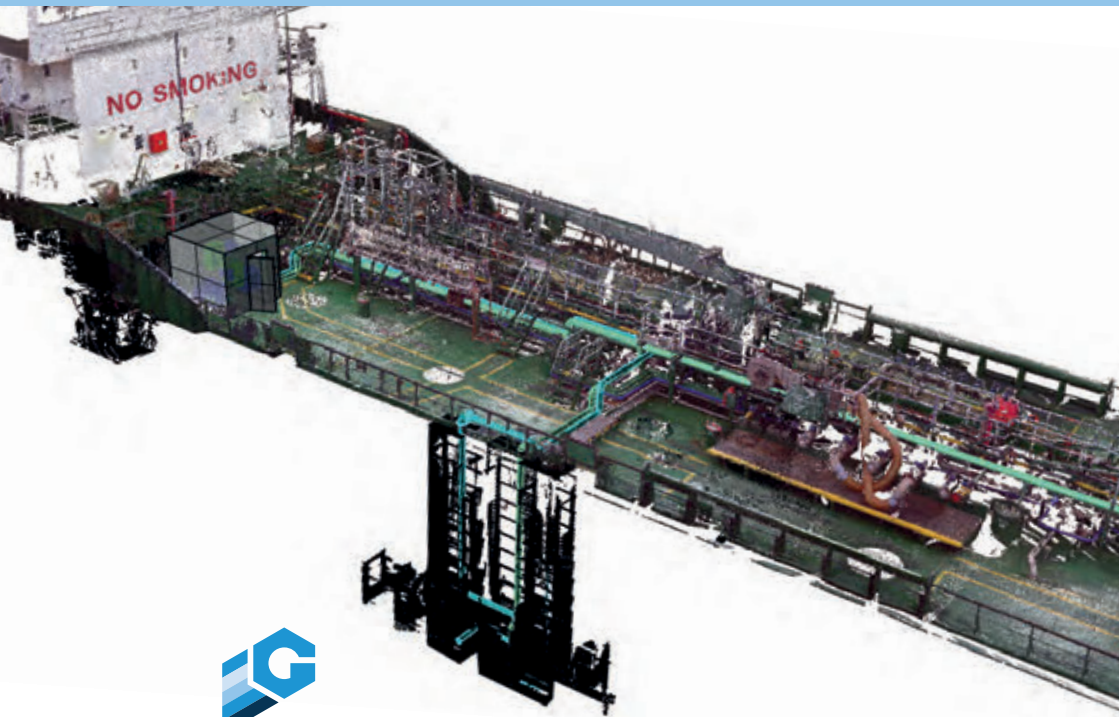


Green Retrofit Guide

PRACTICAL APPROACH TO ENVIRONMENTAL RETROFITS



Green Retrofit Guide

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Dealing with the retrofit challenge

Capital expenditures related to vessel equipment and machinery investments are usually planned, prioritized and approved based upon a fundamental analysis of return on investment and payback period. However, the large capital expenditures required by the IMO and US Coast Guard environmental compliance regulations related to ballast water treatment and sulphur emissions compliance present no such financial payback to shipowners around the world.

Few dispute the environmental benefits of these efforts to control the spread of invasive species and minimize sulphur oxide (SOx) emissions present, but faced with continued downward market pressures and prolonged difficult financial performance, choosing when and how to make these investments is proving a daunting challenge. Some shipowners are choosing to deal with the challenge in a proactive and phased approach while others have simply waited for the inevitable to force them into action.

Recognizing the challenge for shipowners, Goltens established Goltens Green Technologies in 2010 to provide support and guidance to owners navigating these uncharted waters. The sole focus of Goltens Green Technologies' retrofit process is to enable owners to minimize the operational impact of these invasive and non-payback projects and to keep costs to an absolute minimum while ensuring compliance. With a global capability in seven regions around the world, we have proven our process on over 400 compliance retrofit projects tailoring it to address the unique requirements of the owner and their retrofit plans. These projects span the full spectrum of ballast water and emissions compliance solutions and cover a broad range of vessel types.

Goltens Green Technologies has taken an independent approach to the market undertaking projects with all makes and models of systems and compliance solutions being considered by owners. While we have partnered with many

leading ballast water equipment manufacturers in retrofitting and design agreements, we back no particular technology or system. Our sole mission is to ensure that the system chosen by the owner is installed in the most cost-efficient and least invasive manner possible.

In this booklet, we have compiled a broad cross section of information to help shipowners and decision makers understand that these compliance projects can be planned and completed in an organized and efficient manner, and that choosing the right partner to drive the process is a worthwhile investment. We hope that the insight provided into Goltens' process and how this has been applied across a wide range of challenges from single vessel projects to fleet wide retrofits encompassing feasibility studies to full turnkey installations will help chart a confident path forward.

Whatever compliance paths are selected, we hope that like many others in the industry, you will choose Goltens Green Technologies as your retrofit partner.



Roy S. Strand
Chief Operating Officer, Goltens Worldwide

Shipowners around the world are at different stages of dealing with compliance initiatives.

DENIAL

"This is not going to affect us for quite some time."

ANGER

"Are they really driving this enormous investment with no payback with the market conditions as they are?"

AVOIDANCE

"We can change our shipping routes."
"They will grant dispensation."
"We will scrap our vessels before that."

ACCEPTANCE

"This is happening. How are we going to do this?"

ACTION

"We have to do this. We need expert advice."

Wherever you are in this progression, a process-driven approach to retrofit planning will help you navigate these challenges in a time and cost-efficient way.

Goltens Green Technologies' 7 step process

GOLTENS GREEN TECHNOLOGIES FOLLOWS A WELL-PROVEN, FLEXIBLE PROCESS THAT LEVERAGES 3D SCANNING TECHNOLOGY AS THE FOUNDATION FOR EFFICIENT RETROFIT EXECUTION. SHIPOWNERS CAN ENGAGE GOLTENS GREEN TECHNOLOGIES FOR PORTIONS OF THE SYSTEM SELECTION, PLANNING AND DESIGN, OR FOR EXECUTING A COMPLETE TURNKEY SOLUTION.

1

System shortlist or selection

An array of regulations, a variety of technological solutions to address them and the need to efficiently coordinate implementation fleet-wide require an independent partner with in-depth experience and global capability to help navigate the process. Goltens Green Technologies is a highly qualified discussion partner in assessing new and often unproven technologies.



2

Onboard survey and 3D laser scanning

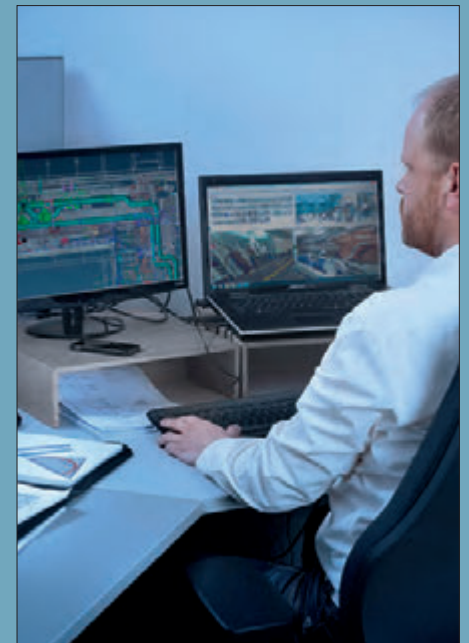
Highly detailed 3D laser scanning is an accurate and efficient solution to determine the feasibility, impact and conflicts associated with installing various solutions on board vessels. It also eliminates most of the risks associated with manual measurement and fabrication on board without prefabrication. Scanning can generally be completed with no disruption to the vessel's operations.



