SCIENCE USER’S GUIDE

for HOVs Pisces IV & V, ROV RCV-150, and R/V Kaʻimikai-o-Kanaloa
This Science User’s Guide (formerly the Dive Briefing) has been authored, or with material supplied, by numerous HURL and UH Marine Center personnel over the years. The revision of this document, beginning in 2005 and with updates every year, is being carried out by Dr. John R. Smith, HURL Science Director.

Front cover: Background is a 3D false color shaded view of a digital elevation model for the main Hawaiian Islands looking from Loihi and the Big Island to the northwest along the Hawaiian Ridge to Kauai and beyond. Photos and data inset from HURL expeditions around the Pacific. Cover design by Brooks Bays, SOEST Publications.

Above photo: Synaphobranchid eel (Dysommina rugosa) colony inhabiting porous rock on Vailulu'u disrupted by Pisces V. NURP/HURL funded projects of Drs. Craig Young (Univ. Oregon) and Hubert Staudigel.

Inside back cover: Painting of Pisces V at Eel City on Vailulu'u by T. Kerby.

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Version 1, last revised: November 01, 2010
I. INTRODUCTION

This Science User’s Guide has been prepared to acquaint you with the Pisces IV and Pisces V human occupied vehicles (HOV), the RCV-150 remotely operated vehicle (ROV) and the research vessel (R/V) Ka’imikai-o-Kanaloa (KoK) so that you can work with HURL personnel to most effectively meet your project goals. For example, an observer who optimizes the use of video cameras becomes an active team member and greatly increases the success of the mission. The pilots will assist you whenever possible; however their primary responsibility is for the operation of the submersible and safety of the occupants. We hope that this information will assist you in making your plans and provide you with background information for a cruise that is not only successful and productive, but enjoyable as well. This guide will serve as a “welcome aboard” document and explains the range of experiences from living aboard KoK to diving with the Pisces submersibles, observing with the ROV, along with onboard data products and reporting requirements. Please see the Deputy Operations Director for fillable soft copies of reports and forms. This guide and forms are also available on the desktop of the conference room computer with printer attached.

The R/V Ka’imikai-o-Kanaloa is the multibeam equipped support vessel for Pisces V, Pisces IV and RCV-150, whose capabilities are described later in this briefing. Images and more detailed specifications of the ship, the submersibles, and the ROV can be viewed on the HURL web at: http://www.soest.hawaii.edu/HURL under ‘Facilities’ and ‘Data & Images’.

Pisces IV and Pisces V are three-person, battery-powered, one-atmosphere submersibles with a maximum operating depth of 2000 m (6,280 ft). They offer scientists direct observation through three view ports, video cameras, instrument placement, sample collecting, and environmental monitoring. They are launched and recovered from the stern of Ka’imikai-o-Kanaloa. The submersible in use is serviced between dives on deck and readied to dive again the next day in most cases. On any given cruise, one of the submersibles will be used to conduct science dives while the other remains in ‘ready’ status within the hangar onboard the support ship. With two submersibles aboard, there is little work area on the aft deck for other activities.

The RCV-150 ROV is a remotely operated robotic submersible. It is piloted from a shipboard station, receiving power and commands from the surface control console via a steel armored electro-mechanical fiber optical cable. The vehicle can operate to depths of 914 meters (3000 feet). It is equipped with a two color video cameras with lights and a CTD which sends data directly up the wire. RCV-150 is primarily used as a video survey tool that can acquire extremely close-up views because of its small size and maneuverability.

The multibeam bathymetric sonar mapping system aboard RV Ka’imikai-o-Kanaloa was upgraded to a SeaBeam 3012 phase 1 hybrid in early 2007. Details are discussed later in this guide. If existing data are available, dive maps will be provided to the operations team prior to your cruise. If you have access to high resolution data, please contact us early on. Otherwise, time and effort must be allotted to map the study area on site prior to dive operations.

Best of success with your science program!
### II. CONTACTS

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Questions about scheduling of dives are to be directed to the **Science Director**:
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HURL’s web site address is [http://www.soest.hawaii.edu/HURL](http://www.soest.hawaii.edu/HURL)

*Pisces sp.*

*by T. Kerby*
III. SUBMERSIBLES *Pisces IV & Pisces V*

**A. Equipment**

The form "HURL Checklist for Dive Equipment, Supplies, and Services" should be submitted to the Operations Director at least two weeks before the dive series or before the dive season begins if the vessel will be on extended deployment. See section VII for additional information and the need to submit this form early for unusual requests and/or when unique or complex interfaces are required. This usually involves equipment brought by the science team and needing power, hydraulics, and/or through the hull communication. The upcoming or current field season schedule is available on the HURL website. The HURL operations staff will place requested scientific equipment aboard the submersible. Not all of the available sampling equipment can be taken on a single dive since the submersible has a limited payload as well as limited space inside. The type and amount of equipment needed on a mission must be discussed with the operations staff well ahead of the dive. Remember to take into account the weight of samples to be collected. There could be an observer (per person) weight limit depending on the nature of the submersible mission, scientific equipment payload, and terrain. Please consult with the Operations Director regarding maximum weight considerations and to discuss your specific technical requirements. During the dive season, please contact personnel at the main HURL office (listed above) to relay your questions to the operations team. A pre-dive briefing will be carried out by the pilots at the beginning of your cruise leg for every observer scheduled for a
submersible dive. This briefing will cover basic diving needs (environmental conditions, clothing advice, dive outline, emergency procedures, scientific equipment and its operation, etc) and will allow you a chance to ask specific questions and get a feel for the inside of the command sphere. If your cruise leg begins diving the first day out of port, please contact the Operations Director ahead of time to get the pre-dive briefing sometime prior to departure (e.g., during loading the day before).

Laser scaling system on *Pisces* submersibles can use either 3 or 4 lasers. Image on right shows laser pattern on seafloor overlapping deployed instrument. Horizontal spacing is 16 cm. Photos are from previous dual and quad scaling systems.

Each submersible is equipped with the following items and can be configured as necessary to accommodate a variety of mission requirements:

1. Cameras
   - Insite Pacific *Mini-Zeus* HDTV, (full time, full high definition recording)
   - ROS low-light CCD, color (full-time standard definition S-video with overlay)
   - Back and white low-light wide-angle CCD (upon request for special projects)
2. Digital video recorders (Compact Flash cards for HD, hard disk unit for S-video)
3. Two hydraulically operated manipulators
4. General purpose science basket (configurable as requested)
5. Applied Microsystems electronic CTD profiler with in-sphere recording
6. Tritech SeaKing scanning sonar
7. Simrad altimeter
8. Benthos pinger receiver
9. TrackLink 5000HA USBL submersible tracking system
10. Sonatech tracking transducer
11. External lights: 3-250 W, 2-500 W tungsten, 1-400 W HMI
12. Externally mounted temperature probes with in-sphere recording
13. Suction sampler 8-bottle Rosette, upon request
14. Slurp gun and rotenone delivery device, upon request
15. Hydraulic cutters and rotary saw, upon request
16. Laser scaling system (tri or quad, 16 cm horizontal spacing)
17. Sealable water samplers (0.7 L) or Niskin bottles (2.5 L), upon request
18. Sealable sediment scoops or push core samplers, upon request
Observers in both *Pisces* submersibles have forward looking viewports (left and right) allowing overlap with the pilot’s viewport (center) and field of view. Face of Chief Pilot/Ops Dir Terry Kerby for scale.

**B. Camera Systems**

In 2009, HURL made the move to full time, full high definition (HD) video with the purchase of two Insite Pacific MINI-ZEUS HDTV cameras. On each sub, the HD camera is mounted adjacent to the ROS color CCD standard definition (SD) camera on a starboard pan and tilt, which provides a good view of the sampling basket and starboard side when traversing along walls. The scaling lasers are now affixed to the HD camera. The ROS standard definition (SD) S-video records/displays the data overlay and is recorded to hard drive with DataVideo’s *DN-10* recorder. The HD video is recorded to high-capacity compact flash cards with Convergent Design’s *Flash XDR*. Both sets of video are copied to external hard drives onboard *KoK* after the dive and one set of drives is provided to the PI along with all their other data. This marks a significant improvement in video quality provided to the science team and archived for future use. Furthermore, the video files are in a format that is ready to be imported into an editing system without any further conversion. In order to support these files, we have purchased a sea-going Apple *Macintosh* laptop as well as a shore-based high-end *Macintosh* editing computer, both loaded with Apple’s *Final Cut Pro*, which is the industry standard non-linear editing software. Tapes and DVDs are not part of the new recording and archiving system. HURL maintains the ability to work with tapes and DVDs only in our onshore Data and Science offices.
Mini-Zeus camera outputs high quality HD video which is recorded to compact flash cards with the Flash XDR, then it is transferred to rugged external hard drives. Video files can be imported directly into a non-linear editing system for analysis and the extraction of highlights.

A black and white low-light wide-angle CCD camera that allows for video to be collected under natural light conditions (referred to as the ‘CCD’ camera) can be installed and used upon request for special projects (e.g., bait stations). Other external cameras, lighting, and recording units from the science team or film groups can usually be accommodated but take some planning and preliminary discussion with the HURL Ops team.

Both new video recording systems on Pisces have enough capacity to not require changing of any media during a normal dive. However, the units should be periodically checked to make sure they are properly recording. Each dive is provided with four 64 GB compact flash cards for the HD video and a single hard drive for the SD video to record up to eight hours of continuous video. Audio from several microphones near the observers is also recorded with the video data onto both the HD and SD. If audio data is an essential part of the mission’s requirement, we suggest the science team invest in personal audio recorders to provide backup in case of video audio failure or interference. Output from the Zeus is analog Component HD which is then converted to digital HD-SDI using an intermediate converter.

You may use the pan and tilt control switches to point the video cameras at the subject. If the camera is not following the action, you may get distant scenes and disappointing video. Excessive use of the pan and tilt drains the submersible’s power and makes for a poor video product. With the new camera configuration, the high power, bright HMI light has moved to the upper pan and tilt, so it may also be adjusted for the best lighting angles. The pilots can maneuver the submersible to bring important subjects into better view. We suggest that you clearly state the time and depth of significant subjects and at the beginning and end of the recorded portion of the dive so that this information is recorded to the audio channel of the video data. The pilot will go over the camera and lighting system with you during the onboard briefing and again during descent if so desired.

A universal time clock in the sub outputs to a video overlay injected into the video stream and recorded to the ROS standard definition video. The overlay can be disabled temporarily for an
uninterrupted video scene. Observers will have to be careful to remember to reactivate the overlay so post-dive logging can effectively occur. There is a big red warning light to help remind you of this task. The overlay will include time, depth, heading, and altitude above bottom and these same values will be recorded in a data file on the onboard computer for later download and inclusion in the data package.

HURL operations personnel will make two complete video copies to external hard disk drives prior to erasing the HD compact flash cards and the SD hard drive unit. One will be archived with HURL on 1 TB drives and will not be accessed by the science team. The second copy on 500 GB or 1 TB drives will go to the PI/Chief Scientist. In order to make most efficient use of the fixed drive size, some shuffling of files to different drives may occur, though in logical fashion. For example, ROV dive video will also be include as well as CTD data, navigation, and pilot photos. If you want additional disk copies for Co-PIs, you will need to bring your own blank disk drives and be prepared to do the copying from the PI drives using science team personnel. Approximately 250 GB total per 7 hour dive for both the HD and the SD video are required. Each 1-2 hour ROV dive with SD video will require about 30 GB. The new primary system to copy, view, and edit the HD files for HURL is an Apple Macintosh computer using Apple’s Final Cut Pro software. For alternate Mac solutions, please contact the HURL Data Manager prior to or after your cruise. HD files can be converted to a PC readable format onboard by HURL personnel and provided to you with a copy of a free PC based viewing program. However, this software does not have editing or extraction capability. HURL can provide access to our shore-based editing computer and video data archive with sufficient notice.

