

**Alvin Post-Cruise Debrief, for Dr. Mandy Joye's cruise AT26-13
Mandy Joye (PI), Adam Soule (CSDS),
Chris German (past CSDS), George Luther (FOA)**

Overview:

This 26 day cruise to Gulf of Mexico in March and April visited brine seeps and sites near the Macondo wellhead to sample fluids, sediments, and biology and make observations at long-term monitoring sites. This was the first science cruise of the new Alvin after the Science Verification Cruise (SVC). The program experienced a significant loss of productivity due to technical issues with Alvin. Overall, the Alvin ops team and ship's crew did an amazing job overcoming challenges with the vehicle and weather to get as much science done as possible.

Mandy's post cruise UNOLS assessment indicated that they lost 4.5 days to weather and 4.0 to ship science equipment (estimated because dives were shortened or started late).

1. Pre-Cruise Planning: did it go OK? Was anything overlooked? If so, how? Did NDSF fail to ask the right questions to tease out your needs? Was anything flagged as necessary at the pre-cruise meeting but was not taken care of by the time of the cruise?

Fine – nothing was overlooked. Mandy's gear on Alvin worked fine.

2. Mobilization: marks out of ten? Was the port-call long enough? Were the agents proficient? Was everything ready as far as NDSF were concerned before the ship sailed? Other issues?

Mandy gives a 10 grade.

2 days were more than sufficient time for mobilization.

Bruce and Captain AD were fantastic and helped with outreach and publicity, which went well as there were 2 different film crews.

CBS was aboard at the Macondo well head – dives 2 and 3. Fox and CBS both did well. NBC did a story but was not on the ship. Up to 40 stories on this cruise to date.

3. Operations – vehicle: did Alvin/Jason/Sentry dive on the days you expected, for the duration you wanted. If not, what reasons did you get from the Expedition Leader? Was anything still broken at cruise end (e.g. Thrusters, Manipulators?)

Dive cancelled due to a scrubber failure and subsequent maintenance.

Battery problems were pretty bad.

Quite a few dives went in later in the morning, and 3 or 4 were due to battery issues.

A hard ground occurred on the starboard battery as H₂O got in the system.

Only 2 dives had more than 4-5 hours bottom time so they were back on deck by 3 pm.

Power would abruptly be gone during a dive even though the pilots thought there was significant power still available. The batteries were not asynchronously charged (discussed also under question 6). They did get 7.5 hours of bottom time when it was charged correctly.

3. Operations – vehicle (continued): did Alvin/Jason/Sentry dive on the days you expected, for the duration you wanted. If not, what reasons did you get from the Expedition Leader? Was anything still broken at cruise end (e.g. Thrusters, Manipulators?)

4.5 dive days were lost to weather.

The Alvin group seemed more conservative when making weather calls as they are learning the new Alvin. On one dive, the sub was down when bad weather occurred on the surface. The dive team was told to shut down power and sit on the bottom. When the weather improved, they dropped weights. By the time they reached the surface, the weather deteriorated and the recovery was rough. The Captain, crew and Alvin team did a great job during the tough recovery.

However, Alvin hit the water hard and the basket broke as a weld failed. Fortunately the safety lines held, but half of the sampled cores were lost. Alvin did not dive the next day, but Mandy thought they could have done a dive except for the fact that there was so much work to do; e.g., repair the basket and the junction boxes, which were ripped off the sub and also flooded. One junction box did not work the rest of the cruise. The Alvin group has much to maintain. An extra Alvin group person would have helped.

On a separate dive another set of 18 cores were lost. Screws were not tightened to secure the box to the basket. She may have found the cores on another recent dive sequence.

4. Operations – NDSF-provided equipment: did the core systems on the vehicle work? Did the cameras perform as required? Was the lighting adequate? Mapping tools? Other sensors? How was the navigation (LBL, DVL)?

Cameras are fabulous BUT lack of overlay and frame grabber is a problem and will require significant post-cruise work. Mandy's group tried calling out the time every 10 minutes so it could be heard on the audio. However, they had no audio on the recordings for greater than half of the dives (seems to still be a problem after the SVC).

A Pilot forgot to push the record button on one dive so one camera did not record.

The Port camera froze and could not record all the time unless the control computer was restarted. The Downlooking camera seems to be a problem as on the SVC as it could not be viewed on the monitors.

