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HISTORIC OPPORTUNITY TO TRANSFORM THE GALICIAN SHIPBUILDING SECTOR

To talk about the Galician naval industry is to talk about one of the great industries of our land. A strategic sector not only because of the number of direct and indirect jobs it generates, but also because of its significant impact on Galicia's socioeconomic environment as a whole.

Not surprisingly, this industry has a high international character, with 90% of the ships built in the last decade in our shipyards destined for export. In addition, its average turnover, during these ten years, has risen to 2,500 million euros, making Galicia the first Spanish community in shipbuilding and ship repair.

A scenario that, like that of all industries and models, has been to some extent truncated by the pandemic. In spite of everything, and after the worst months of this crisis, the sector is facing the future with positive data, with 13 new ships already signed, and with the expectation of closing another 17 orders during the last quarter of the year. If confirmed, at the end of the year, the turnover would reach 750 million, a figure still far from previous years, but which lays the foundations for what is to come.

A future that also passes through the Next Generation European funds, which arise as a historic opportunity for the transformation of the Galician Shipbuilding Industry. On the basis of the work done, our industry should focus on achieving greater competitiveness of the shipyards, providing internal mechanisms and financing to increase efficiency, achieving maximum technological independence in processes and products, focusing on specific training and the maintenance of know-how, and developing a model of integrative relations with the auxiliary and supply industry.

In this framework, European funds represent a magnificent opportunity to optimize and transform this value chain, also betting on productive diversification towards activities that complement and enhance shipbuilding. Offshore wind power or the promotion of modular building to leverage our productive framework and respond to the growth in demand for renewable energy infrastructures are some of the challenges posed.

The possibilities are multiplying, and the Galician Shipbuilding Sector is perfectly positioned. All that is needed is to guarantee collaboration between administrations so as not to see these goals reduced. From the Xunta de Galicia we will continue working with the aim of awakening in the Spanish Government the sensitivity that our Shipbuilding Sector deserves, both so that it can attend on equal terms to these European funds, as well as to promote a specific PERTE (strategic projects for economic recovery and transformation) for this industry, as has already been done in another considered strategic for our economy such as the automotive industry.

A worthwhile effort that will complement the work already done. In recent years, we have invested more than 100 million in improving the competitiveness of the sector, focusing on training, innovation and internationalization; we have facilitated its financing; and we are working on a new support plan with measures to continue taking steps forward in its digitalization and promotion. A bet that must now be reinforced by the European funds. Galicia and the Shipbuilding Industry well deserve it.

FERNANDO GULDRÍS

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ONBOARD INSTRUMENTATION. DATA LOGGING AND MONITORING

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1.- INTRODUCTION

As the years have advanced, the ships built have become increasingly complex and with a high level of technology integration incorporated in their equipment. Deck machinery have not remained unrelated to this modernization and is one of the systems that has also been greatly affected.

The instrumentation installed in Ibercisa´s deck machinery and its drives are becoming increasingly important as support for better maintenance and diagnosis, as well as for continuous improvement in operations with the ultimate goal of achieving greater efficiency at a lower cost.

This instrumentation can be observed in most vessels, being fishing vessels a clear example (trawlers or pelagic), oceanographic research vessels, and towing vessels, among others.

2.- INSTRUMENTATION AND DATA LOGGING

The main mission of the sensors installed in the machines and drives supplied by Ibercisa is to carry out the correct control of the machine for the operation for which it has been designed, in the most efficient way possible. They are used to measure, record and display information in real time of the operating conditions of each one of them, and thus know if they are operating at their optimum working point.

These sensors are also used for monitoring and detection of equipment and drive system failures or malfunctions if anomalous values are observed and recorded in the measured parameters, outside the normal operating range.

Likewise, another functionality that sensors allow is to perform condition-based predictive maintenance (CBM), which enables the customer to anticipate equipment failures before these occur.

To that effect, the main sensors installed in Ibercisa equipment are used to measure the following operating parameters:

• Record of motor **speed** (min^{-1}) and drum (m/min). The sensors used for this purpose can be incremental encoder, tachometer (proximity detector) or absolute encoder.

• Record of **length** of meters from the reel (m). Proximity detectors are used which, through an own algorithm developed in Ibercisa, show the meters extended or the meters of cable remaining on the drum.

• Record of **pull** (ton/kN) of the forces produced on the cable due to the effects of external stresses. Static forces (with the brake applied) and dynamic forces (with the machine rotating) are measured.

• Record of operational **temperature** (º C) of the main drives such as windings of electric motors and frequency converters, as well as the oil for the operation of motors and hydraulic pumps. Bearing temperature of electric motors and shaft generators. Ambient room temperature of electrical cabinets or cooling water to drives and electric motors. Thermostats, PTC and KTY thermistors, and PT100 and PT1000 temperature probes are commonly used.

• Record of **pressure** (bar) of hydraulic systems to know working conditions of the system and consumers, as well as in cooling circuits. Pressure switches with hysteresis and pressure transmitters are used.

• Record of **flow rate** (l/min) of hydraulic systems to know working conditions in the system, as well

as in cooling circuits. Flow switches and flowmeters are used.

• Record of **vibration** recording (mm/s) to determine the operating condition of bearings installed in machines and shaft generators. Accelerometers are used.

• Record of **voltage** (V) and consumption (A) recording on machines and electric drives for power supply and consumption control during operation. Electronic (VSM) or analogical (voltmeter and ammeter) devices are used.

• Record of **operating time** record (hours / cycles) of the different main and auxiliary drives of the system to schedule their preventive maintenance by hours of operation or cycles performed. Analogical hour meters or digital counters are used.

There are other sensors whose measurement is not recorded in time, but are associated with an action or alarm in the control system waiting for a reaction from the operator, for example:

• **Dirt** log for hydraulic filters, to know its operating status and recommend its replacement. Clogging sensors are used.

• **Position** record to delimit the operational range of various components or mechanical actuators, generating an alarm and an action when it is detected. Proximity sensors, linear encoder or absolute encoder are used.

All these data recorded by the different sensors in the equipment, and which are controlled by an industrial controller or PLC, are saved and stored in the industrial PC that Ibercisa supplies with its equipment for subsequent analysis and monitoring.

The local space allocated for parameter logging on the computer's SSD hard disk is usually not less than approximately one (1) month continuously, considering a logging of sixty (60) variables every second, during twenty-four (24) hours every day. Once this space is filled, the following records are overwritten.

3.- MONITORING AND DATA LOGGING

All the data stored on the various machines ('Datalog' file) on the industrial PC installed on board can be consulted and displayed locally by the ship's personnel through the HMI (Human-Machine Interface) screens for the control of the equipment. This data can be represented graphically using the HMI display's own software for better visualization.

Recently, Ibercisa has developed a **web application (APP)** that allows to consult and visualize graphically all the operating parameters of the equipment installed in the vessel remotely, being a very interesting tool for inspectors and/or fleet managers. This application allows to visualize the main operating parameters of the vessel's equipment during its operation or to analyze any possible incident occurred, being able to monitor how the machines are being operated, their operating hours, the pull performed, or the power consumed and regenerated.

The web application is installed and runs on the onboard industrial PC and records the parameters that are decided to be monitored for each machine, as well as the sampling time, reading directly from the PLC. All this data is deployed in the cloud (CLOUD) generating a database. Obviously, it is an essential requirement that the PC on board has an Internet connection.

The customer, who is ashore, can comfortably access with the APP to all stored data from the cloud and can visualize them graphically, at the desired date. The storage space in the cloud is larger than the space allocated locally and can be configured according to the number of data and time of data sampling thereof. In addition, the APP is optimized to only record new data when a parameter undergoes some significant variation over time, or only when a winch is enabled for operation, thus saving storage space.

4.-DATA SECURITY

Data cybersecurity is an issue of great importance and relevance in the industrial field. That is why Ibercisa has been working for several months to increase the security of the data recorded on the vessels, which can later be deployed in the cloud, as well as remote access to the PLC installed on board by the Service engineers.

Ibercisa's industrial PCs incorporate antivirus protection and specific software for the control and management of system vulnerabilities, as well as malware control with real-time notifications. Additionally, software for the encryption of hard disks is incorporated to prevent unauthorized data extraction.

In addition, a Siemens 'Scalance SC615' device is incorporated, with Internet access, through which remote connections are made to access the system securely, in order to diagnose problems or make adjustments to the control system of the equipment, at the customer's request. This device has the multiple function of acting as a router (to establish a remote connection via VPN), as a communication gateway with third parties equipment installed on the vessel where data exchange between different systems is required, and as a firewall isolating Ibercisa's equipment and system from the rest of the vessel's communication network with third parties equipment.

5.-MAINTENANCE AND CONTINUOUS UPGRADING

Ibercisa incorporates an equipment **maintenance** tab in its HMI screens. This tab is configured to give advance notice to the crew to carry out scheduled maintenance on the different winches (mainly greasing and lubrication tasks) based on the operating hours of each of them. Warnings are also added for periodic revision of elements subject to wear due to cyclic workloads.

This functionality is a very useful assistance for the crew to maintain the equipment in its optimal operability state.

During the useful life of the equipment, Ibercisa also proposes and incorporates continuously all those **improvements in the control programming** that are considered advantageous for the customer, in terms of facilitating the visualization, operation and monitoring of the status of winches and their drives.

INVENTORY OF HAZARDOUS MATERIALS, PRELEMINARY RESULTS ON FISHING VESSELS

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INTRODUCTION

On June 30 of this year, the 6-month extension that the European Commission had authorized as a result of Covid-19 for compliance with *Regulation (EU) 1257/2013* ended, by which all vessels greater than 500 GT of European or non-European flag, users of European ports or anchorages, had to carry on board an Inventory of hazardous materials with its pertinent Certificate.

After almost 6 months of the grace period, and despite the fact that there is still a significant bottleneck in the approval of the Inventories with a considerable number of vessels without the Hazardous Materials Inventory Certificate issued, (it is estimated that by December 31, 2020, around one third of the fleet had not started any work to obtain the certificate), we´re in a position to obtain the first conclusions from the work carried out to date, but not without first making a brief immersion in this Regulation that had already been described in greater detail in previous issues.

THE REGULATION (EU) 1257/2013

Regulation (EU) 1257/2013 of the European Parliament and of the Council on the recycling of vessels was created with the intention of accelerating the ratification of the *Hong Kong International Convention,* which has not yet entered into force. Both regulations are, except for some minor clarifications, similar and pursue the same objectives, which can be summarized as preventing, minimizing and, as far as possible, avoiding accidents, injuries and other adverse effects on human health and the environment caused by vessel recycling.

To achieve the above purposes, a number of requirements apply to both ships and recycling facilities. Thus, the latter must be authorized by the competent authorities and meet a series of environmental, management and worker safety requirements. On the other hand, the requirements demanded of ships are based on its recycling plan and on the Inventory of hazardous materials (hereinafter, the Inventory) on which we will focus below.

THE HAZARDOUS MATERIALS INVENTORY

The inventory of hazardous materials (or I.H.M.) is a document where all those materials on board the vessel that are considered as hazardous by the (EU) *Regulation* must be identified.

It consists of 3 parts: Part I includes hazardous materials present in the ship's structure or equipment with an indication of their location and approximate quantities. Part II identifies the wastes generated by the operations and Part III consists of a list of provisions on board the vessel. Parts II and III will be carried out before recycling, while Part I will accompany the vessel throughout its useful life, so it will be kept conveniently updated to reflect changes in equipment and structure, as well as new installations.

The substances listed in Annex I and II of the *Regulation* are considered potentially hazardous. The first includes: asbestos, polychlorinated biphenyls (PCBs), ozone depleting substances, antifouling systems with organic tin compounds (TBT) and perfluorooctane sulfonate acid (PFOS). While in Annex II: cadmium, lead, mercury, hexavalent chromium, polybrominated biphenyls, PBDEs, polychlorinated naphthalenes, radioactive substances, certain paraffins and HBCDDs.

