

Advanced Leak Detection Lidar (ALDL), 7th Quarterly Report

Date of Report: *May 29, 2015*

Contract Number: *DTPH56-13-T-000004*

Prepared for: *DOT, PHMSA*

Project Title: *Advanced Leak Detection Lidar*

Prepared by: *Ball Aerospace & Technologies Corp.*

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For quarterly period ending: *May 31, 2015*

1.0 Funds and Work Completed During this Quarterly Period

This report covers the seventh 3 month period of the research effort. A summary of the project-to-date cost history, which ties to the Delivery Milestones, is provided in **Figure 1**, below. The variance in Q7 remains dominated by late delivery of the laser assembly, Milestone D18, Task T4, which is now imminent with delivery on-site at Ball Aerospace facilities scheduled for the morning of June 8th.

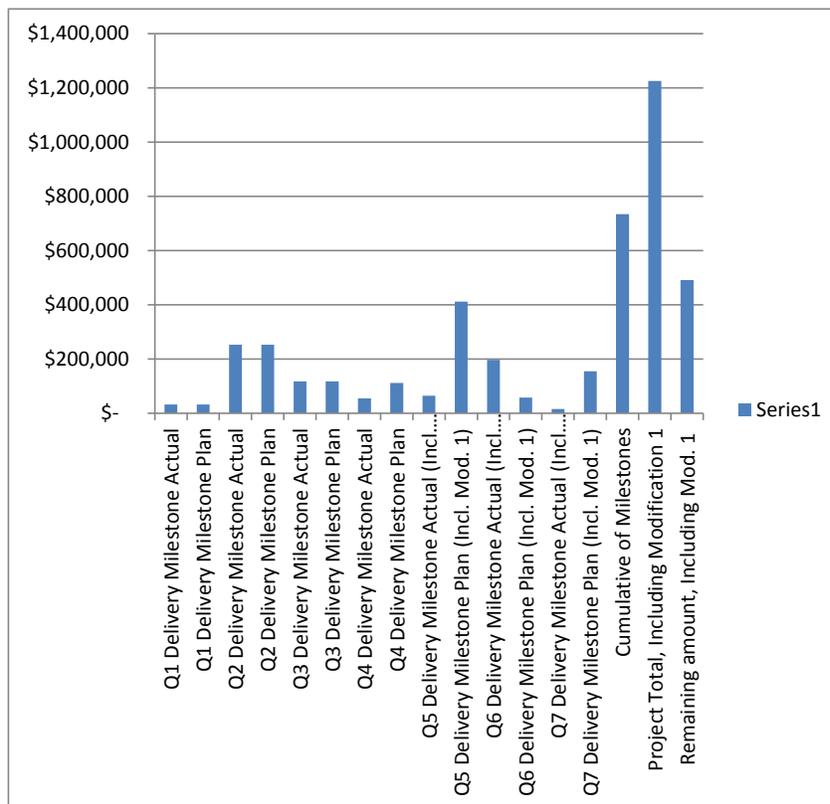


Figure 1, Achievement of payment milestones through the 7th quarter.

2.0 Progress Against 7th Quarter Delivery Milestones

Summary of Progress: There is one main issue affecting progress on the project: This is late completion of the laser assembly. Details of the issue and related corrective actions are provided in the discussion of Delivery Milestones 18 and 25-27, below.

The overall project budget remains a concern. However, Ball Aerospace has committed to contributing limited additional funding, to help ensure key milestones are achieved. A 10 week suspension of most project activity at Ball (i.e. a “bathtub”) was implemented this quarter to conserve project funding while we await completion/delivery of both the laser assembly and WASM components. Other corrective actions are detailed along with each of the missed delivery milestones, in paragraphs below.

The table at the top of the next page summarizes progress against key milestones on ALDL development that are due for completion in Quarters 4 -7. The black Xs indicate the planned completions. Green Xs indicate completions (early, on-time or late, but done) and the red Xs indicate re-planned completions. Note that the Modification Request including Delivery Milestones D32 and D33 was not incorporated into the project until after Q6 had been started. So, while they had been originally planned for Q5, the earliest they could be completed was in Q6.

