THE INDUSTRY'S RECOGNIZED AUTHORITY FOR DESIGN, ENGINEERING AND APPLICATION OF EQUIPMENT AND SERVICES IN THE MARINE ENVIRONMENT

DECEMBER 1991
SINGLE ISSUE PRICE $2.50
Reprint

SEA TECHNOLOGY

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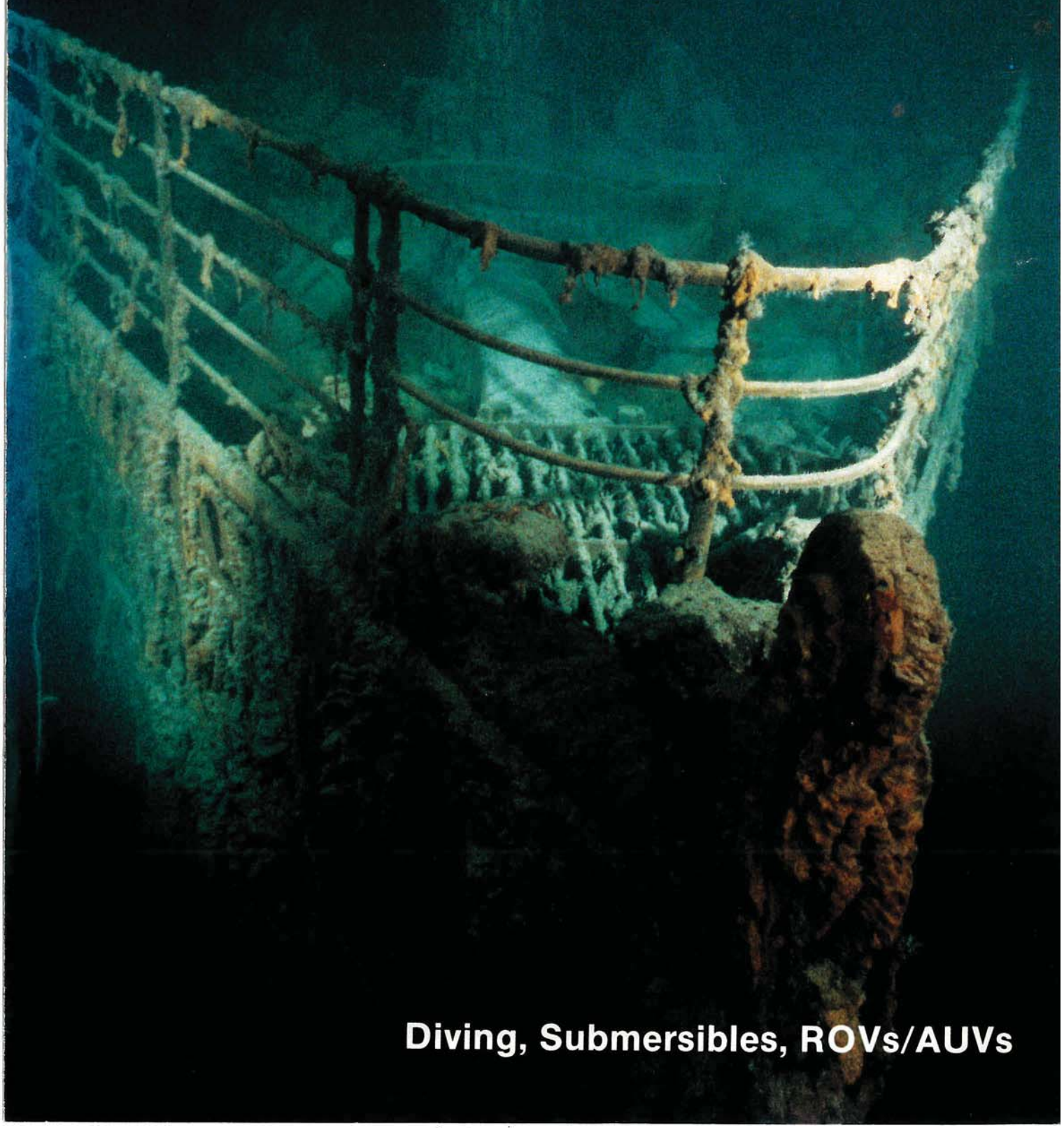