For new vessels, Part I of the Inventory will only

reflect the hazardous materials listed in Annex II as Annex I materials cannot be installed when they exceed the threshold value.

In existing vessels, on the other hand, Part I of the Inventory shall compulsorily reflect the hazardous materials listed in Annex I and, to the extent possible, those listed in Annex II. In this case, the best way to detect hazardous materials, given that the available documentation is rarely conclusive, is by sampling and later laboratory analysis.

FIRST RESULTS

The following are the first data obtained from the work carried out by **F. Carceller** during the preparation of Part I of the Inventory on existing fishing vessels.

A sample of 25 fishing vessels built between 1966 and 2006, all of which were built in shipyards in the northwest of the Iberian Peninsula, was taken into account[1]. Although a larger volume of vessels would be necessary to obtain a clearer picture and extract more reliable conclusions, given the geographical homogeneity in the construction of the vessels considered and their identical typology, we can obtain a first outline of the use of hazardous materials and their current presence in a part of our fishing fleet.

Focusing on the hazardous materials listed in Annex I (mandatory survey on existing vessels), asbestos and ozone depleting substances (ODS) were found in the highest proportion and with the highest frequency on the sampled vessels.

Substances that deplete the ozone layer

The high refrigeration needs required for the preservation of catches make fishing vessels potential carriers of these substances due to the possibility of their use. On the one side, as a primary coolant in refrigeration plants and, on the other, as an expansion agent for expanded polyurethane foams used in many parts of the vessel as an insulating element due to its low coefficient of thermal conductivity.

The use of substances that deplete the ozone layer was already regulated in accordance with Rule 12, Chapter III, Annex VI of Marpol, and by Rule IV / 15 of the Torremolinos Protocol; therefore, no ozone-depleting refrigerants were detected in the sampled vessels. However, in older vessels it has been found to be present in expanded polyurethane foams used for the insulation warehouses, fishing parks, cold plant piping, etc.

Figure 1: particle separator foam 1800 mg/kg de R-11

Specifically, the substances found in the highest proportion were R11 or CFC-11 (trichlorofluoromethane) followed by R22 (chlorodifluoromethane) with ozone depletion potential 1 and 0.05, respectively.

Asbestos

As for the other substance with the greatest presence, asbestos, its excellent physical-chemical properties and its low price promoted that it could be used in a large number of ship materials.

Figure 2: asbestos door joints

1 Except for one unit built in Germany

Of the 25 fishing vessels analyzed, asbestos was detected in 15 of them, representing 60% of the total sample. In the remaining 40% (10 vessels) the analyses carried out on the samples collected did not show the presence of asbestos.

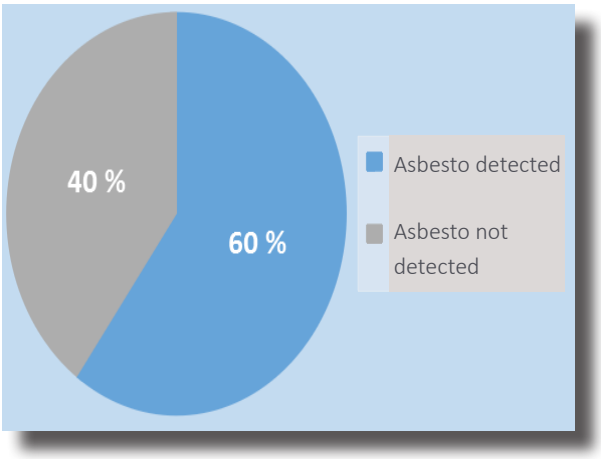

Figure 3: percentage of vessels with presence of asbesto

In our country, the use, production and commercialization of asbestos fibers was prohibited in 2002 by means of the Order of December 7, 2001, which modifies Annex I of R.D. 1406/1989, anticipating the European ban that did not occur until 2005, although some types of asbestos were already prohibited. Using 2002 as a reference year, it can be seen that of the 15 ships in which asbestos was found, only one was built after the ban date.

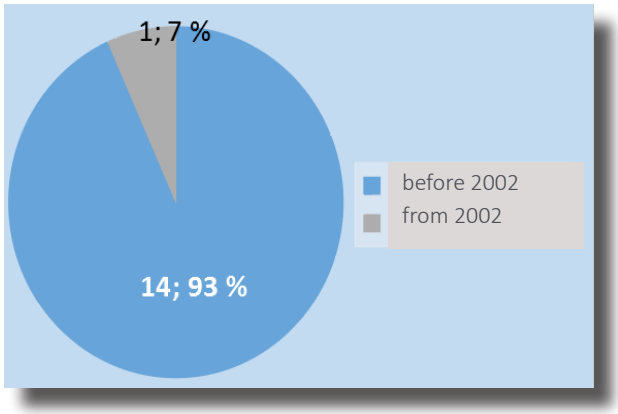

Figure 4: presence of asbestos according with the construction´s year

Therefore, the creation of normative for the regulation of its use has been shown to be an effective method for the control of asbestos in vessels and demonstrates the high degree of compliance with the legislation both in shipyards and throughout the supply chain.

The most frequent locations with presence of asbestos in the sampled vessels were in braided cords used as joints or gaskets of steel doors and accommodation doors. Also, in sandwich panels and false ceilings.

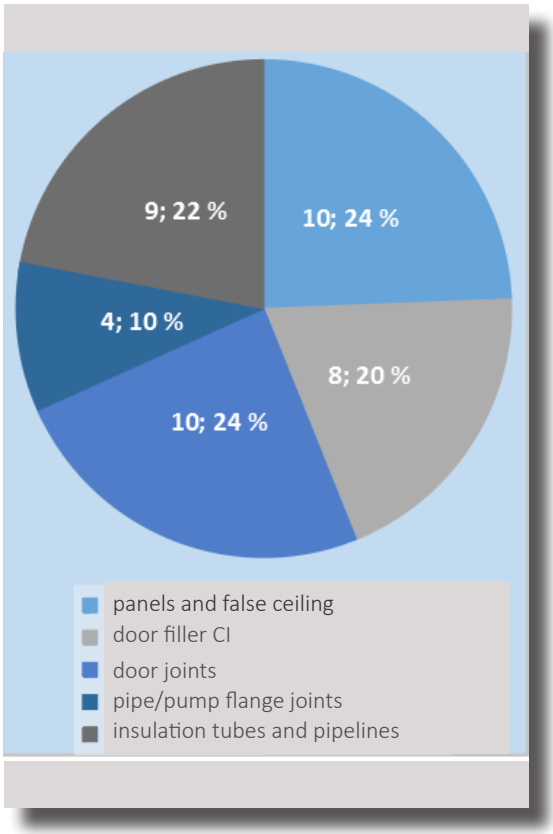

Figure 5: main locations of asbestos

As can be seen in Figure 5, the above mentioned panels are composed of two thin outer layers of GRP covering the inner part composed of asbestos fibers mixed with organic fibers, so a single visual inspection can lead us to misunderstandings. In these panels, it is essential that the external face is in a good state of conservation to avoid the spread of the fibers.

Figure 6: detail of accommodation panel with asbestos fibres (chrysotile)

The remaining locations, although they were present in a smaller percentage of vessels, are found in a similar percentage to the previous ones and may represent a significant amount. Such is the case of one vessel in the sample where a large number of pipes outside the engine room were insulated with woven asbestos cloth.

CONCLUSIONS AND ASSESSMENTS

• Although the use of ODS in refrigerants is practically non-existent, they can still be found in polyurethane foams in older vessels.

• Almost all fishing vessels with asbestos were built before the total prohibition of its use and in all cases the type of asbestos found was chrysotile (the use of amphiboles had been prohibited prior to 2002).

• Only results confirmed by laboratory analysis were used. There are elements with a high probability of containing asbestos that have not been considered due to the impossibility of taking samples, such as the sheathing of electrical cables or the gaskets of pumps or valves. Therefore, a complete sampling of the vessel may show different results.

• In materials with the presence of asbestos, attention must be paid to their friability, which is defined as the ability to detach fibers in response to the simple pressure that we can exert with the hand. Friability will vary depending on the amount of fibers in the manufactured material, the type of blending with other composites and the state of preservation of the material.

• In addition to safeguarding the health of workers involved in ship recycling, the Inventory has also enabled shipowners to know the presence of asbestos on their vessels and to take action to protect their crews.

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A NEW AGE IN SURFACE TREATMENT

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INTRODUCTION

Industrial de Acabados, S.A. (INDASA), is a company specialized in the preparation and treatment of surfaces in the naval, industrial, wind energy and Oil&-Gas sectors, both in repairs and new construction. It was founded in 1968, locating its main headquarters in the city of Gijón. Subsequently, delegations have been opened in Ferrol, Cádiz, Bilbao and Cartagena.

INDASA has more than 50 years of presence in the Spanish and European markets, being always outstanding at national level in the introduction of new technologies and processes, maintaining a standard of quality and execution of first level.

The company has always stood out for its technical excellence, provided by its extensive experience in the management of large projects, specialization in the provision of services and the contribution and integration of human and material resources in the value chain.

Its service culture is based on the values of flexibility and adaptability, national and international geographic mobility and efficient resource management.

INDASA AND THE WATERJETTING

Following its corporate culture and in its firm purpose of remaining at the forefront and being a technological benchmark in its sector, INDASA has made significant investments in waterjetting machinery for use in repair works.

This technology allows the preparation of surfaces by means of an ultra-high pressure water jet, eliminating any trace of contaminants, rust or paint from the surface to be treated.

Among the main advantages of this system, it is necessary to highlight the improvement in efficiency, both in production and in energy, the lower consumption of human and material resources and greater sustainability for the environment.

INDASA is currently providing continuous service at the Astander shipyard, where all repair work on hull and superstructure is carried out by waterjetting, thanks to the commitment between Astander and INDASA to offer their customers the most advanced technology for said works.

It is also providing service in Navantia shipyards in the Bay of Cadiz to the major cruise vacation companies, where the waterjetting standard is the only one capable of meeting the very demanding cleaning and finishing requirements they demand for their vessels.

In addition to these ongoing services, INDASA has made its waterjetting equipment available to Navantia in Ferrol and Cartagena, successfully carrying out several dry dockings for the repair of large vessels as well as ships of the Spanish Navy.

The company currently has a total of 11 ultra-high-pressure pumps (UHP) of German technology purchased from Falch, one of the world's leading manufacturers of this type of technology. 10 of the-

se equipments are capable of providing 2500 bar pressure and one of them can reach up to 3000 bar, if required, for the most demanding jobs. All the equipment acquired is electrically operated with electronic regulation through variable frequency drive. The most efficient industrial solution in terms of electricity consumption and therefore the generation of contaminant emissions.

presión de trabajo	600 - 2500 bar
flujo de agua	9 - 26 l/min
nivel de ruido LpA, LwA + 1,5 dB	75 dB, 95 dB
rendimiento, velocidad de bombeo, presión del agua de entrada, max. temperatura del agua de entrada	125 kW, 610 rpm, 2, 8 bar, 40 °C
tiempo de encendido (horas/día)	24/1
conexión eléctrica / fusible, longitud del cable	400 V, 50 Hz, 250 A, 0 m
motor eléctrico potencia max. /potencia de salida, velocidad de funcionamiento, régimen del ralentí, sistema de refrigeración	160 kW, 132 kW, 650 rpm, 1800 rpm, air

General list of characteristics FALCH BASEJET 125-2500-26-e unit

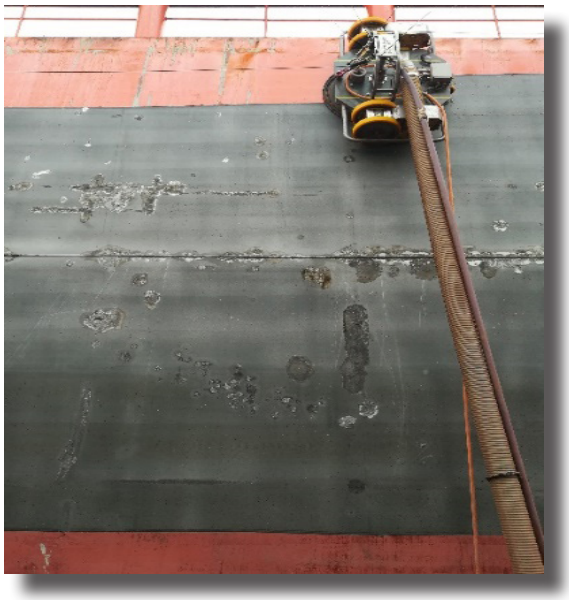
All our equipment is assembled on naval containers to facilitate the transportation and placement of the equipment on the dock as well as to protect the equipment and facilitate maintenance and operation work.

