Bug #1	100 cm/min	175.67	175.41
Bug #2	100 cm/min	176.32	175.89
Variation (sec)		0.65	0.48
Variation (%)		0.246370769	0.001822635

- Tests were then conducted to characterize the performance of each bug with varying amounts of added weight at a travel speed of 300 cm/min., which is the maximum travel speed that the individual bugs are capable of. The added weight was applied to a mounting point at the center of the bug. Results are captured in Table 5.
- Tests were then conducted on bug #2 to characterize its travel performance at 300 cm/min with weight added to a mounting point on the side of the bug. Results are captured in Table 6.
- Tests were then conducted with bug #1 and bug #2 joined together with a 1.5 meter plate (to simulate in service condition) at 100 cm/min. travel speed with various amounts of weight added to the plate at the center point between the two bugs. Results are captured in Table 7. During this test, the bug #1 track latching mechanism hit the axle of the bug as it passed over it. This was a consistent problem regardless of the amount of weight tested. Since this particular track will not be used in the final configuration (thus eliminating the problem), it was not noted in the "observations" column in Table 7.

Table 5. Independent Bug Travel Performance with Added Weight on Top

Bug #1			Bug #2		
Weight Added (lbs)	**Forward 360° (sec)**	**Comments**	**Weight Added (lbs)**	**Forward 360° (sec)**	**Comments**
5	59.66	No problems observed	5	60.01	No problems observed
10	N/A (accelerated test)	N/A	10	59.96	No problems observed
15	59.53	No problems observed	15	59.63	No problems observed
20	59.59	No problems observed	20	59.99	No problems observed
25	60.09	No problems observed	25	60.19	No problems observed
30	N/A	• Difficulty traveling uphill. • Lost motor resistance downhill • Bug completely stopped working • Had to reset program.	30	61.2	Gear skipped once at 270°
N/A	N/A	N/A	36	62.12	• Started to Fall off @ 270° • Stopped adding weight at this point because of decreasing travel speed

Table 6. Bug #2 Travel Performance with Added Weight on Side

Weight Added (lbs)	Forward 360° (sec)	Comparison with Center Mounted Weight (sec)	Variation (sec)	Variation (%)
15	62.75	59.63	3.12	3.37060444
30	65.73	61.2	4.53	4.702584865

Table 7. Joint Bug Travel Performance with Added Weight

Weight Added (lbs)	Observations	Modifications Made	Final Result
0	Initially, the two bugs were running at different speeds, with bug #1 traveling at a higher speed in the downhill direction, and bug #2 "catching up" to it in the uphill sections of the pipe.	Made adjustments to the spacing in the roller mechanism of both bugs, to make sure that the gears were meeting up with the track consistently, regardless of position.	While this fixed the initial problem, it was observed that when hitting the emergency stop button, bug #2 stops after bug #1. This delay throws off the alignment of the two bugs in relation to each other.
16	No problems observed	none	Weight acceptable
26	No problems observed	none	Weight acceptable
33.5	No problems observed	none	Weight acceptable
40	In the uphill direction, bug #1 began to skip gears and travel slower than bug #2.	The spacing of the roller mechanism was further adjusted (tightened) in order to ensure consistent contact between the gear and the track.	The problem was fixed, and the weight determined to be acceptable. However, it was observed that tightening the spacing to this degree was causing wear on the gears so a lubricant was applied to minimize wear.
44.5	At the 6 o'clock position on the pipe, bug #2 began to pull off of the track to the point where the gears were no longer contacting the track, and the bug stopped completely. In the uphill direction, bug #1 began to skip gears.	In order to avoid additional wear on the gears, it was determined that further adjustments of the spacing should not be made	Weight unacceptable

- Given the results of the travel and weight tests, the existing system design had to be modified to decrease the weight of the equipment that will traverse between the two bugs (parallel to the centerline of the pipe). The resulting design is extremely low profile and quite innovative. A dome of protective plastic lens could be placed over the torch control ring to provide ultraviolet protection from the welding arc. The modified system design allows for the removal of the x and z axes (*i.e.*, oscillation and torch height controls) from both bugs. This will further decrease the weight of the system thus increasing payload capability.
- The original design had been finalized until we performed the weight tests on the Serimer-DASA bugs as reported in Table 5 through Table 7. Essentially the amount of weight was increased until the bug (or linked bugs) failed to move or released from the track. This was done to ensure that the bug could manipulate the weight of the additional components without any problems. It was determined that the bug could not hold the amount of weight required by the original design. This was due to the both the mechanics of the bugs and to the changing center of gravity expected with the bug design. A second set of tests were completed on each bug individually with the same results. A modification to the bug design

both lowered the center of gravity and redistributed the expected weight of the components. The modification also decreased the number of and expected total weight of the addition components down to a level the bugs could easily manipulate.

- The final system design is shown in Figure 5 and Figure 6. It features an innovative ring torch positioner that allows the torch to be oriented in an infinite number of compound angles to weld in any conceivable position.
- Close-ups of the "ring" positioner are shown in Figure 7 through Figure 9 at various angles.