C. Tracking and Object Detection Systems

Position of the submersibles is provided by a TrackLink 5000 HA USBL system (new in 2005) that provides improved tracking over the previous system to full operating depth. The TrackLink unit is interfaced with the heading and pitch/roll output from the TSS MAHRS gyrocompass motion sensor used for the multibeam system. A Sonatech Long Baseline Tracking system deck unit provides a back up verification of submersible slant range. A survey quality Trimble SPS461 GPS unit (new in 2010) feeds the various shipboard science and underway data sensors.

Pisces IV and Pisces V are equipped with a Tritech imaging sonar scanner to locate bottom features for navigation. Individual sonar images can be saved to disk, though the files do not include heading or position data. A Simrad altimeter sonar system is used to indicate altitude above the bottom. Directional antennae and pingers are used for site relocation.

D. Sample Collecting

The submersibles are equipped with two hydraulically controlled manipulator arms (Schilling Titan 4 (Pisces V) or Orion (Pisces IV) and a HYCO (Pisces IV & V) for collecting samples and deploying/recovering sampling gear. In order to insure proper identification of the substrates and organisms, we encourage observers to collect specimens. The Schilling arms provide dexterous ability, allowing delicate sampling such as breaking off small pieces of deep sea coral.
and placing them in numbered jars. Rocks can also be collected, but the manipulator and near neutral buoyancy of the submersible limit the ability to break off pieces from outcrops.

Eight suction sampler containers mounted on rotating hydraulic powered rosette platter to collect non-sterile loose material or small organisms.

E. Working Environment

The *Pisces* human occupied vehicles (HOVs) are 7-foot diameter, 1-atmosphere submersibles with life support for 3 persons for at least 72 man hours. Average dive duration in the *Pisces* is 6 to 8 hours. Environmental conditions during shallow dives (less than 400 m) may subject the observer to temperatures from 85 to 95 °F and humidity approaching 100%. “Blue ice” packs help and should be brought by the science teams. During deeper dives, the submersible becomes cold and damp, exacerbated by restricted movement. Observers must bring cold weather gear and make sure it is presented to the sub crew for stowage prior to the dive. Layers work best as the temperature changes gradually. There are no toilet facilities on the submersible, though special supplies are available. If unfamiliar with submersible diving, it is advised that observers consult with the Ops Director or other experienced scientists prior to the cruise. Observers must prepare their own mid-dive meal with foods available in the galley.

F. HOV Dive Outline (Note: Every fifth dive during the field season will include a co-pilot for training in lieu of one science observer. Co-pilots may also be used in difficult terrain such as active submarine volcanoes.)

While the science team should have a plan and location for each *Pisces* dive ahead of time, it is common that each submersible or ROV dive or multibeam survey will lead to new or lack of discoveries and changes in the succeeding dive plans and locations. When possible, the dive details should be presented to the Operations Director the evening prior to the dive, preferably during the after dinner science meeting. Note that the submersibles will not be launched in water deeper than the maximum operating depth of the vehicles. In some cases, exact dive sites are contingent upon the evening ROV and/or multibeam surveys. Discussion with the Ops Director should take place first thing in the morning if this is the case. The operations team will discuss the final dive target with the bridge crew. Warm clothing for the dive should be made available to the Ops team for stowage the evening prior to the dive. Multibeam operations will cease by
0600-0700 in order to line up for the submersible launch. Pack your lunch or snacks at breakfast or the night before.

It is strongly suggested that close attention be paid to dietary and fluid intake prior to a sub dive, along with efficient use of toilet facilities while they are available. Observers must be ready and in the hangar by 0800 and be prepared to board the submersible immediately once the pilot calls out to the deck via radio. The observers will remove their shoes and ascend the ladder to the top of the submersible while out on deck, straddle the tower, and lower themselves into the sphere using handholds and the internal ladder. Familiarity with this acrobatic maneuver will be had during the pre-dive briefing. Please be careful as the vessel will be underway, slowly moving down range during boarding. The launch is relatively quick and you will usually be submerged by 0830. Time on bottom will depend on the depth of the dive.

The pilot will have covered camera operation, emergency and safety equipment and procedures, camera and video recorder operation, and sampling techniques during the pre-dive briefing, though you are welcome to ask for a review of these procedures during the descent. This is also a good time to learn about the scanning sonar system, depth and temperature displays, and become familiarized with the fully loaded interior of the submersible during actual working conditions. If there is no co-pilot, you can learn how to assist the pilot with housekeeping duties to increase the scientific return of your dive program. Descent and ascent rates are typically 4-5 minutes per 100 meters varying with ballast, payload, and passenger weights.

Typically, the submersible will leave bottom by 1530 and be on deck and secured prior to the dinner hour of 1700. Once the submersible is secured and washed down, you may attend to the samples in the basket. If you plan to use the same sample gear on the next day’s dive, please ready it for reuse as soon as possible to allow the Ops team time to reaffix it to the submersible. The Ops team will provide you with CTD, tracking, and overlay data files sometime during the evening along with a reminder to complete the required Quick Look Report (QLR). It is best to complete this report as soon as possible before the dives pile up and blend together in your mind. Copies of video on disk will be provided by the next day and you may review these to assist in the preparation of your QLRs.
Scientific observer in the *Pisces* command sphere (left) maintains a personal log and operates deck unit for customized instrument interfaced with the submersible and operating externally. Typical view from observer’s viewport (right) with manipulator and sample/gear basket in view. Port side allows better view of manipulator and sample basket to keep track of samples while starboard side has less obstructed field of view. When transecting parallel to slopes, one side will be facing downslope and into the blue with not much of the seabed in sight.

Offloading biological specimens from the collection basket on the front of the *Pisces* submersibles (left) which consist of plastic milk crates and/or a plastic “bio box” with hinged lid (right, being pointed to). Various arrangements can be accommodated to meet the sampling goals. Segregated sections are usually necessary to help keep track of the samples and to identify at which site they were collected. Some scientists use numbered tubes.

Example of layered winter type clothing necessary to stay warm during a deep, cold temperature dive (left). Lab assistants Emily Yam and Wongyu Park cheerily process samples from the day’s dive in the lab late at night.
*Pisces V* (left) and *Pisces IV* (right) operating in tandem during two-sub operations. Two-sub ops are not routinely carried out for science diving because of the manpower required to operate, track, and maintain two HOVs at the same time. Pilots are recertified each year in emergency tracking exercises to echo-locate a simulated downed sub.

Pilot in training (PIT) Steve Price (top left) monitors sonar returns in *Pisces V* (top right). Pilots and observers must also monitor life support and video recording systems (bottom left). Pilot Terry Kerby operates *Pisces V* Schilling Titan 7F manipulator control with observer viewports to his left and right (bottom right). Every fifth dive takes a PIT in lieu of one observer. Expect confined quarters with restricted movement. Shallow dives (<400 m) are hot, deep dives are cold, both are damp. Bringing layered clothing works well as the temperature changes gradually.
Lead submersible electronic technician Colin Wollerman and pilot in training makes it happen on a daily basis (left). Submersible maintenance chief Steve Price rises before dawn for pre-dive checkout (right). Early mornings of preparation and late nights of maintenance are common to keep the submersibles diving on schedule.

Small (chase) boat operations include submersible support technicians Dave Wilkinson and Doug Bloedorn (left) enroute to attach the tow line to Pisces IV (center). Unwieldy objects can be recovered by Pisces with surface support by the experienced deck crew of KoK, led by Chief Mate Clary Gutzeit, if planned in advance (right).

Ops director Terry Kerby assigns the day’s launch and recovery duties on the board (left). A good and safe place to watch the launch and recovery is on the outside platform on the mezzanine level by the open hatch (center). **Stay clear of the Captain’s aft control station ("doghouse") view directly above this platform atop the submersible hangar and the main lift winch directly to the left.** Personnel transfer by small boat sometimes does occur and requires agility on the Jacob’s ladder, timing of your steps, and trust of Second Mate John Gall on the line (right). This procedure is usually planned in advance and is subject to conditions on site. Standard procedure is to embark and disembark while moored along a pier.
IV. REMOTELY OPERATED VEHICLE *RCV-150*

A. Description

The *RCV-150* is a remotely operated surveying and sampling tool. The system consists of the vehicle and launching cage and associated power and control consoles. It is piloted from a shipboard station, receiving power and instructions from the surface control console via a steel-armored electro-mechanical optical cable. The vehicle’s compact hydrodynamic design and neutrally buoyant tether cable permit close-up inspections and a high degree of maneuverability at speeds up to 3 knots. Excellent close-up images are thus possible, even closer and with more detail than from *Pisces* (See Appendix I.c. p. 44-45). The vehicle is designed to operate to depths of 914 meters (3000 feet) and in currents up to 2.0 knots.

Following deployment from the ship and its tether management system (TMS), the vehicle swims freely to conduct work on the seafloor or in the water column. The vehicle is equipped with a manipulator for sample collection, a pan and tilt color video camera, and 1500 watts of lighting. Other equipment and sensors may be adapted for use on the ROV. Since the support ship does not have a dynamic positioning (DP) system, the ROV dives mostly occur in traverse or scouting mode rather than extended on-site investigation and sampling. This methodology, though limiting in many ways, is useful for determining dive sites worthy of a manned *Pisces* dive. Because of the heavy TMS cage and maximum 914 m depth, the position of the ROV is assumed to be the same as the support ship.

*B. Camera System and Equipment*

The video recording decks for the ROV system are located in the navigation center. The ROV cameras are S-video but are converted and recorded on digital media. There is one forward looking camera in the vehicle that will tilt, a wide-angle piloting camera, and one fixed downward looking camera in the TMS cage. The latter provides a bird’s eye view of the terrain and the vehicle is ideally kept directly below. One DataVideo *DN-10* hard disk drive unit records the entire dive and copies are made as described for *Pisces* in section III.B. CTD data are also recorded directly to a file onboard and become part of the data package.
The RCV-150 is equipped with the following items and can be only slightly reconfigured:

1. Video cameras: Analog S-video on a tilt, wide angle for piloting, and overhead TMS view
2. Laser scaling system, 6” separation
3. Six (6) 250-W lamps
4. Tritech SeaKing sonar system
5. Hydro Products altimeter
6. Falmouth Scientific Micro CTD
7. Line cutting manipulator
8. Tracking pinger
9. Novatech strobe
10. Video hard disk recorders in Tracking Room

RCV-150 vehicle inside TMS cage during recovery.

C. Tracking and Object Detection Systems
The position of the ROV is assumed to be the same as the support ship for the reasons given above. Standard tracking data are provided as fixes of latitude and longitude every 10 minutes. This can be more often if a request is made to the ROV Ops team prior to or during the dive.

RCV-150 is equipped with a Tritech imaging sonar scanner to locate bottom features for navigation. Sonar images can be recorded on the video record by switching inputs. An altimeter sonar system is used to indicate altitude above the bottom and a depth gauge reports water depth.

D. Sample Collecting
Sample collecting ability with RCV-150 is essentially nil, though under ideal conditions it may be possible to use the limited function manipulator to recover one sample. No sample basket is available at this time.

E. Working Environment

Compared to the cramped, cold/hot, and damp environment of the Pisces command sphere, the control room for the ROV (just aft of the Bridge) is luxurious and comes equipped with toilet facilities and easy access to KoK’s snack and drink rich galley. At worst, the control room, which also serves as the tracking room for the submersibles during the day, can become warm and crowded. Please see the dive outline below for additional information on its best use.

F. ROV Dive Outline

While the science team should have a plan and locations for each ROV dive ahead of time, it is common that each submersible or ROV dive or multibeam survey will lead to new or lack of discoveries and changes in the succeeding dive plans and locations. When possible, the dive details should be presented to the Operations Director or ROV Chief immediately following the submersible dive, and preferably earlier. As with Pisces, the ROV will not be launched in water
deeper than the maximum operating depth. In some cases, exact dive sites are contingent upon the day’s *Pisces* and/or nighttime/service day multibeam survey. The operations team will discuss the final dive target with the *KoK* bridge crew. Steaming to the ROV dive site will take place from approximately 1700-1900. Post-*Pisces* dive chores, dinner, and final ROV preparation and launch line-up are also occurring during this time, as well as science team members dealing with their samples and regaling others with their fantastic tales from the deep. Evening science meetings are also typically held during the hour of 1800-1900.