INDASA's BASEJET 125 kW container assembled units

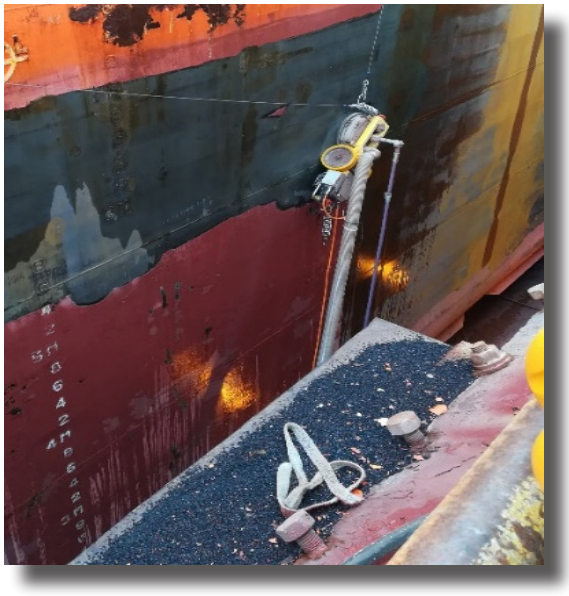
Besides the pumps, INDASA's commitment to waterjetting technology has led it to invest in state-of-the-art robotic application equipment to get the best possible performance from its UHP equipment and to improve the ergonomics and safety of its operators in the process.

The company currently has 4 remote-controlled "Spider" robotized equipment purchased from Hammelmann and Vertidrive, with a working capacity of up to 40 m2/hour on vertical surfaces. This equipment achieves this performance by anchoring itself by means of powerful magnets to the vessel's

sides and moving along the surface through a remote control; additionally, its specific design with discs and rotating head allows the recovery of used water and waste for subsequent treatment in filters and water reuse.



Hammelmann Spiderjet M System



Hammelmann Spiderjet Edge System

In both cases it can be seen that with the equipment in operation, water loss is minimal.

These semi-autonomous equipment are controlled from the safety of the dock by an operator equipped with a remote control and therefore away from any noise or water projection that the equipment may generate. It also allows you to have a global vision of the area you are executing and plan the work in advance, increasing productivity and reducing the number of double passes required to reach the finishing requested by the customer specification.

Indasa also has 4 Falch 400 mm diameter disc equipment called LiftWorker for use on personnel lifting platforms specially certified for this purpose. This system has a performance similar to that of a Spider equipment with the addition that thanks to its adaptable anchorage it can better adjust to complex areas in the bow and stern of the vessel where the spiders can see their performance diminished. Like the Spider equipment, the head with disk allows to recover the water for its recycling or later treatment.

FALCH Liftworker being used in hulls and warehouses

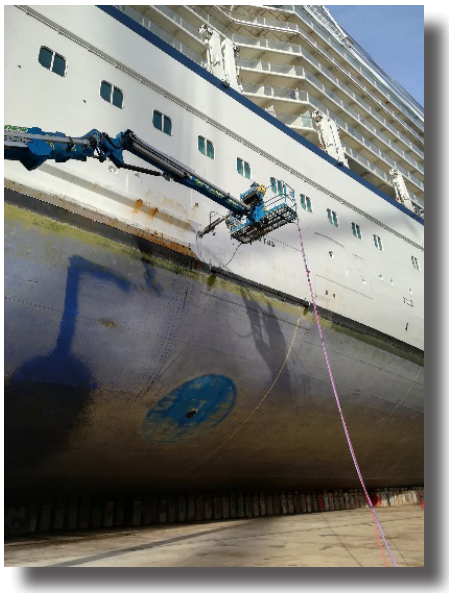
Liftworker FALCH working on bilge

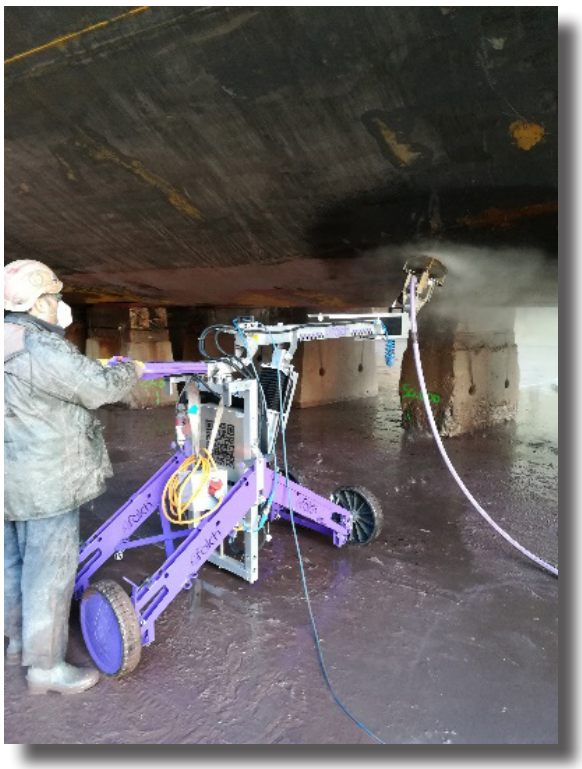
FALCH multiworker system being used in the fender of a holiday cruiser

In this type of disc equipment, the operator's skill with the lifting platform is fundamental, which makes INDASA operators assigned to this function the most efficient in the use of the platform, increasing productivity and reducing the number of passes for the same final finish.

For complex areas such as bottoms, bulbs, balance keels, rudders and propulsion shafts, INDASA has 4 Falch equipment with an adjustable robotic arm called MultiWorker that allows it to reach the most complex areas with a performance of up to 20 m2/hour thanks to its 260 mm diameter head, a performance far superior to any manual system that was being used until the entry into service of this technology.

The equipment is versatile enough to be used on a lifting platform or directly on its own trolley with wheels that allow it to be configured to work on sides, bilge keels, decks and flat bottoms.





FALCH Multiworker working on flat bottom and propulsion shaft area.

Finally, the company incorporates to its fleet of accessories an abundant inventory of lances and rotary nozzles of different capacities to be able to reach any complicated part where robotic systems are not efficient or are directly unable to enter. Edges of solid blocks, hawseholes, limbers, draft marks are not a problem since there are rotary with 6 nozzles, with 4 nozzles and even a new technology with angled nozzles to achieve the best finish in the most complex areas.

SAFETY AND ERGONOMICS AS PRIORITIES

This technology brings improvements in ergonomics and worker safety as well as direct improvements in productivity.

All equipment is designed with safety in mind, with an intrinsically safe design thanks to deadman systems, lances longer than the operator's arm, remote control and encapsulation of the rotating heads inside the waterjetting discs.

INDASA also has two specific mobile wheeled equipment for the preparation of bottoms and covers that keep the lance in vertical position without causing physical wear of the operator.

It must be taken into account that due to the high pressures that are handled with this equipment, the use of manual lances generates an important physical stress on the operator, although always within the limits recommended by the work regulations, which are currently at a maximum of 250 N of recoil.

As can be seen in this table, the different configurations range from a light or moderate reaction for manual use to a reaction solely supported by auxiliary equipment.

INDASA has established work pairs for the use of manual lance in such a way that the operators are always fresh and the roles of supervision of the machinery and use of the lance are exchanged directly at the work station, which has significantly increased the productivity of the manual lance equipment.

In short, robotization is an improvement both for final productivity and for operator safety and ergonomics.

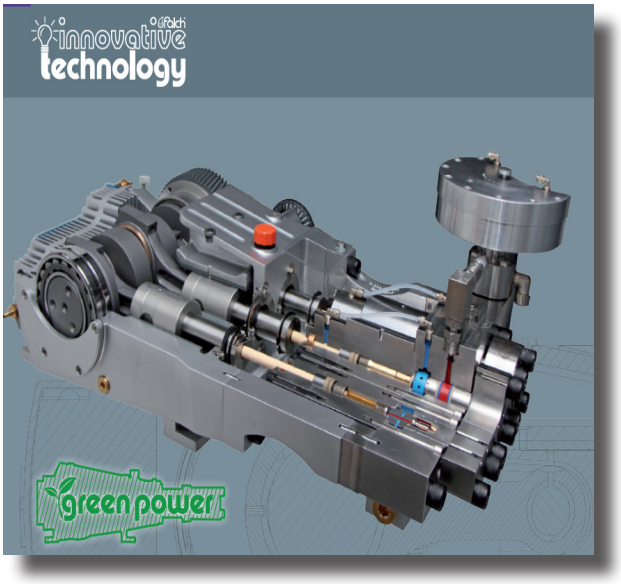
ADVANTAGES OF STATE-OF-THE-ART TECHNOLOGY

This type of waterjetting technology aims to replace the abrasive blasting system with a system that is more innovative, environmentally friendly, efficient and does not rely on a constant supply of abrasive

material to be managed in landfills.

Europe is currently a world leader in the application and development of waterjetting solutions in shipyards. That is why INDASA has established relationships and has acquired equipment from several top-level European manufacturers, among which Falch stands out.

Falch is a German company manufacturer of water pumping equipment from 100 bar to 3000 bar pressure and thanks to its engineering and R&D teams has developed a wide range of accessories and auxiliary equipment for waterjetting works. Falch has its own factory in Germany with more than 23,000 m2 of surface area, of which 5,000 m2 are dedicated exclusively to engineering and development of new prototypes.

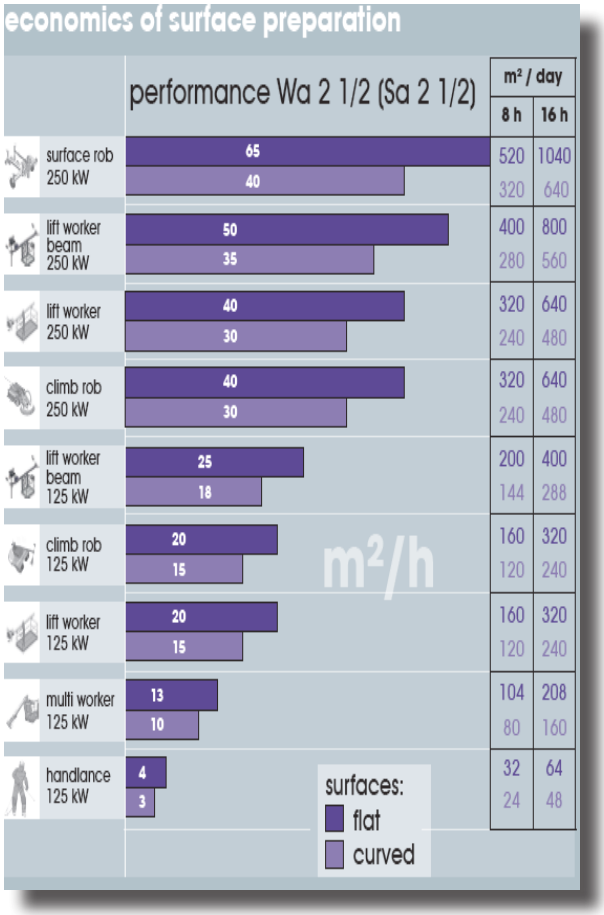


Thanks to the research carried out by Falch and other manufacturers among its customers, of which INDASA has been an active part, it has been possible to develop an important range of robotic accessories that adapt to the needs of dry dock works, so that the technology has matured beyond the individual lances, improving productivity and safety for the operator.