Key Milestone Delivery Number & Name	Q4	Q5	Q6	Q7	Q8	Notes
D14, Validate electrical interfaces	X,X					
D15, Procure receiver and detector components	X		X			Off-axis parabola received in January, 2015
D16, Industry conference & paper	X					Not yet re-planned
D18, Procure laser transmitter components		X			X	Laser assembly has slipped from Q5 into Q8, but performance testing is now complete and pack-and-ship is in-work with delivery slated for 6/8/15.
D19, Update performance model with as-built characteristics		X,X				
D20, Validate signal processing with software in the loop	X	X,				
D22, Fabricate optical bench & structure		X		X,		
D23, Annual peer review			X	X		This milestone had been planned in Q6, but is subject to scheduling by PHMSA
D32, Start pointing SW			X		X	Delayed until after WASM HW delivery to optimize development efficiency.
D25, Integration of transmit components				X	X	This is dependent on laser delivery (D18)
D26, Integration of receive components				X	X	To be done in close conjunction with D25, above, for maximum efficiency.
D27, Final alignments				X	X	This is dependent on laser delivery (D18)
D34, Pointing control SW complete				X	X	Delayed until after WASM HW delivery to optimize development efficiency
D35, WASM completion				X	X	Delayed as part of "bath-tub" strategy while lasers are completed.
D32, Initiating pointing control and geo-location software development		X		X		Project software engineers suggest delaying this task until the WASM hardware is completed to improve the efficiency of software development.
D33, Start Wide Angle Steering Mirror (WASM) fabrication.		X	X			The delay of this milestone is primarily due to delays in finalizing the Modification Request.

The following paragraphs provide specific information for all milestones completed or missed this quarter.

2.1 Completed Milestones:

Delivery Milestone D24. Task T1 Technical Management (Accomplished): Task T1 is the ongoing, level-of effort to organize and manage the project with associated contractual delivery milestones each quarter. Key items for the 7th quarter are:

- Monthly and Quarterly Reports prepared and submitted.
- Schedule/technical issues with the laser assembly continued to be aggressively managed. The discussion under Delivery Milestone 18, below provides details and corrective actions.
- Project management secured \$50,000 of Ball Aerospace profit as additional resource match on the technical project to ensure key technical milestones are achieved in the coming months.
- Project peer review conducted on 5/20/15

- Commercialization progressed well. Section 3.0 provides details of the commercialization and additional resource matching due to be expended through Q7 in this area.

Delivery Milestone D23. Annual Peer Review (Accomplished): The ALDL project peer review was conducted on Day 1 of the PHMSA on May 7th, 2015.

2.2 Milestones from Prior Quarters That Continue to Slip

Delivery Milestone D16. Task T20, Industry Conference Paper and Presentation (Not Accomplished): This milestone was placed on the schedule as a placeholder. We believe that test results from the initial lab demonstration are needed before an abstract and paper for an industry conference should be put forward. We are considering the American Petroleum Institute pipeline industry meeting in April of 2015 as a presentation forum.

Delivery Milestone D18. Task T4, Procure Laser Transmitter Components (Not Accomplished): This milestone was planned for Q5 and is now delayed into Q8. As reported previously, the laser supplier encountered a series of technical issues starting in July of 2014 (and reported as issues in the various monthly reports). As of 5/29 laser performance has been demonstrated to be acceptable and the supplier and Ball have agreed to a delivery date, at Ball, of Monday, June 8th, 2015.

Delivery Milestone D32. Task T23, Initiate Pointing Control and Geo-Location Software Development (Not Accomplished): This activity has not yet been started. Software engineers have suggested that the development will go faster if we wait for the WASM hardware to be available in the lab. As described in the summary, we are exploring use of an existing WASM assembly, but have not yet finished coordinating across the company.