Diving, Submersibles, ROVs/AUVs

Return to the *Titanic:* The Third Manned Mission

New High-Powered Lighting, Dual Soviet Submarines, the Eerie Stillness of a Famous Wreck Promise to Bring Stunning Deep Ocean Images to IMAX Movie Audiences

By Kevin Hardy
Scripps Institution of Oceanography
University of California, San Diego

Why go back? Woods Hole Oceanographic Institution's *Alvin* allowed us the first up-close, in-person views of the remains of the R.M.S. *Titanic.* Those trips in 1986—75 years after her tragic sinking—brought back startling pictures of rusticles, the wine-bottle-littered debris field, the twisted and broken hulk.

The second series of manned dives—this time with IFREMER's deep submersible *Nautile*—brought back the first relics from the Edwardian-Age English ship.

Why go back again?

"Imaging," said Emory Kristof, veteran underwater photographer for the Washington, D.C.-based National Geographic Society. "This was the underwater Mount Everest for imaging technology. We got to do it and do it right."

The dives were chiefly funded by Canadian producer Stephen Low's company, Titanic Films, principally to use the IMAX® Corp.'s 70mm-format camera to capture for millions the feel of the wreck of the R.M.S. *Titanic.* (See the sidebar article by Dr. Joe MacInnis.) Other "conventional" photography and video projects piggybacked on that main expedition.

Like the *Titanic,* this series of submersible dives was done in a big way. The multinational project brought together a pair of deep-diving research submersibles, a huge mother ship, and the most talented underwater lighting and imaging specialists in the world.

The Soviet *Mir-1* and *Mir-2* submersibles are capable of diving for extended periods (up to 20 hours) at 6,000-meter depths. (See *Sea Technology,* December 1988, pp. 12-14.)

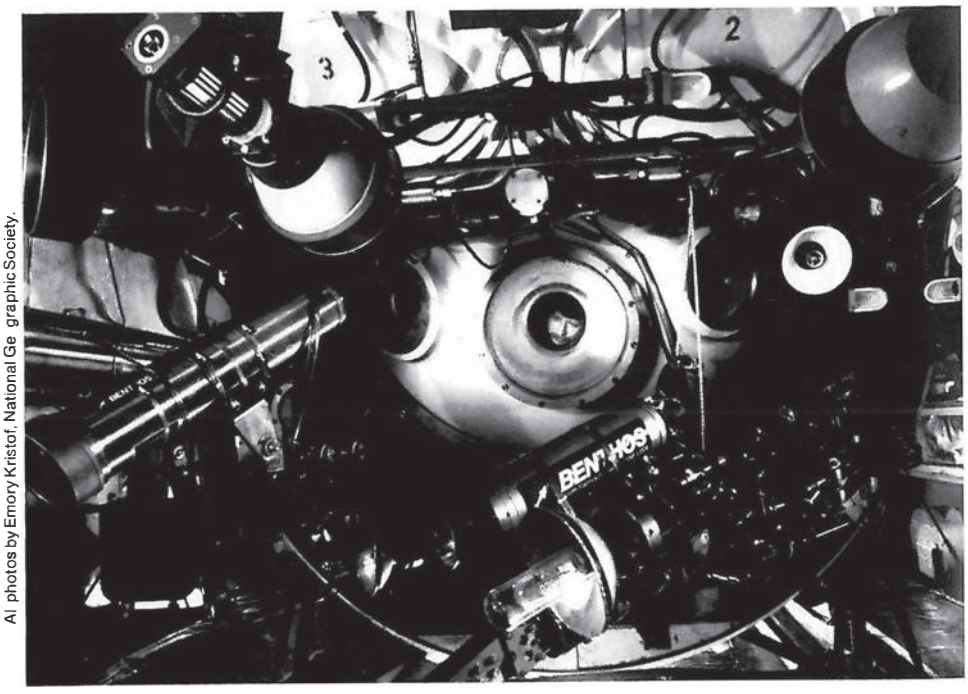
Those associated with the project believe they have returned with the best images ever made of the great ship, which went down after striking an iceberg in the spring of 1912 with a loss of 1,500 lives. Seeing the stills and the video is pretty convincing they're right.