At least one scientific observer must participate in and direct the dive in the control room. There is a specific observer station for the science party to observe and take highlight clips from, which is just across from the pilot’s control station. Several science team members can participate in the dive in this location while others are welcome to watch the dive on any available television or monitor onboard that is connected to the closed circuit television system. It works best for the ROV Ops team if the person(s) responsible for the dive’s direction are clearly identified and take active control of the agenda. Others are free to comment and suggest alternative activities during the dive, but having numerous voices giving directions, especially if contradictory, is distracting to the pilots and results in a more frustrating and less productive dive. Conversations on topics other than the dive at hand should be taken outside the control room as this also distracts the pilots and makes it difficult to hear the requests of the observers.

ROV dives typically last for an hour or so using the live boat transecting mode of operation described above. In typical operational mode, once the observer is satisfied (or the Ops team must end the dive for operational reasons), the vehicle is recovered, the ship repositioned, and the vehicle is lowered again for another dive. Depending on many factors, up to four dives may be accomplished in one evening. ROV operations normally cease by midnight, depending on staffing and the need for the ROV Ops team to participate in the morning *Pisces* launch. Once ROV operations are completed for the evening, data are closed out including CTD, tracking, and video. Video data are provided to the PI along with the other data types and a reminder to complete the required Quick Look Reports for EACH dive, defined as any lowering of the vehicle. **PLEASE STAY CLEAR OF THE UNATTENDED ROV WINCH DURING DIVES.**
V. MULTIBEAM SONAR SYSTEM

A SeaBeam 3012 phase 1 hybrid multibeam sonar bathymetric mapping system is installed aboard RV Ka‘imikai-o-Kanaloa. It was designed and manufactured by L-3 Communications/Klein Associates of Salem, New Hampshire in collaboration with L-3 ELAC/Nautik of Kiel, Germany. The system is capable of acoustically charting the seafloor peaks and valleys with complete high-resolution coverage to depths of 11,000 meters (nearly 7 miles deep). More than 250 individual across-track depth measurements can be made per ping cycle (typically 151), which typically occurs every five to ten seconds in moderately deep water. A swath width of 150º at 1000 meters (90º at 11,000 m) water depth can be ensonified during each pass and SeaBeam can typically acquire good data at ship speeds of 6 knots on RV Ka‘imikai-o-Kanaloa in average seas. Numerous parallel track lines with slight overlap of the swaths are laid out on top of the targeted survey area. Sidescan backscatter data with 12-bit resolution to a maximum of 2000 pixels is coincidentally collected. A specification sheet can be found in the Appendix. The main use of this system for HURL is to map potential submersible or ROV dive sites, which increases safety, operational efficiency, and scientific return.

Note that standard HURL and OTG operations do not include a dedicated multibeam survey technician. Basic operation is possible by the OTG technician, but survey planning, watches, and post-processing and map-making must be carried out by the science team. Dedicated technicians are available from the University of Hawai‘i at added cost to the PI, and in most cases will require a berth(s) taken from the science team share. Survey operations take place at night or on service days.

Seamount survey from 2007 using KoK’s SeaBeam 3012.1 system.
VI. OCEAN TECHNOLOGY GROUP

Newly available is the full suite of over-the-side oceanographic gear, instrumentation, sensors, underway data, and laboratory equipment that the Ocean Technology Group (OTG), the University of Hawai‘i shipboard technical support group, has to offer. One OTG technician sails on HURL cruises in a limited support capacity, usually sufficient with all the HURL operations being carried out. Please contact OTG for more information on what is available at the link below. Note that not all types of deployments are possible with the submersibles aboard. Most OTG ops will be carried out in evenings, nighttime, or on submersible service days.

http://www.soest.hawaii.edu/OTG/

VII. DATA PACKAGES

The HURL Data Department is the custodian of the original video data, digital still images, and mission data disks, archiving the data for later retrieval. These materials are available to other scientists subject to the following: The Principal Investigator may request that permission to use the data be subject to his or her approval for up to two years after a dive (this clause is on page 3 of the Quick Look Report).

The processed Pisces IV/V data package includes the following:

1) **Hard disk copies from the original video source for the entire dive**
   Facilities are available on board Ka‘imikai-o-Kanaloa to copy the original digital video data to external hard drives. One copy on hard disk(s) will be provided to the PI/Chief Scientist. Additional copies must be made by the science team on blank drives or other media and equipment provided by the science team. Approximately 250 GB total per 7 hour dive for both the HD and the SD video
are required. Each 1-2 hour ROV dive with SD video will require about 30 GB. Additional detail can be found in section III.B.

With the new video system, HURL no longer supports the DVD format onboard.

2) **A videolog of substrates/organisms seen in the video**

Videologs are referenced in terms of time (not counter). The identifications are tentative and corrections are appreciated. Scientist notes and logs are incorporated when available. A database of video entries is compiled. This is provided following conclusion the dive season. Track maps overlain on existing bathymetry are also provided, see below.

3) **Copies of the Quick Look Report (QLR) completed by the observer immediately following the dive (required by NOAA)**

Please have your observers fill in the Quick Look Report master that is provided by the HURL Ops team. QLR’s are required for every *Pisces* dive.

4) **CTD data**

Temperature, salinity, pressure (depth), time, density, and dissolved oxygen concentration can be recorded to a data file on the onboard computer.

5) **Tracking Data**

The tracking data provided onboard consists of an Excel file from the submersible tracking system containing latitude and longitude of the ship and submersibles. These data can be easily formatted to feed into other mapping systems such as ArcGIS, GMT, etc. A track map overlain on existing bathymetry will be provided in the data packet following post-processing ashore by the HURL Science and Data Departments. ArcGIS shapefiles can also be requested.

Submersible tracking station manned by HURL ops team member (left). Multibeam bathymetric underlay with ship position and submersible waypoints plotted (right). Tracking data are provided to science team as an Excel file.
The processed RCV-150 ROV data package includes the following:

1) Hard disk copies from the original video source for the entire dive
   One copy of the video data on hard disk(s) will be provided to the PI/Chief Scientist. Additional copies must be made by the science team on blank drives or other media and equipment provided by the science team. Each 1-2 hour ROV dive with SD video will require about 30 GB. Additional detail can be found in section III.B.

   With the new video system, HURL no longer supports the DVD format onboard.

3) Copies of the Quick Look Report completed by the observer immediately following the dive
   Please have your observers type notes into the Quick Look Report master that is provided by the HURL Ops team. QLR’s are required for every RCV-150 ROV dive. Each lowering and launch of the ROV is treated as an individual dive, even if multiple lowerings occur in one nighttime session (as is usually the case).

4) CTD data
   Temperature, salinity, pressure (depth), time, and density can be recorded to a data file on the data logging computer.

5) Tracking Data
   The tracking data provided onboard consists of an Excel file from the tracking system containing latitude and longitude of the ship. Since it uses a cage system, and is limited in both depth and tether out, and operates live boat with no dynamic positioning, the ROV is assumed to be directly below the ship. These data can be easily formatted to feed into other mapping systems such as ArcGIS, GMT, etc. A track map overlain on existing bathymetry will be provided in the data packet following post-processing ashore by the HURL Science and Data Departments. ArcGIS shapefiles can also be requested if desired.
VIII. FORM INFORMATION

Several required forms are included in the Appendix:

The “Authorized Observer List” and the “HURL Checklist for Dive Equipment, Supplies, and Services” are required at least two weeks prior to submersible dives. The time requirement and extent of information for the observer list may vary for foreign ports and extended deployments. For unique and unusual items or complex interfaces, the dive checklist should arrive, preferably with ongoing discussion, while the Ops team is at home port with enough time to prepare for integration of your gear. This is especially necessary for equipment brought by the science team and needing power, hydraulics, and/or through the hull communication.

Please send completed forms to:

Dr. John R. Smith  
Science Director  
Hawai‘i Undersea Research Laboratory  
University of Hawai‘i  
1000 Pope Rd. MSB 303  
Honolulu, HI 96822

Telephone: (808) 956-9669  
Fax: (808) 956-9772  
Email: jsmith@hawaii.edu

The “Medical Consent Form” (required by the State of Hawai‘i) and the “Assumption of Risk and Indemnity Agreement” (required by Federal and State agencies) must be filled out before the dive commences. Please give these to the Operations Director prior to the dive.

The “Quick Look Report” must be filled out by the observer or Principal Investigator immediately following completion of the dive (Principal Investigator must sign the form if submitting hard copies, PI’s signature will be implied if submitting digital copy). You will be provided with a master copy of the Quick Look Report on a floppy disk, CD-ROM, or flash memory device and will be expected to type your notes in. This part of the data package is required by NOAA. Highlight the mission’s accomplishments and discuss the mission’s significance in relation to both NOAA’s and your research goals. Indicate the general scientific contribution of the mission in terms of the organisms and processes observed or measured and the methodology/technology utilized. Indicate your plans for use of the data gathered on this mission and the applications, products and/or benefits to NOAA. Include any comments on the following operational details, where applicable: weather and water conditions affecting operations, safety problems and concerns, dive management and personnel cooperation, logistics and support activities. We will review these in order to spot trends, make adjustments, and thus improve the scientific return in future years. Please call particular items of concern to the attention of the appropriate HURL representative immediately as there is some delay in receiving and reviewing these reports.
The following updates to the “Project Summary Form” (submitted with your proposal) are required by NOAA and are to be submitted to the HURL Science Director on an annual and final basis if your project has been awarded through an RFP process through a NURP center:

The “Annual Status Report” is due one year following the official start of funding if this is a NURP funded project. The PI should submit an updated page 4 of the “Project Summary Form” briefly describing problems, procedures, results (presentations, publications, reports, etc.) to date, continuing projects, and a description of future plans. “The Annual Status Report” should be updated yearly (for multi-year programs) until analysis is completed.

The “Final Report” is due within one year of the completion date (as specified on the “Project Summary Form”) if this is a NURP funded project. The “Final Report” should include the last update of the “Project Summary Form” with any new information. Append details of the results and accomplishments to the updated Project Summary.

IX. PUBLICATIONS

Please send copies of publications resulting directly or indirectly from your submersible dives to the HURL Science Director. Publications of all types are an important measurement of dive results and we need to keep the list current.

If the recipient or its employee(s) use NOAA financial assistance to publish a paper based in whole or in part on the work funded by NURP, the author shall assure that the paper bears the following notation: “This paper is funded (‘in part’ if appropriate) by a grant/cooperative agreement from the National Oceanic and Atmospheric Administration. The views expressed herein are those of the author(s) and do not necessarily reflect the views of NOAA or any of its sub-agencies.”
X. R/V Kaʻimikai-o-Kanaloa

The following is a summary of life at sea aboard R/V Kaʻimikai-o-Kanaloa during HURL submersible operations and discusses the responsibilities of ship’s crew, submersible/ROV support crew, and scientific personnel along with policies and general rules of conduct while aboard ship. These policies and rules may be superseded and updated at any time.

A. Capabilities

Kaʻimikai-o-Kanaloa provides facilities for 10 scientists and 9 technicians (including submersible and ROV crews) and a ship crew of 14 for up to 50 days at sea. The ship is 223 feet in length with a beam of 38 feet. A high bow facilitates operation in rough seas and motion is compensated by anti-roll tanks.
Main Deck

The Main Deck includes the aft deck area with A-frame, submersible hangar, laboratories, and public areas.

The A-frame with telearm on the aft deck is used for launch and recovery of the submersible. The submersible is lifted off of the main deck, extended over the stern and lowered into the ocean. The submersible lift controls are located on the aft deck, allowing the operator an immediate view of the submersible for optimum judgment in the execution of its deployment or recovery.