3

Modeling and concept design

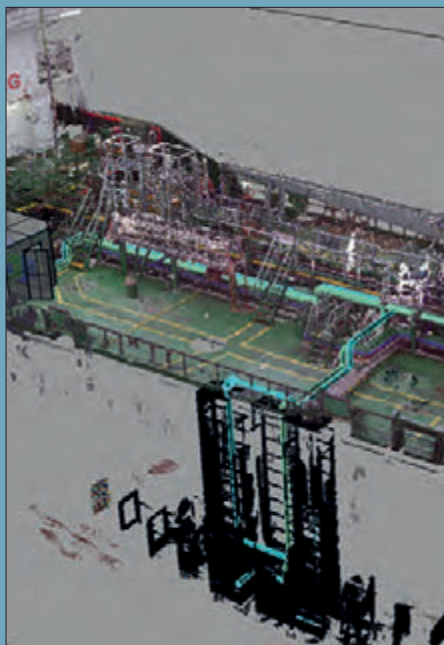
Data generated by a 3D laser scan is used to model the chosen or shortlisted systems into the existing space. At this point, both the shipowner and chief engineer will be able to clearly see that the final system location will not obstruct normal ship functions, and verify available space for maintenance. Several systems can be modeled to show which would be the optimal solution in terms of fit.



4

Detailed engineering

The accuracy of the 3D scan output makes it possible to create a precise production package containing drawings that show all foundations, mechanical and electrical components, as well as a comprehensive overview of all the parts needed for installation. Piping, connections and foundations can be prefabricated with high precision, eliminating the time-consuming pipe fitting process.



5

Purchasing and prefabrication

Goltens Green Technologies delivers a detailed material specification along with the engineering design and installation guide. This way, shipowners get a complete production package that they can rely on Goltens to install, or they can use it at a shipyard of their choice. This gives a realistic price quote based on the materials needed, making it easy to compare estimates from different installation alternatives.



6

Installation and commissioning

Goltens Green Technologies can provide installation, commissioning and crew training services worldwide. Minimizing operational downtime can involve partial work done during dry-docking, alongside or at sea. The global availability of installation teams means voyage patterns can be maintained with minimal disruption.



7

Service

This is possibly the most crucial step in the long-term perspective. Goltens Green Technologies provides ongoing post-installation support and service through its worldwide network.



Benefits of the Goltens Green Technologies process

- System modeling provides increased confidence in investment decision without the need to purchase the system.
- Phased investment approach possible (proof of concept models, detailed design, full system installation).
- Reduction/elimination in vessel downtime due to precision of design and prefabrication.
- Limited onboard work and interruption.
- Reduced design costs on sister vessels.
- Installation flexibility (installation can be completed by Goltens or other qualified installation partner).
- Proven results in over 260 ballast water treatment system retrofits, LSGO system modifications and exhaust gas scrubber installations.

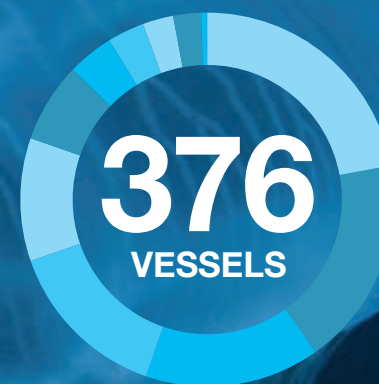
Our Ballast Water Treatment experience

Goltens Green Technologies' expertise in ballast water treatment systems retrofitting is unmatched in the market. The company has an ever expanding list of successfully completed jobs, with well over 200 projects using systems from numerous manufacturers, including Optimarin, BIO-UV, Headway Technology, Severn Trent DeNora, Alfa Laval, Auramarine, NK, Hyde Marine and others.

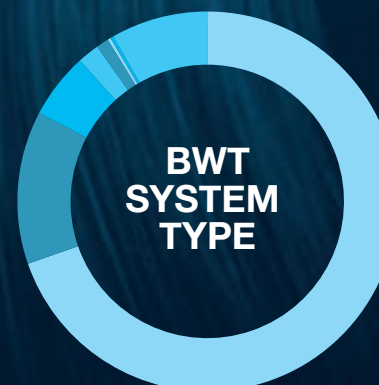
With the IMO Ballast Water Management Convention now ratified, a shortage of systems and design firms capable of facilitating compliance is almost inevitable.

Goltens Green Technologies is helping many forward-thinking shipowners address this in a variety of ways. Some are evaluating and selecting systems and determining location and space requirements; some are piloting installations on one of each class of vessels; others are going forward with a phased fleet-wide installation plan.

Whatever approach is chosen, Goltens Green Technologies can support any and all phases of the project that lead to the most efficient installation possible.



- Bulk carriers (83)
- LNG/LPG tankers (68)
- Product/Chemical tankers (57)
- Specialized offshore vessels (54)
- Container vessels (40)
- General cargo (26)
- Ro-Ro vessels (15)
- Other (12)
- Navy vessels (10)
- Car carriers (9)
- Cruise vessels (2)



- UV systems (262)
- Electrochlorination (49)
- Advanced oxidation (21)
- Ozone (7)
- Chemical injection (4)
- Other (1)
- Electrolysis (1)
- System selection in process - (31)

Efficient action

THERE ARE VARIOUS OPTIONS AVAILABLE, WITHOUT IMMEDIATELY BUYING AND INSTALLING A SYSTEM, THAT ENABLE SHIPOWNERS TO ATTACK THE RETROFIT CHALLENGE IN A PHASED, WELL-PLANNED MANNER.

Now that the convention is ratified, delaying compliance is no longer an option. Forward-thinking owners recognize that there will likely be insufficient capacity in terms of systems and services and are pursuing approaches that will save money and time.

HOW ARE THEY DOING THAT?

Preparations are not a one-size-fits-all model. Goltens Green Technologies is assisting shipowners with a variety of different approaches, ranging from basic to advanced.

BASIC APPROACH

A basic approach consists of a shipboard survey, combined with 3D laser scanning. The available space is measured in detail, and a survey of available power, common ballasting practices and preference of type of treatment system are completed. After this, Goltens prepares a basic design for one or two chosen systems where the main components are modeled in the scanned image showing the shipowner how and where the system could be fitted. These scans are an investment that have greater utility as they can be used at a later point in time for detailed engineering. This is also the stage where a more extensive comparison between systems can be made based on available space, power consumption or ease of installation without the financial burden of purchase.

MEDIUM APPROACH

In this approach a final system choice is made so Goltens can prepare the detailed drawings for all the required pipes and foundations. The result is an engineering package that can be used for production or for comparing quotations from different shipyards or installation companies.

The deliverable is, in fact, an installation guide that can be used by any experienced company to install the system. Additionally, as part of the basic or medium approach, certain preparations can be made during routine dry-docking that may alleviate the need for a special docking to install the system. With the design in hand, preparations such as a new overboard hull connection, installation of additional breakers in the main switchboard or preparing the automation system can be completed ahead of system installation.

ADVANCED APPROACH

The advanced approach takes it one step further but still avoids the immediate purchase of the system. Goltens, or another qualified installation partner, uses the detailed engineering to prefabricate all pipes and foundations and installs them on board. Instead of fitting the actual equipment, dummies are installed so the final system components can be replaced later. A bit of extra installation work is involved, as part of the work needs to be redone, but the advantage is that the cost for the actual system can be postponed.



Shipboard survey and 3D laser scanning are key to either of the approaches taken.