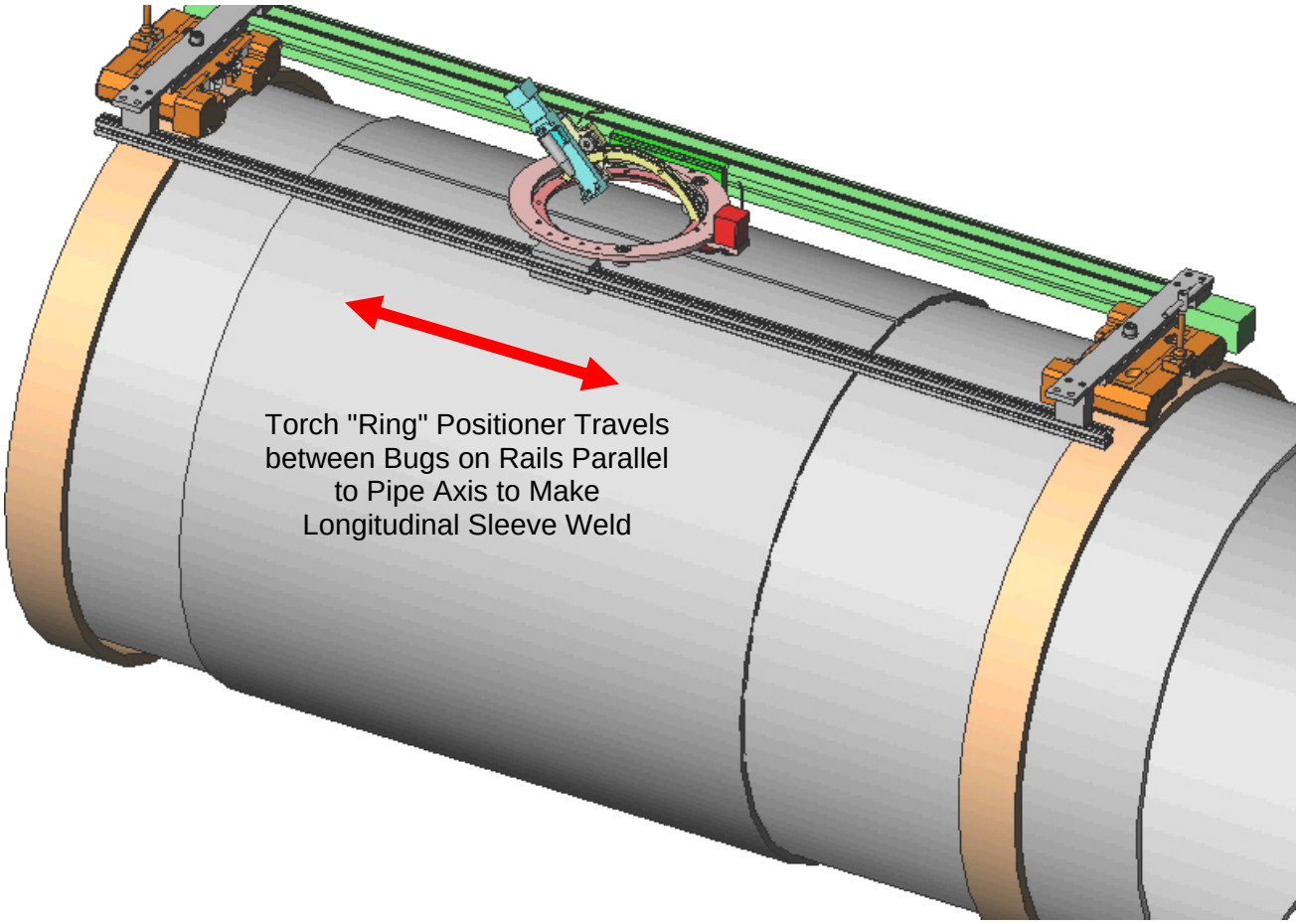

Figure 5. Side View of Modified Design with Lower Profile

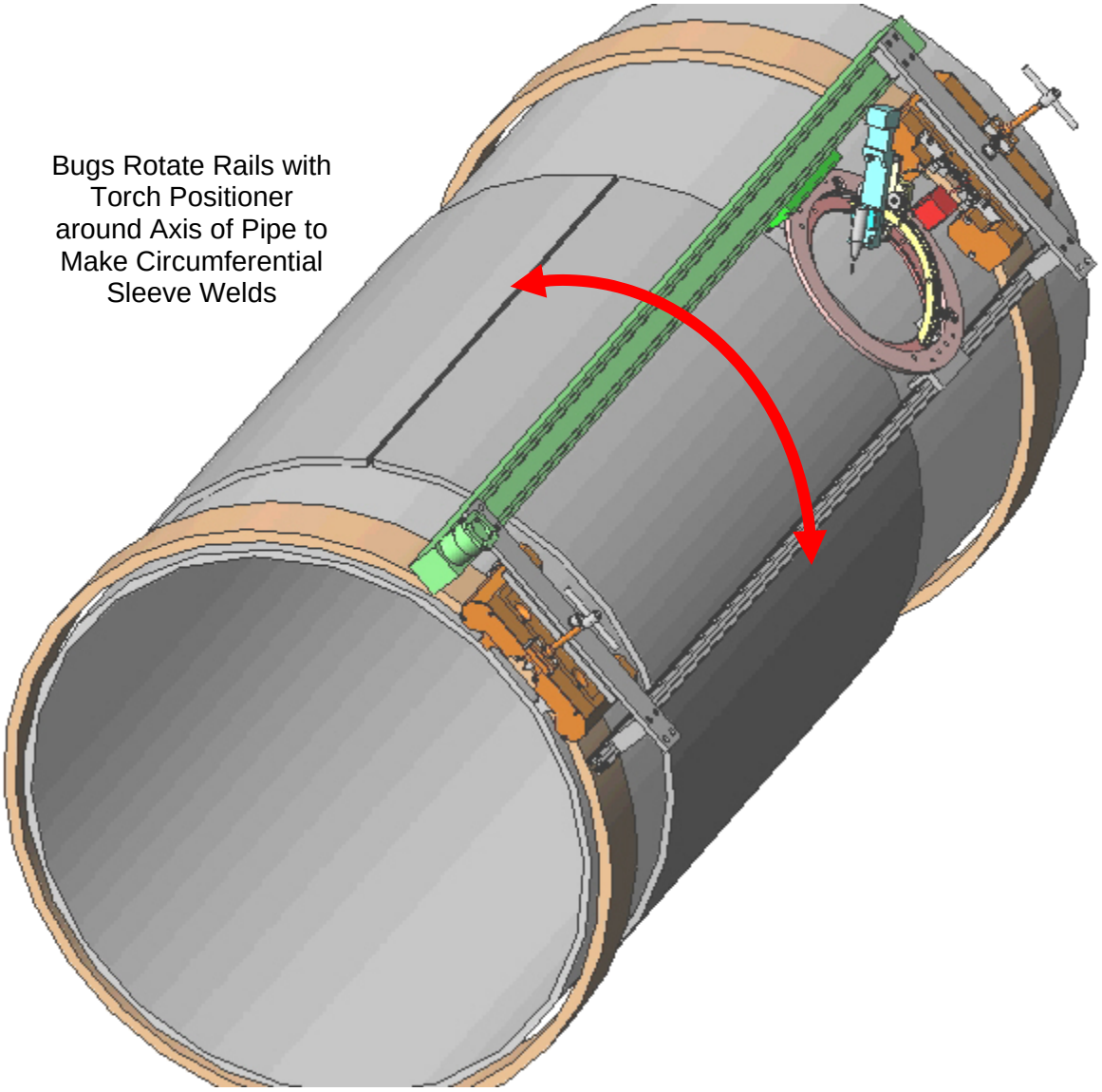