Lighting was fantastic. Made some slight position adjustments to the top lights.

4. Operations – NDSF-provided equipment (continued): did the core systems on the vehicle work? Did the cameras perform as required? Was the lighting adequate? Mapping tools? Other sensors? How was the navigation (LBL, DVL)?

There were navigation problems and they lost much bottom time starting on the 4th dive. Recorded targets on the navigation software from early dives did not allow them to return to those sites.

Mandy wrote notes for XY from Alvin's screen and the lat/lon from the Nav computer, and estimated they were off by ~100 feet. Top lab navigation data also did not match up. Mandy indicated that the converter did not work to give the same position using both methods. Mandy estimated that they lost or used 25-30 hours of bottom time trying to reoccupy sites. The Alvin group seems to be learning the nav software so had some difficulty with using it.

Mandy would give up a science berth for an extra Alvin group data person to keep the navigation and data systems top notch. Not having a data person affects the work of the rest of the Alvin group as they were working so hard on so many issues. There were only 6 Alvin group people for the entire cruise. It appears that they need more personnel at this time for efficient Alvin operations.

5. Operations – User-provided equipment. Did you (the science party as a whole) bring ancillary equipment to the cruise to interface with the vehicle. Did it work? Were there problems? What were the issues? What did the Expedition Leader tell you? How did your experience gel with what you had been told at the pre-cruise meeting. (NB, this presumes that you did remember to tell NDSF that you were bring equipment at the pre-cruise meeting to interface to the vehicle).

Ian McDonald's camera had problems although it functioned on Jason previously. The camera would not work on the surface but would at depth initially. Later it would work on the surface but not at depth. The Camera used RS232 communication from junction boxes on port and starboard sides, and there was a hard ground once. Although Mandy recommended Ian to contact the Alvin group before the cruise, Ian did not bring the camera to the Alvin group beforehand for checks nor did he have enough backup for repairs on ship.

Mandy's Brine trapper for fluid samples (< 40 deg. C) used Alvin hydraulics to work and it worked well. All manual operations worked well.

6. NDSF Personnel – Expedition Leader. How well did you interact with the Expedition Leader? Did you feel you were kept fully up to speed – e.g. vehicle, equipment, team, state of readiness, operational constraints? Did the ExpLdr do a good job managing the rest of the NDSF team? Did they interact well with the Captain/ship's company?

Bruce did a great job.

Good communication with all as noted below regarding batteries.

Dive time decreased as the dive sequence went on, and the Alvin team noted this so took some action on this issue. After a meeting with Bruce, Bob and Captain AD, they cycled batteries to improve dive time, but this was only partially successful. They later took them apart for proper charging. When they did this on the next to last dive, they got good bottom time on the next dive (~7.5 hours). Because of other issues before the cruise (e.g., CO₂ scrubber) and during the cruise, the battery charging was not a top priority before the cruise.

7. NDSF Personnel – Team as a whole. Did they do a professional job? Any outstanding performers who deserve recognition? Any who stood out for negative reasons? If so, what were they? We want to know.

The Alvin group went above and beyond trying to repair items and to maintain systems. They spent long nights doing this so seem to be stretched thin at this time. Another person or two would have helped as they were up late almost every night.

8. Data hand-over. Did you get information at the start of the cruise on what data to expect? Did you get everything you expected at the cruise end? Please check exactly what you got ahead of the TelCon so that I, as CSDS, can check that this matches our internal-to-WHOI data-tracking. Were there any data-quality issues that you identified? Were these already discussed at sea with the Exp. Ldr? Are you aware of any course of action already under way to remedy the situation?

All data were properly transferred – no issue. Framegrabber and overlays are needed.

9. Demobilization. Any unexpected issues that you hadn't been readied for by the pre-cruise planning meeting? Any problems other than that?

No problems. Mandy left cores and brine sampler for others to use.

10. Recommendations. Do you have any suggestions, not already covered, for how to improve scientists' experience with the vehicle(s) you used and/or the wider NDSF?

Condensation issues. Observers noticed water after two hours in the sub on the first dive. Pads were getting saturated and observers' pants were wet causing discomfort on most dives. Pads were removed from the sub to be dried ,and a heater was placed in the sub to reduce water vapor.

Recommendation: Put a H₂O scrubber (silica gel or drierite that can be regenerated)) in line with the CO₂ scrubber.