Currently INDASA continues to participate in the development of such auxiliary waterjetting equipment for shipyard works, providing the manufacturing companies with its know-how and the experience of its work teams in the field to test and improve existing and newly designed equipment.

Some of the new prototypes have been developed under INDASA's direct feedback and needs, resulting in higher productivity for waterjetting tasks under the specific conditions of use in shipyards.

Here it can be seen a table from the manufacturer with the different equipments and their average performances. INDASA has participated directly in the testing of the Surface Rob, LiftWorker and its Beam variant, as well as in new applications of the MultiWorker for shipyard works.



This synergy with the manufacturers is what allows INDASA to have the most modern, efficient and optimized technology for the works inside the shipyards and to continue being a pioneer at national level in the application of new technologies and productive improvements.

Regarding the improvement of this technology in the environmental impact of the work in the shipbuilding industry, here is a comparison of the use of resources and equivalent emissions per square meter of abrasive blasting versus the use of the lance and the use of robotic equipment from the manufacturer Falch.

surface preparation on vessels

	grit blasting	falch uhp handlance	falch uhp robotics
grit kg/sqm	50	–	–
water l/sqm	10 (washing dust)	130	60 – 95
power consumption kW/sqm	18	20	4 – 7
diesel l/sqm	2,7	2,8	0,9 – 1,4
CO_2 kg/sqm*	7,2	7,4	2,5 – 3,7
manpower min/sqm	18	18	2 – 3
performance sqm/h	5	5	40 – 60

(average numbers from real projects)
*without transportation & disposal of grit

As can be seen, the difference in using robotized equipment makes it possible to reduce by more than half the power used per m2 of treated surface and therefore the emissions equivalent to that power, while at the same time increasing productivity tenfold.

In addition, in the case of using disc systems such as the LiftWorker or Spider, the water can be filtered and recycled with minimal losses, which in INDASA's experience can reach 95% of recycling, reusing the same water in different treatment cycles and being able to treat waste when separated by filtration systems.

In this way INDASA can provide this technology even to shipyards where water is a limited or scarce good without affecting the production process.

Filtration systems allow the final waste treated in landfill to be only dry paint sludge, without all the tons of contaminated abrasive that are the typical environmental signature of abrasive blasting use.

In a complete renovation specification of the paint scheme of a vessel's hull work, with full scheme thicknesses between 1500 and 2000 microns, the difference is in generating between 2 and 2.5 kg of solid waste (paint and rust) per m2 compared to a generation of between 50 and 100 kg of solid waste (abrasive + paint and rust) per m2.

In a typical construction site with 8,000 m2 of surface to be treated, the difference in solid waste generation is 20 tons of waterjetting waste after filtration and sludge compaction, versus 800 tons of contaminated abrasive with the consequent savings in working hours of collection, transport, crane movement and management to the hazardous waste landfill.

CONCLUSIONS

INDASA plans in the short term to continue implementing innovative solutions to undertake work in all applicable areas within a vessel and with the intention of streamlining the process, improve productivity, maintain the highest standard of quality finish and reduce the environmental impact of the work. All this without forgetting the improvement of the safety and health conditions of its operators.

Ultimately, the waterjetting system is the future for surface treatment in shipyard repair work and is a giant leap compared to abrasive blasting in terms of productivity, environmental impact and energy efficiency. All this without forgetting the improvement for the operator with better ergonomics and safety at work.

Through strategic alliances with major European manufacturers, Indasa aims to remain as a benchmark in the sector and offering its customers the highest standard of quality and professionalism that has characterized it for the past 50 years with the use of the latest technology and the state of the art in the treatment of surfaces applied to the shipbuilding industry.

MARKET EXPANSION DESIGNS OF THE CUSTOMER, SENER´s RELIABILITY WITH ITS CUSTOMERS

Mª ÁNGELES LÓPEZ CASTEJÓN // Director of Naval Projects at SENER INGENIERÍA

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SENER is committed to reliability with its customers. Increasingly more companies rely on SENER as their expert support in the market they need to expand. From the beginning of the gestation of the project, SENER develops together with its clients the objective characteristics of the product or project in the market and its functionality.

With the latest project for the shipping company **Rimorchiatori Riuniti Panfido & C.s.r.l**, This is how the process was carried out by SENER. A contract was made to develop the conceptual and basic engineering and technical assistance for the construction of a **combined unit** to perform bunkering operations of LNG and MDO (marine diesel oil) to cruise ships propelled with dual LNG/MDO engines.

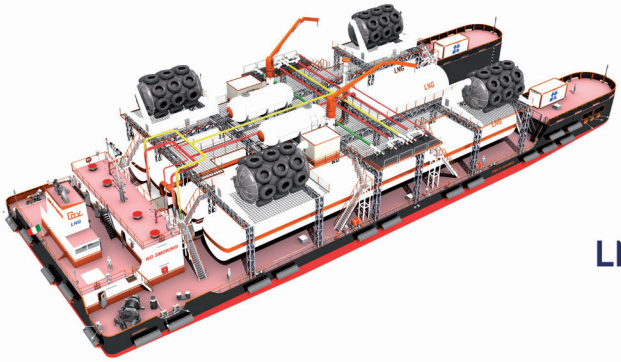
The bunkering unit design is a combination of an LNG-fueled tug (power unit) and a 4,000 m^3 non-propelled LNG supply barge and 1,000 MDO (cargo unit).

This combined unit will operate in Italy and in the Adriatic, therefore, the design had to comply to be able to sail all over the world, and also sail in Venice with the limitation on wave generation. This requirement was critical in the initial design, in the relative position between tug and barge, and in the shapes of the barge.

This project arose from an idea, which was molded side by side Panfido-SENER, always oriented to the final customer of the service to be carried out by Panfido. Due to its innovative nature, it is financed by the European Union through the Poseidon MED II program.

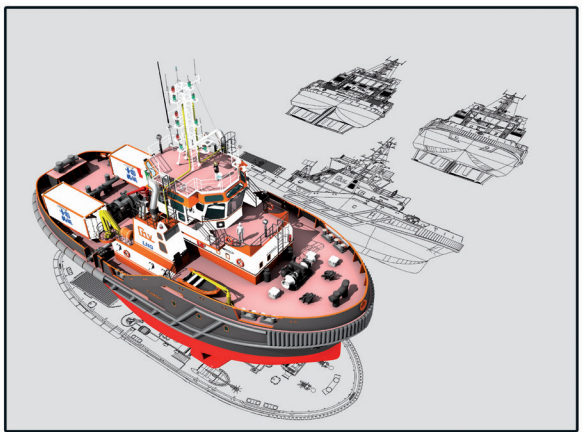
The shipping company **Rimorchiatori Riuniti Panfido & C.s.r.l,** is one of the most important owners of tugboats and barges in Europe, with 130 years of experience in marine services. The tug has been designed and built as a **natural gas and diesel fueled vessel** for towing, escort, rescue, supply and salvage, powered by Voiths and with 65 tons of bollard pull capacity. Therefore, during periods when LNG supply is not required, the tug can be used for harbor towage. On its part, the barge will be used for refueling. Among other benefits, the innovative design focuses on **wave reduction and safety during operation.** The safety in the bunkering operation has been a challenge for the design, studying and performing different risk analyses with different end customers of Panfido, in order to delimit the safety zone of operation, and adapt the design for it. The design increases the efficiency of the project, and the safety of the operation, giving greater added value to the client's service, with its end customer.

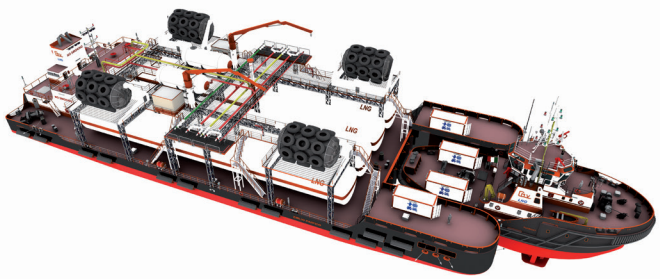
SENER offers **floating and land-based LNG solutions** adapted to the expansion of its clients' businesses, always working closely with its clients from the beginning of the project, where it is able to carry out an **integral project** of the entire LNG chain. With more than **2,500 million euros in liquefied natural gas (LNG) contracts** and references as a turnkey or EPC (Engineering, Procurement and Construction) contractor such as **Sagunto** in Spain, **Dunkerque** in France, **Zeebrugge** in Belgium or **Gate terminal** in the Netherlands, SENER has become a leader in the **LNG sector**. SENER carries out integral civil works projects from LNG Terminals to the jetty suitable for the operation and geo-location, jointly carrying out the jetty works, floating regasification units and bunkering vessels, in order to offer the complete land-sea-floating solution to the client.



SENER

LNG V-TUG 65T & LNG BUNKERING BARGE





THE COMPLEX PROCESS OF CONFRONTING INTERNATIONAL COMPETITION JOINTLY: THE EUROPEAN CONSORTEX PROJECT

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Shipbuilding is a very heterogeneous industrial activity consisting of several complementary activities, such as shipyards, equipment and component manufacturers, the ancillary industry, or the shipping companies and shipowners themselves. In shipbuilding, shipyards act as the industry's driving force, bringing together the supply of many small and medium-sized companies that provide a wide variety of industrial products and services, from ship design, welding, painting, piping, machinery production and installation, navigation and communication equipment or any other set of industrial supplies.

While shipbuilding operates in a highly internationalized market, its ancillary industry, generally made up of a good number of small or medium-sized companies, has a smaller presence in international markets, missing out on the opportunities that the technology and know-how acquired over the years can offer them. Internationalization is a business opportunity in the enterprise strategy and, sometimes, it can be merely a necessity. And for this, in an economic environment dominated by Asian production, where Europe has to focus on the buiding of highly technical vessels with high added value, many companies are finding it very difficult to face their internationalization due to their small size. Growing in size proves to be a key strategy for accessing international markets. But the question is how to do it. And there are two alternatives: enter into a dynamic of purchase of companies or participation in them, or alternative methods of collaboration between different companies are sought: conglomerates of companies, promotion groups, consortia, collaboration networks, etc.

The european CONSORTEX project

In this article, we are going to deal with an experience that has been carried out thanks to a European project in which the Galician Shipbuilding Cluster Association (ACLUNAGA) has participated. The European Union's Interreg Atlantic Area programme is a project framework that provides an ideal context for tackling this issue from an inter-enterprise collaboration approach at a level that goes beyond our borders. The scope of action of this program is the entire European coast of the East Atlantic. In this space, the economic and social importance of the industry and services related to the sea is evident: shipyards, shipping companies, ancillary industry, machinery manufacturers, fishing... The shipbuilding industry also has a significant tractor effect on a set of complementary activities carried out, in most cases, by SMEs. In this context, European regions bordering the Atlantic can collaborate in a common project that ultimately faces the same challenges, benefiting from the synergies provided by companies with a different, but complementary, role in the shipbuilding value chain.