Figure 6. End View of Modified Design with Lower Profile

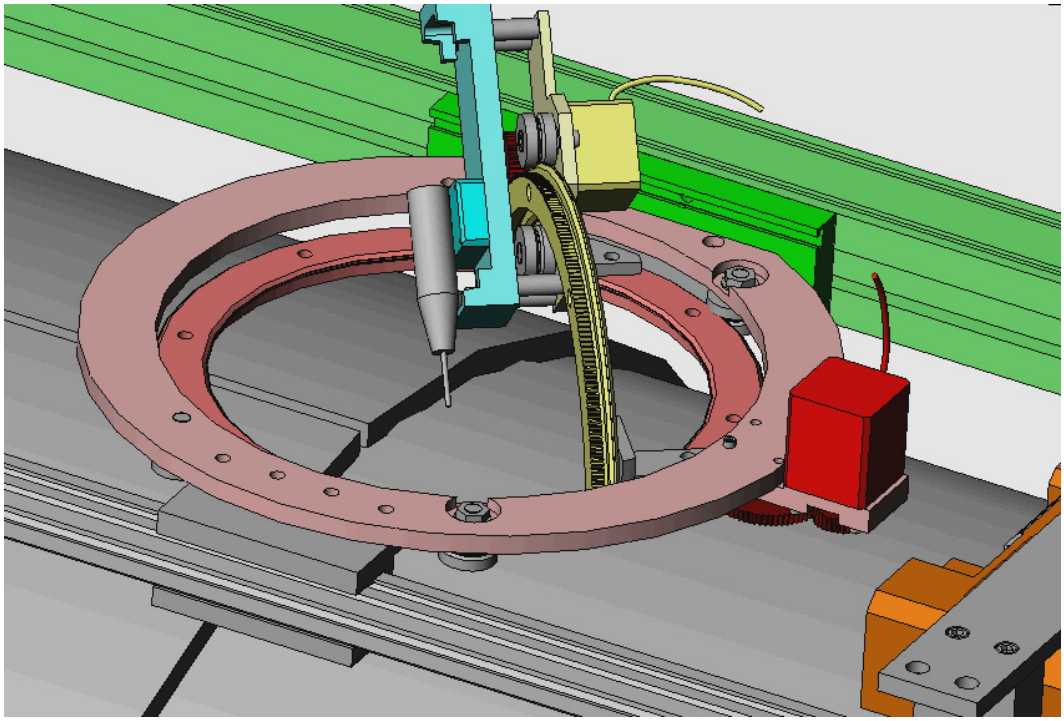

Figure 7. Close-Up of Torch Control (View 1)

