Factory acceptance tests (FAT) for the UH/SOEST 6000 meter capable ROV were held at DOER Marine’s facility in Alameda CA from January 3 – 6, 2013. Dan Greeson, Pete Townsend, Mark Rognstad and Scott Ferguson reviewed the system and observed the tests. DOER has requested that one or more of us return in 10-14 days to observe the final factory tests prior to readying the unit for shipping.

SYSTEM STATUS
The ROV system is nearing completion and was in a reasonable condition to test system functionality. Items not functional at the time of testing included:

- the subsea power transformer;
- the TMS control can was still being wired on the bench;
- all electronic cans and hydraulic valve manifolds were left open and the ROV control can was installed but left open to facilitate testing and ongoing integration;
- the UH-provided fiber-optic multiplexers that provide serial and Ethernet communication over fiber were not functional when the tests began but some channels were configured and integrated as the test proceeded;
- the hydraulic and mechanical components on the TMS that latch the ROV and support payload deployment via the removable “trapeze” were not complete and the latch and trapeze mechanisms were still being machined;
- all components were tested “dry” and all the hydraulic operations were conducted using a deck cart because the ROV and TMS hydraulic pumps must be wet to be run.

Although a substantial amount of work was still in progress this had minimal impact on the FAT. We estimate that the workshop and control vans approached 100% completion and that, absent wet testing, the ROV was 90 to 95% complete and the TMS was 80% complete.

The subsea power transformer had been working for some time but failed on Friday before the FAT began on Thursday. DOER was working with the transformer manufacturer over the holiday weekend to diagnose and repair the unit but at the time of the FAT the transformer was still not working so all the ROV and TMS tests were conducted using bench top power supplies. This meant that the TMS and ROV power cans were partially disassembled during the test and that power supplies had to be reconfigured from time to time but did not impede testing. (The manufacturer was also winding a second transformer in case the delivered one cannot be made to work.)

The TMS control can was not complete because it had to be disassembled and modified when it was determined that two additional boards were required to make
the Shark power monitoring system work as required (contrary to the advice of the Shark support engineers). For that reason the TMS and ROV control can end caps were rough machined and heat-treated but final machining will not be conducted until all the electronics in both cans are tested and verified to be completely functional. This prevented testing of the TMS instrumentation but did not impede testing the ROV or testing of the TMS mechanical functions. In fact having the ROV control can open provided ready access to test points and board-level test lights.

The UH-provide Prizm fiber-optical multiplexers proved to be challenging to commission on the DOER ROV. This has been an ongoing issue, caused substantially by the lack of adequate vendor support. (Prizim has been bought by Moog and their technical support has suffered in the transition.) Pete has a fair amount of experience with the units and provided assistance when requested but at the time of the FAT these units were still not working. Pete worked with a DOER technician to get one of the units working on the bench and then in the control van and on the ROV. Several of the data channels were configured, allowing testing to be done on the major components on the ROV. DOER will continue to activate and commission other channels to provide all the required digital data paths. Pete’s experience is that configuring each channel can be a struggle but once working they remain reliable. Still the amount of effort it is taking to configure these data channels is unsettling and DOER is providing some additional space in the control cans in case a different multiplexer is eventually required.

The latching mechanism on the TMS was being machined during the FAT and the hydraulic components that drive the latch were not in place, thus a dry test of the ROV/TMS latch function and the payload deployment latch could not be conducted.

All testing was done dry with wet testing to be conducted in Hawaii. Some limited wet testing may be performed in the DOER test tank prior to shipping but the tank is small in comparison to the ROV and TMS.

Additionally, the NSF-provided .681 umbilical cable had been tested and provisionally commissioned by Mark Rognstad on Dec 27-28 but DOER had some concerns about the cable’s condition and chose to continue using the 30 m length of .681 cable provided by UH to serve as the interconnect cable between the umbilical winch and the workshop van as a proxy for the umbilical cable. As will be discussed briefly below this was a wise choice.

Finally, DOER did not have an acceptable way of documenting the FAT results so we worked with them to develop a simple but detailed checklist that would clearly document what was being provided and its condition at the time of testing.

DOCUMENTATION AND SPARES
A review of the preliminary documentation was conducted. The documentation is well organized and DOER appears to be doing a good job of redlining the documents during vehicle assembly so that the delivered documentation will reflect the as-built
state of the system. We went through every page of the prints and were impressed with the detail and quality of the content and are sure that the documents will be of great value in maintaining the system. All documentation will be provided in paper and electronic (PDF) form. All electrical and hydraulic diagrams will also be provided in AutoCAD format (DWG files). Final as-built documentation will be provided after the vehicle has shipped. The detailed vehicle mechanical drawings were created in Solidworks and will be provided in paper and PDF only, however DOER will collapse the individual mechanical parts into single, consolidated TMS and ROV “parts” so they can be digitally manipulated as general arrangement drawings for use in cruise planning and in brochures and other documents.