2.3 Milestones for Q7 That are Newly Missed

Delivery Milestone D25. Task T15, Mechanical and Electrical Integration of Transmitter Components (Not Accomplished): This milestone can't be completed without the laser assembly. Integration is now slated for June (next quarter).

Delivery Milestone D26. Task T16, Mechanical and Electrical Integration of Receiver Components (Not Accomplished): This milestone was delayed as part of our "bath-tub" strategy and corrective action to manage the overall budget. It is deemed more efficient to do transmit and receive path integration in close succession in the lab. Integration is now slated for June (next quarter).

Delivery Milestone D27. Task T17, Final Alignments and Test Set-Up (Not Accomplished): This milestone also cannot be completed without the laser assembly. Integration is now slated for June (next quarter).

Delivery Milestone D34, Task D23, Pointing Control and Geolocation Software Development (Not Accomplished): As described for D32, in Q7 above, this activity has not yet been started. Software engineers have suggested that the development will go faster if we wait for the WASM hardware to be available in the lab. As described in the summary, we are exploring use of an existing WASM assembly, but have not yet finished coordinating across the company.

Delivery Milestone D35, Task D24, WASM Fabrication (Not Accomplished): All of the WASM parts are complete except for the electromagnet actuators. The fabrication was delayed as part of the "bath-tub"

strategy to conserve budget until a reasonable level of effort across all aspects of the project could be sustained. WASM final assembly will begin in June and final assembly, including installation of the electromagnet assemblies is targeted for July, 2015 (next quarter).

3.0 Commercialization Update

Note that the commercialization activities are not funded under the contract and, instead, are included as part of the Resource Matching contained in the proposal. Through the 6th Quarter, Ball Aerospace had invested approximately \$90,000 of discretionary funds into ALDL commercialization since project inception. This is roughly 2X the promised resource matching of \$45,000 that was proposed, including Modification #1, through Q7 of the project.

Commercialization activities in Q7 included:

- PG&E submitted a white paper to PRCI in May, 2015. This solicited expanded flight testing and adaptation of the ALDL instrument for both hazardous liquid and natural gas leak detection. PRCI voted against member funding. However, several key companies expressed sufficient interest that PG&E is going forward with a “Joint Industry Partnership” or “JIP” proposal wherein select members would collaborate on the effort independent of PRCI. Chevron, Enbridge and SoCalGas have been identified as likely participants.
- Ball Aerospace made a formal, organizational decision to pursue commercialization at the level of the company president, Rob Strain. The Commercial Space Operations (CSO) business unit has been allocated \$75,000 for business development and \$185,000 for related IR&D. The CSO business unit has committed to ~\$700,000 of commercial revenue in 2016.

4.0 Schedule

The ALDL project remains on schedule. **Figure 2**, on page 6, presents the project schedule. The plan is shown by the blue bars. Completed tasks are shown in green. Delayed tasks are highlighted by yellow bars where schedule slack is being consumed and a red bar where schedule impact is being incurred. The vertical red line on the schedule shows the current date.

Figure 3, on page 8, provides a simplified task flow for the remaining activities on the project.