ECONOMIES OF SCALE – FLEET AGREEMENTS

To reduce the risk of price increase for the treatment system chosen or non-availability of the installation partner of choice, many shipowners are finding it wise to negotiate fleet agreements. Especially for owners of larger fleets, retrofitting will be an onerously large project, so finding the right system manufacturer and installation partner and negotiating for volume-driven pricing becomes especially

important. Working with an experienced and reliable partner will prevent headaches and ensure good quality.

Goltens has secured a number of fleet agreements that stretch over five or six years, ensuring customers that their fleets of vessels are well planned in a relaxed schedule and will be retrofitted in time.

As work can be planned over a longer period, sharper prices are possible to further save the shipowner money.



Goltens Green Technologies helps shipowners with a variety of different approaches.

Basic approach to retrofitting

DUTCH SHIPOWNER ANTHONY VEDER IS PREPARING FOR THE BALLAST WATER TREATMENT SYSTEM INSTALLATION WITH THE “BASIS APPROACH” BY COMPLETING SHIPBOARD SURVEYS COMBINED WITH 3D LASER SCANNING AND PRELIMINARY DESIGN. REPAIR AND MAINTENANCE MANAGER RENÉ VAN DIERENDONCK EXPLAINS THE REASONS BEHIND COMPANY’S STRATEGY.

What prompted Anthony Veder to start planning for a ballast water treatment system installation before the ratification of the Ballast Water Management Convention?

For a large number of vessels in our fleet (mainly our LNG/LPG/LEG carriers of up to 7,500 cubic meters), the size of BWT systems available today is an immense problem in regard to the pipe routing and the space in the engine room.

The Goltens 3D laser scan and shipboard survey provides the ultimate approach for us to find out which system (or systems) can be short-listed. Following that, we will be able to make a decision about which system (or systems) would be the best solution for our fleet. In addition, the 3D scan will be available later on for the detailed engineering stage.

What have you learned from this experience?

We started with organizing the 3D laser scan and the shipboard survey with Goltens on board of our most problematic vessel in respect of available space. The result was that although the space was very tight, it would still be possible to install an available BWT system on board this vessel. We are quite sure that we would not have



BIO UV400m3/h system, looking forward.



Combined LNG/LPG/LEG carrier Coral Methane.

reached this outcome without having carried out the 3D scan. This gives us confidence for the rest of the fleet. We will continue with the 3D scans and the shipboard surveys during the months to come.

What would you recommend to other shipowners when it comes to planning and executing a BWT system installation?

I would say, be prepared. There is a lot that can be done in preparation of the BWT system installation without having to make a final decision about which system is finally going to be installed.



Side view of the system on the tween deck.



3D scan and BWT survey was carried out on board Coral Methane in 2013.

Phased fleet-wide installations

BY PLANNING BALLAST WATER TREATMENT SYSTEM INSTALLATIONS IN A CONTROLLED MANNER, SAGA SHIPHOLDING IS TAKING A PROACTIVE APPROACH TO AN INEVITABLE EXPENSE.

Saga Shipholding, the Norwegian open-hatch bulk carrier subsidiary of Nippon Yusen Kaisha (NYK), has been steadily getting ready for the ratification of the Ballast Water Management Convention since 2010. According to Nils Otto Bjørhovde, Technical Manager at Saga Shipholding, the company plans to retrofit its 24 sophisticated open-hatch bulk carriers with BWT systems by 2016, and Goltens Green Technologies is supporting the shipowner in the process.

For the past few years, Saga Shipholding has been proactively undertaking 3D scanning and detailed engineering design projects for its carriers. Each carrier type has a completely different design but within each class the design is very similar. The small differences are taken out by the laser scanning adjusted in the detailed drawings.

Just recently, Goltens has completed the scanning of the last of the 24 vessels. “We make a long-term plan and follow it,” says Jurrien Baretta, Business Development Manager at Goltens. “We scan the ship when she is in a convenient location and process the data so that four to six months before the planned dry-docking we have all the information ready.”

Saga Shipholding has been carrying out a planning process from 2010 through 2012, evaluating the BWT system types available. “We found that the ultraviolet system made the most sense for us,” says Bjørhovde. “From there,

we chose three suppliers to take part in a tender process, and Optimarin ended up winning the contract to retrofit all of our vessels.”



Nils Otto Bjørhovde, Technical Manager, Saga Shipholding.



Saga Pioneer.

One ship in each class was chosen as lead. Goltens’ experts thoroughly scanned these vessels and made the engineering proposals. After that, all the other vessels were scanned to make sure there were no conflicts based on the proposed designs. Goltens was also coordinating approvals of system drawings by classification societies.

TIME IS OF THE ESSENCE

The fleet agreement with Saga Shipholding had built in another important element: time. All ships are being retrofitted during their regular scheduled dry-dockings, avoiding schedule delays.

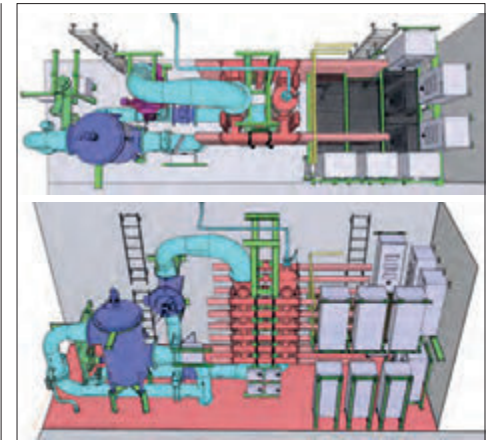
“This is the main reason for starting early,” says Bjørhovde and adds that this approach has supported the strategy of carrying out BWT system installations on six to eight vessels per year until 2016.

AN EASY DECISION

Optimarin brought Goltens in as its engineering partner on the fleet agreement – and Saga Shipholding was pleased with this.

“We knew Goltens as a trusted partner from other jobs, so we were happy for them to get on board here. When we added in their competitive prices, all of this has made it an easy decision for us,” says Bjørhovde.

He said that Goltens’ 3D laser scanning of Saga Shipholding’s fleet was also a large selling point when carrying out retrofits with sister vessels. “Not only does the scanning create huge cost advantages, but it also makes it so much easier when working with all of the smaller details when carrying out prefabrication.”



Views of system design.



Existing ballast pump area (pre-installation).

Saving time and money on sister ship retrofits

FOR SHIPOWNERS WITH FLEETS OF SISTER SHIPS, GOLTENS GREEN TECHNOLOGIES EXPERTS RECOMMEND A PROCESS FOR CREATING 3D MODELS AND PREFABRICATION THAT SAVES TIME AND MONEY.

“Large shipowners generally tend to be more proactive with fitting their fleets with ballast water treatment systems, yet often they do not realize that they can save time and money on sister ships installations,” says Jurrien Baretta, Business Development Manager at Goltens Green Technologies.

Each of the sister ships is scanned, with the vessel operating as normal during the process. After the scan is completed, a 3D model showing how a BWT system would fit into the existing space of one of the ships is created. When this step is completed, the proposed design can be applied to the scan of the sister ships. Instead of creating a 3D model from scratch for each of the vessels, the initial design can be used throughout the sister fleet with some modifications, saving time and costs.

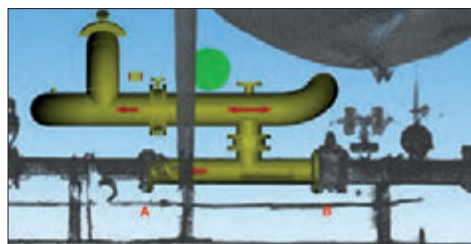
To ensure that the piping design for the first ship fits the sister vessels, a collision check is performed. According to Baretta, this is a crucial step, because no matter how similar sister ships may look, they are rarely exactly the same. If the piping does not fit precisely as it would on the first vessel, the 3D model of the system can be modified.

