R/V *KILO MOANA* UPDATE

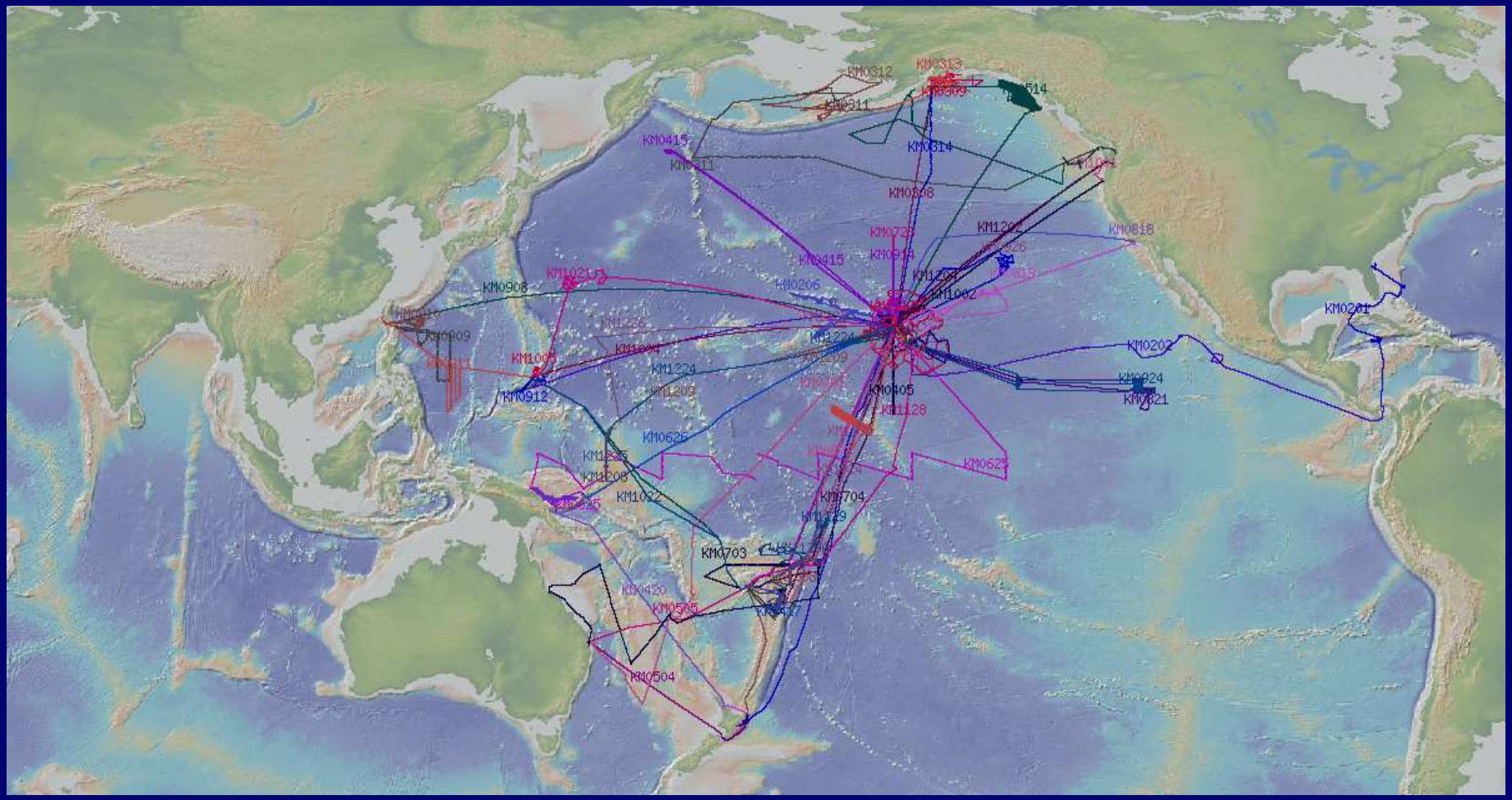
- Progress on Automation, Drives, and other Critical System Upgrades

Alan Hilton, *Marine Superintendent*
University of Hawai'i Marine Center, School of Ocean and Earth Science and Technology, University of Hawai'i at Mānoa

SCHOOL OF OCEAN AND EARTH SCIENCE AND TECHNOLOGY
UNIVERSITY OF HAWAI'I AT MĀNOA

R/V *KILO MOANA* historical shiptrack

The R/V KILO MOANA is a valuable asset to the U.S. oceanographic community, particularly in the Pacific basin. Since delivery in 2002, the ship had an active role supporting multi-discipline oceanographic research programs funded by NSF, ONR and other agencies, and is particularly important for the high tempo cruises required to support the multi-decadal Hawaii Ocean Time Series (HOTS) Program, and others leveraging that data set at the ALOHA station north of Hawaii.