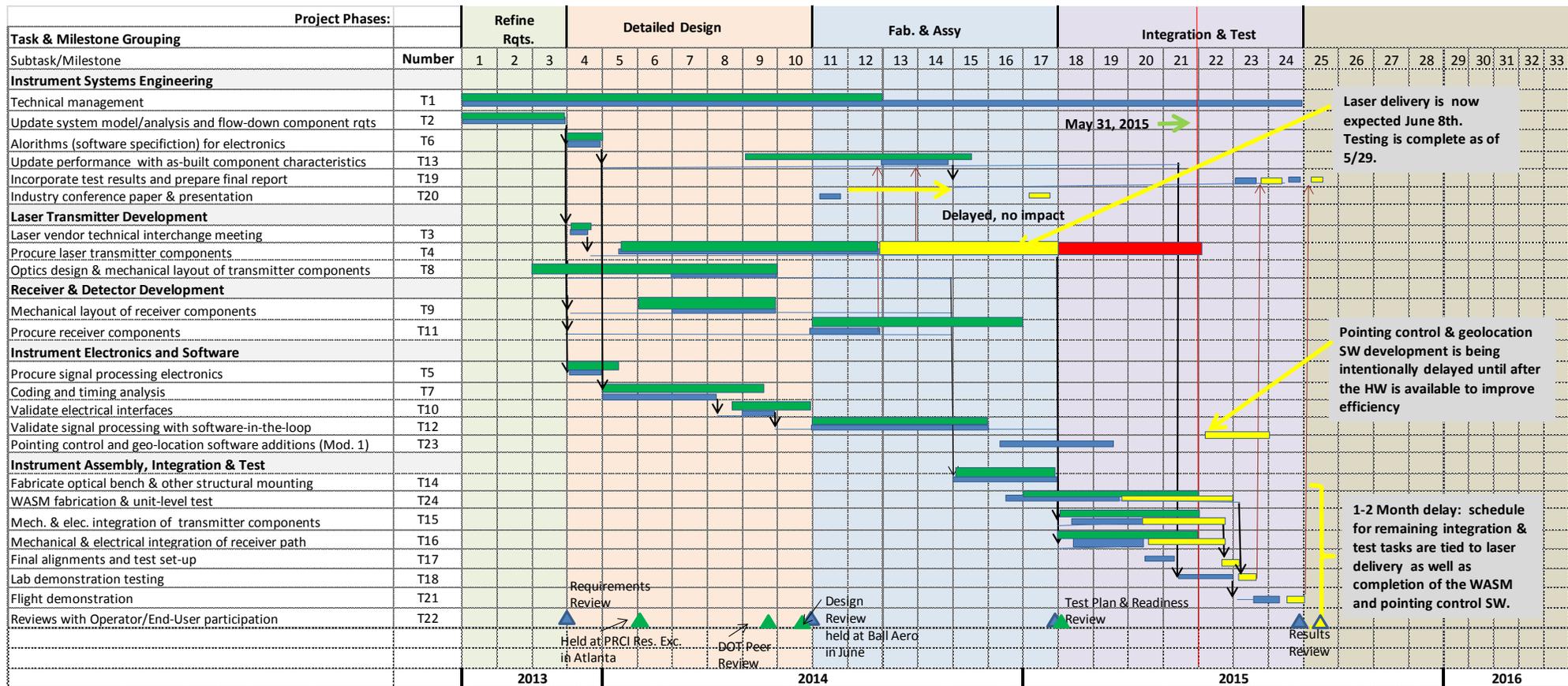


Figure 2, Advanced Leak Detection Lidar (ALDL) schedule progress against plan. Green bars indicate work accomplished. Yellow and red bars indicate delays. The vertical red line marks the end of the seventh quarter of the project (i.e. May 31, 2015). The schedule and list of tasks has been updated to account for Modification #0001. The tan period after the Integration and Test phase is included in the project period of performance and may be used for enhanced testing or refinements of the ALDL technology. At least one month of this “buffer” will be needed to complete the planned work due to late laser delivery.