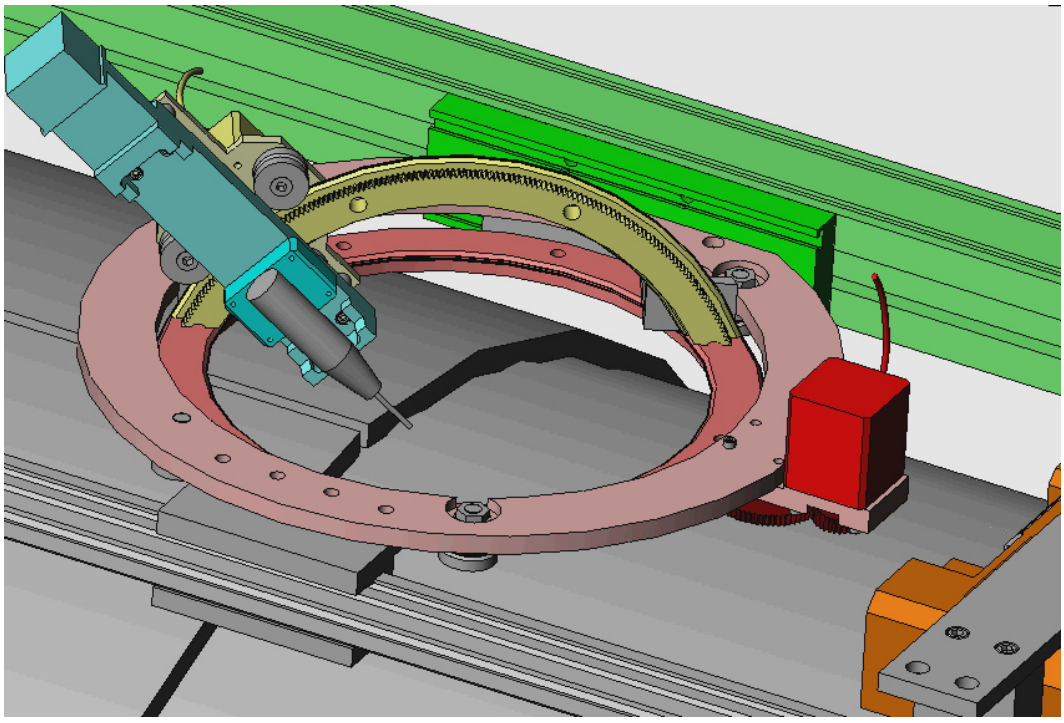

Figure 8. Close-Up of Torch Control (View 2)

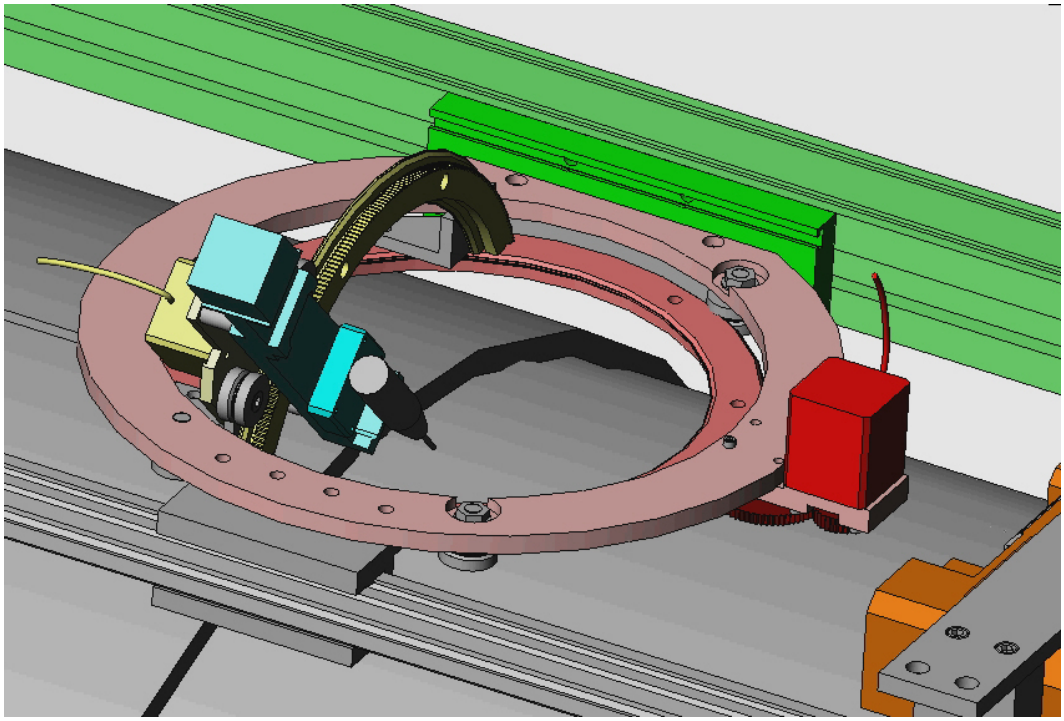

Figure 9. Close-Up of Torch Control (View 3)

- Table 8 contains a bill of materials for the "ring" positioner system and individual component weights. Total estimated weight is 34 lbs. The removal of the x and z axes from each bug decreases total system weight from 56 to 30 lbs. Each bug now weighs 15 lbs instead of 27 lbs. As seen in Table 7, two bugs working together can easily handle up to 40 lbs of payload without difficulty. These components were ordered and are expected within the next 6 weeks.

Table 8. Torch "Ring" Positioner System Components

Component	Weight (lbs)
HLE-60 LINEAR UNIT	
BASE UNIT	5.03
CARRIAGE	1.76
3.62KG/M TRAVEL (1.2)	9.58
IDLER SYSTEM	
IDLER RAIL	3.27
IDLER SLIDER	0.71
BUG MOUNTING PLATES	
46996-3-2013	0.95
46996-3-2014	1.31
46996-3-2015	0.27
46996-3-2016	0.216
TILT AXES	
46996-3-2004	0.25
46996-3-2101	1.80
46996-3-2401	0.19
FULL RING	2.86
1/2 RING	1.06
RSJ-E BEARINGS (3)	0.32
BHJ-C BEARINGS (4)	0.38
MOTORS (2)	0.72
GEARS	0.32
MP5-3 LINEAR UNIT	
Unit	3.00
Total	***34.00***

- In order to complete system schematics, EWI obtained CAD and solid model files from Serimer DASA. Serimer has requested a Non Disclosure Agreement (NDA) for the drawings. EWI submitted our standard NDA agreement to Serimer for review. Waiting to get signed document or proposed changes back from Serimer.