The hangar area shelters the submersible for maintenance work while underway. The submersible is moved from the hangar to the open aft deck on a track system. Alternately, for two-submersible operations one sub is stored on deck directly under the telearm.

The laboratories for processing and analyzing samples recovered with the underwater vehicles include: geological-physical (wet), biological-chemical (wet), clean (dry), SeaBeam (dry), electronics, and video processing. The rock lab provides space for storage and analysis of solid samples recovered from the ocean. It also allows access to the ‘moon pool’ that houses the trolley to transport the sub control and communication equipment in and out of the water.

Seawater properties are measured in the marine chemistry lab. Electronic communication with a CTD (conductivity/temperature/depth) rosette-water sampling array is controlled from a computer console. Physical parameters of the water column that can be measured in situ electronically, such as salinity, temperature and pressure, are displayed in real-time. Experiments to determine further water quality values can then be conducted in the lab. Trace-element determination has its own Clean Room in the back of the lab. A laminar-flow hood
prevents the contamination of samples by dust particles. A 9 ft³ -80 °C freezer is available in the wet lab.

Geological-physical “rock” lab with access to moonpool and tracking tower (left) and video technician Jane Culp handling video data (right) with ultra-cold -80 °C freezer to her right. Various PI and HURL equipment along with the CTD rosette control station are usually set up here, along with storage of items in current use.

A SeaBeam3012.1 multibeam sonar bathymetric mapping system is installed aboard Ka‘imikai-o-Kanaloa. SeaBeam is capable of acoustically charting the seafloor peaks and valleys with complete high resolution coverage to depths of 11,000 meters. A near real-time bathymetric plot of the current survey is produced, and the digital data are recorded for later post-processing on the shipboard workstation computers. These procedures include editing of errant data, navigation merging, gridding of all swaths, combination with other data sets, and more complex color shaded relief plots and interactive 3D “virtual reality” fly-throughs using specialized software and peripherals. Being a deep water 12 kHz system, the SeaBeam 3012.1 sonar is not optimized for coastal depths below 500 meters. The SeaBeam 3012.1 system is a hybrid of the 2112 underhull transducers and transmitter electronics and the new 3012 echoprocessor electronics and does collect sidescan backscatter data along with bathymetry. Some applications of this technology include hydrographic charting for hazards to navigation, search and recovery operations, submersible support, marine resource exploration, scientific research, and surveying of fisheries habitat.

The electronics lab is for repair and development of electronic/electrical equipment associated with various scientific endeavors. Primary use is by HURL’s and ship’s electronic technicians.
Electronics lab (left) mainly used by HURL’s and ship’s technicians. SeaBeam lab main unit and operator’s station (center). Video lab (right) where the duplication of video data takes place, along with storage of media supplies.

The Macintosh laptop computer used for video data transfer from the Pisces and ROV recording devices is located in the ship’s A/V lab. In addition the copying and archiving of the video data to external hard disk drives takes place here. The A/V lab is also used for storage of blank and used Pisces video data media formerly referred to as “data packages.”

Conference room for science team work and meetings (top left), one of two lounges for all crew (top right), ship’s office with copier and email terminal (bottom left), and mess (galley) where all meals are served (bottom right). Access to the shipboard intranet is available in the labs, office, and via wireless in the conference room and hangar. A clothes washer and dryer are available. Laundry supplies and pillows, linens, blankets, and towels are provided.
The 01 Deck has two-person stateroom living accommodations with a shared head between two adjacent rooms. The ship is air-conditioned and heated throughout. The air castle is the open air platform between the berthing area and submersible hangar. This is where the CTD rosette system is stored, maintained, launched, and controlled using a telescoping boom and winch on the 02 deck above. The mezzanine level of the submersible hangar is also accessed on this deck.
The 02 Deck houses the submersible navigation center (tracking room) that is located just aft of the pilothouse for easy and immediate communications with the bridge during operations. This area also serves as the ROV control station. Scientific observers are welcome to these areas during non-critical times.

The covered winch and its deployment boom are used to deploy scientific equipment such as a CTD and bottle rosette system. HURL does not currently own such a system. PI equipment of this sort or PI rental through the UH/SOEST Ocean Technology Group can be accommodated with advance planning.

Ship’s Master Ross Barnes in the pilot house (left), Dan Greeson in the submersible tracking room (center) which also serves as the ROV control station (right) with pilots Peter Townsend and loaner Steven Tottori piloting a dive.

View of the 02 level open deck area from atop the submersible hangar looking forward at dawn on glassy seas.
B. Organizational Structure

1. Administration. The R/V *Ka‘imikai-o-Kanaloa* is owned by the State of Hawai‘i and operated by the University of Hawai‘i. The University of Hawai‘i research vessels are under the operational control of the School of Ocean and Earth Science and Technology (SOEST). Operation of the R/V *Ka‘imikai-o-Kanaloa*, including hiring of the crew, ship maintenance, and logistics support, is the responsibility of the staff at the University Marine Center (UMC) at Snug Harbor under the supervision of the Marine Superintendent. Responsibility for scientific equipment, ship scheduling, cruise planning, and reports is under the jurisdiction of the Port Operations Manager (UMC).

2. SOEST Key Personnel. The School of Ocean and Earth Science and Technology is located on the Manoa Campus of the University of Hawai‘i at 1000 Pope Road, Honolulu, Hawai‘i 96822. Personnel of SOEST involved in Ship Operations are: the Dean School of Ocean and Earth Science and Technology, phone (808) 956-6182, the Director of Administration, School of Ocean and Earth Science and Technology, phone (808) 956-9110, and Terri Duennebier, Marine Operations & Logistics, School of Ocean and Earth Science and Technology, phone (808) 956-3398.

3. UMC. The University Marine Center marine operations is located at #1 Sand Island Access Road, Snug Harbor, Honolulu, Hawai‘i 96819. Normal working hours are 0700 to 1530 Hawai‘i Standard Time. Key Personnel: Stan Winslow, Marine Superintendent, phone (808) 842-9814. Gray Drewry, Port Operations Manager, phone (808) 842-9815. Keith Adams, Purchasing Agent, phone (808) 842-9811. The UMC fax number is (808) 842-9833, email snug@soest.hawaii.edu. The Office Manager is Gen Pickering at (808) 842-9810. The dock side phone for KoK is (808) 842-9818 and cell is (808) 690-5393.

4. Port Facilities. Snug Harbor is part of Honolulu Harbor. The facility is located on the left side of the Sand Island Access Road traveling south just before you reach the bridge to Sand Island. Sand Island Access Road is located about mid-way between the airport and downtown on Nimitz Highway, the main highway between Honolulu Airport and downtown Honolulu (State Route 92). Pier 45 at Snug Harbor is a modern concrete pier 500 feet long with a least depth of 25 feet. Due to new Homeland Security regulations, access to the facility is by key card or photo ID sign in with the guard on duty. Please contact marine center personnel prior to shipping items for your cruise as there are specific guidelines to be followed to ensure timely delivery and acceptance.

C. Scheduling and Planning

1. The Schedule for the R/V *Ka‘imikai-o-Kanaloa* is posted on the UMC homepage (http://www.soest.hawaii.edu/UMC/amarcen.htm). The Port Operations Manager prepares it. The cruises are broken down into two general categories. The first category is those cruises primarily funded by NOAA that involve the use of the University of Hawai‘i’s manned submersible *Pisces V*. These have priority. The second category would be all other cruises. The Hawai‘i Undersea Research Laboratory (HURL) is primarily responsible for developing the NOAA portion of *Ka‘imikai-o-Kanaloa*’s
schedule. The Port Operations Manager works with the HURL office to develop a schedule for non-NOAA users involving *Pisces V*, and independently schedules all other R/V *Ka'imikai-o-Kanaloa* operations.

2. Scientific Party. The composition of the scientific party is the responsibility of the Principal Investigator(s) on each cruise leg. **Before the start of their cruise leg,** the Principal Investigator(s) must provide the UH Port Operations Manager with **personnel details** (sailing list) and copies of the Medical Consent Form and **Assumption of Risk and Indemnity Agreement** for each member of their party. Specific duties of Principal Investigators include: 1) Establish procedures, in consultation with the Operations Director, for conducting the scheduled research project; 2) Maintain close liaison with the ship’s Master and the Operations Director concerning the progress and near-future requirements of the research project; 3) Supervise the work of the science party; 4) Ensure that all members of the science party are aware of and comply with ship regulations, especially safety regulations; 5) Ensure that all equipment brought on board by the science party is properly secured for sea prior to departure; 6) Ensure that all equipment brought on board by the science party is removed from the vessel on return to port and that rooms assigned to scientists as well as lab spaces are debris and trash free, and as clean as possible prior to the science party departing for good; and 7) Assign science party members to science party staterooms and bunks, in consultation with the Operations Director as to which staterooms are available.

3. Multi-PI cruise legs. When a scientific party on a cruise leg includes two or more Principal Investigators, the PI’s must strive to fairly share berthing allotments, video equipment, laboratory space, and alternating dive days whenever possible. The most scientifically serious problems normally arise when dives are cancelled due to weather or equipment failure and the schedule changes. If an adequate solution is not agreed upon by the PI’s, then the Operations Director will referee the discussion and make the on site decision. In some cases, the HURL Director and/or Science Director may be contacted for clarification on variations from proposed and awarded work as a result of weather or equipment problems, or to referee particularly contentious situations.

4. Protocols for responding to cruise plan disruptions due to weather, equipment failure or other unforeseen circumstances.

(a) Occasional ROV or submersible dives lost due to weather or minor equipment failures are forfeited.

(b) Substantial disruptions due to weather or major equipment failure may warrant a rescheduling of the work program of a cruise leg, either by the shipboard Science Coordinator, or by the HURL Science Director or his deputy after consultation by phone, radio or email. Lost dives may be able to be rescheduled or carried over to the following year, subject to geographic, budgetary and programmatic constraints.

(c) In cases of major equipment failure, necessitating abandonment of a cruise leg and return to port, dives not accomplished will be conserved, if practicable, for priority rescheduling and accomplishment at the first suitable opportunity.
(d) Dives awarded that are not accomplished during the year for which they were awarded, or during the year following, are forfeited, except as provided for in (c) above. It is at the discretion of HURL management to carry over the dives beyond this period.

(e) When equipment already deployed on the bottom is scheduled for recovery during a leg, and dives are being lost to weather, sequentially or frequently, the first available dive will be devoted to recovery of the deployed equipment. The dive objective thereby displaced will be rescheduled to the day originally scheduled for the retrieval dive.

D. Shipboard Procedures

1. Authority of the Master. The ship's Master is, by law and tradition, solely and ultimately responsible for the safety of the ship and all personnel involved. Because of these responsibilities, the Master is given full legal authority over all operations and personnel onboard ship. Our Masters are selected with great care and realize that their primary function is to assist the Chief Scientist by doing everything possible to help ensure a successful and comfortable cruise. In practice, the Chief Scientist tells the Master what he/she wants and, unless it is illegal or unsafe, the Master will do everything he can to carry out those wishes. From time to time, the Marine Superintendent may direct that certain economies be practiced with regard to the use of fuel, other consumables, or working overtime.

2. Authority of the Operations Director. The Operations Director is the final authority in determining whether or not a specific submersible or ROV dive plan can be carried out safely. He will determine whether the submersible is ready in all respects for conduct of a dive of any nature, and whether it is to be a 1 or 2 observer dive.

3. Authority of the ROV Manager. The ROV Manager has final authority over the operations of the ROV during a dive, and for keeping the ship Master informed of the progress of the dive. He has the authority to terminate a ROV dive when appropriate. If the ROV becomes entangled, or cannot be retrieved in the normal manner, the ROV Manager is required to notify the Operations Director immediately.

4. Authority of the Submersible Pilot. The Submersible Pilot has final authority over the operations of the submersible during a dive. He will ensure that the dive is safe at all times and will have full authority to abort a dive when appropriate.