Within this programme, the **CONSORTEX Project** (European Maritime Internationalization Consortia) has aimed to encourage small and medium-sized companies involved in maritime clusters to create internationalization consortia specialized in specific parts of shipbuilding together with companies from Portugal, France, Ireland and Great Britain to take advantage of international market opportunities that, separately, cannot be faced with a minimum guarantee of viability. Specialization in certain areas

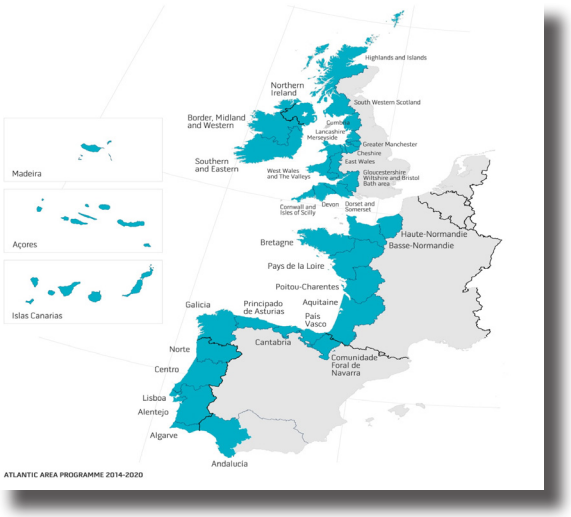

Fig. 1: Area of action of the Interreg Atlantic Area Programme

of shipbuilding production (bridge, engine room, accommodation, deck, etc.), or in certain types of shipbuilding (offshore vessels, cruise ships, scientific vessels, offshore power plants, etc.) is essential, as is the highly technological component of the end products, which makes it possible to offer high added value where competition from Asian shipyards is easier to counteract. The objective of the consortia formed in this project is basically commercial, but their performance extends to all areas of the shipbuilding industry, such as innovation and technological development. And, within a Corporate Social Responsibility approach, the result has an impact on the economy, employment and the society in which these companies are installed.

The **CONSORTEX Project** has been carried out through a partnership of European entities formed by the following institutions:

• **Foro Marítimo Vasco**, Basque Maritime Forum, which has acted as lead partner.

• **Aclunaga**, Galician Shipbuilding Cluster that has played a special role since the very design of the project.

• **Fórum Oceano**, Portuguese Maritime Cluster based in Oporto.

• **Associação das Indústrias Navais**, Portuguese Association of companies in the sector with operations throughout the country and headquarters in Lisbon.

• **Munster Technological University**, based in Cork, Ireland, with a strong connection to the maritime world, including offering degrees in Nautical Science and Naval Engineering.

• **National Maritime**, a British organization, based in Dartford, that connects companies in the sector and provides them with services.

• **Bretagne Pôle Naval**, French Cluster based in Lorient (France).

CONSORTEX
EUROPEAN INTERNATIONALISATION MARITIME CONSORTIA

Interreg Atlantic Area
European Regional Development Fund
EUROPEAN UNION

Fig. 2: CONSORTEX and Interreg Atlantic Area logos

Alium Consulting's methodology

Alium Consulting[1] is a Basque consulting company that has been supporting Foro Marítimo Vasco for many years in the elaboration and development of its strategic plans and in its promotional activity at international fairs. On this occasion, not only providing support in the management of the project, but also, based on his experience in other economic sectors, developed the necessary methodology to move from projections to results.

The formation of consortia is an associative activity that is not new. Many experiences have been developed for this purpose in multiple sectors and geographic areas, which has even led UNIDO to design a methodology[2] for this purpose. This information is of public use and has a high value to be able to face this type of experiences nowadays.

Based on the existing documentation and previous experience in other associative business processes in which the consultant has worked, it has prepared

1. Alium Consulting is currently integrated in International Technical Assistance Consultants (ITAC).
2. ONUDI "Export Consortia Guide". Vienna, 2004.

a document specifically adapted to the needs of the Shipbuilding Sector in the geographical context of the European Atlantic Area. The document is entitled "Export Consortia Incorporation Methodology", and consists of a consultant's manual and a spreadsheet book called "Working Templates", which includes up to thirty-three forms that help the facilitator of the meetings of companies in the search for synergies, the design of the type of consortium to be formed and decision making to guide a joint Business Plan.

The methodology develops the work of setting up business networks through a process consisting of three operational phases and a preliminary phase.

• **Phase 0:** Sensitization: Potential participating companies are informed of the project objectives, the work methodology and everything that is intended to be carried out. Data from interested companies are collected from a questionnaire supported by a web application.

• **Phase 1:** Group c Configuration of the group. The capabilities and expectations of the initially interested companies are analyzed through a diagnosis based on the collection of information. Possible consortia are designed.

• **Phase 2**: Definition of the consortium model. We are already working exclusively with companies that have made a commitment to be part of each consortium or group of companies. Synergies are identified, the business grouping model is analyzed and the commercial strategy is defined through the International Marketing Plan.

• **Phase 3:** Implementation and start-up. The Business Plan is designed to identify the responsibilities, contributions and rights of each participant. The legal formula to be adopted by the entity is established, the rules of the game are identified through the drafting of the statutes and the agreements are signed. The consortium begins to work.

Given that the companies participating in the process come from five different countries, it was planned that each of these phases (except phase 0) would be developed in a concentrated manner through two-day meetings with the participation of the integrated companies, the partner acting as leader in each consortium and the consultants who act as facilitators of the meetings through the methodology provided.

Seeking interested companies

Each of the project partners carried out an information campaign in its area of influence through e-mails to its associates, telephone calls and specific meetings in which companies were duly informed about the project and the advantages that participation in it could bring them. As a result of these activities, the partners identified a total of 298 potential Spanish, Portuguese, French, Irish and British companies.

Based on this initial identification of companies to work with, each partner institution made appointments to hold interviews with its staff to obtain initial information gathered through a questionnaire included in the methodology. This questionnaire collected the following information from each company:

• General data of the company and corporate name

• Basic economic data (sales, capital, foreign sales and market share)

• Role in the market as manufacturer, distributor, engineering...

• Personnel and their distribution by function and gender.

• Main supply of the company and its production capacity.

• Company's supply for bridge, engine room, accommodation, deck or general supplies.

• Quality certifications.

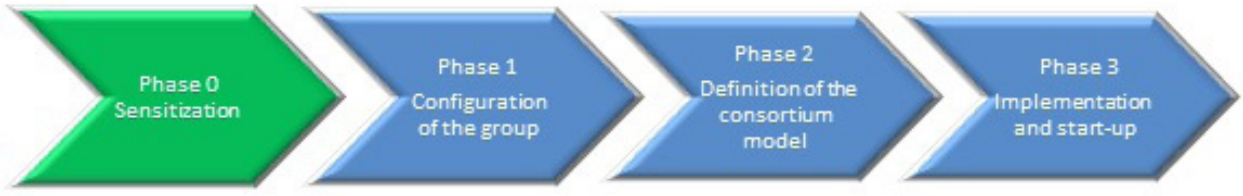

Fig. 3: Phases in the formation of export consortia

• Company's expectations when participating in a consortium of companies in terms of synergies with other companies and markets to be addressed.

For a more efficient processing of the information, the questionnaire was converted into a digital format on the Sphynx platform. The companies that finally completed the questionnaire, a prerequisite for participating in the consortia meetings, were 84.

Identification and consortia incorporation

Based on the information provided, six thematic groups were formed:

• **Naval design**: Led by the Associação das Indústrias Navais and with capital in Lisbon.

• **Bridge:** Led by Fórum Oceano and with capital in Porto.

• **Deck:** Led by the Munster Technological University and with capital in Cork.

• **Engine Room**: Led by Foro Marítimo Vasco and with capital in Bilbao.

• **Accommodation**: Led by Aclunaga and with capital in Vigo.

• **Offshore Energy**: Led by Foro Marítimo Vasco and with capital in Bilbao.

For its conformation, and according to the preferences raised by partners and companies, two rounds of virtual video-conferences were held for each of the groups of companies. The first one took place between November 19 and December 5, 2019 and the second one between February 11 and 28, 2020.

Unfortunately, when the essential face-to-face meetings were about to take place, the COVID-19 pandemic and the consequent widespread confinement in much of the world made it absolutely impossible. So, there was no choice but to continue working from home, holding new meetings, now, by obligation, in virtual format. This is how the third round of meetings took place between October 19 and November 23.

One of the important topics of discussion was the type of consortium to be formed, within the different modalities existing in the market. In general, business collaboration for international marketing usually takes the form of trade promotion alliances or export consortia *per se.* The former are aimed at developing specific or stable cooperation activities to pursue a common commercial objective. They can be simple specific actions or they can reach the level of an international promotion group, which already have a formal cooperation agreement signed and their own Business Plan, even if they do not have to adopt corporate legal formulas. Export consortia, on the other hand, are shared commercial structures, with their own legal personality and human resources independent of the participating companies. They can be commercial (tradings) or commercial intermediation (brokers). In the initial phase of the formation of the working groups, the format that was considered was that of international promotion groups.

After the rounds of previous meetings, between March 2, 3 and 4, a Virtual Congress was held in which 36 companies participated. It was a totally innovative experience, since it was decided to carry it out through the Virbela 3D virtual reality platform, in which people could interact in an immersive environment through an avatar. For most of the participants it was a challenge since it was the first time they used this method. However, the success was resounding and the contents of the meetings could be worked with quite close to reality. There was a presentation event, six consortium meetings, nine individual interviews and a closing ceremony.

Fig. 4: Screenshot of a CONSORTEX Virtual Congress session

The first agreements

The result of the rounds of online meetings and the Virtual Congress was the drafting and signing of six Letters of Intent (LoI), one for each working group. A Letter of Intent (LoI) is a collaboration agreement that includes aspects such as the identification of the parties, the objective of the document (the formation of an export consortium), the reasons why the signatories reach this agreement and what they want to obtain from their joint work, basically access to new markets or growth in size and their subsequent negotiating strength with potential clients, as well as reducing the risks involved in export activities. The document establishes a Coordination Committee, although agreements are not considered binding in case of lack of unanimity. The Letter of Intent is adopted as a first step of collective agreement with little involvement in terms of obligations of the participants, but establishing a mutual interest and a willingness to work collaboratively.

A possible second step for the consolidation of the business groups could be the adoption of a Memorandum of Understanding (MoU), a document that is somewhat longer, more complex and explicit in terms of commitments between the signatories, but which still maintains the autonomy of the parties in the event of discrepancy. In short, both are documents that seek to initiate an initial joint work between the companies that will allow them to gain trust and, if necessary, move towards more demanding associative formulas.

In more advanced step, legal formulas well adapted to this type of activity could be used, such as Economic Interest Groupings (EIGs), European Economic Interest Groupings (EEIGs) or the already typical corporate formulas. EIGs and EEIGs are legal formulas that involve the creation of a new entity with its own legal personality and allow the limitation of liability of the members of the consortium, although this limitation may have some specificities, such as the subsidiary liability of the partners, if applicable.

The result of this process was the formation of six groups of companies, each based on a specific activity and united by the signing of a LoI:

- **Naval design**: Composed of two Portuguese, one Spanish, one British and one Irish company.
- **Bridge**: Formed by a Portuguese, a Spanish, a French and a British company.
- **Deck:** Comprised of two Spanish, one Irish, one French and one British company.
- **Engine Room:** Comprised of two British, one Irish and one Spanish company.
- **Accommodation:** Formed by two Spanish, one Portuguese and one British company.
- **Offshore Energy**: Comprised of three Spanish, three British and two Irish companies.

The six Letter of Intent registered a total of thirty signatures from twenty different companies.

Consolidation of export consortia

Since the signing of the LoIs, the international promotion groups have drawn up the general lines of their Business Plans, which have been set out in their corresponding working documents. In each of them, their size is identified in terms of number of companies, agglutinated personnel, sales figure and markets served, a diagnosis of the sector is made, the mission, vision and short and medium-term objectives are identified, the geographic and sectorial markets to be jointly addressed are determined and the strategic lines for joint work are established.