Sometimes the differences can be quite vast and may require major modifications to the 3D model. In this case, the vessels are no longer considered sisters, and Goltens experts create a new design for the subsequent ships.

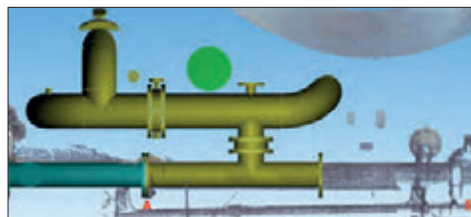
One of the recent sister ship installations that Goltens Green Technologies experts have been working on involved a vessel operating in Southeast Asia. The shipowner requested a scan

of the vessel and needed to get results quite fast. It would take at least a week, including the time needed for travel.

“I looked up the information online and saw that there was a sister of that ship operating nearby. My suggestion was to scan the sister ship and make a proposal based on that. We did not make the final detailed engineering at that point as we needed to survey the actual vessel, but scanning the sister ship helped save time initially,” says Baretta.



Pipe model fits well between flange A and valve B.



Sister vessel with the model from the first vessel where the pipe is missing some length as the distance between flange A and valve B is larger.

Making it fit and work

GULFMARK IS PLANNING AND EXECUTING PHASED FLEET-WIDE RETROFITS OF OPTIMARIN BALLAST WATER TREATMENT SYSTEMS AND GOLTENS GREEN TECHNOLOGIES IS THE PARTNER OF CHOICE.



Highland Prince.



“If it’s scanned, manufactured and installed by Goltens, it fits and works.” That’s the message from Simon Bradford, Operations Superintendent at GulfMark, a company that owns, operates and manages a modern fleet of offshore support vessels.

Goltens recently completed installations on board the company’s platform supply vessel Highland Rover and special purpose vessel Highland Spirit following retrofits to Highland Prince and Highland Monarch. No downtime was involved in any of this work.

Bradford’s decision to use Goltens for scanning, manufacturing and installation came after “problems with some of the earlier installations,” he says.

“It was always where we had employed a third party contractor to do the pipe work and electrics. Our decision was to have the whole contract handled by Goltens. Once we did that, we didn’t seem to have any problems. They do the laser scan, the manufacture of the pipework and installation. And it fits.”

Installation on the Highland Spirit was carried out in port during a planned port stay. “There were other things going on at the same time and Goltens engineers worked carefully alongside other contractors and it all worked out fine,” says Bradford.

Other vessels such as Highland Rover had their installations done at sea by an experienced “riding squad” from Goltens. “They installed the equipment during normal operation ensuring the vessels had no downtime during installation. This was essential for us and our customers, as we did not want to take the vessel off-hire unless absolutely necessary,” says Bradford.

As is usually the case with retrofits, space was a problem on Highland Rover and Highland Spirit. “With all retrofits the problem is finding a way to connect into the existing system and also to find space for the all of the extra equipment that’s being installed. With laser scanning, that can be done at the planning stage,” says Bradford.

According to Bradford, the main advantage of the Goltens approach is the laser scanning. “Because if you don’t do it that way, it’s back to measuring, tack welding, taking the pipes away for full welding, getting them galvanized and returning for fitting. That works to a degree, but it doesn’t compare to laser scanning.”

While he admits there are other companies that do laser scanning, Bradford says GulfMark “has not looked at anybody else for quite some time.”

“We are happy with the service we get from Goltens and with the relationship we have developed,” he explains.

A&P Group rates Goltens Green Technologies tops

IMPRESSED BY THE ACCURACY AND EFFICIENCY OF WORK GOLTENS GREEN TECHNOLOGIES HAD DONE ON RETROFITS FOR KOMAYA SHIPPING, A&P GROUP DIDN'T HESITATE TO RECOMMEND GOLTENS FOR SIMILAR WORK TO SERCO.

Serco was acting on the advice of a partner that has first-hand knowledge of the way Goltens operates when approaching the company with its request for new work.

Referring to work Goltens undertook for the LPG tankers Knightsbridge and Chelsea, Jez Littlejohns, Sales and Marketing Director at A&P Group, says “the seamless way the installations fitted on these vessels gave the yard the confidence to recommend Goltens to Serco for the installation of a ballast water treatment system on board the SD Northern River.”

A multi-purpose auxiliary ship operated by Serco for the UK navy, the vessel is currently the largest operated by Serco Marine Services, both in terms of dimension and gross tonnage.

As with Knightsbridge and Chelsea, Goltens did laser scanning, design, detailed engineering and preparation of all materials for the installation of a BWT system, before A&P Group’s



Jez Littlejohns, Sales and Marketing Director, A&P Group.



SD Northern River.

Falmouth yard fitted the system both mechanically and electrically.

Jurrien Baretta, Business Development Manager at Goltens Green Technologies, says the company’s relationship with A&P Group started by chance, when Komaya Shipping took a Goltens installation package to the yard comprising an installation guide plus all the required materials.

A&P quickly discovered the benefits of the Goltens approach. Laser scanning beforehand makes pre-engineering and prefabrication, as well as finding the optimal positions for piping and equipment, easier than doing this on board the vessel.



Proposed CIP unit location on board LPG tanker Knightsbridge.

Littlejohns estimates the yard saved about two weeks by using prefabricated installation packages from Goltens’ compared with the time it takes to build and fit pipes to a design.

“The drawings and worded spec were very good to use,” says Littlejohns. “The imaging DVD was also excellent as a guide demonstration of the completed image for all.” Goltens produced materials such as piping and foundations to accurate size and Littlejohns says there were very few modifications to the pipes provided.

“The BWT installation, which could easily have been the critical path, became something that happened in the background with very

A&P™

A&P Falmouth

A&P Falmouth, part of A&P Group, is strategically located in North West Europe. Offering extensive ship-repair facilities with three dry docks, vast quay space, craneage and workshops, A&P Falmouth provides high quality and guaranteed turnarounds times that encourage customers to return time after time. A&P also operates main port facilities in the Port of Falmouth with nearly a kilometer of wharfage for cargo, cruise ships and visiting ships, as well as alongside repair. A&P Group is a leading force in the renewable energy sector already working with both local and international partners to develop wave and tidal energy in Cornwall and the UK. A&P Falmouth is the closest port to the recently opened FaBTest site and the closest major port to Wave Hub. It is also the largest engineering, steel fabrication and painting and blasting company in Cornwall with over 9,000m² of workshop facilities, nine major cranes with combine lift of 300t and a wide range of specialist skills and services in house. A&P Group operates across three strategic locations in the UK. Its South West UK facilities at Falmouth combine with its North East UK facilities at Tyne and Tees to offer a rich heritage of marine engineering skills and experience. The firm also has a sister company, A&P Australia, in Sydney, Australia.

minimal input required. This allowed Serco to concentrate on the rest of the refit and make sure other issues were addressed,” says Littlejohns.

He adds that A&P Group did not hesitate to recommend the Goltens approach to Serco because offering the full package of design, class approval, manufacture and supply was a big advantage.

“The detailed information provided by Goltens also allowed A&P Group to give Serco an accurate price and minimal timescale for the installation. This allowed Serco to accurately budget and minimize the costly out-of-service time for the vessel,” says Littlejohns.