Lighting Up the Depths

New technology made the difference. "In order of importance," Kristof noted, "the high-power HMI lights were first. Second was the use of two subs. The combination gave us the ability to image very large areas."

HMI lights are compact, high efficiency light sources that produce a near-daylight spectrum that penetrates much further in seawater than conventional underwater lights. The name derives from H (Hg) for mercury, M for metals (dysprosium, thulium, and holmium) and I for halogen compounds (iodide and bromide). The technology was pioneered by Osram Corp. of Germany in 1969 and won an Oscar in 1988 for its contribution to cinematography.

A 1,200-watt lamp produces 110,000 lumens at the source, up to five times more efficient than tungsten-halogen incandescent lamps. The difference is significant. The lamps were originally adapted to operate underwater for the filming of the movie *The Abyss* by Richard Mula and Pete Romano



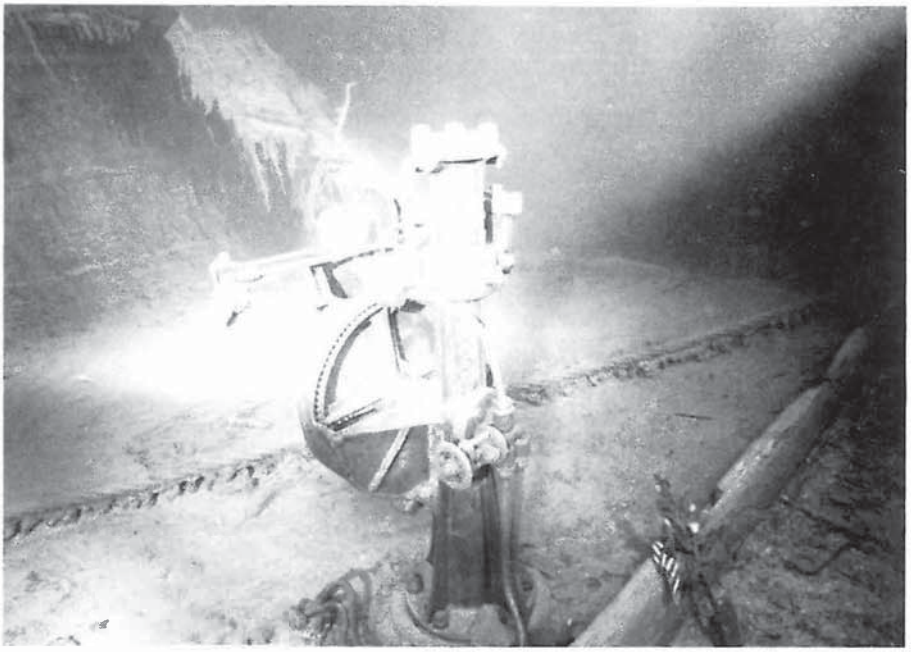
All photos by Emory Kristof, National Geographic Society.

High-power HMI lights mounted on 10-foot booms provided greater penetration in seawater.

of HydroImage Inc. (Los Angeles). They developed and tested a surface-tethered system operating to 250 feet.

Filming of the *Titanic* required surface independent operation and a test depth of 20,000 feet because of a 1.5 safety factor for manned submersibles.

To make them go deep, Mark Olsson, DeepSea Power & Light Inc. (San Diego) adapted the HMI technology using new glass housings, custom machined glass-ceramic lamp bases, and exotic ceramic pressure cases made by Coors Ceramics (Golden, Colorado). A commercially developed compact electronic ballast provided by Cinemills Inc. (Burbank, California) was disassembled and repackaged by Mula to fit a ceramic housing provided by Olsson.