Background on KILO MOANA Control System Issues

1. R/V KILO MOANA (AGOR 26) was built by Atlantic Marine (Jacksonville, FL) under the ABS 2001 rules for an unmanned/ACCU rated plant.
2. The vessel has an integrated diesel electric plant with a centralized automation and propulsion control system employing Rockwell SCRs, and a software control system designed by Electronic Design Inc. (EDI)… (now defunct)…
3. The Rockwell SCRs and related components were not the most current available technology when the ship was built. Certain components were nearing obsolescence when the ship was under construction, and Rockwell ceased training on that system shortly after delivery of KILO MOANA.
4. After breakup of EDI, some remnants of the organization were acquired by L3, and a subset of EDI software design engineers formed a small independent company, Robichaux Automation And Control Inc. (RAACI), recently acquired by Trident.
5. Rockwell replacement parts are getting rare, and some are not available at all. Only one person at Rockwell has the arcane knowledge to deal with the Rockwell logic controllers and software system on the ship, and he is nearing retirement.

Background on KILO MOANA Control System Issues

6. The EDI software has caused continual problems since the ship was first put into service. These problems have been well-documented in reports to USCG, ABS, UNOLS, NSF, and ONR during the ship's operational life, and have necessitated disconnecting much of the automation so that the ship can safely operate.

7. NOAA ships OSCAR DYSON and HENRY BIGELOW were also supplied with EDI systems. After struggling for several years with problems, those systems were completely removed and replaced in 2011 by Intelligent Systems Automation Inc.

8. The THOMPSON-Class AGORs all use GE based-systems for engine monitoring and control, and a separate system for propulsion control. KILO MOANA uses a single system (EDI) for both, which makes her unique (and uniquely vulnerable).

9. EDI system architecture is unlike any normally found in the industry. Hardware and software are not standard or commercially available. Documentation from the original manufacturers and programmers is inadequate. When problems occur, KM is often solely dependent on former EDI employees remaining in the industry with RAACI (just recently acquired by Trident Maritime Systems) with responses not always being timely, or helpful, and often resulting in loss of operating days.

Upgrade/Replacement of KILO MOANA Control System

1. While KM engineers have learned to live with many EDI system idiosyncrasies, regular failures have plagued the ship's operations, and major failures have led to loss of operational days and costs to bring in experts from RAACI and Rockwell to diagnose and correct the problems. Total costs of the failure history since construction have likely exceeded the cost of replacing the control system.

2. In view of the history, ONR and University of Hawaii reached agreement in 2014 to undertake a replacement/upgrade to the KILO MOANA Automation, Control, and other critical systems, with the goal to acquire a robust system consistent with industry standards that will remain supportable/serviceable for at least 12 years.

3. A technical support contract between UH and Alion Systems Inc., a company with many years of experience in replacing/upgrading legacy control systems on Navy and other vessels, was established to provide expert technical support and develop Statement of Work and other documentation to accompany the RFP issued by the University for this project in 2014, and to provide technical oversight services throughout the project execution.

4. The project is proceeding on schedule with several milestones completed, and the major installation phase to start next month and be completed in August 2016.

Upgrade/Replacement of KILO MOANA Control System

Brief details on scope and approach:

The intent is to keep the same basic form, fit and function of the existing Systems so that they will only have to meet the requirements of the original certifications (2001 USCG Unmanned Engine Room and the ABS Under 90 Meter Rules (ACCU). Certain new systems however will be required to meet the latest redundancy, environmental and safety requirements of the 2016 ABS Steel Vessel Rules / USCG Rules.

"Base Package" replacements/upgrades:

- Automation System
- Bow Thruster Control System Operator Interface
- Portable Control Stations
- DP System Interface
- Switchboard Generator Control Modification
- Steering Alarm Modification

"Options" pending design review (have since been awarded):

- Harmonic Filters
- Propulsion Drive System
- Bow Thruster Drive System
- Firemain Hard-Wired System Controls

SCHOOL OF OCEAN AND EARTH SCIENCE AND TECHNOLOGY
UNIVERSITY OF HAWAI'I AT MĀNOA

KILO MOANA Control System – Progress on Schedule

MILESTONE	COMPLETION
Contract between ONR and UH	✓
Disseminate RFP	✓
Bidder's Ship Check Dates	✓
Bid Opening	✓
Award	✓
Post Award Conference/Kickoff Meeting	✓
Design Verification Ship Check	✓
Design Verification Ship Check Report	✓
Preliminary Design and Milestones	✓
Design Review Meeting #1	✓
Design Review Meeting #2	✓
Design Review Meeting #3	✓
Equipment Factory Acceptance Testing	✓
Install Wiring During Alongside Period	✓
Installation and Testing of Equipment	May 2016
Sea Trials and Acceptance	August 2016