Choice partnerships benefit owners

EXPERT ENGINEERING AND INSTALLATION PARTNERS ARE VITAL TO COMPANIES LIKE HYDE MARINE, WORKING TO MEET THE COMING MARKET DEMAND FOR BALLAST WATER TREATMENT SYSTEM RETROFITS TOGETHER WITH GOLTENS GREEN TECHNOLOGIES.

“The company has already been an excellent partner for Hyde Marine with several retrofits completed and more in process. Shipowners can expect high quality upfront engineering and timely installation work from Goltens,” says Chris Todd, Sales Director at Hyde Marine.

He adds that Goltens “has a very detailed approach to the retrofit process including laser scanning, detailed engineering, pre-fabrication of materials, installation, and project management to ensure on-time completion of the retrofit work.”

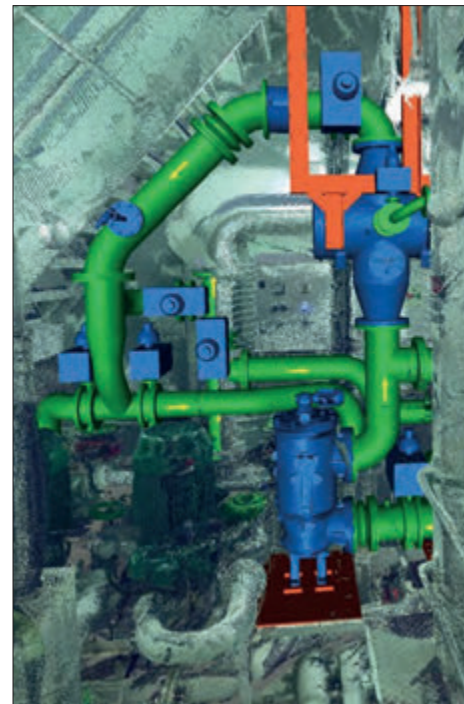
This detailed approach was in action during a recent collaboration between the two companies for a customer in Miami. Seaboard Marine, a container operator based there, contacted Goltens’ specialists in Miami to undertake and manage the end-to-end retrofit of a Hyde Guardian HG200L BWT system on board Seaboard Atlantic. Built in 2009, the vessel is one of 30 that Seaboard operates between the U.S. and major ports throughout Latin America and the Caribbean.

Goltens met with Seaboard to discuss the timing and scope of the project, which included completing the installation of the system during dry-docking in the Bahamas. The proposal was accepted and the project started with 3D scanning of the vessel while it was in port in Miami.

Following that, all piping and installation materials were delivered to the shipyard as planned. The installation by the shipyard went smoothly and was completed on time, receiving a class approval from DNV GL.

Goltens has also worked together with Hyde Marine on an installation on board a ROV survey and construction vessel Polar Queen for Norway based GC Rieber Shipping. The customer contracted Goltens Oslo to provide design and installation services for a Hyde Guardian Gold 300m³/hour ballast water treatment system retrofit.

Given the vessel’s location, Goltens Oslo turned to Goltens Green Technologies resources in Miami to undertake the survey and 3D scanning while the vessel was in the U.S.



Hyde Guardian System modeled on 3D scan output on board Polar Queen.

Following that, the system was modeled and detailed engineering completed by the Goltens’ team in Oslo prior to the piping and installation package being prefabricated and delivered to the shipyard in U.S. for installation.

As a strategic partner for Hyde Marine, Goltens was well aware of the system’s capabilities and requirements and delivered a solution that minimized the cost and timeframe required for the installation.

“Goltens is a premium global service company well known for its expertise in BWT retrofits,” says Todd. “Hyde Marine chooses to partner with such premium companies to offer shipowners the best combination of product and service. We anticipate receiving many orders for equipment based on our partnership.”



Hyde Guardian Gold 300m³/hour system installed on board Polar Queen.



Scan this QR code to view the video of the Hyde Guardian Gold 300m³/hour installation on board Polar Queen.



Hyde Guardian Gold model HG250GS.

Growing together

OPTIMARIN DESCRIBES ITSELF AS “A PIONEER WITHIN THE BALLAST WATER TREATMENT INDUSTRY,” REFERRING TO THE FIRST EVER INSTALLATION OF A BALLAST WATER TREATMENT SYSTEM, WHICH THE COMPANY DID ABOARD PRINCESS CRUISES’ REGAL PRINCESS IN 2000. SINCE THAT HISTORIC INSTALLATION, OPTIMARIN HAS SOLD MORE THAN 450 AND INSTALLED 280 SYSTEMS.

While the company is justifiably proud of its achievements, it is also quick to point out that these were not gained alone. “We are the company with the most experience in retrofits,” says Tore Andersen, CEO at Optimarin. “Much of that experience we got by working with Goltens Green Technologies.”

So it was just one step further in the cooperation between these two companies when Optimarin recently signed a worldwide non-exclusive agreement with Goltens for the installation of Optimarin BWT systems.

The two companies got to know about each other in 2011 when Goltens visited some customers that Optimarin were talking to. “Then we got an inquiry for our biggest retrofit program so



Technip’s pipelay vessel Apache II.



Tore Andersen, CEO, Optimarin.

far, at Saga Shipholding in Norway. We invited Goltens to work with us on that. This ended up in a big contract for us and Goltens in 2012. In the meantime, we had been doing several smaller projects together.”

Andersen says the customer is the ultimate beneficiary of the partnership with Goltens. “Because they are located globally, we can get service where our customers have their ships. Based upon our years of cooperation, we know they are very experienced with 3D scanning, engineering and the installation of our systems and others. They know what it takes to do a successful installation,” says Andersen.

Recent projects the two companies have worked on together include the installation on board the Petroleum Geo-Services offshore seismic vessel PGS Apollo and Technip’s pipelay vessel Apache II.



Scan this QR code to view the video of the Optimarin Ballast System installation on a sister vessel.



As seismic vessels are only in port for a very short time, getting all the information while PGS Apollo was alongside was crucial. Precise 3D scans and accurate pipe manufacturing according to detailed engineering drawings allowed the installation to take place in three days during a port call in the Netherlands.

Also in the Netherlands, Apache II was fitted with an Optimarin system while it was in the dry dock. The customer, Technip, a world leader in project management, engineering and construction for the energy industry, operates a global fleet of 32 specialized vessels for pipeline installation and subsea construction, and required a tight timeline as the vessel was scheduled for dry-docking in a few weeks time.

This meant all scanning, design and prefabrication had to be done ahead of time before Goltens Green Technologies experts joined in Invergordon, Scotland, where the ship was located at the time.

As a lot of jobs were planned for this dry-docking, it was essential to work efficiently with all the parties involved.

The project was completed on schedule and did not result in any delays in the vessel’s departure from the yard. The total piping and electrical installation project, including commissioning, took four weeks to complete.

A Technip spokesman said, “Goltens provided a first-class project management solution during an extremely busy dry-docking. Vessel and onshore technical staff could fully understand the system complexities from the 3D scans Goltens provided.

“From this data, Goltens was able to produce the majority of the pipework off-site and project managed the installation phase on behalf of



Optimarin Ballast System model overlaid on 3D scan results.



Rendering of the BWT system 3D model.



BWT system section installed on board PGS Apollo.

Technip, controlling the shipyard and subcontractor workforce,” said the spokesman.

Andersen says Goltens and Optimarin have solved a number of challenges together during their collaboration. Having matured together, they are now ready for the challenge of getting vessels all over the world compliant with BWT legislation.