DOER has a transparent process for sourcing parts from OEM vendors. Wherever possible components are procured on the open market and the documentation clearly identifies them by vendor and vendor number so that UH can procure the items directly. Only components that have been manufactured by DOER or have been altered in a substantial way must be procured through DOER. As an example, the hydraulic pump for the TMS was procured on the open market but was anodized prior to installation. DOER has identified the original vendor and provided a second anodized pump as a spare. A list of provided spares will be included in an appendix to this report and a list of recommended spares will be provided for separate procurement.

WORKSHOP VAN
Both vans are complete. They are UNOLS- and ABS-compliant, are insulated, have good climate controls (both heat and cooling, the latter oversized for tropical conditions) and good lighting. The workshop van has storage drawers, a work bench and tie downs for the ROV. It also includes the power distribution unit (PDU) for transforming shipboard 480 VAC into subsea power (2500 to 3000 VAC depending on umbilical cable length and subsea power requirements) and actively monitoring the subsea power transmission system for integrity. PDU or subsea power faults automatically trigger power shutdown to protect system equipment in worst-case situations.

CONTROL VAN
The control van has a countertop for vehicle operators and three ergonomic seats that include manipulator and pan and tilt controls mounted on the arm rests. The van is well laid out with a full height equipment rack, upholstered seating for observers and overhead and in-bench storage. Six computer and video monitors were in place and operational for the FAT. Several monitors will be installed prior to shipment. Final monitor arrangement and control layout were discussed during the process of the FAT testing.

The DOER control and monitoring software is functional and works well. The design is modular and configurable. The ROV and TMS systems and controls are intuitive and are identical where possible. The overall system has been created with substantial room for growth in terms of ROV payload capacity and power budget.
Several spare power channels are provided in addition to the “scientific” power (12, 24 and 48 VDC). The software has also been designed to allow the user to configure the screen layout to enable and label those additional functions as needed; this can be done by modifying an XML-based text file that configures the screen.

ROV FUNCTIONALITY AND CONTROL
The DOER SeaMantis and the Schilling Orion 7P manipulators were operated from the control van using ROV-mounted video cameras to observe the manipulator’s operation. The InSite mini-Zeus HD camera was operated from the control van using the pan and tilt mechanism. In addition to the ROV operator controls for pan, tilt and HD camera operation, DOER is providing a separate set of pan, tilt and HD camera controls for use by scientific observers. Four SD cameras were tested; two DOER-provided NanoSeaCams that provide color images in lighted conditions and black and white images in low light, one HURL-provided color MultiSeaCam and one B/W MultiSeaCam. All these cameras were controlled from the control van. All of the ROV hydraulic valves were operated from the control van.

A number of components were not tested including the DVL, the CTD, the altimeters, compasses and USBL triggers on the ROV and the TMS. The scientific power was incompletely tested; only the 12 VDC was available but none of them had been tested prior to the FAT. Based on what we saw during this trip we anticipate that these components will be quickly brought on line.

TMS FUNCTIONALITY AND CONTROL
The TMS hydraulics were operated using temporary controls to demonstrate the tether payout and level-wind mechanism. The TMS tether control appears to be well-designed and functions cleanly. The fiber-optic slip ring was installed and functional. Although power had to be provided to the ROV by temporary lab power supplies, the fiber that controlled the ROV was operated through the temporary umbilical into the TMS, through the slip-ring and into the ROV via the tether, coming as close as possible to an end-to-end test.

LAUNCH AND RECOVERY SYSTEM
After the FAT we discussed the situation with the LARS. DT Marine will provide the winch as planned but DOER will take over the design of the remainder of the LARS once the TMS fabrication is completed. DOER is confident that the LARS will meet specifications and be compliant with Appendix A. Given the excellent results with the TMS design we are all comfortable with that decision.

SUMMARY
Although the entire system wasn’t functional for the FAT the items that were tested leaves us feeling confident that the complete system will meet or exceed our specifications. The DOER engineers and technicians were completing subsystems while we were there and were working in a very transparent fashion. Once a function was complete they immediately allowed us to observe the results with good success. None of the UH team expressed any reservations about what we
observed. All in all, once the testing got underway with a reasonable test structure in place we were pleased by the results.

.681 UMBILICAL CABLE
Mark Rognstad has put significant efforts into testing the cable that was assigned to us by the cable pool and has run tests that lead us to believe that the cable is in marginal condition and should NOT be used. He has circulated his results in a separate document.

SPARES LIST
(to be provided)