CTD & Multibeam: The absence of a CTD and multibeam sonar was noticed and sorely missed. Mandy was excited about the possibility of using Alvin to do fine-scale mapping and had heard that it would be available for this cruise and was disappointed that it was not.

10. Recommendations (continued). Do you have any suggestions, not already covered, for how to improve scientists' experience with the vehicle(s) you used and/or the wider NDSF?

Pilot Seat: Nearly every observer commented that all pilots were having discomfort with the pilot seat. The pilots also indicated that it was uncomfortable. In Mandy's view the uncomfortableness of the seat distracted the pilots from their work.

Personnel: The Alvin team was working as hard as Mandy has ever seen and getting burned out because of it. She felt that the dive program would have benefitted from an additional person or two. Specifically a person who could have handled the Alvin data and put their focus on navigation and video issues would have saved a considerable amount of time. Having such a person would likely have allowed the team address the battery issues sooner as well.

**Alvin Post-Cruise Debrief, for Dr. Mandy Joye's cruise AT26-13
Mandy Joye (PI), Adam Soule (CSDS),
Chris German (past CSDS), George Luther (FOA)**

Overview:

This 26 day cruise to Gulf of Mexico in March and April visited brine seeps and sites near the Macondo wellhead to sample fluids, sediments, and biology and make observations at long-term monitoring sites. This was the first science cruise of the new Alvin after the Science Verification Cruise (SVC). The program experienced a significant loss of productivity due to technical issues with Alvin. Overall, the Alvin ops team and ship's crew did an amazing job overcoming challenges with the vehicle and weather to get as much science done as possible.

**Alvin Post-Cruise Debrief, for Dr. Mandy Joye's cruise AT26-13
Mandy Joye (PI), Adam Soule (CSDS),
Chris German (past CSDS), George Luther (FOA)**

Overview:

Mandy's post cruise UNOLS assessment indicated that they lost 4.5 days to weather and 4.0 to ship science equipment (estimated because dives were shortened or started late).

Response -

22 Dives scheduled – 17 Dives completed (avg bot time = 5hr 7 m)

3 Full dives lost due to weather

1 Dive lost due to scrubber fault response

1 Dive lost due to basket rebuild and A-frame eval (post heavy weather recovery)

Some delays for weather, transit time, new vehicle and equipment demands, crew/user experience level

1. Pre-Cruise Planning: did it go OK? Was anything overlooked? If so, how? Did NDSF fail to ask the right questions to tease out your needs? Was anything flagged as necessary at the pre-cruise meeting but was not taken care of by the time of the cruise?

Fine – nothing was overlooked. Mandy's gear on Alvin worked fine.

Response – as noted pre-cruise went fine

2. Mobilization: marks out of ten? Was the port-call long enough? Were the agents proficient? Was everything ready as far as NDSF were concerned before the ship sailed? Other issues?

Mandy gives a 10 grade.

2 days were more than sufficient time for mobilization.

Bruce and Captain AD were fantastic and helped with outreach and publicity, which went well as there were 2 different film crews.

CBS was aboard at the Macondo well head – dives 2 and 3. Fox and CBS both did well. NBC did a story but was not on the ship. Up to 40 stories on this cruise to date.

3. Operations – vehicle: did Alvin/Jason/Sentry dive on the days you expected, for the duration you wanted. If not, what reasons did you get from the Expedition Leader? Was anything still broken at cruise end (e.g. Thrusters, Manipulators?)

Dive cancelled due to a scrubber failure and subsequent maintenance.

Battery problems were pretty bad.

Quite a few dives went in later in the morning, and 3 or 4 were due to battery issues.

A hard ground occurred on the starboard battery as H₂O got in the system.

Only 2 dives had more than 4-5 hours bottom time so they were back on deck by 3 pm.

Response - Dive delays were associate with reestablishing day to day routine, demands of upgraded submersible and low level of recent operational experience. No delays associated with battery issues. Minor delay associated with battery cable connector ground (not uncommon)

10 dives with bottom times > 5 hours (1 extended due to rough weather), 4 dives with bottom time > 4 hours, 3 dives with bottom times < 4 hours. Avg Bottom Time 5h 7m.

3. Operations – vehicle: did Alvin/Jason/Sentry dive on the days you expected, for the duration you wanted. If not, what reasons did you get from the Expedition Leader? Was anything still broken at cruise end (e.g. Thrusters, Manipulators?)