Perfectly matched

ALFA LAVAL AND GOLTENS GREEN TECHNOLOGIES WORK TOGETHER TO SUPPORT CUSTOMERS.

Alfa Laval has been delivering equipment to the marine sector for decades, and its products are currently found aboard about 75 percent of the global ocean-going fleet.

“The main focus of Goltens Green Technologies is to serve shipowners in the best possible way, so it is an excellent fit for us to work with a top-class company like Alfa Laval that delivers high-quality equipment,” says Jurrien Baretta, Business Development Manager at Goltens.

While the two companies have been collaborating for many years, they now intend to work more closely together. Their most recent collaboration was a project for Komaya Shipping, which had chosen the Alfa Laval PureBallast system for its LPG tanker Chelsea.

The Goltens team flew to Curaçao, where the vessel was in the dry dock, and completed the 3D scanning in a day. Goltens then prepared a first draft of the proposed design.

After review, the preliminary design was agreed on, and detailed engineering was performed with Goltens delivering pipe isometrics,

foundation drawings and an installation manual. Alfa Laval provided the hardware, while Goltens created the piping and cable runs.

Baretta adds that Goltens worked closely with Alfa Laval’s technical department to ensure correct integration in the existing systems on board the vessel.

Creating a seamless service for the customer is one objective of the closer cooperation the two companies now envisage. “If there is a problem, we will solve it together,” says Stephen Westerling Greer, Global Business Manager for PureBallast at Alfa Laval. “The customer gets the benefit of two organizations operating together. It’s a hand-in-glove scenario, where we complement each other to support the customer.”

Now that owners have accepted the inevitability of the convention entering into force, Westerling Greer says he is seeing more interest in the market now. “The enquiry rate has jumped since December 2014 by volume of enquiries and fleet sizes. Whereas before customers would

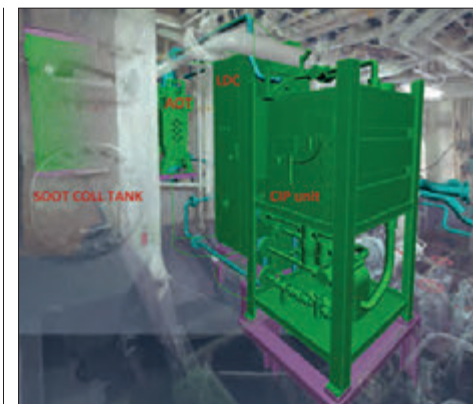


Alfa Laval PureBallast system.

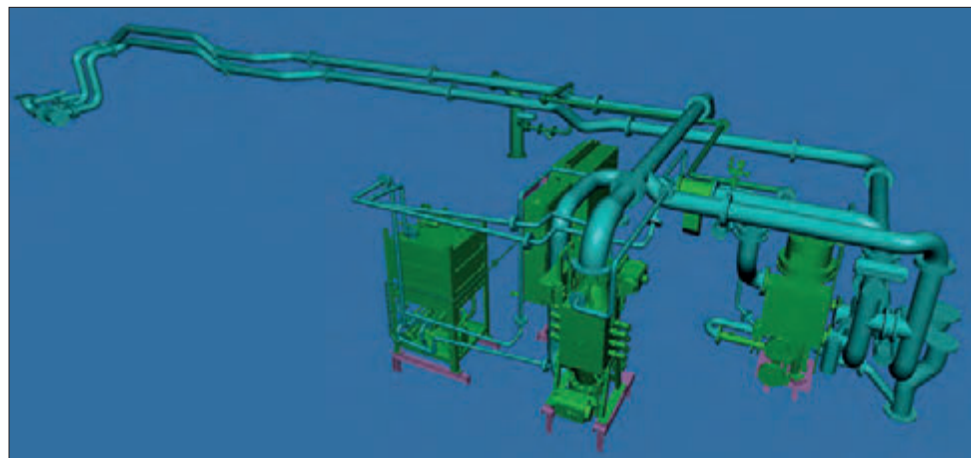
approach us saying ‘We’ve got ships to retrofit and we will think about installing a system,’ now they say ‘We’ve got a specific amount of ships with docking schedules, and we want to try a system or two so that we are prepared for the ratification when it comes.’ We see a lot more focus on the technical and commercial scoping and the impact on ship as far as asset utilization is concerned.”

“Customers are concerned with the ability of suppliers to support them during the retrofit project, from system assessment through concept engineering to completion and commissioning and into the life of the ship. Collaborating with a partner such as Goltens definitely gives confidence to our customers when talking to them around their project needs,” comments Westerling Greer.

Knowledge of the retrofit projects and working with a focus on the customer’s required outcome are key aspects to the success of the project. “Goltens has taken the early steps and have gone through the experience curve for retrofit projects with many now behind them,” says Westerling Greer. “They have a handle on all aspects including project management, ship survey and concept designs, detailed engineering and coordination of sub-suppliers, dock yards and customers. Goltens delivers the quality and confidence of their offer and are prepared to be an active partner that compliments Alfa Laval’s quality and services related to PureBallast systems. We are looking forward to a strong, positive and long-term relationship that supports our customers.”



Proposed CIP unit and LDC location in front of the soot cleaning tank.



3D image of the system installation on board Chelsea.



Completed installation.

Sulphur emissions compliance

The sulphur emission control legislation is in effect and will be phased in to tighten standards globally by 2020. Various compliance options are available to shipowners to address these regulations, and Goltens Green Technologies has experience with them all.

Options range from the installation of scrubbers to remove sulphur emissions while maintaining the ability to run on low-cost heavy fuel, to fuel system modifications that allow the vessel to run effectively on low-sulphur gas oil (LSGO). The second option requires modifications to the fuel system, generally involving the installation of LSGO coolers to increase the viscosity of the fuel, thereby avoiding long-term wear damage to the engine. For LNG vessels, a full boiler retrofit to allow for operation on tri-fuel is also being pursued by many operators.

Whatever path is chosen, installation can be more efficiently and confidently completed leveraging Goltens' 3D scanning and modeling as the basis for highly accurate engineering design.

SULPHUR EMISSION CONTROL AREAS

Sulphur emission control legislation related to MARPOL Annex VI has been in effect for quite some time within designated Sulphur Emission Control Areas (SECA or ECA). These SECAs are areas where strict controls to minimize sulphur emissions from vessels were established. The SECAs in effect are the Baltic Sea (2005), the North Sea (2006), U.S. and Canada (2011) and the U.S. Caribbean (2013). Within these areas, sulphur limits for fuel have gradually been reduced from 1.5% prior to 2010 to a limit of 0.10% starting in 2015. To date these regulations have largely affected only vessels trading within the ECAs but that will begin to change over the next five years.

The rest of the world's fleet will feel the impact of the legislation in 2020 when sulphur limits are scheduled to drop globally to 0.5%.



Exhaust gas scrubbers installed in 18 days

A LARGE CRUISE VESSEL OWNER ENGAGED GOLTENS GREEN TECHNOLOGIES TO UNDERTAKE THE INSTALLATION OF TWO EXHAUST GAS SCRUBBERS ON ONE OF THEIR SHIPS EQUIPPED WITH SIX GMT/SULZER DIESEL ELECTRIC GENERATOR SETS.

The scope of the project was to perform all evaluation, planning, design and installation for two exhaust gas scrubber towers of over 10 meters high on two diesel generators. The entire operation had to be completed before the end of the cruise ship's dry-docking period in the U.S.