5. Joint Authority. The Master of the vessel and the Director of Dive Operations must jointly agree that weather and sea conditions allow for safe diving operations. Either, on his own authority, may cancel a scheduled submersible or ROV dive. Similarly, either may abort an ongoing dive due to worsening weather and/or sea conditions. When the submersible pilot is instructed by the tracking room to surface, he must comply with all due speed.
E. General Safety

The seagoing profession is by nature a hazardous one, which is especially true on research vessels where there is usually very little freeboard in the working area and the decks are frequently awash and slippery. Because of these conditions and the fact that most work is performed at or near to the side or stern of the ship, and heavy equipment and instruments are often lowered and recovered from the water, it is imperative that all safety instructions be scrupulously observed by all hands. Any situation that might involve danger should be corrected at once or reported to the Mate on Watch for further action. A minor accident at sea can prove serious or even fatal due to the fact that the ship may be days away from professional medical help. The Chief Scientist is responsible for the general operation and safety of the scientific laboratories and stowage areas; however, it must be remembered that ultimate legal responsibility for the safety of the entire ship lies with the Master. The Master must stop any procedure that he deems to be inherently unsafe. Periodic inspection of all scientific spaces and work areas should be made by a scientist and ship's officer to help find potential hazards. All hands are responsible for safety and, above all, they should exercise good common sense. Some specific rules and regulations are as follows:

When you go aboard, ensure that all your equipment and instrument are properly secured for sea. This includes your personal belongings in your stateroom;

Do not wear open-toed shoes, sandals, or "go-aheads" while working on deck. Good work shoes with rubber soles and heels are recommended. Safety shoes (steel-toed) are strongly suggested when working heavy loads;

Do not go topside when decks are secured because of heavy weather. If you must go out alone, be sure you inform the Mate on Watch when you leave and when you return;

Do not climb any of the ship's masts or superstructure without the permission of the Mate on Watch;

Do not sit or lean on lifelines, railings, or other temporary barriers along the sides or stern of the ship;

Do not smoke in bed or other prohibited areas, smoking is prohibited in ALL internal spaces of the ship. Fire is one of the most dangerous hazards encountered at sea and most fires are caused by personnel error and carelessness;

Secure all doors and hatches either open on their hooks or completely closed and dogged. Do not let them swing free;

Stay out of the bight (loop) of all running rigging, especially wires, ropes, and blocks that are under stress; never straddle or step across a line laid out on deck unless you are absolutely certain that it isn't a working line;

When working with suspended weights, keep them under control at all times by using steadying lines. Don't let yourself get caught between a swinging weight and a stationary part of the ship;

Wear life jackets or life vests when working on deck, or in areas where a fall might result in going overboard. When working aloft, wear a safety belt;
Do not put any equipment in the water until notified that it is safe to do so by the Mate on Watch;

Above all, keep your eyes and ears open. Pick up, clean up, and securely stow all loose gear and lines after each use and report any unsafe conditions to the Chief Scientist and the Master.

During submersible operations, the following apply to the back deck:

The transport, launch, and recovery of the submersible while underway presents a unique set of circumstances which mandates that those directly involved with the operation or are in close proximity to the operation remain safety conscious at all times. *Pisces V* and *Pisces IV* weigh 15 tons and that weight, coupled with the accelerations and forces added by ship's motion and sea conditions, put considerable strain on all of the various components of the sub-handling systems. Persons embarked in *Ka'imikai-o-Kanaloa* should be ever aware of their surroundings and alert for dangerous conditions that could arise due to ship's motion. This is particularly true during submersible launch and recovery operations. For that reason, the following rules will apply:

The **Surface Director** will coordinate the launch and recovery of the submersible and is responsible for safety on the back deck during launch and recovery operations. All members of the science party must clear the back deck during launch and during recovery until the sub is secured in its hangar.

All persons on the back deck at any time during launch and recovery operations or when the submersible is on deck and not securely fastened, **must** wear both a life vest and hardhat.

Normally, only those directly involved will be on the back deck during launch and recovery; however, the Surface Director may allow an observer(s) only if he/she is properly instructed and wearing the required hardhat and life vest.

Persons in or on top of the hanger are cautioned that, at times, both the towline and lift line are under heavy strain. If a fitting gives way or if a line parts, it will recoil. For that reason, never stand in line with any line under strain during any operations. All persons are reminded to stay out of the bight (loop) of any line on deck under any circumstance. Also, never cross over or straddle a line in use, walk around.

**BECAUSE OF THE CONSTANT GASSING OF THE SUBMERSIBLE BATTERIES, THERE WILL BE ABSOLUTELY NO SMOKING INSIDE THE HANGER WHEN THE SUBMERSIBLE IS PRESENT.** Most of this time the batteries will be under charge and the atmosphere in the vicinity of the submersible could be quite combustible.
Pisces V recovery in fair (left) and foul (center, right) seas in the South Pacific. Be ready for changing conditions.

F. RVOC Safety Training Manual

The RVOC SAFETY TRAINING MANUAL contains information on safety practices and procedures on board research vessels. Chapter 1, The Science party Supplement, highlights safety matters which pertain to all embarked in a Science Party and is required reading. Additionally, all in the party should be aware of the contents of this safety manual and refer to the appropriate section(s) for specific operations.

G. Drill and Emergency Procedures

Fire and Abandon Ship drills are required by law and are held weekly. A Fire and Abandon Ship drill will be held shortly after departure and all hands are required to participate. Life jackets must be worn at all drills. Immediately after joining the ship you should learn the location of your life jacket, survival suit, life raft, and other lifesaving equipment. You should also learn the location of fire extinguishers and fire-fighting equipment in all areas you will frequent. Your assignments for all drills and emergencies are listed on the assignment card located on your bunk.

1. Signals

Fire and Emergency: One continuous blast on the ship's whistle and General Alarm for a period of at least 10 seconds. Word will also be passed by mouth and general announcing system.

Abandon Ship: Seven short blasts and one long blast on the ship's whistle and General Alarm. Word will also be passed by mouth and general announcing system.

Man Overboard: Pass the word "Man Overboard" to the bridge. Five long blasts on the ship's whistle.

Dismissal from Drills: Three short blasts on the ship's whistle and General Alarm. Word will also be passed by mouth and general announcing system.

2. Procedures

Fire and Emergency: Upon hearing the Fire and Emergency signal, all scientists and passengers must don a complete set of clothing and a life jacket and muster on the fantail
or, if the fantail is inaccessible, on the 02 deck aft of the pilot house and await instructions. Survival suits will not be required for drills. The ship's company will fight the fire and may call upon the scientific party for assistance.

**Abandon Ship:** Upon hearing the Abandon Ship signal, all scientists and passengers don a complete set of clothing, including a hat if possible, and a life jacket and proceed to the assigned abandon-ship life raft. Bring any equipment listed on your bunk assignment card including your survival suit. Stand by and wait for instructions from Ship's Company.

**Man Overboard:** Upon hearing the words "Man Overboard," pass the word along throughout the ship by word of mouth. If you see the person overboard, keep your eye on him, point continuously at him to assist the Bridge Lookout, and throw a life ring over the side if one is near. Ensure that the Mate on Watch is aware of the person overboard. As soon as possible, the Chief Scientist should conduct a muster to determine who is missing. Stay clear of the bridge and recovery area unless your assistance is requested. If you fall overboard, don't swim toward the vessel; tread water, and let the ship come to you. Remember - in a Man Overboard situation the number one priority is "Do not take your eyes off the person in the water."

### H. Normal Sailing Hours

In port, the working day begins at 0700 and end at 1530. An "operational day" begins at and ends at 0800. The R/V *Ka'imikai-o-Kanaloa* will sail at 0800 of the first funded day and must return no later than 0800 after the last funded day. Alternate scheduling may occur in foreign ports.

### I. Messing Facilities

1. **Mess Deck.** The mess seats 24 people and is quite comfortable. All the scientists and ship's company mess together. Check the menu board in the galley for updated hours.

   Meal hours at sea are:
   - Breakfast.............. 0715 to 0815 (Return to port mornings may serve at 0600)
   - Lunch................... 1115 to 1215
   - Dinner.................. 1700 to 1800

   Meal hours in port are:
   - Breakfast.............. 0630 to 0700
   - Lunch................... 1115 to 1145
   - Dinner.................. 1700 to 1800 (when served)

   We ask that you remain clear of the mess deck one half-hour before and one hour after meal hours to allow the galley crew to set up and clean the mess deck. Due to the close proximity of persons eating in the mess deck, high standards of neatness and cleanliness are required. Footwear, shirts, and suitable shorts or trousers will be worn at all times. Dirty, ragged, or smelly clothing will not be tolerated in the mess deck or lounge area.
Hats, caps, or swimming attire will not be worn in the mess deck during meal hours. Because everyone cannot be seated at the same time, we ask that you do not loiter in the mess deck after you have finished eating.

2. **Night Rations**. Night rations and snacks are available on the mess deck and in the galley refrigerator. Ice cream and other frozen foods are available in the ship's freezer. Please feel free to help yourself at any time to any night rations that are available. All hands are expected to keep the mess deck clean and to place all dirty dishes and utensils in the galley sink.

3. **Personnel Authorized to Eat in the Mess Deck**. When the ship is in port in Honolulu, only the Ship's Company is allowed to eat on board. In all ports, the scientists authorized to live on board are also authorized to eat on board. Guests may be invited to eat on board provided the Cook is informed in advance and permission is obtained from the Master or, if he is unavailable, a ship's officer.

4. **Personnel Authorized to Live On Board**. Because of new Homeland Security regulations for ports, all oncoming science party should board during normal working hours in port (0700-1530) when crew members can sign you in and provide a visitor’s pass while in port. Random gear searches are required by the U.S. Coast Guard. To enter the UH Marine Center facility you will need proper picture identification (driver’s license, passport, etc). There is also a locked gate on the gangway to the ship which requires an access code. To board the ship after hours you will need to arrange for a HURL escort. Upon return to Honolulu, the scientific party should move off the ship prior to the noon meal on the day of return if the ship returns prior to 0800. Breakfast will be served. If the ship returns after 0800, the scientific party should be off prior to noon meal on the following day. In this latter case, the noon and evening meals will be provided on the day that the ship returns as well as breakfast on the following day. The Master or Marine Superintendent must approve all exceptions to this policy.

**J. Prohibited Items**

1. **Alcoholic Beverages**. The consumption of alcoholic beverages while the ship is underway is permitted only with the expressed permission of the Master in every case. At no time will alcoholic beverages be consumed by personnel on watch, going on watch, or while engaged in ship's business or scientific work. The following specific rules apply to all crewmen and scientists alike:
   - Embarked personnel shall not perform or attempt to perform any scheduled duties within 4 hours of consuming alcohol.
   - Embarked personnel shall not be intoxicated at any time.
   - Embarked personnel shall not consume any intoxicant while on watch or on duty.
   - Embarked personnel may consume a legal prescription or non-prescription drug, provided the drug does not cause the individual to be intoxicated.
2. **Illegal Drugs.** The University of Hawai‘i is committed to maintaining a drug-free work place and a safe and healthy work environment for all employees. This policy is strictly enforced on Ka‘imikai-o-Kanaloa. Consequently, all persons embarked are prohibited from engaging in the unlawful manufacture, distribution, dispensing, possession or use of drugs or controlled substances. The possession or use of illegal drugs is a violation of U. S. Law. Discovery of even trace amounts of illegal drugs by U. S. officials can result in the vessel being impounded, and some or all persons on board being arrested. Because of the serious consequences of even minor drug violations the following procedures shall be enforced:

The Master shall exert every effort to prevent illegal drugs or substances from being brought on board ship. Unannounced and thorough searches of the ship, including staterooms and personal effects will be made when deemed necessary and the results of these inspections entered in the ship's log.

Any illegal drugs or substances discovered by the Master, Chief Scientist or other ship's officers will be confiscated and placed in the Master's safe. Complete details concerning the amount and type of drugs, how, when and where they were discovered, together with the offender(s) name(s) will be entered in the ship's log. Upon arrival in port, the offender(s) and drugs will be turned over to U. S. Officials.