The application and development of these plans and the dynamism they acquire will define, in the near future, the results that these six groups of companies may have in the international markets, and it will be seen if the difficulties inherent to the naval sector itself, to the international market conditions, and to the work with partners from different countries with sometimes different ways of working, but with shared objectives, are overcome through the collaboration between companies from different parts of the Atlantic Arc.

This has also been one of the objectives of the CONSORTEX project, part of the European Interreg Atlantic Area programme: to strengthen small and medium-sized companies in the shipbuilding industry and overcome national borders through transboundary collaboration between different countries bordering the same ocean.

"THE LEGEND OF THE ARTEAGA. THE FIRST SUPERTANKER BUILT IN SLIPWAY"

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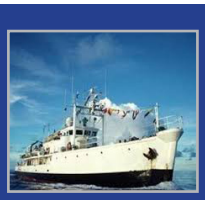


The history of the tanker Arteaga is one of the most mythologized in the naval imaginary of Ferrol, besides being by itself one of the great milestones of world shipbuilding, being with its 325,000 tons of deadweight not only the largest vessel built in Spain in its day, but also the largest in the world built on a slipway. This fact represented a leap forward in the shipbuilding industry, since up to that date all large tankers had been built and floated in dock. Launching it from the slipway was such a great challenge that engineers and technicians from all over the world, including some from Japan, the leading country in the construction of this type of vessels, had their eyes on Astano, hoping that the ship would break in half when it entered the water.

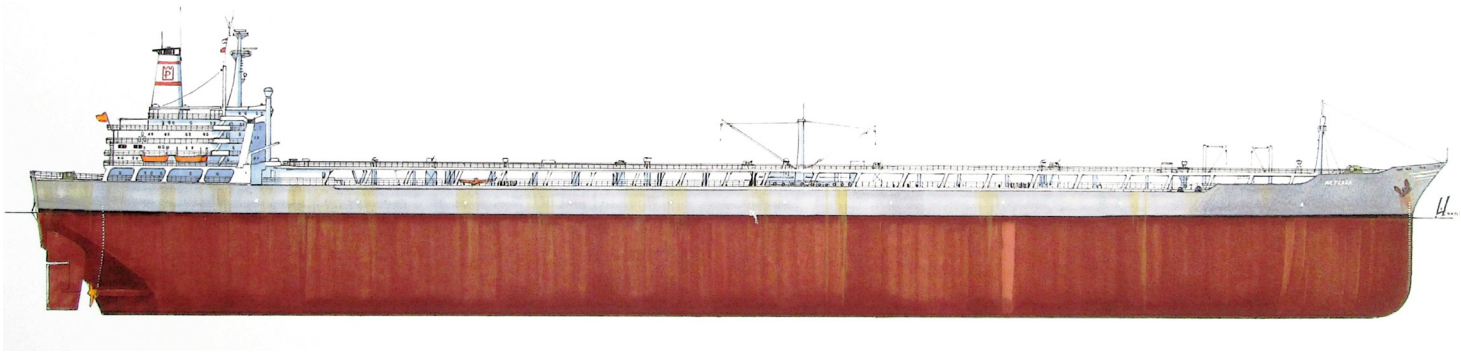
The Suez Canal served as a spur to the development of increasingly large tankers on two occasions. The first, for five months in 1956 because of the Sinai war. The second and most important, during eight years after the 1967 Six-Day War. In both cases, the oil produced in the Middle East had to go around Africa to the south to reach Europe, and shipowners were compensated by building larger and larger vessels to be able to transport as much oil as possible on each voyage.

The Idemitsu Maru, built in Japan in 1966 by Ishikawajima Harima Heavy Industries, opened the era of Very Large Crude Carriers with its 210,000 deadweight tons. And in 1968, the Universe Ireland became the first of the Ultra Large Crude Carriers to exceed 320,000 deadweight tons. In 1971, Société Maritime Shell and Compagnie Nationale de Navigation de France ordered the Chantiers de l'Atlantique shipyard to build four new tankers that would break the half million deadweight ton barrier.

But all these new constructions had one thing in common: they had been built in a dry dock to then be set afloat. It is a slow method during which the dock is flooded until the water level inside and outside the dike is equalized, the vessel floats and leaves the dike; stresses and pressures on the hull are damped and distributed in an undemanding manner. The traditional alternative is launching, in which the ship slides down the inclined slipway on which it was built until it reaches the sea and is afloat. During this moment, which does not last more than a few seconds, the vessel withstands forces, loads, pressures and speeds that in some cases reach the highest values of its entire life. Shipbuilding at the time questioned whether such large ships could withstand the stresses of launching, assuring that they would most likely break in half when they reached the water.

But, what if it could be done? That was what José María González-Llanos, an engineer and Navy officer, defended, who in 1941 had founded ASTANO (acronym for Astilleros y Talleres del Noroeste). The shipyard had grown over the next three decades from 33 employees and 3,000 square meters to

Picture courtesy of: NAVANTIA



Picture courtesy of: Roberto Hernández, Ilustrator (www.elilustradordebarcos.wordpress.com)

more than 5,000 employees and 755,000 square meters in Fene, on the southern shore of the Ferrol estuary. The opportunity to prove it came when the government of Franco's dictatorship signed on May 22, 1969 a mega-contract with the multinational Gulf Oil Co. by which the latter would operate refineries in Spain while committing to the construction of the necessary fleet in this country, a total of eleven vessels divided into two tankers of 100,000 tons, four of 230,000 tons and five of 325,000 deadweight tons, one of them, the Arteaga.

In order to be able to build all these vessels, the shipyard was expanded and modernized, highlighting the new gantry crane above all the improvements. Built in 1971 by the Spanish company Maquinista Terrestre Marítima following the design of the German company PHB, with its 800 tons of elevation, 145 meters of span and 75 meters of height under beam, it was the largest in Europe at the time of its construction. The new crane improved the service capacity of slipways one and two and the structure assembly area, while becoming a symbol of the company and a reference point in the county's skyline.

Picture courtesy of: NAVANTIA

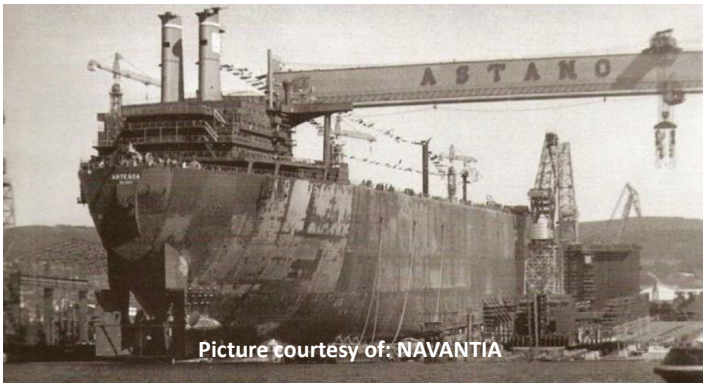
ASTANO's NC-226 construction began with its keel laying on November 20, 1970. The dimensions of the new vessel were gigantic: 347.94 meters in length, 53.37 meters in beam, 32 meters in depth and 323,087 deadweight tons. Its propulsion plant, consisting of two groups of Kawasaki turbines, was capable of generating 27,500 kW, which allowed it to reach a maximum speed of 14.7 knots by means of two propellers, accompanied by two semi-balanced vertical rudders that facilitated the tanker's maneuverability and steering. The cargo area was divided longitudinally into eight zones, with central and lateral tanks, of which twenty two were dedicated to cargo and two to clean ballast. The superstructure was located aft, and in its interior there were seven public spaces, a main saloon, other saloons and three dining rooms, as well as a hospital, laundry and swimming pool.

Seventeen months later, on April 15, 1972, the vessel was ready for launching. The expectation was maximum, and technicians from half the world (including the legendary Japanese engineers) came to Ferrolterra to witness the event. People crowded in the tribune, near the slipways, the As Pías bridge or in the neighborhood of Caranza. At 17:14, the time of high tide, the steel giant began to slide into the water, with experts from the Institute for Aerospace Technology on board to take different readings in order to check if the predicted stresses were correct and thus improve the calculation programs and the launch reinforcement required for the next vessels.

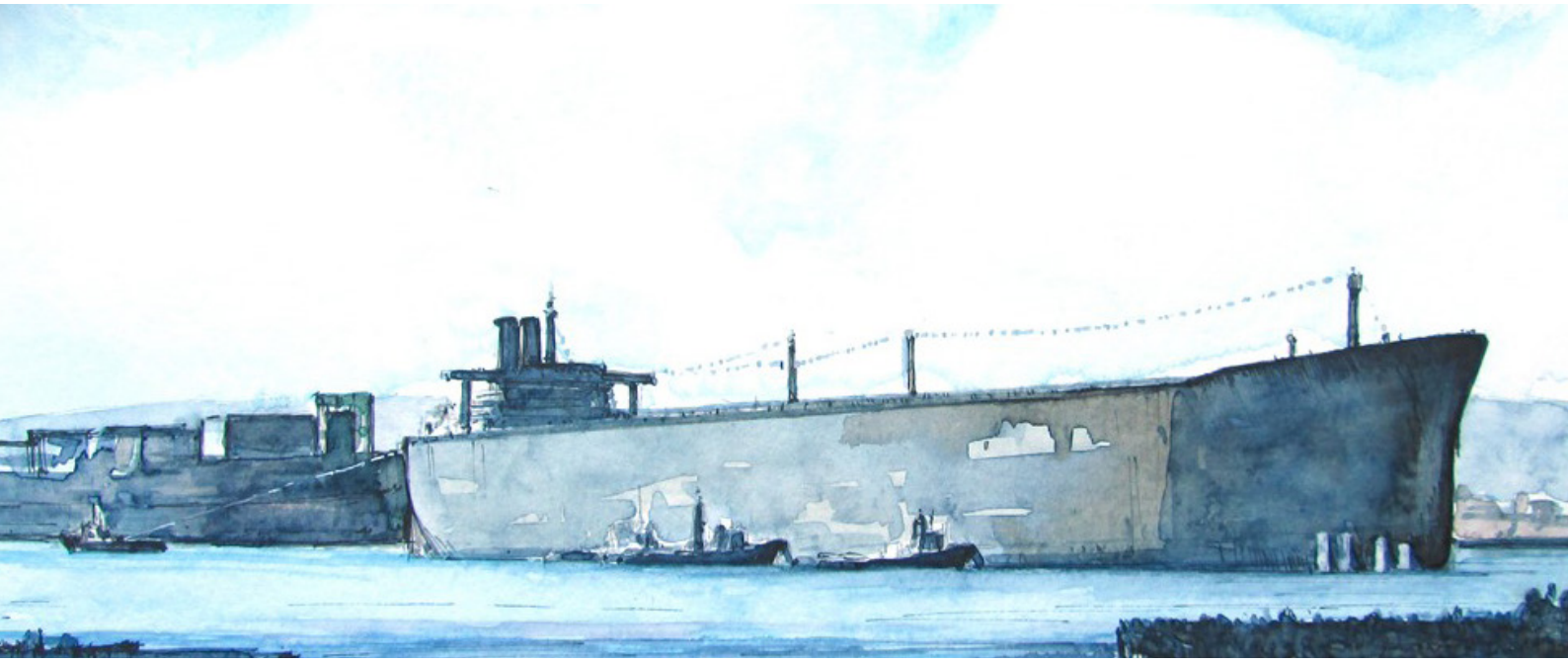
The Arteaga reached the water without any problems, apart from those caused by the wave generated by its launching in the immediate vicinity. Applause, shouts of excitement and the sirens of the tugboats floating around them mingled. The largest tanker built in Europe and the second largest in the world made ASTANO the world leader in the construction of this type of vessel. The Arteaga was followed by other giants such as the 362,946 DWT Al-Andalus in 1974 and the 365,000 DWT Santa Maria in 1975.