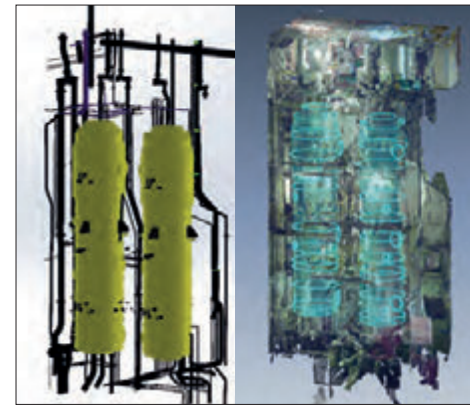
DETAILED PLANNING AND PREPARATION

Goltens' technical management went on board the vessel to evaluate the project, determine space requirements and logistical obstacles. Leveraging the well-proven Goltens process, they undertook the 3D laser scanning of the spaces to facilitate system modeling. After the 3D modeling, Goltens' experts completed the detailed design and mapped out a definitive process, manning plan and timeline for the removal of the existing exhaust silencers and the installation of the exhaust gas scrubbers within the set timeframe.

Using the detailed design, Goltens' specialists were also able to prefabricate foundation structures in the company's workshop and ship the prefabricated material to the vessel in time for its arrival in the dry dock.



Rigging exhaust gas scrubber section aboard.



3D models of scrubber system and connections.



Rigging scrubber section into the ship.

PHASED APPROACH FOR SCRUBBER INSTALLATION

Goltens mobilized a 10-man riding crew to perform demolition and prepare the engine casing for the rigging and installation operations. Despite a three-day delay in beginning the dismantling due to unforeseen operational demands for the engines, all preparatory work was completed by Goltens' team during a nine-day underway period prior to docking.

Once the vessel was in the dry dock, Goltens deployed over 40 technicians and technical managers to complete the project within the 10-day dry-docking period. After an initial 24-hour delay due to severe weather, the team removed all eight exhaust silencers and installed all scrubber tower sections in just 22 hours, before the crane was struck due to another storm. Goltens ran two shifts with a minimum of two supervisors per shift to ensure that quality controls and safety standards were adhered to throughout the project.

INSTALLATION RESULTS

Despite significant delays caused by operational requirements underway and severe weather at the beginning of the dry-docking, Goltens kept to the schedule, working around the clock to complete the installation. As a result, the project was completed a day ahead of schedule and the vessel was able to leave the dry dock as planned.

LSGO modifications on seven LNG carriers

GOLTENS GREEN TECHNOLOGIES EXPERTS WERE ENGAGED TO UNDERTAKE THE RETROFITTING OF SEVEN Q-FLEX LNG CARRIERS WITH LOW SULPHUR GAS OIL (LSGO) COOLING SYSTEMS AND CONTROLS. THE VESSELS WERE ALL UNDER CHARTER BY THE SAME OPERATOR BUT OWNED BY DIFFERENT OWNERS (THREE AND FOUR RESPECTIVELY).

The key objective of the projects was to attain operational Sulphur Emission Control Areas (SECAs) compliance and main engine reliability for each vessel in 2015.

The cooler installation and piping modification objective was to ensure that after manual change-over from heavy fuel oil (HFO) to LSGO that a minimum viscosity of 2 percent would be attained in the LSGO fuel, subsequently optimizing engine reliability, operability and maintainability.

Goltens conducted a 3D laser scan on board one sister vessel to determine space integration of cooler and piping layout into purifier room. The scope of supply consisted of installation of new fresh water cooler, additional installation of fresh water piping, modification of existing fuel supply system and supply of all in line components.

The onboard survey enabled Goltens to draft both general arrangement drawings and generate isometric drawings to provide accurate prefabrication of piping, which in turn reduced the project installation schedule on board.

Upon customer and class approval of drawings, Goltens completed fabrication of all vessels piping. The installation schedule was completed in close cooperation and dialogue with both the equipment manufacturer and the vessels' owners.

The installations were all satisfactorily completed at anchorage or on ballast voyage between Asia and UAE as well as Europe and UAE.

As a result of this work, the customer has recommended Goltens' support to conduct similar future projects with other key LNG carriers and tanker operators.



LSGO Cooler installed on board.

SECA compliance for 15 vessels

TWO SHIPOWNERS WITH 15 Q-FLEX LNG CARRIERS UNDER CHARTER FOR THE SAME LNG OPERATOR ENGAGED GOLTENS GREEN TECHNOLOGIES TO SUPPORT THEIR FLEET-WIDE LOW SULPHUR GAS OIL (LSGO) BUNKER AND TRANSFER MODIFICATION PROJECT.

This project was aimed at achieving operational Sulphur Emission Control Areas (SECAs) compliance for each vessel in 2015 without taking the vessels out of service.

The piping modification objective was to ensure that each vessel would have available and sufficient capacity of low sulphur gas oil (LSGO) for use in SECA locations and to provide trading and fuel selection flexibility.

The owners recognized that this was a short-term solution and that although the modifications would ensure compliance, they would not optimize engine reliability, operability and maintainability without the eventual installation of an LSGO cooler to increase the viscosity of the fuel.

Goltens conducted a survey on board one of the Q-Flex vessels to determine space integration and piping layout. This facilitated effective prefabrication that was carried out in Goltens' workshop to minimize installation time on board the vessel.

Upon customer and class approval of drawings, Goltens completed fabrication of all required piping. The installation schedule was satisfactorily conducted in line with globally recognized quality standards.

Following the work completed by Goltens' experts, all of the 15 vessels are now SECA compliant. Goltens completed the required scope on all 15 vessels while they were in service without any loss or delays of cargos.



Installation of fuel transfer line on board.



Preparing for fuel system pressure testing.

Other retrofit solutions

NOT ALL SCANNING AND DESIGN WORK IS RELATED TO COMPLIANCE. GOLTENS GREEN TECHNOLOGIES APPLIES THE SAME PROCESS TO A WIDE RANGE OF RETROFITS THROUGHOUT THE GLOBE TO SPEED UP AND IMPROVE THE ACCURACY OF COMPLEX PROJECTS.

DUAL FUEL RETROFITS OF DIESEL ENGINES

Goltens has the ability to undertake the retrofit of installed diesel generators to run on dual fuel, closely cooperating with market leading manufacturers. These retrofits involve the installation of complex piping and control systems, and the scanning and design process increases accuracy and speeds the installation.

REVERSE ENGINEERING

Goltens Green Technologies has experience in reverse engineering to create complex models used for risk mitigation and integration into detailed engineering packages for upgrades and modifications. Typically applied to compound curvature of hulls and propellers.

PIPING RENEWALS

Goltens Green Technologies is also able to create detailed isometric drawings of piping systems and prefabricate the pipe spools to dramatically reduce installation time.

PIPING DATABASE

For vessels subject to excessive wear and tear on their piping systems, having a pre-designed set of drawings "in the box" can be very beneficial. All details with regard to exact size and material specification are in the Goltens database for prefabrication at the location of choice.

CHALLENGING RIGGING WORK

Goltens utilizes scanning and modeling to determine the optimal routes for machinery movement and removal with the minimum possible disruption and hull cutting.

Signature process applied to piping renewal

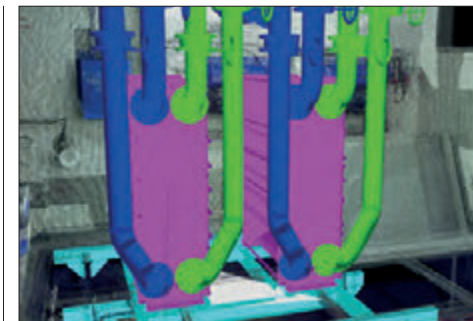
GOLTENS GREEN TECHNOLOGIES EXPERTS APPLIED THE WELL-PROVEN, FLEXIBLE PROCESS THAT LEVERAGES 3D SCANNING TECHNOLOGY TO A TURNKEY INSTALLATION OF PIPING SYSTEMS ON BOARD A SEISMIC VESSEL.