A set of three high efficiency, sharp cutoff reflectors for wide flood, medium flood, and spot were designed by Olsson. The reflectors are the first ever to correct for the refractive effects of water.

Underwater electrical cables and connectors were supplied by SEA CON®/Brantner & Associates Inc. and Impulse Enterprise (both of San Diego) and certified for manned submersible operation to *Alvin* specifications by Barry Waldon of Woods Hole.

The solid-state switch control panel located inside the submersible and external oil-filled junction boxes were designed and built by Chris Nicholson and Jeff Ledda, Deep Sea Systems International Inc. (Falmouth, Massachusetts), who also oversaw the difficult task of mechanical and electrical interfacing requirements to the Soviet *Mir* submersibles.

Success from the First Try

Kristof joyfully noted that when everything showed up from the different designers, parts bolted together and switched on the first try.

Four HMI lamps were installed on both *Mir-1* and *Mir-2,* mounted in pairs on two booms that crossed like arms over the front of the subs during

Eerie images from the deep: At top, daring but precise maneuvers by both *Mir* pilots allowed this "one of a kind" photo of *Titanic's* propeller. At left, HMI lights illuminated hydraulic steering assist mechanism. Small memorial at right was placed by 1987 French expedition. Below, *Mir* diver-assist crewman waits for *Keldysh* in background.

the descent and ascent to the wreck site. These booms were then hydraulically opened to either side of the sub, providing a 10-foot separation from the cameras, which in turned minimized backscatter into the lenses. A total of eight HMI lamps provided the highest power lighting system ever used in the deep sea.

The photographers, Kristof said, "had 20 times the light than *Alvin* carried in 1986." Added Olsson: "What struck me most as a designer is that we placed 250,000 watts of incandescent-equivalent light on those two subs by virtue of increased electrical efficiency, a shift in color temperature, and highly efficient reflectors."

Bevy of Specialized Cameras

The cameras used on this dive included the IMAX 70mm cinema, a

Following tradition, memorials went down to the *Titanic* on the *Mirs'* final dive. Dr. Joe MacInnis (right), one of the mission instigators and film's co-executive producer, holds plaque listing all the expedition's players. At left, technical coordinator Chris Nicholson displays memorial to submersible and ROV expert/historian, Frank Busby, who died last year. At center is Dr. Anatoly M. Sagalevitch, Soviet scientist and designer/manager of the two deep-diving submersibles that were key to making the IMAX movie—and the *Titanic* expedition—happen.

Movie-Making in the Deeps

Dr. Joe MacInnis is a Canadian physician and writer who has spent the last 30 years studying the relationship between humankind and the sea. In the 1960s, as medical director of Ocean Systems Inc., he worked on the physiological problems of deep diving. During the 1970s, MacInnis led 15 expeditions to the high arctic to study human performance problems of working under the polar ice cap—becoming the first to dive beneath North Pole and also leading the successful quest to find the H.M.S. Breadalbane *lost over a century ago 600 miles north of the Arctic Circle. For the past eight years, he has turned his attention to the deep ocean, making his first dive on the* Titanic *in 1987. It was then that the idea was born—the best way to see the great ship, and the deep ocean, was in the IMAX giant screen format.*

By Dr. Joe MacInnis
Co-Executive Producer
*IMAX-*Titanic *Film*

Last summer, the most complex and costly deep-diving expedition ever conducted took place in the western North Atlantic. Its technology included two Soviet *Mir* submersibles, two IMAX giant-screen cameras, and a suite of new lighting and video systems. Its target was R.M.S. *Titanic*.

During a three-week period, 17 dives were made to the bow and stern sections at a depth of 4,000 meters. The first comprehensive scientific study of the *Titanic* wreckage--including biology, geology, and metallurgy—was carried out by Canada's Bedford Institute of Oceanography and the Soviet Union's P.P. Shirshov Institute of Oceanology.