After its launching, the Arteaga went to Euskadi, where it transported oil for a decade to the Petronor refinery in Somorrostro (Vizcaya), depositing it in Bantry-Bay (Ireland), from where the crude oil was sent to Santurce in smaller vessels. In 1982 the ship was sold to the Saudi Arabian shipping company Abqaiq Navigation Shipping and renamed Abqaiq. Just one year later, on June 10, 1983, the tanker arrived in Kaohsiung (Taiwan) to be scrapped.

ASTANO, for its part, after achieving glory with the supertankers, began a production decline that ended with the reconversion of the 1980s, which took the shipyard away from ship production. Even then, the factory was able to reinvent itself and become a benchmark in the construction of offshore units, but a new setback at the beginning of the century in the form of a veto on all shipbuilding left the shipyard's slipways empty once again. Despite the fact that the prohibition ended on January 1, 2015, the former ASTANO is still not building new ships, and its activity has shifted towards the manufacture of structures for offshore wind power.



Picture courtesy of: NAVANTIA



Picture courtesy of: Roberto Hernández, Ilustrator (www.elilustradordebarcos.wordpress.com)

HYDROGEN IN THE DECARBONISATION OF THE FISHING INDUSTRY

ANDRÉS FERRO // Industrial Engineer at NEUWALME´s Technical Department

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In order to achieve the decarbonisation proposed in the COP26 agreements, the first step is to electrify all sectors. This electrification will be progressive and parallel to the decarbonisation of electricity generation itself.

During the period 2021-2030, the installation of an additional electricity generation capacity with renewables of 59 GW (PNIEC) is expected.

This increase in generation will require specific measures to match generation with demand, since it will not always be synchronized. Electricity will be generated from photovoltaics whenever the sun shines, and wind turbine rotors will turn when the wind is blowing, even if there is no demand. This will force us to manage this excess energy, storing it in the most appropriate way in each case, to be used at times when demand exceeds production.

In those sectors or processes where electrification is not feasible, new fuels will be introduced, renewable fuels.

In this article, we will focus on analyzing the decarbonization scenario of a sector where pure electrification is not a suitable option, the coastal fishing fleet.

It is defined as *coastal fishing*, that which is carried out less than 60 miles from the coast, where the tides or periods of stay at sea are short, less than two weeks. Within this category, a distinction must be made between vessels where the working day is less than 24 hours, that is, those that return to port every day.

These fishing vessels do not need long autonomies, so the fuel capacity is generally less than 25,000 liters. Require reduced crews, so that the areas of qualification are also reduced, giving priority to a large carrying capacity for the catches.

ENERGY CONSUMPTIONS.

Many of these vessels have oleo-hydraulic or even electric operating machinery, counting on a generator set to produce the necessary electrical power. Another common configuration is to connect an oil-hydraulic pump to the main engine of the boat.

Bow thrusters, often hydraulic, or cranes, have high power requirements, with values in excess of 55 kW. Other machinery and general onboard systems increase the total consumption of the installation. We cannot leave out of the equation the propulsion system, undoubtedly, the main consumption of these vessels and, a priori, the most critical and difficult point to decarbonise.

It is difficult to establish an average value for the installed power, so we will take as a reference value to make our estimates, a vessel for auxiliary work in the mussel mussel platforms, a mussel vessel.

Total length	*17.97 m*
Max. beam	*5.55 m*
Depth	*2.3 m*
Medium draught	*1.7 m*
Warehouse capacity	*20 Cubic meters*
Fuel capacity	*3.000 L*
Fresh water capacity	*2.000 L*
Installed power	*272 CV*
Crew	*3 People*

This mussel boat is equipped with a three-phase generator set of 68 kW of maximum power, capable of providing up to 123 amperes at 400V, which feeds the following hydraulic equipment:

- Crane. 37kW
- Hopper. 5 kW
- Servo rudder. 4kW
- Mussel processing. 7kW
- Auxiliary systems. 5kW

In addition, another oil-hydraulic pump, connected to the main engine of the 270CV by means of a clutch, feeds the control equipment:

- Bow thruster. 50kW
- Vertical mooring winch. 4kW

Fuel consumption to produce 1 kW/h for internal combustion engines ranges from 217 to 272 g/kWh for diesel engines and from 229 to 353 g/kWh for gasoline engines. Expressed in another way, about 15 liters of fuel for a consumption of 55kWh.

ELECTRIFICATION

Replacing the diesel generator set with an emission-free electrical generation system is not technically difficult. The simplest option, but not the most appropriate, would be to install a battery system and a three-phase inverter of equivalent power.

A good lithium battery has an energy density of 300Wh / kg, so to achieve a range of 10 hours, we must be able to store 550kWh. This will require a storage system weighing 1800 kg, compared to 988 kg for the diesel generator set. On the other hand, it is necessary to contemplate the recharge of the batteries once moored in port, we will need 10 hours if a fast charger such as that of vehicles is used. It doesn't seem viable.

Another option is to use a hydrogen fuel battery. First of all, let's see what this equipment consists of. Basically, they are electrochemical devices that produce electricity from the chemical reaction between hydrogen and oxygen present in the air. This equipment consists of a large number of cells, which are responsible for facilitating the reaction between the two gases. Each cell contains two electrodes separated by an electrically insulating membrane. The electrode on the hydrogen side will be the anode and the one on the oxygen side will be the cathode.

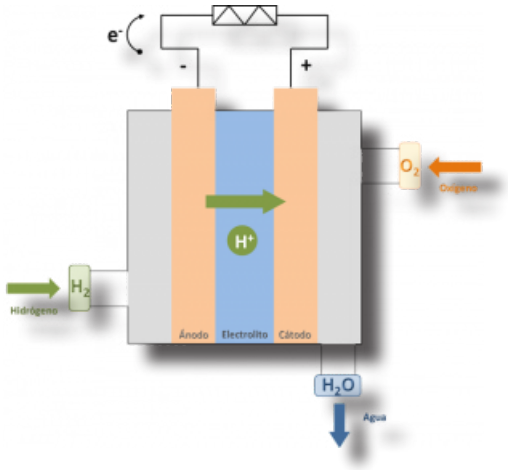
- Anode reaction: $H_2 \rightarrow 2H^+ + 2e^-$
- Cathode reaction: $\frac{1}{2} O_2 + 2H^+ + 2e^- \rightarrow H_2O$
- Global reaction: $H_2 + \frac{1}{2} O_2 \rightarrow H_2O$

As a result of this chemical reaction, only water and a flow of electrons between the anode and cathode are obtained. For this battery to work, we only need to supply a controlled flow of hydrogen and oxygen. The standard voltage of each cell is 1.23V, so hydrogen fuel cells need many cells to achieve higher voltages.

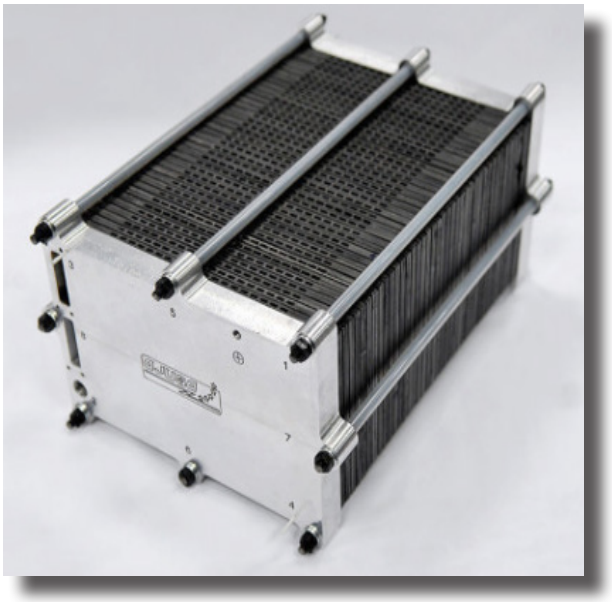
FUEL SYSTEMS DETAILS

Consumption 25%:	5,5 L/H (1,45 Gal/H)	**Type of fuel:**	Diesel
Consumption 50%:	10,2 L/H (2,69 Gal/H)	**Fuel quality:**	Fueloil diesel ASTM
Consumption 75%:	15 L/H (3,96 Gal/H)	**Type of injection pump:**	Individual
Consumption 100%:	19,9L/H (5,26 Gal/H)	**Type of pump regulation:**	Mechanical

Consumption data. Solé Diesel 85GT Generating Set



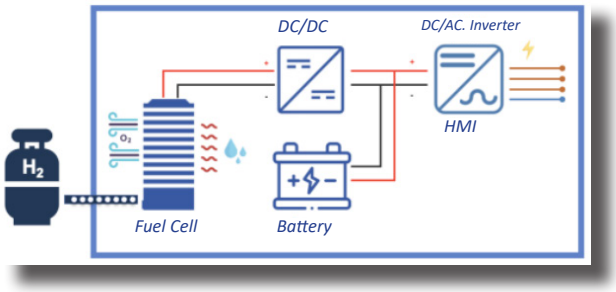
Basic PEM battery



PEM Battery - AJUSA

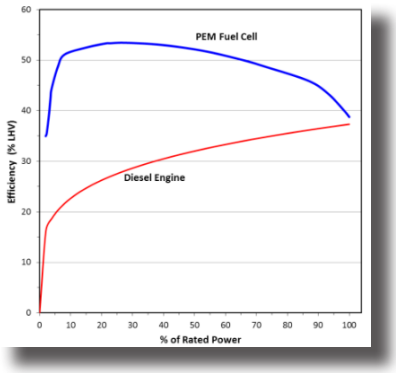
As with a generator set or a battery system, a power electronic equipment is needed to adapt and convert the battery voltages to the values usable by our industrial equipment, 400V-50Hz three-phase.

Currently, there are commercial solutions for electricity generation using hydrogen fuel batteries, and recently, Toyota announced that it will market a version of the battery in its Mirai vehicle, conditioned for non-automotive uses.



Generation´s system diagram through H2 battery

The advantages of a fuel cell system over a diesel generator are clear, they are very quiet during operation and do not produce vibrations, in addition to not generating any type of pollutant emissions. On the other hand, efficiency is higher and they do not depend on the Carnot cycle, as is the case with thermal engines.



STORAGE

To power the fuel cell system, gaseous hydrogen is required at a relatively low pressure, between 2 and 10 bar depending on the manufacturer. The efficiency of fuel cells is close to 50%, so to produce 1 kWh we´ll need 0.06 kg of hydrogen, 60 grams of hydrogen. If we install on board a generation system through a fuell cell, for a consumption of 55kWh, we will need only 3.3 kg H2 per hour.

There are several ways of storing hydrogen, being the option of compressing it at high pressures, the most developed and widely used. Hydrogen is the lightest gas, with a density of only 0.0899 kg/Nm3, so to store the amount needed for 10 hours of auto-

nomy, we will need (3.3 * 10 / 0.0899) = 367 Nm3. If we compress it to 350 bar, it will occupy a little more than 1 cubic meter, 1000 liters.

This is an amount equivalent to the storage capacity of Hyundai's XCient truck, which carries up to 32kg, distributed over several carbon fiber cylinders (Type III). Carbon fiber reinforced cylinders have the advantage over conventional cylinders, which require less steel for their construction so they are much lighter for the same working pressures. In addition, they can be placed in any position and distributed in several zones. These type III cylinders are marketed in different sizes, both in length and external diameter, and solutions up to 200L can be found.

HYDROGEN RECHARGE

Hydrogen recharging is carried out from refueling stations designed for this purpose, in which hydrogen can be generated at the station itself, or it is supplied from large mobile storage facilities. Refueling times are relatively short and much shorter than the recharging times of a battery system. A basic dispenser, is capable of supplying 32kg of hydrogen in less than 15 minutes.