One of the world's largest geoscience companies approached Goltens for a solution for their vessel piping system upgrades. Their C-Class seismic vessel required upgrades for the main engine cooling and fuel systems, along with a new bunkering line and time was a factor.

To complete the piping upgrades in the most efficient manner with the absolute minimum amount of asset downtime, Goltens leveraged its proven Green Technologies' process used for ballast water treatment systems and sulphur emission control retrofits.

Goltens' experts performed 3D laser scanning and modeling of the systems, followed by the detailed engineering for the main engine cooling and fuel system upgrades and the new bunkering line. The next steps included the prefabrication and onboard installation of all piping and a complete electrical installation, including electrical control cabinets for the shaft and engine cooling systems. Goltens' specialists also updated all relevant ship documentation and completed the sea trial.

The project was completed with most of the installation work done at sea with the exception of the new overboard and sea chest intake with no operational impact. Based on the success of this project, Goltens was approached again by the same company for completing the exact same task for a sister vessel.



Main engine cooling system modeled over 3D scan output.



Part of the main engine cooling system installed on board.

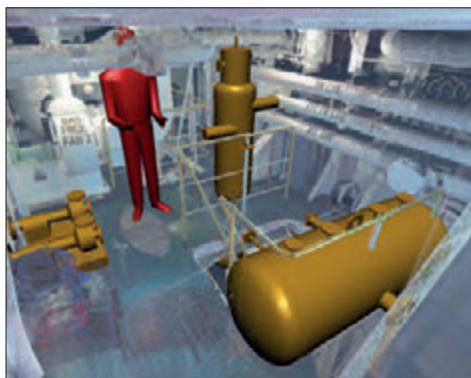
Oil boiler retrofit in Poland

GOLTENS GREEN TECHNOLOGIES RECENTLY CARRIED OUT A THERMAL OIL BOILER RETROFIT ON BOARD A 12,000 DWT CHEMICAL TANKER IN SZCZECIN, POLAND, APPLYING ITS SIGNATURE SCANNING AND DESIGN PROCESS.

After receiving dimensional sketches from the manufacturer of the boiler, Goltens sent a proposal for the positioning of all equipment to the client. Following up on that, 10 days after receiving the diagrams with pipe specs and part lists Goltens sent another proposal for the routing of the boiler lines. After this was approved, Goltens started with the detailing.

The engineering package created by Goltens contained:

- Position of the components
- Drawings of the foundations
- Drawings of the cable trays and flat bars
- Isometric drawings for the piping in the pump room



Positioning of components.



Thermal oil drain tank.

As an extra loading platform, one deck higher, was made aft, Goltens made alterations to the original diagrams of the cargo system, as requested by the client. The company also took care of the arrangement of the loading platform, for which a 3D scan was made.

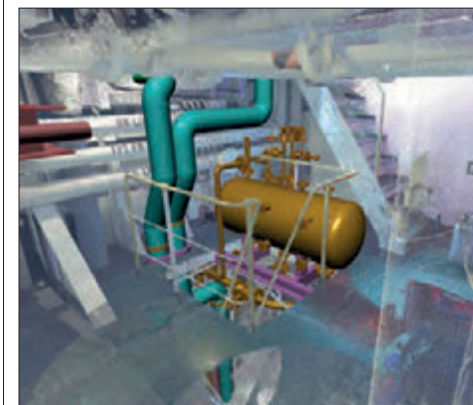
Several scans were also made of the pump and engine rooms to find space to place the boiler. All scans, which give a panoramic view of the scanned area, were processed and made available for online viewing by the client.

The main components placed for the retrofit were a heat exchanger, expansion and buffer tanks, two circulation pumps on the lower deck, drain tank, filling and drain pump.

Steelwork for the electrical components was created by the yard from the drawings of cable trays and flat bars that Goltens created.



Top view of the installation.



Expansion tank near staircase.



Piping below the upper engine room deck.

Increasing efficiency with 3D scanning

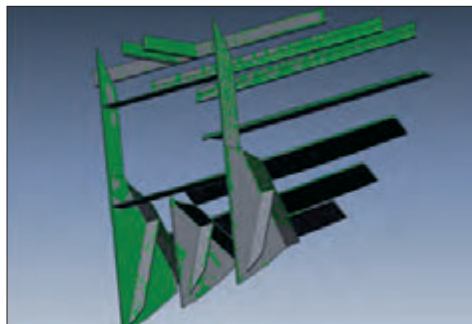
A CANADIAN SHIPYARD UNDERTAKING AN EXHAUST GAS SCRUBBER INSTALLATION ON A CRUISE VESSEL NEEDED TO FABRICATE A NEW SEA CHEST AS PART OF THE SCOPE OF THE PROJECT. THE SEA CHEST WAS REQUIRED TO ACCOMMODATE THE ADDITIONAL PUMPS NEEDED FOR THE EXHAUST SCRUBBERS.

On a previous job for a similar cruise vessel, Goltens Green Technologies had performed 3D scanning, modeling, and reverse engineering of the other vessel's sea chest. Upon completion, Goltens provided this as an example to the Canadian yard to allow them to evaluate this as part of their project planning. The yard immediately recognized the value of the precise model of the as-built hull curvature to their project and engaged Goltens to undertake a similar project for them.

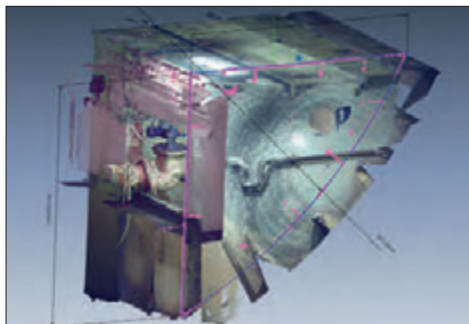
Goltens attended the vessel during a port stay and performed the scan of the sea chest and surrounding areas with no interference to vessel operations. From the data collected, reverse engineering of the hull and structures of the

compartment was performed to create 3D parametric models. These models were then turned over to the yard's naval architects to complete the design for the new sea chest.

The model allowed the architects to design precisely to the shape of the hull and around the existing structure, saving fabrication and installation hours as well as engineering time. Due to this precision, the yard's naval architects were able to prefabricate plates exactly to size and fit everything up with minimal modification. This served as a major timesaver in comparison to traditional shipyard fitting methods of manually modifying the plates with hammers, torches and grinders to fit the plates to the hull curvature.



Comparative weather mapping of internal structure.



Modeling of hull curvature and bulkheads.

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Worldwide Service Network



As a leading independent global provider of ship repair services, Goltens has constantly been presented with new challenges by shipowners, who have one main objective – how to keep their vessels in operation.

Goltens has refined and proven a repeatable process that enables owners to confidently evaluate, design and install the most appropriate solutions to address environmental regulations with minimal interruption to operation – avoiding unnecessary downtime.

Goltens Green Technologies is a highly skilled and experienced global force with resources in every region in which Goltens operates around the world. Leveraging heavy investments in technical experts and the latest laser scanning and design technology, Goltens delivers turnkey solutions to address a wide array of environmental compliance challenges.

Goltens Green Technologies has the depth of experience to help shipowners select the right system and navigate the process resulting in the execution of a well-planned and swift upgrade of their existing fleet in a time and cost-efficient manner.

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