- Table 9 contains the complete list of all equipment that has been ordered and if it has been received at the time this report was written.

Table 9. List of Ordered System Components and Receipt Status

Description	Part Number	Quantity	Unit Price	Total Price	Order Date	Vendor	Rec'd
Magnets for track		2	176.80	353.60	1/5/2006	Bug-O	Yes
Software - PID Toolkit	779509-03	1	1,145.00	1,145.00	3/30/2006	National Instruments	Yes
Pipe Stand:: rated @ 2500 lb	2683T26	2	190.50	381.00	4/25/2006	Mcmaster	Yes
Pipe Stand V Wheels	2683T23	2	78.53	157.06	4/25/2006	Mcmaster	Yes
Thrust bearing cage assembly	5909K31	5	2.28	11.40	5/30/2006	Mcmaster	Yes
.032" thick for 1/2" shaft diameter thrust bearing	5909K44	10	0.75	7.50	5/30/2006	Mcmaster	Yes
Software - Motion Toolkit	778804-03	1	1,010.00	1,010.00	6/26/2006	National Instruments	Yes
Gear - 30 TEETH 0.8 MOD BRASS SPUR GEAR	A 1B 2MYK08030	2	13.22	26.44	7/25/2006	ROCKFORD CONTROLS OHIO	Yes
Gear - 64 TEETH 0.8 MOD STAINLESS SPUR GEAR	S10T08M064S050	1	18.26	18.26	7/25/2006	ROCKFORD CONTROLS OHIO	Yes
Linear Unit Belt-driven Actuator	HLE060-RB-NL-E-1200	1	3,346.00	3,346.00	7/31/2006	MotionTech	
AVC SLIDE - MP5-3 with 4 carriages under the load plate	MP5-3	1	1,254.25	1,254.25	7/25/2006	SMi4motion.com	
6K 8 axis motion controller from Parker	6K8	1	4,042.00	4,042.00	7/31/2006	Motion USA	
25 pin connector	vm25	4	89.00	356.00	7/31/2006	Motion USA	
60 watt power supply for 6K	PS-60W	1	246.00	246.00	7/31/2006	Motion USA	
base module for 6k	eym32-ii	1	281.00	281.00	7/31/2006	Motion USA	
Analog input module	sim8-an-in	1	82.00	82.00	7/31/2006	Motion USA	
Analog output module	SIM8-an-out	1	123.00	123.00	7/31/2006	Motion USA	
EAC series stepper motor drive		2	407.00	814.00	7/31/2006	Motion USA	
10 ft command cable	71-0160137-10	2	58.00	116.00	7/31/2006	Motion USA	
gear reducer	pv17fe-010-parkert-hv17	2	322.00	644.00	7/31/2006	Motion USA	
MS T-NUT	100-2353-01	10	6.00	60.00	7/31/2006	Motion USA	
LINEAR SLIDE	30-1818	1	48.00	48.00	7/31/2006	Motion USA	
ALUMINUM EXTRUSION 1800 MM LENGTH	12-028x 1800 MM	1	22.00	22.00	7/31/2006	Motion USA	
T-NUT	20-055	10	2.00	20.00	7/31/2006	Motion USA	
NEMA 17 Stepper motor	LV173-01-FL	2	222.00	444.00	7/31/2006	Motion USA	
360 degree ring slide	R25-255 R360P	1	1,102.37	1,102.37	7/27/2006	BishopWisecarver	
180 degree ring slide	R25-255R180P	1	689.54	689.54	7/27/2006	BishopWisecarver	
gear/bearing	RSJ25E	4	49.04	196.16	7/27/2006	BishopWisecarver	
gear/bearing	BHJ25C	3	43.43	130.29	7/27/2006	BishopWisecarver	

- EWI is contemplating using only one motion controller (the NI controller) and adding Serimer hardware to be controlled by the NI motion controller. EWI needs to meet with Serimer to discuss the possibility.

- The Software Functionality task list was finalized as follows:

  Laser Surface Scanning
  - Gather raw data from SRI sensor
  - Piece together laser scans to create displacement map
  - Determine layers of buildup required
  - Review previous weld bead for possible readjustment of layers

  Laser Seam Tracking
  - Seam track during welding linear sleeve beads
  - Seam track during welding girth weld beads

  Operator Interface
  - Operator power-on system
  - Operator choose sleeve weld
  - Operator choose corrosion fill
    - operator choose 4 (or more) points to identify perimeter of area
    - operator start laser scanning process
    - operator verify pattern for fill
    - operator begin fill pattern
  - Operator "free weld" with bug

  Motion Pattern
  - Home to 0,0,0 position upon startup
  - Linear lines for sleeve
  - Oscillation at 45 degree angle
  - Oval/circular patterns for tempering

- The Motion Pattern task list was finalized as follows:

  Corrosion Patch Fill
  - Longitudinal travel
  - Oscillation circumferentially
  - Torch tilt angle to counteract gravity
  - Work push/drag angle
  - Tempering beads to encircle patch

  Sleeve Weld Longitudinal
  - Longitudinal travel
  - Oscillation circumferentially
  - Torch tilt angle to counteract gravity/ bead placement
  - Work push/drag angle

Sleeve Weld Circumferential

- Circumferential travel
- Oscillation at 45º and longitudinally
- Torch tilt angle to counteract gravity
- Work push/drag angle for bead placement