3. **Search and Seizure.** The Master of a vessel at sea is responsible for the safety of the vessel and all persons embarked therein. For this reason, he has broad authority to inspect all areas of his vessel, including personal belongings, for dangerous conditions or contraband. Persons embarked do not enjoy the same right to privacy as in their homes or temporary quarters ashore. All searches will be conducted by two persons (one scientist for science spaces) in a manner least offensive to the individual. Any contraband will be seized and disposed of accordingly.

4. **Drug and Alcohol Testing.** There are drug and alcohol tests kits on board. In the event of a major accident involving personal injury, oil spills, or significant material damage, federal law requires that all persons who may have contributed to the accident be tested for drugs and alcohol. There are no exceptions. The Master will decide who will be tested. Additionally, if accused of drug or alcohol use, an individual not in the crew may elect to be tested to show innocence. For example, a negative breathalyzer test would eliminate reasonable cause for a search for alcohol.

5. **Firearms and Sheath Knives.** Firearms and large sheath knives are not permitted on board. Should these items be purchased ashore during a voyage, they must be given to the Master to hold until the ship returns to port and the owner debarks.
K. Personal Conduct

1. Because of the confined space, isolation, and intimate living conditions, the social environment on board a research vessel is considerably different than that ashore. Privacy is greatly reduced, and interactions can become more intense. Instances that in everyday living would be annoying can take on exaggerated importance in a shipboard environment. In general, everyone should be very sensitive to this altered social condition and strive to be a good shipmate. Be alert that your personal habits and mannerisms could be annoying to others who, by virtue of the circumstances, must maintain a close association both in a working and off-work environment. In matters that are non-essential to the work at hand, be willing to modify your behavior somewhat if necessary to diffuse a possible conflict.

2. Sexual awareness and tensions can be heightened at sea. Anyone on board ship may be subject to more intense attention, welcomed or not, than they might experience on shore. This attention can be magnified to the point of sexual harassment. In order to reduce the possible occurrence of an unwelcome incident, everyone should consider the effect that certain actions and attitudes may have on others. Immodest dress, provocative gestures, and flirtatious behavior could create an atmosphere that would lead to a sexual harassment incident. Public displays of affection can easily lead to an unsolicited and unwelcome sexual advance by another. Sexual harassment is defined as manifestations of sexual discrimination that result in appropriate, coercive, or illegal communication that degrades the dignity of an individual. Examples are:

   Repeated sexually oriented communications, comments, gestures, or physical contact which demean the individual or create an intimidating, hostile, or offensive work environment.

   Showing of sexually explicit videos, photographs, etc. in common areas as the ship's lounge. (Showing of sexually explicit videos on the ship entertainment system is not allowed.)

   Offers or threats to influence or to alter, either directly or indirectly, an individual's career or other conditions of service in order to secure sexual favors.

3. Sexual harassment is unlawful. As an assault on an individual's rights and dignity, it is clearly inconsistent and unacceptable with the standards of the University of Hawai‘i. All persons are asked to use common sense and judgment in such matters; however, in the case of overt sexual harassment, it is the aggrieved person's right and obligation to report the offense to the Chief Scientist or Master of the vessel. The failure of a supervisor to take immediate, appropriate action where it was known, or should have been known, that a case of inappropriate conduct existed, would place that supervisor in serious jeopardy should future legal action be warranted. All personnel must be aware of this position and be warned that we will take decisive action whenever an allegation is made. Clearly, the best way to prevent serious incidents is to provide counseling and take action at the first indication of the problem.
L. Housekeeping

There are no stewards assigned in R/V Ka‘imikai-o-Kanaloa; therefore, all hands are expected to keep their staterooms and work areas clean and sanitary. The ship's crew will take care of general cleaning in the mess deck, lounge, common heads, passageway, and ship's operating spaces. You can make their job easier by cleaning up any mess you may make in these areas. Scientists will be responsible for cleaning the laboratories and scientific work areas. If you require assistance, check with the Chief Mate. The supply of fresh water is adequate but limited. Do not waste water when cleaning, showering, or washing clothes.

M. Communications

R/V Ka‘imikai-o-Kanaloa is equipped with modern communications equipment. The most reliable method of communication for data transmission is the INMARSAT-C system. KoK is equipped with a HF SSB transceiver, two VHF transceivers, and a cellular phone. All radio communications from the ship to other facilities are strictly regulated by law, and all messages via HF or VHF pertaining to the ship or scientific operations must have the approval of the ship's Master or Mate on watch before being transmitted. Brief personal messages or emergency communications can be sent between UMC and the ship at anytime. Contact the UMC office if assistance is required. The telephone number of Ka‘imikai-o-Kanaloa in port is (808) 847-5058 and the cellular number is (808) 722-0839. New since 2005 is a Fleet 77 system with ship-to-shore satellite voice capability and enhanced email capability. Science team will be assigned individual shipboard accounts and there will be charges ($0.25/kb) beyond 4 kb per day payable by cash or check to the ship’s ET prior to disembarking.

N. Post Cruise Requirements

1. Clean up. Every effort is made to make R/V Ka‘imikai-o-Kanaloa a clean and comfortable ship for each scientific group coming on board. If this goal is to be accomplished, each departing scientist must do his share to clean up the laboratories and staterooms. In the laboratories, all personal gear and debris should be removed and the area left in a clean and neat condition. In the staterooms, in addition to cleaning the room, sinks should be scoured and the rugs vacuumed. Blankets should be folded neatly at the foot of the bed and all soiled linen placed in the laundry bags provided. The heads and showers should also be scoured and cleaned. The location of any personal gear left on board must be reported to the Master.

2. Off-loading. When the ship returns to port, all cruise-specific scientific gear should be taken off the ship. Off-loading requirements should be noted in the cruise plan. On multi-leg cruises, material left on board for future use should be specified in cruise plans and coordinated with the Master. Heavy loads that will require use of a commercial shore crane must be allowed for and the Master notified well in advance of arrival.
O. Miscellaneous Information

1. **General Restrictions.** With very few restrictions, you are free to visit any part of the ship, and we encourage you to look around and get acquainted with the crew. Do not enter voids, tanks, or other isolated spaces without checking with the Mate on Watch. If you would like to visit the engine room, make arrangements to do so with the Chief Engineer who will be glad to show you around. Normally you are free to visit the bridge at any time with the permission of the Mate on Watch. Visitors to the bridge are restricted by law when the vessel is getting underway, mooring, or operating in restricted waters. If you have any questions about R/V *Ka'imikai-o-Kanaloa*, please feel free to ask any of the ship's officers. Our only purpose is to help you accomplish your mission in a safe and economical way. We are eager to do anything we can to make your stay a profitable and happy experience.

2. **Medical Information.** Medical treatment resources on board are very limited. No medical doctor is assigned, but the Master and Ship's Officers have first aid training. The ship has a small medical locker that contains pain killers, various antibiotics, aspirin, cough medicine, cut and burn lotions, and other common-use items recommended by the Maritime Health Services. Only persons in good general health should be assigned to the scientific party. Persons who require medication to sustain good health take a great risk in going to sea. Loss of medications overboard or due to flooding, fire, or abandoning ship, etc., is always a possibility. Special medications are not normally stocked in the medical locker. Members of the scientific party who require special medication must ensure that they have adequate supplies on board before getting underway. The Port Operations Manager will provide a Medical History Form to all scientists scheduled to depart on a cruise. This completed form will be forwarded to the Maritime Health Services headquarters to assist it in providing medical advice if an emergency occurs. Except in extreme emergencies, prescription drugs will not be dispensed without the approval of MHS physicians.

   All injuries must be reported. The Master will ensure that an Employee's Report of Injury Form is completed and forwarded to the University Marine Center as soon as practical. The Chief Scientist will assist in completing this form when members of the scientific party are involved. All injuries and sickness, no matter how slight, will be entered in the ship's log. All medical information is kept strictly confidential.

3. **Swimming and SCUBA Diving.** Swimming from the ship at sea for recreational purposes will not be permitted without the express approval of the Master and the concurrence of the Chief Scientist. Recreational SCUBA diving is not permitted when the ship is at sea. If swimming or SCUBA diving is scheduled as part of the scientific operation, it will be noted in the Ship's Operating Plan. All diving must be approved well in advance by the University of Hawai‘i Diving Control Board. All diving or swimming operations must be approved by the Master.

4. **Hazardous Materials.** Programs requiring the use of hazardous materials, including all radioactive substances, will be coordinated with the Port Operations Manager well in
advance of the cruise. Special permission is required by the University of Hawai‘i for the use of such material aboard ship. Material requiring special handling or exposure will be severely limited, both in its use and location on board ship. Permits required for the acquisition, transportation, or use of hazardous material must be obtained by the Chief Scientist and copies made available to the Port Operations Manager. MSDS sheets for all chemicals must be presented to the Chief Mate or Master prior to loading. If there are large volumes to be stored aboard, special arrangements must be made ahead of time. All chemicals must be removed from the vessel at the conclusion of a cruise, unless specific arrangements have been made with the following science teams to be responsible for their use and/or removal. For extended operations to distant foreign ports, planning ahead with the UH Marine Center staff and ship’s crew will be key

5. Exercise Equipment. There is limited exercise equipment available on board.

6. Smoking. There is no smoking within the interior of the ship. Smokers must go topside to smoke.

R/V Ka‘imikai-o-Kanaloa on station with Pisces in ideal sea conditions. This is not always the case.
XI. APPENDIX

I. Specifications Sheets
   a. Pisces IV
   b. Pisces V
   c. RCV-150
   d. SeaBeam
   e. R/V Kaimikai-o-Kanaloa

II. Required Forms
   a. Authorized Observers list
   b. Dive Equipment Checklist
   c. Medical Consent
   d. Assumption of Risk
   e. Quick Look Report
   f. Annual/Final Report

*Pisces* in action working on the seafloor in different locations performing various sampling and observational tasks.
PISCES IV
Deep Submergence Research Vehicle

GENERAL DATA
Length: 20’
Width: 10’ 6”
Height: 11’
Weight: 13 tons
Payload: 250 lbs.
Crew: 1 Pilot 2 Observers
Life Support: 140 hours for 3 people
Max. Operating Depth: 6,500 ft.
Power: Two lead-acid battery systems: 120 VDC at 330 Ah capacity
12-24 VDC at 220 Ah cap.
Propulsion: two side mounted reversible thrusters tiltable through 100 degrees
Speed: 3 Kts.
Duration: 7 – 9 hours

CONSTRUCTION
Builder: International Hydrodynamics of Vancouver, British Columbia
Classed by American Bureau of Shipping
Vancouver, British Columbia
Builder: International Hydrodynamics of

LIFE SUPPORT
Oxygen and CO2 absorbent for daily use is sufficient for twice normal mission duration.
Independent emergency supplies available for 120 hours for 3 people.
Full face air masks available in case of cabin air contamination.
MSHA-NIOSH approved self-contained Oxygen-Generating Breathing Apparatus available for 3 crew.

SYSTEMS
Buoyancy Control
Soft ballast tanks displace a total of 1904 lbs.

H.P. Air
Carried in 5 externally mounted cylinders with a total capacity of 600 scf at 3000 psi. Used for ballast system and emergency breathing apparatus.

Oxygen
Two 22 ft³ cylinders available for daily use.
Independent emergency supply in 4 externally mounted cylinders has a capacity of 480 cu. ft. at 3000 psi.

Ventilation
Cabin Atmosphere is monitored by oxygen analyzers. Oxygen level is maintained by constant flow. CO2 is removed by a electrically powered scrubber unit and granular CO2 absorbent material.

Hydraulic System
Electric pump and solenoids provide 3 gallons per minute at 1000 psi to the following equipment:
-HYCO manipulator
-Basket basket up and down
-Ascent/Descent weight drop cylinders
-Thruster tilt
-Movable drop weights
-2 camera pan and tilt system
-Tilttable scanning sonar head
-2 spare functions for science equipment
-A separate dedicated hydraulic system operates a Schilling Orion manipulator.