SCHOOL OF OCEAN AND EARTH SCIENCE AND TECHNOLOGY
UNIVERSITY OF HAWAI'I AT MĀNOA

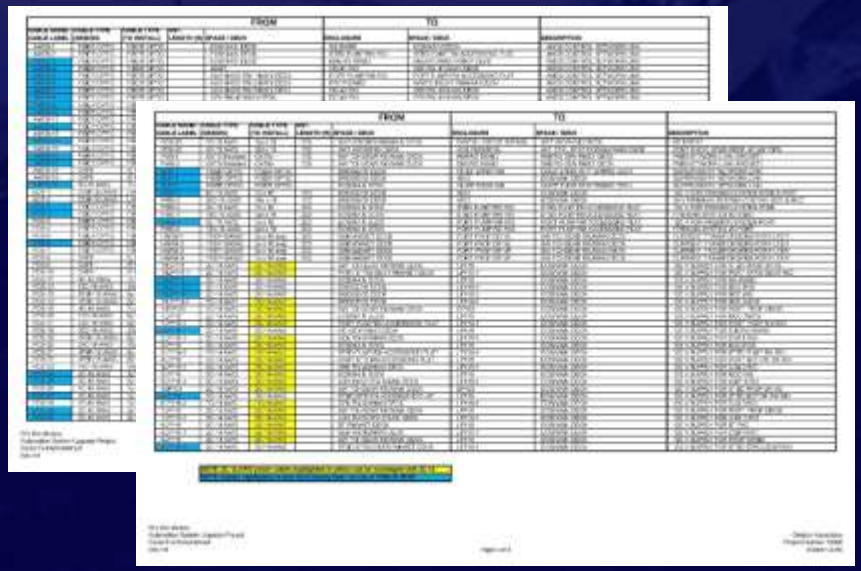
Recent Progress on KILO MOANA Control System

New Wire Pulls completed during alongside availability in Feb-Mar 2016:

- Approximately 40% of the new electrical cables were installed dockside at the Marine Center during Feb 11 – Mar 4, 2016. Existing cable transits with spare blocks were modified, and wires were pulled to the closest proximity of their final source and destinations. Progress color-coded on Cable Pull Spreadsheet_P4 (images below).

- Some cable transits are currently full, and may be freed up when unused cables are removed in the installation phase to allow room for new cables.

- Some cable runs will require new multi-cable transits installed. In these cases new wires were run to the bulkhead nearest the destination, awaiting installation of new cable transits.



SCHOOL OF OCEAN AND EARTH SCIENCE AND TECHNOLOGY
UNIVERSITY OF HAWAI'I AT MĀNOA

Recent Progress on KILO MOANA Control System

Factory Acceptance Trials in Anacortes, WA - March 2016:

- The new Alarm Management and Control System (AMCS) and Power Management System (PMS) factory acceptance tests took place in Anacortes on March 15-16 and deemed satisfactory overall.

- AMCS back planes / electronics and PMS workstations have been boxed and shipped to join the new enclosures already in Honolulu, prepped for installation.

SCHOOL OF OCEAN AND EARTH SCIENCE AND TECHNOLOGY
UNIVERSITY OF HAWAI'I AT MĀNOA

Installation Challenges for KILO MOANA Control System

"MAKING THEM FIT" … Sample challenges to be overcome:

- PUMP ROOM CABINET - Currently the new OAC cabinet will not fit through an existing ladderway. To affect install a section of the bolt-in ladder will be removed and stowed in an adjoining compartment.

- AMCS ENCLOSURES IN STEERING FLAT - The access hatch openings for these spaces are too small for the new AMCS enclosures. However, KM is currently replacing these hatches with new ones. Once cut out, the opening is large enough for the enclosures.

SCHOOL OF OCEAN AND EARTH SCIENCE AND TECHNOLOGY
UNIVERSITY OF HAWAI'I AT MĀNOA

Installation Challenges for KILO MOANA Control System

“HEAVY AND AWKWARD” … Sample challenges to be overcome:

- ACTIVE HARMONIC FILTERS –The new units (2 per enclosure) replacing the original passive filters weigh 480 lb each. The existing enclosures are plenty large enough for the new units once the existing filters have been removed, but the internal structure will have to be modified and cross members removed for new filters to be installed.