Position A Capabilities

- Longitudinal travel
- Oscillation circumferentially
- Torch tilt angle to counteract gravity
- Work push/drag angle
- Tempering beads to encircle patch

Position B Capabilities

- Circumferential travel
- Torch tilt angle to counteract gravity
- Work push/drag angle for bead placement
- Oscillation at 45º and longitudinally

Required Additional Motion Capabilities

- Torch tilt angle to counteract gravity
- Work push/drag angle
- Tempering beads to encircle patch
- Oscillation at 45º and longitudinally

- Motion control software was purchased (National Instruments Part No. 778804-03).
- PID control software was purchased (National Instruments Part No. 779509-03).
- Continued developing laser-inspection of corroded areas. Have switched from using simulated corrosion to using actual pipe corrosion. Figure 10 shows the laser scanner attached to a Serimer bug, sitting on a pipe with actual corrosion.

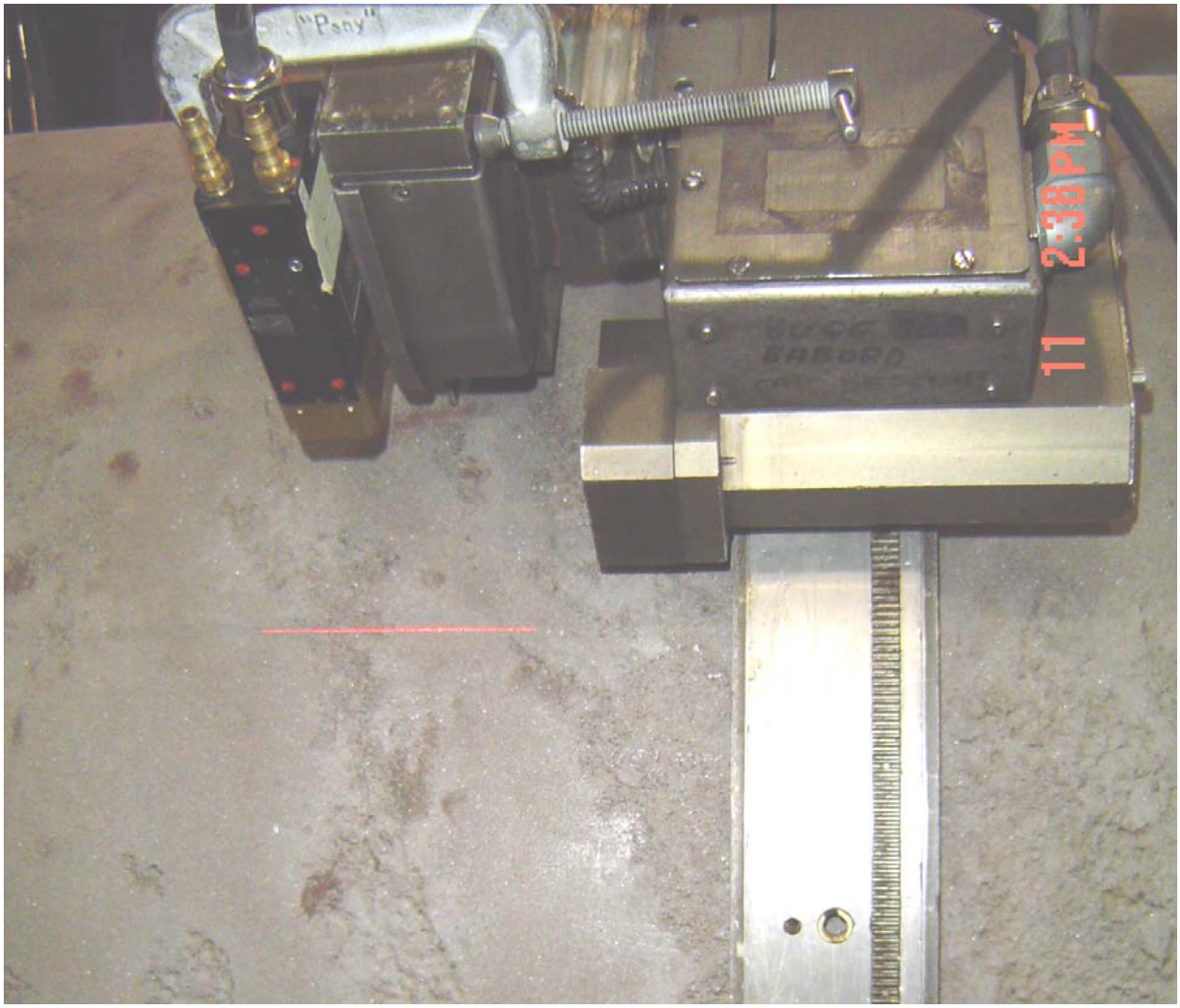

Figure 10. Laser Scanner on Pipe with Actual Corrosion

- Figure 11 is a laser scan of a patch of corrosion from the pipe pictured in Figure 10.