Controls and Instrumentation
The pilot has available all controls necessary for the operation of all submersible systems in both normal and emergency situations including thruster controls, buoyancy controls and indicators, battery condition instruments, depth and pressure gauges, magnetic compass, life support monitoring instruments and controls, and surface and underwater communications.

EQUIPMENT
The submersible is equipped with the following items and can be configured as necessary to accommodate a variety of mission requirements.
Insitue Pacific MINI-ZEUS HDTV camera
ROS low-light CCD color camera
B&W low-light wide-angle CCD
Digital video recorders
Two hydraulically operated manipulators
General purpose science basket
Applied Microsystems electronic CTD profiler
Tritech SeaKing digital HD sonar
Kongsberg-Simrad 1007 200 m altimeter
Benthos multi-frequency pinger receiver
TrackLink 5000HA USBL submersible tracking system
Sonotech long baseline acoustic tracking system
External lights: 3- 250 W, 2-500 W tungsten
2-400 W HMI’s available

EQUIPMENT (continued)
2 K VH digital magnetic compasses
Externally mounted temperature probes with internally mounted monitors
Suction sampler 8-bottle Rosette
Hydraulic cutters
Hydraulic rotary saw
Laser scaling system
Push core samplers
Sealable sediment scoops - 4 arrays of 9 samplers, capacity ~1kg ea
Water samplers - 2 arrays of 6 samplers, capacity ~700ml ea

SAFETY FEATURES
Jettison equipment:
Main trim weight 500 lb
Port emergency drop weight 250 lb
Starboard emergency drop weight 250 lb
Thrusters can be jettisoned in the event of entanglement
Extended life support capacity for 3 to 5 days, mainly dependent on crew weight
Salt water leak detectors in bilge, battery boxes, electrical junction boxes, and controllers
Acoustic locating pinger receiver system
Emergency self contained re-breathers
Full face mask air breathing system for contaminated atmosphere
Emergency life support rations, water, and space blankets
One main and one backup 24 VDC emergency battery power banks to power CO2 scrubber circulating fan
cabin lights
underwater telephone
VHF radio
tracking transponder
hydraulic solenoids
Soft ballast tanks have an accessible exterior port to allow a rescue vehicle to insert an external air source to add buoyancy.
PISCES V
Deep Submergence Research Vehicle

GENERAL DATA
Length: 20'
Width: 10'6"
Height: 11'
Weight: 13 tons
Payload: 175 lbs.
Crew: 1 Pilot 2 Observers
Max. Operating Depth: 6,280 ft
Power: Two lead-acid battery systems:
120 VDC at 330 Ah capacity
12 - 24 VDC at 220 Ah capacity
Propulsion: Two side mounted reversible thrusters tiltable through 90 degrees.
Speed: 3 Kts.
Duration: 7-9 hours

CONSTRUCTION
Builder: International Hydrodynamics of Vancouver, British Columbia.
Classed by American Bureau of Shipping
Materials: Personnel sphere, Trim sphere, and Aft sphere: HY 100 steel
Frame: Welded, oil-filled, pressure compensated tubular steel.
Viewports: 3 forward-looking acrylic windows, 6" interior-14" dia exterior
Penetrators: 28 316 SS inserts to pass electrical, hydraulic air, and oxygen supplies through the hull.

LIFE SUPPORT
Oxygen and CO₂ absorbent for daily use is sufficient for twice normal mission duration. Independent emergency supplies available for 120 hours for 3 people. Full face air masks available in case of cabin air contamination.
MSHA-NIOSH approved self-contained Oxygen-Generating Breathing Apparatus available for 3 crew.

SYSTEMS
Buoyancy Control
Soft ballast tanks displace a total of 1904 lbs. using H.P. air.
Dropable descent/ascent weights.
Hard ballast tanks and hydraulically powered seawater pump give 450 lbs. of trim adjustment.
H.P. Air
Carried in 8 externally mounted cylinders with a total capacity of 890 scf at 3000 psi. Used for ballast system and emergency breathing apparatus.

Oxygen
Two 22 ft³ cylinders available for daily use. Independent emergency supply located in aft sphere has a capacity of 454 cu. ft. at 2640 psi.

Ventilation
Cabin atmosphere is monitored by oxygen and CO₂ analyzers. Oxygen level is maintained by constant flow. CO₂ is removed by electrically powered scrubber unit and granular CO₂ absorbent material.

Hydraulic System
Electric pump and solenoids provide 4 gallons per minute at 200 psi to the following equipment:
- HYCO manipulator
- Thruster tilt
- 2 camera pan and tilt systems
- Ascent and descent drop weights
- Tiltable scanning sonar head
- Sample basket up and down
- 2 spare functions for special science sample collecting systems.
- A separate dedicated hydraulic system operates a Schilling Titan 4 manipulator. This system can be used as utilities hydraulics in the event of an emergency via a manually operated crossover valve.

Controls and Instrumentation
The pilot has available all controls necessary for the operation of all submersible systems in both normal and emergency situations including thruster controls, buoyancy controls and indicators, battery power instruments, depth and pressure gauges, magnetic compass, life support monitoring instruments and controls, and surface and underwater communications.

EQUIPMENT
The submersible is equipped with the following items and can be configured as necessary to accommodate a variety of mission requirements:
- Insite Pacific MINI-ZEUS HDTV camera
- ROS low-light CCD color camera
- B&W low-light wide-angle CCD
- Digital video recorders
- Two hydraulically operated manipulators
- General purpose science basket
- Applied Microsystems electronic CTD profiler
- Tritech SeaKing digital HD sonar
- Kongsberg-Simrad 1007 200 m altimeter
- Benthos multi-frequency pinger receiver
- TrackLink 5000HA USBL submersible tracking system
- Sonatech long baseline acoustic tracking system
- External lights: 3- 250 W, 2-500 W tungsten
- 2-400 W HMI’s available
- 2 KVH digital magnetic compasses
- Externally mounted temperature probes with internally mounted monitors
- Suction sampler 8-bottle Rosette
- Hydraulic cutters
- Hydraulic rotary saw
- Laser scaling system
- Push core samplers
- Sealable sediment scoops - 4 arrays of 9 samplers, capacity ~1kg ea
- Water samplers - 2 arrays of 6 samplers, capacity ~700ml ea

SAFETY FEATURES
Jettison equipment:
- Main emergency drop weight 480 lb
- Port emergency drop weight 250 lb
- Starboard emergency drop weight 250 lb
- Thrusters can be jettisoned in the event of entanglement
- Extended life support capacity for 3 to 5 days, mainly dependent on crew weight
- Salt water leak detectors in bilge, battery boxes, electrical junction boxes, and controllers
- Acoustic locating pinger receiver system
- Emergency self contained re-breathers
- Full face mask air breathing system for contaminated atmosphere
- Emergency life support rations, water, and space blankets
- One main and one backup 24 VDC emergency battery power banks to power: CO₂ scrubber circulating fan cabin lights underwater telephone VHF radio tracking transponder hydraulic solenoids
- Soft ballast tanks have an accessible exterior port to allow a rescue vehicle to insert an external air source to add buoyancy.
RCV-150
Remotely Operated Vehicle

(First 3 photos below from RCV, last 2 from Pisces)

General Data
Length: 52”
Width: 47”
Height: 43”
Buoyancy in water: 15 lb
Weight in air: 1,215 lb
Payload: 100 lb
Operators: 2
Max. Operating Depth: 3,000 ft
Power: 880 VAC via umbilical
Propulsion: four 10” diameter thrusters, two horizontal, two vertical
Speed: 1.5 knots forward, 0.5 knot vertical (approximate)
Duration: limited by operator endurance

Construction
Hydro Products Corporation, San Diego, California
Materials
syntactic foam
filled glass reinforced plastic
aluminum pressure bottles
glass dome

Systems

Hydraulic System
Electrically driven hydraulic pump,
15 gpm, to the following equipment
thrusters
manipulator

Controls and Instrumentation

The pilot and co-pilot have available all controls necessary for the operation of all remote operated vehicle systems in both normal and emergency situations.

Equipment

Analog video camera on pan/tilt, wide angle camera, and overhead cage camera, recorders
Laser scaling system, 6” separation
Six (6) 250-W lamps
Tritech SeaKing scanning sonar system
Hydro Products altimeter
Falmouth Scientific Micro CTD
Line cutting manipulator
Tracking pinger, USBL beacon on TMS
Novatech strobe
SeaBeam 3012.1 (2012/3012 hybrid) 
Multibeam sonar bathymetric mapping system

Technical Specifications

<table>
<thead>
<tr>
<th>SEA BEAM 3012 Phase 1 Upgrade Specifications</th>
</tr>
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<tbody>
<tr>
<td><strong>Frequency:</strong> 12 kHz</td>
</tr>
<tr>
<td><strong>No. of Beams:</strong> Variable to &gt;250 (equal distance spacing)</td>
</tr>
<tr>
<td><strong>Accuracy:</strong> Better than 0.5% of Water Depth (Average Across Swath)</td>
</tr>
<tr>
<td><strong>Sidescan:</strong> 12-Bit Resolution to maximum 2000 pixels</td>
</tr>
<tr>
<td><strong>Average Footprint Resolution:</strong> 2 Degree x 2 Degree</td>
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<tr>
<td><strong>Swath vs. Depth:</strong></td>
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<tr>
<td>1000m Depth — 150°</td>
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<tr>
<td>2000m Depth — 130°</td>
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<tr>
<td>4500m Depth — 120°</td>
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<tr>
<td>8,000m Depth — 100°</td>
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<tr>
<td>11,000m Depth — 90°</td>
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<tr>
<td><strong>Max. Vessel Speed:</strong> 12 Knots (100% Coverage) = system spec 6-9 Knots = KoK platform spec</td>
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<tr>
<td><strong>Workstations:</strong> PC based HydroStar Online</td>
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<tr>
<td><strong>Transducer Arrays:</strong> Projectors are molded modules, each containing ceramic resonators: 10 Modules Hydrophones are molded modules, each containing ceramic line elements: 8 Modules</td>
</tr>
<tr>
<td><strong>Environmental Limits:</strong> Roll ± 10° Pitch ± 10° Yaw ± 5° Temperature 5° to 40° C Humidity 10% - 80% Non-Condensing</td>
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* Performance based on typical backscatter level of -26 dB and total noise level equivalent to Sea State 4.

The hybrid system uses the transmitter and underhull projectors and hydrophone modules from the 2112 and the echoprocessor and HydroStar operator’s station from the 3012.
R/V Ka‘imikai-O-Kanaloa

The Research Vessel R/V Ka‘imikai-O-Kanaloa was originally the M/V Western Strait. The M/V Western Strait was constructed by Mangone Shipbuilding as a Diesel Electric Seismic Vessel in 1979. The vessel was converted to a Research Vessel and Submersible Support Ship for use by the University of Hawai‘i HURL program by Bender Shipyard in 1992.

DESCRIPTION OF VESSEL
R/V KA‘IMIKAI-O-KANALOA

BUILT: 1979 (Modified in 1993)
LENGTH: (LOA) 223’
BEAM: 38’
DRAFT: 13'6”
GROSS TONNAGE: 259
DISPLACEMENT: 1,961 tons
CREW: 14
SCIENCE CREW: 19
SCIENTIST: 10
PISCES V: 6
ROV: 3
OWNERSHIP: State of Hawai‘i
STATE I.D. NO.: HA-343-XS
MAIN ENGINES:
(2) Detroit Diesel (16D-149HT) 1035 SHP(ea)
BOW THRUSTER:
1000 HP (Electric) (Derated to 250 HP)
SERVICE GENERATOR:
1-250KW 12V71 Detroit Diesel
AUXILIARY GENERATOR:
1-150KW 8V71 Detroit Diesel
SPEED:
CRUISING: 10 knots
FULL: 11 knots
MINIMUM: 1 knot
ENDURANCE:
50 days (Food Stores & FW)
RANGE:
15,000NM (60 days - Fuel)
FUEL CAP.: 175,744 Gal.
LABORATORIES:
ROCK: 303 sq. ft.
WET: 300 sq. ft.
CLEAN: 150 sq. ft.
DRY: 300 sq. ft.
CONFERENCE ROOM: 250 sq. ft.
HANGAR: 1,332 sq. ft.
SEWAGE SYSTEM:
Red Fox Marine Sanitation Device (RF-750M)
INCINERATOR: None
PROPELLORS: Twin-Fixed Pitch (SCR Drive)

SCIENTIFIC CAPABILITIES:

Primarily designed as support ship for the UH manned submarine (PISCES V) and an ROV. Also capable of conducting research in Biology and Chemistry. CTD capable.