Power would abruptly be gone during a dive even though the pilots thought there was significant power still available. The batteries were not asynchronously charged (discussed also under question 6). They did get 7.5 hours of bottom time when it was charged correctly.

Response – depletion of available battery power is not linear ie tends to diminish at a faster rate late in the dive (same as in the past). Valuable experience was gained by the pilots on how best to interpret the new battery monitoring system. Asynchronous charging is routine as batteries are of different capacity and actually helps balance available power. Primary battery capacity issue associated with operational schedule and long service interval on one of the installed batteries. Follow on cruises show improved battery performance once routine service interval re-established. Currently the normal battery service interval has been reestablished and the recorded bottom time and battery capacity are consistent with the pre-upgrade submersible (possibly improved).

3. Operations – vehicle (continued): did Alvin/Jason/Sentry dive on the days you expected, for the duration you wanted. If not, what reasons did you get from the Expedition Leader? Was anything still broken at cruise end (e.g. Thrusters, Manipulators?)

4.5 dive days were lost to weather.

The Alvin group seemed more conservative when making weather calls as they are learning the new Alvin.

Response – the same weather evaluation was employed as in the past with the same weather minimums. This cruise had more variable ie borderline weather and some lack of accuracy associated with the weather reporting received (see follow on slide).

3. Operations – vehicle (continued): did Alvin/Jason/Sentry dive on the days you expected, for the duration you wanted. If not, what reasons did you get from the Expedition Leader? Was anything still broken at cruise end (e.g. Thrusters, Manipulators?)

On one dive, the sub was down when bad weather occurred on the surface. The dive team was told to shut down power and sit on the bottom. When the weather improved, they dropped weights. By the time they reached the surface, the weather deteriorated and the recovery was rough. The Captain, crew and Alvin team did a great job during the tough recovery.

However, Alvin hit the water hard and the basket broke as a weld failed. Fortunately the safety lines held, but half of the sampled cores were lost. Alvin did not dive the next day, but Mandy thought they could have done a dive except for the fact that there was so much work to do; e.g., repair the basket and the junction boxes, which were ripped off the sub and also flooded. One junction box did not work the rest of the cruise. The Alvin group has much to maintain. An extra Alvin group person would have helped.

Response - The noted dive experienced a sudden gale that was not forecasted and required the noted response. A good portion (approx. ½) of the science objectives had been accomplished on the dive at the time of the storm. Recovery was rough as noted with a failure of a basket weld and science gear lost due to heavy swell on recovery. Basket releases opened (as designed) and were partially contaminated with seawater. Follow on dive was cancelled to repair basket and prepare for following dives. Post repair, all basket J-boxes and components functioned for the rest of the cruise.

4. Operations – NDSF-provided equipment: did the core systems on the vehicle work? Did the cameras perform as required? Was the lighting adequate? Mapping tools? Other sensors? How was the navigation (LBL, DVL)?

Cameras are fabulous BUT lack of overlay and frame grabber is a problem and will require significant post-cruise work. Mandy's group tried calling out the time every 10 minutes so it could be heard on the audio. However, they had no audio on the recordings for greater than half of the dives (seems to still be a problem after the SVC).

Response – overlay exists but does not get embedded in the video. Audio was disabled in response to recording issues identified during SVC (this was reported to the science users at the start of the cruise – ie no audio). Audio corrected and re-enabled for follow on cruises.

4. Operations – NDSF-provided equipment: did the core systems on the vehicle work? Did the cameras perform as required? Was the lighting adequate? Mapping tools? Other sensors? How was the navigation (LBL, DVL)?

A Pilot forgot to push the record button on one dive so one camera did not record.

The Port camera froze and could not record all the time unless the control computer was restarted.

The Down-looking camera seems to be a problem as on the SVC as it could not be viewed on the monitors.

Lighting was fantastic. Made some slight position adjustments to the top lights.

Response – Group is still learning new system but at present most operational errors have been corrected. Noted intermittent issues with system ‘freezing’ are under evaluation . ‘Down-looking’ camera is new science still camera. At present the video and images from this camera are recorded on the camera internal memory and the image is available on the pilot’s monitor. Many improvements to the video system have been added since the Joye cruise and system usability and performance improvements are currently in progress.