In the case of a refueling station to serve a fleet of vessels such as the one we have analyzed, a rather bulky storage system will be required if we propose it from compressed hydrogen. Thus, we must resort to a more higher energy density storage system, such as liquid hydrogen, which has a density of 70.8 kg/m3. These installations are more complex than the compressed gas ones and require constant energy expenditure to keep hydrogen below-253ºC, the temperature at which it is liquid at atmospheric pressure.

CONCLUSIONS

Currently there are already commercial solutions to cover all the necessary aspects to carry out the gradual decarbonization of the sector, and from companies such as Neuwalme, engineering and integration services can be offered to carry out such necessary projects, taking into account that, for every liter of diesel consumed, about 2.64 kg of CO2 are emitted, let's do the math...

Interview with: José Jerónimo // General Manager of:

GAMELSA *(Gallega de mecanizados Electrónicos S.A.)* **comercial@gamelsa.com**

Today we interview: José Jerónimo Pérez Gimeno, General Manager of GAMELSA. **GAMELSA (Gallega de Mecanizados Electrónicos S.A.)** is a supplier of metal transformation manufacturing services, specialized in thin and medium thicknesses of sheet metal and tube, which integrates a large number of production processes to supply products with a large amount of added value. It has a highly experienced engineering team, and incorporates the latest machinery in the processing of sheet metal and tube, which allows them to achieve **precise solutions** (accurate, economical and just-in-time parts) and **complete processes**: Complete solution to all the needs of all types of customers.

Gamelsa understands the importance of renewing and renewing itself through research, development and continuous innovation to adapt to an ever-changing market with a high level of demand.

• Innovation is discussed as one of the pillars for the development of companies. To what extent has R+D+i been important in Gamelsa's trajectory? And how far has it taken you?

Innovation is imprinted in GAMELSA's DNA, as a company belonging to the TELEVÉS Corporation, with a very high technological component and which reinvests 7% of its turnover on a sustainable basis in R+D+i, is something we have always kept very much in mind. In terms of innovation in production processes, we have always been a company with a strong innovation component since its foundation in 1984, and from the very first steps we opted to incorporate advanced manufacturing processes for sheet metal processing. Gamelsa was one of the first companies in Spain to have laser cutting, and one of the first in the 90's to automate processes such as stamping or welding in our sector.

• What is the origin of GAMELSA, do you continue to maintain the original lines of activity, or have you diversified your activity?, What does Gamelsa bring to this sector which is not traditionally yours?, What future perspective do you see for it?

Gamelsa was born within the Corporation to meet the Group's needs: chassis and enclosures for electronic equipment, all types of ironworks and supports, components for antennas, satellite dish disks, etc.

But from our beginnings there is also the concern to look for clients belonging to other sectors whose

needs can be met with our productive capacitiesIn this way, we have worked over the years for different clients in various sectors such as shipbuilding, automotive, renewable energies, railroads, industry and food, among others. This has been accentuated in recent years, in which, as our sales to third parties have increased significantly, Gamelsa's dependence on sales to other Televés Group companies has been reduced from 50% to 25% of total turnover. The naval sector had great relevance for us at the time, manufacturing furniture, for example, but as the activity in Ferrol decreased, it lost specific weight for our company, something that strategically we intend to recover as it is a very interesting line of activity for us.

• You have been in the market for more than 30 years, what is the key to stay so many years? What does GAMELSA offer that the rest of its competitors do not?

Mainly we differ from other metal transformation companies, from my point of view, in two aspects: one in terms of quality of work, the market perceives that our product has a degree of quality in geometry, dimensional, welding, finishes, etc., above the industry average. In addition, Gamelsa has certifications that guarantee our processes, with special emphasis on welding processes (EN 15085, EN 1090 and ISO 3834).

The second differential factor is that our company incorporates a great capacity for both design and production processes. Our technical office designs and calculates mechanical elements and integrated electronics; and in our facilities we can manufacture from simple elements to highly complex finished product without practically resorting to subcontracting. Laser cutting of sheet metal and tube, manual and automatic welding, adhesives, surface treatments, assemblies, painting... everything is done in Santiago. This gives us a lot of solvency in terms of product and process knowledge, as well as allowing us to have immediacy in terms of deadlines, as we do not depend on others. All this makes us very competitive.

• From your point of view, what is the biggest challenge you have faced at GAMELSA, and do you foresee any other challenge in the short or medium term?

I would like to highlight that in recent years we have undertaken a profound process of change. In 2017, a strategic plan was made for the period 2017-2020 in which the foundations were laid for a reorientation of the business, the change since then has been significant in customer typology, ways of working, etc. Once the deadlines and objectives of this plan were met, a second strategic plan for 2021-2023 was presented. This second strategic plan comes with a major associated investment plan that reinforces our commitment to the modernization and automation of manufacturing facilities and production management processes.

This is related to the challenge you are asking me about. To undertake in such a short period of time a process of change of this magnitude, with all that is associated with it, the doubling of our turnover or the total change of management of the company, and to do it with the difficulties of the last two years, pandemic and shortage and increase in the price of raw materials, increase in the price of energy supplies, etc.; managing this change in such a difficult context has been an important challenge for the organization.

Another challenge we face is related to keeping pace in terms of production technologies and production management. We have always had this vocation to be advanced in terms of our production processes, but it is true that in recent years we have made important efforts to reinforce this aspect. For example, we are in the middle of a project to incorporate Industry 4.0 processes - Smart Factory, together with other companies of the Group and CTAG and with funding from the Galician Innovation Agency (GAIN), which ends in 2022 and in which we are working intensively on aspects such as digitization and automation focused on short and medium series, etc.

• Would you say that the way of competing today has changed, in what sense? In both the national and international markets, do you consider that there has been any significant change in the way of doing business, of winning contracts?

Without a doubt, the way of competing has changed. In recent years we had suffered the entry into our traditional markets of competitors from countries such as India or Turkey, due to purchasing

policies that give a very prominent weight to the price, even at the cost of sacrificing quality in part. Currently, a change in trend is beginning to be noticed, partly caused by difficulties in international transport and others derived from the health crisis.

Another important change we are noticing is that the relationship with our target customers is becoming more and more digitalized, through B2B portals, or shared Teamcenter to integrate us in the design processes of our customers. This way of working is here to stay, and in recent years we have prepared ourselves thoroughly to be a reference in this field.

• Are your company's competitors at regional, national or international level?

Part of the change that has taken place in Gamelsa, that reorientation of business that I mentioned, is to go from being eminently local, with sales mainly in Galicia and for our Group, to supplying the whole of Spain: Basque Country, Levante, Catalonia... and also abroad. In other words, although we have a very important presence in Galicia, we have experienced growth in our exports, both peninsular and international, reaching between 10 and 15% of international sales in this aspect and depending on the times. In addition, many of our clients do export the majority of their production.

• Do you encounter difficulties for the development of your activity: infrastructure, transportation, logistics, environmental regulations... could you tell us the advantages and disadvantages, strengths and weaknesses of the region?

One of the changes resulting from the action plans in our strategic plans has been that our sales are less local than in the past. By changing and moving away from the location of our customers, we do incur higher logistics costs and penalize in some way in terms of deadlines, since we are in Galicia. It doesn't help to be in one of the corners of Europe, but it is also something that forces us to be more efficient, to be more effective in order to compensate for these disadvantages.

As far as regulations are concerned, I think we all play by the same rules, at least in Europe. It does penalize us with Asian countries because they do not incur the same costs, but I do not consider that in our region, in Galicia, we have competitive disadvantages.

Due to its proximity to Galicia, I think it is worth mentioning the case of Portugal, whose administration is providing a series of aids that make its companies more competitive, direct aids for the acquisition of machinery, direct fiscal aids, availability of industrial land; so they have certain advantages over us, but at a national level we are all in similar conditions. It's something that can help but you can't count on it as a basis either. You have to have a strategic plan for the business, everything that comes after that is great, but we can't complain in this aspect.

• In March 2020, the emergence of COVID-19 led to the paralysis of economic activity in most of the productive sectors. What was the situation of GAMELSA before the crisis caused by the pandemic?

Before the pandemic, we were in a very favorable situation; in February 2020 we were significantly ahead of the objectives set in the aforementioned strategic plan. The pandemic penalized us because all economic activity slowed down for months, thanks to the commitment and effort of the entire staff and the management team, we were able to hold out without having to apply extraordinary measures such as layoffs or employment regulation. We were able to withstand the situation with the flexibility measures available to us. Fortunately, we have had few cases of the virus in the staff, and the cases that have occurred have not been transmitted among the personnel.

• How has this crisis affected you? If it has affected you

As I mentioned before, the economic slowdown caused by the pandemic cut our progression, fortunately we got over the bump in a few months and we are currently at the highest levels of activity in our history, although it is true that this year we are suffering the sharp increases in raw material prices and energy supply, increased wage costs, etc. that are significantly affecting our profitability, since most of the projects we are manufacturing were sold before we could imagine that the current situation would occur. En cualquier caso, son dificultades sobrevenidas con las que tenemos que lidiar noso-

tros y el resto de competidores. Fortunately, we are in a good financial situation, with little leverage, so we are confident of weathering the storm.

• Have you had to change your strategy or plans for the future as a result of the economic situation that has arisen with the pandemic?

As I said, the crisis situation has affected us and continues to affect us, but the answer to your question is that we are not going to change our strategy, we are convinced that our strategy is correct, and despite the added difficulties we are ambitious and maintain our plans and objectives.

• Gamelsa develops its activity for several productive sectors, including the shipbuilding sector. What are the medium and long term plans for the peninsular market, and for the international one?

Although the shipbuilding sector was very relevant for us, over the years it lost some of its specific weight and now it is one of our strategic lines of growth, focusing on specialized production in which, due to the difficulty of execution, there are fewer competitors, such as fine boilermaking and work with small thicknesses in aluminum and stainless steel. In shipbuilding sector there are many auxiliary companies that have a lot of area covered in other types of work where we are not going to be competitive. But we are working in these niches that I mentioned before.

• Another challenge we are facing is the renewal of the workforce, why are young people not attracted to the sector?, How can companies seduce young talent?, Do you have this problem/difficulty in GAMELSA?. Why do you think it is?

It is true that we are a company with a very strong manual labor component. We are finding it difficult to find qualified workers both for the generational replacement of the workforce and to support our own growth. Santiago is not the most industrial area of Galicia and it is difficult to find people with the level we require, which is above average. We are talking about very complicated bends, very difficult welds, and in this sense it is not easy to find people with a good domain of the profession.

There are several factors that have an influence, such as training problems, or the model of collaboration and approximation between the academic world and the private business world that does not quite fit, people are not prepared for the real needs; the Dual Vocational Training does not quite start... they talk about the model and it is intended to do as in Germany, but our business fabric has nothing to do with it. There are many companies with 500 workers, but here it is difficult to apply this model with a workforce of 50 workers, trying to absorb 8 workers in dual training does not make much sense, a different model would have to be proposed.

• Protecting the environment is one of the challenges facing the industry. Do you think measures are being taken in this regard, do they negatively affect you? How could it be improved?

We are focused on complying with all the regulations, the requirements are increasing, and as a socially responsible company we are very concerned about this aspect.

By knowing our processes we take steps to be more sustainable, producing less waste, for example. All our plans are aimed at reducing our environmental footprint. In terms of sustainability, we are making progress, and with our strategic plans we are becoming more viable in every sense, that is, we are going beyond mere compliance because it makes us more sustainable and viable. We take measures to reduce our carbon footprint, energy consumption, improvements in the use of raw materials, use of renewable energies and self-consumption, change of machinery for more efficient ones... our objective is to produce more, but consuming less, wasting fewer resources and generating less waste.

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