The financial management of the expedition originated in Canada through a partnership between IMAX Corp. and my company, Undersea Research International, both based in Toronto. Some $6 million was raised to pay for the Soviet charter and production of the IMAX film. Technical management was led by the Institute of Oceanology, IMAX Corp., and the firms mentioned in the accompanying article by Kevin Hardy.

IMAX is a Canadian company specializing in giant-screen science and educational films. Each year, 30 million people see IMAX films in 77 theatres in 15 countries. These theatres are usually located in museums or science centers, such as the Smithsonian Institution in Washington, D.C., or the National Science Museum in Tokyo.

Both my co-executive producer, Andre Picard, and I believe that the six-story-high screen—3,000 times larger than a television image—is the ideal format to display the science and technology—the educational adventure—of the deep ocean.

Our IMAX *Titanic* film is being produced by Stephen Low, the celebrated Canadian documentary filmmaker. Under his creative genius, the visual narrative will be stunningly different from anything ever seen since the *Titanic* was discovered by a French-American team in 1985. In October 1992, IMAX-*Titanic* will be premiered at the Liberty Science Center in New York.

However, for the 130 Soviets, Canadians, and Americans aboard the research ship *Akademik Mstislav Keldysh,* the IMAX-*Titanic* expedition was more than science and filmmaking. It was an international collaboration between former Cold War enemies, working together, sharing the same life support system 2-1/2 miles under the Atlantic's surface.

This magazine, *Sea Technology,* contributed to this collaboration. In December 1988, Dr. Anatoly Sagalevitch wrote an article calling for Western scientists to use the *Mir* submersibles for international scientific and educational purposes. This past summer's expedition was the translation of that call into meaningful action. /st/

Benthos Inc. (North Falmouth, Massachusetts) 35mm still camera modified by the late Al Chandler, a Soviet 70mm still, a Deep Sea Systems International 3-D video camera pair, and a Sony HiRes three-chip CCD video camera specially modified by Al Giddings of Ocean Images (Oakland, California) and Sam Raymond of Benthos.

Newly available low-light, 500 ASA, Kodak 5296 film was procured for the IMAX cameras, which were mounted unmodified into one of the *Mir* submersibles. Lenses and film could be changed *in situ.*

Soviet Submersibles Key

The two *Mir* deep-diving research submersibles were designed and fabricated by the Finnish shipbuilder, Rauma-Repola Oy (Helsinki and Tampere), under the direction of Dr. Anatoly M. Sagalevitch, head of the Soviet deep submergence program for the P. P. Shirshov Institute of Oceanology, Academy of Sciences of the U.S.S.R. The *Mir* design features high-strength maraging nickel steel hulls and 200-millimeter front viewpoints, much larger than the 120-millimeter ports on either the *Alvin* or *Nautile* submersibles.

The *Mir's* 100 KW battery module is large enough to supply all necessary power to both the sub and the HMI lights for extended periods. A pair of robotic manipulators, well positioned equipment mounting pads, plus numerous penetrators made the *Mir* vehicles functionally superb.

The *Mir* sub was "the perfect camera housing for the IMAX," kidded Kristof. "We were able to jam the camera, extra film canisters, and even a photographer into it!"

The use of two submersibles allowed such unique opportunities as backlit and cascading lighting set-ups. "And," noted IMAX photographer Ralph White, "the other sub could act as a tow truck in the event we had a problem."

"I was impressed with the skills, the sub technology, and the in-depth operational knowledge of the Soviets," said Nicholson. "They are very astute technically."

The subs were deployed about an hour apart. The *Mir* submersibles used an effective five-transponder, long baseline positioning system made in the Soviet Union. Positions of the *Mirs* were displayed on computer-like screens inside the subs. Inter-sub communications were maintained through a Soviet UQC system. The two vehicles would typically meet at the bow of the *Titanic,* separate for planned independent filming, then re-rendezvous for joint shots. Mission profiles were carefully prepared and discussed prior to each dive.