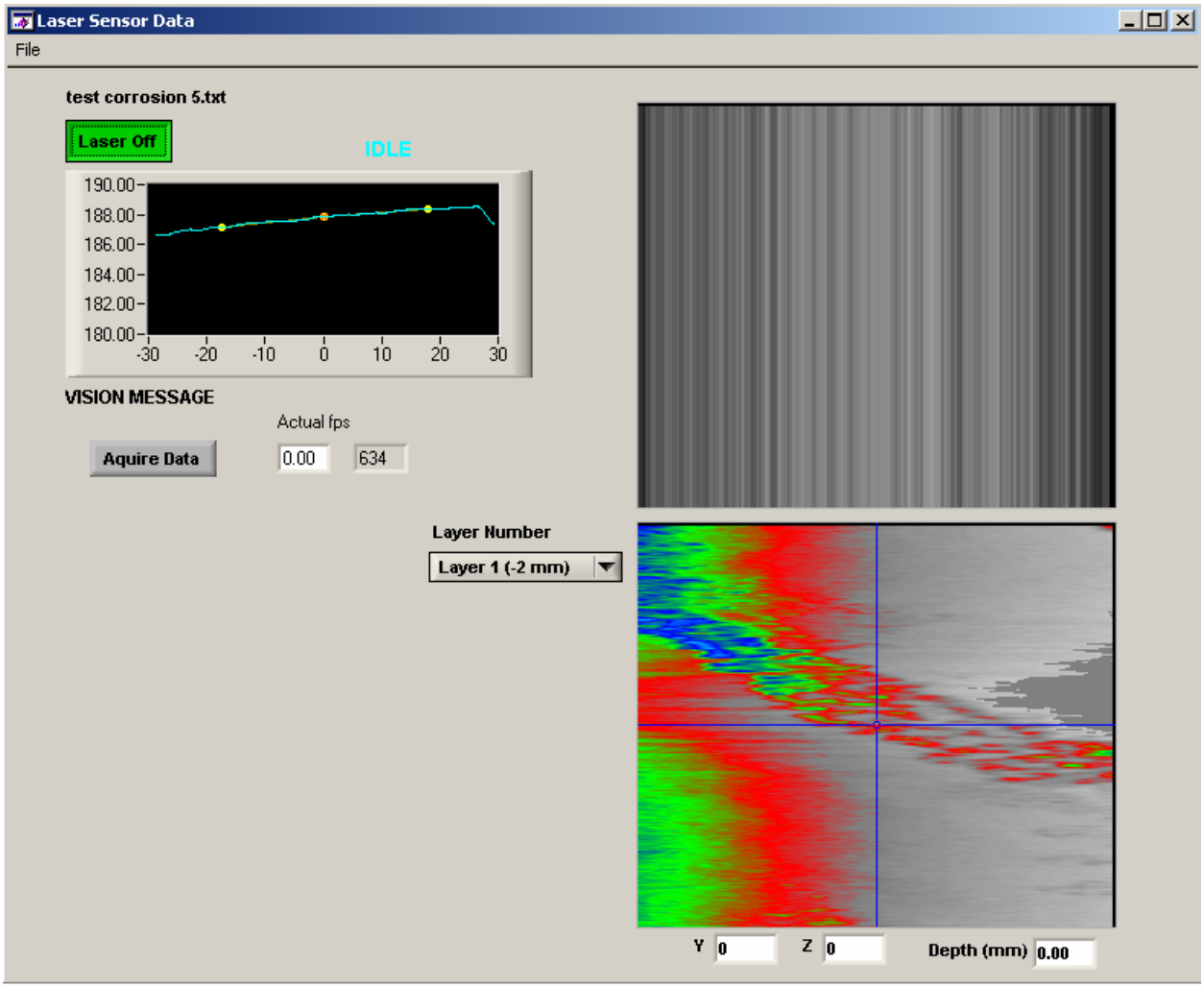

Figure 11. Raw or Unprocessed Scan of Actual Corrosion Patch of 6 cm x 40 cm area

- Added to laser software the ability to "patch together" several swathes of laser scans to assemble a topographical map. Figure 12 is a "patched together" (*i.e.*, processed) topographical corrosion map over an 18 cm x 50 cm area.