SEABEAM: A SeaBeam 210 multibeam sonar bathymetric mapping system is installed aboard Ka‘imikai-o-Kanaloa. SeaBeam is capable of acoustically charting the seafloor peaks and valleys with complete high resolution coverage to depths of 11,000 meters (nearly 7 miles deep). A near real-time contour plot for the current swath is produced, and the digital data are recorded for later post-processing on the shipboard Silicon Graphics UNIX workstations. Some applications of this technology are: hydrographic charting for hazards to navigation, search and recovery operations, submersible support, marine resource exploration, scientific research, and localization of seamounts as natural fish aggregation devices.

WINCHES: Northern Line coring winch (Model 3355-EHAOW); 24.7 mm double armored electro-optical cable (ROV Uniblical). Markey DUSH-6 Hydrographic Winch with capacity of 7,000 m of .322 three conductor cable.

STERN A-FRAME: Moveable (15 ton capacity)

CRANES: One Pitman Crane (02 Deck) with capacity - 10,000 lbs., one Aurora 45F Folding Crane, Model 45KTN/C 10,000 (Main deck aft) with capacity - 40,000 lbs. at 15 ft, 16,200 lbs at 25 ft and 10,000 lbs at 45 ft.

DARK ROOM AND STRAZA TOWER: 4’ X 4’ square moon pool

WEB PAGE ADDRESS:
http://www.soest.hawaii.edu/HURL/hurl.html
**Ship Specifications:**

Built: 1979
Modified: 1993
Length: 223'
Beam: 38'
Draft: [Summer Freeboard] 13' 6"
Displacement: [Summer Freeboard] 1961 Long Tons
Crew: 14
Submersible Crew: 7
Scientific Personnel: 12
Main Engines: Electric 1,000 HP [Derated to 250]
Bow Thruster: Electric 1,000 HP [Derated to 250]
Ships Service Generators: 1-250 kW 12 V 71 Detroit Diesel
Auxiliary Generator: 1-150 kW, 8 V 71 Detroit Diesel
Clean Power Generator: None
Propellers: Twin Fixed Pitch
Speed, Cruising: 10 knots
Speed, Full: 11 knots
Speed, Minimum: 1 knot
Endurance: 50 Days [considered limit of reasonable food supplies]
Range: 60 Days-12,000 NM; Fuel EXH-15,000 NM
Fuel Capacity: 175,774 gal
Average Fuel Consumption: 2,700 gal/day [Cruising]
Freshwater Capacity: 53,038 gal
Desalinator: Lifestream RO system capable of making 3,000 gal fresh water per day
Distilled Water Maker:
Ownership: State of Hawai‘i
Operator: University of Hawai‘i

Panoramic view from R/V Ka‘imikai-o-Kanaloa as she sails down the leeward coast of Oahu.
Science staterooms are usually #2, 8, 10, 12, and 17 (all are 2-person).

Staterooms #2 and #17 have their own head; the others share with an adjoining room. Please try to organize your team into same gender staterooms and same gender sharing heads. If this is not possible, please let the HURL Science or Ops Director know and we will work with the Captain on devising an acceptable berthing plan.
# PERSONNEL SAILING LIST

DATES of EXPEDITION: 

PI/CH. SCI.: 

<table>
<thead>
<tr>
<th>NAME</th>
<th>TITLE</th>
<th>AFFILIATION</th>
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</table>
Please fill this out with all of your dives in mind, and then discuss specific needs for each dive with the Operations Director during the expedition.

**HAWAII UNDERSEA RESEARCH LABORATORY**  
**CHECKLIST FOR DIVE SERIES**  
**EQUIPMENT, SUPPLIES AND SERVICES**

1. **NAVIGATION** (All are standard data in package)  
   - Navigated submersible dive track  
   - Navigated ROV dive track  
   - Launch and recovery stations

2. **SAMPLING EQUIPMENT** (*Pisces* submersibles only, standard gear is checked)  
   - Small specimen box with lid  
   - Compartmentalized sampling basket  
   - Large specimen basket with lid  
   - Suction device  
   - Rotenone delivery device  
   - Sediment samplers  
   - Water samplers  
   - CTD  
   - Dissolved Oxygen sensor  
   - Temperature probe(s)  
   - Measuring devices  
   - Scanning sonar  
   - Pinger or labeled site relocation bucket lids  
   - Laser scaling system (Tri or Quad)  
   - Other ___________________________________

*Please let us know below if any of the standard sensors are critical for your research.

_________________________________________________________________

3. **SCIENCE TEAM GEAR REQUIRING INTERFACING**  
   (Contact Ops Director ASAP)  
   - If needs electric power, list details: _________________________________
   - If needs hydraulic power, list details: _________________________________
   - If needs through hull comms, list details: _________________________________

3. PI/CH.SCI.: _________________________________

4. PROJECT TITLE: ___________________________________________________________________

5. LOCATION: _____________________________ CRUISE DATES: ________________________
MEDICAL CONSENT FORM

1. STATEMENT OF FITNESS TO DIVE IN THE SUBMERSIBLE

The *Pisces IV & V* submersibles are 7-foot diameter, 1-atmosphere submersibles with life support for 3 persons for at least 72 man hours. Average dive duration in the *Pisces IV & V* are 6 to 8 hours. Environmental conditions during shallow dives may subject the observer to temperatures from 85 to 95 °F and humidity approaching 100%. During deeper dives, the submersible becomes extremely cold and damp, exacerbated by restricted movement. There are no toilet facilities on the submersible, though special supplies are available. If unfamiliar with submersible diving, it is advised that observers consult with the Operations Director or other experienced scientists prior to the cruise.

I have read the statement above. I am not unduly susceptible to high or low temperatures and humidities and can remain in a confined space for up to 8 hours.

2. IN CASE OF EMERGENCY

First person to contact is ___________________________________

_________________________________ Phone _______________________

Second person to contact is ___________________________________

_________________________________ Phone _______________________

3. CHECK ONE OF THE FOLLOWING:

( ) I consent to and authorize any medical doctor or dentist and others working under their supervision to treat me for any injury or illness. I further agree to pay any and all such dental and medical costs, expenses and charges, and to release, discharge and hold harmless the State of Hawaii, its employees and agents from and against any medical treatment or care.

( ) I do not consent to or authorize any medical doctor or dentist or others working under their supervision to treat me for any injury or illness. I therefore agree to assume the risk of any injury or damages to myself from the lack of medical care or treatment and further agree to release and hold harmless the State of Hawaii, its employees and agents from and against any liability and any claim or demand arising out of or in connection with said failure to provide any medical care or treatment.

_________________________________  _______________________
Signature                              Date

_________________________________     _____________________
Home Address                           Phone
ASSUMPTION OF RISK AND INDEMNITY AGREEMENT

I, the undersigned, in full recognition and appreciation of the dangers and hazards inherent in going to sea on research vessels and in submersible diving to which I may be exposed during the period from __________ to __________ do hereby freely participate in such activities as a volunteer. I affirm that I am fully acquainted with the R/V Kaʻimikai-o-Kanaloa, Pisces IV & V, and RCV-150 (vessel, craft, etc.) being used and am familiar with the inherent hazards involved and the procedures which are applicable in such activities; I have fully informed the University or its agent(s) coordinating the activity of this fact, and hereby agree to assume the risks and responsibilities surrounding my participation in such activities undertaken by me on a voluntary basis. I hereby agree to defend, hold harmless, indemnify and release the University of Hawaii, the Research Corporation of the University of Hawaii, the National Oceanic and Atmospheric Administration and any other granting agencies that lend support to this activity from and against all claims or demands for damage, including claims for property damage, personal injury or death, arising out of my failure to exercise reasonable care in the above stated activities and those which result from causes beyond the control of and without the fault or negligence of the University of Hawaii, the Research Corporation of the University of Hawaii, the National Oceanic and Atmospheric Administration, other granting agencies, their officers, agents or employees, during the period of my voluntary participation as aforesaid.

IN WITNESS WHEREOF, I have caused the Assumption of Risk and Indemnity Agreement to be executed this _____ day of __________, 20__.

______________________________
(Volunteer)
HAWAI‘I UNDERSEA RESEARCH LABORATORY

QUICK LOOK REPORT (QLR) for Pisces and RCV-150

DIVE: ______________

(Extend length of sections as needed/appropriate)

MISSION STATUS

Location: __________________________________________________________

Latitude: _____° _____ Longitude: _____° _____

Mission Date: ______________ Duration: ____ hours ____ mins

Maximum Depth: ______________________ meters

Project Title: _______________________________________________________

Principal Investigator: ____________________________________________

Address: _______________________________________________________

____________________________________________________

____________________________________________________

____________________________________________________

Phone: ___________________________________

Observer 1: _________________________ Observer 2: _________________________

Address: __________________________ Address: _________________________

________________________________________

________________________________________

Pilot 1: ___________________________ Pilot 2: ___________________________

Scientific Data Acquired: Prepare an abstract outlining your objectives, techniques, findings, etc.

Objectives:
Observations, findings, etc:

Observed Species list:

MISSION EVALUATION:

Limitations, failures, or operational problems noted:

Recommendations for corrective action or improvement:

In your opinion, did the mission essentially achieve its purpose? Compare actual work accomplished with the work that was expected to be accomplished:

List specimens or samples collected on the mission:
DATA RELEASE

Data may be retained by the project leader for up to 2 years after the mission date with the following exception. NOAA may request to use photos for publication or publicity purposes at any time.

Fill in the appropriate statement below and sign this form.

I hereby release the data archived by HURL for public consumption following mission (Project title):

________________________________________________________________________
________________________________________________________________________

Held on _________________ (date of dive) in the following way:

a. CTD data by ____________ (date)

b. Video and images by ____________ (date)

c. Other ____________ (date)

d. I will give my written consent to individuals wishing to use these data prior to the above dates depending on the nature of the request(s).

____________________________________________
Principal Investigator
ANNUAL/FINAL REPORT

NOAA's Office of Undersea Research
Submersible Science Program

Report Status: __________ Final or Continuing __________
Date of Report: __________ Dive Numbers: ________________
Inclusive Dates of Mission: ___________________________________
Project Title: ________________________________________________________________
________________________________________________________________
Principal Investigator: ________________ Signature: __________________________
Names of Co-Investigators: ___________________________________________
________________________________________________________________
I. Abstract of Mission Results: Please include diagrams or figures as appropriate.

II. Please discuss the following:
   A. Significance of the mission in relation to your research goals.
   B. Scientific contributions of the mission in terms of species, patterns, and processes
      observed or measured. Were the initial hypotheses addressed; were any new ones
      posed as a result of the mission? Was the methodology and/or technology utilized
      successful and repeatable by others?
   C. For continuing status reports, indicate the extent of data analysis or manuscript
      preparation completed to date.
   D. Advantages of NOAA's Undersea Research Program to your research
      investigations.
   E. Plans for use of the data gathered on this mission and the applications, products
      and/or benefits to NOAA.

III. Please include any comments on the following operational details, where applicable:
   A. Weather and water conditions affecting operations
   B. Safety problems and/or concerns
   C. Dive management and personnel cooperation
   D. Logistics and support activities
Pisces V at Eel City on Vailulu’u submarine volcano in American Samoa.

Painting by Terry Kerby ©2005