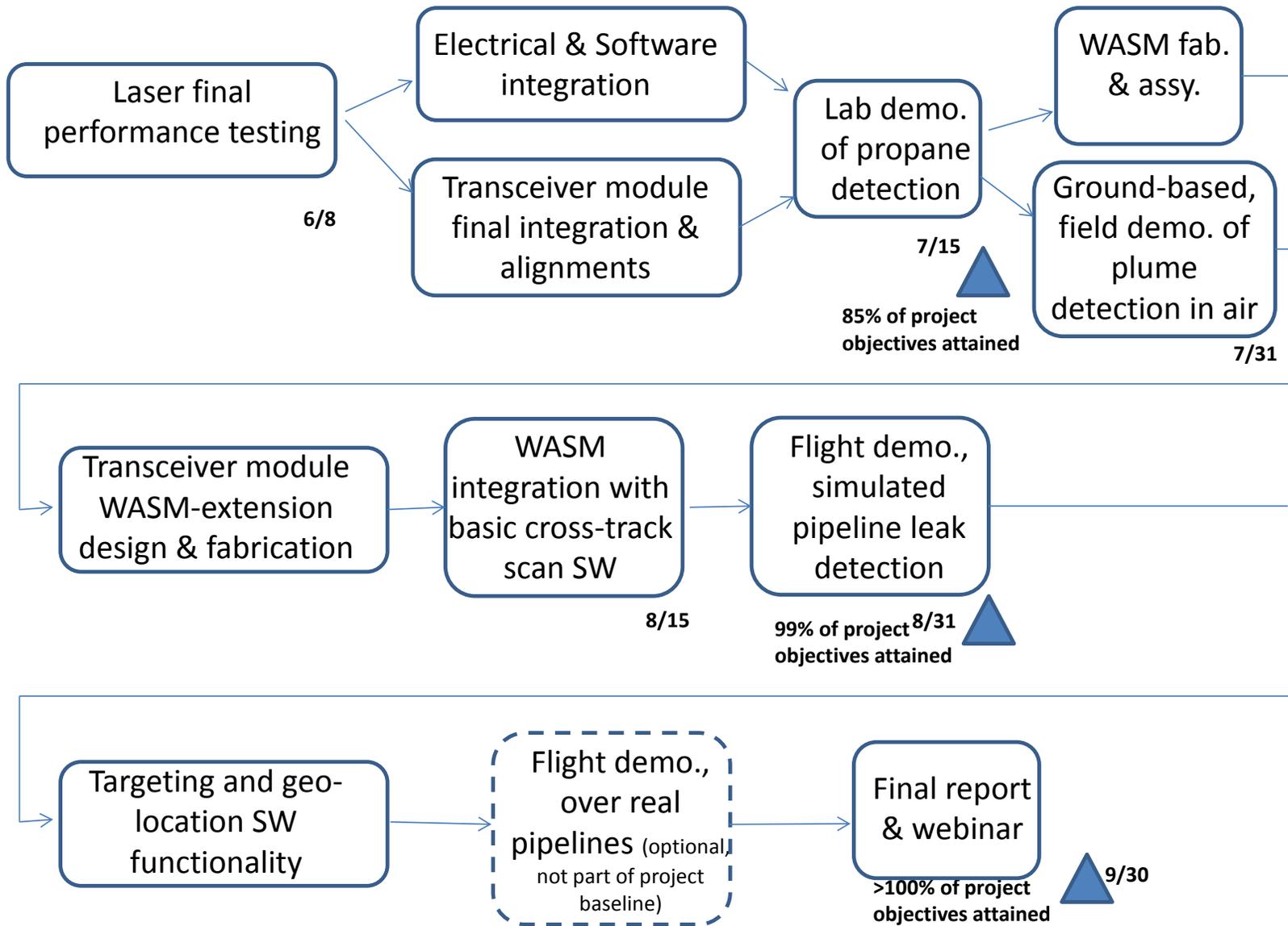


Figure 3, Simplified flow diagram of remaining project activities and tasks. Note that the ground-based field demonstration is a recommended modification to the Agreement for risk reduction ahead of flight testing.

5.0 Payment Milestones

Payment milestones D23 and D24 will be submitted for the seventh Quarter as summarized in Section 2.

Milestones D16, D18, D32 were missed in Q7, continue to be delayed, and will not be submitted for payment. Milestones D25, D26, D27, D34 and D35 were to have been completed in the seventh quarter and are now delayed.

D18, which remains incomplete pending delivery of the lasers, is having an impact on the overall project schedule.

All of the missed payment milestones are anticipated to be completed and submitted for payment in the eighth quarter.