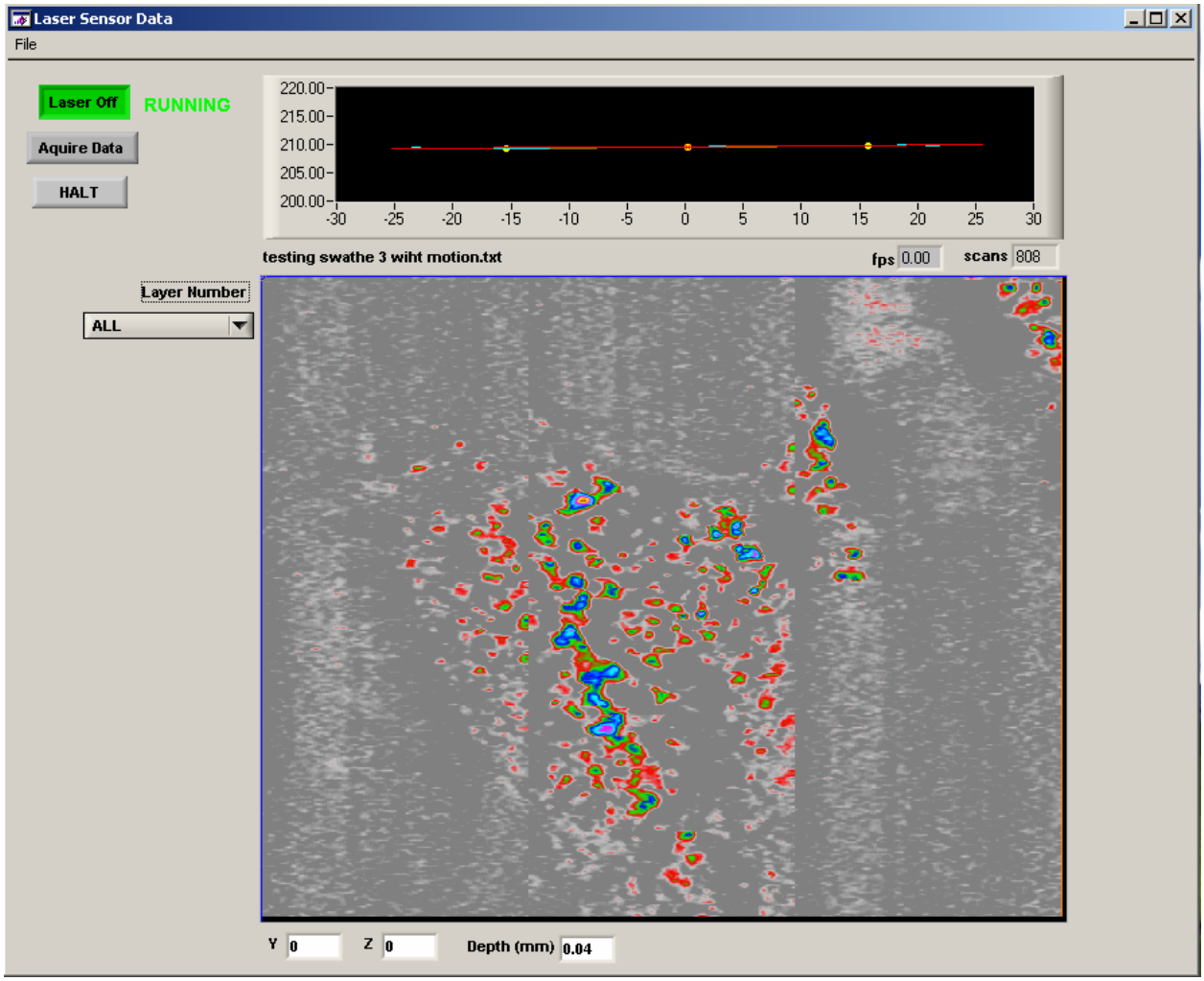

Figure 12. Topographical Corrosion Map

Task 4 - Laboratory Development and Evaluation

- Task initiated; activities planned to begin in July.
- Scheduled for completion by December 2006.

Task 5 - Weld Procedure Qualification

- Obtained the remaining bend test results and hardness traverses for the last physical testing for the welding procedure qualifications.
- Completed weld procedure qualification write-up that appeared in the last quarterly report.
- Task complete on April 27, 2006.

Task 6 - Field Testing and Validation

- EWI Project Manager provided TCPL with a summary report of the project to date to bring the new TCPL contact (David Taylor) up to speed on the system in preparation for the field trials. When the system is fully tested in the laboratory and ready for field deployment, David Taylor will find a suitable field location where it will more than likely be used to weld a repair sleeve.
- Scheduled for completion by the end of November 2006.

Task 7 - Final Report

- Task activities planned to begin in October 2006.
- Draft Final Project Report due to DOT on December 31, 2006. EWI's Holiday shut down begins on December 22 and the report will be put in the mail on or before that date.
- DOT's input for the Draft Final Report is due to EWI by February 2, 2007 for inclusion in the Final Report.
- Final Report due to DOT on February 28, 2007.

4.0 Public Page

The repair and remediation of in-service pipelines is a safety critical process that must be closely controlled, but which must nevertheless be performed using cost-effective techniques. For large diameter pipelines, the use of manual welding is time-consuming and there is a greater risk of operator error due to the long welding times. Similarly, higher strength pipelines require precise weld bead placement to ensure correct tempering of previous weld layers and the electrodes conventionally used will not provide adequate weld metal properties on pipe grades above X80. There is, therefore, a need to develop advanced welding repair and remediation methods for in-service pipelines.

Working in collaboration with TransCanada Pipeline (TCPL), Pipeline Research Council International (PRCI), Serimer DASA, and the Welding Engineering Research Centre of Cranfield University, Edison Welding Institute (EWI) is leading a project funded by the U.S. Department of Transportation's Research and Special Programs Administration to extend the current capabilities of in-service welding by developing an automated welding system for use on in-service pipelines.

The project is comprised of the following tasks:

1. Review of Industry Needs, Requirements, and Current Practices - in process
2. Technical Specifications for Automated In-Service Welding System - in process
3. Design and Build of Automated In-Service Welding System - in process
4. Laboratory Development and Evaluation
5. Weld Procedure Qualification
6. Field Testing and Validation
7. Final Report

The project team has just completed the design of a mechanized, multi-axis welding carriage with adaptive control/tracking for low hydrogen gas metal arc welding (GMAW) and flux cored arc welding (FCAW) which features Serimer DASA welding equipment. Motion control algorithms were written to integrate Serimer DASA components with an innovative torch control system designed for maximum torch positionability. Weld procedure qualifications are complete. Laboratory evaluations have been initiated. TransCanada Pipelines will begin searching for a suitable location for the field trials.

The major objectives of this program are to:

- Develop an automated welding system for use on in-service pipelines
- Implement a real-time adaptive control system to ensure reliable welding conditions
- Evaluate system performance through laboratory trials
- Validate the system and gain regulatory approval by qualification of procedures complying with recognized industry standards and perform field trials

For the coordination, preparation and distribution of press releases, please contact Lisa McClintock, EWI Marketing and Communications, at phone number 614-688-5130 or via Email at lisa_mcclintock@ewi.org.