4. Operations – NDSF-provided equipment (continued): did the core systems on the vehicle work? Did the cameras perform as required? Was the lighting adequate? Mapping tools? Other sensors? How was the navigation (LBL, DVL)?

There were navigation problems and they lost much bottom time starting on the 4th dive. Recorded targets on the navigation software from early dives did not allow them to return to those sites. Notes for XY from Alvin's screen and the lat/lon from the Nav computer, and estimated they were off by ~100 feet. Top lab navigation data also did not match up. Mandy indicated that the converter did not work to give the same position using both methods. Mandy estimated that they lost or used 25-30 hours of bottom time trying to reoccupy sites. The Alvin group seems to be learning the nav software so had some difficulty with using it.

Response – the above estimate of impact on bottom time is excessive. Some noted nav issues were associated a lack of experience with the new software but in general the navigation program is working reasonably well. In some cases, nav fixes and noted errors may have been associated with historical nav data (ie data obtained from different vehicles and systems). In many cases, nav was good enough to immediately return to past sites (gas volcano). The noted offset (100 feet ~ 30m) is not unusual with the USBL when no survey is employed prior to diving. On following cruises, navigation use improved and included regular use of SENTRY underlay data. The group is continuing evaluation of available nav data 'deliverables' and system usability to identify improvements (toplab and sub nav).

4. Operations – NDSF-provided equipment (continued): did the core systems on the vehicle work? Did the cameras perform as required? Was the lighting adequate? Mapping tools? Other sensors? How was the navigation (LBL, DVL)?

Mandy would give up a science berth for an extra Alvin group data person to keep the navigation and data systems top notch. Not having a data person affects the work of the rest of the Alvin group as they were working so hard on so many issues. There were only 6 Alvin group people for the entire cruise. It appears that they need more personnel at this time for efficient Alvin operations.

Response – The Alvin group is considering the value of an operations position that includes a higher level of data knowledge and experience although it is unlikely that this will expand into a full time, data only position. The group is working with the SSSG techs and WHOI engineers to better define the day to day data deliverables and improve the usability of the data for the science users.

5. Operations – User-provided equipment. Did you (the science party as a whole) bring ancillary equipment to the cruise to interface with the vehicle. Did it work? Were there problems? What were the issues? What did the Expedition Leader tell you? How did your experience gel with what you had been told at the pre-cruise meeting. (NB, this presumes that you did remember to tell NDSF that you were bring equipment at the pre-cruise meeting to interface to the vehicle).

Ian McDonald's camera had problems although it functioned on Jason previously. The camera would not work on the surface but would at depth initially. Later it would work on the surface but not at depth. The Camera used RS232 communication from junction boxes on port and starboard sides, and there was a hard ground once. Although Mandy recommended Ian to contact the Alvin group before the cruise, Ian did not bring the camera to the Alvin group beforehand for checks nor did he have enough backup for repairs on ship.

Mandy's Brine trapper for fluid samples (< 40 deg. C) used Alvin hydraulics to work and it worked well. All manual operations worked well.

Response – agree with above notes – we are working with future users to help improve the pre-cruise preparation of science gear, particularly those that interface with the sub's systems. We see great value in a camera like Ian's.

6. NDSF Personnel – Expedition Leader. How well did you interact with the Expedition Leader? Did you feel you were kept fully up to speed – e.g. vehicle, equipment, team, state of readiness, operational constraints? Did the ExpLdr do a good job managing the rest of the NDSF team? Did they interact well with the Captain/ship's company?

Bruce did a great job.

Good communication with all as noted below regarding batteries.

Dive time decreased as the dive sequence went on, and the Alvin team noted this so took some action on this issue. After a meeting with Bruce, Bob and Captain AD, they cycled batteries to improve dive time, but this was only partially successful. They later took them apart for proper charging. When they did this on the next to last dive, they got good bottom time on the next dive (~7.5 hours). Because of other issues before the cruise (e.g., CO₂ scrubber) and during the cruise, the battery charging was not a top priority before the cruise.

Response – we had good communications with the science party throughout the cruise. Battery notes as outlined on a previous slide (ie battery issues were associated with one battery that had a long service interval – no battery servicing was possible during the cruise other than the normal charging attention)

7. NDSF Personnel – Team as a whole. Did they do a professional job? Any outstanding performers who deserve recognition? Any who stood out for negative reasons? If so, what were they? We want to know.