The large amount of lighting and camera equipment created a negative forward trim in the *Mir* subs. Syntactic foam supplied by Syntech Materials Inc. (Springfield, Virginia) provided compensating buoyancy.

Science on the Bottom

Canada's Bedford Institute of Oceanography participated in the dives. Dr. Stephen Blasko, expedition chief scientist for BIO, sees the wreck as a unique time marker. "The ship was brand new when she hit the bottom," said Blasko, "since she went down on her maiden voyage." The research team investigated such phenomenon as current action, seabed processes including metal migration into bottom sediments, metallurgical effects of long-term deep-water exposure on iron-based alloys, and broad biological studies.

Applications of this knowledge may find their way into offshore oil pipeline service life projections, toxic waste disposal, and other ecological studies.

Blasko expects to be able to add to the understanding of the *Titanic* structural failure. Preliminary studies of samples recovered from the wreck indicate the use of metals that were much more brittle than today's steels.

White, citing the available time series of photographs of the *Titanic,* said there appears "a lot more marine life and deterioration since 1987." Blasko agreed that the ship looks badly corroded but adds that recovered plates do not appear to have lost much thickness.

How It All Began

This project began six years ago when Dr. Joe MacInnis approached IMAX in Toronto about using their large-format camera in the deep ocean. Since then, he and Kristof have worked together trying to eliminate the technical problems and build the team. In 1988, Kristof started conversing with Sagalevitch about the proposed expedition. Others approached key potential vendors during the engineering evaluation phase.

The actual new equipment design and construction phase for the third *Titanic* manned mission was done in under one year. The multiple paths concluded in the series of dives this past summer.

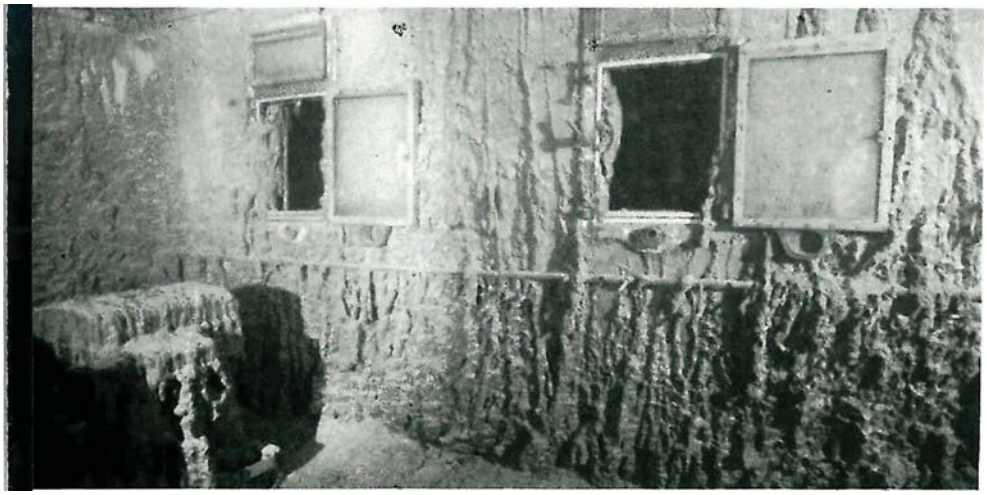
On the starboard forward side of the *Titanic* is a gaping hole large enough to pull one of the submersibles into. This, in fact, was done, producing some incredible images from both submersibles.

In one of the most exciting dives, both submersibles met together under the stern near the giant propellers and rudder. When Kristof pointed out that 100 percent of the Soviet deep submergence assets were under the potentially dangerous overhang of the wreck, photographer Giddings coolly replied, "What could go wrong?"

On the final dive, a memorial plaque to Frank Busby was placed on the *Titanic's* bridge by Sagalevitch, Nicholson, and MacInnis.