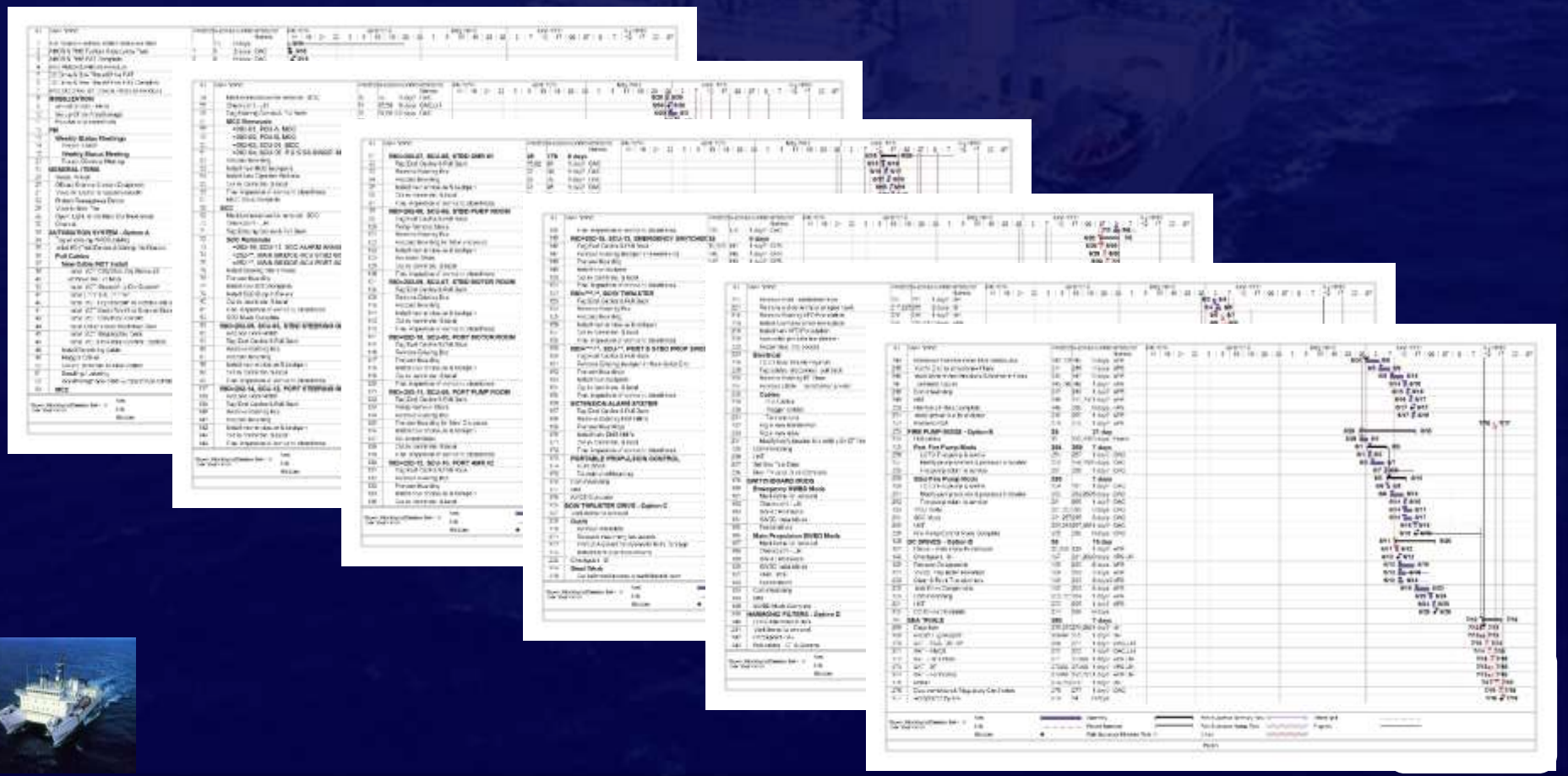
- BOW THRSTER CABLES – The existing cables from the bow thruster transformer to the breaker will need to be relocated. They are long enough for the new components but wrestling these anacondas to get them where needed will be difficult.

SCHOOL OF OCEAN AND EARTH SCIENCE AND TECHNOLOGY
UNIVERSITY OF HAWAI'I AT MĀNOA

Installation Schedule for KILO MOANA Control System

May 21st – August 24th, 2016 (KM alongside in Honolulu):

Contractor has developed a detailed installation plan including harbor & sea trials, commissioning and acceptance. A condensed schedule, based on contractual requirement to operate 7 days/week, has yielded about 3 weeks of contingency time within the planned installation period.



Until then…

R/V *KILO MOANA is at sea, doing science…*

SCHOOL OF OCEAN AND EARTH SCIENCE AND TECHNOLOGY