The Alvin group went above and beyond trying to repair items and to maintain systems. They spent long nights doing this so seem to be stretched thin at this time. Another person or two would have helped as they were up late almost every night.

Response – the work load this cruise was partially related to the demands of the upgraded vehicle and the low level of operational experience of the crew. At present the group is determining the schedule for hiring additional crew with the goal to add ET/Data experience as noted previously (likely a function of the schedule for 2015).

8. Data hand-over. Did you get information at the start of the cruise on what data to expect? Did you get everything you expected at the cruise end? Please check exactly what you got ahead of the TelCon so that I, as CSDS, can check that this matches our internal-to-WHOI data-tracking. Were there any data-quality issues that you identified? Were these already discussed at sea with the Exp. Ldr? Are you aware of any course of action already under way to remedy the situation?

All data were properly transferred – no issue. Framegrabber and overlays are needed.

Response – Replacement frame grabber is in progress. Overlays are available for viewing during a dive but are not embedded in the video (this is as planned). It is unlikely that an embedded data overlay will be added to the system. The group is looking at the total data set created on each dive and is working to improve the cross over and correlation between the recorded video and the nav and sensor/science data. It is likely that the frame grabber will help answer some of the above comments.

9. Demobilization. Any unexpected issues that you hadn't been readied for by the pre-cruise planning meeting? Any problems other than that?

No problems. Mandy left cores and brine sampler for others to use.

Response – as noted de-mob was fine

10. Recommendations. Do you have any suggestions, not already covered, for how to improve scientists' experience with the vehicle(s) you used and/or the wider NDSF?

Condensation issues. Observers noticed water after two hours in the sub on the first dive. Pads were getting saturated and observers' pants were wet causing discomfort on most dives. Pads were removed from the sub to be dried ,and a heater was placed in the sub to reduce water vapor.

Recommendation: Put a H₂O scrubber (silica gel or drierite that can be regenerated)) in line with the CO₂ scrubber.

Response – the noted condensation is consistent with a larger sphere (ie greater available surface area for condensation to form). The group is looking at measures to improve comfort and to minimize any condensation issues.

10. Recommendations. Do you have any suggestions, not already covered, for how to improve scientists' experience with the vehicle(s) you used and/or the wider NDSF?

CTD & Multibeam: The absence of a CTD and multibeam sonar was noticed and sorely missed. Mandy was excited about the possibility of using Alvin to do fine-scale mapping and had heard that it would be available for this cruise and was disappointed that it was not.

Response – pre-cruise communications clearly stated that the RESON multibeam would not be available for the cruise. The group is actively working to integrate the sonar into the new sub's systems.

The group is scheduling procurement of a replacement CTD (past CTD was deemed unusable when sent for cal/evaluation). New CTD will report data to the on-board data system and will be easy to correlate with other dive data.

10. Recommendations (continued). Do you have any suggestions, not already covered, for how to improve scientists' experience with the vehicle(s) you used and/or the wider NDSF?

Pilot Seat: Nearly every observer commented that all pilots were having discomfort with the pilot seat. The pilots also indicated that it was uncomfortable. In Mandy's view the uncomfortableness of the seat distracted the pilots from their work.

Response – overall sub ergonomics were widely reported as improved. The group is evaluating improvements to the seat and work area ergonomics although in general the seat is a marked improvement from the pas 'box' seat. Not all pilots share the opinion that the seat is as uncomfortable or distracting as reported. Pilot positioning is also a function of the larger sphere and available seat placement and this will factor into the overall evaluation of planned interior improvements.

10. Recommendations (continued). Do you have any suggestions, not already covered, for how to improve scientists' experience with the vehicle(s) you used and/or the wider NDSF?

Personnel: The Alvin team was working as hard as Mandy has ever seen and getting burned out because of it. She felt that the dive program would have benefitted from an additional person or two. Specifically a person who could have handled the Alvin data and put their focus on navigation and video issues would have saved a considerable amount of time. Having such a person would likely have allowed the team address the battery issues sooner as well.

Response – as noted previously, additions to the crew are planned. Video and nav issues did not impact the work load as significantly as suggested. Most of the additional hours were associated with day to day upkeep and the process of reestablishing the daily dive routine. Additional personnel will help and as noted we are looking at the suite of experience required to support the new systems, including data and navigation. Battery issues were as noted previously.