HMI Lights Made the Difference

"In looking at the videos and IMAX footage," said Mark Olsson, "what is most striking is the much longer dis-



Wide coverage by HMI lights is most obvious with this view of *Titanic's* officers' quarters.

tance at which HMI lights provide the appearance of a full color image compared to other lighting systems like quartz-halogen. The HMI lights are enormously richer in yellows, greens, and blues."

Prior to the *Titanic* dives, the *Mir* submersibles—minus the HMI lights—were used to image "black smokers" coming from hydrothermal vents on the mid-Atlantic ridge TAG (trans-Atlantic geotraverse) site.

As is true with any seaborne operation, the team encountered problems. Given the combination of experience, skill, and backup systems, the overall mission was uncompromised.

Separate ceramic housings were chosen because of the material's electrically insulative properties to contain the HMI lighthead with its 45 kilovolt lamp ignitor and the electronic ballast. The housings were sleeved with plastic for impact resistance and oil-filled for added safety of the submersibles. The added plastic aggravated an unexpected thermal sensitivity of the electronic ballast. On the *Titanic* dives, the prototype high-power lamps had to be shut down after intervals of 20 minutes to cool. Straightforward solutions to the thermal problem exist, noted Olsson, but a tight development schedule left no time at the end.

The *Mir* forward-looking Ulvertech Ltd. (Cumbria, U.K.) sonars didn't function initially at the seafloor. "We could see the *Titanic* out the viewport, but not on the sonar," said White, also the man with the most dive time on the *Titanic.* Like a guide from the Old West who lead settlers through the unknown passes of the Sierra Nevadas, White used personal knowledge and hand-drawn maps to direct the submersibles in their investigations of the great wreck.

On the surface, the hand-held Magellan Systems Corp. (San Dimas, California) GPS NAV 1000 PRO was used for global positioning system (GPS) location fixes rather than the system aboard the support ship, *Akademik Mstislav Keldysh.*

Moving Imaging Forward 10 Years

The focus of this third manned dive on the *Titanic* allowed a lot of new technology to come together. Emory Kristof, who has traveled the world on assignment for *National Geographic* says with personal satisfaction, "This is the best thing I've ever worked on. We moved underwater imaging forward 10 years. Personally speaking, the pictures are the biggest and best I've ever done."

Citing the team spirit, fair weather, and just plain good luck associated with the project, Chris Nicholson said, "I've been on a lot of trips, but this one was truly blessed."

On a dark and cold night nearly four score years ago, the story ended differently for another group of people who roamed the decks of the *Titanic.*

A CBS Television special featuring footage from Giddings' HiRes Sony camera is expected to air in the spring to coincide with the 80th anniversary of the sinking of the *Titanic.* The IMAX film is presently scheduled for release in October 1992.

A refined commercial version of the HMI lights, the DeepSea Power & Light "SeaArc 1200," is envisioned for *Alvin, Sea Cliff,* and other deep submergence vehicles. Some additional development remains, but the overall performance of the lamps was demonstrated impressively.

The 3-D images of the *Titanic,* the TAG hydrothermal vents, and five years worth of deep water animals are being prepared for display in aquariums and museums using Sony Laserdisk equipment. In doing this, the *National Geographic* intends to provide "the deep ocean experience" to everyone.

An extended 19-month program using the exploration capabilities of the *Mir* submersibles and the *Keldysh* is currently being organized through Woods Hole Oceanographic Institution by Dave Gallo.

Acknowledgements

The author sincerely thanks the numerous individuals who were there and who contributed immeasurably to writing this article. Their help assures the *Sea Technology* reader of a technically accurate account of this historic mission to R.M.S. *Titanic.* /st/

Kevin Hardy is an associate development engineer at Scripps Institution of Oceanography, La Jolla, California, where he has worked since 1972. He holds an A.S. in science and a bachelor of science degree in industrial technology from San Diego State University. Hardy was editor of the Marine Technology Society's publication Currents *from late 1986 through late 1990. He was recently elected a Fellow in that society.*